Acta Zoologica Academiae Scientiarum Hungaricae

VOLUME 46 - NUMBER 1 - 2000

HUNGARIAN NATURAL HISTORY MUSEUM, BUDAPEST

ACTA ZOOLOGICA ACADEMIAE SCIENTIARUM HUNGARICAE

AN INTERNATIONAL JOURNAL OF ANIMAL TAXONOMY AND ECOLOGY

Acta Zoologica Academiae Scientiarum Hungaricae is published quarterly from February 1994 (other issues in May, August and November) by the Hungarian Natural History Museum and the Biological Section of the Hungarian Academy of Sciences with the financial support of the Hungarian Academy of Sciences.

For detailed information (contents, journal status, instructions for authors, subscription, and from Volume 40 onward title, author, authors' addresses, abstract, keywords and a searchable taxon index) please visit our website at

http://actazool.nhmus.hu/

Acta Zoologica Academiae Scientiarum Hungaricae 46 (1), pp. 1–17, 2000

SPATIAL DISTRIBUTION OF CARABIDS ALONG GRASS-FOREST TRANSECTS

MAGURA, T.[1], B. TÓTHMÉRÉSZ[2] and T. MOLNÁR[1]

[1]*Department of Zoology, Kossuth L. University*
POBox 3, H-4010 Debrecen, Hungary
E-mail: magura@tigris.klte.hu
[2]*Ecological Institute, Kossuth L. University*
POBox 71, H-4010 Debrecen, Hungary
E-mail: tothmerb@tigris.klte.hu

Spatial distribution of ground-beetles and associations between carabids and environmental variables were studied in grass-forest transects in the Aggtelek National Park in Hungary. The carabid assemblages of the grass, the forest edge and the forest interior can be separated from each other by principal coordinates analysis, suggesting that all habitats have a characteristic and distinct species composition. The collected carabid species can be divided into five groups by indicator species analysis: (1) habitat generalists, (2) forest generalists, (3) species of the grass, (4) forest edge species, and (5) forest specialists. Distributions of the eighteen most frequent carabids were generally aggregated. There were significant correlations between the carabid abundance and the following abiotic factors: relative cover of the leaf litter, the herbs, the shrubs, and the canopy layer. Biotic factors, like the abundance of the carabids' prey, and the occurrence of other carabids were also correlated significantly with the distribution of particular species at the studied spatial scale. For the eighteen most frequent species we found 7 significant positive and 4 significant negative correlations of the abundance patterns. For two species (*Molops piceus* (PANZER, 1793) and *Pterostichus burmeisteri* HEER, 1841), which are of similar size, spatial pattern and seasonal activity, we found significant negative interaction suggesting interspecific competition between them. The results stress the importance of an integration of biotic and abiotic factors in carabid ecology, and also provide an empirical approach for understanding spatial distribution of carabids.

Key words: forest edge, aggregation indices, indicator species, community organisation

INTRODUCTION

There is a current debate whether the spatial distribution of a species in a community is determined by their autecological characteristics or by community organisation (NIEMELÄ & SPENCE 1994, LÖVEI & SUNDERLAND 1996).

Quantitative knowledge about habitat associations and spatial pattern of carabids in Hungary is relatively poor. Further studies, based on comparisons among habitat types are necessary to demonstrate more precisely the habitat requirements of carabid species. This knowledge is essential to assess the relative importance of environmental factors and species interactions in structuring communities in different habitats. Knowledge of exact habitat requirements is also needed for the purposes of nature conservation and conservation biology, in order to identify potentially rare habitats and species, and to assess their vulnerability and needs of protection (NIEMELÄ & HALME 1992).

Carabid beetles, like most organisms, are generally non-randomly distributed on several spatial scales (LUFF 1986, BÁLDI & ÁDÁM 1991, NIEMELÄ & SPENCE 1994, NIEMELÄ *et al.* 1990). This non-random carabid occurrence is determined by the heterogeneous distribution of abiotic conditions and resources (NIEMELÄ *et al.* 1992*a*). However, there are several scales of environmental heterogeneity, and species responses may be determined by different factors at various levels of environmental pattern (NIEMELÄ *et al.* 1992*b*). For example, on the regional scale the distribution of a particular carabid species may be determined mainly by geographic, climatic and historical factors (HENGEVELD 1987, PENEV & TURIN 1994, PENEV 1996). But on a local scale, that is, in an area which is well within the dispersal radius of the species, variation in distribution across habitat types may be determined by environmental conditions and interspecific interactions (NIEMELÄ *et al.* 1985, 1996, LUFF *et al.* 1992, HALME & NIEMELÄ 1993, EYRE 1994, EYRE & LUFF 1994).

In this paper we present an analysis of ground-beetle distribution on a local scale, in grass-forest transects at the ecological scale of interacting populations (NIEMELÄ & SPENCE 1994). Our objectives were to assess the extent of variation in the distribution of carabid species, and to relate this to habitat characteristics and to spatial distribution of co-occurring carabid species.

MATERIAL AND METHODS

Study area and sampling

Sampling area was located at the Northern Mountains in the Aggtelek National Park, near the Mogyorós Peak (Haragistya). In this region oak-hornbeam forests (*Querco-Carpinetum*) and a grass association (*Polygalo majori-Brachypodietum pinnati*) are the most extensive. There are three habitat types on the research area:

(1) Grass (*Polygalo majori-Brachypodietum pinnati*), with dense herbaceous vegetation dominated by *Polygala major, Brachypodietum pinnatum, Filipendula vulgaris, Salvia pratensis, Inula hirta, Geranium sanguineum.* The litter layer, the shrubs and the canopy layer are missing in this habitat. Its area was approx. 40 ha.

(2) Forest edge, with dense herbaceous vegetation originating from the adjacent grass. The shrub layer is also dense in this habitat, consisting mainly of shrubs and saplings of the canopy trees (*Carpinus betulus*, *Corylus avellana* and *Prunus spinosa*). The litter layer is thick and the canopy layer is less closed than in the forest interior.

(3) Forest interior: oak-hornbeam forest, with thick litter layer, moderate herbaceous and shrub layer and with 85–95 % canopy cover. The size of the forest stand was greater than 100 ha.

Beetles were collected using unbaited pitfall traps, consisting of plastic cups (diameter 100 mm, volume 500 ml) containing ethylene-glycol as a killing-preserving solution (SPENCE & NIEMELÄ 1994). Three replicated parallel transects of pitfall traps were set across the three studied habitats, about 50–70 meters from each other. The transects were perpendicular to the forest edge.

There were 42 traps placed every 1.25 meter along each transect (14 traps per habitat). Altogether there were 3×3×14=126 traps. Trapped individuals were collected monthly (Niemelä *et al.* 1990) from March to November. All carabid beetles taken in pitfall traps were identified to species using standard keys (Freude *et al.* 1976).

To study associations between the distribution of carabids and the environmental variables, we studied five environmental factors. We estimated the percentage cover of the leaf litter layer, the herbs, the shrubs and the canopy layer within a radius of 0.5 meter around each trap. We also studied the abundance of the potential food resources of the carabids (abundance of other animals that fell in the traps). These invertebrates (e.g. Lumbricidae, Mollusca, Isopoda, Chilopoda, Aranea, and Coleoptera larvae) are surface dwellings, therefore they can be regarded as food source for the carabids. It was proved by serological method (Sergeeva 1994) that these invertebrates are prey for carabids.

Data analyses

Principal coordinates analysis (PCoA) using the Bray-Curtis index of similarity was used for carabid abundances to asses similarities in carabid assemblages of the traps (Gauch 1986). We used the NuCoSA package (Tóthmérész 1993).

The IndVal (Indicator Value) approach was applied to find indicator species and species assemblages characterising the grass, the forest edge and the forest interior (Dufrêne & Legendre 1997). Its goal is to find indicator species and/or species assemblages characterising groups of samples. The novelty of this approach lies in the way that this method combines a species' relative abundance to its relative frequency of occurrence in the various groups of samples. Statistical significance of the species indicator values is evaluated using a randomisation procedure. The start of this approach consists of obtaining a classification of sample units using one of the classical methods of data analysis. We obtained a typology from the principal coordinates analysis using Bray-Curtis index of percentage similarity for carabid abundances. Based on this site typology IndVal identifies the indicator species corresponding to the various groups. Indicator species are defined as the most characteristic species of each group, found mostly in a single group of the typology and present in the majority of the sites belonging to that group. This duality, which is of ecological interest, is rarely exploited completely in such analyses; often only the distribution of abundances in the various groups is used. In these cases, species occupying only one or two sites in one habitat group and present only in that group (rare species) receive the same indicator value as species occupying all sites of that habitat group and found only in that group. There is an important difference between these two species. The first one is an asymmetrical indicator, according to the IndVal terminology, which means that its presence cannot be predicted in all sites of one habitat, but contributes to the habitat specificity. The second type of species, on the contrary, is a true symmetrical indicator: its presence contributes to the habitat specificity and one can predict its presence in all sites of the group. With the IndVal it is possible to distinguish the two types of indicator species; the species that have an indicator value greater than 55% are regarded as symmetrical indicator species (Dufrêne & Legendre 1997).

To characterise the spatial distribution of carabids, we calculated the index of dispersion, I_δ, which is defined as the variance-to-mean ratio (Diggle 1983): $I_\delta = s^2/\bar{x}$, where s^2 the variance, and $\bar{x}$ the average number of individuals. An I_δ value close to one indicates a random distribution. $I_\delta > 1$ indicates aggregated, while $I_\delta < 1$ indicates regular distribution. The departure from randomness can be tested by the test statistic $ID = (n-1)s^2/\bar{x}$. It has approximately χ^2 distribution with $(n-1)$ degrees of freedom. This approximation is reasonable provided $n > 6$ and $\bar{x} > 1$.

Multiple regression was used to study whether any of the environmental measurements and of abundance of the other carabids could be used to predict distribution of a particular carabid species. Catches of the common carabid species were compared among fourteen traps in habitats with Kruskal-Wallis nonparametric ANOVA. A Tukey-type multiple comparison was then used to compare catches from the habitat types (Sokal & Rohlf 1981). For the eighteen most frequent species the correlation between the number of trapped individuals and the degree of their aggregation was calculated by the Pearson's product-moment correlation. Before the calculations the number of individuals was transformed by a logarithmic transformation to provide normality. The correlation between the abundance of a species and number of traps from which it was recorded was calculated by the Spearman rank correlation. The analyses were done by the SPSS-PC program.

RESULTS

A total of 40 carabid species (4339 individuals) were recorded in the pitfall traps (Table 1). The ground-beetle catch was dominated by *Abax parallelepipedus* (PILLER et MITTERPACHER, 1783). This species accounted for 35.05 % of the individuals caught.

Table 1. Two-way indicator table showing the species indicator power for the habitats. In the columns for each species the first number indicates the number of specimens, the second the number of traps wherein the species was captured, in this sample group. The IndVal(%) column indicates the species indicator value for the corresponding clustering level. ** indicates a significant (*p*<0.01), while *ns* means a not significant IndVal value.

	IndVal (%)		Grass	Forest edge	Forest interior
GRASS					
Pterostichus melanarius	79.69	**	158/34	3/3	2/2
Synuchus vivalis	70.54	**	79/30	2/2	0/0
Carabus violaceus	67.36	**	134/36	59/27	14/13
Harpalus rufipes	51.54	**	61/22	1/1	1/1
Carabus arcensis	34.29	**	48/18	21/15	3/3
Carabus montivagus	34.01	**	25/16	2/2	4/4
Pterostichus ovoideus	26.19	**	16/11	0/0	0/0
Amara convexior	8.47	**	4/4	1/1	0/0
Amara communis	7.14	**	3/3	0/0	0/0
Calathus fuscipes	7.14	**	3/3	0/0	0/0
Poecilus cupreus	7.14	**	3/3	0/0	0/0
Cicindela campestris	4.76	ns	2/2	0/0	0/0
Platynus dorsalis	2.38	ns	1/1	0/0	0/0
Agonum viridicupreum	2.38	ns	1/1	0/0	0/0
Amara aenea	2.38	ns	1/1	0/0	0/0
Amara apricaria	2.38	ns	1/1	0/0	0/0
Amara familiaris	2.38	ns	1/1	0/0	0/0
Amara lucida	2.38	ns	1/1	0/0	0/0
Anisodactylus signatus	2.38	ns	1/1	0/0	0/0

	IndVal (%)		Grass	Forest edge	Forest interior
Badister meridionalis	2.38	ns	1/1	0/0	0/0
Bembidion lampros	2.38	ns	1/1	0/0	0/0
Harpalus latus	2.38	ns	1/1	0/0	0/0
Harpalus rubripes	2.38	ns	1/1	0/0	0/0
Platyderus rufus	2.38	ns	1/1	0/0	0/0
ALL HABITATS					
Abax parallelepipedus	96.03	ns	143/37	591/42	787/42
Molops piceus	84.13	ns	94/33	126/34	169/39
Carabus convexus	31.75	ns	15/13	17/10	26/17
Carabus nemoralis	27.78	ns	15/12	14/11	19/12
Carabus intricatus	15.87	ns	8/8	9/8	4/4
Panagaeus bipustulatus	4.76	ns	3/3	3/3	0/0
FOREST EDGE					
Carabus coriaceus	28.57	**	4/4	28/18	10/8
Amara ovata	4.76	ns	0/0	2/2	0/0
Pterostichus niger	2.38	ns	0/0	1/1	0/0
FOREST EDGE AND FOREST INTERIOR					
Pterostichus oblongopunctatus	91.67	**	0/0	178/35	620/42
Pterostichus burmeisteri	86.48	**	3/3	74/33	248/41
Carabus hortensis	59.88	**	5/5	101/34	35/20
FOREST INTERIOR					
Aptinus bombarda	69.71	**	1/1	3/3	68/31
Abax ovalis	68.77	**	10/7	26/16	170/35
Abax parallelus	25.56	**	11/8	3/3	24/17
Abax carinatus	8.57	ns	2/2	2/2	6/6

There was a strong, positive correlation between the abundance of a species and the number of traps from which it was recorded (Spearman r_S=0.9923, p<0.0001, n=40). The collected 40 species can be partitioned into four distinct groups according to their frequency of occurrence among the 126 traps. Two species (*Abax parallelepipedus* (PILLER et MITTERPACHER, 1783) and *Molops piceus* (PANZER, 1793)), which were found in more than 100 traps and represented by a mean of more than 3 individuals per trap, were designated as habitat generalists and eudominant species. Five other species (*Pterostichus oblongopunctatus* (FABRICIUS, 1787), *Pterostichus burmeisteri* HEER, 1841, *Carabus violaceus* LINNAEUS, 1758, *Abax ovalis* (DUFTSCHMID, 1812) and *Carabus hortensis* LINNAEUS, 1758) that were captured in more than 55 traps with more than 1 individuals per trap, can be referred to as dominant species. Eleven other species, which were found in 20–40 traps and were represented by a mean catch of more than 0.15 individuals per trap, can be designated as subdominant species. The other 22 species that were captured in less than 20 traps with less than 0.15 individuals per trap, are rare species.

The result of the ordination (PCoA) shows that there was an arch effect suggesting a gradient in the data (GAUCH 1986), namely, the carabid assemblages change gradually from the grass towards the forest interior along the transects (Fig. 1). Carabid samples of traps from the grass, the forest edge, and the forest interior were separated from each other. The composition of the carabid samples of the forest edge was more similar to the forest interior than to the grass. It is also evident, that there is a gradient in the species composition, because the traps are arranged along an arch.

The collected carabid species can be divided into five groups by characterising the habitats by indicator species (IndVal approach; Table 1):

(1) habitat generalists that occurred numerously in all habitat types (e.g. *Abax parallelepipedus* (PILLER et MITTERPACHER, 1783), *Molops piceus* (PANZER, 1793), *Carabus convexus* FABRICIUS, 1775, *Carabus nemoralis* O. F. MÜLLER, 1764 and *Carabus intricatus* LINNAEUS, 1761);

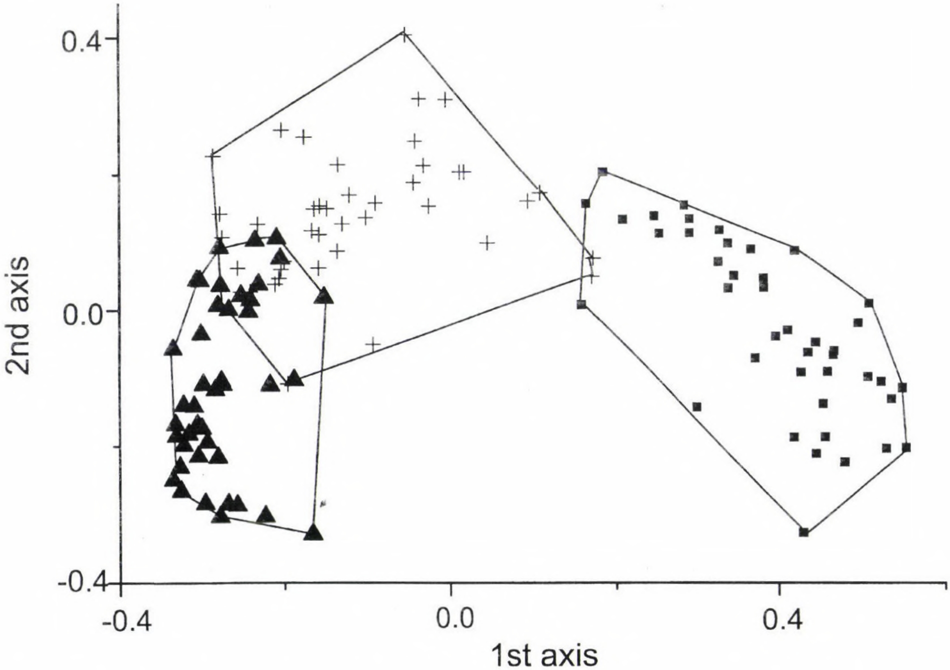


Fig. 1. Ordination of pitfall catches by principal coordinates analysis using the Bray-Curtis index of dissimilarity. ■: grass, +: forest edge, ▲: forest interior

(2) forest generalists that were recorded exclusively in the forest habitats or were the most abundant in the forest habitats (forest edge and forest interior) (e.g. *Pterostichus oblongopunctatus* (FABRICIUS, 1787), *Pterostichus burmeisteri* HEER, 1841 and *Carabus hortensis* LINNAEUS, 1758);

(3) species of open habitat that were captured exclusively in the grass or were the most abundant in the grass (e.g. *Pterostichus melanarius* (ILLIGER, 1798), *Synuchus vivalis* (PANZER, 1797), *Carabus violaceus* LINNAEUS, 1758, *Harpalus rufipes* (DE GEER, 1774), *Carabus arcensis* HERBST, 1784, *Carabus montivagus* PALLIARDI, 1825 and *Pterostichus ovoideus* (STURM, 1824));

(4) forest edge species that occurred exclusively or were the most abundant in the forest edge (e.g. *Carabus coriaceus* LINNAEUS, 1758, *Amara ovata* (FABRICIUS, 1792) and *Pterostichus niger* (SCHALLER, 1783)); and

(5) forest specialists that were recorded exclusively or numerously in the forest interior (e.g. *Aptinus bombarda* (ILLIGER, 1800), *Abax ovalis* (DUFT-

Table 2. The index of dispersion to characterise the spatial distribution of frequent carabid species in the habitats. A value close to one indicates a random distribution. A significantly greater value than one indicates aggregated spatial distribution, while a value smaller than one indicates a regular dispersion. The "-" sign shows that the statistical test is not applicable. *, ** and *** indicate significant ($p<0.05$, $p<0.01$ and $p<0.001$, respectively), while *ns* not significant departure from the randomness.

	Grass	Forest edge	Forest interior
Carabus arcensis	3.2683 ***	–	–
Carabus convexus	–	–	–
Carabus coriaceus	–	–	–
Carabus hortensis	–	1.8674 ***	–
Carabus intricatus	–	–	–
Carabus montivagus	–	–	–
Carabus nemoralis	–	–	–
Carabus violaceus	4.1624 ***	1.7383 **	–
Harpalus rufipes	2.7609 ***	–	–
Pterostichus burmeisteri	–	1.4067 *	2.0390 ***
Pterostichus melanarius	2.9799 ***	–	–
Pterostichus oblongopunctatus	–	2.7717 ***	6.9289 ***
Molops piceus	1.2600 ns	1.5285 *	1.7031 **
Abax parallelepipedus	2.7517 ***	4.4699 ***	3.7124 ***
Abax parallelus	–	–	–
Abax ovalis	–	–	2.8798 ***
Synuchus vivalis	2.6505 ***	–	–
Aptinus bombarda	–	–	1.6858 **

SCHMID, 1812), *Abax parallelus* (DUFTSCHMID, 1812) and *Abax carinatus* (DUFTSCHMID, 1812)).

The dominant and subdominant species generally showed aggregated distribution (Table 2). There was significant positive correlation between the number of individuals and the degree of aggregation for a species (r=0.6375, p=0.0033, n=19) indicating that more abundant species were more aggregated.

Sometimes, variation in carabid catches among the fourteen traps in the same habitat was greater than the variation among habitats (Table 3) indicating the importance of strong microhabitat variations controlling carabid distribution. Differences among the habitats in the number caught individuals, on the other hand, were significant for all the dominant and subdominant species, except *Carabus convexus* FABRICIUS, 1775, *Carabus nemoralis* O. F. MÜLLER, 1764 and *Carabus intricatus* LINNAEUS, 1761. This result suggests the clear habitat preference of carabid species.

Multiple regression analyses between the distribution of carabids and the environmental variables and occurrence of other carabids were significant (p<0.05) for all the dominant and subdominant species, except *Carabus intricatus* LINNAEUS, 1761 and *Carabus nemoralis* O. F. MÜLLER, 1764, while the multiple regression was marginally significant for *Abax parallelus* (DUFTSCHMID, 1812) (Table 4). Relative cover of the leaf litter was a significant negative predictor for two carabid species (*Abax parallelepipedus* (PILLER et MITTERPACHER, 1783) and *Aptinus bombarda* (ILLIGER, 1800). Cover of the herbs was a significant positive predictor for *Carabus coriaceus* LINNAEUS, 1758. Relation-

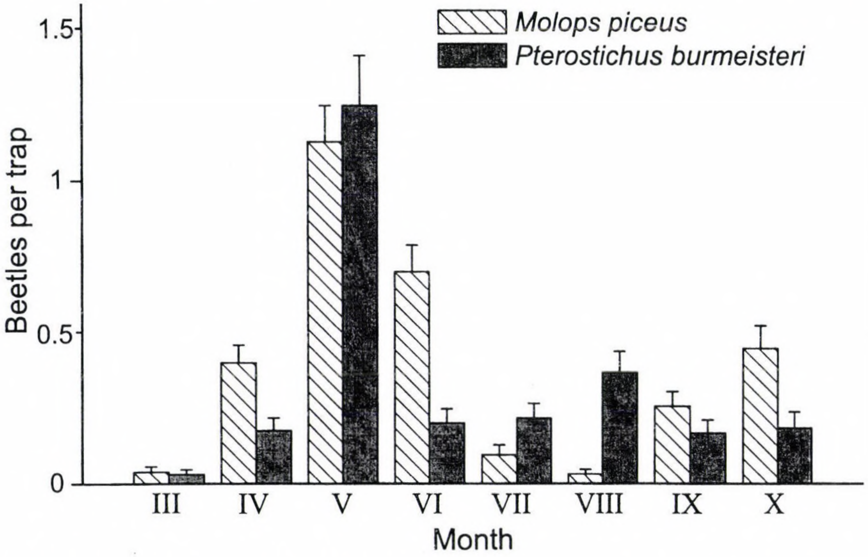


Fig. 2. Seasonal dynamics of the average number of individuals per trap of *Molops piceus* and *Pterostichus burmeisteri* based on 126 traps

ship between the cover of shrubs and the carabids' catch was significant for two species (*Abax parallelepipedus* (PILLER et MITTERPACHER, 1783) and *Molops piceus* (PANZER, 1793)). Canopy cover was a significant positive predictor for *Abax parallelepipedus* (PILLER et MITTERPACHER, 1783). Abundance of carabids' preys was a significant positive predictor for three carabids (*Carabus*

Table 3. The value of Kruskal-Wallis non-parametric ANOVA (*H*) and its statistical significance (*ns*: not significant. *: $p<0.05$. **: $p<0.01$ and ***: $p<0.001$) for the variation among the habitat types and for the variation among transects within habitat types. The result of Tukey-type multiple comparison among habitat types is given by indicating significant or not significant (=) differences; the significance level is $p<0.05$. Legends: F – forest interior, E – forest edge and G – grass.

Species	Variation among habitat types	Result of a Tukey-type comparison among habitat types	Variation among transects within the grass	Variation among transects within the forest edge	Variation among transects within the forest interior
ALL HABITATS (habitat generalists)					
Abax parallelepipedus	72.11 ***	F>E>G	9.72 **	8.99 *	13.58 **
Molops piceus	11.18 **	F=E, E=G, F>G	0.92 ns	3.51 ns	7.15 *
Carabus convexus	3.01 ns	F=E=G	3.23 ns	1.64 ns	9.68 **
Carabus nemoralis	0.15 ns	F=E=G	4.98 *	0.20 ns	4.97 *
Carabus intricatus	1.93 ns	F=E=G	1.21 ns	2.07 ns	2.15 ns
GRASS SPECIES					
Pterostichus melanarius	78.15 ***	F=E<G	1.19 ns	2.10 ns	4.10 ns
Synuchus vivalis	70.43 ***	F=E<G	15.39 ***	1.03 ns	–
Carabus violaceus	42.48 ***	F=E<G	3.40 ns	7.69 *	0.36 ns
Harpalus rufipes	45.85 ***	F=E<G	21.69 ***	2.00 ns	2.00 ns
Carabus arcensis	15.93 ***	F=E<G	18.54 ***	1.84 ns	2.10 ns
Carabus montivagus	19.85 ***	F=E<G	10.05 **	1.03 ns	8.63 *
EDGE SPECIES					
Carabus coriaceus	13.99 ***	F=G<E	2.16 ns	2.65 ns	8.04 *
FOREST INTERIOR AND EDGE SPECIES (forest generalists)					
Pterostichus oblongopunctatus	93.44 ***	F>E>G	–	0.08 ns	24.78 ***
Pterostichus burmeisteri	87.50 ***	F>E>G	2.10 ns	0.29 ns	11.34 **
Carabus hortensis	47.36 ***	F=G<E	3.10 ns	4.14 ns	3.90 ns
FOREST INTERIOR SPECIES (forest specialists)					
Aptinus bombarda	67.70 ***	F>E=G	2.00 ns	2.10 ns	7.07 *
Abax ovalis	54.05 ***	F>E=G	6.61 *	1.26 ns	15.52 ***
Abax parallelus	14.21 ***	F>E, E=G, F=G	4.33 ns	2.10 ns	0.08 ns

Table 4. Environmental variables and other carabids contributing significantly (negatively or positively) as predictors for all the dominant and subdominant species by multiple regression analysis. Carabid species abbreviations: C arce=*Carabus arcensis*, C conv=*Carabus convexus*, C cori=*Carabus coriaceus*, C mont=*Carabus montivagus*, C nemo=*Carabus nemoralis*, H rufi=*Harpalus rufipes*, Pt bur=*Pterostichus burmeisteri*, Pt mel=*Pterostichus melanarius*, Pt obl=*Pterostichus oblongopunctatus*, Mo pic=*Molops piceus*, A ater=*Abax parallelepipedus*, A para=*Abax parallelus*, A oval=*Abax ovalis*, Sy viv=*Synuchus vivalis*, Ap bom=*Aptinus bombarda*.

	C arce	C conv	C cori	C mont	C nemo	H rufi	Pt bur	Pt mel	Pt obl	Mo pic	A ater	A para	A oval	Sy viv	Ap bom
R^2	0.3059	0.3543	0.3430	0.3286	0.2018	0.5840	0.7278	0.5807	0.7171	0.3691	0.6223	0.2467	0.5768	0.4930	0.4781
F	2.0633	2.5687	2.4446	2.2918	1.1837	6.5736	12.515	6.4839	11.869	2.7395	7.7140	1.5331	6.3814	4.5530	4.2890
$p<$	0.010	0.001	0.010	0.010	ns	0.001	0.001	0.001	0.001	0.001	0.001	ns	0.001	0.001	0.001
cover of litter											–				–
cover of herbs			+												
cover of shrubs										+	+				
canopy cover											+				
carabids' prey		+				+								+	
C arce						–								–	
C conv			+												
C cori		+													
C mont						–									
C nemo										+					
H rufi	–			–											
Pt bur									+	–					
Pt mel														+	
Pt obl							+			+			+		
Mo pic					+		–		+						
A para													+		
A oval									+			+			
Sy viv	–							+							

convexus FABRICIUS, 1775, *Harpalus rufipes* (DE GEER, 1774) and *Synuchus vivalis* (PANZER, 1797)). There were eleven significant relationships between the distribution of particular carabid species and the occurrence of other carabids. The majority of these relationships were positive. A notable exception was the pair *Molops piceus* (PANZER, 1793) (body length 11–15 mm) and *Pterostichus burmeisteri* HEER, 1841 (12–14.5 mm), which have nearly identical body sizes and seasonal activity (Fig. 2), and showed negative association in abundance. In the case of three species (*Carabus hortensis* LINNAEUS, 1758, *Carabus intricatus* LINNAEUS, 1761, *Carabus violaceus* LINNAEUS, 1758) we have found no significant correlations between their distribution and the environmental variables and occurrence of other carabids.

DISCUSSION

In our study the aggregated distribution pattern was typical for the carabids; there were 19 cases where the statistical test was applicable and 18 distribution patterns out of 19 were significantly aggregated (Table 2). Non-random spatial distributions were commonly reported for carabids (LUFF 1986, NIEMELÄ 1988*a*, NIEMELÄ *et al.* 1992*ab*). The analyses of indicator species and the variation in carabid catches among traps and habitats (Tables 1 and 3) also show that the collected carabid species have a clear habitat and microsites preferences with specific environmental conditions. The causes of the variation in catches among traps and habitats are unclear (LUFF 1986, NIEMELÄ *et al.* 1986). One difficulty is that descriptions of the environment are rarely accurate enough to support inferences about determinants of spatial distribution (NIEMELÄ & SPENCE 1994). In the literature, four not mutually exclusive factors are mentioned that might explain the spatial distribution of carabid beetles (NIEMELÄ 1988*a*, NIEMELÄ *et al.* 1985, 1988, 1996): (1) differences in environmental conditions (e.g. habitat heterogeneity, food resources, microclimate), (2) autecological characteristics of the species, (3) small-scale dispersal, and (4) interspecific interactions.

Our analyses showed that a significant proportion of the variation in catch was associated with a particular kind of environmental heterogeneity reflected by the cover of leaf litter, herbs, shrubs, canopy layer and by the distribution of carabids' preys (Table 4). This may be a fairly general pattern among carabids because clear preferences for microsites defined by ground vegetation and litter have also been detected elsewhere (THIELE 1977, NIEMELÄ 1990, NIEMELÄ *et al.* 1992*a*). Multiple regression analyses showed that canopy layer was a significant positive predictor for *Abax parallelepipedus* (PILLER et MITTERPACHER, 1783). *Abax parallelepipedus* (PILLER et MITTERPACHER, 1783) is a habitat generalist (Table 1), but significantly more individuals were captured in the forest interior than in the other habitats (Table 3), suggesting the importance of microsites preference within the movement area. The significant negative association between leaf litter and *Abax parallelepipedus* (PILLER et MITTERPACHER, 1783) and *Aptinus bombarda* (ILLIGER, 1800) is surprising. LOREAU (1987) reported that *Abax parallelepipedus* (PILLER et MITTERPACHER, 1783) is active mainly on the surface of the litter. Perhaps this species can move easier in a habitat with limited litter layer. The same may be supposed for *Aptinus bombarda* (ILLIGER, 1800). Since many carabid species are generalist predators, scavangers or omnivorous, the amount of available prey may influence location of foraging (HENGEVELD 1985, NIEMELÄ *et al.* 1986, LOREAU 1987) and carabids may aggregate in habitats with a high amount of prey (BRYAN & WRATTEN 1984). This may explain the positive relationships between the abundance of carabids' preys and the four carabid species (Table 4). Behavioural responses (e.g. mating behaviour, involving sexual pheromones) may also lead to aggregations in pitfall traps (LUFF 1986).

Similarly to NIEMELÄ and SPENCE (1994) we also found significant positive correlation between the number of individuals and the degree of aggregation for the eighteen studied species. This may be interpreted as more abundant species are more aggregated. It may also be regarded as a simple statistical rule. Indeed, it is evident that both the mean and the variance are dependent on density, even when the pattern is not random. BARTLETT (1936) suggested that the relative variance was likely to be a linear function of the mean. Zoologists frequently attribute a similar statement to IWAO (1968) for the relationship of Morisita index and the mean. The Morisita index is closely related to the index of dispersion. TAYLOR *et al.* (1978) studied the pattern and density relationship for a huge variety of different species, and they concluded that the multiplicative law, suggested by TAYLOR (1961) provides a better fit between variance and mean. This relationship is usually mentioned as Taylor's power law (SOUTHWOOD 1978). The observed relationship during our study is clearly a variant of the Taylor's power law. We used non-parametric rank correlation, therefore the result does not depend on the exact shape of the curve, just on the monotony of the relationship.

On the studied spatial scale the different habitats (grass, forest edge, forest interior) are not independent of each other and there appears to be movement between the adjacent habitats (NIEMELÄ 1988*b*, NIEMELÄ and HALME 1992). Although the majority of the species showed clear differences in abundance between the habitat types, most species were also found outside their optimal environment (Table 1). Small-scale dispersal between habitat patches may be caused by density-dependent processes (GRÜM 1971), and also by movement between reproduction habitat and hibernation habitat (WALLIN 1986, ANDERSEN 1997).

At the studied spatial scale, the occurrence of other carabids was a significant predictor of the abundance of a particular dominant and subdominant species (Table 4). Most of the correlations were positive, suggesting similar response to habitat properties. Previous works (NIEMELÄ *et al.* 1992*b*, NIEMELÄ & SPENCE 1994) also reported some negative relationships. These relationships were usually between species of clearly different body sizes or seasonal activities, or both, and are probably better attributed to different microhabitat preferences than to effects of interspecific interactions. In our study there was a negative relationship between the spatial distribution of the small *Synuchus vivalis* (PANZER, 1797) and the much larger *Carabus arcensis* HERBST, 1784 which also showed maximum activities at different times of the season. For similar reasons interspecific competition is not a likely explanation for the other pairs of species showing a significant negative relationship: *Carabus arcensis* HERBST, 1784 and *Harpalus rufipes* (DE GEER, 1774); *Carabus montivagus* PALLIARDI, 1825 and *Harpalus rufipes* (DE GEER, 1774)

Interspecific competition may be suspected to contribute to the negative relationship between *Molops piceus* (PANZER, 1793) and *Pterostichus burmeisteri* HEER, 1841 (Table 4) which are of similar size and showed similar habitat preference (Table 1) and similar patterns of seasonal activity (Fig. 2). Other data sets (MAGURA & MOLNÁR 1997, MAGURA & TÓTHMÉRÉSZ 1997, MAGURA *et al.* 1997, 1998*a*, *b*) suggest that negative interactions are not a general feature of these two species. NIEMELÄ (1988*a*) and NIEMELÄ and SPENCE (1994) also reported two carabid species with similar size and seasonal activity which showed negative interaction in a forest habitat, while these species in other forest associations showed a high overlap in spatial distribution and in seasonal activity (NIEMELÄ *et al.* 1992*b*, NIEMELÄ & HALME 1992) or there were no correlation between the occurrence of the two species (NIEMELÄ *et al.* 1993). These facts suggest that the type of relationships between the occurrence of carabids may not be a general feature. The interactions can vary among habitat types with different environmental attributes. Further manipulative and non-manipulative studies are necessary to prove the presence of competition between *Molops piceus* (PANZER, 1793) and *Pterostichus burmeisteri* HEER, 1841 because distributional data (spatially non-overlapping distribution) are just the first step to evaluate the mechanism of interspecific competition.

Overall, our results suggest that carabids are useful as an indicator group to asses the environmental variation, as they show different habitat choices. Our study implies that distribution of carabids is determined not only by abiotic environmental factors, like soil types and soil properties (LUFF *et al.* 1989, 1992, NIEMELÄ *et al.* 1992*b*, BAGUETTE 1993, EYRE & LUFF 1994, ŠUSTEK 1994), microclimatic conditions (NIEMELÄ *et al.* 1986, MÜLLER-MOTZFELD 1989, SPENCE *et al.* 1996), heterogeneity of vegetation (NIEMELÄ 1990, BLAKE *et al.*

1996), cover of decaying woods and leaf litter (NIEMELÄ *et al.* 1992*a*, EYRE & LUFF 1994) but also by biotic factors, like distribution of other ground-dwelling animals (e.g. ants; NIEMELÄ *et al.* 1992*a*), abundance of carabids' preys (NIEMELÄ *et al.* 1986, HALME & NIEMELÄ 1993, GUILLEMAIN *et al.* 1997), intraspecific competition (MÜLLER 1986, LOREAU 1990) and interspecific competition (LENSKI 1982, 1984, LOREAU 1989). THIELE (1977) and DEN BOER (1980, 1985) emphasize the priority of abiotic factors in the determination of carabid distribution and in the organisation. Our result stresses that a synthesis is needed, which integrates competition with other abiotic and biotic ecological factors. This synthesis would help a lot in understanding community organisation of carabids, but in this respect, we are still at the beginning (NIEMELÄ 1993).

*

Acknowledgements – The research was supported by Hungarian Scientific Research Fund (OTKA, grant nos T25888 and T32130).

REFERENCES

ANDERSEN, A. (1997) Densities of overwintering carabids and staphylinids (Col., Carabidae and Staphylinidae) in cereal and grass fields and their boundaries. *J. Appl. Entomol.* **121**: 77–80.

BAGUETTE, M. (1993) Habitat selection of carabid beetles in deciduous woodlands of southern Belgium. *Pedobiol.* **37**: 365–378.

BÁLDI, A. & ÁDÁM, L. (1991) Habitat selection of ground-dwelling beetles during dolomitic succession. *Annls hist.-nat. Mus. natn. hung.* **83**: 245–251.

BARTLETT, M. S. (1936) Some notes on insecticide tests in the laboratory and in the field. *Suppl., J. Roy. Stat. Soc.* **3**: 185–194.

BLAKE, S., FOSTER, G. N., FISHER, G. E. J. & LIGERTWOOD, G. L. (1996) Effects of management practices on the carabid faunas of newly established wildflower meadows in southern Scotland. *Ann. Zool. Fennici* **33**: 139–147.

BRYAN, K. M. & WRATTEN, S. D. (1984) The responses of polyphagous predators to spatial heterogeneity: aggregation by carabid and staphylinid beetles to their cereal aphid prey. *Ecol. Entomol.* **9:** 251–259.

DEN BOER, P. J. (1980) On the survival of populations in a heterogeneous and variable environment. *Oecologia* **50**: 39–53.

DEN BOER, P. J. (1985) Fluctuations of density and survival of carabid populations. *Oecologia* **67**: 322–330.

DIGGLE, P. J. (1983): *Statistical Analysis of Spatial Point Patterns.* Academic Press, London, 148 pp.

DUFRÊNE, M. & LEGENDRE, P. (1997) Species assemblages and indicator species: the need for a flexible asymmetrical approach. *Ecological Monographs* **67**: 345–366.

EYRE, M. D. (1994) Strategic explanations of carabid species distributions in northern England. Pp. 267–275. *In* DESENDER, K. *et al.* (eds): *Carabid Beetles: Ecology and Evolution.* Kluwer Academic Publishers, Dordrecht.

EYRE, M. D. & LUFF, M. L. (1994) Carabid species assemblages of North-East England woodlands. Pp. 277–281. *In* DESENDER, K. *et al.* (eds): *Carabid Beetles: Ecology and Evolution*. Kluwer Academic Publishers, Dordrecht.

FREUDE, H., HARDE, K. W. & LOHSE, G. A. (1976) *Die Käfer Mitteleuropas*. Goecke and Evers, Krefeld, 302 pp.

GAUCH, H. G. (1986) *Multivariate analysis in community ecology*. Cambridge Univ. Press, Cambridge, 298 pp.

GRÜM, L. (1971) Spatial differentiation of the Carabus L. (Carabidae, Coleoptera) mobility. *Ekologia Polska* **19**: 1–34.

GUILLEMAIN, M., LOREAU, M. & DAUFRESNE, T. (1997) Relationships between the regional distribution of carabid beetles (Coleoptera: Carabidae) and the abundance of their potential prey. *Acta Oecologica* **18**: 465–483.

HALME, E. & NIEMELÄ, J. (1993) Carabid beetles in fragments of coniferous forest. *Ann. Zool. Fennici* **30**: 17–30.

HENGEVELD, R. (1985) Dynamics of Dutch beetle species during the twentieth century (Col. Carabidae). *J. Biogeogr.* **12**: 389–411.

HENGEVELD, R. (1987) Scales of variation: their distinction and ecological importance. *Ann. Zool. Fennici* **24**: 195–202.

IWAO, S. (1968) A new regression method for analysing the aggregation pattern in animal populations. *Res. Popul. Ecol.* **10**: 1–20.

LENSKI, R. E. (1982) Effects of forest cutting on two Carabus species; evidence for competition for food. *Ecology* **63**: 1211–1217.

LENSKI, R. E. (1984) Food limitation and competition: a field experiment with two Carabus species. *J. Anim. Ecol.* **53**: 203–216.

LOREAU, M. (1987) Vertical distribution of activity of carabid beetles in a beach forest floor. *Pedobiol.* **30**: 173–178.

LOREAU, M. (1989) On testing temporal niche differentiation in carabid beetles. *Oecologia* **81**: 89–96.

LOREAU, M. (1990) Competition in a carabid beetle community: a field experiment. *Oikos* **58**: 25–38.

LÖVEI, G. & SUNDERLAND, K. D. (1996) Ecology and behavior of ground beetles (Coleoptera: Carabidae). *Ann. Rev. Entomol.* **41**: 231–256.

LUFF, M. L. (1986) Aggregation of some Carabidae in pitfall traps. Pp. 385–397. *In* DEN BOER, P. J. *et al.* (eds): *Carabid Beetles, their Adaptations and Dynamics*. Gustav Fischer, Stuttgart, New York.

LUFF, M. L., EYRE, M. D. & RUSHTON, S. P. (1989) Classification and ordination of habitats of ground beetles (Coleoptera, Carabidae) in north-east England. *J. Biogeogr.* **16**: 121–130.

LUFF, M. L., EYRE, M. D. & RUSHTON, S. P. (1992) Classification and prediction of grassland habitats using ground beetles (Coleoptera, Carabidae). *J. Environ. Management* **35**: 301–315.

MAGURA, T. & MOLNÁR, T. (1997) Comparison of the carabid fauna of the Ménes-valley and a higher karst plateau (Coleoptera: Carabidae). Pp. 117–122. *In* TÓTH, E. & HORVÁTH, R. (eds): *Research in Aggtelek National Park and Biosphere Reserve*. Aggtelek National Park Directorate, Jósvafő.

MAGURA, T. & TÓTHMÉRÉSZ, B. (1997) Testing edge effect on carabid assemblages in an oak-hornbeam forest. *Acta zool. hung.* **43**: 303–312.

MAGURA, T., TÓTHMÉRÉSZ, B. & BORDÁN, ZS. (1997) Comparison of the carabid communities of a zonal oak-hornbeam forest and pine plantations. *Acta zool. hung.* **43**: 173–182.

MAGURA, T., TÓTHMÉRÉSZ, B. & BORDÁN, ZS. (1998*a*) Edge effect on carabid assemblages in a deciduous forest. P. 715. *In* BRUNNHOFER, V. & SOLDÁN, T. (eds): *Book of Abstracts, 6th European Congr. Entomology*. Ceské Budejovice, 1998. August 23–29.

MAGURA, T., TÓTHMÉRÉSZ, B. & BORDÁN, ZS. (1998*b*) Effects of non-native spruce plantation and nature management practice on Carabidae (Coleoptera). P. 716. *In* BRUNNHOFER, V. & SOLDÁN, T. (eds): *Book of Abstracts, 6th European Congr. Entomology*. Ceské Budejovice, 1998. August 23–29.

MÜLLER, J. K. (1986) Anpassungen zur intraspezifischen Konkurrenzverminderung bei Carabiden (Coleoptera). *Zool. Jb. Syst.* **113**: 343–352.

MÜLLER-MOTZFELD, G. (1989) Laufkäfer (Coleoptera: Carabidae) als pedobiologische Indikatoren. *Pedobiol.* **33**: 145–153.

NIEMELÄ, J. (1988*a*) Carabid beetles in shore habitats on the Åland Islands, SW Finland: the effect of habitat availability and species characteristics. *Acta Oecol./Oecol. Gener.* **9**: 379–395.

NIEMELÄ, J. (1988*b*) Habitat occupancy of carabid beetles on small islands and the adjacent Åland mainland, SW Finland. *Ann. Zool. Fennici* **25**: 121–131.

NIEMELÄ, J. (1990) Effect of changes in the habitat on carabid assemblages in a wooded meadow on the Åland Islands. *Notulae Entomol.* **69**: 169–174.

NIEMELÄ, J. (1993) Interspecific competition in ground-beetle assemblages (Carabidae): what have we learned? *Oikos* **66**: 325–335.

NIEMELÄ, J. & HALME, E. (1992) Habitat associations of carabid beetles in fields and forests on the Åland Islands, SW Finland. *Ecography* **15**: 3–11.

NIEMELÄ, J. & SPENCE, J. R. (1994) Distribution of forest dwelling carabids (Coleoptera): spatial scale and the concept of communities. *Ecography* **17**: 166–175.

NIEMELÄ, J., HAILA, Y., HALME, E., LAHTI, T., PAJUNEN, T. & PUNTTILA, P. (1988) The distribution of carabid beetles in fragments of old coniferous taiga and adjacent managed forest. *Ann. Zool. Fennici* **25**: 107–119.

NIEMELÄ, J., HAILA, Y., HALME, E., PAJUNEN, T. & PUNTTILA, P. (1990) Diversity variation in carabid beetle assemblages in the southern Finnish taiga. *Pedobiol.* **34**: 1–10.

NIEMELÄ, J., HAILA, Y., HALME, E., PAJUNEN, T. & PUNTTILA, P. (1992) Small-scale heterogeneity in the spatial distribution of carabid beetles in the southern Finnish taiga. *J. Biogeogr.* **19**: 173–181.

NIEMELÄ, J., HAILA, Y. & PUNTTILA, P. (1996) The importance of small-scale heterogeneity in boreal forests: variation in diversity in forest-floor invertebrates across the succession gradient. *Ecography* **19**: 352–368.

NIEMELÄ, J., HAILA, Y. & RANTA, E. (1986) Spatial heterogeneity of carabid beetle dispersion in uniform forests on the Åland Islands, SW Finland. *Ann. Zool. Fennici* **23**: 289–296.

NIEMELÄ, J., HALME, E. & HAILA, Y. (1990) Balancing sampling effort in pitfall trapping of carabid beetles. *Entomol. Fennica* **1**: 233–238.

NIEMELÄ, J., LANGOR, D. & SPENCE, J. R. (1993) Effects of clear-cut harvesting on boreal ground-beetle assemblages (Coleoptera: Carabidae) in western Canada. *Conserv. Biol.* **7**: 551–561.

NIEMELÄ, J., RANTA, E. & HAILA, Y. (1985) Carabid beetles in lush forest patches on the Øland Islands, south-west Finland: an island-mainland comparison. *J. Biogeogr.* **12**: 109–120.

NIEMELÄ, J., SPENCE, J. R. & SPENCE, D. H. (1992) Habitat associations and seasonal activity of ground-beetles (Coleoptera, Carabidae) in central Alberta. *Can. Ent.* **124**: 521–540.

PENEV, L. (1996) Large-scale variation in carabid assemblages, with special reference to the local fauna concept. *Ann. Zool. Fennici* **33**: 49–63.

PENEV, L. & TURIN, H. (1994) Patterns of distribution of the genus Carabus L. in Europe: approaches and preliminary results. Pp. 37–44. *In* DESENDER, K. *et al.* (eds): *Carabid Beetles: Ecology and Evolution*. Kluwer Academic Publishers, Dordrecht.

SERGEEVA, T. K. (1994) Seasonal dynamics of interspecific trophic relations in a carabid beetle assemblage. Pp. 367–370. *In* DESENDER, K. *et al.* (eds): *Carabid Beetles: Ecology and Evolution*. Kluwer Academic Publishers, Dordrecht.

SOKAL, R. R. & ROHLF, F. J. (1981) *Biometry*. W. H. Freeman, New York, 310 pp.

SOUTHWOOD, T. R. E. (1978) *Ecological Methods*, 2nd ed., Chapman and Hall, London, 524 pp.

SPENCE, J. R. & NIEMELÄ, J. (1994) Sampling carabid assemblages with pitfall traps: the madness and the method. *Can. Ent.* **126**: 881–894.

SPENCE, J. R., LANGOR, D. W., NIEMELÄ, J., CÁRCAMO, H. A. & CURRIE, C. R. (1996) Northern forestry and carabids: the case for concern about old-growth species. *Ann. Zool. Fennici* **33**: 173–184.

ŠUSTEK, Z. (1994) Windbreaks as migration corridors for carabids in an agricultural landscape. Pp. 377–382. *In* DESENDER, K. *et al.* (eds): *Carabid Beetles: Ecology and Evolution*. Kluwer Academic Publishers, Dordrecht.

TAYLOR, L. R. (1961) Aggregation, variance and the mean. *Nature* **189**: 732–735.

TAYLOR, L. R. WOIWOD, I. P. & PERRY, J. N. (1978) The density-dependence of spatial behaviour and the rarity of randomness. *J. Anim. Ecol.* **47**: 383–406.

THIELE, H. U. (1977) *Carabid Beetles in Their Environments*. Springer-Verlag, Berlin, Heidelberg, New York, 369 pp.

TÓTHMÉRÉSZ, B. (1993) NuCoSA 1.0: Number Cruncher for Community Studies and other Ecological Applications. *Abstracta Botanica* **17**: 283–287.

WALLIN, H. (1986) Habitat choice of some field-inhabiting beetles (Coleoptera: Carabidae) studied by recapture of marked individuals. *Ecol. Entomol.* **11**: 457–466.

Revised version received 21st February, 2000, accepted 5th June, 2000, published 7th July, 2000

Contributions to a MANUAL OF PALAEARCTIC DIPTERA

edited by L. PAPP and B. DARVAS

Volume 2

Nematocera and Lower Brachycera

In the bulky volumes of the "*Contributions to a Manual of Palaearctic Diptera*" morphological, physiological, genetical, ecological and economic up-to-date knowledge of dipterous species (midges and flies), which have significant importance in genetics as model organisms, in plant cultivation as pests or beneficial parasitoids, in animal husbandry and human health as vectors of serious illnesses and which are important for ecosystem function, are treated. Morphological keys (with excellent figures) for adults and larvae, which help readers with identification of dipterous pests and parasitoids are provided, while readers in field of applied dipterology will find suitable environmentally friendly methods against pests or biological control methods, among others. Time table of series: 1997 – Volume 2, 1998 Volume 3 (Higher Brachycera), 1999 – Volume 1 (General and Applied Dipterology) and Appendix Volume.

The 2nd volume contains 38 dipterous family chapters by 23 specialists from 12 countries. with 1895 figures on 258 plates.

November 30, 1997, 592 pages
ISBN 963 04 8836 1 (Series)
ISBN 963 04 8837 x (Volume 2)
Foundation for the Publicity of the Hungarian Science
Publisher: Science Herald, Budapest

Order should be sent to
E. w. Classey Ltd.
Natural History Publisher & Bookseller
Oxford House, 6 Marlborough Street, Faringdon
Oxon SN7 7JP, UK
Facsimile: (44)-1367 244800
E-mail: bugbooks@classey.demon.co.uk

Acta Zoologica Academiae Scientiarum Hungaricae 46 (1), pp. 19–26, 2000

DETECTION OF SPATIAL AUTOCORRELATION AMONG BIRD TERRITORIES BASED ON LINE TRANSECT CENSUSES

C. MOSKÁT

Animal Ecology Research Group of the Hungarian Academy of Sciences (HAS)
c/o Hungarian Natural History Museum, Ludovika tér 2, H-1083 Budapest, Hungary
E-mail: moskat@zoo.zoo.nhmus.hu

Spatial autocorrelations in the territories of four marshland-nesting passerines (Sedge Warbler *Acrocephalus schoenobaenus*, Reed Warbler *A. scirpaceus*, Reed Bunting *Emberiza schoeniclus* and Savi's Warbler *Locustella luscinioides*) were demonstrated by correlograms computed by Moran's I coefficient. The data set was based upon territory mapping of breeding birds in Kis-Balaton Nature Reserve (W Hungary). For the Sedge Warbler seven consecutive line transect censuses were also evaluated. Except for the first two transect censuses, which were carried out at the beginning of the breeding season, autocorrelation analysis of the line transect censuses revealed similar patterns as the more accurate, but more time-consuming, territory mapping. Spatial autocorrelation analysis of transect data revealed the main features of the autocorrelation structure, the high value at any of the first three lags, but no autocorrelation at lag 4 or 5. I conclude, that the line transect censuses provide adequate data to detect spatial relationships in territorial birds.

Key words: spatial autocorrelation, Moran's I, line transect, bird census, marshland, *Acrocephalus* sp.

INTRODUCTION

Statistical analysis of spatial pattern of animals and plants has became one of the major topics in ecology in the last few decades. A wide range of methodological tools has been developed from the block-quadrat variance analysis preferred by quantitative plant ecologists (e.g. GREIG-SMITH 1983, KERSHAW & LOONEY 1985, etc.) to the geostatistical tools applied for Geographic Information Systems (GIS). For example, RIPLEY (1987) suggested to use of point-pattern analysis for bird nests, and analyzed the nests of the Common Buzzard (*Buteo buteo*), based on nearest-neighbour distances (RIPLEY 1985). MOSKÁT *et al.* (1992) applied the block-quadrat variance methods and dispersion indices for detecting patterns of territories of marshland-nesting bird species. There are many other issues that can be addressed by spatial autocorrelation. Spatial autocorrelation analysis is suitable to reveal relationships among sample sites in a geographic space, where arrangements of sample sites could be irregular (e.g. random), or regular (e.g. a transect or a lattice) (SOKAL & THOMSON 1987). HU and MOSKÁT (1994) used Monte Carlo simulation to show that the representation of spatial autocorrelations by spatial correlograms are useful to reveal habitat selection features of habitat specialists and generalists.

Line transect censuses are often used in avian biology for monitoring populations (JÄRVINEN *et al.* 1991). The goal of this paper is to investigate how census accuracy affect the usability of these censuses for the analysis of spatial autocorrelation in the distribution of bird territories. If spatial autocorrelation can be detected from transect censuses of territorial birds, then this would offer an easy-to-use technique for field ornithologists. In the present paper I use transect data to reveal spatial autocorrelation. Spatial autocorrelation on the data sets arised from territory mapping and line transect censuses are also compared. In addition, changes of spatial autocorrelation in the territory structure during the breeding season is also evaluated.

MATERIAL AND METHODS

The censuses were carried out by the Finnish line transect method (JÄRVINEN & VÄISÄNEN 1975, 1976) in Kis-Balaton Nature Reserve (MOSKÁT & BÁLDI 1999). Censuses were done by walking on the small dikes crossing the marshland. A 8.8 km segment of dike was used as a census route, and it was censused 8 times during the breeding season on the following dates: in April (4, 16, and 26), and in May (7, 9, 21, 23, and 29) in 1991, following the standard rules of the line transect method (JÄRVINEN & VÄISÄNEN 1976, IBCC 1977). Territory mapping (ANON 1969, see also SVENSSON 1979) was also applied on the results of these single line transect censuses. In the present study occurrences within 50 m on only one side of the observer's route were used for analysis. We choosed this limit of lateral distance because most birds were detected in the main belt (0–25 m) and in the adjacent 25 m wide belt of the supplementary belt. The concentration of breeding territories was observed in this narrow edge zone of the marshland, which was influenced by the edge effect (BÁLDI & KISBENEDEK 1999, MOSKÁT & BÁLDI 1999). For this reason the pattern of territories in our censuses could easily be simplified to a transect, a set of continuous quadrats. Birds usually had elongated territories in this edge zone. From practical reasons the route was divided into sections of 200 m.

Kis-Balaton lies at the mouth of the River Zala inlet to Lake Balaton, W Hungary (46°42'N, 17°21'E). The vegetation is *Phragmites australis* and *Typha angustifolia*, but a few bushes and trees of *Salix alba*, *S. fragilis*, and *Alnus glutinosa* also occur (LŐRINCZ *et al.* 1990).

The spatial autocorrelations were calculated using the TRANSPAT computer program (HU & MOSKÁT 1993). We calculated the Moran's I autocorrelation coefficient (formula Z_d) with normalisation tests (CLIFF & ORD 1973). For comparison of autocorrelations SOKAL and THOMSON (1987) suggested to compute the Manhattan distances between pairs of correlograms. The procedure matrix is subjected to UPGMA cluster analysis to detect the similarity structure. For computation of agglomerative cluster analysis the program SYN-TAX (PODANI 1993) was applied.

RESULTS AND DISCUSSION

Both spatial correlograms and semi-variograms are often used to display spatial autocorrelation. They show the same information, but tendencies are reversed. In the present paper I prefer correlograms over variograms, because the casual representation of the correlograms easily demonstrates the negative and positive autocorrelations. Nevertheless, under special circumstances semi-variograms may be more informative than correlograms, or vica versa.

Spatial autocorrelation of 4 passerines is given on Fig. 1. Although the correlograms presented here cover a wide range of the spatial scales, the values on the left side of the figure are more important than values on the right at higher distance classes. The figure shows that the Sedge Warbler (*Acrocephalus schoenobaenus*) formed small territories in patches. One km (0.8–1.8 km) long sections of reedbed showed an intensive clumping, but another 0.2–1.9 km long sections remained empty. Spatial autocorrelation shows high autocorrelation at the first steps. Because of the clumping of Sedge Warblers' territories there is a high chance to find another territory in the close vicinity of any territory. The correlogram of the Reed Warbler (*Acrocephalus scirpaceus*) show no autocorrelation at lag 2. This is explained by the nesting behaviour of this species, which also has small territories, but this species is more evenly distributed over the

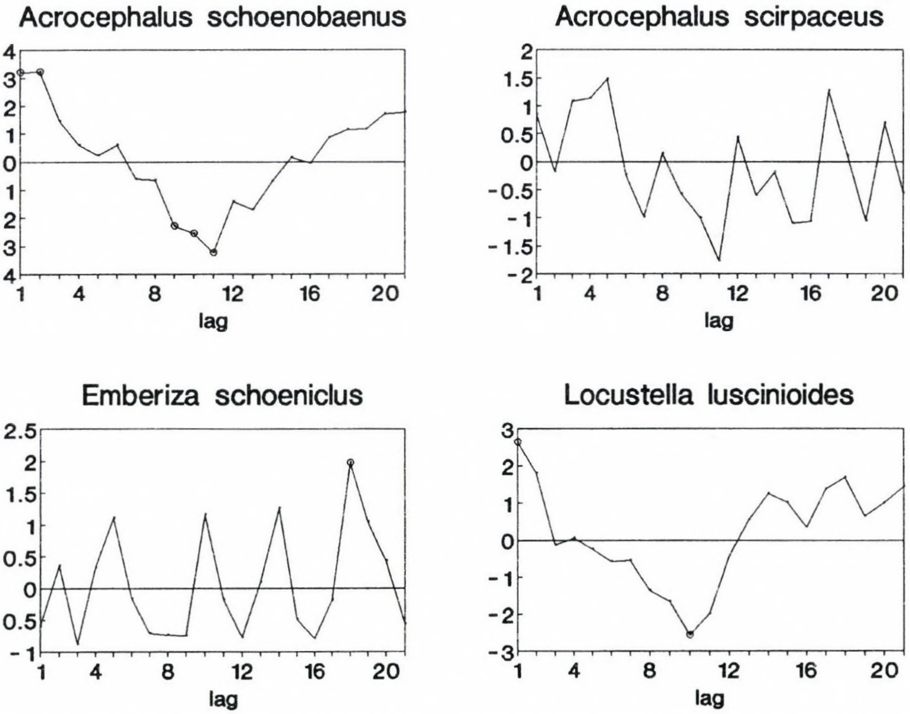


Fig. 1. Spatial correlograms of four marshland-breeding passerines (Sedge Warbler *Acrocephalus schoenobaenus*, Reed Warbler *A. scirpaceus*, Reed Bunting *Emberiza schoeniclus*, and Savi's Warbler *Locustella luscinioides*) based on the territory mapping method. (Ordinate: Moran's I (version Z_d) spatial autocorrelation coefficient. Significant autocorrelation coefficients ($P<0.05$) are indicated by open circles.)

whole transect than the Sedge Warbler. Although the habitat is not saturated, the high density of Reed Warbler territories makes high values of autocorrelation at lags 3–5. The autocorrelogram of the Reed Bunting (*Emberiza schoeniclus*) territories show a special figure. It has not revealed autocorrelation at the first few lags. It is explained by the greater territories of this species, which form long narrow territories along the census route, i.e. in edge habitat of the marshland. Since the transect was handled as a continuous set of 200 m long segments, one Reed Bunting territory often occupied more than one of these segments. Furthermore, Reed Bunting territories did not join to each other, so small empty sections were found at several places. The small territories of the Savi's Warbler (*Locustella luscinioides*) also showed some clumping, but they distributed not as evenly as the Sedge Warbler. The figures of the latter two species were similar to each other, but the Savi's Warbler showed somewhat smaller autocorrelations.

The former results were based upon the territory maps. Single line transect censuses may also have the potential use in autocorrelation analysis. The mapping method results in territories, whereas the single line transect censuses result in individual bird observations. As bird territories have some considerable extention, it is difficult to say what part of the territory is necessary to use in spatial autocorrelation analysis. In the present study I characterized each territory by a point, which was chosen as the centre of the territory. Another possibility is to search for nests, and choose nest positions instead of the centre of territories. Although the latter method is advantegous in some cases, it is time-consuming and many nests may not be found even after substantial labour. Single line transect censuses can handle single observations of territory-holding birds, so the spatial pattern revealed may depend on the fact where in the territory was the given bird observed. This problem arises when territories are large, at higher densities, and at fine-scale of observations, e.g. when small distance classes are used in transect data.

Figure 2 shows the dendrogram of cluster analysis based on the spatial autocorrelations of 7 consecutive line transect censuses of Sedge Warblers

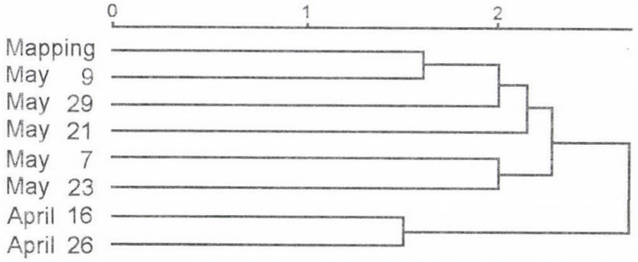


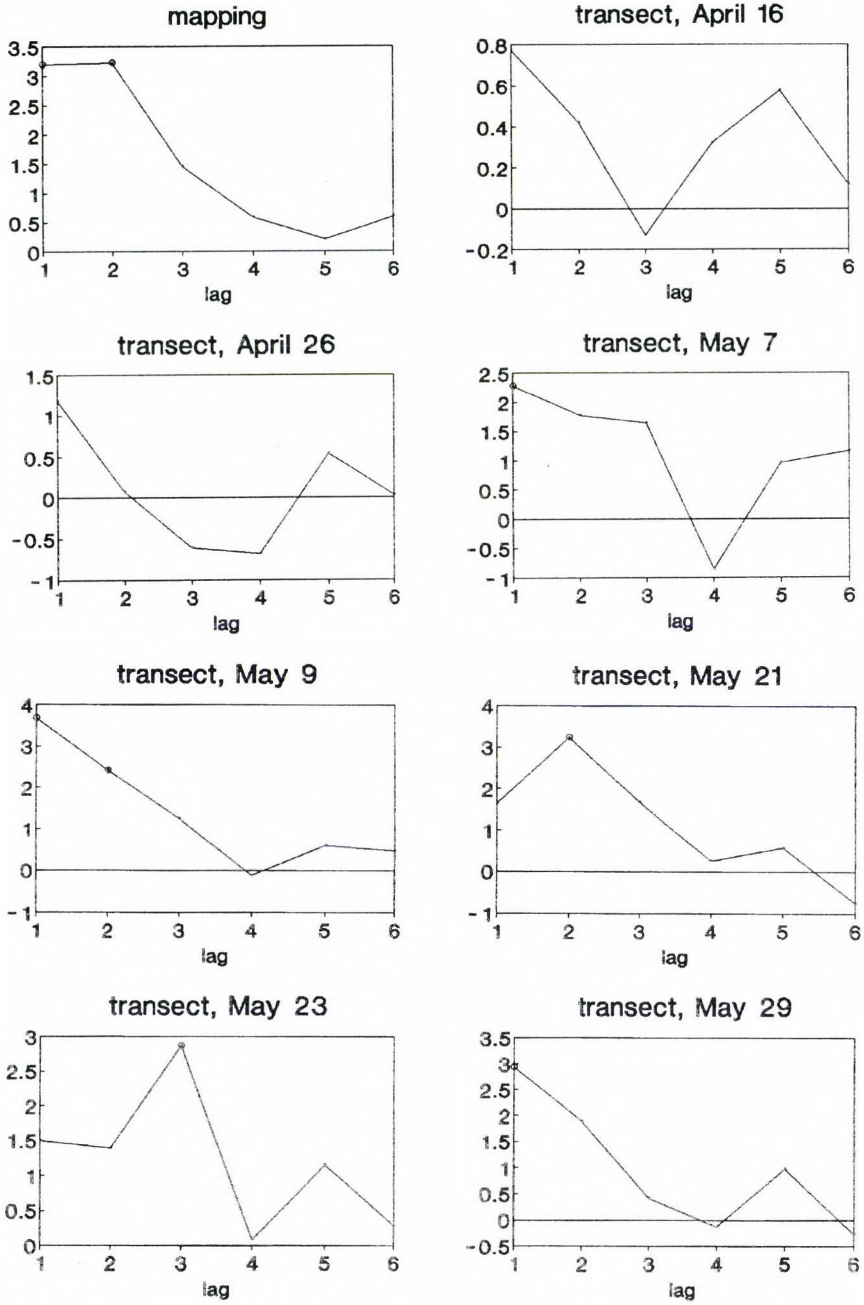
Fig. 2. Agglomerative cluster analysis of autocorrelation structure (up to 6 lags) obtained by the territory mapping method ("Mapping") and 7 consecutive line transect censuses, denoted by the date of census. Autocorrelation was calculated by the Moran's I for the Sedge Warbler

(denoted by dates of the line transect) and the result of the territory mapping method ("Mapping"). In the dendrogram "Mapping" is closely related to the 4th single line transect census carried out on May 9. At this time most of the breeding Sedge Warblers has already arrived and started to breed. The closely-related censuses ("May 29", "May 21", and also the group of "May 7" and "May 23") were amalgamated into a big cluster. Only censuses refered to as "April 16" and "April 26" formed a separate branch in the dendrogram. These censuses represent the earliest two line transect results, because this species was not observed on April 7. In April not all of the breeding birds have already arrived (Table 1). Early arriving birds, generally the older birds in the best body condition try to occupy the highest quality nest sites (BENSCH & HASSELQUIST 1991, URANO 1985). Most correlograms of these censuses showed significant ($P<0.05$) autocorrelation values at the first lags along the transect, whereas the first line transect census showed small and non-significant values. The pattern of the correlograms showed high similarity on the left side of the correlogram (lags 1–6) (Fig. 3). (Autocorrelation values at high lags may have limited relevance because of the decreasing sample size.) Most correlograms showed a minimum inflection point at lag 4, where no or little negative autocorrelation was detected. Only the first two censuses carried out in April showed a minimum value at lag 3 (no autocorrelation in census "April 16"), or nonsignificant negative autocorrelation at lags 3 and 4 (in census "April 26"). The latter two censuses were separated in the dendrogram of the agglomerative cluster analysis (Fig. 2).

Although a single line transect census may detect more birds than the mapping method, especially when nonbreeding birds (migrants or unpared males) stay temporarily in the area, they generally underestimate densities. The mapping method is a time-consuming procedure, but results in a good estimation of "true" densities. The line transect technique is rapid, and it is easy to carry out. For this reason the mapping method is regarded as an "absolute" technique, but the less reliable line transect method is known as a "relative" method (JÄRVINEN & VÄISÄNEN 1975). MOSKÁT and BÁLDI (1999) analyzed the same data-set used in the present paper in order to evaluate the usefulnes of the Finnish line transect method in marshland habitat. For the Sedge Warbler the main belt data showed

Table 1. Number of Sedge Warbler territories (n) in consecutive single line transect censuses (denoted by LT1 to LT7) between April 16 and May 29, 1991 in Kis-Balaton Nature Reserve. Censuses were carried out along a 8.8 km census route censusing birds in a 50 m wide belt at the edge of the reed-bed. Single line transects are compared to territory mapping (TM).

	TM	LT1	LT2	LT3	LT4	LT5	LT6	LT7
date	April 16–May 29	April 16	April 26	May 5	May 9	May 21	May 23	May 29
n	49	21	13	37	53	48	38	44
%	100	43	27	76	108	98	78	90



mapping

transect, April 16

transect, April 26

transect, May 7

transect, May 9

transect, May 21

transect, May 23

transect, May 29

Fig. 3. Correlograms of the aboundance of the Sedge Warbler obtained by the territory mapping method ("Mapping") and by single line transects (denoted by the date of the census). Ordinate: Moran's I (version Z_d) spatial autocorrelation coefficient. Significant autocorrelation coefficients ($P<0.05$) are indicated by open circles

an overestimation (193% of the density obtained by the mapping), but the estimation varied between 27–108% for the 50 m wide belt used in this study (Table 1).

Not only the number of territories changed over the breeding season (e.g. WIENS 1969), but the number of non-stationary birds as well (migrants: flying across the area, or staying in the area for a few days; floaters: unmated males), which may modify the results of the line transect censuses (MOSKÁT & BÁLDI 1995). Nevertheless, the breeding population is difficult to estimate because of predation. Interspecific territoriality may also modify the single-species pattern. For these reasons reseachers have to take into consideration these factors when specific questions are addressed to spatially related ecological problems. The mapping method is sensitive to measure an average state of the breeding season, excluding the extreme values of migration peaks, irregular floaters and low singing activity, i.e. the low detectability periods of the territory holder males. For this reason the mapping method seems to be the best technique if autocorrelation of the the spatial population is examined, but main trends may also be revealed by single line transects. Single line transect censuses seem to be useful to demonstrate changes of spatial autocorrelation during the breeding season, when autocorrelation is robust, and well-defined.

*

Acknowledgements – The study was supported by the Hungarian Scientific Research Fund (OTKA, grant no. T16510). The author is indebted to A. BÁLDI for his help during the fieldwork and his comments on the manuscript.

REFERENCES

ANON (1969) Recommendations for an international standard for a mapping method in bird census work. *Bird Study* **16**: 249–254.

BÁLDI, A. & KISBENEDEK, T. (1999) Species-specific distribution of reed-nesting passerine birds across reed-bed edges: effects of spatial scale and edge type. *Acta zool. hung.* **45**: 97–114.

BENSCH, S. & HASSELQUIST, D. (1991) Territory infidelity in the polygynous Great Reed Warbler Acrocephalus arundinaceus: The effect of variation in territory attractiveness. *J. Anim. Ecol.* **60**: 857–871.

CLIFF, A. D. & ORD, J. K. (1973) *Spatial autocorrelations.* Pion Ltd., London.

GREIG-SMITH, P. (1983) *Quantitative plant ecology.* 3rd ed., Blackwell Sci. Publ., Oxford.

HU, Z.-J. & MOSKÁT, C. (1993) TRANSPAT. A computer program for spatial autocorrelation analysis of transect data in ecology. *Ornis hung.* **3**: 73.

HU, Z.-J. & MOSKÁT, C. (1994) Effect of habitat selection strategy on spatial correlograms in a heterogeneous environment: a simulation study. *Acta zool. hung.* **40**: 369–377.

IBCC (International Bird Census Committee) (1977) Introduction to bird census studies. *Pol. ecol. stud.* **3**: 7–17.

JÄRVINEN, O. & VÄISÄNEN, R. A. (1975) Estimating relative densities of breeding birds by the line transect method. *Oikos* **26**: 316–322.

JÄRVINEN, O. & VÄISÄNEN, R. A. (1976) Finnish line transect censuses. *Ornis Fennica* **53**: 115–118.

JÄRVINEN, O., KOSKIMIES, P. & VÄISÄNEN, R. A. (1991) Line transect census of breeding land birds. Pp. 33–40. *In* KOSKIMIES, P. & VÄISÄNEN, R. A. (eds): *Monitoring bird populations.* Zoological Museum, Finnish Museum of Natural History, Helsinki.

KERSHAW, K. A. & LOONEY, J. H. H. (1985) *Quantitative plant ecology.* 3rd ed., Edward Arnold, London.

LŐRINCZ, G., MOSKÁT, C., WALICZKY, Z. & BANKOVICS, A. (1990) Faunal mapping and environmental quality analysis by a new GIS technique. Pp. 45–50. *In* STASTNY, K. & BEJCEK, V. (eds): *Bird census and atlas studies.* Proc. 11th Int. Conf. on Bird Census and Atlas Work, Prague, The Czech Republic.

MOSKÁT, C. & BÁLDI, A. (1995) How to increase accuracy of point count techniques: simulation and field studies. Pp. 457–461. *In* BISSONETTE, J. A. & KRAUSMANN, P. R. (eds): *Integrating people and wildlife for a sustainable future.* Proc. First International Wildlife Management Congress, The Wildlife Society, Bethesda, Maryland, USA.

MOSKÁT, C. & BÁLDI, A. (1999) The importance of edge effect in line transect censuses applied in marshland habitats. *Ornis Fennica* **76**: 33–40.

MOSKÁT, C., WALICZKY, Z., & BÁLDI, A. (1992) Dispersion and association of some marshland-nesting birds: a matter of scale. *Acta zool. hung.* **38**: 47–62.

PODANI, J. (1993) *SYN-TAX-pc. Computer programs for multivariate data analysis in ecology and systematics. Version 5.0. User's guide.* Scientia Publ., Budapest, Hungary.

RIPLEY, B. D. (1985) Analyses of nest spacings. Pp. 151–158. *In* MORGAN, B. J. T. & NORTH, P. M. (eds): *Statistics in Ornithology.* Lecture Notes in Statistics No. **29.**, Springer, Berlin.

RIPLEY, B. D. (1987) Spatial point pattern analysis in ecology. Pp. 407–429. *In* LEGENDRE, P. & LEGENDRE, L. (eds): *Developments in numerical ecology.* NATO ASI Series G: Ecological Ser. Vol. 14, Springer Verlag, Berlin.

SOKAL, R. R. & THOMSON, J. D. (1987) Applications of spatial autocorrelation in ecology. Pp. 432–466. *In* LEGENDRE, P. & LEGENDRE, L. (eds): *Developments in numerical ecology.* – NATO ASI Series G: Ecological Ser. Vol. 14, Springer Verlag, Berlin.

SVENSSON, S. E. (1979) Census efficiency and number of visits to a study plot when estimating bird densities by the territory mapping method. *J. Appl. Ecol.* **16**: 61–68.

URANO, E. (1985) Polygyny and the breeding success of the Great Reed Warbler, Acrocephalus arundinaceus. *Res. Pop. Ecol.* **27**: 393–412.

WIENS, J. A. (1969) An approach to the study of ecological relationships among grassland birds. *Ornithol. Monogr.* **8**.

Revised version received 14th March, 2000, accepted 5th June, 2000, published 7th July, 2000

Acta Zoologica Academiae Scientiarum Hungaricae 46 (1), pp. 27–33, 2000

HABITAT SELECTION OF MIGRATING SEDGE WARBLERS (ACROCEPHALUS SCHOENOBAENUS) AND MARSH WARBLERS (A. PALUSTRIS) IN A SOUTH-HUNGARIAN REED SWAMP

J. GYURÁCZ[1] and L. BANK[2]

[1]*Department of Zoology, Berzsenyi College*
P. O. Box 170, H-9701 Szombathely, Hungary
E-mail: gyjozsi@fs2.bdtf.hu
[2]*Local Group of County Baranya, BirdLife Hungary*
Felsőmalom u. 22, H-7621 Pécs, Hungary

Data from a ringing program in a South Hungarian reed swamp, were used to analyse the horizontal and vertical distribution of the juvenile, adult Sedge Warblers and Marsh Warblers during autumn migration. The horizontal spatial pattern of the juvenile and adult Sedge Warblers showed clumped distribution in the reed bed. One thousand three hundred and twenty-five (35%) juvenile and 203 (27%) adult Sedge Warblers were caught in three internal nets of the first line of mist-nets, which represents only 16% of the nets. These 3 nets are standing in the 30–40 m wide zone near open water. Juvenile Marsh Warblers' distribution was clumped, but there was no significant trend in the number of juveniles along the shore–open water gradient (R2 = 0.07). Adult Marsh Warblers' distribution was random in the reed bed. The vertical spatial distribution of the age classes were 1 significantly clumped for both species. The investigation of food dispersion in a reed bed, the vegetation structure and the interspecific competition among reed warblers is required to better understand the habitat selection of reed warblers.

Key words: habitat selection, spatial distribution, Sedge Warbler, *Acrocephalus schoenobaenus*, Marsh Warbler, *Acrocephalus palustris*

INTRODUCTION

The Sedge Warbler (*Acrocephalus schoenobaenus*) and Marsh Warbler (*A. palustris*) are very common breeding birds in the marshlands of Europe (CRAMP 1992). These species prefer reed beds as a stopover habitat during autumn migration in Hungary (GYURÁCZ & CSŐRGŐ 1994, CSŐRGŐ 1995, GYURÁCZ & BANK 1997) and spend the winter in Africa, south of the Sahara (DOWSETT *et al.* 1988).

The habitat selection is one of the most important mechanisms in the ecological segregation of bird populations. The spatial distributions of passerine species during the breeding and the wintering (BARLEIN 1983) seasons have been studied in more detail than during migration (BACCETTI 1985, PAMBOUR 1990, HONZA & LITERÁK 1997). Food availability and vegetation structure are known to influence the spatial distribution of most breeding and migrating birds (PEARSON *et al.* 1979, HALAND & BURKJELAND 1982, SHENNAN 1985, ORMEROD *et al.* 1991, MOREL & MOREL 1992, PEARSON & LACK 1992, MOSKÁT *et al.* 1993). Competition has always been regarded as an important factor in habitat selection by sympatric warblers (ROLANDO & PALESTRINI 1989, HOI *et al.* 1991, LEISLER 1992, CATCHPOLE 1973).

In one of our former studies – with less individual number and different statistical methods, however – we surveyed the area distribution of the Sedge Warbler in relation to the age (GYURÁCZ & BANK 1997). In this study, data from a long-term ringing program in a south Hungarian reedswamp, were used to compare the horizontal and vertical distribution of juvenile and adult Sedge Warblers and Marsh Warblers during postbreeding migration. We checked two hypotheses: (1) The area distribution of the two warbler species does not differ in the migration period. (2) The area distribution of the juvenile and adult birds does not differ in the migration period of either species.

STUDY SITE AND METHODS

The study was carried out at Sumony Bird Ringing Station, Hungary (Lake Sumony: 45°58'N, 17°56'E) where a large reed bed is around the fish pond. *Scirpeto-Phragmitetum* with *Thypha* is the dominant plant association. The data were collected during autumn migration, from 1989 to 1995 (30 July–September 10, 1989; 28 July–September 09, 1990; 27 July–September 08, 1991; 26 July–September 13, 1992; 17 July–September 19, 1993; 16 July–September 17, 1994; 17 July–September 17, 1995). The birds were caught in the reed bed, using 18 mist-nets 12 m in length, with four 50 cm high shelves (20–25 cm between the ground and the first shelf). Four-line

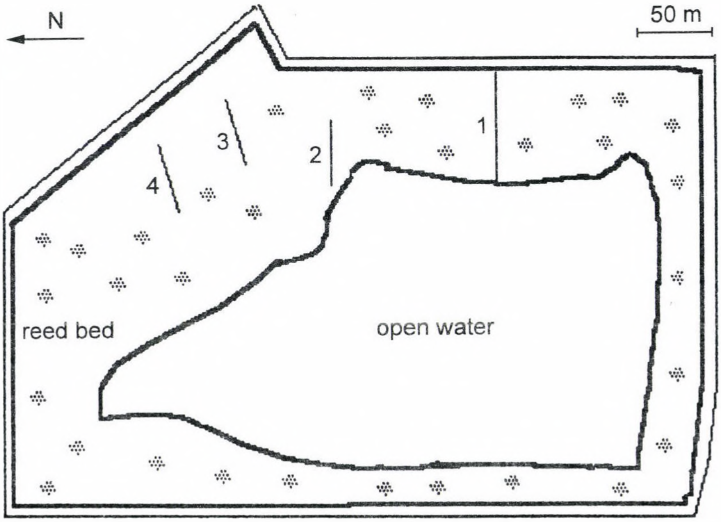


Fig. 1. Location of the mist-nets (line 1: 6 nets, lines 2–4: 4 nets each at Lake Sumony

of mist-nets net line 1: 6 nets, line 2: 4 nets, line 3: 4 nets, line 4: 4 nets, Fig. 1) were on a raised path 20–30 cm above the water level in a homogenous area of *Phragmitetum*. The net and shelf number were recorded for each bird. The birds were ringed, weighed and measured.

The index of clumping (I) was used to analyse the spatial distribution of birds (SOUTHWOOD 1978): $I = s^2/D$, where s^2 = variance and D= mean number of trapped birds by net. The distribution can be random (I=1), spaced (I<1) or clumped (I>1). We used the χ^2 – test to estimate the relationship between the number of birds caught and the location of capture. Statistical analyses were performed with the Statgraf and Windows Excel 5.0 softwares.

RESULTS

During seven study periods 3820 juvenile, 740 adult Sedge Warblers and 197 juvenile, 43 adult Marsh Warblers were trapped in the reed bed. 1325 (35%) juvenile and 203 (27%) adult Sedge Warblers were caught in three internal nets of the first line of mist-nets (Fig. 1), which represents only 16% of the nets. These 3 nets are standing in the 30–40 m wide zone near open water. Both age classes were spatially clumped in the reed bed (juvenile: I = 62.95, χ^2 = 1079, d.f. = 17, P<0.01, adult: I = 7.27, χ^2 = 123.78, d.f. = 17, P<0.01). The number of juvenile (R^2 = 0.92) and adult (R^2 = 0.7) Sedge Warblers caught decreased significantly from open water to shore at first line of mist-nets (Fig. 2). Juvenile Marsh Warblers' distribution was clumped (I=1.97, χ^2 = 33.32, d.f.=17, P<0.05), but there was no significant trend in the number of juveniles along the shore-open water gradient (R^2 = 0.07, Fig. 3). Adult Marsh Warblers' distribution was spaced in the reed bed (I = 0.89, χ^2 = 15.16, d.f. = 17, P>0.05).

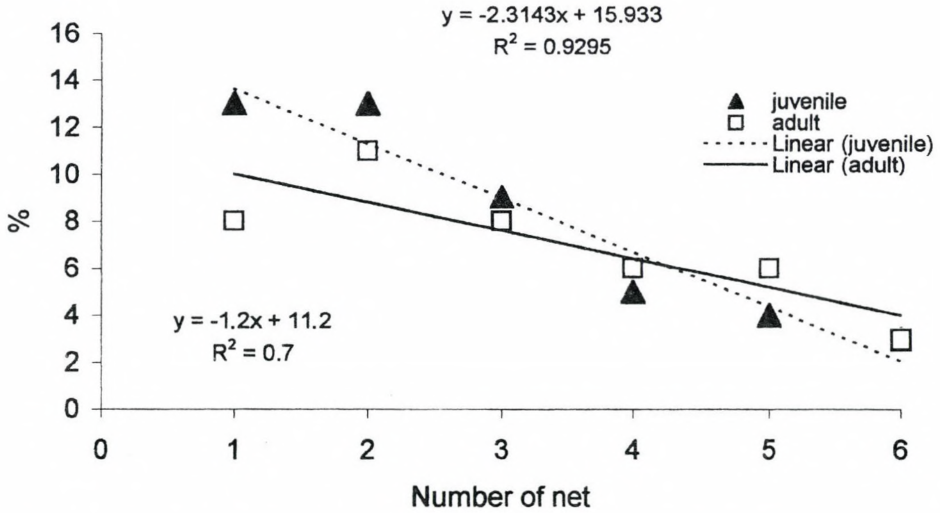


Fig. 2. Capture rate of Sedge Warblers from open water (net 1) to shore (net 6) at the first line of mist-nets

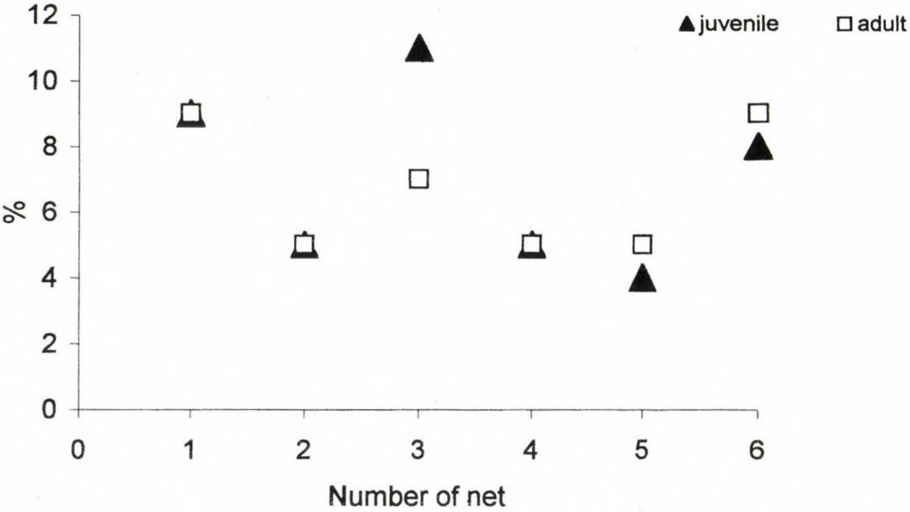


Fig. 3. Capture rate of Marsh Warblers from open water (net 1) to shore (net 6) at the first line of mist-nets

1484 (33%) juvenile, 280 (33%) adult Sedge Warblers and 139 (37%) juvenile, 28 (35%) adult Marsh Warblers were caught in third net shelf. The vertical spatial distribution of birds was significantly clumped for both species and age classes (Sedge Warbler; juvenile: I = 68.86, = 206.4, d.f. = 3, P<0.01, adult: I = 15.24, χ^2 = 45.79, d.f. = 3, P<0.01, Marsh Warbler; juvenile: i = 17.28, χ^2 = 51.74, d.f. = 3, P<0.01, adult: I = 2.71, χ^2 = 8.12, d.f. = 3, P<0.05, Figs 4 and 5).

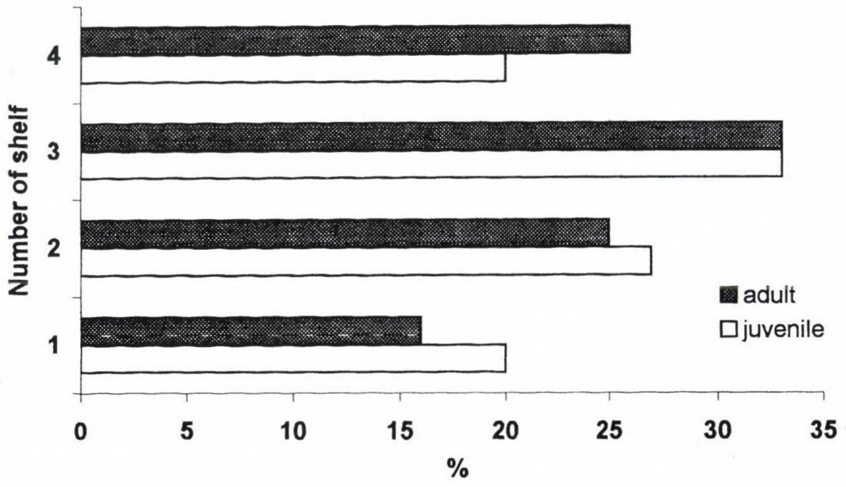


Fig. 4. Capture rate of Sedge Warblers from the lower to the upper net shelf

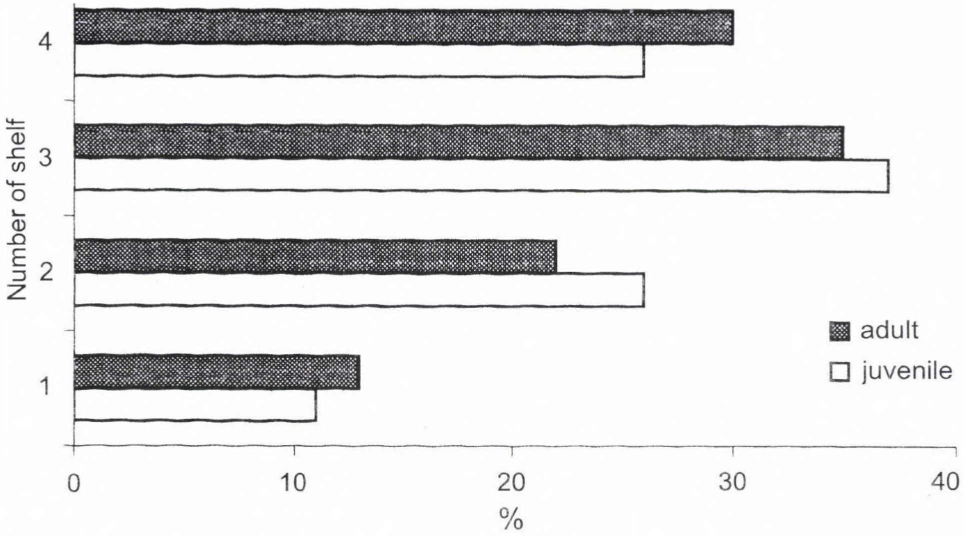


Fig. 5. Capture rate of Marsh Warblers from the lower to the upper net shelf

DISCUSSION

According to our results, partially refusing both the first and second hypotheses, we can state that on the studied area, in the autumn migration period there is a difference in the horizontal distribution pattern of the Sedge Warbler and Marsh Warbler species. In the hatching period both species prefer the external, shoreward reedy areas having a more heterogeneous vegetation structure and occupy a nesting territory there (CSŐRGŐ 1995, BÁLDI & KISBENEDEK 1999). However, according to our result, in the autumn migration period, the young and old Sedge Warblers as well as the young Marsh Warblers are grouping in the reed areas toward the open water surface while the old Marsh Warblers do not exhibit edge preference in the migration period. In the second half of August and in September, the Sedge Warbles from the area of the Baltic Sea are intermitting their migration in a large number in the reed belt of the Lake Sumony (GYURÁCZ & CSŐRGŐ 1991, 1994). By this period, in the shoreward part of the reed – due to the drier microclimate – the food base is decreasing and the invertebrates that serve as nutrient for the birds are found in larger number in the reeds being more close to the open water surface (VÁSÁRHELYI 1995). Therefore, the young and old birds migrating later prefer the belt close to the open water surface, abounding in food. According to studies of PAMBOUR (1990) in France as well as HONZA & LITERÁK (1997) the Czech Republic, after the hatching period, in the first half of the migration period (second part of July, August), this edge preference shift cannot be observed. The Sedge Warblers were grouping similar to the pattern observed in the hatching period. However, the spatial distribution of the age groups was not analysed. At Sumony, the edge preference of the old specimens of the Marsh Warblers cannot be demonstrated because a significant part of the old birds is already gone by then and later this species can be found on the area in a small number only (GYURÁCZ 1994).

Regarding the vertical distribution we can sustain both of our hypotheses, that we cannot observe differences concerning the species or the age groups. The majority of the specimens is grouping in the upper part of the reed and this pattern is similar to the one observed in other European reeds (BERTHOLD & SCHLENKER 1975, ORMEROD 1990, PAMBOUR 1990). This pattern is attributed – according to niche and ecomorphological studies – to the competition of the bird species inhabiting the reeds. In the lower part of the reed, other species, such as the Savis's Warbler (*Locustella luscinioides*) and the Moustached Warbler (*A. melanopogon*) that feed there in a larger number.

The investigation of food dispersion, vegetation structure, infra- and interspecific competition in the reed bed habitat is required to better understand the spatial distribution of Sedge Warblers and Marsh Warblers during migration.

*

Acknowledgements – We wish to express our gratitude to the members of the BirdLife Hungary who helped us with the field work. J. GYURÁCZ was supported by the Soros Foundation and by a PhD scholarship (PFP-0923/1998) from the Ministry of Culture and Education.

REFERENCES

BACCETTI, N. (1985) The vertical distribution of three passerine birds in marshland of Central Italy. *Ringing and Migration* **6**: 93–96.

BAIRLEIN, F. (1983) Habitat selection and associations of species in European passerine birds during southward, postbreeding migrations. *Ornis Scandinavica* **14**: 239–245.

BÁLDI A. & KISBENEDEK, T. (1999) Species-specific distribution of reed-nesting passerine birds across reed-bed edges: effects of spatial scale and edge type. *Acta zool. hung.* **45**(2): 97–114.

BERTHOLD, P. & SCHLENKER, R. (1975) Das "Mettnau-Reit-Illmitz-Programm" – ein langfristiges Vogelsfangprogramm der Vogelwarte Radolfzell mit vielfaltiger Fragestellung. *Vogelwarte* **28**: 97–123.

CATCHPOLE, C. K. (1973) Conditions of coexistence in sympatric breeding populations of Acrocephalus warblers. *J. Anim. Ecol.* **42**: 623–635.

CRAMP, S. (ed.) (1992) *Handbook of the Birds of Europe, the Middle East and North Africa.* Vol. 6, pp. 130–145. Oxford Univ. Press, Oxford

CSŐRGŐ, T. (1995) Niche segregation and microhabitat preference of warblers within a reed stand. Pp. 138–144. In VÁSÁRHELYI, T. (ed.): *The animal world of reed belts in Hungary.* Magyar Természettudományi Múzeum, Budapest. [In Hungarian with English summary]

DOWSETT, R. J., BACKHURST, G. C. & OATLEY, T. B. (1988) Afrotropical ringing recoveries of Palearctic migrants (I. Passerines). *Tauraco* **1**: 29–63.

GYURÁCZ, J. (1994) *Study of autumn migration of the Acrocephalus species.* Doctoral thesis. JPTE, Pécs. [in Hungarian with short English summary]

GYURÁCZ, J. & BANK, L. (1997) Spatial distribution of migrating Sedge Warblers (Acrocephalus schoenobaenus) in a Hungarian reed bed. *Ornis Hungarica* **7**: 43–47.

GYURÁCZ, J. & CSŐRGŐ, T. (1991) Az öreg és a fiatal madarak vonulása közti különbségek négy nádiposzáta (Acrocephalus spp.) fajnál. Pp. 164–171. In GYURÁCZ, J. (ed.): MME III. Tudományos ülése. [In Hungarian with English summary]

GYURÁCZ, J & CSŐRGŐ, T. (1994) Autumn migration dynamics of the Sedge Warbler (Acrocephalus schoenobaenus) in Hungary. *Ornis Hungarica* **4**: 31–37.

HALAND, A. & BURKJELAND, S. (1982) Distribution and breeding habitat of the Sedge Warbler (Acrocephalus schoenobaenus). *Fauna norv. ser. C. Cinclus* **5**: 65–72.

HOI, H., RICHLER, T. & DITTAMI, J. (1991) Territorial spacing and interspecific competition in three species of reed warblers. *Oecologia* **87**: 443–448.

HONZA, M. & LITERÁK, I. (1997) Spatial distribution of four Acrocephalus warblers in reedbeds during the postbreeding migration. *Ringing & Migration* **18**: 79–83.

LEISLER, B. (1992) Habitat selection and coexistence of migrants and Afrotropical residents. *Ibis* **134**: 77–82.

MOREL, G. J. & MOREL, M. Y. (1992) Habitat use by Palearctic migrant passerine birds in West Africa. *Ibis* **134**: 83–87.

MOSKÁT, C., BÁLDI, A. & WALICZKY, Z. (1993) Habitat selection of breeding and migrating icterine warblers Hippolais icterina: a multivariate study. *Ecography* **16**: 137–142.

ORMEROD, S. J. (1990) Possible resource partitioning in pairs of Phylloscopus and Acrocephalus Warblers during autumn migration through a South Wales reed-swamp. *Ringing & Migration* **11**: 76–85.

ORMEROD, S. J., JENKINS, R. K. B. & PROSSER, P. J. (1991) Further studies on the pre-migratory weights of Sedge Warblers Acrocephalus schoenobaenus in south west Wales: patterns between sites and years. *Ringing & Migration* **12**: 103–112.

PAMBOUR, B. (1990) Vertical and horizontal distribution of five wetland passerine birds during the postbreeding migration period in a reed bed of the Camargue, France. *Ringing and Migration* **11**: 52–56.

PEARSON, D. J., BACKHURST, G. C. & BACKHURST, D. E. G. (1979) Spring weights and passage of Sedge Warblers Acrocephalus schoenobaenus in central Kenya. *Ibis* **121**: 9–19.

PEARSON, D. J. & LACK, P. C. (1992) Migration patterns and habitat use by passerine and near passerine migrant birds in eastern Africa. *Ibis* **134**: 89–98.

ROLANDO, A. & PALESTRINI, C. (1989) Habitat selection and interspecific territoriality in sympatric warblers at tow Italian marshland areas. *Ethology, Ecology and Evolution* **1**: 169–183.

SHENNAN, N. M. (1985) Relationships between morphology and habitat selection by male Sedge Warblers Acrocephalus schoenobaenus. *Ringing & Migration* **6**: 97–101.

SOUTHWOOD, T. R. E. (1978) *Ecological methods with particular reference to the study of insect populations.* Chapman & Hall, London.

VÁSÁRHELYI, T. (1995) *The animal world of reed belts in Hungary.* Magyar Természettudományi Múzeum, Budapest, 199 pp. [in Hungarian with short English summary]

Revised version received 10th April, 2000, accepted 5th June, 2000, published 7th June, 2000

The oribatid species described by Berlese (Acari)

MAHUNKA, S. and L. MAHUNKA-PAPP

The authors had the opportunity for years to study the Oribatid species described by Berlese currently deposited in the Istituto Sperimentale per la Zoologia Agraria at Florence. The results of this series of studies are summarized in this volume.

The volume begins with an essay-like Introduction heavily relying on subjective opinions discussing the general questions of Oribatology. The following section lists Berlese's species placed in the modern system helping the specialists with morphological notes and many drawings; here also the condition of the specimens is discussed and lectotypes are designated.

The third, large section is the catalogue proper, wherein all the species are listed in the systematic order together with their combination and synonymic names. Here one may find all the literature data, usually missing from ordinary works, with reference to Description and Taxonomy, Distribution, with special emphasis on Catalogues whose references are partly unreliable. Where it was deemed necessary further information are added under the heading of Remarks. The volume closes with a very detailed list of literature.

ISBN 963 7093 27 3
325 pages with several figures. Soft bound.
© Hungarian Natural History Museum, Budapest, 1995
Price: 40 US dollars excl. p. & p.

Order should be sent
to the Hungarian Natural History Museum, Library
Baross u. 13., Budapest, H–1088 Hungary
Fax: (36–1) 3171669

Acta Zoologica Academiae Scientiarum Hungaricae 46 (1), pp. 35–52, 2000

BRACONIDAE (HYMENOPTERA) FROM MONGOLIA, XIV: DORYCTINAE, HELCONINAE, METEORINAE, EUPHORINAE, BLACINAE, OPIINAE AND ALYSIINAE*

J. PAPP

Department of Zoology, Hungarian Natural History Museum
H–1088 Budapest, Baross u. 13, Hungary

Thirty braconid species are listed from Mongolia of which five proved to be new to science: *Peristenus kaszabi* sp. n., *Dinotrema firmidens* sp. n., *Phaenocarpa aurosetosa* sp. n., *Phaenocarpa propebakinum* sp. n., *Synaldis sinaulice* sp. n. and seventeen species new to her fauna. Faunistic contributions are presented for every species, taxonomic remarks to those species where necessary. With 36 original figures.

Key words: Mongolia, Braconidae, subfamilies, faunistics, new species

INTRODUCTION

A total of thirty braconid species are reported from Mongolia, the species are arranged in seven subfamilies as follows (between brackets the respective species numbers): Doryctinae (1), Helconinae (2), Meteorinae (1), Euphorinae (8), Blacinae (2), Opiinae (3) and Alysiinae / Alysiini (13). One euphorine species: *Peristenus kaszabi* sp. n. and four alysiine species: *Dinotrema firmidens* sp. n., *Phaenocarpa aurosetosa* sp. n., *Phaenocarpa propebakinum* sp. n. and *Synaldis sinaulice* sp. n. proved to be new to science. Seventeen species are new to the fauna of Mongolia. The thirty braconid species have been collected in 32 localities. Collecting data are presented for every species in an abbreviated form, i.e. only the locality numbers ("No.") are given after the respective species; the full data of the collecting localities are listed under the chapter title "List of the collecting data", in this respect see also Z. KASZAB's six reports of his collecting trips to Mongolia (in *Folia ent. hung.* 1963–1968 vols 16–21). The non-KASZAB's collecting data of Mongolia are presented according to the full data of the labels attached to the respective specimens. The braconid material here discussed is deposited in the Hungarian Natural History Museum (Department of Zoology), Budapest.

---

* Ergebnisse der zoologischen Forschungen von Dr. Z. KASZAB in der Mongolei, Nr. 509.

Abbreviations applied in the descriptions: Alar venations (after VAN ACHTERBERG 1993: 5) Fore wing – *m-cu* = transverse medio-cubital or recurrent vein; r = transverse radial vein; r-m = second transverse cubital vein; 1CU1, 2-CU1 and 3-CU1 = first, second and third sections of the discal vein; 1-M = basal vein; 2-M = third section of the cubital vein; 2-SR-M = second section of the cubital vein; 2-SR = first transverse cubital vein; 3-SR and 4-SR (= SR1) = second and third sections of the radial vein; CU1a and CU1b = first and second sections of the parallel vein. – Hind wing – 1r-m = transverse radio-medial vein; 1-M = first section of the medial vein; 2-SC-R = second section of the subcostal vein. – Ocelli – OD = longest diameter of the ocellus; OOL = ocellar-ocular line (i.e. shortest distance between hind ocellus and compound eye); POL = postocellar line (i.e. shortest distance between hind two ocelli).

LIST OF THE COLLECTING DATA
(according to their increasing locality numbers, see KASZAB l. c.)

No. 281. Central aimak: Zuun-Chara, 850 m, auf Feldern des Forschungsinstituts für Pflanzenschutz, von Kulturpflanzen und Unkraut gekötschert, 8.VII.1964.

No. 298. Central aimak: Ulan-Baator, Nucht in Bogdo ul, 12 km SO vom Zentrum, 1500–1800 m, am Waldrand und auf den Steppenwiesen gekötschert, 22–23.VII.1965.

No. 409. Cojbalsan aimak: Somon Chalchingol, 600 m, am linken Ufer des Flusses Chalcin gol, in einem lichten *Salix*-Auwald geeinzelt. 13–14.VIII.1965.

No. 433. Cojbalsan aimak: 15 km N von Somon Galuut, 850 m, breites Tal mit blumenreicher Wiese, gekötschert, 17.VIII.1965.

No. 486. Central aimak: Ulan-Baator, Nucht in Bogdo ul, 12 km SO vom Zentrum, 1600 m, Tal mit einem Bach, beiderseitig mit steilen Berghängen, an der nördlichen Seite Nadelwald, am Bachufer Birkenbäume, die Südseite ist eine trockene, steinige Steppe, am Waldrand und im Tal sowie auf den üppigen Wiesen gekötschert, 27.VIII.1965.

No. 499. Central aimak: Ulan-Baator, Nucht in Bogdo ul, 5 km S vom Zentrum, 1600 m, im Talgrund vom Gesträuch (sie waren knospentragend oder eben die Blätter entfaltend), von trockenem Gras, von Frühlingsblumen (*Trollius*, *Ranunculus* etc.) gekötschert, 6.VI.1966.

No. 504. Central aimak: Songino, 24 km SW von Ulan-Baator, 1300 m, im Galeriewald des Überschwemmungsgebietes gekötschert, 7.VI.1966.

No. 508. Central aimak: Ulan-Baator, Nucht im Bogdo ul, 1880–2000 m, gekötschert, vorwiegend von den Erlen und Birken, 9.VI.1966.

No. 519. Central aimak: SO von Somon Bajanzogt, 1600 m, am Waldrand von blühendem Gestruch (Weiden und Birken) gekötschert, 11.VI.1966.

No. 523. Central aimak: etwa 30 km O von Somon Nalajh, 1530 m, gekötschert im feuchten Talgrund sowie an den trockeneren, kahlen Berghängen bis zum Waldrand, 14.VI.1966.

No. 539. Archangaj aimak: Changaj Gebirge, 8 km W von Somon Urdtamir, 1620 m, mit Hilfe der "Malaise-Falle" gefangen, 19.VI.1966.

No. 614. Chovd aimak: 3 km N von Somon Uenc, im Tal des Flusses Uenc gol, 1450 m, gekötschert im Talgrund neben dem Bach, 2–3.VII.1966.

No. 637. Chovd aimak: Mongol-Altaj-Gebirge, Uljasutajn gol, 45 km NNO von Somon Bulgan, 1400 m, linker Nebenflu des Bulgan gol, etwa 6–8 km vor der Mündung des Bulgan gol, tiefer Engpa, sehr steil abhängende Berge mit spärlicher Vegetation, im Talgrund kleines bewässertes Ackerfeld, an den felsigen Berghängen blühende *Caragana*, im Talgrund gekötschert und am Berghang von *Caragana* geklopft, 6.VII.1966.

No. 732. Bulgan aimak: 9 km O von Somon Abzaga, 1300 m, gekötschert, 23.VII.1966.

No. 739. Central aimak: Ulaan chodag, 16 km S von Somon Öndörschireet, 1500 m, vorwiegend von blühender *Urtica* etc. gekötschert, 24.VII.1966.

No. 746. Central aimak: Ulan-Baator, Nucht in Bogdo ul, 12 km SO vom Zentrum, 1800–2000 m, vom Gesträuch und von Unkraut gekötschert, 27.VII.1966.

No. 749. Central aimak: SO von Somon Bajazogt, 1600 m, von der üppigen Vegetation im Talgrund und am Waldrand gekötschert, 27.VII.1966.

No. 926. Central aimak: Tosgoni ovoo, 5–10 km N von Ulan-Baator, 1500–1700 m, an den Südhängen der Gebirgssteppe, am Nordhang mit einem Birkenwald, gekötschert, 19–20. und 23–24.VII.1967.

No. 931. Central aimak: Ulan-Baator, Nucht im Bogdo ul, 12 km SO vom Zentrum, 1500–1600 m, mit sehr üppiger Vegetation bedeckter Talgrund neben dem Bach, im Talgrund gekötschert, 21.VII.1967.

No. 945. Central aimak: 11 km OSO von Somon Bajanzogt, 1600 m, zehn Ethylenglykol-Bodenfallen im Wald eingegraben 13.VI.1968, aufgenommen am 26.VII.1968.

No. 959. Bulgan aimak: 30 km NNW von Somon Daschincilen, 1200 m, sehr trockene, öde *Caragana*-Steppe, von der niedrigen, spärlich wachsenden *Caragana* gekötschert, 15.VI.1968.

No. 961. Bulgan aimak: zwischen Somon Chischig-Öndör und Somon Orchon, 23 km NNO von Chischig-Öndör, 1390 m, bewaldetes Hügelland, ausgedehnte Birken- und Nadelholzwälder, an den Waldrändern Gebüsch, im Talgrund nasse Wiesen, am Waldrand und auf der Steppe gekötschert, 15.VI.1968.

No. 967. Bulgan aimak: 7 km NW von Somon Chanzargalant, 1350 m, nach W auslaufendes Tal, steile Berghänge, am Nordhang alter Nadelholzwald, am Südhang steinige Gebirgssteppe mit Gebüsch, der Talgrund mit Waldlichtungen und blühendem Unterholz, gekötschert am Waldrand und im Tal, 16.VI.1968.

No. 970. Same as No. 967, 16.VI.1968. Zehn Ethylenglykol-Bodenfallen eingegraben: 5 am Nadelholz-Waldrand und 5 an einem kahlen, steilen Berghang, entleert am 22.VII.1968.

No. 973. Bulgan aimak: Namnam ul Gebirge, 23 km NW von Somon Chutag, 1150 m, an den Berghängen junge Nadelholzwälder und Birkenwald, im letzteren mit alleinstehenden, sehr alten Birken und sibirischen Zedern, im Talgrund neben dem Bach Weidengebüsch und ausgedehnte Gebirgsteppe, gekötschert, 17.VI.1968.

No. 978. Chövsgöl aimak: 6 km von Somon Tosoncengel, 1480 m, trockener Nadelholzwald, steile, steinige Berghänge, dicht bewachsene Wasserrissen mit blühendem Gebüsch, gekötschert, 18.VI.1968.

No. 987. Chövsgöl aimak: 84 km W von der Stadt Mörön, etwa 10 km NO vom Fluß Delger mörön, 1650 m, in einer Schlucht mit sehr steilen, steinigen Berghängen, am Südhang von blühender *Caragana* gekötschert, 20.VI.1968.

No. 1010. Uvs aimak: am Fluß Changilcagijn gol, 6 km SW von Somon Baruunturuum, 1350 m, breites Flußbett (derzeit hie und da mit wenig Wasser), Pappel-Auenwald mit ganz trockenen Terrassen und trockenen Berghängen, überall viele *Thymus* und *Artemisia*, die Steppe ist steinig und kurzrasig, im Flußbett vor allem von blühender *Caragana* und von *Iris* gekötschert, 24.VI.1968.

No. 1066. Uvs aimak: Südrand des Sees Örög nuur, 1500 m, gekötschert neben dem See an der nassen, kurzrasigen Wiese, besonders von blühenden *Ranunculus* und von *Lasiagrostis*, 5.VII.1968.

No. 1123. Chövsgöl aimak: N. von Somon Chatgal am SW-Ecke des Sees Chövsgöl nuur, 1650 m, am Seeufer Nadelholzwald, stellenweise mit Lichtungen, an den Waldrändern und in Lichtungen blühende Pflanzen, gekötschert, 18.VII.1968.

No. 1135. Bulgan aimak: Namnan ul Gebirge, 23 km NW von Somon Chutag, 1150 m, an den Berghängen junger Nadelholzwald und Birkenwald, im letzteren mit alleinstehenden, sehr alten Birken und sibirischen Zedern, im Talgrund neben dem Bach Weidengebüsch und ausgedehnte Gebirgssteppe, an den Wasserrissen und an den Waldrändern sehr üppige Vegetation mit Doldenblütlern, gekötschert, 21.VII.1968.

LIST OF THE SPECIES

Subsequently thirty braconid species are reported from Mongolia which belong to seven subfamilies. From among them five species are new to science (their descriptions are presented under the title "Descriptions of the new species") and seventeen species are new to the fauna of Mongolia. Besides the obligatory faunistic data zoogeographic and/or taxonomic notes are added where necessary. As indicated before the faunistic data are given in an abbreviated form citing only the collecting locality numbers, the resolution of the respective numbers see in the chapter entitled "List of the collecting data".

DORYCTINAE

Rhyssalus longicaudis (TOBIAS et BELOKOBYLSKIJ, 1981) – Locality: 2 ♀♀: No. 945. – Described from the Russian Far East Maritime Territory ("Tchuguevka"), reported from further two localities in Russia (Sverdlovsk, Sankt Petersburg region) and Finland. New to the fauna of Mongolia.

HELCONINAE

Diospilus capito (NEES, 1834) – Locality: 1 ♂: No. 926.
Diospilus ephippium (NEES, 1834) – Locality: 1 ♂: No. 987.

METEORINAE

Meteorus eadyi HUDDLESTON, 1980 – Localities: 1 ♂ (in PAPP 1980: 401 listed under the name *M. profligator* HALIDAY and here emendated): No. 486. 2 ♂♂ (in PAPP l.c. listed "2 ♀" under the name *M. profligator* HALIDAY and here emendated): No. 1010. – First reported from Mongolia by me (PAPP 1992: 304).

EUPHORINAE

Leiophron (Euphoriana) frater TOBIAS, 1986 – Locality: 1 ♀: No. 934. – Body 2.4 mm long. Antenna with 15 antennomeres. Notaulix indicated by a row of fine punctures behind. Petiole moderately broadening posteriorly, longitudinally striated. Head reddish yellow, meso- and metasoma blackish brown. Antennomeres 7–8 yellow, rest of flagellum darkening brownish. Tegula yellow, legs reddish yellow. – Described from Kazakhstan and from the European part of Russia. New to the fauna of Mongolia.

Peristenus facialis (THOMSON, 1891) – Localities: 1 ♂ (in PAPP 1967: 194 listed under the name *Euphorus accinctus* HALIDAY and here emendated): No. 281. 1 ♂: No. 523. 8 ♂♂: No. 732.

Peristenus kaszabi sp. n.: for description see p. 41.

Peristenus microcerus (THOMSON, 1891) – Localities: 3 ♀♀: No. 504. 1 ♀ + 1 ♂: No. 519. – The species name *microcerus* was synonymized by LOAN (1974: 218) with *Peristenus facialis* (THOMSON, 1891). Considering RICHARDS's key (1967) and redescription of *microcerus* it seems to represent a valid species. After RICHARDS known from Sweden and England. New to the fauna of Mongolia.

Peristenus nitidus (CURTIS, 1833) – Localities: 1 ♀: No. 504. 2 ♀♀: No. 961. 2 ♀♀: No. 973. – In Europe a frequent to common species. New to the fauna of Mongolia.

Peristenus orchesiae (CURTIS, 1833) – Localities: 2 ♂♂: No. 614. 1 ♂: 637. – Widely distributed in Europe. New to the fauna of Mongolia.

Peristenus pallipes (CURTIS, 1833) – Localities: 1 ♂: No. 499. 2 ♂♂: No. 508. 2 ♀♀: No. 519. 1 ♀: 523. 1 ♂: 939. 1 ♂: 1066. Taken only in June. – Frequent to common in the Holarctic Region.

Streblocera macroscaphus (RUTHE, 1856) – Locality: 1 ♀: No. 409. – Antenna with 19 antennomeres. First tergite twice as long as broad behind. Ground colour of body orange yellow; propodeum, first and last tergites brownish. – A Palaearctic species. New to the fauna of Mongolia.

BLACINAE

Blacus (Ganychorus) diversicornis (NEES, 1834) – Locality: 1 ♂: 180 km NW of Baruum Urt, taken with soil trap, 11–18.VIII.1972, leg. F. MÉSZÁROS. – Distributed in the western Palaearctic Region, reported nearest to Mongolia from Kazakhstan. New to the fauna of Mongolia.

Blacus (Blacus) filicornis HAESELBARTH, 1973 – Locality: 1 ♀: No. 523. – The female specimen at hand represents a monstrous form: right antenna short, i.e. flagellomeres short corresponding to female and with 17 antennomeres, left antenna long, i.e. flagellomeres like in male and with 19 antennomeres. Only female genitalia present. – First reported (with question-mark) from Mongolia by HAESELBARTH (1973b: 79).

OPIINAE

Opius (Cryptonastes) impatientis FISCHER, 1957 – Localities: 1 ♂ (det. FISCHER 1995): No. 926. – Known from many countries in the western Palaearctic Region. New to the fauna of Mongolia.

Opius (Xynobius) kaszabi FISCHER, 1968, G new. – Localities: 1 ♂: No. 749. 1 ♂: No. 959. – The species was described by FISCHER (1968: 101) on the basis of two female specimens from Mongolia; hitherto known only from this country. – The male form is similar to the female. Antenna with 28 (1 ♂) and 32 (1 ♂) antennomeres. Head in dorsal view 1.88 times as broad as long, eye as long as temple and latter less rounded. Scutellum apically rugulose, otherwise just uneven. Tergites 2–3 almost smooth, shiny.

Opius (Hypocynodus) lara FISCHER, 1968 – Locality: 1 ♀: No. 433. – The female specimen was taken in the type-locality in Mongolia, up to this time known only from this country. – Antenna with 24 antennomeres. Head in dorsal view 1.9 times as broad as long, eye as long as temple. First tergite entirely polished. Body 2.1 mm long.

ALYSIINAE

Alysia (Alysia) frigida HALIDAY, 1838 – Localities: 1 ♀: No. 739. 1 ♂: No. 1010. – The female specimen at hand deviating in a few respects from the two females reported from Mongolia, loc. No. 926a (PAPP 1991: 218): (1) antenna with 31 (and not with 39) antennomeres, (2) distal antennomeres 1.5 times (and not 1.6–1.7 times) as long as broad, (3) ovipositor sheath somewhat shorter than hind tibia (and not as long as hind tibia + basitarsus), (4) mandible reddish yellow (and not vivid yellow). – The male specimen bears a long second submarginal cell, i.e. 3–SR as long as 2–SR. – A Holarctic species, nearest to Mongolia known from East Russia and China. New to the fauna of Mongolia.

Dinotrema firmidens sp. n.: for description see p. 43.

Idiasta daurica BELOKOBYLSKIJ, 1998, ♂ new. – Locality: 2 ♂♂: No. 523. – The species was described on the basis of a single female specimen from Far East of Russia. My two males match well the description. Body 3.3–3.8 mm long. Antenna with 39 (1 ♂) and 42 (1 ♂) antennomeres, second flagellomere 1.3 times as long as first flagellomere (that of female: "Antenna with more than 16 antennomeres" BELOKOBYLSKIJ 1998: 278). Temple posteriorly rugulose-uneven. Metasoma black, only second tergite faintly rusty. – Described recently from Chita Region (Russia: Siberia). New to the fauna of Mongolia.

Orthostigma breviradiale KÖNIGSMANN, 1969 – Locality: 1 ♂: No. 978. – Reported nearest to Mongolia from Kamchatka Peninsula (BELOKOBYLSKIJ 1998: 210). New to the fauna of Mongolia.

Phaenocarpa (Discphaenocarpa) angustiptera PAPP, 1968 – Localities: 1 ♀: No. 931. 1 ♀: No. 970. – In the eastern Palaearctic Region first reported by me (PAPP 1994: 137) from Korea, later reported from the Far East Territory of Russia (BELOKOBYLSKIJ 1998: 226). New to the fauna of Mongolia.

Phaenocarpa (Phaenocarpa) aurosetosa sp. n.: for description see p. 45.

Phaenocarpa (Phaenocarpa) curvula (THOMSON, 1895) – Locality: 1 ♂: No. 967. – Hitherto known only from Sweden. New to the fauna of Mongolia.

Phaenocarpa (Phaenocarpa) nigripes GURASASHVILI, 1983 – Localities: 1 ♀ + 2 ♂♂: No. 298. 2 ♀♀: No. 746. – Claws of both the females and males basally with a large lobe. Notaulix distinct but shallowing posteriorly. Antenna with 30–32 (♀) and 35 (♂) antennomeres. Otherwise the five Mongolian specimens (3 ♀♀ + 2 ♂♂) match well the redescription by FISCHER (1990: 120). *N. rec.* or *r-m* antefurcal and not "interstitial" as given in the keys: FISCHER 1990: 110 couplet 17 and 1993*c*: 523 couplet 21. – Described from Georgia, reported from several territories of East Russia, nearest to Mongolia from Buryatia (BELOKOBYLSKIJ 1998: 223–224). New to the fauna of Mongolia.

Phaenocarpa (Phaenocarpa) propebakinum sp. n.: for description see p. 47.

Phaenocarpa (Phaenocarpa) subruficeps GURASASHVILI, 1983 – Locality: 2 ♂♂: No. 1123. – The species is known only by its male form which is very similar to the male of *Ph. ruficeps* NEES. The distinction between the two species is restricted to a single feature of mesoscutum: *ruficeps* here without and *subruficeps* here with a medio-longitudinal sulcus. – Described and hitherto known from Georgia (Abhazia). New to the fauna of Mongolia.

Synaldis armeniaca FISCHER, 1993 – Locality: 1 ♂: No. 1135. – Body 1.5 mm long. Antenna with 19 antennomeres. Head in dorsal view between temples slightly broader than between eyes, 1.6 times as broad as long. – Described from Armenia. New to the fauna of Mongolia.

Synaldis sinaulice sp. n.: for description see p. 49.

Synaldis sulcata FISCHER, 1962 – Locality: 1 ♀: Chentey aimak, 65 km NNW from Öndörchaan, VII 1980, leg. Zs. PEREGI. – Antenna with 16 antennomeres, otherwise matching the original description (FISCHER 1962: 19). – Known from Croatia (Istria Peninsula), Tunesia, I have a specimen (1 ♀) from Turkey. New to the fauna of Mongolia.

DESCRIPTIONS OF THE NEW SPECIES

EUPHORINAE

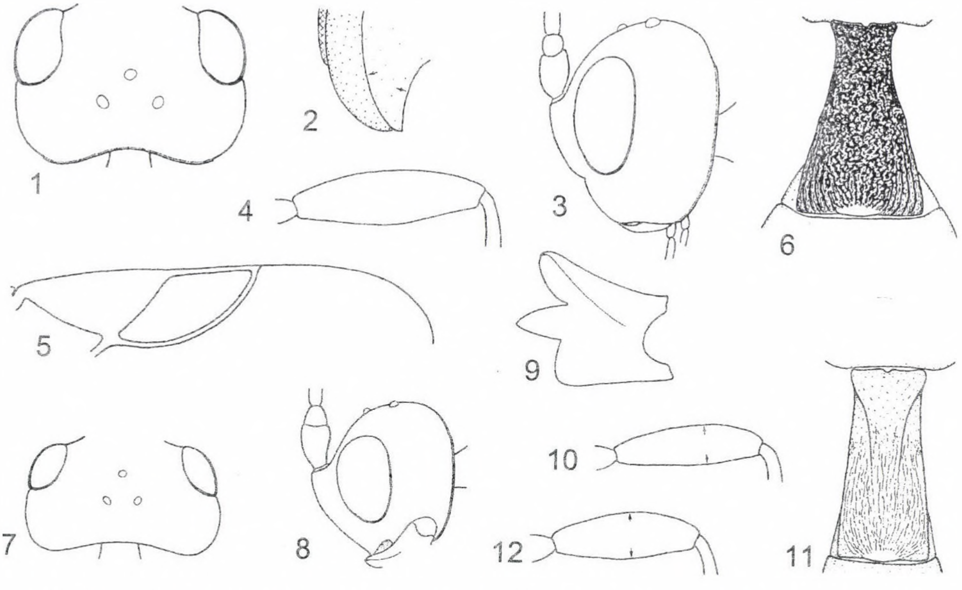
Peristenus kaszabi sp. n. ♂

(Figs 1–6)

Material examined (4 ♂♂). – Male holotype and three male paratypes: Mongolia, Bulgan aimak, 9 km East from Somon Abzaga, 1300 m, 23 July 1966, leg. KASZAB (loc. No. 732). – Holotype and three paratypes are deposited in the Hungarian Natural History Museum (Department of Zoology), Budapest, Hym. Typ. Nos 7883 (holotype) and 7884–7886 (paratypes).

Etymology. – The new species is dedicated to Dr. ZOLTÁN KASZAB (1915–1986), collector of the type specimens during his fourth zoological expedition to Mongolia in July 1966.

Description of the male holotype. – Body 3.2 mm long. Antenna as long as three-fourths of body and with 23 antennomeres. First flagellomere 1.14 times as long as second flagellomere; first flagelomere 2.6 times, second flagellomere 2.4 times as long as broad apically, further flagellomeres progressively shortening and attenuating so that penultimate flagellomere 1.5 times as long as broad. – Head in dorsal view (Fig. 1) subcubic, 1.5 times as broad as long, temple moderately rounded, eye as long as temple. Occipital and hypostomal carinae ventrally not connected by a branch (Fig. 2, see arrows). OOL : OD : POL as 13 : 5 : 12. In lateral view eye 1.9 times as high as wide, temple 1.4 times as long as eye and beyond eye evenly wide (Fig. 3). Face twice as wide as



Figs 1–12. 1–6. *Peristenus kaszabi* sp. n.: 1 = head in dorsal view, 2 = left hind part of head with hypostomal and occipital carinae indicated with arrows, 3 = head in lateral view, 4 = hind femur, 5 = distal part of right fore wing, 6 = first tergite. – 7–11. *Dinotrema firmidens* sp. n.: 7 = head in dorsal view, 8 = head in lateral view, 9 = mandible in frontal view, 10 = hind femur, 11 = first tergite. – 12. *Dinotrema propelamur* PAPP: hind femur

high, densely and finely punctate, setose. Clypeus 2.1 times as wide below as high medially, its lower margin convex and finely crenulate, otherwise clypeus smooth and shiny. Intertentorial line clearly twice tentorial-ocular line. Frons macropunctate, vertex and temple polished with a few hairpunctures.

Mesosoma in lateral view 1.4 times as long as high. Pronotum transverse-medially rugose, anteriorly and posteriorly smooth with disperse hairpunctures, shiny. Median lobe of mesoscutum macropunctate, lateral lobes smooth with sparse hairpunctures. Scutellum polished. Propodeum entirely rugose. Precoxal sulcus crenulate, mesopleuron above rugose otherwise polished with a few hairpunctures. – Hind coxa smooth, shiny. Hind femur 3.6 times as long as broad medially (Fig. 4), hind tibia eight times as long as broad distally and hind basitarsus seven times as long as broad; hind basitarsus as long as tarsomeres 2–4 combined.

Fore wing: Pterostigma wide, twice as long as wide and issuing veins *2–SR* and *3–SR* from its middle; vein *1–R1* half length of pterostigma and one-fourth longer than width of pterostigma; *r* missing, i.e. *2–SR* and *3+4–SR* (or *3–SR + SR1*) joining directly pterostigma close to each other (Fig. 5). Vein *m-cu* interstitial, *1–CU1* : *2–CU1* as 4 : 21. Basal cell slightly less setose than discal or submarginal cells. – Hind wing with distinct subbasal cell; proportional length of *1–M* : *1r-m* : *2–SC+R* as 15 : 13 : 10.

First tergite (or petiole) fairly evenly broadening posteriorly, i.e. 1.56 times as long as broad behind, pair of small spiracles at its middle, rugose and posteriorly with striate elements (Fig. 6). Transverse borders of further tergites indistinct, tergites polished.

Ground colour of body black with much faint brownish tint. Scape and pedicel yellow, flagellum darkening brown. Clypeus rusty. Palpi pale brownish yellow, mandible brownish yellow and apically blackish. Tegula brownish yellow. Legs yellow, hind tibia and tarsi 2–3 faintly brownish fumous. Wings hyaline, pterostigma brown, basally yellowish, median veins opaque brownish.

Description of the three male paratypes. – Similar to the male holotype. Body 2.9–3 mm long (1 ♂: 2.9, 2 ♂♂: 3). Antenna with 22 (2 ♂♂) and 23 (1 ♂) antennomeres. Vein *m-cu* of fore wing interstitial (1 ♂) as well as more (1 ♂) or less (1 ♂) postfurcal.

Female and host unknown.

Distribution: Mongolia.

The new species, *Peristenus kaszabi*, is nearest to *P. prodigiosus* CHEN et VAN ACHTERBERG, 1997 (China) considering their relatively short and posteriorly clearly broadening petiole, macropunctate frons and mesoscutum and the dark coloured body; the two species are distinguished by the features keyed:

1 (2) Head in dorsal view transverse, 1.7 times as broad as long, temple rounded and eye 1.2 times as long as temple (Fig. 436 in CHEN & VAN ACHTERBERG 1997: 189). Vein *r* present and pterostigma issuing *r* from its middle (Fig. 434 l.c.). Mesopleuron macropunctate-rugose. Occipital and hypostomal carinae ventrally connected by a branch (cf. Fig. 407 in CHEN & VAN ACHTERBERG 1997: 186). Temple beyond eye with a small reddish spot. ♂: 3.1 mm *P. prodigiosus* CHEN et VAN ACHTERBERG

2 (1) Head in dorsal view less transverse or subcubic, 1.5 times as broad as long, temple moderately rounded, eye as long as temple (Fig. 1). Vein *r* absent and pterostigma issuing *2–SR* and *3+4SR* somewhat distally from its middle

(Fig. 5). Mesopleuron smooth and shiny. Occipital and hypostomal carinae ventrally not connected by a branch (Fig. 2). Temple beyond eye with a faint brownish tint. ♂: 3–3.2 mm **P. kaszabi** sp. n.

ALYSIINAE

Dinotrema firmidens sp. n. ♂
(Figs 7–11)

Material examined (2 ♂♂). – Male holotype + one male paratype: Mongolia, Central aimak, SO von Somon Bajanzogt, 1600 m, 11 June 1966, leg. Kaszab (loc. No. 519). – Holotype and one paratype are deposited in the Hungarian Natural History Museum (Department of Zoology), Budapest, Hym. Typ. Nos 7887 (holotype) and 7888 (paratype).

Condition of the types. – 1. Holotype: left antenna damaged, with 18 antennomeres, left fore leg hardly to be seen owing to the mounting. 2. Paratype: right antenna damaged, with 18 antennomeres.

Etymology. – The species name "firmidens" refers to the unusually strong first tooth of the mandible.

Description of the male holotype. – Body 1.8 mm long. Antenna somewhat longer than body and with 20 antennomeres. First flagellomere 2.2 times, second flagellomere 1.8 times as long as broad, further flagellomeres faintly attenuating so that penultimate flagellomere twice as long as broad. – Head in dorsal view (Fig. 7) transverse, 1.8 times as broad as long, eye 0.8 times as long as temple, temple somewhat bulging, i.e. head between temples a bit broader than between eyes. Head 1.4 times as broad as mesoscutum between tegulae. Ocelli small and almost round, OOL clearly twice as long as POL. Eye in lateral view 1.7 times as high as wide and 0.8 times as wide as temple, temple beyond eye slightly narrowing ventrally (Fig. 8). Mandible (Fig. 9) conspicuously broadening distally, along its median line slightly longer than broad between teeth 1 and 3; tooth 1 unusually large and broadening basally, tooth 2 spiky and less large than tooth 1, between teeth 1 and 2 an incision, tooth 3 rounded; outer surface of mandible smooth. Tentorial pit twice as wide as long and not reaching eye, its distance from eye half its width. Shortest width of face 1.8 times its median height. Head polished, face and clypeus finely hairpunctured.

Mesosoma in lateral view 1.25 times as long as high. Midpit short linear, less deep. Precoxal suture short, restricted to middle of mesopleuron, narrow and subcrenulate. Hind margin of mesopleuron smooth. Propodeum along medio-longitudinal weak carina rugulose, anteriorly crossing a short transverse carina, anteriorly from transverse carina a distinct medio-longitudinal carina; lateral pair of spiracles small, lateral margin of propodeum rugulose-subrugulose (cf. Fig. 34 in PAPP 1999: 231). – Hind femur 3.8 times as long as broad distally (Fig. 10, see arrows).

Fore wing somewhat longer than body. Vein *3–SR* 2.25 times as long as *2–SR* and *4–SR* 2.7 times as long as *3–SR*. Subdiscal cell issuing *CU1a* clearly posteriorly from *3–CU(1)* + *CU1b* (cf. Fig. 35 l.c.).

Metasoma somewhat shrivelled, about as long as mesosoma. First tergite (Fig. 11) moderately broadening posteriorly, twice as long as broad behind and 1.2 times as broad behind as basally, pair of spiracles before middle of tergite, pair of basal keels converging and merging into longitudinal and faint rugulo-striation of tergite. Further tergites polished.

Ground colour of body black, metasoma beyond first tergite with faint brownish tint. Antenna brownish black, mandible dark rusty, palpi brown. Tegula dark brown. Coxae, trochanters and femora blackish to dark brown, tibiae and tarsi brown, base of tibiae 2–3 light brown. Wings subhyaline, veins brown.

Description of the male paratype. – Similar to the male holotype. Body 2 mm long. Antenna with 21 antennomeres.

Host unknown.

Distribution: Mongolia.

The new species, *Dinotrema firmidens*, runs to *D. cruciata* (FISCHER, 1973) (Austria) with the help of FISCHER's key (1976) considering their long tentorial pit, antenna with 20–21 antennomeres and long first tooth of mandible; the two species are distinguished by the features keyed:

1 (2) Tooth 2 of mandible somewhat longer than tooth 1, mandible along median line 1.7 times as long as broad between teeth 1 and 3. In dorsal view temple beyond eye not bulging, eye as long as temple. Tegula, legs and tergites 1–2 reddish yellow. ♀: 2.7 mm *D. cruciata* FISCHER

2 (1) Tooth 2 of mandible shorter than tooth 1, tooth 1 conspicuously large, mandible along median line slightly longer than broad between teeth 1 and 3 (Fig. 9). In dorsal view temple beyond eye somewhat bulging, eye 0.8 times as long as temple (Fig. 7). Tegula, legs and tergites 1–2 dark brown to black(ish). ♂: 1.8–2 mm **D. firmidens** sp. n.

Considering the strong first mandibular tooth of the new species, *D. firmidens* is near to *D. propelamur* PAPP, 1999 (Mongolia), the two species differ from each other by the following features:

1 (2) Tooth 1 of mandible not broadening basally (Fig. 33 in PAPP 1999: 231). Antenna with 16 antennomeres, first flagellomere 2.7 times as long as broad. First tergite more broadening posteriorly, pair of spiracles beyond middle of tergite (Fig. 36 l.c.). Hind femur 3.3 times as long as broad medially (Fig. 12, see arrows). Fore half of metasoma and legs light brown. ♀: 2.1 mm *D. propelamur* PAPP

2 (1) Tooth 1 of mandible clearly broadening basally (Fig. 9). Antenna with 20–21 antennomeres, first flagellomere 2.2 times as long as broad. First tergite less broadening posteriorly, spiracles before middle of tergite (Fig. 11). Hind femur 3.8 times as long as broad distally (Fig. 10, see arrows). Fore half of metasoma and legs dark brown to black(ish). ♂: 1.8–2 mm **D. firmidens** sp. n.

Phaenocarpa (Phanocarpa) aurosetosa sp. n. ♀♂
(Figs 13–20)

Material examined (3 ♀♀ + 1 ♂). – Female holotype: Mongolia, Central aimak, Ulan-Baator, Nucht in Bogdo ul, 1500–1600 m, 21 July 1967, leg. KASZAB (loc. No. 931). – One female paratype (as *Ph. picinervis* HALIDAY in PAPP 1967: 212): Mongolia, Uburchangaj aimak, Changaj Mts, Ongijn gol, 10 km ENE from Arbajcher, 1800 m, 29 June 1964, leg. KASZAB (loc. No. 220). – One male paratype: Mongolia, Chövsgöl aimak, 8 km N from Somon Burenchaan, along Delger mörön river, 1450 m, 20 June 1968, leg. KASZAB (loc. No. 990). – One female paratype: Mongolia, Bajan-Ölgij aimak, in the valley of Chavcalyn gol river, 24 km E from Somon Cagannuur, 1890 km, 29 June 1968, leg. KASZAB (loc. No. 1043).

Holotype and three paratypes (2 ♀♀ + 1 ♂) are deposited in the Hungarian Natural History Museum (Department of Zoology), Budapest, Hym. Typ. Nos 7889 (holotye) and 7890–7892 (paratypes).

Condition of the types. – 1. Female holotype: ultimate flagellomere of right antenna missing. 2. One female paratype (loc. No. 220): left antenna damaged, with 20 antennomeres. 3. One female paratype (loc. No. 1043): left antenna damaged, with five antennomeres; missing: fore left and hind right tarsi; fore left wing beyond pterostigma strongly shrivelled. 4. One male paratype (loc. No. 990): right antenna damaged, with 20 antennomeres.

Etymology. – The species name "aurosetosa" refers to the golden setae of the head and mesoscutum.

Description of the female holotype. – Body 3.1 mm long. Antenna somewhat longer than body and with 25 antennomeres (left antenna). First flagellomere 3.6 times and second flagellomere 5.4 times as long as broad apically, second flagellomere 1.5 times as long as first flagellomere, penultimate flagellomere 2.2 times as long as broad, flagellum filiform and not attenuating. – Head in dorsal view (Fig. 13) twice as broad as long, eye 1.8 times as long as temple, temple rounded, occiput excavated. Ocelli small and round, POL : OD : OOL as 8 : 3 : 15. Eye in lateral view nearly round, 1.25 times as high as wide, temple beyond eye one-third less (12 : 18) and evenly wide. Mandible as in Fig. 14, between teeth 1 and 2 no incision, mandible itself 1.5 times as long medially as broad between teeth 1 and 3. Face hairpunctured, punctures along eye dense. Head rather densely and golden setosed, setae concentrically arranged around ocellar field, setae short and directed outwards (Fig. 13).

Mesosoma in lateral view 1.25 times as long as high. Notaulices evenly and moderately deep, uncrenulate, meeting behind in a linear midpit. Mesoscutum densely hairpunctured and covered with golden setae directed backwards. Prescutellar furrow twice as wide as long along median carina, laterally from carina uneven; pair of fields laterally from prescutellar furrow 1.3–1.4 times as wide as long. Areola basalis (of propodeum) issuing anteriorly a medio-longitudinal keel, horizontal part of propodeum smooth and shiny, its declivous (or vertical) part medially strigulose, laterally rugose (Fig. 15). Precoxal suture wide, crenulate, mesopleuron polished, below tegulae hairpunctured. – Hind femur 5.5 times as long as broad distally (Fig. 16). Hind claw long and moderately curved as in Fig. 17.

Fore wing as long as body. Pterostigma 3.6 times as long as wide, issuing *r* from its distal third, *r* short, *3–SR* 1.36 times as long as *2–SR*, *4–SR* just less than twice as long as *3–SR* and reaching tip of wing. Vein *m-cu* antefurcal; along *r-m* as well as at meeting of submarginal cells 1–2 and first discal cell (or along vein *2–SR–M* and bases of veins *2–SR* and *2–M*) with dense and dark hairs (Fig. 18). Vein *1CU1+2CU1* 1.3 times as long as *m-cu*.

First tergite (Fig. 19) as long medially as broad behind, clearly and evenly broadening posteriorly, i.e. twice as wide behind as basally, pair of spiracles before its middle, pair of basal keels meeting at middle of tergite, tergite itself medially strigose and laterally polished. Further tergites polished. Ovipositor sheath in lateral view about as long as metasoma or as long as hind tibia.

Ground colour of body black; pronotum and mesoscutum rusty, scutellum and metanotum dark rusty. Clypeus dark rusty, mandible rusty, palpi brownish. Scape and pedicel rusty, flagellomeres 1–6 darkening rusty, rest of flagellum blackish. Tegula and legs brownish yellow, tarsi brown fumous. Wings subhyaline, pterostigma and veins brown, dense setae along *r-m* and at meeting of submarginal cells 1–2 and first discal cell blackish.

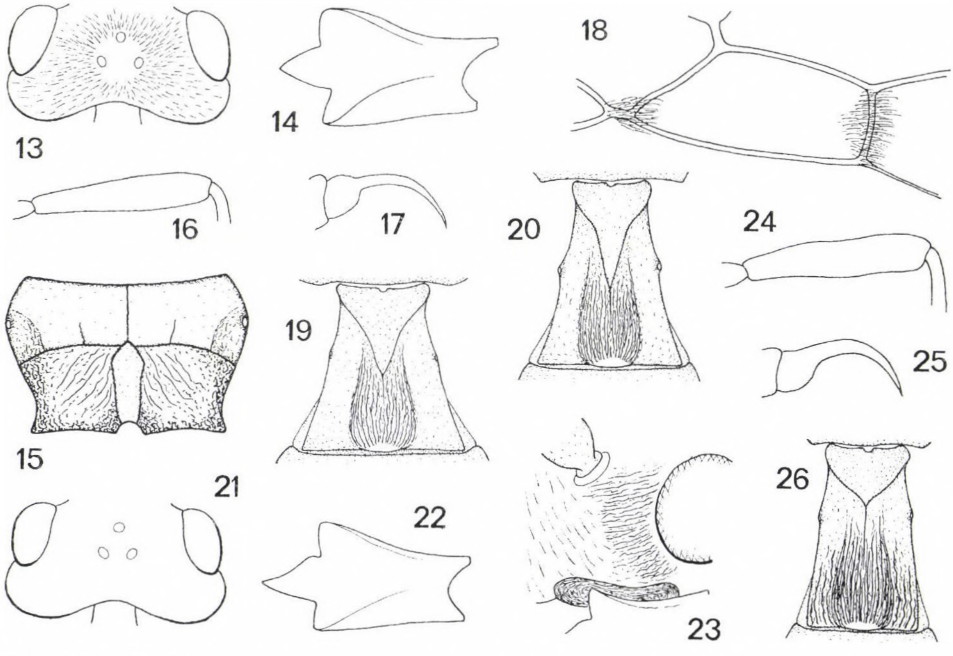
Description of the two female paratypes. – Similar to the female holotype. Body 2.7 (1 ♀) and 3.3 (1 ♀) mm long. Antenna with 24 (1 ♀) and 26 (1 ♀) antennomeres. Pronotum, mesoscutum, scutellum and metanotum dark rusty, lateral lobes of mesoscutum black.

Description of the male paratype. – Similar to the female. Body 3.5 mm long. Antenna with 32 antennomeres. Mesoscutum entirely black. First tergite 1.25 times as long as wide behind, its sculpture somewhat rougher (Fig. 20).

Host unknown.

Distribution: Mongolia.

The new species, *Phaenocarpa (Phaenocarpa) aurosetosa*, is nearest to *Ph. (Ph.) vulcanica* BELOKOBYLSKIJ, 1998 (Russia: Kamchatka Peninsula) conside-



Figs 13–26. 13–20. *Phaenocarpa (Phaenocarpa) aurosetosa* sp. n.: 13 = head in dorsal view, 14 = mandible in frontal view, 15 = propodeum, 16 = hind femur, 17 = claw of hind tarsus, 18 = second submarginal cell of fore wing, 19 = first tergite of female, 20 = first tergite of male. – 21–26. *Phaenocarpa (Phaenocarpa) propebakinum* sp. n.: 21 = head in dorsal view, 22 = mandible in frontal view, 23 = lateral part of face and eye, 24 = hind femur, 25 = claw of hind tarsus, 26 = first tergite

ring their densely setose head and mesoscutum, along vein *r-m* of fore wing also densely setose alar membrane; the two species are differentiated by the following features keyed:

1 (2) First tergite 1.3–1.4 times as long as broad behind (Fig. 8 in BELOKOBYLSKIJ 1998: 237). Eye in dorsal view 1.1–1.5 times as long as temple. Pterostigma 4.2–6 times as long as wide. Propodeum with a keel extending on its basal third. Antenna of female with 27–29 antennomeres. Mesosoma in lateral view 1.6–1.7 times as long as high. ♀: 2.7–3.1 mm *Ph. (Ph.) vulcanica* BELOKOBYLSKIJ

2 (1) First tergite as long as broad behind (♀: Fig. 19) or somewhat longer than broad behind (♂: Fig. 20). Eye in dorsal view 1.8–1.9 times as long as temple (Fig. 13). Pterostigma 3.6–4 times as long as wide. Propodeum with a narrow areola basalis (Fig. 15). Antenna with 24–26 (♀) and 32 (♂) antennomeres. Mesosoma in lateral view 1.2–1.3 times as long as high. ♀: 2.7–3.3 mm, ♂: 3.5 mm **Ph. (Ph.) aurosetosa** sp. n.

Phaenocarpa (Phaenocarpa) propebakinum sp. n. ♀
(Figs 21–26)

Material examined (2 ♀♀): Female holotype and one female paratype: Mongolia, Central aimak, Ulan-Baator, Nucht in Bogdo ul, 1600–1700 m, taken with soil trap, 22 July – 27 August 1965, leg. KASZAB (loc. No. 297b).

Holotype and one paratype are deposited in the Hungarian Natural History Museum (Department of Zoology), Budapest, Hym. Typ. Nos 7893 (holotype) and 7894 (paratype).

Condition of the types. – 1. Holotype: left antenna with 28 antennomeres, i.e. ultimate two flagellomeres missing; left fore wing somewhat creased. 2. Paratype: right flagellum missing (scape + pedicel present); hind femur + tibia + tarsus of left leg missing; distal part of left fore wing creased, that of right fore wing somewhat teared.

Etymology: The species name "propebakinum" indicates its nearest ally, *Ph. basarukini* BELOKOBYLSKIJ, in an abbreviated form propeba[saru]kini.

Description of the female holotype. – Body 3.4 mm long. Antenna about one-fourth longer than body and with 30 antennomeres. First flagellomere indistinctly thicker than second flagellomere and 2.8 times as long as broad apically, second flagellomere four times as long as broad apically and 1.3 times as long as first flagellomere; penultimate flagellomere twice as long as broad. – Head in dorsal view (Fig. 21) transverse, 1.85 times as broad as long, eye 1.4 times longer than temple; temple bulging, i.e. head between temples a bit broader than between eyes; occiput excavated. Ocelli small and elliptic, POL : OD : OOL as 6 : 5 : 15. Eye in lateral view nearly round, 1.25 times as high as wide, temple beyond eye ventrally moderately broadening and 0.7 times as wide as eye. Mandible as in Fig. 22, between teeth 1 and 2 a weak incision, mandible itself 1.7 times as long medially as broad between teeth 1 and 3, moderately broadening distally. Face hair-punctured and shiny, lateral field beside eye with horizontal rugulae-striolae (Fig. 23). Head (temple, vertex, frons, occiput) polished, face and clypeus setose.

Mesosoma in lateral view 1.5 times as long as high. Notaulix evenly deep, subcrenulate, meeting behind in a deep midpit. Pronope present, laterally from pronope crenulate to subcrenulate, otherwise pronotum smooth and shiny. Mesoscutum and scutellum smooth and shiny. Prescutellar furrow twice as wide as long along median carina, laterally from carina smooth; pair of fields laterally from prescutellar furrow 1.4 times as wide as long. Propodeum scrobiculate, areola basalis hardly distinct, antero-medially with a strong short carina, laterally from it propodeum uneven. Precoxal suture wide and crenulate, otherwise mesopleuron polished. – Hind femur 4.5 times as long as broad distally (Fig. 24). Hind claw less long and curved as in Fig. 25.

Fore wing about one-sixth longer than body. Pterostigma five times as long as wide, issuing *r* clearly distally from its middle, *r* short, *3–SR* 1.4 times as long as *4–SR* just less than twice as long as *3–SR* and reaching tip of wing. Vein *m-cu* antefurcal; vein *1CU1+2CU1* a bit longer than *m-cu*.

First tergite (Fig. 26) 1.65 times as long as broad behind, weakly broadening posteriorly, i.e. subparallel-sided, pair of spiracles before middle of tergite, pair of keels converging and reaching middle of tergite; first tergite medio-longitudinally rugo-striate, laterally uneven-striolate, further tergites polished. Ovipositor sheath long, a bit longer than hind tibia.

Body black, metasoma beyond first tergite brownish black. Scape and pedicel dark rusty brown, flagellum darkening rusty brown to brown. Mandible rusty, palpi pale. Tegula and legs brownish yellow. Wings subhyaline, pterostigma and veins brown.

Description of the female paratype. – Similar to the female holotype. Body 3.4 mm long. Antenna with 31 antennomeres. Metasoma beyond first tergite dark brown.

Host unknown.

Distribution: Mongolia.

The new species, *Phaenocarpa propebakinum*, is closely related to *Ph. basarukini* BELOKOBYLSKIJ, 1998 (East Russia) considering their mandible, claws and wing venation, the two species differ from each other by a few and rather subtle features:

1 (2) Eye in dorsal view one-and-a-half times to twice as long as temple. First tergite distinctly broadening posteriorly, 1.3–1.5 times as long as broad behind (Fig. 95: 13 in BELOKOBYLSKIJ 1998: 246). Antenna with 44 antennomeres, penultimate flagellomere three times as long as broad. Ovipositor sheath short, at most half as long as hind tibia. Hind femur 5–5.6 times as long as broad distally (Fig. 95: 11 l.c.). Body black with more or less rusty pattern, metasoma beyond first tergite rusty brown. ♀: 3–3.4 mm
Ph. (Ph.) basarukini BELOKOBYLSKIJ

2 (1) Eye in dorsal view 1.3–1.4 times as long as temple (Fig. 21). First tergite almost parallel-sided, 1.65–1.7 times as long as broad behind (Fig. 26). Antenna with 30–31 antennomeres, penultimate flagellomere twice as long as broad. Ovipositor sheath long, as long as hind tibia. Hind femur 4.5–5 times as long as broad distally (Fig. 24). Body black, metasoma beyond first tergite brownish black. ♂: 3.5–4 mm **Ph. (Ph.) propebakinum** sp. n.

With the help of BELOKOBYLSKIJ's key (1998: 223–268, couplets 8–12) the new species runs also to *Ph. (Ph.) uzonica* BELOKOBYLSKIJ, 1998 (Russia: Kamchatka) considering their common feature as horizontal rugulo-striolate field along inner margin of eye; the two species are clearly separated by the keyed features:

1 (2) First tergite 1.2–1.4 times as long as broad behind and more broadening posteriorly (Fig. 92: 8 in BELOKOBYLSKIJ 1998: 232). Face almost entirely rugose. Head in dorsal view strongly bulging. Ovipositor sheath short, about half as long as metasoma. Metasoma beyond first tergite dark reddish brown. ♀: 3.6–3.7 mm *Ph. (Ph.) uzonica* BELOKOBYLSKIJ

2 (1) First tergite 1.65–1.7 times as long as broad behind and less broadening posteriorly (Fig. 26). Face along inner margin of eye horizontally rugulose-striolate (Fig. 23). Head in dorsal view bulging (Fig. 21). Ovipositor sheath long, about as long as metasoma. Metasoma beyond first tergite brownish black. ♀: 3.4 mm **Ph. (Ph.) propebakinum** sp. n.

Synaldis sinaulice sp. n. ♀
(Figs 27–32)

Material examined (1 ♀): Female, holotype: Mongolia, Mittelgobi aimak, 20 km S von Somon Delger-zogt, 1480 m, 9 Juni 1967, leg. KASZAB (Nr. 779). – Holotype is deposited in the Hungarian Natural History Museum (Department of Zoology), Budapest, Hym. Typ. No. 7895.

Condition of the holotype. – 1. Left fore and right middle legs missing. 2. Right fore and hind wings glued on the card; left fore wing on its apical part torn.

Etymology: The species name "sin[e]aulice" refers to the absence of the notaulix on the mesoscutum.

Description of the female holotype. – Body 1.4 mm long. Antenna short and relatively thick, about as long as head, mesosoma and first tergite combined and with 12 antennomeres. First flagellomere twice, second flagellomere 1.75 times and penultimate flagellomere also 1.75 times as long as broad apically. – Head in dorsal view (Fig. 27) transverse, 1.66 times as broad as long, temple slightly bulging, i.e. head between temples a bit broader than between eyes, temple just longer than eye and rounded, occiput excavated. Head 1.56 times as broad as mesosoma between tegulae. Ocelli small and elliptic, POL : OD : OOL as 5 : 3 : 8. Eye in lateral view 1.6 times as high as wide and 0.9 times as wide as temple, temple beyond eye indistinctly narrowing ventrally (Fig. 28). Mandible (Fig. 29) 1.2 times as long medially as broad between teeth 1 and 3, broadening distally; tooth 1 less and tooth 3 more rounded, tooth 2 spiky, between teeth 1 and 2 no excision, outer side of mandible smooth. Tentorial pit short and elliptic, its distance from eye equal to its longer diameter, i.e. clearly not reaching eye. Shortest width of face 1.75 times its median height. Head polished, face and clypeus with very fine hairpunctures.

Mesosoma in lateral view 1.25 times as long as high. Notaulix (also on declivous fore part of mesoscutum) entirely missing. Midpit short linear. Precoxal suture short, linear, deep, subcrenulate. Hind margin of mesopleuron smooth. Scutellar sulcus weakly arched, finely crenulate (Fig. 30).

Propodeum polished, with a medio-longitudinal weak carina, along carina rugulose; pair of small spiracles on latero-median part of propodeum. – Hind femur 3.8 times as long as broad medially (Fig. 31).

Fore wing about one-fifth longer than body. Vein *4–SR* almost twice as long as *r + 3–SR*.

Metasoma about as long as mesosoma. First tergite (Fig. 32) 1.8 times as long as broad behind, almost evenly broadening posteriorly; pair of spiracles at middle of tergite; pair of converging keels short, ending clearly before middle of tergite. First tergite medially just uneven, otherwise together with further tergites polished. Ovipositor sheath in lateral view 1.5 times as long as first tergite or as long as hind tarsomeres 1–2 combined.

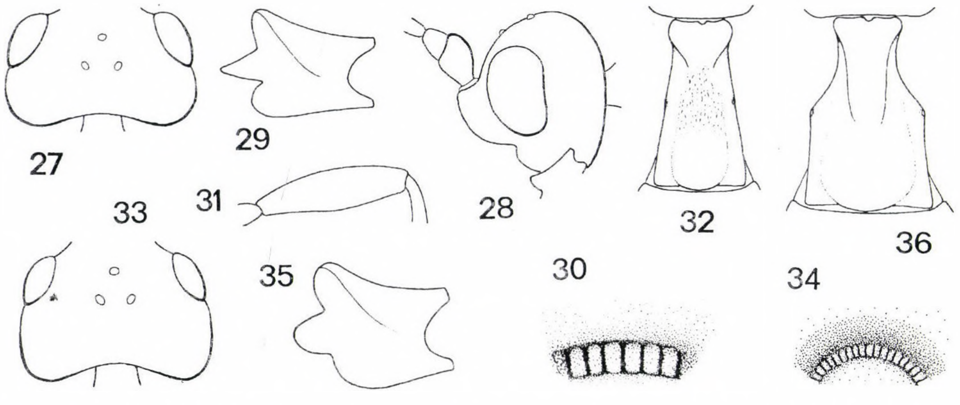
Body dark brown. Scape and pedicel light brown, flagellum brown. Palpi pale brownish. Legs brownish to light brownish (tibiae + tarsi). Tegula light brown. Wings hyaline, pyetostigma brownish, veins pale brownish.

Male and host unknown.

Distribution: Mongolia.

The new species, *Synaldis sinaulice*, stands nearest to *S. jordanica* FISCHER, 1993 (Jordan), both species lacking notaulix entirely, propodeum polished and with a medio-longitudinal keel, mandible short; the two species are distinguished by the following features:

1 (2) Head in dorsal view cubic, 1.5 times as broad as long, temple 1.6 times as long as eye, head behind eye distinctly broader between temples than between eyes (Fig. 33). Antenna with 18 antennomeres. Scutellar sulcus arched, its crenulae radially arranged (Fig. 34). Mandible: tooth 1 more rounded, tooth 2 rounded and tooth 3 less dentiform (Fig. 35). Ovipositor



Figs 27–32. 27–32. *Synaldis sinaulice* sp. n.: 27 = head in dorsal view, 28 = head in lateral view, 29 = mandible in frontal view, 30 = scutellar sulcus, 31 = hind femur, 32 = first tergite. – 33–36. *Synaldis jordanica* FISCHER: 33 = head in dorsal view, 34 = scutellar sulcus, 35 = mandible, 36 = first tergite

sheath as long as first tergite. First tergite basally strongly narrowing (Fig. 36). Legs yellowish brown. ♀: 2 mm *S. jordanica* FISCHER

2 (1) Head in dorsal view transverse, 1.66 times as broad as long, temple just longer than eye, head behind eye indistinctly broader between temples than between eyes (Fig. 27). Antenna with 12 antennomeres. Scutellar sulcus less arched, its crenulae less radially arranged (Fig. 30). Mandible: tooth 1 less rounded, tooth 2 spiky and tooth 3 usual in form (Fig. 29). Ovipositor sheath 1.5 times as long as first tergite. First tergite basally not strongly narrowing (Fig. 32). Legs brownish. ♀: 1.4 mm **S. sinaulice** sp. n.

REFERENCES

ACHTERBERG, C. VAN (1993) Illustrated key to the subfamilies of the Braconidae (Hymenoptera: Ichneumonoidae). *Zool. Verh. Leiden* **283**: 1–189.

BELOKOBYLSKIJ, S. A. (1998) Tribe Alysiini. In: *Key to the Insects of Russian Far East*, Vladivostok Dal'nauka, Vol. **IV**. Neuropteroidea, Mecoptera, Hymenoptera. Pt. 3: 708 pp. – Alysiini: pp. 163–298.

CHEN, X. & ACHTERBERG, C. VAN (1997) Revision of the subfamily Euphorinae (excluding the tribe Meteorini Cresson) (Hymenoptera: Braconidae) from China. *Zool. Verh. Leiden* **313**: 1–217.

CHEN, J. & WU, ZH. (1994) The Alysiini of China (Hymenoptera: Braconidae: Alysiinae). *China Agriculture Press* 178 pp. + 40 tables [in Chinese with English abbreviated text p. 154–168].

FISCHER, M. (1962) Das Genus Synaldis Förster (Hymenoptera, Braconidae). *Mit. Zool. Mus. Berlin* **38**(1): 1–21.

FISCHER, M. (1968) 141. Opiinae. Ergebnisse der zoologischen Forschungen von Dr. Z. Kaszab in der Mongolei (Hymenoptera, Braconidae). *Reichenbachia (Dresden)* **11**(11): 97–114.

FISCHER, M. (1971) Untersuchungen über die europäischen Alysiini mit besonderer Berücksichtigung der Fauna Niederösterreichs (Hymenoptera, Braconidae). *Pols. Pismo Ent. Wroclaw* **41**(1): 19–160.

FISCHER, M. (1973) Neue Aspilota-Arten aus der Steiermark (Hymenoptera, Braconidae, Alysiinae). *Verh. zool.-bot. Ges. Wien* **113**: 103–120.

FISCHER, M. (1976) Erste Nachweise von Aspilota-Wespen im Burgenland (Hymenoptera, Braconidae, Alysiinae). *Ann. Naturhist. Mus. Wien* **80**: 343–410.

FISCHER, M. (1990) Westpaläarktische Phaenocarpa-Arten: Vorläufiger Bestimmungsschlüssel, Deskriptionen und Redeskriptionen (Hymenoptera, Braconidae, Alysiinae). *Ann. Naturhist. Mus. Wien* **91B**: 105–135.

FISCHER, M. (1993*a*) Neubeschreibungen und Wiederbeschreibungen von Kieferwespen (Hym., Braconidae, Alysiinae: Tribus Alysiini) der Alten Welt. *Linzer biol. Beitr.* **25**(2): 593–647.

FISCHER, M. (1993*b*) Zur Formenvielfalt der Kieferwespen der Alten Welt: Über die Gattungen Synaldis Foerster, Trisynaldis Fischer und Kritscherysia Fischer gen. nov. (Hymenoptera, Braconidae, Alysiinae). *Ann. Naturhist. Mus. Wien* **94/95B**: 451–490.

FISCHER, M. (1993*c*) Einige Phaenocarpa-Wespen aus der Alten Welt: Redeskription und Stellung in einem vergleichenden System (Hymenoptera, Braconidae, Alysiinae). *Linzer biol. Beitr.* **25**(2): 511–563.

HAESELBARTH, E. (1973*a*) Die Blacus-Arten Europas und Zentral-Asiens (Hymenoptera, Braconidae). *Veröff. zool. Staatssamml. München* **16**: 69–170.

HAESELBARTH, E. (1973b) Ergebnisse der zoologischen Forschungen von Dr. Z. Kaszab in der Mongolei, No. 333. Braconidae IV. (Hymenoptera). *Fol. ent. hung.* **26** (Suppl.): 75–81.

LOAN, C. C. (1974) The European species of Leiophron Nees and Peristenus Foerster (Hymenoptera, Braconidae, Euphorinae). *Trans R. ent. Soc. Lond.* **126**(2): 207–238.

PAPP, J. (1991) Braconidae (Hymenoptera) from Mongolia, XI. *Acta zool. hung.* **37**(3–4): 217–224.

PAPP, J. (1994) Braconidae (Hymenoptera) from Korea, XV. *Acta zool. hung.* **40**(2): 133–156.

PAPP, J. (1999) Braconidae (Hymenoptera) from Mongolia, XIII: Alysiinae. *Acta zool. hung.* **45**(3): 221–246.

RICHARDS, O. W. (1967) Some British species of Leiophron (Hymenoptera, Braconidae, Euphorinae) with description of two new species. *Trans. R. ent. Soc. Lond.* **119**: 171–186.

TOBIAS, V. I. (1986) 27. order Hymenoptera, fam. Braconidae (Part 1). In: *Handbooks for the Identification of Insects of the European Part of the USSR* III (Hymenoptera) **4**: 1–501.

Revised version received 20th March, 2000, accepted 5th June, 2000, published 7th July, 2000

Acta Zoologica Academiae Scientiarum Hungaricae 46 (1), pp. 53–78, 2000

SURVEY OF THE TAIWANESE ETHMIINAE (LEPIDOPTERA, OECOPHORIDAE) WITH DESCRIPTIONS OF THREE NEW SPECIES*

KUN, A.[1] and CS. SZABÓKY[2]

[1]*Department of Zoology, Hungarian Natural History Museum*
H-1088 Budapest, Baross u. 13, Hungary
E-mail: kuni@zoo.zoo.nhmus.hu
[2]*Forest Research Institute*
H-1023 Budapest, Frankel Leó út 42–44, Hungary

The characterization of the Ethmiinae species of Taiwan, with the descriptions of *Ethmia penesella* sp. n., *E. pseudozygospila* sp. n. and *E. susa* sp. n. are given. The taxonomic status of *E. okinawana* (MATSUMURA, 1931) is revised, the male genitalia of *E. zygospila* MEYRICK and *E. octanoma* MEYRICK are described and illustrated for the first time. With 56 figures.

Key words: Ethmiinae, *Ethmia*, new species and taxonomic status, Taiwan

INTRODUCTION

The genus *Ethmia* is cosmopolitan, more than 40 species are known from the south-eastern Palaearctic. The genus is richly represented in China, where 31 are known; by comparison 11 have been recorded from India, 6 from Nepal, 9 from Japan, only one from Korea, 7 from the Philippines and 14 from Australia. The major works dealing with the Taiwanese fauna and the taxonomy of the eastern Asian (Pacific and Himalayan–Sino–Tibetan) Ethmiinae are as follows (in alphabetical order): DIAKONOFF (1969), HEPPNER & INOUE (1992), INOUE *et al.* (1993), LIU (1980), MATSUMURA (1931) and SATTLER (1967).

In the last few years several Hungarian lepidopterists worked intensively in large regions of Southeast Asia, including the island of Taiwan. Due to these expeditions, a large material of Ethmiinae containing more than 300 individuals has been collected during the last three years.

As a result of the investigations made on the material mentioned above, and on the collection of British Museum (Natural History) (= BMNH), London, as well as the survey of the literature data, the presence of 14 *Ethmia* species in Tai-

---

* Results of the joint project of the Hungarian Natural History Museum, Budapest and the Taiwan Forestry Research Institute, Taipei, entitled with "Biodiversity studies on the Lepidoptera fauna of Taiwan: taxonomy, fauna genetics and inventory of selected lepidopteran families", No. 2.

wan have been ascertained; three of them are new to science. The description of the new species and hitherto unpublished sexes of two species are given in the "Systematics".

SYSTEMATICS

Ethmia maculata SATTLER, 1967
(Figs 1, 25, 41)

Ethmia maculata SATTLER, 1967, Microlepidoptera Palaearctica, Vol. 2, page 121, plates 8, 59, 101: fig. 60.

Diagnosis: *E. maculata* and *E. autoschista* MEYRICK, 1932, are hardly separable at the first sight. *E. autoschista* is brighter than *E. maculata* and the forewing arrow markings are less blended. The male genitalia of *E. autoschista* differ from those of *E. maculata* by the long, thin, crook-like cucullus and the long arrow-shaped, divided uncus, while the female genitalia have more sclerotized sterigma and ostium than in *E. maculata*.

Description (Fig. 25): Wingspan 25–27 mm. Antenna filiform, with slightly dilated basal segments; scape with black scales above and white scales below, flagellum with brown scales; maxillary palp whitish grey. Labial palp white with black scales on medial and last segments; proboscis basis white; frons and vertex white, similarly with black scales on top; thorax white with five black spots; tegulae white with a pair of black spots at base (Fig. 41). Forewing overlaid with black markings on whitish background; characteristic marking of forewing a long, arrow-shaped marking from middle of cell to outer margin of wing, rest of markings consisting of elongate spots. Hindwing whitish grey; without costal brushes; cilia whitish. Forelegs and midlegs whitish with black rings, especially on tarsus, hindleg whitish grey. Abdomen grey, yellow from 5th to 8th segments, with two black spots on dorsal surface of each segment.

Male genitalia (Fig. 1): Uncus bifid with deep medial incision, apices rounded. Posterior part of gnathos lacking, anterior part well developed, finely dentate, fused with large, sclerotized dorsal plates on each side. Labis rudimentary; dorsal part of anellus sclerotized, more or less rectangular. Valva with bristles; costal margin with well-developed triangular, sclerotized basal plate. Cucullus quadratic, with triangular apical lobe and pointed outer extension, ventral surface covered with strong bristles. Sacculus with short, characteristic fold at base; vinculum without developed saccus. Aedeagus gun-shaped, cornuti long, fine, bristle-like.

Female genitalia: Ovipositor strongly sclerotized, anterior apophyses short, thick. Antrum membranous, with a sclerotized caudal ring. Ductus bursae thin, twice as long as abdomen; signum "dentate bar" (sensu POWELL 1973, meaning a shallow crease with numerous, more or less equal sized teeth).

Material examined. Taiwan. 1 specimen, Kanshirei, 1000 ft., 3.V.1908, A. E. Wileman GU-7481 BM. Prov. Nantou: 11 specimens, 6 km E of Wushe, 1300 m, 24°01'82''N, 121°10'65''E, 21.IV.1997, leg. PEREGOVITS & KUN; 1 specimen, Lushan, 24.VIII.1984, leg. B. S. CHANG Nanshanchi, Jenai, 13–17.IV. 1999 C. S. LIN & W. T. YANG; 8 specimens, 3 km E of Tili, 555 m, 16.XI.1996 and 27–28.V.1997, leg. CS. SZABÓKY; 8 specimens, Ursun Forest, 16 km E of Kuoshing, 560 m, 29–30.X.1996 and 8.VI.1997 and 24.V.1997, leg. CS. SZABÓKY; 1 specimen, 3 km SW of Tsuifeng, 2100 m, 31.X.1996, leg. CS. SZABÓKY; 2 specimens 3 km E of Tili, 555 m, 28.V.1997, leg. T. CSŐVÁRI; 1 specimen, Ursun Forest, 560 m, 16 km E of Kuoshing, 24.VI.1997, leg T. CSŐVÁRI; 7 specimens, Dongpuu, 1300 m, 10. IX. 1993, leg. H. R. TZUOO; 1 specimen, Tonpu, 1200 m, 22.IX.1994, leg. H. R. TZUOO; 4 specimen, Tonpu, 19.IV.1995, leg. B. S. CHANG; 20 specimens, Jenai, Chunyang, IX.1.1995, IV.27–28.1993, 10–12.VIII.1998 UV light, leg. C. S. LIN & W. T. YANG (KUN gen. no. 142); 2 specimens, Wushe, 28–29.IV.1993, 30.VIII–1.IX.1992, leg. C. S. LIN; 2 specimens, Meifeng, 28–29. VII. 1997, UV light, C. S. LIN. & W. T. YANG, KUN Gen. No.: 138; Prov. Taitung: 1 specimen, 3 km W Hungyeh village 350 m, 14.XI.1996, leg. CS. SZABÓKY. Prov. Kaoshiung: 5 specimens, 26 km SE of Taoyuan, 1370 m, 4. and 15.XI.1996 and 2.VI.1997, leg. CS. SZABÓKY; Prov. Taichung: 1 specimen, Pashenshan, 1000 m, 4, 6.IV.1995, leg. C. M. FU; 6 specimens, Henglung, 1.X.1983, 8.VIII.1983, 11.VII.1983 leg. B. S. CHANG (coll. BMNH London, HNHM, coll. SZABÓKY, NMNS, Taichung, coll. C. M. FU, coll. H. R. TZUOO).

Distribution: China: Hunan, Chekiang; Taiwan.

Bionomics: The flight period of the species is rather long, specimens were collected in IV–VI, X–XI, the habitats are subtropical forests.

Remarks: This species-group contains also an undescribed species from Nepal; this Nepalese species is considerably larger than its relatives, with the wingspan about one and half times larger than those of *E. maculata* and *E. autoschista*.

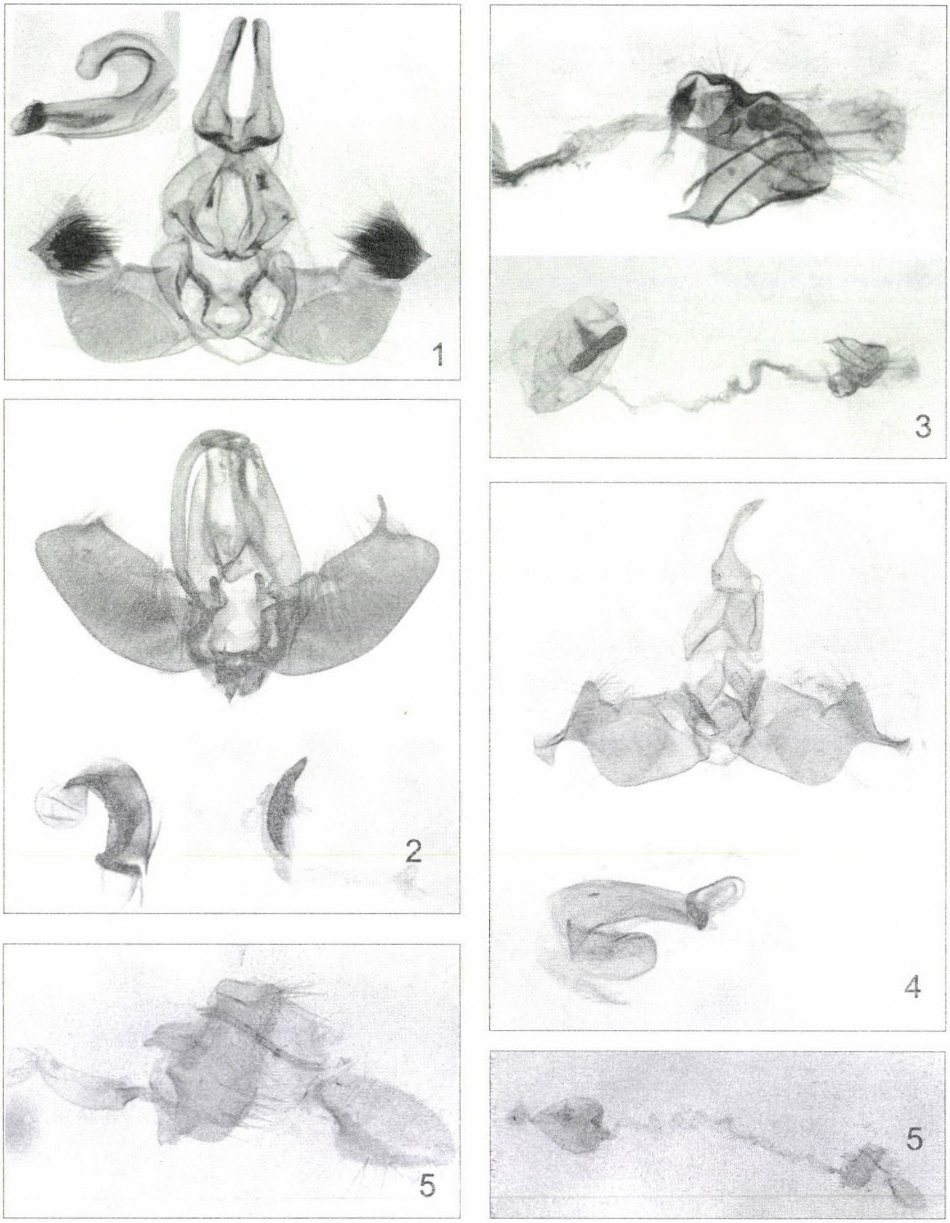
Ethmia lineatonotella (MOORE, 1867)
(Figs 2–3, 26, 42)

Hyponomeuta lineatonotella MOORE, 1867, Proc. zool. Soc. London 1867: 669; plate 33, fig. 18.
Psecadia vitattopunctata MATSUMURA, 1931, 6000 Illustr. Ins. Japan, p. 1085.

Diagnosis: Allied to *E. palawana* SCHULTZE, 1925, and *E. galactarcha* MEYRICK, 1928, both known from the Indo–Malaysian region. *E. palawana* has only three long striae on the forewings, not four as in *E. lineatonotella*. *E. galactarcha* differs from *E. lineatonotella* by its larger wingspan, and the brighter forewing with reduced numbers of striae.

Description (Fig. 26): Wingspan 40–50 mm. Antenna filiform; scape with yellow scales, flagellum yellowish, with brown scales distally. Maxillary palp yellow, consisting of four segments. Labial palp yellow with black ring on medial segment. Proboscis yellowish. Frons and vertex yellowish with black scales on top (apically). Thorax yellowish with six black spots; tegulae white with a pair of black spots at base (Fig. 42). Forewing overlaid with black markings on yellowish background: seven spots at basal part, four characteristic long striae running parallel with costa; additional five spots ("apical spots") between marginal spots and long striae; two larger spots at outer edge of cell between veins cu2 and m2, these spots may fuse into a larger patch. Hindwing brownish, orange at base; with strong costal brushes; cilia yellow. Forelegs and midlegs faint yellow with black rings. Tarsus black with light tip. Hindleg orange; abdomen similarly orange-coloured.

Male genitalia (Fig. 2): Uncus sclerotized, very long, slender, hooked. Posterior part of gnathos lacking, anterior part broad. Anellus with small, stocky dorsal heel, labis finger-shaped. Valva wide, bean-shaped, covered with bristles, cucullus with long, strong, acute, variably curved process; sacculus wide. Dorsal margin of aedeagus convex, vesica with long, wide cornutus terminating in stronger, apically bi- or trifid thorn.



Figs 1–5. *Ethmia* spp. genitalia slides. 1 = *E. maculata* SATTLER, male V, A; 2–3 = *E. lineatonotella* (MOORE), 2 = male, V, A, Ve, 3 = female, O, F; 4–5 = *E. okinawana* (MATSUMURA), 4 = male, V, A, 5 = female, O, F (Abbreviations: V = valva, A = aedeagus, Ve = vesica, O = ovipositor, F = entire female genitalia)

Female genitalia (Fig. 3): Ovipositor strongly sclerotized, papillae anales conical, setose, posterior apophyses thin, longer than papillae, anterior apophyses wedge-shaped, acute. Antrum with sclerotized ventral half-ring and small, quadratic, medially twisted medial plate. Ductus bursae long, tubular, helicoid with a few coils, membranous with rather strong scobination. Corpus bursae rather big, spherical, signum very large, trilobate, covered with more or less equal teeth.

Distribution: India: Darjeeling, Assam, Kurseong; Burma; Vietnam; Taiwan.

Type material examined: Lectotype: female, *Hyponomeuta lineatonotella* Moore (see Sattler 1967) (coll. BMNH, London).

Additional material examined. Taiwan. Prov. Pingtung: 48 specimens, 10 km SE of Mutan, 470 m, 07–10.III.1997, leg. Gy. Fábián & L. Németh. Prov. Taipei: 5 specimens, Pi Hu, cca 50 km SE Taipei, 450 m, 24°54'02''N, 121°45'27''E, 4–5.IV.1997, leg. Peregovits & Kun. Prov. Taitung: 2 specimens, 4 km N of Tupan, 390 m, 13.XI.1996 and 14.VI.1997, leg. Cs. Szabóky; 2 specimens, 2 km N of Tupan, 500 m, 25.X.1995, leg. T. Csővári; 2 specimens, 3 km W Hungyeh village, 350 m, 13.VI.1997, leg. Szabóky; 1 specimen, 7 km E of Taimali, 710 m, 30.V.1997, leg. Cs. Szabóky. Prov. Nantou: 8 specimens, Ursung Forest, 560 m, 16 km E of Kuoshing, 29–30.X.1996, leg. Szabóky; 8 specimens, 3 km E of Tili, 555 m, 27–28.V.1997, leg. Cs. Szabóky; 27 specimens, 15 km N of Puli, 500 m, 28.II.1996, leg. Fábián & Németh; 1 specimen, 3 km E of Tili, 555 m, 28.VI.1997, leg. T. Csővári; 6 specimens, Ursung Forest, 16 km E of Kuohsing, 560 m, 24.VI.1997, leg. T. Csővári; 1 specimen, Dongpuu, 1300 m, 10.IX.1993, leg. H. R. Tzuoo; 1 specimen, Tonpu, 1200 m, 22.IX.1994, leg. H. R. Tzuoo; 3 specimens, Huisun Forest Area, 770 m, 28.III.1996, leg H. R. Tzuoo; 7 specimens, Huishun 4.V. 1984, 28.IV. 1985, 19.VII. 1985, 2.IV.1983 leg. B. S. Chang; 1 specimen, Fenghuangku, 6.VI.1994. leg. C. S. Lin & W. T. Yang; 1 specimen, Fenghuangku, 15.IV.1994 leg. M. L. Chan & W. T. Yang; Prov. Taichung: 1 specimen, Anmashan, 2100 m, 19.VIII.1995, leg. C. M. Fu. Prov. Taoyuan: 29 specimens, 16 km E of Fuhsing, 870 m, 16.VII.1997 and 4.X.1995, leg. T. Csővári. 8 specimen Fushing 25.IX.1981, 16.X.1981 leg. B. S. Chang; Prov. Ilan: 3 specimens, 3 km S of Suao, 400 m, 6.X.1995, leg. T. Csővári; 4 specimens, Fu-Shan Botanical Garden, LTER site, 700 m, 24°45'47''N, 121°35'75''E, 4–7.VIII.1999, leg. A. Kun & E. Juhász; 1 specimen, Kaoi, 27.XI. 1981, leg. B. S. Chang; 8 specimens, Paosan, 11–15. X. 1988 leg. C. S. Lin; 1 specimen Shuili. 30. VII. 1990 leg. C. M. Lin Prov Nantou: 1 specimen Chunyang, Jenai, 6–8.X. 1988 leg. C. S. Lin; 2 specimens Wushe, 11–13.X.1989, 5–6.X. 1989 leg. C. S. Lin; Prov Kaohsiung, 1 specimen Liu-Kuei, butterfly valley, 21–23.XI.1987. W. H. Chen; 1 specimen Liu-Kuei Tunchi, 6–8.IX.1989 leg. C. S Lin 13 specimens Shanpin 27–30.III.1988, 3–4.IV.1988, 9–13.V.1988 leg. Ling & Wang

Vietnam: N Vietnam: 1 specimen, Tam Dao, 800 m, 28.XI.1992, leg. Sinjaev, 1600 m, Mt. Fan-si–Pan (Nord), primary forest, Cha-pa, 22°17'N, 103°44'E, 20–30.IV.1995, leg. Sinjaev & local collector; 10 specimens, 2400 m, Mt. Fan-si-Pan, Cha-pa, 22°15'N, 103°46'E, 8–29.V.1993 leg. Sinjaev & Simonov; 1 specimen, Tam Dao (Sek. Wald) 60 km NW Hanoi, 1200 m, 21°34'N, 105°20'E, 1–5.V.1993, leg. Sinjaev & Simonov; Tonkin, Mt. Fan-si-Pan (Nord), Cha-pa, 22°15'N, 103°45'E, 2–4.III.1993, leg. Dr. R. Brechlin (coll. HNHM, Budapest, coll. Szabóky, NMNS, Taichung, coll. C. M. Fu, coll. H. R. Tzuoo, coll. Museum Witt).

Bionomics: The species appears in large numbers at artificial light in subtropical forests at lower elevations, representing the most common species of Ethmiinae in Taiwan. Its flight period extends from February to November; possibly in numerous generations.

Remarks: *E. lineatonotella* can easily be confused with certain Lithosiidae species.

Ethmia okinawana (MATSUMURA, 1931) **stat. rev.**
(Figs 4–5, 27, 43)

Symmoca okinawana MATSUMURA, 1931, 6000 Illustr. Ins. Japan, p. 1086.

Diagnosis. This taxon has long been considered synonymous with *E. assamensis* BUTLER, 1879, representing a form of one of the most widespread eastern Palearctic species of the genus (*E. assamensis* is known from Pakistan: Kashmir, Margalla Hills, Kaghan valley; North India: Assam, Punjab, Sikkim; Ceylon; China: Yunnan, Lungtan, Jiansu; Bhutan; Nepal, respectively). The external appearance and some features of the genitalia of both sexes of *E. okinawana*, however, differ rather strongly from any population of *E. assamensis*, with its area restricted to some parts of Japan and Taiwan. The morphological differences discussed below are considered here specific ones, displaying no intermediate forms between *E. okinawana* and *E. assamensis*.

Externally, *E. okinawana* is regularly smaller in average, it has less black scales on the labial palp, the thorax is marked with five black spots, the forewing markings are less extensive, with only three apical spots and the three medial spots being strong, arranged into a common line, not joining with other dark markings of the wing. In comparison, *E. assamensis* is larger, although the individual variation is large, overlapping partly with that of *E. okinawana*. The labial palp of *E. assamensis* is darker, having more black scales, the thorax marked with six black spots. The forewing markings are more extensive, the apical area marked with five spots, the three medial spots partly connected to each other and to a darker grey patch below the cell.

In the male genitalia the distal processus of the valva is longer and twisted in *E. okinawana*, the cucullus is smaller, narrower, the distal third of the aedeagus narrower, more tapering and the sclerotized ring of the carina is considerably larger, stronger than in *E. assamensis*. The main differences in the female genitalia are as follows: the 8th segment is generally narrower in *E. okinawana*, the anterior apophyses are much shorter, weaker and the antrum is significantly shorter than that of *E. assamensis*, its distal part strongly broadened.

Description (Fig. 27): Wingspan 26–28 mm. Antenna filiform; scape with black scales above and white below. Maxillary palp grey. Labial palp grey, with black ring on last segment and with two black rings on second segment; base of proboscis whitish grey. Frons and vertex grey, vertex with black scales at top. Thorax with five black spots, tegulae grey with black spot at base (Fig. 43). Forewing overlaid with black markings on grey background; with three characteristic, strong medial spots arranged into a common line, not joining with other dark markings of wing, apical area with three elongate spots; cilia grey. Hindwing grey with yellowish base; male with costal brushes; cilia grey. Forelegs and midlegs grey with black scales; hindleg yellow with black tarsal rings. Abdomen yellow.

Male genitalia (Fig. 4): Uncus long, sclerotized, narrow; gnathos poorly recognizable as a weakly sclerotized medial plate with narrow, bar-like lateral arms. Labis membranous, digitiform;

basal plate of anellus rounded, small, weak, postero-lateral arms stronger, elongate. Valva rather broad, ventral surface hairy, basal part of valva with more or less triangular costal area. Cucullus small, narrow triangular with apex finely rounded, distal process long, twisted. Sacculus large, sclerotized, densely hairy. Dorsal margin of aedeagus convex, narrow, distal third tapering, carina with strongly sclerotized ring; vesica without cornuti.

Female genitalia (Fig. 5): Ovipositor strongly sclerotized, papillae anales conical, setose, with apex finely rounded, posterior apophyses slender, as long as papillae. 8th segment sclerotized, narrow, anterior apophyses short, weak, broadly triangular. Antrum short, sclerotized, distal part strongly broadened. Ductus bursae long, tubular, membranous, helicoid with several coils. Corpus bursae spherical, with small, rounded appendix, signum large, covered with more or less equal teeth.

Distribution: Taiwan, Japan: W. Honshu, Kyushu, Okinawa, Shikoku.

Material examined. Taiwan. Prov. Nantou: 1 female, 3 km E of Tili, 550 m, 16. IX.1996, leg. CS. SZABÓKY, Slide No. 30.; 5 specimens, 3 km E of Tili, 555 m, 27–28.V.1997, 120°58'E, 23°47'N, leg. CS. SZABÓKY, Slide No. 28; 1 specimen, Chunyang, 31.V.1995, leg. M. L. CHAN & C. S. LIN 1 specimen, Ursung Forest, 560 m, 16 km E of Kuohsing, 29–30.X.1996 leg. CS. SZABÓKY; 1 specimen, Jenai, Chunyang, 31–22.V.1995, UV Light, leg. C. S. LIN & W. T. YANG, KUN Gen. No.: 139; Prov. Kaoshiung: 3 specimens, 26 km SE Taoyuan, 1370 m, 29.VI.1997, leg. T. CSŐVÁRI, Slide No. 29; 11 specimens, 26 km SE Taoyuan, 1370 m, 15.XI.1996 and 4.XI.1996, leg. CS. SZABÓKY. Prov. Taitung: 1 specimen, 3 km of Hungyeh village, 350 m, 1.VI.1997, leg. CS. SZABÓKY; 1 specimen, "Formosa 17. V. 1908, A. E. Wileman 1913–180"; Huishun 9.III.1984, leg. B. S. CHANG (coll. BMNH London, coll. HNHM, Budapest, coll. SZABÓKY, NMNS, Taichung).

Bionomics: The adults were collected at artificial light. The species is presumably bivoltine, the flight periods are V-VI and X-XI.

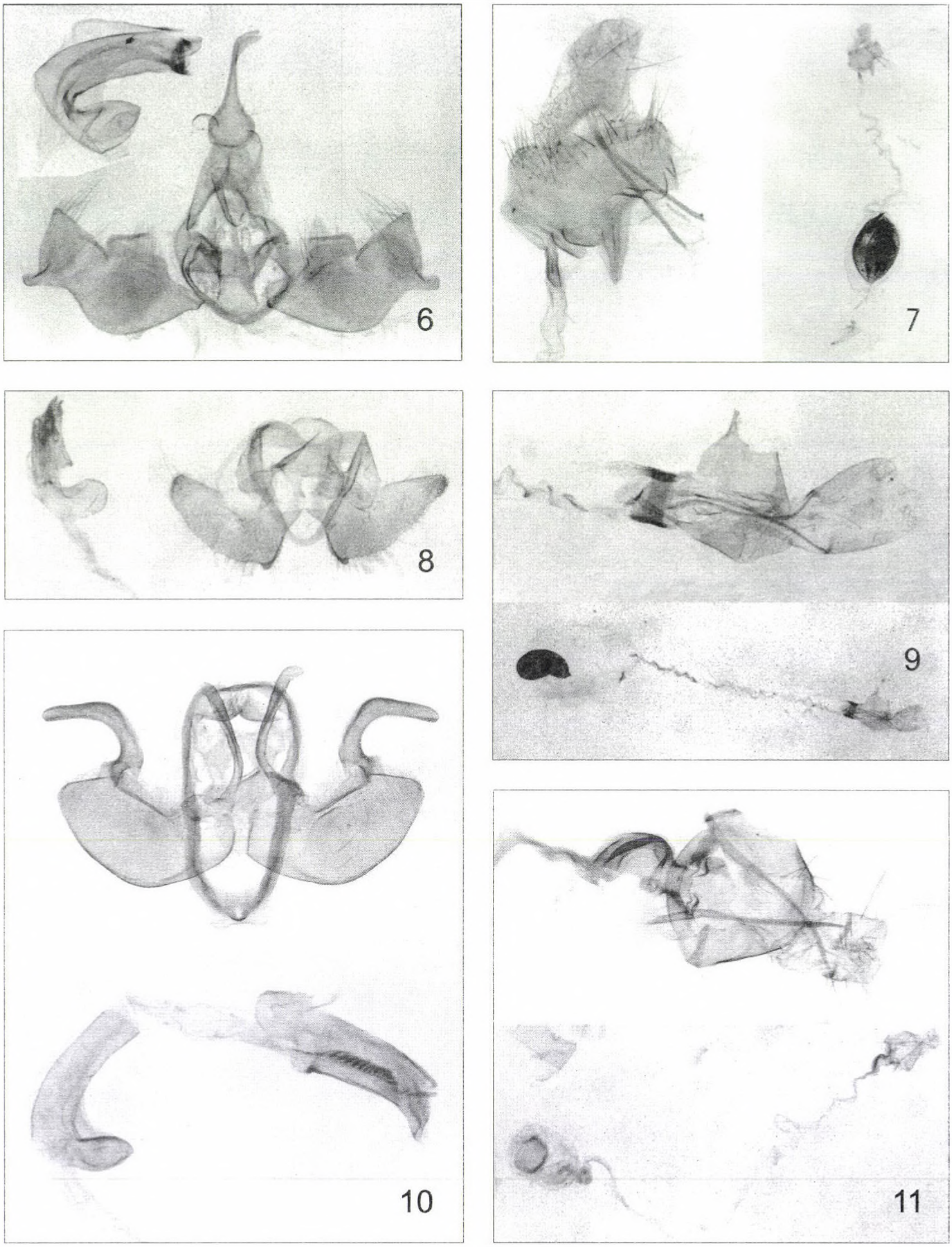
Remarks: The morphological differences between the Japanese and the continental Asian "*E. assamensis*" were also mentioned by SATTLER (1967), but, owing to the limited material available, he had not separated the two taxa in his monographic work on the Palearctic *Ethmia* species.

Ethmia assamensis (BUTLER, 1879)
(Figs 6–7, 28, 44)

Type material examined: holotype of *E. assamensis*, female, "Cachar. [BM registration number 18]78.70", "Azinis assamensis Butler Type", "BM genitalia slide no. 7458". Lectotype and 14 paralectotypes of *E. hockingella* (WALSINGHAM, 1880) (see SATTLER 1967; a junior subjective synonym of *E. assamensis*).

Additional material examined: a large series from the following localities: Pakistan: Kashmir, Margalla Hills, Kaghan valley; North India: Assam, Punjab, Sikkim; Ceylon; China: Yunnan, Lungtan, Jiansu; Bhutan; Nepal (87 specimens in BMNH, London, 14 specimens in HNHM, 8 specimens in coll. CS. SZABÓKY).

Taxonomic notes. As mentioned above, *E. assamensis* and *E. okinawana* represent two distinct species, the morphological differences between them are discussed under the diagnosis of the preceding species. *E. assamensis* do not occur in Taiwan, formerly published data refer to *E. okinawana*.



Figs 6–11. *Ethmia* spp. genitalia slides. 6–7 = *E. assamensis* (BUTLER), 6 = male, V, A, 7 = female, O, F; 8–9 = *E. lapidella* (WALSINGHAM), 8 = male V, A, 9 = female O, F; 10–11 = *E. octanoma* MEYRICK, 10 = male, V, A, 11 = female, O, F (Abbreviations: V = valva, A = aedeagus, Ve = vesica, O = ovipositor, F = entire female genitalia)

Ethmia lapidella (WALSINGHAM, 1880)
(Figs 8–9, 29, 45)

Hyponomeuta lapidellus WALSINGHAM, 1880, Proc. zool. Soc. London 1880: 86; plate. 12, fig. 1.
Psecadia decempunctella MATSUMURA, 1931, 6000 Illustr. Ins. Japan. p. 1085.

Diagnosis: The members of the *E. lapidella* species-group are very similar externally, the identification requires the study of the genitalia. Another confusing moment is that there are three species described by their female sex only: *E. octanoma* MEYRICK, based on one female from Taiwan: Kosempo (see below), *E. nobilis* DIAKONOFF, 1969, three female types, and *E. reposita* DIAKONOFF, 1969, a single female specimen; both from the Philippine Islands. The taxonomic relegation of these three species is as yet problematic, further investigations (and material) are required to clarify the problem. *E. octanoma* can be distinguished from *E. lapidella* both by the features of the wing pattern and the genitalia. The dark marking of *E. lapidella* is represented by eight fairly visible spots while *E. octanoma* is marked with six spots only. *E. lapidella* has four spots in the apical part of the forewing, *E. octanoma* has only three. The hindwing of *E. octanoma* is much brighter than that of *E. lapidella*. The male genitalia of *E. octanoma* differ from those of *E. lapidella* by their elongate, crook-shaped cucullus, and the longer narrow, basal process (labium). Antrum of *E. reposita* is similar in type to that of *E. lapidella* by their upturned lateral margins but it is less sclerotized, short, flattened; in addition, the signum is lacking, similarly to those of *E. nobilis* and *E. octanoma*.

Description (Fig. 29): Wingspan 19–21 mm. Antenna filiform; scape with grey, flagellum with brown scales; maxillary palp, labial palp and base of proboscis grey. Frons and vertex grey with black scales on top. Thorax grey, with four black spots; tegulae grey, with black scales apically (Fig. 45). Forewing overlaid with black spots on grey background; altogether ten spots and one small group of black scales; apical group consisting of four spots, one of them bigger than others, one larger spot in middle of cell, another spot below it, one spot between costa and cell, three smaller spots at basal 1/5 of wing, base of wing with small group of black scales. Hindwing bright grey, marginal area somewhat darker; costal brush absent; cilia grey. Legs bright yellow, abdomen greyish.

Male genitalia (Fig. 8): Uncus reduced to two tongue-shaped, densely setose lobes. Gnathos weak, posterior and anterior parts undeveloped. Labis membranous, narrow, valva simple, narrowly elliptical with rounded apex, ventral surface sparsely covered with long bristles. Costal area short, costal margin strongly angled at basal third, sacculus with small, rounded, sclerotized ventral extension proximally. Aedeagus dorsally convex, carina with short, strong, hooked ventral plate. Vesica with two strong, flattened, arrow-shaped cornuti.

Female genitalia (Fig. 9): Ovipositor conical, weakly sclerotized. Papillae anales elongate, with scarce, fine setae, apices rounded. Apophyses posteriores very long, slender, apophyses anteriores relatively thick, medium-long. Antrum sclerotized, short, flattened, with upturned lateral margins. Ductus bursae very long, membranous, tubular, with several coils. Corpus bursae large, elliptical-ovoid, signum "notched keel" (sensu POWELL 1973), with rows of variably large teeth, basal plate with deep, V-shaped emargination.

Type material examined: Lectotype: Dharmsala, Punjab, wild *Salvia*, e. l., VIII. 1875, Hocking, GU-14275 BM (see SATTLER 1967) (BMNH London).

Additional material examined. Taiwan. Prov. Nantou: 5 specimens, 6 km E Wushe, 1300 m, 24°01'82''N, 121°10'65''E, 21.IV.1997, leg. PEREGOVITS & KUN. Prov. Pingtung: 1 specimen, on the Road no. 199, 500 m, 22°14'38''N, 120°51'51''E, 19.IV.1997, leg. PEREGOVITS & KUN; 27 specimens, Kenting National Park, Kenting Forest Recreation Area, 300 m, 21°57'62''N, 120°48'89''E, 17–18.IV.1997, leg. PEREGOVITS & KUN; 11 specimens, Kenting National Park, Kenting Forest Recreation Area, 300 m, 21°57'62''N, 120°48'89''E, 15–20.VIII.1999, leg. A. KUN. & E. JUHÁSZ; 1 specimen, 10 km SE of Mutan, 400 m, 7–8.IV.1997, leg. CSORBA & RONKAY. Prov Taitung: 4 specimens, 7 km E of Taimali, 710 m, 30.V.1997, leg. CS. SZABÓKY; 4 specimens, 3 km W of Hungyeh village, 350 m, 1.VI.1997 and 5.XI.1996, leg. CS. SZABÓKY; 1 specimen, 4 km N of Tupan, 390 m, 10.VI.1996, leg. CS. SZABÓKY; 13 specimens, Lanyu, Szudaugou, 25–26.IV.1997. UV light, leg. M. L. CHAN; Kenting Park, 9.IX.1996, leg. C. S. LIN; Lanyu Yonghsingnungchuang, 24–25.IV.1997 leg. W. T. YANG.

Distribution: India: Punjab; Japan: Kyushu; Taiwan, and a few problematical specimens from China.

Bionomics: Altogether more than 40 specimens were collected in the southern part of Taiwan, in IV–VI and XI, generally at lower altitudes.

Remarks: The wing pattern of *E. lapidella* shows a slight variability. There are some further species allied to this species-group, *E. heptasema* TURNER, 1898, from Australia, and other, yet undescribed species from Celebes, Vietnam and Pakistan.

Ethmia octanoma MEYRICK, 1914
(Figs 10–11, 30, 46)

Ethmia octanoma MEYRICK, 1914, Supplementa Entomologica, 1914, 3: 55.

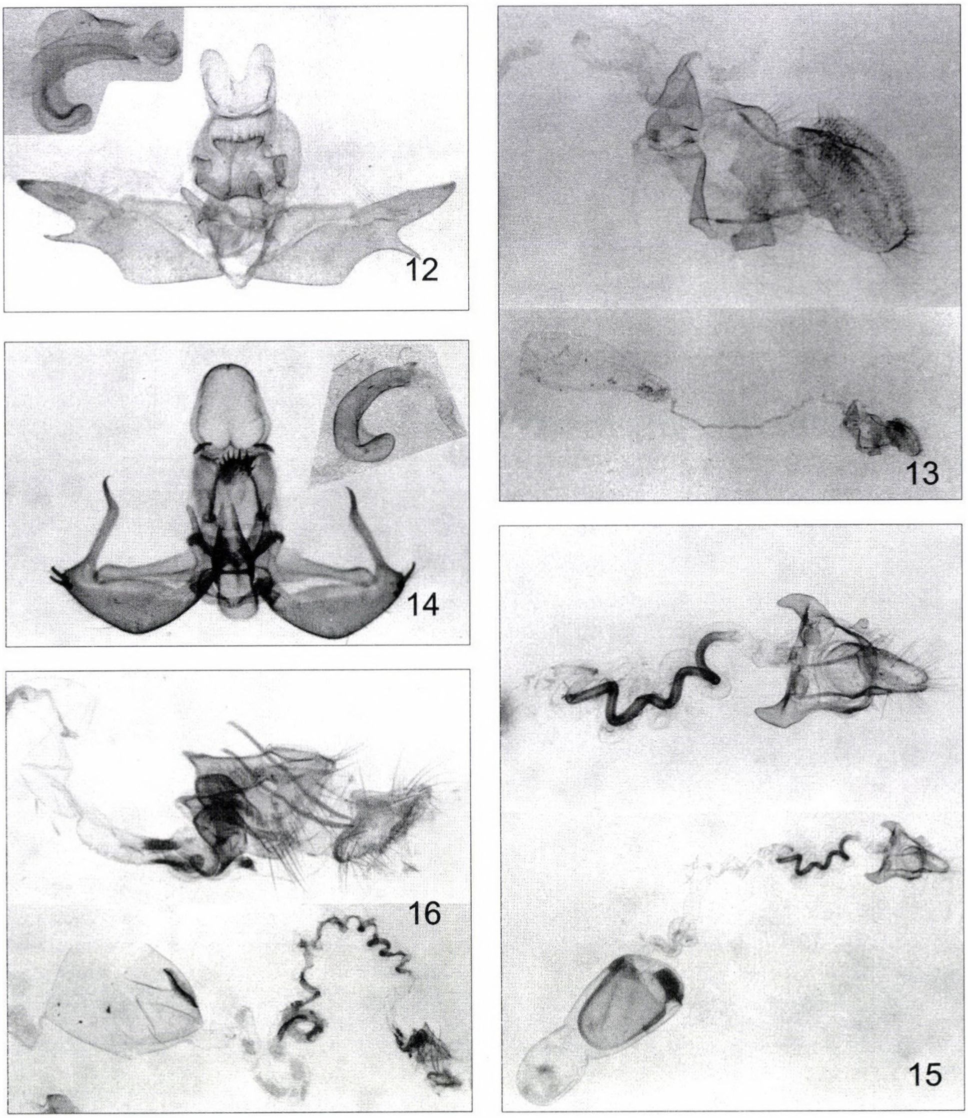
Diagnosis: see the preceding species.

Description (Fig. 30): Wingspan 20–23 mm. Antenna filiform; scape with bright grey scales, flagellum with grey scales; maxillary palp, labial palp and base of proboscis grey. Frons and vertex grey, with black scales on top. Thorax grey, with four black spots; tegulae grey, with black scales terminally (Fig. 46). Forewing overlaid with black spots on grey background; wing pattern consisting of six black spots, three spots in apical area, one larger spot at middle of wing, two further black spots at basal and at medial thirds of veins an1+2, an additional, elongate group of black scales near base of costa and at base of wing. Hindwing bright grey, basal part yellowish; without costal brushes; cilia bright grey. Legs bright yellow, abdomen greyish.

Male genitalia (Fig. 10): Uncus reduced to two tongue-shaped, slightly hairy lobes. Gnathos weakly sclerotized, posterior and anterior parts undeveloped; labis long, narrow, rather strong, stick-like. Vinculum strong, U-shaped, with flattened, rounded saccus-lobes. Valva short, ventral margin arcuate, with angular ventro-apical edge, ventral surface covered with hairs. Costa long, "cucullus" forming elongate, crook-like process; sacculus with sclerotized fold at base. Aedeagus curved dorsally convex, vesica armed with about a dozen small, sclerotized, acute cornuti.

Female genitalia (Fig. 11): Ovipositor conical, weakly sclerotized. Papillae anales elongate with apices rounded, setose with scarce, fine setae. Apophyses posteriores very long, slender, apophyses anteriores short, weak. Ventral plate of antrum sclerotized, ductus bursae very long, one and half as long as abdomen, membranous, tubular with several coils, posterior part dilated, flattened, falcate, with strongly sclerotized crests. Corpus bursae large, spherical, signum absent.

Material examined: Taiwan. 1 specimen, in coll. BMNH London, slide No. GN-7473 BM. Prov. Pingtung: 2 specimens, on the Road No. 199, 500 m, 22°14'38''N, 120°51'51''E, 19.IV.1997, leg. PEREGOVITS & KUN; 10 specimens, Kenting National Park, Kenting Forest Recre-



Figs 12–16. *Ethmia* spp. genitalia slides. 12–13 = *E. epitrocha* (MEYRICK), 12 = male, V, A, 13 = female, O, F; 14–15 = *E. maculifera* (MATSUMURA), 14 = male, V, A, 15 = female, O, F; 16 = *Ethmia praeclara* MEYRICK, female, O, F (Abbreviations: V = valva, A = aedeagus, Ve = vesica, O = ovipositor, F = entire female genitalia)

ation Area, 300 m, 21°57'62''N, 120°48'89''E, 17–18.IV.1997, leg. PEREGOVITS & KUN (coll. HNHM). Prov. Kaoshiung: Kaoshiung City, Campus of Sun Yet-Sen University, 18.IV.1997 leg. SHEN-HORN YEN.

Slide Nos KUN 60 (male), KUN 64 (female).

Distribution: Presumably endemic to Taiwan.

Bionomics: *E. lapidella* and *E. octanoma* can be found in similar subtropical forest habitats, often syntopically in the lower southern areas of Taiwan. *E. octanoma* seemingly has a smaller range than *E. lapidella*, appearing as less frequent. The species was collected by our expeditions only in April. The foodplant of *E. octanoma* in Taiwan *Ehretia resinosa* (Boraginaceae) (SHEN-HORN YEN, pers. com.).

Remarks: The male genitalia are illustrated here for the first time. SATTLER (1967) supposed the synonymy of *E. octanoma* with *E. lapidella* but these two taxa represent two, clearly separable, distinct species. On the other hand, the sympatric occurrence of more than one species of this species-group in Taiwan was correctly predicted by him.

Ethmia crocosoma MEYRICK, 1914
(Figs 31, 43)

Ethmia crocosoma MEYRICK, 1914, Exotic Microlepidoptera, 1: 173.

Type material examined: Lectotype: Darjiling, Bengal, D. 05, GU-7449 (see CLARKE 1965) (BMNH, London).

Additional material examined: Nepal: 1 specimen, Koshi, Taplejung area, SW of Mamankhe, 1700 m, 87°57'E, 27°26'N, 6–7.IV.1996, Slide No. 13, leg. G. CSORBA, S. T. KOVÁCS and L. RONKAY (HNHM Budapest).

Remarks: The nominotypical *E. c. crocosoma* MEYRICK was mentioned from Taiwan by DIAKONOFF (1969), this record needs confirmation. The range of *E. crocosoma crocosoma* extends to India (Sikkim, Darjeeling) and Nepal (Koshi), the subspecies *E. c. resignata* DIAKONOFF, 1969, is known only from the Philippines.

Ethmia epitrocha (MEYRICK, 1914)
(Figs, 12–13, 32, 48)

Ceratophysetis epitrocha MEYRICK, 1914, Suppl. Ent. 3: 54.

Diagnosis: The wing pattern of *E. epitrocha* is confusingly similar to that of *E. c. crocosoma* but it is smaller in size (*epitrocha*: 20–25 mm, *crocosoma*: 28–35 mm) and the frons of *E. epitrocha* is black while it is white in *E. c. crocosoma*.

Description (Fig. 32): Wingspan of male 20–22 mm, that of female 22–25 mm. Male antenna filiform, grey, basal segments strongly dilated, with white scales. Scape also with white scales; maxillary palp reduced, labial palp black with white ring on last segment; proboscis white. Frons black, vertex whitish. Thorax whitish with four black spots; tegulae white with a pair of black spots at base (Fig. 48). Forewing overlaid with black markings on white background, consisting mostly of elongate, rather big black patches (Fig. 32). Hindwing grey, without costal brushes; cilia whitish. Forelegs and midlegs grey with black rings, hindlegs whitish grey, abdomen yellow, 3rd to 7th segments with two black spots on each segment.

Male genitalia (Fig. 12): Uncus hood-like, flattened, bifid with deep, more or less V-shaped medial incision; anterior and posterior parts of gnathos well-developed, posterior part dentate, anterior part wide, covered with small warts. Labis membranous, rather short, broad at base, tapering apically. Valva elongate, apically acute, covered with hairs, ventral margin with long, acute, wedge-shaped lobe at distal end of sacculus. Costa forming long, sclerotized triangular plate; dorsal margin of aedeagus convex, carina with small, sclerotized ventral tooth, without cornuti.

Female genitalia (Fig. 13): Ovipositor sclerotized, papillae anales subconical, setose, posterior apophyses thin, as long as papillae anales, anterior apophyses short, broadly triangular, finely pointed. Ductus bursae long, tubular; corpus bursae rather long, spherical; signum absent.

Type material examined: MEYRICK has stated in the original description (1914) that the description was based on two specimens originating from "Kankau (Koshun) and Kosempo, in May and October". One of these specimens, labelled as "paralectotype", preserved in the BMNH, has been examined.

Additional material examined: Taiwan. Prov. Pingtung: 37 specimens, Kenting National Park, Kenting Forest Recreation Area, 300 m, 21°57'62''N, 120°48'89''E, 17–18.IV.1997, leg. PEREGOVITS & KUN; 18 specimens, Kenting National Park, Kenting Forest Recreation Area, 300 m, 21°57'62''N, 120°48'89''E, 15–20.VIII.1999, leg. A. KUN & E. JUHÁSZ; 1 specimen, Kenting, 17–18.V.1993, leg. C. S. LIN & W. T. YANG; 1 specimen, 10 km E of Mutan, 400 m, 7–8.IV.1997, leg. G. CSORBA & L. RONKAY; 1 specimen, on the Road No. 199, 500 m, 22°14'38''N, 120°51'51''E, 19.IV.1997, leg. PEREGOVITS & KUN. Prov. Nantou: 2 specimens 6 km E Wushe, 1300 m, 24°01'82''N, 121°10'65''E, 21. IV. 1997, leg. PEREGOVITS & KUN; 1 specimen, Tongpu 19.IV.1985 B. S. CHANG; 2 specimens, Huisun Forest Area, 15 km N of Puli, 500 m, 7–8.VI.1997, leg. B. HERCZIG & L. RONKAY; 1 specimen, Huisun Forest Area, 15 km N of Puli, 500 m, 12–13.IV.1997, leg. G. CSORBA & L. RONKAY; 1 specimen, Huisun Forest Area, 15 km N of Puli, 770 m, 29.VII.1996, leg H. R. TZUOO; 1 specimen, Dongpuu, 1300 m, 10.IX.1993, leg. H. R. TZUOO; 1 specimen, Chungyang, 28.IV.1995 M. L. CHAN & W. T. YANG; 5 specimens, Jenai, Chunyang, 21–22.VIII.1995, UV Light, leg. C. S. LIN & W. T. YANG; 1 specimen, Wushe, 28–29.IV.1993; 1 specimen, Wushe, 30–1.IV.1993; 2 specimen, Wushe, 21–22. IV. 1992 leg. C. S. LIN; 2 specimens, Ursung Forest, 16 km E of Kuohsing, 560 m, 8.VI.1997 and 16.VI.1997, leg. CS. SZABÓKY; 8 specimens, Ursung Forest Camping, 17 E of Kuohsing, 560 m, 23.V.1997 and 6–7.VI.1997, leg. CS. SZABÓKY; 4 specimens, 3 km E of Tili, 550 m, 28.VI.1997, leg. T. CSŐVÁRI. Prov. Taichung: 1 specimen, Hui-Sun Experimental Forest Area, Guandaushi LTER site, 15 km N of Puli, 950 m, 24°04'49''N, 121°02'08''E, 12–13.IV.1997, leg. PEREGOVITS & KUN; 4 specimens, 3 km E of Tili, 550 m, 27–28.V.1997, leg. CS. SZABÓKY. Prov. Kaohsiung: 4 specimens, Liu-Kuei, San-Ping Forest Research Station, 700 m, 22°58'16''N, 120°41'15''E, 14–15.IV.1997, leg. PEREGOVITS & KUN; 1 specimen, Liu-kuei, C. S. LIN; 2 specimens, 5 km W of Chihpen, 350 m, 5.VII.1996, leg. G. CSORBA & L. NÉMETH; 28 specimens, 26 km SE of Taoyuan, 1370 m, 4.XI.1996, 2.VI.1996, and 15.XI.1996, leg. CS. SZABÓKY; 26 km SE of Taoyuan, 1370 m, 29.VI.1997, leg. T. CSŐVÁRI. Prov. Taitung: 21 specimens, 4 km N of Tupan, 390 m, 31.V.1997, 13–14.XI.1996 and 10.VI.1997, leg. CS. SZABÓKY; 30 specimens, 3 km W of Hungyeh village, 13.VI.1997 and 1.VI.1997, leg. CS. SZABÓKY; 3 specimens, 7 km E of Taimali, 710 m, 30.V.1997, leg. CS. SZABÓKY; 19 specimens, Lanyu, Szudaugou, 25–26.IV.1997. UV light, leg. M. L. CHAN; 1 specimen, Pashenshan, 1000 m, 16.III.1996, leg. C. M. FU; 1 specimen Lanyu Yonghsingnungchuang, 24–25.IV.1997 leg. W. T. YANG; 3 specimens, Lanyu 17.VII.1990, 28.VIII.1990, 6.VII.1991 leg. H. Y. WANG; 5 specimens, Lanyu, lighthouse, 15.IX.1990, 28.VIII.1990, 9.X.1990, 6.VII.1991, 3.VIII.1990 leg H. Y. WANG; 2 specimen, Lanyu, Weather station, 6.III.1991, 2.I.1991 leg. H.Y.Wang 1 specimen, Lutao, 4.VII.1991 leg. H. Y. WANG; Huishun, 28.VIII.1985 leg. B. S. CHANG; Kenting 18.X.1984 leg. B. S. CHANG; Prov. Tayuan: Henglung 1.X.1983, 8.VIII.1983 leg. B. S. CHANG.

Distribution: China: Hunan, Kiangsu, Chekiang; Japan; Taiwan.

Bionomics: The Taiwanese specimens were collected at late spring (III-VI) and in November, the species probably has two distinct generations.

Remarks: A sexually dimorphic species: the male is smaller in size and the antenna has strongly dilated basal segments. The individual variation of the wing pattern is rather small. *E. epitrocha* was proved to be the commonest *Ethmia* in Taiwan.

Ethmia maculifera (MATSUMURA, 1931)
(Figs 14–15, 33, 49)

Symmoca maculifera MATSUMURA, 1931, 6000 Illustr. Ins. Japan, p. 1086.
Ethmia mesozyga MEYRICK, 1935, Exotic Microlepidoptera, 4: 603.

Diagnosis: The closest relatives of *E. maculifera* are *E. epitrocha*, *E. penesella* sp. n. and *E. susa* sp. n. The legs and the abdomen of *E. maculifera* are grey without dark rings and/or spots, while the legs of *E. epitrocha* are black-ringed and the thorax is yellow with dark spots, in addition, the wing pattern is more extensive, consisting of a larger number of black patches. The differences between *E. maculifera*, *E. penesella* sp n. and *E. susa* sp. n. are discussed in the diagnosis of *E penesella* sp. n.

Description (Fig. 33): Wingspan 20–22 mm. Antenna filiform, with grey scales, scape with white scales, maxillary palp rudimentary, whitish. Labial palp whitish; proboscis grey; frons and vertex whitish with black scales on top. Thorax whitish, with four black spots; tegulae white with a pair of black spots at base (Fig. 49). Forewing overlaid with black markings on whitish grey background; two apical spots; a larger costal spot at 1/3 of wing, twin spots at middle of wing, three spots below cell in submedian fold, one of them near to base. Hindwing grey, without costal brushes; cilia whitish. Legs and abdomen whitish grey.

Male genitalia (Fig. 14): Uncus typically hood-like; socii short, sclerotized, falciform bars, fused partly with base of uncus. Anterior part of gnathos absent, posterior part thin, dentate; labis membranous, narrow. Valva hairless, costa of valva long, thin; cucullus with long, arcuate, geniculate process, distal part of sacculus with seta-bunch. Aedeagus dorsally convex, vesica without cornuti.

Female genitalia (Fig. 15): Ovipositor strongly sclerotized, papillae anales conical, setose, posterior apophyses thin, as long as papillae. 8th segment narrow, ring-like, anterior apophyses very short, wedge-shaped. Lamella postvaginalis large, strongly sclerotized, broadly claw-like, basal part with inflated, rounded, scobinate emergence. Antrum small, weakly sclerotized, ductus bursae long, tubular, membranous, helicoid with several coils. Corpus bursae rather big, bilobate, signum large, quadrate, a "notched keel" but without emargination, with more or less equal teeth.

Type material examined: Holotypus: Fukuoka, Japan, T. E. 7. 5. 29, GN–7453 (BMNH London).

Additional material examined. Taiwan. Prov. Pingtung: 3 specimens, Kenting National Park, Kenting Forest Recreation Area, 300 m, 21°57'62''N, 120°48'89''E, 17–18.IV.1997, leg. PEREGOVITS & KUN; 1 specimen, 10 km SE of Mutan, 400 m, 7–8.IV.1997 leg. G. CSORBA & L. RONKAY. Prov. Nantou: 1 specimens, Tongpu, 19.VIII.1985; 1 specimen, 3 km E of Tili, 555 m, 120°58'E, 23°47'N, 27–28.V.1997, leg. CS. SZABÓKY; Ursun Forest, 16 km E of Kuoshing, 560 m, 121°00'E, 24°05'N, 8.VI.1997, leg CS. SZABÓKY. Prov. Kaoshiung: 1 specimen, 26 km SE of Taoyuan, 1370 m, 120°52'E, 23°17'N, 2.VI.1997, leg. CS. SZABÓKY.

Distribution: Japan: Kyushu: Fukuoka; Taiwan.

Bionomics: The specimens were collected at the late spring–early summer period (April–June), at low altitude, the collecting habitats are subtropical forests.

Ethmia praeclara MEYRICK, 1910
(Figs 16, 34, 50)

Ethmia praeclara MEYRICK, 1910, Trans. Ent. Soc. London, 1910, p. 460.

Diagnosis: A difficult group consisting of numerous, mostly subtropical species, besides *E. praeclara*, *E. nigroapicella* (SAALMÜLLER, 1880), *E. dentata* SATTLER et DIAKONOFF, 1966, *E. thoreae* MEYRICK, 1910, *E. duplicata* MEYRICK, 1914, *E. submersa* DIAKONOFF, 1966, *E. argopa* MEYRICK, 1910, *E. hilarella* (WALKER, 1863). The adults are very similar externally, the revision of the group is required. *E. dentata* differs externally from *E. nigroapicella* and *E. praeclara* by the lack of the dark spots of the tergites of the four basal segments. The differences between the genitalia of the three Taiwanese species are easily recognizable in the anterior part of the gnathos, the shape of the valva and in the shape and sclerotization of the antrum.

Description (Fig. 34): Wingspan 33–37 mm. Antenna filiform; scape with black scales apically, flagellum with grey scales; labial palp grayish with black rings, one and half on medial, two on last segment. Base of proboscis greyish; frons and vertex grey, with black scales on top. Thorax grey with four black spots; tegulae grey with a pair of black spots at base (Fig. 50). Forewing overlaid with 18 black dots on grey background, a row of eleven marginal dots. Hindwing orange-yellow, apical patch dark brown, covering outer 1/6 of wing. Forelegs and midlegs grey with black rings, hindleg orange-yellow with black rings on tarsus. Abdomen orange-yellow, tergites with small, rounded dots, sternites with pairs of rounded dots on each segment.

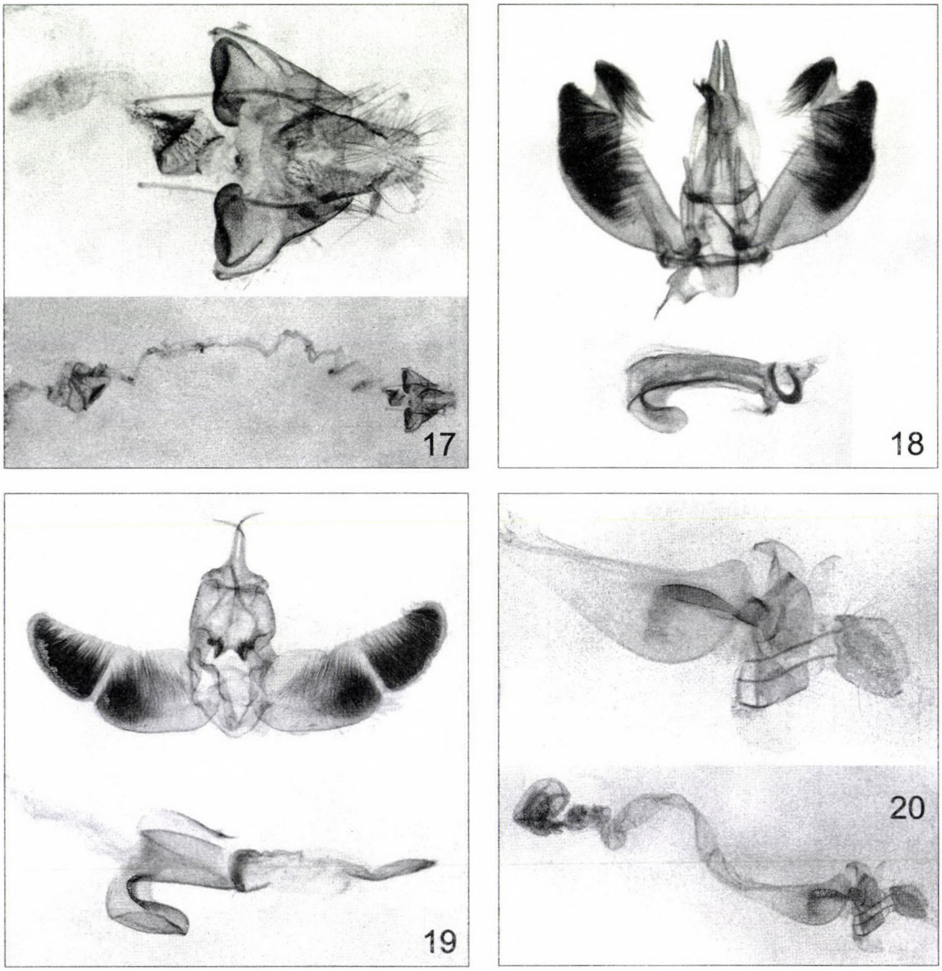
Male genitalia: Uncus bifurcate with deep medial incision; anterior part of gnathos with wide, head-like apical part, covered with more or less equal teeth; labis long, finger-shaped, hairy. Valva elongate, ventrally curved, saccular and apical parts covered densely with strong hairs, costa of valva long; cucullus sclerotized, elongate, apically rounded, densely hairy, ventral margin with small, sclerotzed process at base of cucullus. Aedeagus gun-shaped, carina with narrow, strongly sclerotized ring.

Female genitalia (Fig. 16): Ovipositor strongly sclerotized, papillae anales conical, setose, posterior apophyses thin, one and half times longer than papillae, anterior apophyses very short, inflated, fused with lateral margins of lamella postvaginalis. Lamella postvaginalis strongly sclerotized, with acute anterior extension, basal part with inflated, scobinate emergence; ventral surface covered with large, flat scales. Antrum with fine, sclerotized half-ring, ventral and dorsal surfaces with sclerotized, dentate plates. Ductus bursae very long, tubular, membranous, helicoid with several coils. Corpus bursae rather big, ovoid, appendix well-developed, signum very large, smoothly sclerotized, a deep crease horizontally.

Distribution: Taiwan; Philippines: Luzon; Indonesia: Borneo: Sabah; Celebes; Java; Lombok; Bali; New Guinea; Australia: Queensland.

Bionomics: A poorly known species, flying probably during the day and attracted rarily to artificial light. The flight period is rather long, the adults were collected between January and July.

Material examined. Taiwan. 1 specimen from "Takow, Formosa, 30 July, 1905 A. E. Wileman" in the BMNH London; one female, "G. Tompoe, Paloe, W Celebes, 2700, I. 1937, J. P. A. Kalis" (coll. HNHM).



Figs 17–20. *Ethmia* spp. genitalia slides. 17 = *E. dentata* SATTLER et DIAKONOFF, female, O, F; 18 = *E. nigroapicella* (SAALMÜLLER), male, V, A; 19–20 = *E. zygospila* MEYRICK, 19 = male, V, A, 20 = female, O, F (Abbreviations: V = valva, A = aedeagus, Ve = vesica, O = ovipositor, F = entire female genitalia)

Ethmia dentata SATTLER et DIAKONOFF, 1966
(Figs 17, 35, 51)

Ethmia dentata SATTLER et DIAKONOFF, 1966, Ent. Ber. Amst. 26: 189; figs 1, 2, 3.

Diagnosis: See the preceding species.

Description (Fig. 35): Wingspan 23–28 mm. Antenna filiform; scape with black scales apically, flagellum with grey scales; maxillary palp consisting of four segments. Labial palp whitish, with two black rings on second and third segments; proboscis longer than labial palp, its base whitish. Frons and vertex grey, with black scales on top. Thorax grey with four black spots; tegulae grey with a pair of black spots at base (Fig. 51). Forewing overlaid with 15–17 black dots on grey background and with a row of 10 marginal dots. Hindwing orange-yellow, dark brown apical patch covering about 1/5 of wing; cilia yellow. Forelegs and midlegs grey with black rings, hindleg orange-yellow with black tarsal rings. Abdomen orange-yellow, tergites 5, 6 and 7 with small, rounded dots, sternites 2–7 with pairs of rounded dots on each segment.

Male genitalia: Uncus apically bifurcate with long, pointed arms, and with bristles at base; Anterior part of gnathos forming sclerotized, rounded capitulum, covered with equally long teeth; posterior part membranous; labis long, finger-like. Valva elongate, apical third tapering, cucullus slightly broadened, covered with hairs and bristles, ventral margin with wedge-shaped extension. Costa of valva long, strong, quadrangular, saccular part large, setose. Aedeagus with convex dorsal margin and with strongly sclerotized thin ring of carina. Vesica armed with large, pectiniform bundle of long spinules.

Female genitalia (Fig. 17): Ovipositor strongly sclerotized, papillae anales conical, setose, posterior apophyses slender, twice as long as papillae. Anterior apophyses fused with lamella postvaginalis. Lamella postvaginalis large, sclerotized, with very short apical processi, scobinate, inflated emergences large, foot-shaped. Antrum with fine sclerotized half-ring, ventral surface with broader, smoothly sclerotized plate, dorsal surface with strongly dentate zone. Ductus bursae long, tubular, helicoid with several coils. Corpus bursae globular, with well-developed appendix, signum large, more or less smoothly sclerotized, with laced margins, deep crease horizontally.

Type material examined: paratype, female, Takow, Formosa, 21.IV.1905, leg. A.E. Wileman (coll. HNHM, presented by the BMNH London).

Distribution: Japan: Kyushu: Amami Island, Toshima: Tobetsu; Formosa: Takow; Philippines: Luzon.

Bionomics and habitat: The behaviour of the species is similar to that of its relatives, of *E. praeclara* and *E. nigroapicella*. The flight period extends from IV to XI.

Ethmia nigroapicella (SAALMÜLLER, 1880)
(Figs 18, 36, 52)

Psecadia nigroapicella SAALMÜLLER, 1880, Jahresber. Senckenberg. naturf. Ges. 1879/ 80: 310.
Ethmia collonella WALSINGHAM, 1907, Fauna Hawaiiensis 1: 507; pl. 15 fig. 6.
Ethmia meteoris MEYRICK, 1911, Trans Linn. Soc. Lond. 14: 289.
Ethmia systematica MEYRICK, 1922, Exotic Microlepidoptera 2: 552.
Psecadia apicalis MATSUMURA, 1931, 6000 Illustr. Ins. Japan, p. 1084; with fig. (No. ?).

Diagnosis: See the diagnosis of *E. praeclara*.

Description (Fig. 36): Wingspan 24–28 mm. Antenna filiform; scape with black scales basally; flagellum with grey scales and cilia; Labial palp whitish, second and third segments with black rings, one and a half on medial, two on apical, segment. Basal part of proboscis greyish; frons and vertex grey with black scales on top. Thorax grey with four black spots; tegulae grey with a pair of black spots at base (Fig. 52). Forewing overlaid with 15 black dots on grey background, and a row of 7 marginal dots. Hindwing orange-yellow, apical patch dark brown, covering 1/7 of hindwing; cilia yellow. Forelegs and midlegs grey with black rings, hindleg orange-yellow with black tarsal rings. Abdomen orange-yellow, tergites with small round dots, sternites 1–6 with pairs of rounded dots on each segment.

Male genitalia (Fig. 18): Uncus bifurcate with deep medial incision; anterior part of gnathos long, with more or less equal, strong teeth, posterior part wide, membranous; labis long, thin, hairy. Valva elongate, distally curved, saccular and apical parts covered densely with strong hairs, costa of valva long; cucullus sclerotized, falciform, with apex rounded. Aedeagus gun-shaped, carina with strong, thin sclerotized ring, vesica armed with long, pectiniform bundle of long spinules.

Female genitalia: Ovipositor strongly sclerotized, anterior apophyses fused with lamella postvaginalis. Lamella postvaginalis large, sclerotized; scobinate, inflated emergence large, elongate. Antrum with fine sclerotized half-ring, dorsal surface with diffusely dentate zone. Ductus bursae long, tubular, helicoid with several coils. Signum very large, more or less smoothly sclerotized, with crenulate margins, a deep crease horizontally.

Material examined: Taiwan, male "Takow, Formosa, 21.IV.1905 A. E. Wileman" (coll. HNHM).

Distribution: Madagascar; Seychelle Islands; India: Assam; Burma: Shan states; Kei Island (near New Guinea); Samoa; Hawaii: Honolulu.

Bionomics: The moths are on the wing between III–IX. The summarized details of the life cycle and immature stages of *E. nigroapicella* were published by ZIMMERMANN (1978).

Remarks: *E. nigroapicella* can be found on the trunks of *Cordia subcordata*, *C. sebestena* etc. trees, appearing as pest of these plants. It is recorded as occasionally visiting the artificial light.

Ethmia zygospila MEYRICK, 1934
(Figs 19–20, 37, 53)

Ethmia zygospila MEYRICK, 1934, Exotic Microlepidoptera 4: 459.

Diagnosis: *E. zygospila* can be confused with *E. pseudozygospila* sp. n.; the detailed comparison is given under the description of the new species. Both species were collected in the same site in Taiwan by A. E. Wileman.

Description (Fig. 37): Wingspan 22–24 mm. Antenna filiform; scape with black scales above and with white ones below; flagellum covered with brown scales and bristles. Maxillary palp white with black scales, labial palp white, with one black ring on each segment. Proboscis whitish, frons and vertex white, thorax with four black spots; tegulae white with black basal dot (Fig. 53). Forewing overlaid with black markings on white background; a long, rather broad, bisinuate black stripe running from base of costa, below cell towards apex into cilia, consisting of partly or fully fused, elongate spots characteristic of this species. Hindwing grey; with black costal brushes; cilia grey. Legs and abdomen greyish.

Male genitalia (Fig. 19): Uncus bifid, with long, slender, acute arms. Posterior part of gnathos forming a rather long, sclerotized, pointed medial process, anterior part wide, divided into two symmetrical lobes, covered with strong bristles and teeth; labis sclerotized, broad, finger-shaped. Valva rather broad, sligthly curved, apically tapering, with apex finely rounded, ventral margin with slight incision below cucullus. Ventral surface covered densely with long hairs, costal plate of valva small, rounded triangular. Aedeagus convex, rather flat, hook-like, vesica with a long, flattened, apically pointed cornutus.

Female genitalia (Fig. 20): Ovipositor sclerotized, papillae anales conical, setose, posterior apophyses thin, longer than papillae; anterior apophyses short, narrow, pointed. Antrum short, sclerotized, a ring-like tube. Ductus bursae rather broadly tubular with "tightly appressed" coils, posterior end flattened, with strongly sclerotized bar. Corpus bursae spherical, signum narrow, elongate, a "shallow crease".

Material examined: Taiwan: "Formosa , Kanshirei, 1000 ft, 21.IV.1908, A. E. Wileman", GU-7478–BM in the BMNH London. Prov. Taitung: 1 male, Chihpen Hot Springs, 400 m, 10–11.VI.1997, leg. B. HERCZIG & L. RONKAY, Slide No. KUN 37; 1 male, Chihpen Hot Springs, 400 m, 6.IV.1997, leg. CSORBA & L. RONKAY, Slide No. 38; 1 female, 4 km N of Tupan, 390 m, 14.VI.1997, 120°52'E, 22°28'N, leg. CS. SZABÓKY, Slide No. 40; 1 specimen 7 km E of Taimali, 710 m, 20.V.1997, leg. CS. SZABÓKY; 1 specimen, 3 km W of Hungyeh village, 350 m, 13.VI.1997, leg. CS. SZABÓKY. Prov. Nantou: 1 specimen, Ursung Forest, 16 km E of Kuoshing, 560 m, 29–30.X.1996, leg. CS. SZABÓKY; 2 specimens, 3 km E of Tili, 555 m, 27–28.V.1997, leg. CS. SZABÓKY. Prov. Kaoshiung: 26 km SE of Taoyuan, 1370 m, 4.XI.1996, leg. CS. SZABÓKY; Chiai Meishan Juili, 3–4, XI,1995, leg. M. L. CHAN & W. T. YANG.

Distribution: Taiwan; presumably endemic.

Bionomics: The species is probably bivoltine, the adults are on the wing from April to June and in September-October. The habitats of the specimens observed are subtropical forests at lower elevations (between 300–1500 m a.s.l.).

Remarks: The male and its genitalia are illustrated here for the first time. According to the configuration of the male genitalia, the species belongs to the *dodecea*-group as supposed by SATTLER (1967).

Ethmia pseudozygospila sp. n.

(Figs 21–22, 38, 54)

Holotype: female, "Taiwan, Pingtung Province, Kenting National Park, Kenting Forest Recreation Area, 300 m, 21°57'62''N, 120°48'89''E, 17–18.IV.1997, leg. A. Kun & L. Peregovits". Slide No. 36. The holotype is preserved in the Hungarian Natural History Museum, Budapest.

Paratypes: Taiwan: Prov. Kaoshiung: 2 specimens, 26 km SE of Taoyuan, 1370 m, 2.VI.1997, 120°52'E, 23°17'N, leg. CS. SZABÓKY (slide No. KUN 34). Prov. Taitung: 4 specimens, 3 km W of Hungyeh village, 350 m, 14.XI.1996, 1.VI.1997 and 13.VI.1997, 120°52'E, 22°28'N, leg. CS. SZABÓKY (slide No. KUN 35); 2 specimens, 4 km N of Tupan, 390 m, 31.V.1997, leg. Cs. SZABÓKY. Prov. Nantou: 13 specimens, Wushe, 28–29.IV, 30–1.VI. 1993, 25–27.V.1993, 10–12.VIII.1998, leg. C. S. LIN & W. T. YANG, UV light. 1 female, "Formosa, 29.VIII.1907, A.E. Wileman, 1913–180"; 1 specimen, "Formosa, Kanshirei 1000 ft 16.IV.1906, A. E. Wileman (abdomen absent)". Lanyu: 2 specimens, Szudaugou, 25–26. IV. 1997. UV Light, leg. M. L. CHAN; 1 female, "China, Canton, A. E Wileman, Com. Inst, Ent. Coll. No. 11555"; 1 female, "Formosa 9.V.1907, A. E. Wileman, BM Genitalia Slide No. 7436"; 1 specimens, Jenai, Chunyang, VIII.10–12.1998, UV light, leg. C. S. Lin & W. T. Yang, Four of the paratypes are deposited in The Natural History Museum (BMNH), London and 16 paratypes in the National Museum of Natural Science, Taichung. The rest of the paratypes are preserved in the Hungarian Natural History Museum and in the private collection of CS. SZABÓKY.

Diagnosis: The new species resembles externally *E. zygospila*, but is smaller in size (wingspan of *E. pseudozygospila* 14–16 mm, that of *E. zygospila* 22–24 mm), the forewing markings are less distinct, the blackish spots fused into broad, diffuse, more or less V-shaped fascia, and the hindwing is much paler, a whitish grey. The black thoracic pattern is also different, *E. pseudozygospila* has four dots at caudal half of thorax, while *E. zygospila* has only three, one of them on prothorax, further two at lateral edges of metathorax. The genitalia of the two species are strongly dissimilar, see figs 19–20, 21–22.

Description (Fig. 38): Wingspan 14–16 mm. Antenna filiform; scape with brown scales above and white scales below; flagellum covered with brown scales and bristles. Maxillary palp and labial palp white, with two black rings on first and last segments; proboscis also white. Frons white, vertex white with black scales on top. Thorax whitish grey with four black spots; tegulae whitish grey, with black basal dots (Fig. 54). Forewing overlaid with black markings on whitish grey background; forewing markings less distinct, blackish spots fused into broad, diffuse, more or less V-shaped fascia; cilia as ground colour. Hindwing whitish grey; male with costal brushes, cilia also grey. Legs whitish grey, hindlegs with black scales on tarsus. Abdomen grey.

Male genitalia (Fig. 21): Uncus long, bifid, with pointed arms; posterior part of gnathos dentate with six thorns, anterior part wide, covered with fine teeth; labis membranous, broad. Costa of valva triangular, naked, cucullus with long, knob-like, strongly hairy processus distally, sacculus triangular, hairy. Aedeagus with convex dorsal margin; its dorsal, membranous "coat" (manica) large, humped; carina with sclerotized, narrow ring, vesica with a sclerotized, flat, plate.

Female genitalia (Fig. 22): Ovipositor sclerotized, papillae anales conical, apically curved, with long bristles at base. Posterior apophyses as long as papillae anales, anterior apophyses short, basally widened, subtriangular. Antrum short, funnel-like, with stronger, quadrangular caudal plates on both surfaces. Ductus bursae rather short, tubular. Corpus bursae spherical, signum narrow, very long, with a fine, long medial increasion.

Distribution: Taiwan, China: Canton.

Bionomics: Early stages and foodplant are unknown. The specimens of the type series were found in the lower zones of Taiwan (between 300–1500 m a.s.l.). According to the collecting data, the species may have two separate broods; the flight periods are April–June and August–November.

Etymology: The specific name refers to the similarity of the species with *E. zygospila*.

Ethmia penesella sp. n.

(Figs 23, 39, 55)

Holotype: male, "Taiwan, County Kaohsiung, Liu-Kuei, San-Ping Forest Research Station, 700 m, 22°58'16''N, 120°41'15''E, 14–15.IV.1997, leg. L. Peregovits & A. Kun" (slide No. KUN 42). The holotype is preserved in the Hungarian Natural History Museum, Budapest.

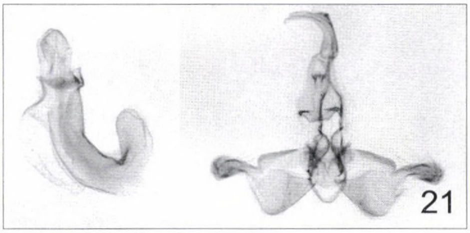
Paratypes: Taiwan, 3 males, with the same data as the holotype, slide No. KUN 41.

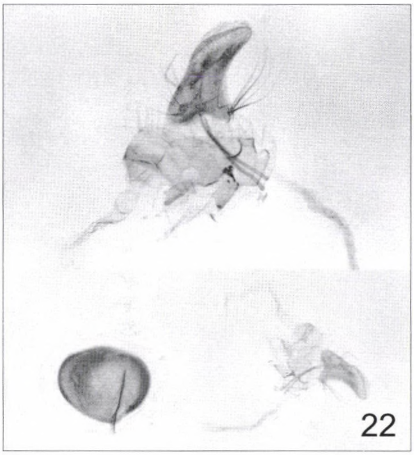
The paratypes are deposited in The Natural History Museum, (BMNH), London, the National Museum of Natural Science, Taichung, and in the Hungarian Natural History Museum, Budapest.

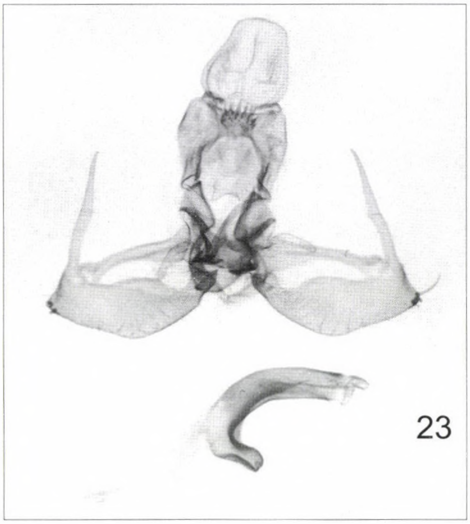
Diagnosis: The wing pattern of *E. penesella* is very similar to those of *E. maculifera* and *E. susa* sp. n. but *E. penesella* is much larger in size than the other two related species, the forewing ground colour is unicolorous grey and the abdomen is conspicuously yellow. The abdomen of *E. susa* is also yellow, with a pair of black dots on the last four tergites, while *E. maculifera* has a whitish grey abdomen.

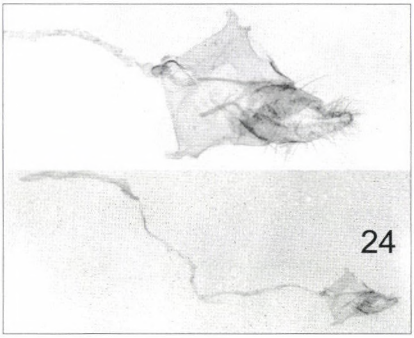
The male genitalia of *E. penesella* differ from those of *E. maculifera* in almost every detail, the most conspicuous features are the considerably larger size and the much longer, straight, more acute, process of the cucullus.

Description (Fig. 39): Wingspan 30–32 mm. Antenna filiform, with whitish grey scales; scape, maxillary palp, labial palp and proboscis whitish grey. Frons and vertex grey, vertex with black scales on top. Thorax whitish, with four black spots, tegulae with black basal dots (Fig. 55). Forewing grey, marked with ten black spots arranged into two main groups which contain five spots each. Dots of basal group somewhat larger, especially those of costal area. Basal streak of


21


22


23


24

Figs 21–24. *Ethmia* spp. genitalia slides. 21–22 = *E. pseudozygospila* sp. n., 21 = male, paratype, V, A; 22 = female, holotype, O, F; 23 = *E. penesella* sp. n., male, paratype, V, A; 24 = *E. susa* sp. n., female, holotype, O, F (Abbreviations: V = valva, A = aedeagus, Ve = vesica, O = ovipositor, F = entire female genitalia)

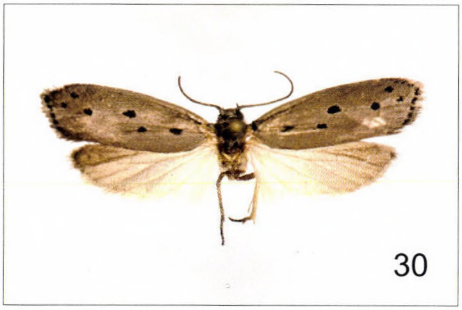

25


26


27


28

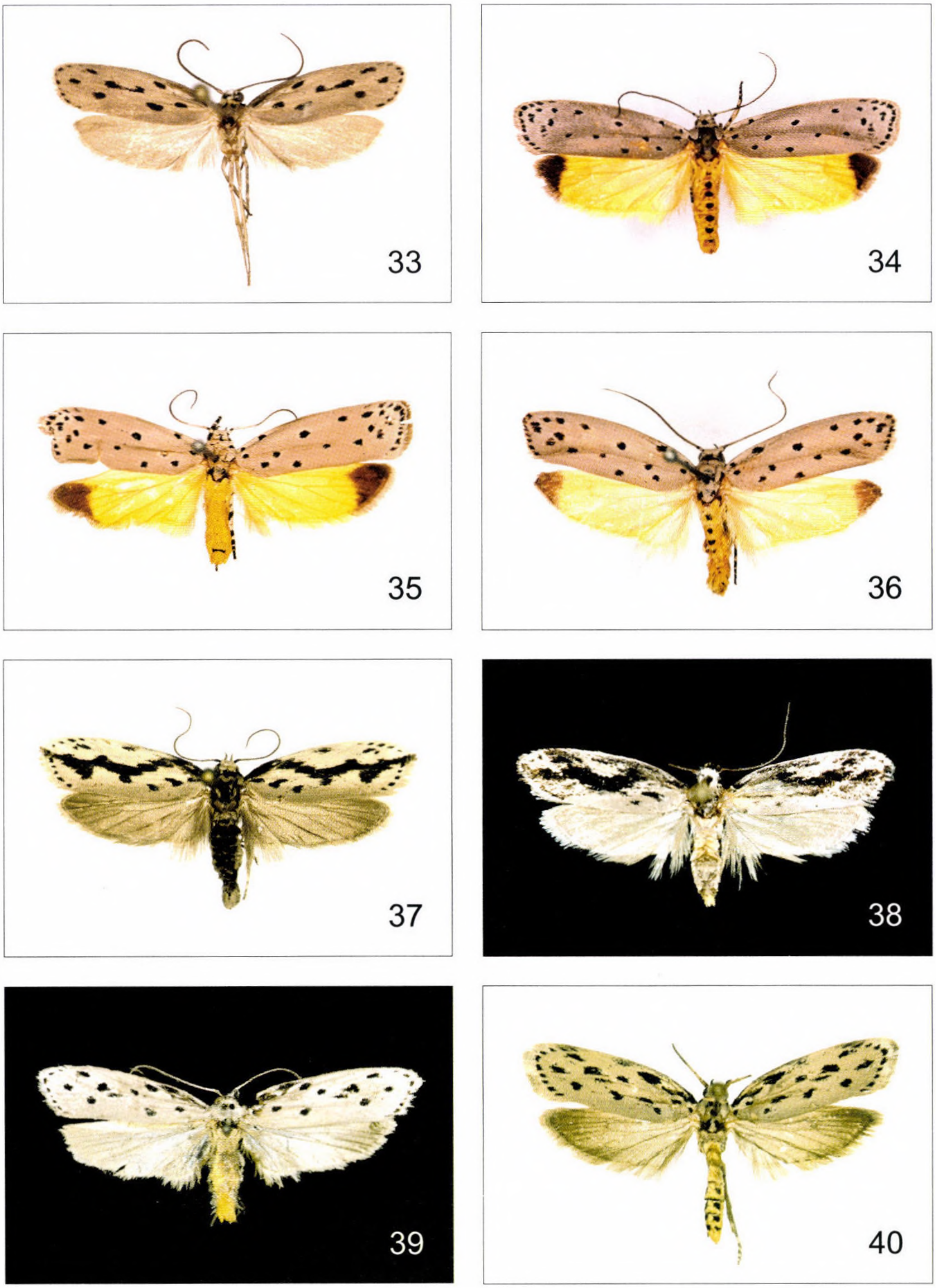

29


30


31


32

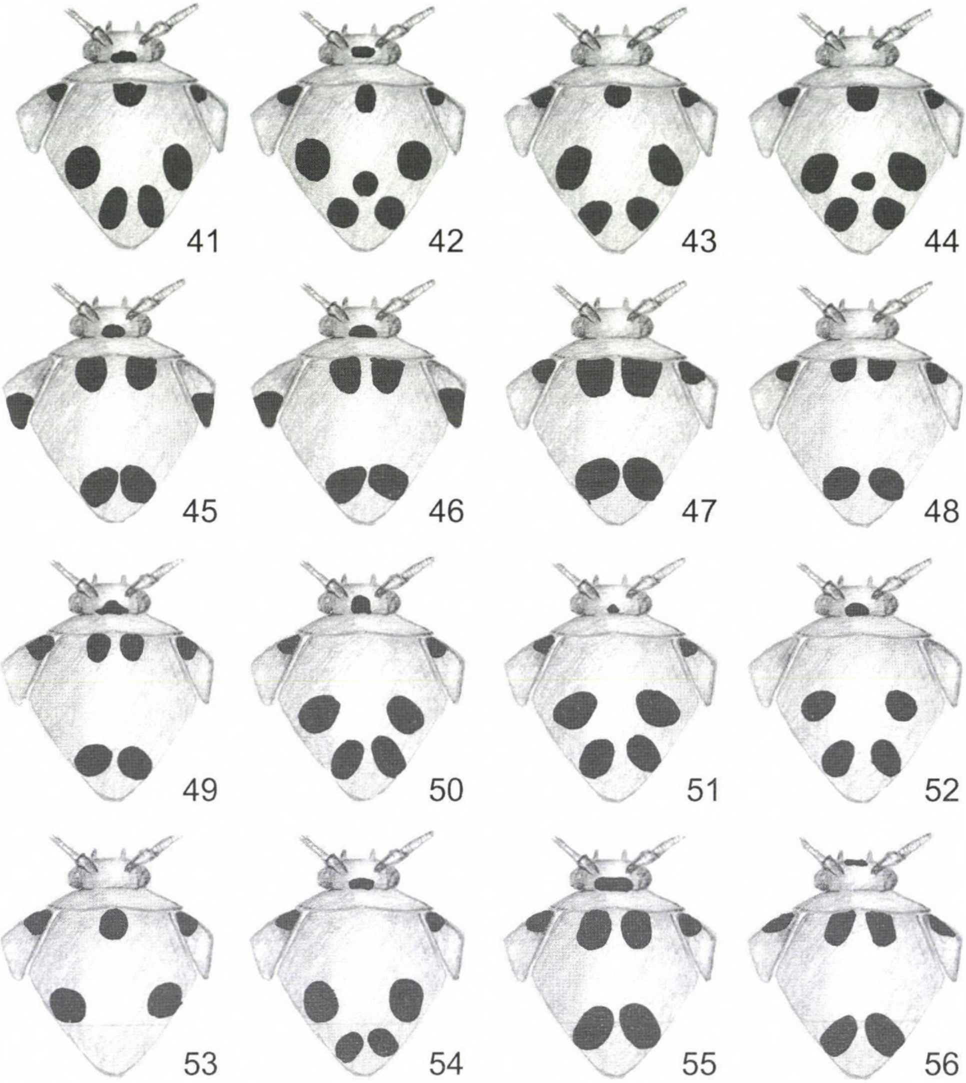
Figs 25–32. *Ethmia* spp.: 25 = *E. maculata* SATTLER, 26 = *E. lineatonotella* (MOORE), 27 = *E. okinawana* (MATSUMURA), 28 = *E. assamensis* (BUTLER), 29 = *E. lapidella* (WALSINGHAM), 30 = *E. octanoma* MEYRICK, 31 = *E. crocosoma* MEYRICK, 32 = *E. epitrocha* (MEYRICK)



Figs 33–40. *Ethmia* spp.: 33 = *E. maculifera* (MATSUMURA), 34 = *E. praeclara* MEYRICK, 35 = *E. dentata* SATTLER et DIAKONOFF, 36 = *E. nigroapicella* (SAALMÜLLER), 37 = *E. zygospila* MEYRICK, 38 = *E. pseudozygospila* sp. n., 39 = *E. penesella* sp. n., 40 = *E. susa* sp. n.

submedian fold short, marked with white scales, terminal line represented by 8–9 small black dots. Hindwing whitish grey; with costal brushes, cilia as ground colour. Forelegs grey with black rings; midlegs and hindlegs grey with black scales on tarsus. Abdomen yellow, without black markings.

Male genitalia (Fig. 23): Uncus well-developed, hood-like, weakly hairy. Socii small, short, bar-like, posterior part of gnathos mace-like, strongly dentate, anterior part membranous. Labis membranous, narrow, finely curved, densely setose; anellus sclerotized, trapezoidal, with long,



Figs 41–56. Thoracic pattern of *Ethmia* spp. 41 = *E. maculata* SATTLER, 42 = *E. lineatonotella* (MOORE), 43 = *E. okinawana* (MATSUMURA), 44 = *E. assamensis* (BUTLER), 45 = *E. lapidella* (WALSINGHAM), 46 = *E. octanoma* MEYRICK, 47 = *E. crocosoma* MEYRICK, 48 = *E. epitrocha* (MEYRICK), 49 = *E. maculifera* (MATSUMURA), 50 = *E. praeclara* MEYRICK, 51 = *E. dentata* SATTLER et DIAKONOFF, 52 = *E. nigroapicella* (SAALMÜLLER), 53 = *E. zygospila* MEYRICK, 54 = *E. pseudozygospila* sp. n., 55 = *E. penesella* sp. n., 56 = *E. susa* sp. n

slender dorso-lateral arms. Valva rather short, rounded quadrangular, distal part with heavily sclerotized "seta-brunches"; costa long, narrow, cucullus with very long, acute, almost straight apical processus, base of sacculus slightly hairy. Aedeagus narrowly tubular, convex, distal part with narrow, long, sclerotized dorsal and ventro-lateral plates. Vesica with long row of fine, pointed denticuli.

Female. Unknown.

Bionomics: No observations about the early stages and the foodplant are known. The specimens of the type series were collected in the San-Ping Forest Research Station (LTER site) in the middle of April, deep inside a mixed subtropical forest.

Distribution: Taiwan.

Ethmia susa sp. n.

(Figs 24, 40, 56)

Holotype: female, "Taiwan, Prov. Nantou, Ursun Forest, 16 km E of Kuohsing, 560 m, 8.IV.1997, 120°00'E, 24°05'N, leg. Cs. Szabóky" (slide No. KUN 73). The holotype is deposited in the Hungarian Natural History Museum, Budapest.

Diagnosis: the comparison of the new species with its relatives is given in the diagnosis of the preceding species. The female genitalia differ mostly from those of *E. maculifera* by their longer ovipositor, the finely scobinate, long, membranous, corpus bursae, and the absence of the signum.

Description (Fig. 40): Wingspan 22–24 mm. Antenna filiform, with whitish grey scales; scape and maxillary palp whitish grey. Labial palp black with grey tip; proboscis whitish grey. Frons black, vertex grey. Thorax whitish with four black spots, tegulae with distinct black basal spots (Fig. 56). Forewing grey, marked with twelve black spots arranged into four oblique, parallel rows. Base of costa black, terminal line consisting of ten small black(ish) dots. Hindwing grey; cilia as ground colour. Forelegs grey with black rings; midlegs and hindlegs grey with black scales on tarsi. Abdomen yellow, last four tergites with pairs of black dots.

Female genitalia (Fig. 24): Ovipositor less sclerotized, papillae anales elongate-conical, apically pointed, densely setose, posterior apophyses long, slender, anterior apophyses short, slightly curved, apically rounded. Antrum small, cup-shaped, with a fine, sclerotized half-ring. Ductus bursae very long, tubular, coiled, corpus bursae elongate-sacculiform, membranous with fine scobination, signum absent.

Distribution: Taiwan.

Bionomics: The life history and the habitats of the species are poorly known, the unique type specimen was collected at light in a mixed deciduous forest at rather low altitude.

Etymology: Patronym for Zsuzsa ("Susa"), lovely daughter of the second author.

*

Acknowledgements – We are grateful to the staff of the Lepidoptera Collection of the Hungarian Natural History Museum, LÁSZLÓ RONKAY, LÁSZLÓ PEREGOVITS and LÁSZLÓ GOZMÁNY, and to KEVIN R. TUCK (The Natural History Museum, London) who have helped and given us valuable advice to the manuscript. We are indebted to the staff of the Taiwan Forestry Research Institute and the Taiwanese Ecological Research Network (TERN) for their support and help in the field work and their permission to collect at their research sites, MAN-MIAO YANG, MEI-LING CHAN (National Museum of Natural Science, Taichung), CHIEN MING FU, HAN RONG TZUOO, SHEN-HORN YEN (Imperial College, London) and THOMAS WITT (Witt Museum, Munich) for the loan of *Ethmia* material from SE Asia.

REFERENCES

AMSEL, H. G. (1969) Eine neue chinesische Ethmia-Art. *Beitr. Naturk. Forsch. Südws. Dtl.* **28**: 75–76.

BUTLER, A. G. (1879) Collection of Lepidoptera from Cachar, N. E. India. Hyponomeuta assamensis, n. sp. *Trans. Ent. Soc. London* **1879**: 6.

CLARKE, J. F. G. (1965) *Catalogue of the Type specimens of Microlepidoptera in the British Museum (Natural History) described by Edward Meyrick.* Vol. V. pp. 417–438. Trustees of The British Museum (Natural History), London.

COMMON, I. F. B. (1990) *Moths of Australia.* Melbourne Univ. Press, pp. 246–249, pl. 4: 25, 26; pl. 5: 2.

DIAKONOFF, A. (1969) Key to Philippine Genera of Ethmiidae. *Bull. U.S. nat. Mus.* **257**: 249–259.

HARUTA, T. (1995) *Moths of Nepal*, Part 4. *Tinea* Vol 14 (Suppl. 12).

HEPPNER, J. B. & INOUE, H. (1992) *Lepidoptera of Taiwan, Checklist.* Association for Tropical Lepidoptera, Florida.

INOUE, H., SUGI, S., KUROKO, H., MORIUTI, S. & KAWABE, A. (1993) *Moths of Japan.* Kodansha, Tokyo.

LIU, Y. (1980) A study of Chinese Ethmia Hübner (Lepidoptera: Ethmiidae) in classification, distribution and numerical taxonomy. *Entomotaxonomia* **2**(4): 267–284, illustr.

LIU, Y, BAI, J. (1993) Lepidoptera: Coleophoridae, Argyresthiidae, Plutellidae, Gelechiidae, Ethmiidae, Yponomeutidae, Tortricidae, Cochylidae. *In* CHEN, S. (ed.): *Insects of the Hengduan Mountains region.* Vol. 2. Science Press, Beijing. pp. 867–1547.

MEYRICK, E. (1910) Description of Malayan Micro-Lepidoptera. *Trans. Ent. Soc. London*: 460.

MEYRICK, E. (1914) *Exotic Microlepidoptera*, **1**: 173.

MEYRICK, E. (1914) Pterophoridae, Tortricidae, Ecosmidae usw. *Suppl. Ent.* **3**: 55.

MEYRICK, E. (1932) *Exotic Microlepidoptera*, **4**: 347.

MEYRICK, E. (1934) *Exotic Microlepidoptera* **4**: 459.

MATSUMURA, S. (1931) *6000 Illustr. Ins. Japan.* 1085 pp.

POWELL, J. A. (1973) *A systematic monograph of New World ethmiid moths (Lepidoptera, Gelechioidea).* Smithsonian Contr. Zool. No. **120**: 1–302.

ROBINSON, G. S., TUCK, K. R. & M. SHAFFER (1994) *Smaller moths of South-East Asia.* The Natural History Museum, London, pp. 66–67.

SATTLER, K. (1967) *Ethmiidae. Microlepidoptera Palaearctica. Vols 1, 2*, Wien.

SATTLER, K. & DIAKONOFF, A. (1966) Description of a new species of Ethmiidae (Lepidoptera). *Ent. Ber., Amst.* **26**: 189; figs 1, 2, 3.

SHIN, Y.-H. (1983) *Illustrated Flora & Fauna of Korea.* Vol. 27 Insecta (IX).

WANG, H.-Y. (1996) *Guide Book to Insects in Taiwan* (17). Supplement of moths. p. 140.

ZIMMERMANN, E. C. (1978) *Insects of Hawaii, Part II. Vol. 9.* Univ. Press Hawaii, Honolulu, pp. 921–928.

Revised version received 14th March, 2000, accepted 5th June, 2000, published 7th July, 2000

ACTA ZOOLOGICA ACADEMIAE SCIENTIARUM HUNGARICAE

An international journal of animal taxonomy and ecology

Instruction to authors

Submission of a paper implies that it has not been published previously, that is not under consideration for publication elsewhere, and that if accepted for the Acta Zoologica Hungarica, the authors will transfer copyright to the Hungarian Academy of Sciences/the Hungarian Natural History Museum as is customary. Articles and illustrations become the property of the HAS/HNHM.

Papers must be in English with British spelling, and be original contributions in the field of animal taxonomy, systematics, zoogeography and ecology. All manuscripts must be submitted to one of the editors (editor, assistant editor).

Entire manuscripts must be submitted on IBM compatible floppy disk and in duplicate printed copies and the author should retain a copy. In the case of multiple authors, the corresponding author should be indicated. Series of numbered papers will not be considered.

Manuscripts must be printed with double spacing (including the reference list), and with wide margins (30–35 mm) on the left side of the paper only. Authors are requested to keep their communications as concise as possible. Footnotes should be avoided or minimized, and italics should not be used for emphasis. A running head of not more than 30 letters should be supplied.

The manuscript should contain the following information:

Title should be followed by the name and full address of the author(s). Where possible, the fax and/or e-mail number of the corresponding author should be supplied with the manuscript, for use by the publisher.

Abstract should be a brief summary of the contents and conclusions of the paper, and should not be longer than 200 words and should not contain references.

Key words should not be more than five (exceptionally 6) key word entries.

Introduction should contain a brief survey of the relevant literature and the reasons for doing the work.

Materials and Methods supply sufficient information to permit repetition of the experimental or field work. The technical description of methods should be given only when such methods are new.

Results should be presented concisely. Only in exceptional cases will it be permissible to present the same set of results in both table and a figure. The results section should not be used for discussion.

Discussion should be separate from the results section and should deal with the significance of the results and their relationship to the object of the work (and, this is the place of the identification key in taxonomic revisions).

Acknowledgements (at most in 10 lines).

References. In principle the Harvard system is to be followed. References should be detailed in the following order: authors' names and initials, date of publication (in parentheses), the title of the article, the name of the journal as abbreviated in the World List of Scientific Periodicals (4th edn 1963), the volume, and the first and last pages of the article, e.g.

NORRBOM, A. L. and KIM, K. C. (1985) Taxonomy and phylogenetic relationships of Copromyza Fallén (s.s.) (Diptera: Sphaeroceridae). *Ann. Entomol. Soc. Am.* **78**: 331–347.

For books the author's names, date of publication, title, edition, page reference, publisher's name and the place of publication should be given, e.g.

HINTON, H. E. (1981) *Biology of insect eggs*, vol. 2. Pergamon Press, New York, 234 pp.

or

MCALPINE, J. F. (1981) Morphology and terminology, adults. Pp. 9–63. *In* MCALPINE *et al.* (eds) *Manual of Nearctic Diptera*, vol. 1. Agriculture Canada, Ottawa.

In the text references should be given as MARSHALL (1992) or (MARSHALL 1992). When a citation includes more than two authors, e.g. GREY, BLACK and WHITE, the paper should be referred to in the text as GREY *et al.*, provided that this not ambiguous. If papers by the same author(s) in the same year are cited, they should be distinguished by the letters, *a, b, c,* etc., e.g. MARSHALL (1992*a*).

References to papers "in press" must mean that the article has been accepted for publication. References to "personal communications" and unpublished work are permitted in the text only: references to papers in preparation or submitted are not permissible.

All necessary **illustrations** should accompany the manuscript, but should not be inserted in the text. All photographs, graphs and diagrams should be numbered consecutively in Arabic numerals in the order in which they are referred to in the text. Glossy photographs or positive prints should be sent unmounted wherever possible and should be kept to a minimum. Figures should be of good quality. Explanation of lettering and symbols should be given in the figure caption and only exceptionally in the figures. Lettering and symbols to appear on the illustration should be of sufficient size to allow for considerable reduction where necessary (usually proper for a 50% reduction in size). Scales must be indicated on micrographs, not by magnifications in the legends. Figure size must not exceed 24×30 cm. On the back of each illustration should be indicated the author's name, the figure number (in Arabic numerals), and the top of the illustration, where this is not clear. Halftones should be included only when they are essential. Details and quotation of publication of colour plates should be made to the editors. The following symbols should be used on line drawing: ● ■ ❍ ❑ ▲ ◆ ♦ etc.

Legends to figures should be typed on a separate sheet. They should give sufficient data to make the illustration comprehensible without reference to the text.

Tables and appendices should be constructed so as to be intelligible without reference to the text, numbered in Arabic numerals and typed on separate sheets. Every table should be provided with an explanatory caption and each column should carry an appropriate heading. Units of measure should always be indicated clearly (metric units are preferred). All tables and figures must be referred to in the text.

Only standard **abbreviations** should be used. Arbitrary abbreviations and jargon will not be accepted.

The Latin names should be given for all species used in the investigation, although taxonomic affiliation and authority need not be provided in the title.

Page proofs will be sent to the author (or the first-mentioned author in a paper of multiple authorship) for checking. Corrections to the proofs must be restricted to printers' errors. Any substantial alterations other than these may be charged to the author. Authors are particularly requested to return their corrected proofs as quickly as possible in order to facilitate rapid publication. Please note that authors are urged to check their proofs carefully before return, since late corrections cannot be guaranteed for inclusion in the printed journal.

Fifty reprints free of charge will be sent to the first author; extra copies of the issue (at a specially reduced rate) can be ordered on the form which will accompany the proofs. These should be returned to: The Editorial Office of the Acta Zoologica, Hungarian Natural History Museum, Budapest, Baross u. 13, H–1088, Hungary

The **page charge** required from authors outside Hungary is USD 15 per printed page. In exceptional cases, the page charge may be waived. Please contact the editor in before submitting a paper if you ask for a waiver. Authors of papers exceeding 16 printed pages are asked to pay USD 40 (or HUF equivalent) for each such page, i.e. all costs of publication (irrespective of their nationality).

FOR FURTHER INFORMATION PLEASE CONTACT US
The Editorial Office of the Acta Zoologica
H–1088 Budapest, Baross u. 13, Hungary
Fax: (36–1) 3171669
http://actazool.nhmus.hu/
E-mail: perego@zoo.zoo.nhmus.hu

SUBSCRIPTION INFORMATION

Orders should be addressed to

Editorial Office of the Acta Zoologica
Hungarian Natural History Museum
H–1088 Budapest, Baross u. 13, Hungary
Fax: (36–1) 3171669
E-mail: perego@zoo.zoo.nhmus.hu

Typeset: Pars Ltd., Budapest.
Printed by Mondat Ltd., Hungary

CONTENTS

HU ISSN 1217–8837

Acta Zoologica

Academiae Scientiarum Hungaricae

VOLUME 46 - NUMBER 2 - 2000

HUNGARIAN NATURAL HISTORY MUSEUM, BUDAPEST

ACTA ZOOLOGICA ACADEMIAE SCIENTIARUM HUNGARICAE

AN INTERNATIONAL JOURNAL OF ANIMAL TAXONOMY AND ECOLOGY

Acta Zoologica Academiae Scientiarum Hungaricae is published quarterly from February 1994 (other issues in May, August and November) by the Hungarian Natural History Museum and the Biological Section of the Hungarian Academy of Sciences with the financial support of the Hungarian Academy of Sciences.

For detailed information (contents, journal status, instructions for authors, subscription, and from Volume 40 onward title, author, authors' addresses, abstract, keywords and a searchable taxon index) please visit our website at

http://actazool.nhmus.hu/

Acta Zoologica Academiae Scientiarum Hungaricae 46 (2), pp. 79–102, 2000

ANT ASSEMBLAGES ASSOCIATED WITH LOWLAND FORESTS IN THE SOUTHERN PART OF THE GREAT HUNGARIAN PLAIN

ALVARADO, M. and GALLÉ, L.

Department of Ecology, University of Szeged
H-6701 Szeged, Pf 51, Hungary
alvaro@bio.u-szeged.hu, galle@bio.u-szeged.hu

A survey of ants in 11 native forests and 13 plantations of introduced trees resulted in an inventory of altogether 36 species. The number of species was the highest in the native poplar forests (total: 24, mean: 13.33±4.16), and the lowest in the hybrid poplar plantation (13 and 6.33±1.15, respectively). Ants were numerically most abundant in native poplar and oak forests and least in black locust habitats. The typical forest ant species could be found in the forests native in the region (poplar, oak) or in the Carpathian basin (pine), whereas the fauna of the introduced forests (hybrid poplar, black locust, Russian olive) consisted of the fraction of either degraded forest or grassland ant communities. The fauna of the open juniper forests also consisted of both forest and grassland species, but more characteristic for natural sites. Neither close correlation between the regional distribution and the local density, nor definite bimodal trend in the regional distribution was observed. There was, however, a close correlation between the information content of distribution and the local densities of the ant species.

Key words: ant assemblages, forests, commonness, rarity, diversity

INTRODUCTION

The Carpathian Basin plays an important role in biodiversity preservation. Due to its transitional geographic position, it is characterized by the overlap of distinct biogeographic regions and the joint occurrence of floral and faunal elements with different distribution centres. Several historic biogeographic effects have contributed significantly to the high level of biodiversity still preserved here (VARGA 1995). A great number of species, which became already extinct in Western Europe, are represented in this region by large populations. Central European landscapes could preserve their relative stability over the past few centuries due to the fact that traditional land use maintained a sustainable mosaic-like structure of nature-like, semi-natural and traditionally managed habitats (VARGA 1998). Several of these areas survived, although more than 70% of the country is cultivated, approximately 17% of the country is wooded or afforested, 9% is covered by near-natural woodlands and 4% is presently protected as nature reserve (KELEMEN *et al.* 1995).

Hungarian forests have become progressively more fragmented over extensive parts of their distributional range, mainly due to agricultural intensification, urbanization and other human activities. Simultaneously with this fragmentation a replacement of indigenous forests has taken place. Poplar (*Populus alba*), oak (*Quercus robur*) and juniper (*Juniperus communis*) stands were replaced by introduced species like black locust (*Robinia pseudoacacia*), pine (*Pinus nigra*, *Pinus silvestris*), Russian olive (*Elaeagnus angustifolia*) and hybrid poplar (*Populus alba* var. *hybrida*), which were introduced to Hungary for the first time in 1710, in 1784, in 1903 and 1920 onwards, respectively (MAGYAR 1961). At present, the stands of alien tree species amount to some 46 per cent of the areas covered by forests in Hungary, which clearly indicates the magnitude of forestry operations and man-made alterations. There is a growing ecological and conservation concern about the replacement of natural forests by introduced ones as it has transformed the scenery of Hungarian forests (KELEMEN *et al.* 1995).

Ants are an outstanding group in the structure and function of the terrestrial ecological communities (ANDERSEN 1987, 1990, ANDERSEN & MCKAIGE 1987), because they have an important influence on the soil, vegetation, and other faunal groups both directly and indirectly. As scavengers they are important agents of energy turnover and nutrient cycling (GREENSLADE & GREENSLADE 1984, GOESSWALD 1985, ANDERSEN 1988, PETAL 1992, FROUZ *et al.* 1997) and they have an important influence on soil structure and formation (PETAL 1980, MANDEL & SORENSON 1982, LEVAN & STONE 1983, JOHNSON 1992), too. As ants are successful colonizers of burned stands, cleared forests (ANDERSEN & YEN 1985, TOUYAMA 1996, PUNTILLA & HAILA 1996) and even mines (MAJER 1983, 1984, 1985), and sensitive indicators of habitat degradation (PETAL 1994), their research and monitoring could give important information for both ecology and conservation biology.

From the aspect of conservation biology, two kinds of approaches have been in the focus of interest recently: the diversity and the commonness-rarity dichotomy. Diversity measurement, the several kinds of indices that have been created and calculated and the search for an ideal measure is still a never-ending topic. New kinds of diversity indices are still appearing (TÓTHMÉRÉSZ 1995, SMITH & WILSON 1996) and several kinds of interpretations are available (LANDE 1996). Despite of all this debate on the practical usefulness of diversity indices, it remains one of the most widely used characteristics of ecological communities, although the belief that a diversity index provides a basis for getting a full understanding of community structure is not well founded owing to some opinions (PIELOU 1975). Working in different successive stages of sand-dune areas in South Finland, Hungary and Poland, GALLÉ and co-workers (GALLÉ 1991, 1992, GALLÉ *et al.* 1998) found that the diversity of ant assemblages increases along the different successional stages of the vegetation, but declines in the final phase of succession. Although rarity is the other up-to-date topic, nowadays there are controversial definitions of it (KUNIN & GASTON 1997, PAPP 1998) from the relatively simple "core and satellite" species dichotomy (HANSKI 1982) to the more sophisticated classifications (RABINOWITZ *et al.* 1986, PAPP 1998).

In Hungary, several studies have been carried out on ant assemblages of sand dune areas (GALLÉ 1990*a, b*, 1992, 1999) and on grassland ant communities (GALLÉ 1981, 1986*a*, GALLÉ *et al.* 1994). However, sparse information is available about the ant assemblages of Hungarian forests (HARTNER 1994) and their development (GALLÉ 1990*b*). In this study, our principal aim is the characterization of the distribution patterns, the composition and the diversity of ant assemblages in several forest types inhabiting the southern part of the Great Hungarian Plain. We compare the species richness and equitability of forest sites in which indigenous species are dominant (poplar, oak and juniper), and sites in which introduced species are dominant (black locust, pine, Russian olive and hybrid poplar). We furnish data on the distribution and density of ant species in the investigated lowland forests.

MATERIAL AND METHODS

Research was conducted in twenty-four indigenous and introduced forest sites in the southern part of the Great Hungarian Plain, near Szeged, approximately 200 km south-east of Budapest. The sites were located on the outskirts of Szeged (3 sites), in Ópusztaszer (30 km north of Szeged, 3 sites), in Balástya (35 km north-west of Szeged, 3 sites), in Ásotthalom (25 km west of Szeged, 9 sites), in Bócsa and Bugac regions of the Kiskunság National Park (50 km north-west of Szeged, 6 sites). Information concerning age, degree of disturbance and vegetation structure of the studied forest sites is summarized in Table 1. Details of habitats and their correlation with ant assemblages are given by ALVARADO (1999).

Ants were sampled with pitfall traps consisting of 6 cm diameter plastic cups, partly filled with ethylene-glycol as a preservative. 15 traps with at least 3 m spacing were placed at each site. Traps were employed three times for 7 day periods, in the consecutive 3 months in the summer. Ants were identified to species level using standard keys and recent reviews (SEIFERT 1988*a, b*, 1992, 1996).

Ants were classified as frequent or rare species on the basis of their average abundance, the number of sites occupied by them, the between-site rate of aggregation and the information content of their regional distribution. The average abundance was estimated as the average number of individuals cought by pitfall traps in those habitats, where the species occured. The rate of aggregation was computed by a simple index of dispersion, I = variance/mean, based on the number of occupied traps in all habitats. The information content of the regional distribution, which is a function of both site number and the rate of between-site aggregation, was assessed with Shannon-Wiener index based on the number of traps. Three indices were chosen to measure alpha species diversity: the Shannon-Wiener index with natural logarithm, which emphasises the richness in terms of the proportional abundance of species, the Simpson index, which is weighted towards the abundance of the commonest species, and the reciprocal of the Berger-Parker index, which highlights species equitability/dominance (MAGURRAN 1988).

Table 1. Location, age, vegetation structure and degree of anthropogenic disturbance for 24 forests patches. Disturbance degree: 0 = no disturbance, 1 = some disturbance is evident, 2 = high disturbance, 3 = very high disturbance. Twigs: number of twigs on the ground surface was estimated in 50 by 50 cm quadrates A set of ten such quadrates were taken at each site during three monts (45 quadrats per place). Abbreviations: B. locust = Black locust, H. poplar = Hybrid poplar, Comm. plantation = commercial plantation

Forest code	Location	Forest type	Age (years)	Canopy cover (%)	Trees (%)	Bushes (%)	Herbs (%)	Mosses (%)	Twigs	Disturbance	Notes
APo1	Ásotthalom	Poplar	100	15	10	25	15	no	272	0	Natural reserve
APo2	Ásotthalom	Poplar	100	20	15	5	85	no	217	0	Natural reserve
BuPo3	Bugac	Poplar	40	30	50		80	no	159	0	Natural reserve
AOa1	Ásotthalom	Oak	80	40	50	40	10	no	667	2	
AOa2	Ásotthalom	Oak	80	25	15	15	20	no	340	1	
BuOa3	Bugac	Oak	40	40	50	1	5	1	229	0	Natural reserve
OOa4	Ópusztaszer	Oak	60	35	50	5	1	no	722	3	
OOa5	Ópusztaszer	Oak	60	45	20	15	70	no	469	3	
BuJu1	Bugac	Juniper	30			60		5	94	0	Natural reserve
BoJu2	Bócsa	Juniper	50			70		no	7	0	Natural reserve
BoJu3	Bócsa	Juniper	50			60		no	4	0	Natural reserve
ABl1	Ásotthalom	B. locust	50	30	50		20	no	300	3	Recreation
OBl2	Ópusztaszer	B. locust	30		60	2			511	2	
BuBl3	Bugac	B. locust	15	15	5	70	50	no	193	0	Natural reserve

Table 1 (continued)

Forest code	Location	Forest type	Age (years)	Canopy cover (%)	Trees (%)	Bushes (%)	Herbs (%)	Mosses (%)	Twigs	Disturbance	Notes
APi1	Ásotthalom	Pine	40	40	35	15	40	10	325	1	Comm. plantation
APi2	Ásotthalom	Pine	25	15	30	2	75	5	370	1	Comm. plantation
APi3	Ásotthalom	Pine	15	50	50		20	20	235	1	Comm. plantation
APi4	Ásotthalom	Pine	5	15		20	20	no	10	1	Comm. plantation
SzE1	Szeged	Eleagnus	15	7	10		80	no	5	3	Grazing ground
SzE2	Szeged	Eleagnus	15	10	15		75	no	5	3	Grazing ground
SzE3	Szeged	Eleagnus	15	8	10		90	no	3	3	Grazing ground
BaHp1	Balástya	H. poplar	30	30	50		30	no	227	2	Comm. plantation
BaHp2	Balástya	H. poplar	15	55	50		10		164	2	Comm. plantation
BaHp3	Balástya	H. poplar	15	70	65			2	229	2	Comm. plantation

The ordination of the habitats on the basis of ant species composition was achieved by carrying out a correspondence analysis, the symmetric weighting option was chosen for the analysis (GAUCH 1982). The NuCoSa (TÓTHMÉRÉSZ 1993*a*) and SYN-TAX (PODANI 1993) packages were used for computations. Diversity profiles were employed for scale-dependent diversity characterization, while the Rényi's diversity index family was used because it is known to provide good results for communities of all sizes (TÓTHMÉRÉSZ 1995). Diversity profiles were then computed using the DiVord package (TÓTHMÉRÉSZ 1993*b*).

Using a modified form of the niche position-breadth analysis (MACNALLY & DOOLAN 1986, GALLÉ *et al.* 1998) we estimated the values of two parameters, called position (α) and breadth (β) obtained from multivariate data on the ant composition for the various forests types. The range of assemblages occupied by a species in the ordination factor space is called species's breadth (β) and the distance of the species range centre from the origo, i.e. the commnity specificity of the species in question is the position (α).

RESULTS

A total of 16088 individuals belonging to 36 ant species were caught in the traps, the richest genera being *Lasius* (8 species), *Formica* (8 species), *Camponotus* (4 species), *Myrmica* (4 species) and *Leptothorax* (3 spp.). All species had already been recorded in the Hungarian Plain. Altogether 24 ant species were found in poplar (mean 13.33±4.16), 21 in oak (mean 10±1.73), 20 in pine (mean 11.25±3.86), 18 in Russian olive (mean 11±4.35), 17 in juniper (mean 11.66±0.57), likewise in black locust (mean 9.33±2.08), and 13 in hybrid poplar forests (mean 6.33±1.15). The results of diversity analysis do not agree completely with these findings. Shannon and Simpson indices revealed the following order: Juniper > Black locust > Pine > Poplar > H. poplar > Oak = Russian olive (Table 2).

The diversity ordering using the Rényi's parameter showed that the ant assemblages of juniper forests are more diverse than the other habitats (Fig. 1). The

Table 2. Indices of species diversity for ant assemblages in seven forest habitats (24 sampled forests). The values represent the maximum and minimum values in each case.

				Species diversity indices		
Forest type	No. of sites	No. ant species	Shannon evenness	Shannon index	Simpson index	Reciprocal of Berger-Parker
Poplar	3	24	0.42–0.47	1.01–1.38	0.51–0.67	1.5–2.5
Oak	5	19	0.27–0.55	0.53–1.35	0.25–0.78	1.1–2.1
Juniper	3	17	0.64–0.79	1.60–1.96	0.72–0.83	2.4–3.9
Pine	4	18	0.43–0.72	0.96–1.73	0.53–0.77	1.5–3.1
Russian olive	3	18	0.45–0.60	1.07–1.19	0.51–0.55	1.4–1.7
Black locust	3	17	0.54–0.91	1.27–1.78	0.60–0.81	1.7–3.7
H. poplar	3	13	0.45–0.58	0.73–1.14	0.41–0.57	1.3–2.1

oak and Russian olive habitats could not be ordered according to their ant species diversity, however, as the diversity profiles intersected each other. This proves that the diversity indices we used order the assemblages differently.

The dominance diversity curves of the different forests are very similar, with the exception of native poplar forests. On this basis we can assume that the structure of the ant assemblages in the poplar forests differs from the other habitats (Fig. 2).

Seven numerically dominant species, *F. fusca*, *L. platythorax*, *F. truncorum*, *F. sanguinea*, *Tetramorium caespitum*, *F. rufa* and *L. psammophilus* represented 79.7% of the total number of individuals collected.

Although we found a bimodal distribution in the species number/site number histogram (Fig. 3), but after we had grouped the occupied sites in other ways, this bimodality was lost. No correlation was found between the local densities and the number of occupied sites ($r = 0.14$, $p > 0.1$), therefore, this set of data do not support HANSKI's (1982) core and satellite species theory. In accordance with these findings, a continuous transition was observed between frequent and rare species in the values of the product of density, number of occupied sites and the reciprocal of the between-site aggregation of the distribution (Table 3, Fig. 4). It

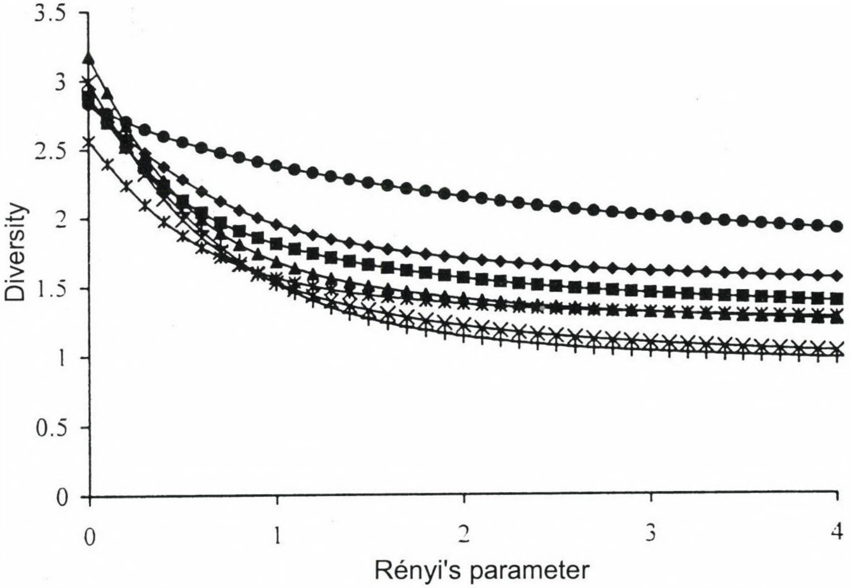


Fig. 1. Diversity ordering of the studied ant assemblages by the Rényi's diversity index function. Curves with higher values suggest higher diversity of the tested ant assemblages. Intersecting curves means that differences in diversity cannot be established. Forests: Poplar, Oak, Juniper, Pine, Russian olive, Black locust, Hybrid poplar

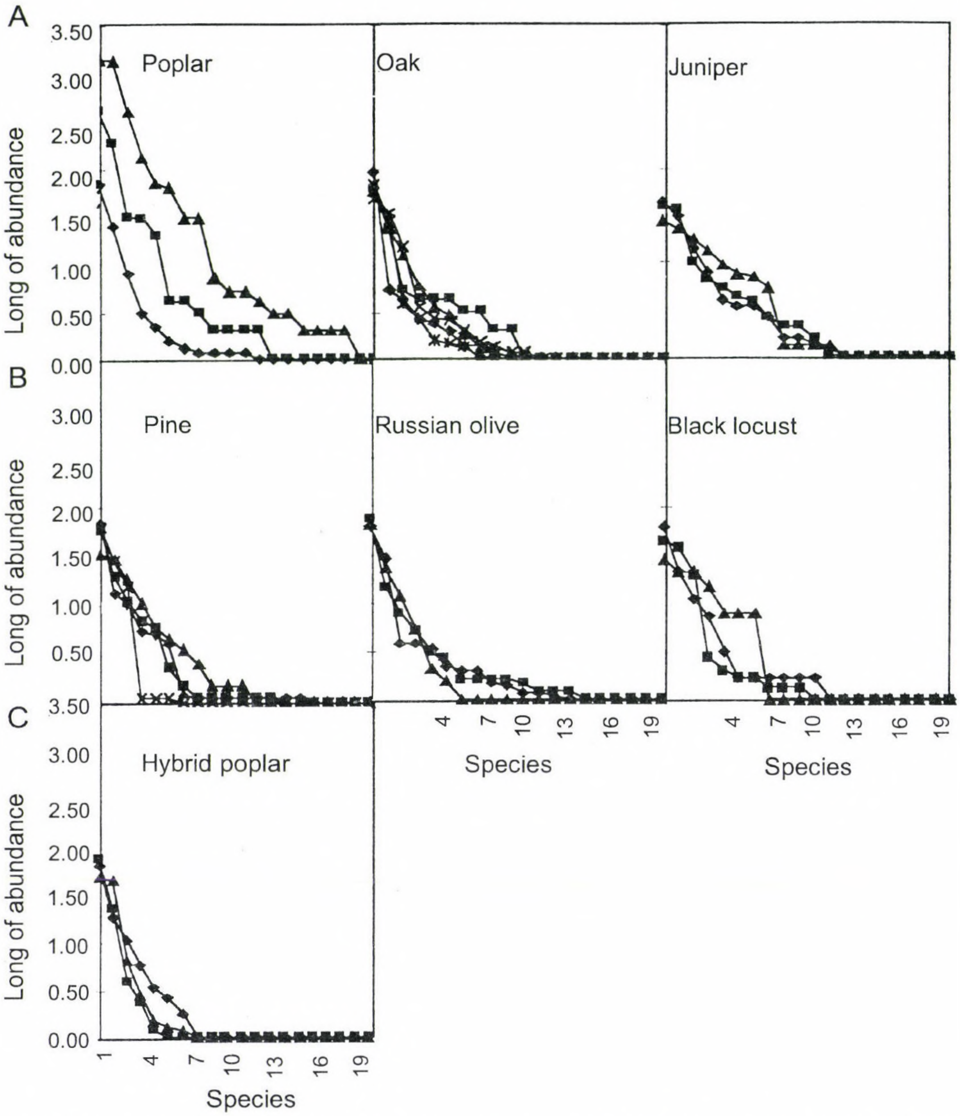


Fig. 2. Dominance diversity curves for seven types of lowland forest in southern part of the Great Hungary. Number of species per forest type was plotted against log abundance. A: Native forests – Poplar = APo1, APo2, BuPo3; Oak = AOa1, AOa2, BuOa3, OOa4, OOa5; Juniper = BuJu1, BoJu2, BoJu3. B: Long-introduced forests – Pine = APi1, APi2, APi3, APi4; Russian olive = SzE1, SzE2, SzE3; Black locust = ABl1, OBl2, BuBl3. C: Recently-introduced forests – Hybrid poplar = BaHp1, BaHp2, BaHp3.

Table 3. Information content of the regional distribution for the studied ant species. The rate of aggregation was computed by the index of dispersion, I = variance/mean, based on the number of occupied traps in all habitats. c*i= Number of individuals *reciprocal of the between-site agregation of the distribution

No.	Species	No. of individuals	No. of sites	1/I	c*i
1	*Anergates atratulus*	107	2	0.3	32.10
2	*Camponotus fallax*	17	9	0.472	8.02
3	*Camponotus piceus*	3	2	0.41	1.23
4	*Cataglyphis aenescens*	116	2	0.028	3.25
5	*Camponotus truncatus*	3	2	0.082	0.25
6	*Camponotus vagus*	223	12	0.079	17.62
7	*Solenopsis fugax*	58	10	0.31	17.98
8	*Dolichoderus quadripunctatus*	43	9	0.186	8.00
9	*Formica cunicularia*	62	13	0.13	8.06
10	*Formica fusca*	3216	17	0.052	167.23
11	*Formica polyctena*	1	1	1	1.00
12	*Formica pratensis*	1	1	1.045	1.05
13	*Formica rufa*	1057	5	0.132	139.52
14	*Formica rufibarbis*	140	9	0.095	13.30
15	*Formica sanguinea*	1774	10	0.057	101.12
16	*Formica truncorum*	1998	5	0.038	75.92
17	*Lasius alienus*	7	3	0.353	2.47
18	*Lasius carniolicus*	56	2	0.4	22.40
19	*Lasius fuliginosus*	7	2	0.191	1.34
20	*Lasius niger*	311	6	0.184	57.22
21	*Lasius paralienus*	1057	5	0.042	44.39
22	*Lasius platythorax*	2242	9	0.042	94.16
23	*Lasius psammophilus*	956	9	0.033	31.55
24	*Cthonolasius sp.*	7	4	0.804	5.63
25	*Leptothorax interruptus*	2	2	1.045	2.09
26	*Leptothorax nylanderi*	804	15	0.051	41.00
27	*Leptothorax unifasciatus*	710	20	0.068	48.28
28	*Myrmica sabuleti*	501	20	0.123	61.62
29	*Myrmica schencki*	40	3	0.119	4.76
30	*Myrmecina graminicola*	4	2	0.621	2.48
31	*Myrmica rubra*	1	1	1	1.00
32	*Myrmica salina*	115	2	0.082	9.43

Table 3 (continued)

No.	Species	No. of individuals	No. of sites	1/I	c*i
33	*Plagiolepis vindobonensis*	85	3	0.087	7.40
34	*Polyergus rufescens*	26	4	0.302	7.85
35	*Tapinoma ambiguum*	382	8	0.049	18.72
36	*Tetramorium caespitum*	1241	19	0.093	115.41

is obvious, that two out of these three metrics, i.e. the occupied site number and the rate of aggregation are two sides of the information content of the distribution of the species in question, which can be measured with Shannon-Wiener function. Plotting this function against log density of the species, a significant correlation is obtained ($r = 0.39$, $p < 0.02$), but the segregation between common and rare species appears to be very slight in this case, too (Fig. 5).

The detailed ant composition of the forest is given in Appendix 1. Differences in the ant composition was found dependent on the forest types. Ants were numerically the most abundant in poplar habitats and the least in black locust habitats.

The native poplar and oak forest habitats could be characterized with *F. fusca*, which is the most typical forest ant species in the Great Hungarian Plain. *Formica* s. str. species ("red wood ants": *F. rufa*, *F. truncorum*, *F. polyctena*) occured also in the planted pine woods, as they belong to the original fauna of pine forests. *Camponotus vagus*, which is a thermophilous and xerotolerant ant, is re-

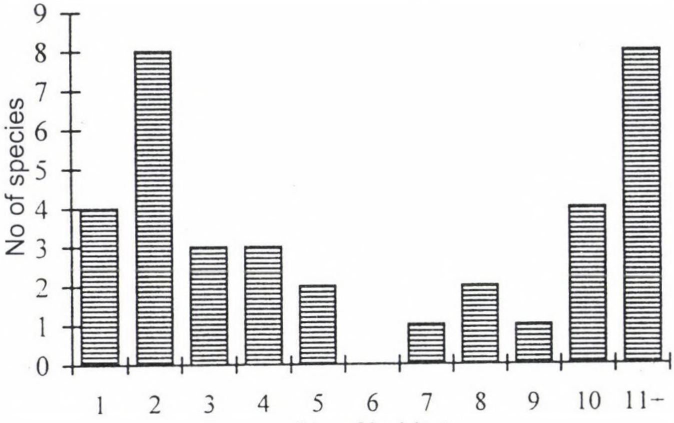


Fig. 3. Number of species plotted against the number of occupied sites

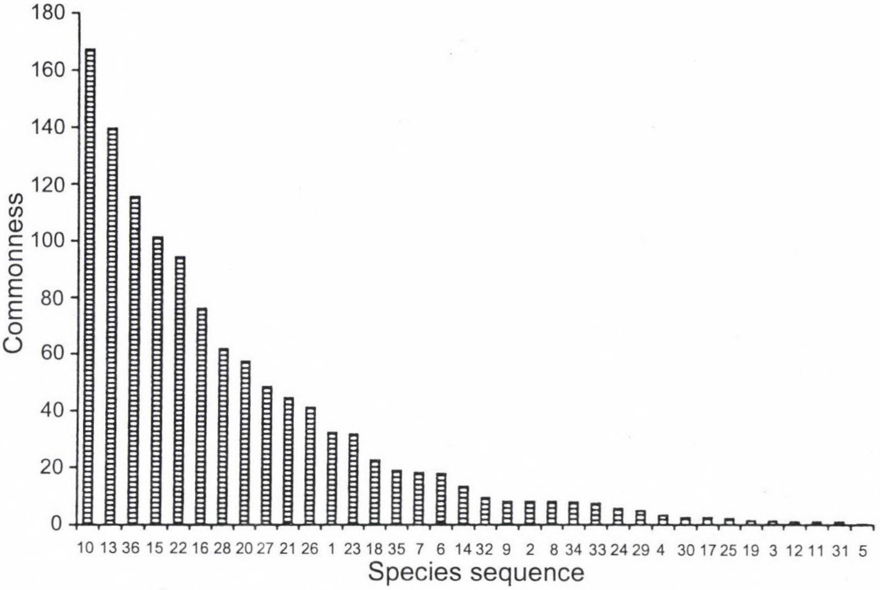


Fig. 4. Rank sequence of species performed on the basis of their "commonness", a product of the local density, number of occupied sites and distribution of evenness

stricted to the open forest sites (e.g., poplar, juniper). The ant assemblages of juniper woods consist of both thermophilous forest and grassland ants, owing to the open character of these habitats. In the introduced forests, including young pine plantations, the dominant ant species are grassland faunal elements (*L.*

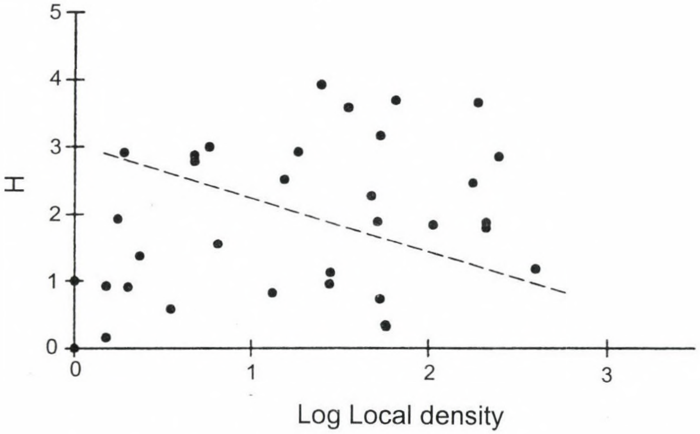


Fig. 5. The information content of species distribution (H) as a function of the local density. Dots above the slashed line can be regarded as "common" and those below the line as "rare"

Table 4. Mann-Whitney test of significance for 24 different forest types. Native forests: Poplar, Oak, Juniper. Old introduced: Black locust, Pine. Recently introduced: Russian olive, Hybrid Poplar. FOSA: *Formica sanguinea*; TETC: *Tetramorium caespitum*; FOFU: *Formica fusca*; LEPNY: *Leptothorax nylanderi*

	U	p-level
Native / old introduced		
FOSA (> abundant in old introduced forests)	11	0.01
Native / recently introduced		
TETC (> abundant in recent introduced forests)	8	0.01
FOFU (> abundant in native forests)	7.5	0.01
Old introduced / recently introduced		
LEPNY (> abundant in old introduced forests)	4.5	0.02

niger, *L. psammophilus*, *L. paralienus*, *L. alienus*, *T. caespitum*, *T. ambiguum* etc.), which are poor fractions of different grassland ant communities.

On the basis of the Mann-Whitney test (ZAR 1996), performed to compare the number of individuals in the different forests, few significant values remained after employing Bonferroni's correction. We found that between native forests/ recently introduced ones, *F. fusca* was significantly more abundant in the native

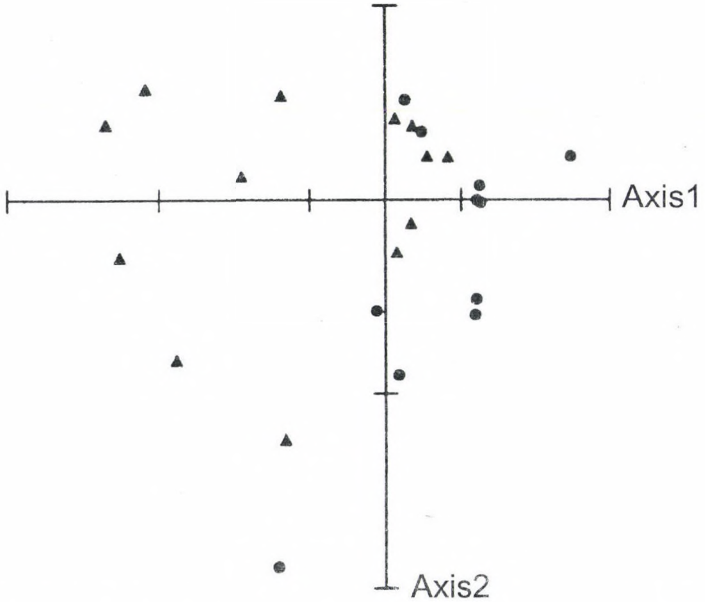


Fig. 6. Ordination diagram of the sites based on the composition of the ant assemblages using correspondence analysis. Filled circles: native forests, Filled triangles: introduced forests

forests and *T. caespitum* in the recently introduced ones. Between native/old introduced forests: *F. sanguinea* is more abundant in the old introduced forests, and when we compared old introduced forests/recently introduced forests: *L. nylanderi* was more abundant in the old introduced ones (Table 4).

The correspondence analysis of the 24 different forests, based on their species composition (Fig. 6), showed only a very slight overlap between the assemblages of the native forests and those of the introduced ones, suggesting different successional pathways of these forests. The position of juniper wood is between the two other types.

The analysis of community-specificity, i.e. the position (α) and breadth (β), of the thirty six ant species resulted in a highly significant negative correlation between these two parameters ($r = -0.68$, $p < 0.001$, Fig. 7). The two extremes in Fig. 7 are the specialists and the generalists in the given set of the communities. The specialists, like *F. polyctena*, *F. pratensis* and *M. rubra*, have a large position value and are ocupying more extreme types of communities. Whereas the group of generalists as: *T. caespitum*, *L. unifasciatus*, *F. cunicularia*, and *M. sabuleti* have a large breadth value and are present in many kinds of assemblages.

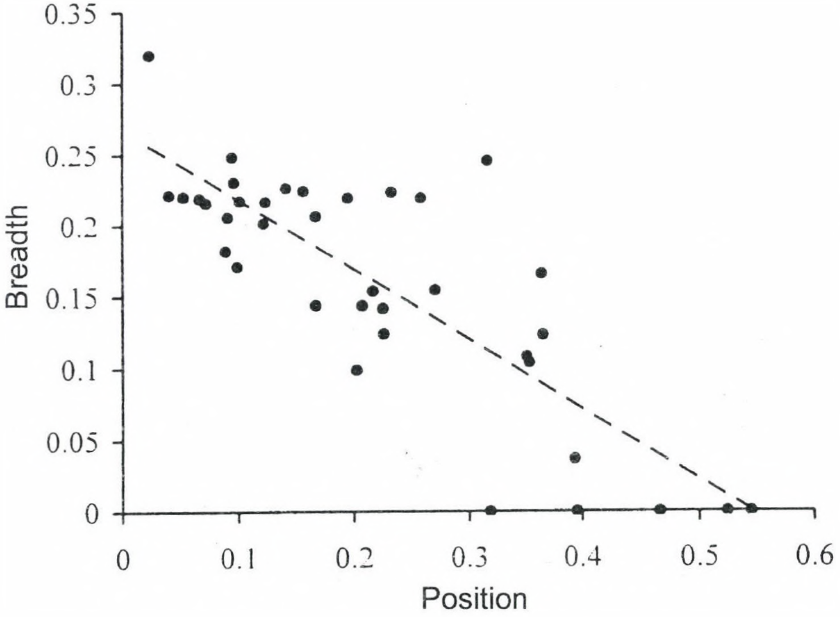


Fig. 7. The position and breadth plane. The location of each species in the plane is shown (36 ant species). A large position value indicates that an ant species is a community specialist, whereas a large breadth value shows that a species is present in a wide range of communities

DISCUSSION

Our survey shows that a wide variety of ant assemblages occurred in seven forest types in the southern part of the Great Hungarian Plain. Similar studies have been conducted in some other East-European countries as well. CZECHOWSKI *et al.* (1995), and GALLÉ *et al.* (1998) characterized ant assemblages in Poland. GALLÉ (1986*b*) recorded a total of 35 ant species from the Kiskunság National Park in Hungary and, more recently, MARKÓ (1997) noted 16 ant species in Transsylvanian forests of Romania. Our findings indicate that the number of species and diversity of ant assemblages in forests of the southern part of the Great Hungarian Plain are similar or higher than those in the neighbouring regions.

Examining the species richness, we found that poplar forests showed the highest value (24 spp), while hybrid poplar forests had the lowest one (13 spp). As regards to evenness we found that oak tree sites had the lowest values (0.27–0.55) and juniper tree sites the highest (0.64–0.79). Information on the diversity of Hungarian forest ants is quite scarce, and precise definition for the gradient of succession for the forests we examined was therefore not possible. CONNELL (1978), dealing with variations in diversity within local areas, tested the intermediate disturbance hypothesis, which suggests that the highest diversity is maintained at intermediate scales of disturbance. He then applied the hypothesis to tropical communities such as rain forests and coral reefs. PUNTILLA *et al.* (1991), working on the colonization of clearcut forests in the southern Finnish taiga, found that during succession an increase of species richness was followed by a decrease probably because of increased shade of the canopy cover. TOUYAMA (1997), studying *Lucydophyllous* forests in different developmental stages in south-western Japan, found that the myrmecofauna decreases in diversity as an effect of disturbance. In successional sand dune areas of the Hungarian Plain, diversity increases in the mature stages of ant community succession, but there is a decline at the final phase (GALLÉ 1998). This is most likely a consequence of the high density of the red wood ant (*F. polyctena*) in such areas. In our survey juniper forests of the Kiskunság National Park showed the highest degree of ant diversity, where anthropogenic disturbance and degradation were very low. The transitional character of these sites could also assure the maintenance of its diversity. In comparison, ant diversity was the lowest in Russian olive forests located in the vicinity of Szeged, where anthropogenic disturbance was quite high and grazing was evident.

Three basic levels can usually be distinguished in the competition hierarchy of boreal ants (VEPSÄLÄINEN & PISARSKI 1982). The group of highest level competitiors, the territorials in Central and Northern Europe, includes ants, which all belong to the Formicinae subfamily [the subgenera *Formica* s. str. L. and

Coptoformica MÜLL., *Formica (Serviformica) cinerea* MAYR., *L. fuliginosus*)]. These are relatively abundant species in forests and forest boundaries. As a general rule of thumb, the higher the dynamic density, the higher the colony is in the competition hierarchy (SAVOLAINEN & VEPSÄLÄINEN 1988). According to ZAKHAROV (1975), numeric dominance is synonymous with behavioural (competitive) dominance. The most numerous species in our study were *F. fusca*, *L. platythorax*, *F. truncorum*, *F. sanguinea*, *T. caespitum*, *F. rufa* and *L. psammophilus*. Since *F. fusca*, *L. platythorax*, *T. caespitum* and *L. psammophilus* are not top competitors, numeric dominance cannot be considered as a synonym for behavioural (competitive) dominance. The effects of competitive interactions may be difficult to infer and this makes more difficult to define possible ant hierarchies in the investigated habitats.

Examining the order of diversity for the forests in question we found that *L. platythorax* appeared to be the more abundant species in the juniper forest located in Bugac. SEIFERT (1991) defines *L. platythorax* as a sibling species of *L. niger*, occurring in forests, bogs and fens. Much higher *L. platythorax* densities are normally seen in areas with less extreme moisture. Although the Bócsa forests were fairly isolated and not show any sign of degradation, *L. platythorax* was not present there. *T. ambiguum* and *T. caespitum* had very similar abundances there. The absence of aggressive species is evident and *L. platythorax* was numerically dominant because of this. According to SAVOLAINEN and VEPSÄLÄINEN (1988), when territorial species are absent, lower-level species are shifted higher up in the hierarchy. Abundance of dominant ants can reduce the fitness of the submissive species (SAVOLAINEN & VEPSÄLÄINEN 1988), and affect species richness and evenness (ANDERSEN 1992, CAMMELL *et al.* 1996, GALLÉ *et al.* 1998). Such phenomenon can explain the high diversity seen in the Juniper forests as well. Territorial expansion of superior competitors drive weaker species to extinction or compel them to change their nesting sites. But in communities lacking territorial species the hierarchical relations are much less predictable (DOBRZANSKI & DOBRZANSKA 1975), and the community structure may be mainly attributable to adverse abiotic (climatic) factors (GALLÉ 1975) or the diversity of microhabitats (BOOMSMA & VAN LOON 1982).

In black locust forests *L. nylanderi*, a typical forest ant, belonging to the native ant community, is one of the most dense species. Original native forest, mostly oaks, were replaced by black locust and some remnants of the original fauna could survive there. In spite of their low species number, black locust forests are located second in the diversity order, this could be explained by the fact that they are environmentally stressing habitats (e.g. no aphids, extreme microclimate), keeping the density of the populations evenly low.

Pine forests showed results consistent with those from SAVOLAINEN and VEPSÄLÄINEN (1989), insofar that *F. sanguinea* and *F. rufa* are at the top of the hierarchy, *T. caespitum* and *L. paralienus* are intermediate ones, while *F. fusca* is a submissive species located at the bottom. *F. sanguinea* was the most abundant species in well-established forests but was completely absent in younger ones. *F. sanguinea* seems to colonize more rapidly than other species by spreading through nest-splitting (OIONEN 1956), and hence this species may be able to impede or prevent the colonization of wood ants in early stages of forest succession (OIONEN 1956, ROSENGREN *et al.* 1979). The coexistence of *F. sanguinea* and *F. fusca* is further explained by the fact that the former establishes itself in new colonies via temporary nest parasitism in the nests of the latter (dulosis). The difference in the ant species number according to the age of the patch is a very important aspect. A possible succession pathway can be characterized by the ant species that are present in each patch. The youngest pine patch may function as an open habitat where pionering ant species arrive first. *C. aenescens* is a species typical of very hot and dry habitats, called "desert ants". In the young planted pine forests the microclimatic conditions are more harsh, the vegetation more scarce and this allows *C. aenescens* to occupy these habitats. *T. caespitum* is a very xerophilous species, prefers open and dry places (SEIFERT 1996) and together with *L. paralienus* dominate also the young pine patch. In the 15 years old patch *F. sanguinea* and *F. fusca* appeared and their abundance reach a maximum in the 25 years old patch. Simultaneously the number of *T. caespitum* and *L. paralienus* decreases till the age of 40 years, and after that age they are completely absent. A very similar situation was found in a succession of ant communities in moist pine forest in Poland (CZECHOWSKI 1995), where the highest number of nests in the young pine (*Pinus silvestris*) stands belonged to *T. caespitum*. CZECHOWSKI (1995) observed significant changes accompanying the transition from the young pine stands (6 years old) to the maturing tree stands (> 50 years). The abundant occurrence of these xerophilous species was obviously related to the aridity of the open habitats, and their disappearance later was connected with the increasing degree of shade and humidity. According to PISARSKI and CZECHOWSKI (1994), *F. polyctena* and *aquilonia* are typical for mature successional stages, they establish themselves in a habitat very slowly. In the southern part of the Great Hungarian Plain, *F. rufa* and *F. polyctena* are typical for the climax forest stages, in poplar and pine forests, respectively. Some other forests ant species, such as *F. fusca* and *Leptothorax* spp., can be found in younger successional stages, too.

Hybrid poplar forests revealed *T. caespitum* and *L. platythorax* as the most numerous species. Some encounter species like *T. caespitum* can play the role of a superior competitor, in very species-poor ant communities (SAVOLAINEN & VEPSÄLÄINEN 1988). Further investigations dealing with species interactions is needed to test this assertion. The presence of *L. niger* in these forests could be explained by the fact that they were surrounded by agricultural land. This is consistent with SEIFERT (1991) who described *L. niger* as a species that is predominant in urban areas and open agricultural land. The low value of diversity correlates to the low value in species richness (13 spp.).

In oak and poplar forests we observed *F. truncorum* which is an aggressive and territorial species. Its dominance might be explained by the aggressiveness and high territoriality. *F. fusca* and *Leptothorax* species (submissives) are also rather numerous here. Oak forests appeared to have relatively low values of diversity. With the exception of Bugac, the majority of the sites were located in places where anthropogenic disturbance was quite high.

In Russian olive forests *F. sanguinea* was the most numerous species, followed by *L. paralienus* and *L. platythorax*. These forests are the only locations of *M. salina*, because of their harder soil, with high salinity. The low value of diversity in Russian olive forests could be explained by the high density of dominant species. MABELIS (1984), working in a dune valley in the Netherlands, also found that species are stronger competitors when they have a greater overlap in their biological requirements. When the overlap is very small they may tolerate each other in the same foraging area, but when the overlap is large they may exclude each other. However, the availability of the resources in relation to the density of the workers determines the competitive process that will actually take place. In the boreal taiga, territorial and specially polycalic species asume the role of organizing species and seem to impoverish local ant species assemblages (SAVOLAINEN & VEPSÄLÄINEN 1988).

Are some ant faunas impoverished because of the suppressing effect of the large scale conquerors, or did the large scale conquerors originate in environments with impoverished ant faunas? According to HÖLLDOBLER and WILSON (1990) the fewer the ant species in a local community, the more likely the community will be dominated by one or more species. This Dominance-Impoverishment rule might also be applicable to the forests we investigated. In our case impoverished forests will be those where *F. sanguinea* and *F. truncorum* (generalist species) were present in higher abundance (oak, Russian olive and pine forests). Forests with higher values of diversity didn't reveal any high abundance of dominant ants (juniper, black locust).

Another aspect that is worthwhile to consider is the distribution of forest and grassland ant species in the different forest sites. According to our results native poplar and oak forests are characterised by an original range of forest ant species, while in introduced forests these ant species are replaced by grassland ant species. Despite their native character juniper forests showed a very high number of grassland species. This could be explained by the fact that surveyed juniper sites are open habitats, they are young and at initial state of succession.

Appendix 1. Total number of collected ants from the 24 sampling sites (3 times 15 traps) in the seven sampled forests (standardized data)

	Poplar			Oak					Juniper			B. locust			Pine				R. olive			H. poplar		
	APo1	APo2	BuPo3	AOa1	AOa2	BuOa3	OOa4	OOa5	BuJu1	BoJu2	BoJu3	ABl1	OBl2	BuBl3	APi1	APi2	APi3	APi4	SzE1	SzE2	SzE3	BaHp1	BaHp2	BaHP3
Anergates atratulus (Schenck)	0	0	4	0	0	0	0	0	0	0	0	0	0	102	0	0	1	0	0	0	0	0	0	0
Camponotus fallax (Nylander)	0	0	0	1	2	3	4	0	0	0	1	1	0	1	4	0	0	0	0	0	0	0	0	
C. piceus (Leach)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
C. truncatus (Spinola)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
C. vagus (Scopoli)	47	30	29	0	3	0	0	0	3	64	19	1	0	0	1	1	3	0	27	0	0	0	0	0
Cataglyphis aenescens (Nylander)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	126	0	0	0	0	0	0
Cthonolasius sp.	0	3	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Dolichoderus quadripunctatus (L.)	0	0	1	3	2	6	9	12	0	0	0	0	2	0	1	1	0	0	0	0	0	6	0	0
Formica cunicularia Latreille	0	1	4	0	0	0	0	1	3	1	38	0	1	2	1	1	0	0	4	3	0	0	0	3
F. fusca L.	162	180	1371	0	57	427	10	745	16	2	1	9	1	0	41	156	35	0	0	0	0	22	0	0
F. polyctena Förster	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F. pratensis Retzius	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F. rufa L.	0	0	390	0	2	1	0	0	0	0	0	0	0	0	623	0	0	0	50	0	0	0	0	0

Appendix 1 (continued)

	Poplar			Oak					Juniper			B. locust			Pine				R. olive			H. poplar		
	APo1	APo2	BuPo3	AOa1	AOa2	BuOa3	OOa4	OOa5	BuJu1	BoJu2	BoJu3	ABl1	OBl2	BuBl3	APi1	APi2	APi3	APi4	SzE1	SzE2	SzE3	BaHp1	BaHp2	BaHP3
F. rufibarbis Fabricius	0	1	1	0	0	0	0	10	13	3	85	0	0	0	0	0	0	0	22	1	0	0	7	1
F. sanguinea Latreille	1	0	0	0	0	15	0	0	0	0	0	1	0	1	114	495	65	1	1304	12	0	0	0	0
F. truncorum Fabricius	0	0	127	0	0	0	0	1868	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0
Lasius alienus (Förster)	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
L. carniolicus (Mayr)	0	0	0	0	0	0	0	0	0	0	53	0	0	0	0	0	0	0	0	3	0	0	0	0
L. fuliginosus (Latreille)	0	0	0	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
L. niger (L.)	0	0	0	4	0	0	16	0	0	0	0	1	0	0	1	1	0	0	0	0	0	1	0	288
L. paralienus Seifert	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	248	589	378	0	0	0	0
L. platythorax Seifert	0	0	1319	10	20	167	0	0	227	0	0	0	0	0	0	0	0	0	0	9	128	0	381	0
L. psammophilus Seifert	453	381	0	5	0	2	0	0	0	68	0	3	0	5	2	1	0	1	0	0	0	0	0	35
Leptothorax interruptus (Schenck)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
L. nylanderi (Förster)	4	3	2	276	3	37	202	15	0	0	0	84	4	0	89	85	7	1	4	0	0	0	0	0
L. unifasciatus (Latreille)	8	19	29	0	1	87	286	75	2	2	0	14	3	2	38	41	10	0	0	1	1	81	15	12

Appendix 1 (continued)

	Poplar			Oak					Juniper			B. locust			Pine				R. olive			H. poplar		
	APo1	APo2	BuPo3	AOa1	AOa2	BuOa3	OOa4	OOa5	BuJu1	BoJu2	BoJu3	ABl1	OBl2	BuBl3	APi1	APi2	APi3	APi4	SzE1	SzE2	SzE3	BaHp1	BaHp2	BaHP3
Myrmecina graminicola (Latreille)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0
Myrmica rubra (L)	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M. sabuleti Meinert	14	29	68	13	4	19	86	48	9	8	1	28	3	0	29	51	1	0	11	38	45	12	0	0
M. salina Ruzsky	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	61	75	0	0	0	0
M. schencki Emery	2	2	0	0	0	0	0	0	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plagiolepis vindobonensis Lomnicki	0	0	0	0	0	0	0	0	0	16	68	0	0	0	0	0	1	0	0	0	0	0	0	0
Polyergus rufescens (Latreille)	0	0	1	0	0	0	0	0	0	0	21	1	0	3	0	0	0	0	0	0	0	0	0	0
Solenopsis fugax (Latreille)	1	1	2	0	0	0	0	0	13	6	1	0	0	0	0	0	5	0	22	3	9	0	0	0
Tapinoma ambiguum Emery	0	0	60	0	0	1	0	0	157	5	27	0	0	122	0	0	0	0	9	1	0	0	0	2
Tetramorium caespitum (L.)	1	0	3	0	3	0	1	10	70	10	14	1	0	53	1	11	58	531	61	22	22	3	112	317
Number of ant species / forest site	10	12	18	7	10	11	11	11	12	11	12	11	7	10	15	13	11	6	13	14	6	7	5	7
Number of individuals/ forest site	689	648	3352	312	93	763	621	2779	274	148	198	142	15	114	943	838	141	377	2073	525	176	124	404	339
Mean number of ant species/ forest type	13.33±4.16			10±1.73					11.66±0.57			9.33±2.08			11.25±3.86				11±4.35			6.33±1.15		

Acknowledgements – We would like to express our sincere thanks to Prof. A. A. MABELIS, Prof. XAVIER ESPADALER and KARI VEPSÄLÄINEN for their valuable comments and advice regarding the manuscript. The study was supported by Hungarian Scientific Research Fund (OTKA, grant no. T020149).

REFERENCES

ALVARADO, M. (2000) Habitat correlates of ant assemblages in different forests of the South Pannonian Plain. *Tiscia* **32** [in press]

ANDERSEN, A. N. (1987) Ant community organization and environmental assessment. In: MAJER, J. D. (ed.): *The role of invertebrates in conservation and biological survey.* Western Australian Department of Conservation and Land Management Report, pp. 43–52.

ANDERSEN, A. N. (1988) Nest mound soil of the seed dispersing ant Aphaenogaster longiceps enhances seedling growth. *Aust. J. Ecol.* **13**: 469–471.

ANDERSEN, A. N. (1990) The use of ant communities to evaluate change in Australian terrestrial ecosystems: a review and a recipe. *Proc. Ecol. Soc.* **16**: 347–357.

ANDERSEN, A. N. (1992) Regulation of "momentary" diversity by dominant species in exceptionally rich ant communities of the Australian seasonal tropics. *Am. Nat.* **140**: 401–420.

ANDERSEN, A. N. & YEN A. L. (1985) Immediate effects of fire on ants in the mallee of northwestern Victoria. *Aust. J. Ecol.* **10**: 25–30.

ANDERSEN, A. N. & MCKAIGE, M. E. (1987) Ant communities at Rotamah Island Victoria, with particular reference to disturbance and Rhytidoponera tasmaniensis. *Proc. Roy. Soc. Vict.* **99**: 141–146.

BOOMSMA, J. J. & VAN LOON, A. J. (1982) Structure and diversity of ant communities in successive coastal Dune valleys. *J. Anim. Ecol.* **51**: 957–974.

CAMMELL, M. E., WAY, M. J. & PAIVA, M. R. (1996) Diversity and structure of ant communities associated with oak, pine, eucalyptus and arable habitats in Portugal. *Ins. Soc.* **43**: 37–46.

CONNELL J. H. (1978) Diversity in tropical rain forests and coral reefs. *Science* **199**: 1302–1310.

CZECHOWSKI, W., PISARSKI, B. & KATSUSUKE, Y. (1995) Succession of ant communities (Hymenoptera: formicidae) in moist pine forests. *Fragmenta Faunistica, Tom. 38* **24**: 447–486.

DOBRZÁNSKI, J. & DOBRZÁNSKA, J. (1975) Ethological studies in the ant Tetramorium caespitum Mayr. II interspecific relationships. *Acta Neurobiologica Experimentalia* **35**: 311–317.

FROUZ, J., SANTRUCKOVÁ, H. & KALCIK, J. (1997) The effect of wood ants (Formica polyctena Foerst.) on the transformation of phosphorous in a spruce plantation. *Pedobiologia* **41**: 437–447.

GALLÉ, L. (1975) Factors stabilizing the ant populations (Hymenoptera: Formicidae) in the grass associations of the Tisza basin. *Tiscia* **10**: 61–66.

GALLÉ, L. (1981) The role of niche relations and competitive strategies in the diversity and structure of grassland ant communities. Regulation of social insect populations. *Proc. Symp. Social Insect Section PES, Skierniewice 21–25 September 1981*, pp. 1–3.

GALLÉ, L. (1986*a*) Habitat and niche analysis of grasslands ants (Hymenoptera: Formicidae). *Ent. Generalis* **11**: 197–221.

GALLÉ, L. (1986*b*) The ant fauna of the Kiskunság National Park (Hymenoptera: Formicoidea). In: MAHUNKA, S. (ed): *Fauna of the Kiskunság National Park.* Akadémiai Kiadó, Budapest, pp. 135–162.

GALLÉ, L. (1990*a*) The assembly of sand dune ant communities. In: VEERESH, G. K., MALLIK, B., VIRAKTAMATH, C. A. (eds): *Social insects and the environment.* Oxford and IBH, New Delhi, pp. 706–707.

GALLÉ, L. (1990*b*) Assembly of sand-dune forest ant communities. *Memorabilia Zool.* **44**: 1–6.

GALLÉ, L. (1991) Structure and succession of ant assemblages in a north European sand dune area. *Holarctic Ecology* **14**: 31–37.

GALLÉ, L. (1992) The ecology and structure of ant assemblages in successional sand dune areas. In: ZOMBORI, L. & PEREGOVITS, L. (eds): Proc. 4th ECE/XIII. SIEEC. Hung. Nat. Hist. Mus., Budapest, pp. 715–719.

GALLÉ, L., KOVÁCS, E. & HEVÉR, A. (1994) Pattern transformation of ant colonies in a successional sandy grassland. *Memorabilia Zool.* **48**: 81–90.

GALLÉ, L., KÖRMÖCZI, L., HORNUNG, E. & KEREKES, J. (1998) Structure of ant assemblages in a Middle-European successional sand-dune area. *Tiscia* **31**: 19–28.

GAUCH, H. G. (1982) *Multivariate analysis in community ecology.* Cambridge Univ. Press, New York. 298 pp.

GÖSSWALD, K. (1985) Die Waldameise als Bioindikator der Waldverderbnis mit besonderer Berucksichtigung der Koniginnenmassenzucht. *Z. angew. Zool.* **3**: 349–378.

GREENSLADE, P. J. M. & GREENSLADE, P. (1984) Soil surface insects of the Australian arid zone. In: *Arid Australia.* Australian Museum, Sydney. pp. 153–176.

HANSKI, I. (1982) Dynamics of regional distribution: the core and satellite species hypothesis. *Oikos* **38**: 210–221.

HARTNER, A. (1994) Adatok a Formica rufa hangyacsoport (Hymenoptera, Formicidae) in Hungary. [Data on the distribution of the Formica rufa species group (Hymenoptera, Formicidae) in Hungary.] *Állatt. Közl.* **80**: 57–64. [in Hungarian]

HÖLLDOBLER, B. & WILSON, O. (1990) *The ants.* Springer Verlag, USA.

JOHNSON, R. A. (1992) Soil texture as an influence on the distribution of the desert seed-harvester ants Pogonomyrmex rugosus and Messorpergandei. *Oecologia* **89**: 118–124.

KELEMEN, J., GILLY, ZS., VAJDA, Z. & PÁL-SZABÓ, F. (1995) *Proc. Eurosite General Meeting Kiskunság National Park.* Kecskemét. pp. 29.

KUNIN, W. E. & GASTON, K. J. (1997) *The biology of rarity.* Chapman & Hall, Oxford. 280 pp.

LANDE, R. (1996) Statistics and partitioning of species diversity, and similarity among multiple communities. *Oikos* **76**: 5–13.

LEVAN, A. M. & STONE, E. L. (1983) Soil modification by colonies of black meadow ants in a New York old field. *Soil Sci. Soc. Am. J.* **47**: 1192–1195.

MABELIS, A. A. (1984) Interference between wood ants and other ant species (Hymenoptera, Formicidae). *Netherlands J. Zoology* **34**(1): 1–20.

MACNALLY, R. C. & DOOLAN, J. M. (1986) An empirical approach to guild structure: habitat relationships in nine species of Eastern-Australian cicadas. *Oikos* **47**: 33–46.

MAGURRAN, A. E. (1988) *Ecological diversity and its measurement.* Chapman & Hall. London. 179 pp.

MAGYAR, P. (1961) Alföldfásítás. Akadémiai Kiadó, Budapest, 622 pp. [in Hungarian].

MAJER, J. D. (1983) Ants: bio-indicators of minesite rehabilitation, land use and land conservation. *Environ. Manag.* **7**: 375–383.

MAJER, J. D. (1984) Recolonization by ants in rehabilitated open-cut mines in northern Australia. *Reclam. Reveg. Res.* **2**: 279–298.

MAJER, J. D. (1985) Recolonization by ants of rehabilitated mineral sand mines on North Stradbroke Island, Queensland, with particular reference to seed removal. *Australian J. Ecology* **10**: 31–48.

MANDEL, R. D. & SORENSON, C. J. (1982) The role of the western harvester ant (Pogonomyrmex occidentalis) in soil formation. *Soil Sci. Soc. Am. J.* **46**: 785–788.

MARKÓ, B. (1997) Különböző típusú erdők hangyaközösségeinek összehasonlító vizsgálata. [A comparative study of ant assemblages in different forest types]. *Múzeumi Füzetek, Kolozsvár* **6**: 183–189. [in Hungarian, English abstr.].

OIONEN, E. A. (1956) On the ants of the rocks and their contribution to the afforestation of rocks in southern Finland. *Acta Entomol. Fennica* **12**: 1–212. [in Finnish, English abstr.]

PAPP, L. (1998) "Outlaws": some evolutionary aspects of rarity in insects. *Tiscia* **31**: 29–33.

PETAL, J. (1980) Ant populations, their regulation and effect on soil in meadows. *Ekol. Pol.* **28**(3): 297–326.

PETAL, J. (1992) The role of ants in nutrient cycling in forest ecosystems. *In* BILLEN, J. P. J. (ed.): Biology and Evolution of Social insects. Leuven Univ. Press, Belgium, pp. 167–170.

PETAL, J. (1994) Reaction of ant communities to degradation of forest habitats in the Karkonosze mountains. *Memorabilia Zool.* **48**: 171–179.

PISARSKI, B. & CZECHOWSKI, W. (1994) Ways to reproductive success of wood ant queens. *Memorabilia Zool.* **48**: 181–186.

PIELOU, E. C. (1975) *Ecological diversity.* Wiley, New York, 165 pp.

PODANI, J. (1993) *SYN-TAX-pc. Computer programs for multivariate data analysis in ecology and systematics.* Scientia Publishing, Budapest, 104 pp.

PUNTILLA, P., HAILA, Y., PAJUNEN, T. & TUKIA, H. (1991) Colonisation of clearcut forests by ants in the southern Finnish taiga: a quantitative survey. *Oikos* **61**: 250–262.

PUNTILLA, P. & HAILA, Y. (1996) Colonisation of a burned forest by ants in the southern Finnish boreal forest. *Silva Fennica* **30**(4): 421–435.

RABINOWITZ, D., CAIRNS, S. & DILLON, T. (1986) Seven forms of rarity and their frequency in the flora of British Isles. In: SOULÉ, M. E. (ed): *Conservation biology. The science of scarcity and diversity.* Sinauer, Sunderland, pp. 182–204.

ROSENGREN, R., VEPSÄLÄINEN, K. & WUORENRINNE, H. (1979) Distribution, nest densities, and ecological significance of wood ants (the Formica rufa-group) in Finland. *O. I. L. B. Bull. SROP, II* **3**: 181–213.

SAVOLAINEN, R. & VEPSÄLÄINEN, K. (1988) A competition hierarchy among boreal ants: impact on resource partitioning and community structure. *Oikos* **51**: 135–155.

SAVOLAINEN, R. & VEPSÄLÄINEN, K. (1989) Niche differentiation of ant species within territories of the wood ant Formica polyctena. *Oikos* **56**: 3–16.

SEIFERT, B. (1988*a*) A revision of the European species of the ant subgenus Cthonolasius. *Ent. Abh. Mus. Tierk., Dresden* **51**(8): 143–180.

SEIFERT, B. (1988*b*) A taxonomic revision of the Myrmica species of Europe, Asia Minor and Caucasia. *Abh. Ber. Naturkundemus, Görlitz* **62**(3): 1–75.

SEIFERT, B. (1991) Lasius platythorax n. sp., a widespread sibling species of Lasius niger (Hymenoptera: Formicidae). *Entomol. Gener.* **16**(1): 69–81.

SEIFERT, B. (1992) A taxonomic revision of the Palaearctic members of the ant subgenus Lasius s. str. (Hymenoptera: Formicidae). *Abt. Ber. Naturkunde Mus., Görlitz* **65**(1): 1–27.

SEIFERT, B. (1996) *Ameisen: beobachten, bestimmen.* Naturbuch Verlag, Augsburg. 351 pp.

SMITH, B. & WILSON, J. B. (1996) A consumers guide to evenness indices. *Oikos* **76**: 70–82.

TÓTHMÉRÉSZ, B. (1993*a*) NuCoSa 1.00: Number cruncher for community studies and other ecological applications. *Abstr. Bot.* **7**: 283–287.

TÓTHMÉRÉSZ, B. (1993*b*) DiVoRd 1.50: A program for diversity ordering. *Tiscia* **27**: 33–44.

TÓTHMÉRÉSZ, B. (1995) Comparison of different methods for diversity ordering. *J. Veget. Science* **6**: 283–290.

TOUYAMA, Y. (1996) Myrmecofaunal change under fire disturbance. *Edaphologia* **56**: 25–30.

TOUYAMA, Y. (1997) Myrmecofauna of lucidophyllous forests in different developmental stages in South-Western Japan. *Ecological Research* **12**: 131–138.

VARGA, Z. (1995) Geographical patterns of biodiversity in the Palaearctic and in the Carpathian Basin. *Acta zool. hung.* **41**: 71–92.

VARGA, Z. (1998) *Steppe-like grasslands in Hungary: Conservation and sustainable use. In: Ecological aspects of grassland management.* 17th EGF meeting. DATE, Debrecen, pp. 299–311.

VEPSÄLÄINEN, K. & PISARSKI, B. (1982) Assembly of island ant communities. *Ann. Zool. Fenn.* **19**: 327–335.

ZAKHAROV, A. A. (1975) Dinamitseskaya plotnosti povedenie muravev. *Zh. Obschej Biologii* **36**: 243–250.

ZAR, J. H. (1996) *Biostatistical analysis.* 3rd ed. Prentice Hall, New Jersey. 662 pp.

Revised version received 14th February, 2000, accepted 30th June, 2000, published 24th July, 2000

Acta Zoologica Academiae Scientiarum Hungaricae 46 (2), pp. 103–114, 2000

RELATIONSHIPS BETWEEN THE ABUNDANCE OF BREEDING BIRDS IN WESTERN POLAND AND THE STRUCTURE OF AGRICULTURAL LANDSCAPE

KUJAWA, K.[1] and P. TRYJANOWSKI[2]

[1]*Research Centre for Agricultural and Forest Environment of Polish Academy of Sciences*
Field Station, Szkolna 4, 64–003 Turew, Poland, e-mail: ortolan@priv7.onet.pl
[2]*Department of Avian Biology and Ecology, Adam Mickiewicz University*
Fredry 10, 61–701 Poznan, Poland, e-mail: ptasiek@main.amu.edu.pl

The relationships between bird abundance and landscape structure were studied in nine plots located in an agricultural landscape in W Poland. Numbers of bird species per plot ranged from 3 to 31, densities from 3.8 to 32.8 pairs/10 ha. Habitat parameters, as percentage of tree cover ranged from 0 to 14.5%, meadows from 0 to 48.5%, habitat diversity (H') from 0.004 to 1.07, density of forest – field ecotones from 0 to 144 m/ha, density meadows and crop field ecotones from 0 to 38 m/ha, and ecotones between crop fields – from 0 to 245 m/ha. The number of bird species per plot increased most significantly with tree cover (r^2=0.63 in linear regression); the density of breeding pairs also increased linearly with tree cover (r^2=0.85 in linear regression). Tree cover was also the main factor influencing the density or species number of particular nesting-guilds with the exception of the density of ground-nesters, which was not significantly related to any 'habitat' variable. The relationships between wood cover and species number appeared to be non-linear, showing higher slope values at smaller values of wood cover. Protection of high bird abundance in western Poland is strongly linked with the preservation of margin habitats, especially woodlots, which provide nesting opportunities for most of the species occurring in farmland in W Poland.

Key words: breeding bird community, agriculture, management implications, Poland

INTRODUCTION

In an agricultural landscape the communities of birds in margin habitats (especially hedges and small woods) have been shown to differ from cultivated areas in their higher species richness and population densities (BEZZEL 1982, FLADE 1994). However, differences in the richness of bird communities at the landscape scale are not easily explained by research on particular landscape elements since the different elements are mutually interactive in their modification of the structure of bird communities. Thus, for example, population densities of species characterising open habitats are negatively correlated with the presence and quality of woodland/crop field ecotones (OELKE 1968, BERG & PART 1994, KUJAWA 1994). Bird species associated with woods in agricultural landscape depend not only on the percentage cover of such areas, but also on their degree of fragmentation (CIESLAK 1985, KUJAWA 1997), and locations with respect to one another (LACK 1988) as well as to the surrounding landscape (BELLAMY *et al.* 1996). In consequence, many authors (SCHIFFERLI *et al.* 1985, BASTIAN *et al.* 1989, BROWN & STILLMAN 1993, BUCKLAND & ELSTON 1993) showed that the abundance of breeding birds could be explained by very few variables characterising farmland. Among these, the most important were variables describing non-farmed, patchily distributed habitats – woods, shrubs or marshes (their percentage cover or relative length). In Poland research based on precisely measured features of landscape structure and entire communities of breeding birds is needed. Admittedly, some studies have considered differences in the richness of communities in relation to landscape structure, but the characterisation has either been a purely descriptive one, or presenting only the percentage shares of different elements (GÓRSKI 1988, JERMACZEK & TRYJANOWSKI 1990, KOT 1990, KUJAWA 1994, TRYJANOWSKI 1999).

The aim of the study was to reveal the relationships between farmland structure and the abundance of breeding birds, i.e. how do the amount of tree cover, meadows, the density of habitat edges and the diversity of agricultural land affect the structure of avian communities.

MATERIALS AND METHODS

Study area

The work was performed in the Wielkopolska region (W Poland), which is one of the most transformed parts of Poland due to the development of agriculture. The woods are mostly intensively used, and cover up to 20% of the whole area. The main crops are wheat, rye, sugar beet, potatoes, corn and rape. The abundance of breeding birds as well as the landscape structure were studied on nine sampling plots (with an area of 24–56 ha) located 10–60 km from Poznan.

Four study plots (T1, T2, T3, T4) are located within the General D. Chlapowski Landscape Park, c. 40 km S of Poznan and within a 5 km radius of the village of Turew (52°04'N, 16°49'E). This area is located on the Koscianska Plain (KONDRACKI 1988), at 70–90 m a.s.l. Arable land takes up 66% of the area, with the remaining agricultural land (c. 9% of the total) being meadow or pasture. The most characteristic feature of the Turew area is differentiated hedges and small woods of which the oldest have existed for about 170 years. The dominant planted species is *Robinia pseudacacia*. Its variously aged stands are mixed with *Quercus robur*, *Fraxinus excelsior*, poplars (*Populus* spp.), *Ulmus campestris*, *Acer platanoides* and *Pinus silvestris*.

Another three plots (S, P1 and P2) are located near Poznan, directly next to a built-up area (52°31'N, 16°48'E). The plots represent the typical intensively used farmland in the Poznan Lakeland (KONDRACKI 1988), 80–90 m a.s.l. The prevalent majority of the neighbourhood of our plots were arable fields and woodlots were limited to small clumps, lanes and hedges at the village edges. In the lower, wet part of the study area the trees are mainly limes (*Tilia* spp.), maples (*Acer* spp.), *Quercus robur*, *Alnus glutinosa* and poplars, whereas higher parts in very dry places are dominated by *Pinus silvestris* with undergrowth of *Sambucus nigra*.

Two further plots (W1 and W2) are located in the western part of the Wielkopolska Region, almost 70 km W from Poznan, in the Zbaszyn Trench (52°07'N, 16°04'E), 70–80 m a.s.l. The plots were typically agricultural, the arable fields amounting to 80 % of the area, but several kilometres

Table 1. Landscape ecological variables of the nine study plots in W Poland

Plot	S	P1	P2	W1	W2	T1	T2	T3	T4
Area (ha)	55	36	54	24	32	35	38	55	46
Crop (%)	97.0	87.4	99.1	94.8	98.4	61.1	37.0	93.0	97.4
Wood (%)	1.8	3.0	0.0	4.0	0.7	13.7	14.5	7.0	0.2
Grass (%)	0.0	0.0	0.0	0.0	0.0	18.1	48.5	0.0	2.3
Other (%)	1.2	9.6	0.9	1.2	0.9	7.1	0.0	0.0	0.0
Woodedge (m/ha)	13	28	0	17	29	65	144	82	3
Cropgrass (m/ha)	0	0	0	2	0	38	22	0	29
Cropcrop (m/ha)	44	40	60	89	50	0	4	0	245
Diversity (H')	0.16	0.44	0.004	0.23	0.09	1.07	1.00	0.25	0.13

to the west there are large complexes of pine forest. In the fields there are still mostly deciduous trees, located mainly in wet parts of the area and along the roads.

The comparative characteristics of the study plots are given in Table 1.

Methods

The study was carried out in 1994. For each plot, topographical maps and aerial photographs were used to determine the following variables describing habitat heterogeneity: 1. grass, wood, other – the cover (expressed as a proportion – from 0 to 1) of main habitat types other than crop fields, respectively – natural grasslands, woods and others combined (e.g. small built-up areas, roads, wasteland etc.); 2. diversity – the Shannon diversity index H':

$$H' = -\sum_{i=1}^{n} p_i \ln (p_i)$$

where n is the number of habitats and p_i – the proportion of the *i*-th habitat; 3. woodedge – the amount of wood edges per unit area of plot (in m/ha); 4. cropcrop, cropgrass – the ecotones between crop fields and between crop fields and grasslands, respectively, expressed as a proportion of total ecotones length divided by plot size (m/ha).

The densities of bird populations were estimated using the combined version of the mapping method (TOMIALOJC 1980). The method involved 8–10 (mostly 9) censuses per plot between April and June, beginning half an hour before sunrise and ending 4–5 hours later depending on the weather and bird activity. For more exact mapping, points of reference were designated and marked in woods with a shortage of natural orientation points. The numbers of pairs of *Buteo buteo*, *Strix aluco*, corvids and *Sturnus vulgaris* were determined on the basis of the numbers of nests found. *Cuculus canorus* was excluded from the analyses due to its non-territorial breeding behaviour, which makes the density estimation unreliable. The birds breeding on the study plots were grouped into nesting-guilds according to TRYJANOWSKI (1999).

Statistical analysis of relationships between landscape structure and abundance of birds on the study plots was carried out using simple regression and forward stepwise multiple regression. The dependent variables were the number of species and the density of bird populations (according to whole community or to nesting-guilds), while the independent variables were the ones describing plot structure. The variables expressed as proportions were transformed with the arcsine (x) function for normalised values of the proportional type (ZAR 1984). After transformations the distribution of all variables did not differ from normal (Kolmogorov-Smirnov test, P>0.05). All statistics were carried out using SPSS/PC statistical package (NORUSSIS 1986).

RESULTS

On the study plots a total of 39 breeding bird species were recorded, its actual value ranged from 3 to 31 on the study plots (Appendix). The bird communities showed clear differences according to different values of habitat parameters (Table 2). Before performing the multiple stepwise regression analysis, the relationships between 'habitat' variables and 'bird' parameters were checked by Pearson correlation. It was shown that three 'habitat' variables were significantly linked with most of the ten analysed 'bird' variables: habitat diversity (H'), tree cover, and the amount of forest ecotones. On the other hand, they were markedly inter-correlated (Table 3). The presence of inter-correlated variables makes the interpretation of regression results unreliable (ROBERSTON *et al.* 1993), thus for further analyses the number of these variables should be reduced as much as possible. We excluded diversity as a 'secondary' habitat measurement, it is a function of its components (including tree cover) and is highly correlated with other variables, only with one exception. In addition, we also excluded plot size, which was not correlated with any 'bird' variable. Summing up, for the stepwise regression, the following 'habitat' variables were taken as independent: tree cover (wood), grassland cover (grass), other margin habitats (other), amount of the ecotones between crop fields (cropcrop) and amount of ecotones between crop fields and grasslands (cropgrass).

Table 2. Structure parameters of breeding bird communities of studied plots

PLOT	S	P1	P2	W1	W2	T1	T2	T3	T4
Total									
Species number	16	14	3	10	23	31	31	25	7
Pairs/10 ha	9.8	8.9	3.8	15.4	15.0	29.7	32.8	16.7	12.8
Species in nest-guilds									
Hole-nesters	2	3	0	3	0	6	7	7	0
Lowly nesting spp.	3	2	0	6	3	5	7	2	1
Highly nesting spp.	4	3	0	9	1	11	9	8	1
Ground-nesters	6	5	3	4	5	8	7	7	5
Density in nest-guilds									
Hole-nesters	0.4	1.1	0.0	1.6	0.0	5.1	8.2	4.7	0.0
Lowly nesting spp.	2.0	1.1	0.0	5.3	2.5	13.4	13.0	6.1	0.5
Highly nesting spp.	1.3	1.1	0.0	4.4	0.8	12.9	11.7	6.2	0.2
Ground-nesters	7.1	5.8	3.8	6.3	12.1	9.3	8.4	4.7	12.3

Multiple stepwise regression analysis with farmland variables showed that 'bird' variables were most significantly linked with tree cover, with the exception of the number of ground nesting species (Table 4). The results of stepwise regression analysis are in most cases exactly the same as the results of correlation coefficient analysis. For explaining the between-plots variation of the species number the most significant variable was woods, which explained 63% (P<0.01) of the variation observed (Table 4). Total density of breeding birds was dependent mainly also on woods, explaining 85% (P<0.001) of the variation observed.

The variation of species number between plots of ground nesting species depended in 59% on variable woods (P<0.05), while no variable was found at P<0.05 for bird density. Also, for the species, which build open nests lowly above the ground, the most important factor was woods. The number of species was dependent on this variable in 48% (P<0.05), and the density of low nesting species was linearly dependent on woods (95%, P<0.001). The number of species nesting in tree-holes was related in 88% on woods, and their density – in 94% (P<0.001) on the same variable. Also the density of highly nesting species was very strongly dependent on woods (in 99%, P<0.001). The same variable was the

Table 3. Pearson correlation coefficients between 'bird' on 'habitat' parameters. Explanations of habitat variables – see text; ns – non-significant. * – P<0.05. ** – P<0.01. *** – P<0.001

	Crop	Wood	Grass	Other	H'	Wood-edge	Crop-grass	Crop-crop
Total sp. number	-0.75*	0.82**	0.63 ns	0.17 ns	0.76*	0.83**	0.37 ns	-0.66 ns
Total density	-0.89**	0.93***	0.84 ns	0.06 ns	0.89**	0.84**	0.68*	-0.37 ns
Species number of hole nesters	-0.79*	0.89**	0.60*	0.18 ns	0.76*	0.86**	0.29 ns	-0.65 ns
Number of lowly nesting species	-0.73*	0.74*	0.68*	0.05 ns	0.70*	0.63 ns	0.32 ns	-0.38 ns
Number of highly nesting species	-0.72*	0.86**	0.52 ns	0.18 ns	0.75*	0.66 ns	0.39 ns	-0.51 ns
Species number of ground-nesters	-0.71*	0.80*	0.54 ns	0.22 ns	0.75*	0.72*	0.55 ns	-0.47 ns
Density of hole-nesters	-0.90**	0.96***	0.84**	0.03 ns	0.84**	0.96***	0.46 ns	-0.56 ns
Density of lowly nesting species	-0.90**	0.98***	0.79*	0.13 ns	0.91**	0.83**	0.60 ns	-0.54 ns
Density of highly nesting species	-0.90**	0.99***	0.77*	0.17 ns	0.92**	0.82**	0.61 ns	-0.54 ns
Density of ground-nesters	-0.08 ns	0.01 ns	0.17 ns	-0.07 ns	0.13 ns	0.00 ns	0.55 ns	0.46 ns

most important for the number of species in this guild, but together with grassland, explaining 90% of the variability. All the results are collected in Table 4. Summing up, the results of the step-wise regression are very similar to the results of correlation coefficient analysis and they indicate a decisive role of wood habitats for explaining the between-plots variation of bird density and abundance.

The analyses presented shows that in most cases (except the density of ground-nesters) the relationships between 'habitat' variables and species number

Table 4. The results of the forward stepwise multiple regression of 'bird' on 'habitat' variables

Variable	Coefficient	SE	t	P
Number of species (r^2=0.63, P<0.01)				
Const	10.29	2.84	3.6	<0.01
Woods	150.0	38.98	3.8	<0.01
Density of birds (r^2=0.85. P<0.001)				
Const	8.30	1.700	4.9	<0.01
Woods	156.5	23.34	6.7	<0.001
Number of species nesting on the ground (r^2=0.59, P<0.01)				
Const	4.43	0.468	9.5	<0.0001
Woods	22.53	6.424	3.5	<0.01
Density of species nesting on the ground (r^2=0.25, P<0.1)				
No variables were entered	–	–	–	–
Into model	–	–	–	–
Number of species nesting lowly in vegetation (r^2=0.48, P<0.05)				
Const	1.70	0.772	2.2	<0.1
Woods	30.49	10.60	2.9	<0.01
Density of species nesting lowly in vegetation (r^2=0.90, P<0.001)				
Const	0.427	0.509	0.8	ns
Woods	89.47	6.987	12.8	<0.0001
Number of species nesting highly in vegetation (r^2=0.90, P<0.001)				
Woods	117.75	16.82	7.0	<0.001
Grass	-17.39	6.83	2.5	<0.05
Density of species nesting highly in vegetation (r^2=0.99, P<0.0001)				
Woods	86.64	3.486	24.9	<0.0001
Number of species nesting in tree-holes (r^2=0.88, P<0.0001)				
Woods	53.92	6.68	8.1	<0.0001
Density of species nesting in tree-holes (r^2=0.94, P<0.0001)				
Woods	48.68	3.932	12.4	0.0001

(r = 0.74–0.89) are weaker than those between the 'habitat' variables and bird density (r = 0.93–0.99) (Table 3 and 4). It seems that the difference is caused by non-linear relationships between the species number (total or within nest-guilds) and woods (Fig. 1), which cannot be well fitted to linear equation.

DISCUSSION

The avifauna of the plots studied may be regarded as typical for that occurring in agricultural landscapes of West Poland (JERMACZEK & TRYJANOWSKI 1990, KUJAWA 1994, TRYJANOWSKI 1999). The following species are characteristics for this community: *Motacilla flava*, *Acrocephalus palustris* and this community is dominated by *Alauda arvensis*. On the other hand, we recorded remark-

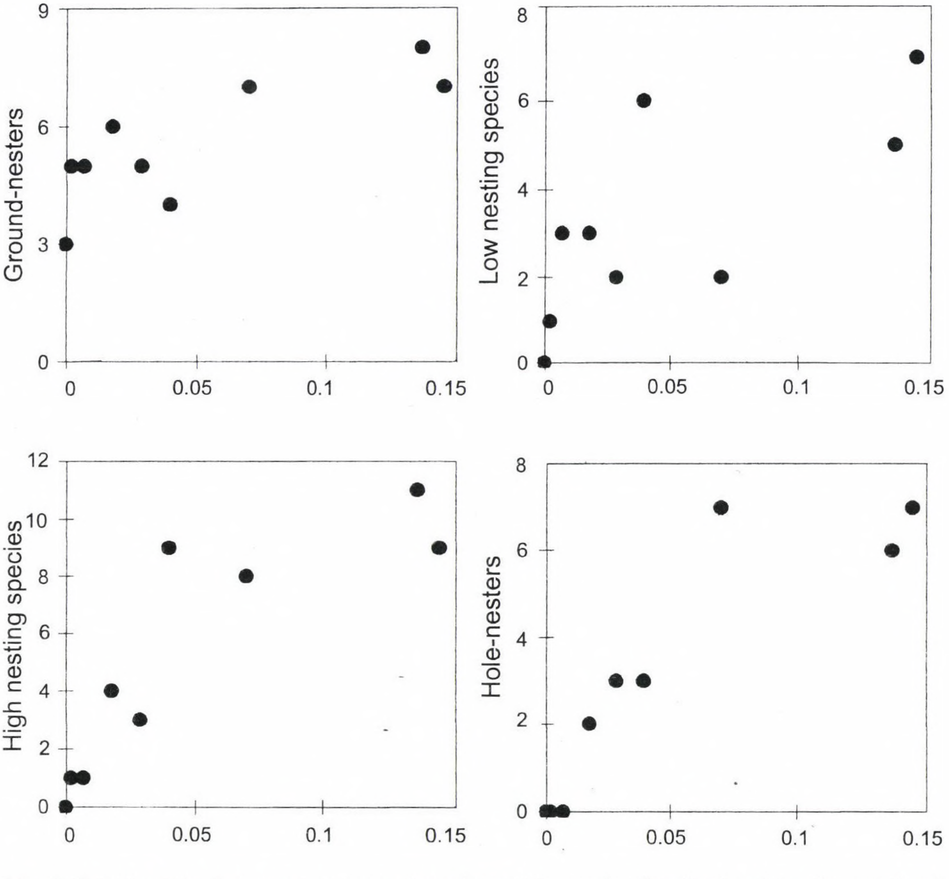


Fig. 1. Relationships between tree cover (transformed by arcsine function) and species number in the nest-guilds

able between-plots variation in bird density, as well as number of species. Our results showed that differences in the bird communities, as well as in the nesting-guilds in the agricultural landscape, may be explained by reference to a small number (1–2) of variables characterising the landscape structure. It is clear from the results that tree cover plays a decisive role in the forming of bird communities in agricultural landscapes. BONGIORNO (1982), SCHIFFERLI *et al.* (1985), O'CONNOR & SHRUBB (1986), FUCHS & SCHIFFERLI (1989) and BERG & PART (1994) obtained similar results.

However, the results from Ireland (LYSAGHT 1989) do not point to a positive relationship between the overall density of linear hedges and the number of species, and population density. Calculated on the basis of data found in the cited work, the Spearman's rank correlation coefficients, r_S were even negative – with respective values of -0.15 and -0.20 ($P>0.05$). This unexpected result may be linked to limited variation in the density of hedges (from 122–157 m/ha). The same explanation may be given for the surprising result obtained by BULL *et al.* (1976). In this study the removal of 1/3 of the hedges in an area had no noticeable negative effect on the overall population density, or species richness of the bird communities despite the obvious decline in species density, e.g. in hole-nesters.

As a consequence, analyses of variation in bird abundance could be interpreted at two spatial scales: (a) scale of a single element of landscape, and (b)

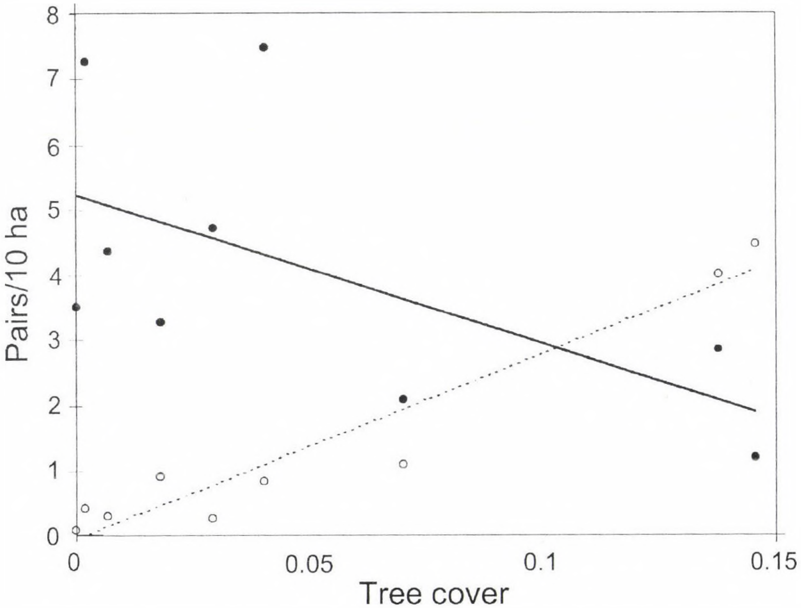


Fig. 2. Relationships between tree cover (transformed by arcsine function) and two ground-nesters: *Emberiza citrinella* (circles) and *Alauda arvensis* (filled circles)

scale of the whole landscape. Our results show that there was a possibility to explain variability in bird abundance depending on a landscape parameter. The strong correlations between landscape parameters and bird abundance used in our study suggest that if we analyse sufficiently long series of plots, the effect of singular variables on birds may be overlooked.

The density of ground-nesters was the only 'bird' parameter, which was not dependent on any measured 'habitat' variables. The reason is the diverse relationships between some ground-nesting species and 'habitat' variables. For example the density of some species, e.g. *Emberiza citrinella* increases with tree cover, but that of some others, e.g. *Alauda arvensis* decreases (Fig. 2). Thus, even though the number of ground-nesting species increases with tree cover, the density did not.

In the present study, total density of breeding birds was markedly lower than in many other studies in Great Britain, which were carried out in areas with similar percentage of tree cover (O'CONNOR & SHRUBB 1986). This is an unexpected result, because the intensity of British farming is higher than the Polish one, so one may rather expect a reverse relation. Probably it may be linked with the very long (5000 years) history of British farming, which provided enough time for forest species to adapt to altered habitats (O'CONNOR & SHRUBB 1986). Very long transition from the forest to field system may also explain why up to 80% of farmland avifauna in Great Britain represent forest species, while it is less than 30–50% in Poland.

In conclusion, the most important landscape element affecting bird richness and abundance in farmland is the tree cover percentage. This variable explains 63% of the variability in bird species numbers and 85% of the total density. Among nest-guilds only the density of ground-nesters was not correlated to any of the measured 'habitat' variables. The other nesting-guilds may be predicted in relation to tree cover and the determination coefficient regarding to total density amounted to 0.94–0.99, and regarding to species number 0.48–0.90. The results showed essential importance of marginal woodland habitats for conserving bird richness and abundance in farmland of West Poland.

*

Acknowledgements – We are grateful to the farmers who granted us regular access to their land and supplied valuable information on farmland management. We are grateful to Z. KOSINSKI, A. SURMACKI, and especially R. J. FULLER and three anonymous reviewers for their helpful comments on an earlier draft. The study was partly found by the Committee for Scientific Research (No. 6 PO4G 046 11).

REFERENCES

BASTIAN, O., HUMMITZSCH, P. & SCHRACK, M. (1989) Beziehungen zwischen Landschaftsstruktur und Artenvielfalt der Avifauna in der Agrarlandschaft nördlich von Dresden. *Zool. Abhandl.* **45**: 53–73.

BELLAMY, P. E., HINSLEY, S. A. & NEWTON, I. (1996) Factors influencing bird species numbers in small woods in south-east England. *J. Appl. Ecol.* **33**: 249–262.

BERG, A. & PART, T. (1994) Abundance of breeding farmland birds on arable and set-aside fields at forest edges. *Ecography* **17**: 147–152.

BEZZEL, E. (1982) *Vögel in der Kulturlandschaft.* Ulmer Verlag, Stuttgart, 350 pp.

BONGIORNO, S. (1982) Land use and summer bird populations in northwestern Galicia, Spain. *Ibis* **124**: 1–20.

BROWN, A. F. & STILLMAN, R. A. (1993) Bird-habitat associations in eastern Highlands of Scotland. *J. Appl. Ecol.* **30**: 31–42.

BUCKLAND, S. T. & ELSTON, D. A. (1993) Empirical models for the spatial distribution of wildlife. *J. Appl. Ecol.* **30**: 478–495.

BULL, A. L., MEAD, C. J. & WILLIAMSON, K. (1976) Bird-life on a Norfolk Farm in relation to agricultural changes. *Bird Study* **23**: 163–182.

CIESLAK, M. (1985) Influence of forest size and other factors on breeding bird species number. *Ekol. Pol.* **33**: 103–121.

FLADE, M. (1994) *Die Brutvogelgemeinschaften Mittel- und Norddeutschlands.* IHV-Verlag, Eching, 879 pp.

FUCHS, E. & SCHIFFERLI, L. (1980) Comparative censuses in Swiss farmland. Pp. 107–113. *In* OELKE, H. (ed.): *Bird Census Work and Nature Conservation, Proc. VI. Intern. Conf. Bird Census Work.* Göttingen.

GÓRSKI, W. (1988) Birds breeding in the farmland of the Damnica Plateau (NW Poland). *Acta orn.* **24**: 29–61.

JERMACZEK, D. & TRYJANOWSKI, P. (1990) Breeding bird communities in the farmland of Ziemia Lubuska and Western Wielkopolska (Western Poland) with the consideration of arable fields. *Lub. Przegl. Przyr.* **1–3**: 3–26.

KONDRACKI, J. (1988) Geografia fizyczna Polski. [Physical geography of Poland]. PWN, Warszawa, 464 pp.

KOT, H. (1990) The effect of suburban landscape structure on communities of breeding birds. *Pol. Ecol. Stud.* **14**: 235–261.

KUJAWA, K. (1994) Influence of land-use change within agricultural landscapes on the abundance and diversity of breeding bird communities. *In* RYSZKOWSKI, L. & BAAZY, S. (eds): *Functional Appraisal of Agricultural Landscape in Europe.* ZBSRiL PAN, Poznan, pp. 183–196.

KUJAWA, K. (1997) Relationships between the structure of mid-field woods and their breeding bird communities. *Acta orn.* **32**: 175–184.

LACK, P. C. (1988) Hedge intersections and breeding bird distribution in farmland. *Bird Study* **35**: 133–136.

LYSAGHT, L. S. (1989) Breeding bird populations of farmland in mid-west Ireland in 1987. *Bird Study* **36**: 91–98.

NORUSIS, M. J. (1986) *SPSS/PC+. Advanced statistics.* SPSS, Chicago. 482 pp.

O'CONNOR, R. J. & SHRUBB, M. (1986) *Farming and birds.* Cambridge Univ. Press, Cambridge, 284 pp.

OELKE, H. (1968) Wo beginnt bzw. wo endet der Biotop der Feldlerche? *J. Orn.* **109**: 25–29.

OBORNE, P. (1984) Bird numbers and habitat characteristics in farmland hedgerows. *J. Appl. Ecol.* **21**: 63–82.

ROBERSTON, P. A., WOODBURN, M. I. A., NEUTEL, W. & BEALEY, C. E. (1993) Effects of land use on breeding pheasant density. *J. Appl. Ecol.* **30**: 465–477.

SCHIFFERLI, L., BLUM, H. & NAEF-DAENZER, B. (1985) Einfluss der Landschaftsstruktur auf die Zahl der Brutvogelarten im aargauischen Reusstal. *Orn. Beob.* **82**: 251–264.

TOMIALOJC, L. (1980) The combined version of the mapping method. Pp. 92–106. *In* OELKE, H. (ed): *Bird Census Work and Nature Conservation, Proc. VI. Intern. Conf. Bird Census Work*, Göttingen.

TRYJANOWSKI, P. (1999) Effect of habitat diversity on breeding birds: comparison of farmland bird community in the region of Wielkopolska (W Poland) with relevant data from other European studies. *Pol. J. Ecol.* **47**: 153–174.

ZAR, J. H. (1984) *Biostatistical analysis*. Prentice-Hall, Englewood Cliffs, New Jersey, 365 pp.

APPENDIX

List of species breeding on the study plots.
Abbreviations: PR – number of pairs, PL – number of plots

Species	PR	PL
Alauda arvensis	145.5	9
Fringilla coelebs	62	5
Emberiza citrinella	48.5	9
Motacilla flava	42.5	8
Sturnus vulgaris	26.5	6
Carduelis carduelis	22.5	7
Passer montanus	17.5	5
Parus major	15.5	4
Parus caeruleus	14.5	4
Turdus merula	13.5	5
Hippolais icterina	12.5	4
Miliaria calandra	12	5
Sylvia atricapilla	11	4
Carduelis cannabina	9	6
Motacilla alba	9	7
Turdus philomelos	9	4
Carduelis chloris	8.5	3
Sylvia communis	8.5	6
Acrocephalus palustris	7.5	4
Luscinia megarhynchos	6.5	2
Emberiza hortulana	5.5	3
Certhia brahydactyla	4.5	2
Phylloscopus collybita	4.5	3
Sylvia borin	4.5	3

Species	PR	PL
Oriolus oriolus	4	4
Emberiza schoeniclus	3.5	3
Anas platyrhynchos	3	2
Buteo buteo	3	2
Coccothraustes coccothraustes	3	1
Columba palumbus	3	3
Muscicapa striata	3	2
Passer domesticus	3	2
Sitta europaea	2.5	3
Anthus trivalis	2	2
Erithacus rubecula	2	1
Perdix perdix	2	2
Pica pica	2	1
Saxicola rubetra	2	2
Sylvia curruca	2	2
Turdus pilaris	2	1
Streptopelia decaocto	1.5	2
Dendrocopos major	1	1
Galerida cristata	1	1
Lanius collurio	1	1
Phylloscopus trochilus	1	1
Serinus serinus	1	1
Strix aluco	1	1
Luscinia luscinia	0.5	1

Revised version received 21st April, 2000, accepted 30th June, 2000, published 24th July, 2000

Acta Zoologica Academiae Scientiarum Hungaricae 46 (2), pp. 115–146, 2000

USE OF RADIOTELEMETRY ON SNAKES: A REVIEW

ÚJVÁRI, B. and Z. KORSÓS

Department of Zoology, Hungarian Natural History Museum
H–1088 Budapest, Baross u. 13, Hungary
E-mail: ujvari@zoo.zoo.nhmus.hu
korsos@zoo.zoo.nhmus.hu

Radiotelemetry is a useful technique for studying certain aspects of the life history and ecology of snakes. In the present paper a comprehensive overview is given of all the methodological experiences of herpetological radiotelemetry in the past 25 years. A useful guideline shows how to plan and carry out a study on snakes using this advanced method. Summaries and helpful comments are presented of almost every chapter of such a project; the possible aims of the study, the choice of the snake species in question, the selection of the study area and the different transmitters, attaching the transmitter to the snake's body, obtaining optimum results and the analysis of the results.
Separate chapters deal with the relevant technical aspects of radiotelemetry: type, size, lifespan and efficiency of the different transmitters and receivers; immobilisation of the snakes: anaesthesia and control during and after the implantation of the transmitter, cold immobilisation and local anaesthesia.
Results, which can be obtained by radiotelemetry are thoroughly discussed: location of the snakes with different techniques, details of behaviour, feeding, breeding, hibernation and habitat preference. Mathematical formulas for identifying and calculating home range size and movement are briefly referred. Concepts and solutions of biotelemetry as a useful aid for studying thermoregulation and the thermal biology of snakes is also described.
As an example, experiences from a project on a small European grassland viper (*Vipera ursinii rakosiensis*) are presented in order to illustrate problems and practical solutions when carrying out a radiotelemetric study.
Two tables on the radiotelemetric studies carried out on snakes further complement the review.

Key words: herpetological radiotelemetry, biotelemetry, anaesthesia, location, home range, thermoregulation, snakes, *Vipera ursinii rakosiensis*

INTRODUCTION

Until the beginning of the 70's only little information could be gathered about the biology, life history, thermal and territorial ecology, and behaviour of free living snakes. A revolutionary breakthrough was gained by the introduction of radiotelemetric techniques. The first such studies on snakes investigated the factors regulating their body temperature (MCGINNIS & MOORE 1969, OSGOOD 1970). Some months later FITCH and SHIER (1971) reported on radiotelemetric studies on 67 individuals of 8 species. The transmitters used were relatively heavy, with a short distance operation and lifespan. By continuously improving the technique it became possible to monitor the snakes' activity during a longer period. Even today, however, because of the large size of transmitters (relative to the animal's body), radiotelemetry is generally considered more useful for large species. Its efficiency, precision, low time and energy requirements, and the fact that it can produce results on species otherwise very difficult to study, makes the dispersion and further development of the method more justified. In North America, species of *Crotalus*, *Agkistrodon* and *Nerodia* (JACOB & PAINTER 1980, LANDRETH 1973, MOORE 1978, REINERT & CUNDALL 1982, REINERT & ZAPPALORTI 1988) have mostly been studied by radiotracking. In the genus *Sistrurus*, only a large species (*Sistrurus catenatus*) was studied by telemetry (REINERT & KODRICH 1982). In Japan, *Trimeresurus flavoviridis* (WADA *et al.* 1971); in Costa Rica, *Lachesis muta*; in Peru, *Bothrops atrox*; and in Europe, mainly *Natrix* (HUEY *et al.* 1989, MADSEN 1984, MERTENS 1994), *Coronella* (SPELLERBERG & PHELPS 1975) and *Vipera* species (NAULLEAU 1987*a, b*, 1989) were the objects of field investigations applying this technique. For a more detailed summary of radiotelemetric studies carried out on snakes, see Tables 1 and 2.

The present paper gives a comprehensive overview of all the methodological experiences of herpetological radiotelemetry in the past 25 years and, at the same time, tries to give a useful guidance on how to plan and carry out a study using this technique on snakes. It is built up according to the structure of an actual project; starting at the choice of the species to be studied, the possible aims, through the choice of the different transmitters and receivers, useful hints for the application of the method, to the evaluation of the results.

PLANNING A RADIOTELEMETRIC STUDY

Why radiotelemetry?

Radiotelemetry is a useful method to get a closer view on certain aspects of life history of cryptic animals like snakes. A number of factors, which cannot be studied with traditional observation, are possible to register and measure: seasonal and daily activity pattern, home range, microhabitat and substrate preference, etc. Recording temperature data, relation and regulation of the snake's body depending on the ambient temperature can be clarified. Thermoregulation and activity patterns might lead to intra- and interspecific niche-segregation (MOORE 1978). With the ability to follow snakes almost under any circumstances, data on feeding, digestion, shedding, mating, etc. can be gained, together with behavioural patterns of all these phenomena (REINERT *et al.* 1984).

Selection of the species

The choice of the species to be radiotracked and the method to be used depends on the purpose and the limitations of the study. If the purpose is not the monitoring of a particular species, but rather to test the method itself that we wish to apply, then it is best to select a common, large snake species. The larger the body size of the animal, the easier it is to get good results (BROWN & PARKER 1976, CIOFI & CHELAZZI 1991, MCGINNIS 1976, NAULLEAU 1973). On the other hand, if the species to be studied is already selected on other basis (e.g. taxonomic reasons, nature conservation projects, etc.), and it is relatively small, the availability of the appropriate equipment is necessary to be carefully considered.

Selection of the study area

Some of the physiology-related factors like feeding, digesting, mating, change of body temperature have mainly been studied in terraria or enclosures (FLEURY & NAULLEAU 1987, NAULLEAU 1973, 1979). Observing thermoregulation of snakes, however, can easily be realised under natural circumstances as well, provided that automatic data recording is available. Daily activity pattern of the animals can be recorded both in enclosures and in the field. Seasonal activity pattern, on the other hand, is best to record in natural circumstances, since it is effected by a number of factors, which are difficult to reproduce or forecast. There are studies dealing with the use of artificial hibernating and hiding places (FLEURY & NAULLEAU 1987). Special questions, such as orientation of snakes, should be answered with specially planned experiments (e.g. LANDRETH 1973).

Selection of the radiotelemetric equipment

What do we want to study? – The first thing that has to be decided is the aim of the study. Do we want to locate the movements of the snakes, measure their home range, daily activity pattern, or some physiological parameters, or maybe all together? In order to get data about the home range it is appropriate to select a simple, cheap and small transmitter, whereas physiological records can only be gained through the application of more complicated, heavier, advanced systems. If the purpose is to monitor body temperature, the type and the fixing of the transmitter is an important matter, influencing the nature of data.

If the aim of the study is just to follow the snake, a single-staged transmitter with triangle-shaped signal is good enough for this purpose. The length of the signal of these transmitters and the pause in-between cannot be identified precisely – so there is no possibility to code more information than location. A two-staged transmitter is recommended for the collection of biotelemetric data. This type of transmitters has a so-called quadratic signal, i. e. the length of the signal and the pause can be precisely identified. Additional information can be gained by measuring these time intervals. Depending on the physiological factors to be studied a transmitter with only two pause values (so-called digital transmitter) can also be used. The disadvantage of this type that it can only register two different states (e. g. "standing – laying", "motion – still", "live – dead" states). Its use on snakes due to their anatomy is quite limited. Only one study has found this transmitter type useful to define the habitat selection of the North American *Thamnophis elegans* (HUEY *et al.* 1989). When the animal was moving, the signal impulse was doubled, so movements and resting could be identified. Sensors (called digital mortality sensors) detecting long lasting pause in motion can be used to observe the beginning and the end of hibernation (FUISZ 1995).

Much more widespread are the so-called analogue transmitters, which have continuously changing signal parameters according to the factor they measure. Body temperature, heart rhythm, etc. of the snakes can easily be recorded in this way.

The size of the transmitter and of the snake – Most of the investigators recommend a transmitter that does not infer the normal mobility of the snake. A limit value of about 4–5% of the body mass is generally given (REINERT 1992, SECOR 1994, WEATHERHEAD & ANDERKA 1984), but in the case of smaller species length and width of the transmitter can also be important. For a small, slender snake the transmitter should be accordingly slender (WEATHERHEAD & ANDERKA 1984). Our experiences also show that even if the transmitter is less than 4% of the body mass, having a large diameter object under the skin can cause intolerable inconvenience to the snake.

It is suggested to apply as small transmitters as possible. Table 1 shows this relation in the past 25 years. Although a decrease in the relative transmitter size could have been expected, this is not the case undoubtedly due to unavoidable technical reasons.

The lifespan of the transmitter and the length of the study period – Because of the high price of the transmitters, the troubles caused by the implantation, and the life cycle of the snakes, every scientist would like to use the equipment they purchase as long as possible. Unfortunately, the smaller the transmitter (including batteries), the shorter is its lifespan. In the case of large snakes the size of the transmitter is a less important factor, but in small vipers it is difficult to find an appropriate transmitter, which gives signals safely and long enough. The lifespan of a transmitter – the amount of energy it uses – depends primarily on its type (whether single- or two-stage), the strength of the signal, and the pulse length and pulse frequency. One-stage transmitters need lesser power supply (1.3–1.5 V), and work for longer period, accordingly. A two-stage transmitter needs more than double amount of power (3–3.6 V), but its lifespan is considerably shorter. The stronger the signal we want, the bigger power is needed. In order to increase the lifespan of the batteries, a signalling combination of short impulse – long pause is favourable. A more advanced method is a transmitter with a miniature,

Table 1. Types and sizes of transmitters used on snake species.

Types	Weight [g]	Size [mm]	Frequency [MHz]	Transm. weight/ body weight [%]	Opera- tional life [days]	Reception range [m]	Type	Manufacture	Authors
No type	11	13×35	26.87–26.94	7–11	40±10	–	–	–	BROWN & PARKER (1976)
SM1	2.5	25×9×8	148–149	0.9–1.0	40	150–500	–	AVM Instrument Company	CIOFI & CHELAZZI (1991)
No type	16	50×21×4	26.600–26.750	–	–	–	–	–	FITCH & SHIRER (1971)
SS–1	2.5	ca. 20	173.20–173.35	–	236	–	Simple	–	GENT & SPELLERBERG (1993)
Model T	–	–	–	–	14	–	Digital	Mini–Mitter Company	HUEY *et al.* (1989)
No type	17	60×22	27.555–27.615	12	–	–	–	Mini–Mitter Company	JACOB & PAINTER (1980)
No type	13.5	50×20	148	–	21	1500	Thermosensitive	–	LANDRETH (1973)
Short range	–	30×15	27.24	–	–	–	Thermosensitive	–	LILLYWHITE (1980)
Long range	–	–	27.24	–	–	–	Thermosensitive	–	LILLYWHITE (1980)
No type	3.5	17×12×7	27	5.4–0.9	90	50–100	Simple	–	MADSEN (1984)
Short range	–	6×16	–	–	4	–	Thermosensitive	–	MCGINNIS & MOORE (1969)
Long range	–	15×60	–	–	–	100	Thermosensitive	–	MCGINNIS & MOORE (1969)
Model SM–2	20	25×15	–	0.1	12	–	Thermosensitive	AVM Instrument Company	MONTGOMERY & RAND (1978)
No type	–	20×10	–	–	–	–	Thermosensitive	–	MOORE (1978)

Table 1 (continued)

Types	Weight [g]	Size [mm]	Frequency [MHz]	Transm. weight/ body weight [%]	Operational life [days]	Reception range [m]	Type	Manufacture	Authors
BD–2GTI	1.95	19×8×6	152	1.3–3.0	133–197	600–700	Thermosensitive & simple	Holohil Systems Inc. Ltd.	NAGY & KORSÓS (1999)
No type	15	60×15.5	108	–	53	–	Thermosensitive	CEBAS*	NAULLEAU (1979)
AVM	15–20	50×15	150	4–8	28–70	–	Thermosensitive	–	NAULLEAU (1987)
No type	16–20	–	–	5.7	180–120–90[a]	200	Thermosensitive	–	NAULLEAU (1989)
No type	12–15	60×15.5	88–108	–	53	–	Thermosensitive	CEBAS	NAULLEAU & MARQUES (1973)
Long–range	12	40×15	27	2.4	–	100	Thermosensitive & simple	–	OSGOOD (1970)
Short–range	6	20×10	0.5–1.6	1.2	–	0.5[b]	Thermosensitive	–	
Model T	4–5	30×12	–	2–9	30	5–100	Thermosensitive	Mini–Mitter Company	PETERSON (1987)
CHP–2P	6.1	32×14.7×9.2	–	5	150–270	250–600	–	Telonics Inc.	PLUMMER & CONGDON (1994)
SB 2–IV	3–12	–	–	1.8–4	120–300	200–500[c] 1000–1500[d] 2300[d]	Simple	AVM Instrument Company	REINERT & CUNDALL (1982)
SM1	12–15	–	–	–	60	500	–	AVM Instrument Company	REINERT & ZAPPALORTI (1988)
CHP–2P	6.1	32×14.7×9.2	–	4.7	150–270	250–600	Thermosensitive	Telonics Inc.	SECOR (1994)

Table 1 (continued)

Types	Weight [g]	Size [mm]	Frequency [MHz]	Transm. weight/ body weight [%]	Operational life [days]	Reception range [m]	Type	Manufacture	Authors
TT–IU–080	20	50×20	150–153	<4	–	200–500	Thermosensitive	G. Stuart Enterprises	Shine & Lambeck (1985)
AVM	20	70×12	–	–	70	–	Simple	AVM Instrument Company	Tiebout & Cary (1987)
Long–range	11	13×35	26.87–26.94	–	15	100	–	Made by the authors after Osgood (1970)	Tomko (1972)
BD–2GT	2	16×9	152	4	–	500–700	–	Holohil Systems Ltd.	Újvári & Korsós (1997)
No type	38	10×6×8	700	–	–	100	Simple	Institute for Medical Electronics	Wada *et al.* (1971)
No type	15	52×12.5	172	4	–	150–300	–	Made by the authors	Weatherhead & Anderka (1984)

a – 6 months at 10°C, 4 months at 20°C, 3 months at 30°C
b – with an expensive antenna, 1.0×1.2×4.0 m enclosure area
c – mountainous, heavily wooded terrain
d – in flat, less wooded terrain
e – from the top of a fire tower in mountaineous country

*CEBAS Centre d'Études Biologiques des Animaux Sauvages (recent name: Centre d'Études Biologiques de Chizé – Centre National de la Recherche Scientifique).

built-in magnetic switch, and in the last few years programmable transmitters have also been introduced to the market (SZEMETHY 1995). In latter, the transmitting period of a transmitter can be pre-set with a computer according to the active life periods of the animal (i. e. it can be switched off during the longer resting period, hibernation, aestivation, etc.). For the time being, unfortunately, the precision of this type of transmitters is largely depending on the ambient temperature (about 20% deviation from the pre-set time schedule), which makes the accurate programming more difficult, and ultimately the animal could be lost. The maximal lifespan of the radio transmitters for small reptiles today are around 6–8 months (on 25°C), and this is not enough to cover a whole year life cycle. Maybe with the programmable transmitters this period can be extended, but we have not found yet any references mentioning their use on snakes.

The lifespan of the temperature sensitive transmitters highly depends on the ambient temperature (NAULLEAU 1989). In high ambient temperature these transmitters give impulses at a higher rate, requiring more power, which decreases their lifespan. A transmitter that works for 6 months at 10°C will shorten its activity to 4 months at 20°C and to 3 months at 30°C, respectively. We have experienced similar results in our study: the manufacturer gave 7–8 months as an expected lifespan at 25°C, whereas the transmitters stopped signalling after about 5 months. The only possible explanation is that during the summer at a body temperature of 30–35°C the transmitters needed much higher energy than expected (ÚJVÁRI & KORSÓS 1997).

The transmission range and the size of the study area – During a radiotelemetric study our primary aim is to find the animal with certainty, but this depends on field conditions and the behaviour of the snakes as well. In a relatively flat field, without major shading and disturbing objects, a small transmitter can produce a signal detectable from large distances. In a forest or a rocky area, however, where the signal can be reflected or absorbed by the complex structure of the habitat, it is better to use a transmitter with relatively stronger signals.

The performance of the transmitter can be improved with the appropriate length of its antenna, and the range of receiving the signals can be enlarged by using a more sensitive receiver and antenna system. With increased performance of the receiver, the effective transmission distance can be extended. A transmitter with a usual 0.5 meter transmission distance can eventually be used in an area of 1.0×1.2×4.0 m (OSGOOD 1970). The effective distance, however, depends also on the position of the animal (for more details see e.g. FUISZ 1995, MADSEN 1984, WADA *et al.* 1971).

THE RADIOTELEMETRY: TECHNICAL BASES

The receiver

A receiver of the best choice makes the work easier, the time of the localisation shorter, hence the efficiency of the transmitters bigger. It should be small, lightweight, compact, withstand water, shock and rough environmental conditions. Walkie-talkies used in early works enabled only tracking of moving animals (OSGOOD 1970). More novel instruments have a gain control to increase sensitivity, a noise filter to reduce interference, fine tuning, channel selection, etc. In some cases automatic or programmable data processing is also available. Some receivers have prefixed frequency range in which they can track a transmitter, usually burned into the memory by the manufacturing company. Frequency range was usually wide in the early receivers, meaning they had high noise ratio. New equipments, like the Telonics (Arizona, USA, type: TR-4 for 150–154 MHz) used by us have a selectable radio band width of 10 kHz, but there are also receivers with 1–2 kHz selectivity.

For biotelemetric purposes a receiver able to measure the length of and pauses between signals has to be purchased. A simple basic equipment can also be upgraded to this level by appropriate accessories. NAULLEAU (1989) for instance, used an A.V.M. LA 12 v. Custom RB 4/6 receiver with automatic data recorder to monitor body temperature. It had a limited receiving range of about 30 m radius (without adjusting the antenna). Several similar data processors (signal indicators, etc.) can be attached to the Telonics receivers as well. These assemblies are generally less expensive, and can be gradually developed to more advanced systems. When investigating home range, or simply starting a new study, it is usually enough to invest into a basic equipment, and then adopt and complete it to the special conditions of the given species. In our opinion complex receiving instruments are less exploitable for radiotelemetric research on snakes, because the specific conditions make inevitable the individual modifications.

The receiving antenna

An appropriate antenna should be selected according to the measuring methods. For tracking purposes directional H-type and Yagi antennas are a good choice. In the case of species with relatively small home ranges, there are folding or assembling models, which need little space to carry. Yagi antennas are efficient for bigger distances as well, depending on their size and the number of elements. For exact identification of the location of the animals short-distance loop antennas do their job. They are absolutely necessary if one is to follow the animal's movement precisely. We could track a burrowing viper under the ground by the Telonics RX loop antenna almost centimetre by centimetre.

In biotelemetric studies Yagi and H-type antennas are also useful if combined with direction identification. A method invented by NAULLEAU (1979, 1989) and GILMER *et al.* (1971) was an automatic data recorder attached to a Yagi antenna in the field. The original range was 200 meters, but due to the shadowing effects of field objects it decreased to 30 meters, still enough for their study.

When the purpose is definitely to collect only physiological parameters, and direction identification is not necessary, the omnidirectional whip antenna can detect a signal from a greater area. Its advantage in not disturbing the animals from a close distance is obvious (GENT & SPELLENBERG 1993, MERTENS 1994, SZEMETHY 1995). In enclosures a combination of several whip antennas can cover the whole area, depending on the performance of the transmitters. Data collection is, however, more efficient if the ground area is equipped with a loop antenna system (MCGINNIS & MOORE 1969, MOORE 1978).

When using a receiving antenna, the fact should be taken into consideration that the transmitting antenna in the snake has a horizontal position (snakes move usually along the soil surface) whereas the signal given is polarised vertically (SZEMETHY 1995). It is important to orientate the receiving antenna according to this and also to the shadowing or mirroring effect of the field objects. The wave length of the signal (calculated from the transmitting frequency, see below) gives a hint during this process. On open, plain terrain with smaller field objects than the wave length, the receiving antenna should be held in a vertical position because the objects cannot shadow or disturb the signal. In a forest, or in the field with objects of a comparatively large size, horizontal position is more appropriate to measure the horizontally polarised component of the signal (SZEMETHY 1995). WADA *et al.* (1971) used a simple television antenna which could not receive any signal in the extreme case when the animal supplied with the transmitter moved into a hole.

The transmitter

The transmitter has three main components: the signalling electric circuit, the power supply, and the transmitting antenna. The majority of its mass (60–70%) is given by the battery, the rest includes the circuit to which the short whip antenna is attached, and the plastic cover. Description of the circuit is given in various articles (IKEDA & OSHIMA 1971, NAULLEAU & MARQUES 1973, OLDERS *et al.* 1985, STEBBINS & BARWICK 1968). Different manufacturers apply various battery types. Mercury cells with 1.4 or 2.8 Voltage are widely accepted because of their high specific performance (GENT & SPELLERBERG 1993, HUEY *et al.* 1989, NAULLEAU & MARQUES 1973, REINERT & CUNDALL 1982, REINERT & ZAPPALORTI 1988). In temperature sensitive transmitters usually two pieces of 1.5 V silveroxyd batteries are built in (OLDERS *et al.* 1985, PETERSON 1987). Despite their high temperature tolerance and performance capacity lithium thionyl chloride batteries are only rarely used (3.5 V, 290 mAh, see NAULLEAU 1989, WEATHERHEAD & ANDERKA 1984), perhaps due to their price and availability.

Signalling – The transmitting circuit itself is simply an oscillator giving impulse at a certain rate on a certain frequency. Frequency stability is achieved by a quartz crystal, and defined by its geometrics. The first transmitters signalled at AM 530–1600 kHz and FM 88–108 MHz. Their drawback was the small transmitting distance, less than 1 meter. Other rarely used frequency bands were CB 27 MHz and VHF 138–174 MHz (OSGOOD 1970), having the advantage of a cheap receiver ("Walkie-Talkie"). They soon went out of fashion because these overcrowded bands have many disturbing signals, and the transmitters had a short life span. Nowadays frequencies around 150 MHz are the most widespread in the field of radiotelemetry.

To produce signals in the 100–170 MHz a very thin quartz crystal is necessary, which is vulnerable and has a weak temperature stability. To achieve higher frequency a thicker crystal is used which resonates at 49–50 MHz, and is tuned up to three times of its base frequency. Direction measuring is better on high frequencies, but penetrating through field objects is weaker. In water, on the other hand, signals at lower frequencies disperse more effectively, and 40–49 MHz is more appropriate (FUISZ 1995). WADA *et al.* (1971) in their paper published the first report about a transmitter of 700 MHz, which they could hardly follow when the snake moved into water. SHINE and LAMBECK (1985), however, had good results with a transmitter of 150–153 MHz in *Acrochordus arafurae* living in water, too.

The transmitting antenna – The length of the transmitting antenna is scaled according to the frequency of the oscillator. It should be compared to the wavelength: the closer to it the higher its performance, and the greater the transmitting distance. The formula by REINERT (1992) expresses the relation between the wavelength and the frequency of the transmitting oscillator:

Wavelength (m)= Velocity of light (300,000,000 m/s)/Frequency (in Hertz)

For example, in the case of the most frequently used 150 MHz (= 150,000,000 Hz) an antenna length of 2 meters would be ideal. This is obviously impossible (in a snake), so usually 1/4, 1/6 or 1/8 λ are chosen. This gives a more acceptable 25–50 cm antenna size, which is readily applicable in bigger species (REINET 1992, REINERT & CUNDALL 1982, SZEMETHY 1995, ZAPPALORTI & REINERT 1988).

The transmitting antennas are almost exclusively omnidirectional, flexible, teflon or plastic coated whip antennas. They are implantable into the body cavity of the snake, sometimes in the intestinal tract, when the antenna is coiled around the transmitter. Even so, an antenna in the alimentary canal disturbs very much the normal digesting process, causing vomiting or starving. The transmitter or its antenna, on the other hand, can also be damaged by the digestive enzymes (REINERT 1992). The size of the antenna implanted into the snake depends also on environmental conditions: in diverse, rocky habitats, for instance, it is recommended to use a longer transmitting antenna in order to increase the output performance. The limit is, of course, the size of the given snake species. In our case with the meadow viper of an average body size of 40 cm, the maximum antenna length with the transmitter on 151 MHz could not exceed 8–9 cm (about 20% of body length). The transmitting distance was accordingly short, although the manufacturer gave a reference to 1000 m, good quality signals could generally be received only from 200 meters. Considering the relatively small home range of this insectivorous viper, this was still sufficient for our study, however the whip antenna caused some problem for us. The antenna of the transmitter is usually a flexible plastic coated copper wire, which is put under the skin of the snake (ventral side), directed towards the head, parallel to the vertebral column. In our study about 7 weeks after the implantation, studied snakes were found in the field having pierced their skin by the blue coated antenna wires. The wire pierced the skin at about the half length of the animal, on the side of the belly, and cca. 2–3 cm length of the antenna was sticking out of the body. The snakes were otherwise healthy, with normal defending behaviour and good condition. We put the antenna back under the skin and fixed the wound with an adhesive surgical band. We think that the antenna wasn't sufficiently flexible and softly coated, this may have been the reason for the unconvenient injury of the snakes.

The cover – The cover of the transmitter should fulfil several criteria. The original material must be water resistant, strong but easy to shape, removable (in the case of battery replacement), and protective (to encapsulate the vulnerable parts of the transmitter). It is important to withstand the digestives and other body fluids in the case of intragastric and intraperitoneal insertion, and also should not cause inflammation or irritation. McGINNIS (1967) potted his transmitter in epoxy and coated with beewax film to prevent reaction of the epoxy with body fluids. OSGOOD (1970) used silicone rubber. Pure silicon and epoxy are too rigid, hard to shape, so they are often mixed with paraffin (MADSEN 1984, PETERSON 1987). This is important when one wants to replace the batteries. Some transmitters were coated with Dupont Elvax 260 vinyl acetate copolymer and paraffin (ratio 1:5 or 3:7) (GOODMAN & GIBSON 1970, NAULLEAU 1987, 1989, WEATHERHEAD & ANDERKA 1984). More recently 1:1 or 3:1 mixture of paraffin and beeswax are most widespread (REINERT 1992, REINERT & CUNDALL 1982, SHINE & LAMBECK 1985, ZAPPALORTI & REINERT 1988). Beeswax is a soft, water resistant, gentle to tissues, easy to shape, smooth material, ideal for transmitter coating. The paraffin component increases its resistance and strength.

ATTACHING A TRANSMITTER

There are several methods of attaching a radio transmitter to a snake's body (Table 2). The method to be used depends on the aim of the study, whether we only want to observe the movements of the animal, or collect physiological data as well. In the first case the transmitter can simply be attached to the skin surface, whereas in the other case the transmitter should be placed inside the body of the snake. In the following chapters the different methods are shortly described, then it continues with the problems of implantation, including immobilisation, anaesthesia, operation and post-operational control.

Apart from attaching the transmitter to the body surface, there are three different methods of "implantation" widely used in the literature: force-feeding into the stomach or gut (NAULLEAU 1979, NAULLEAU & MARQUES 1973, REINERT 1992), implantation into the coelomic or abdominal cavity (REINERT 1992, REINERT & CUNDALL 1982), and subcutaneous implantation (NAULLEAU 1987, 1989, PLUMMER & CONGDON 1994).

Table 2. Attachment and anesthesia methods during the radiotelemetric studies of different snake species.

Authors	Species	Attachment	Anaesthesia
BROWN & PARKER (1976)	*Coluber constrictor*	Palpated in the stomach + thin nylon	–
CIOFI & CHELAZZI (1991)	*Coluber viridiflavus*	Externally	5 °C refrigerator for 15 min
FITCH & SHIRER (1971)	*Elaphe obsolata* *Pituophis melanoleucus* *Coluber constrictor* *Agkistrodon contortrix* *Lampropeltis calligaster* *Thamnophis sirtalis* *Natrix sipedon* *Crotalus horridus*	Force feeding + abdominal implantation	–
GENT & SPELLERBERG (1993)	*Coronella austriaca*	Externally	–
HUEY *et al.* (1989)	*Thamnophis elegans*	–	Brevital sodium
JACOB & PAINTER (1980)	*Crotalus viridis*	Surgical implantation Force feeding	Fluothane
LANDRETH (1973)	*Crotalus atrox*	Force feeding	–
LILLYWHITE (1980)	*Acanthophis antarcticus* *Austrelaps superbus* *Notechis scutatus* *Pseudechis porphyriacus* *Pseudonaja nuchalis* *P. textilis* *Unechis flagellum*	Force feeding	–
MADSEN (1984)	*Natrix natrix*	Intrapleuro–peritoneal & subcutaeously	Ketalar, Rompun, Xylocaine
MCGINNIS & MOORE (1969)	*Boa constrictor*	Force feeding	–
MONTGOMERY & Rand (1978)	*Boa constrictor*	Force feeding	–
MOORE (1978)	*Crotalus mitchelli pyrrhus* *Crotalus cerastes laterorepens*	Orally inserted	–
NAGY & KORSÓS (1999)	*Natrix natrix*	Subcutaneously	Fluothane (4%), SBH–Ketamin
NAULLEAU (1979)	*Vipera aspis*	Force feed with mouse	–

Authors	Species	Attachment	Anaesthesia
NAULLEAU (1987, 1989)	*Elaphe longissima*	Subcutaneously	5°C refrigerator for one hour & local anesthetized by Hostacin or Laocaine
OSGOOD (1970)	*Natrix taxispilota*	Force feeding	–
PETERSON (1987)	*Thamnophis elegans*	Subcutaneously	Crushed–ice for 3–4 h
PLUMMER & CONGDON (1994)	*Coluber constrictor*	Surgically implanted in the body cavity	MS 222 + Halothane
REINERT & CUNDALL (1982)	*Crotalus horridus* *Agkistrodon contortrix*	Surgically implanted in the body cavity	MS 222 + Halothane
REINERT & ZAPPALORTI (1988)	*Crotalus horridus*	Surgically implanted in the body cavity	MS 222 + Halothane
SECOR (1994)	*Crotalus cerastes*	Surgically implanted in the body cavity	MS 222 + Halothane
SHINE & LAMBECK (1985)	*Acrochordus arafurae*	Force feeding	–
TIEBOUT & CARY (1987)	*Nerodia sipedon*	Surgically implanted in the body cavity	–
TOMKO (1972)	*Masticophis t. taeniatus*	Palpated in the stomach + thin nylon string	–
ÚJVÁRI & KORSÓS (1997, 1999)	*Vipera ursinii rakosiensis*	Subcutaneously	Ketamin, Halothane
WADA *et al.* (1971)	*Trimeresurus flavoviridis*	Subcutaneously	–
WEATHERHEAD & ANDERKA (1984)	*Elaphe obsolata*	Subcutaneously	–

On the skin

A radio transmitter attached to the snake's body surface may prove to be useful in few cases and for short study periods only. GENT and SPELLERBERG (1993) turned to this method prompted by the strict nature conservation regulations in Great Britain and the endangered situation of their study object, the smooth snake (*Coronella austriaca*). The transmitter was placed on the snake behind the cloaca at the first section of the tail and fixed by glue and medical tape. This method could fix the transmitter for a period between 0.07–9.71 days. During the three-year study of GENT and SPELLERBERG from the 39 marked specimens 6 lost the transmitter and 7 got caught in the vegetation due to the "package" on the tail. The conclusion is that this method can be recommended only in the case of very short term observations and when the implantation represents a high risk of loosing even one single specimen. With an externally fixed transmitter, almost permanent monitoring is necessary to prevent any problem arising from the movement difficulties. This, on the other hand, can cause heavy disturbances and likely changes the natural behaviour of the study animal.

Another method of attaching externally the transmitter is protected at least against the loss of it. A thin nylon thread led subcutaneously through two incisions on the subcaudal plates behind the cloaca can fix the transmitter to the vertebral column (CIOFI & CHELAZZI 1991). The subcaudal diameter of the snakes is smaller than the maximal body diameter, so a transmitter small enough less disturbs their movement. The method has a great advantage due to the following reasons: for the replacement of the transmitter (or the batteries) there is no need of surgical treatment. According to the authors, it can also be used in smaller species.

In the stomach

The simplest method to supply a snake with a radio transmitter and which is already used for a long time is to force-feed the device into the stomach (OSGOOD 1970). JACOB and PAINTER (1980) have put the transmitter in mineral oil to promote the swallowing. In the beginning of the era of telemetry, transmitters were implanted into mice then force feed by the snakes (FITCH & SHIRER 1971, NAULLEAU 1979, NAULLEAU & MARQUES 1973). The transmitter takes soon a fix position in the snake and stays there for a period of several days to several months. The animal continues normal feeding and digesting, the alien body in the stomach seems to disturb it only slightly. According to different authors, the force-fed transmitter has no effect on the feeding, digesting and voiding of the snakes, neither on their body temperature (NAULLEAU 1979, SHINE & LAMBECK 1985). However, force-feeding is not an appropriate method for long term studies, because the transmitter in the stomach may disturb the natural behaviour of the snakes (FITCH & SHIRER 1971), and sooner or later they vomit the device (NAULLEAU 1979, NAULLEAU & MARQUES 1973). Besides, the lack of antenna has a consequence of relatively short effective transmitting radius. Putting a constricting tape around the body may prevent vomiting the snake (BROWN & PARKER 1976, FITCH 1987, FITCH & SHIRER 1971, JACOB & PAINTER 1980), but this obviously causes further problems with the movement. According to the study of LUTTERSCHMIDT and REINERT (1990) the transmitter in the stomach has a similar effect to the snake's behaviour than that of a swallowed prey. Force-fed snakes have also chosen a substrate with slightly higher temperature in contrast to those without food. Their normal feeding behaviour, however, was out of cycle and they spent more time without food, lying on the sun. Some observations showed that the transmitter in the stomach can alter (usually rise) the body temperature (FITCH & SHIRER 1971, KITCHELL 1969, LUTTERSCHMIDT & REINERT 1990, LYSENKO & GILLIS 1980, NAULLEAU 1983, REGAL 1966, SAINT GIRONS 1975). JACOB & PAINTER (1980) suggested that the fact that rattlesnakes came out and started sunbathing after the beginning of hibernation may also be due to the effect of transmitters. A too small transmitter, however, can easily go through the whole intestine, and eventually leave the snake with the excrement (MCGINNIS & MOORE 1969).

In the coelomic cavity

REINERT and CUNDALL (1982) reported a complex implantation method, in which the transmitter was placed in the abdominal cavity in front of the sexual organs, and the antenna was led subcutaneously toward the head of the rattlesnake. The placement of the antenna was carried out with the help of a 20 cm long injection needle. The wire was thread with the needle section by section through the skin. The method was adopted in several other studies (PLUMMER & COGDON 1994, REINERT & ZAPPALORTI 1988, SECOR 1994). It was successfully used on more than 100 specimens of 8 species. No problem with feeding, growing, or breeding was experienced. There are examples of snakes carrying radio transmitter in the coelomic cavity for 9 years without disturbance (REINERT 1992). SHINE and LAMBECK (1985), however, oppose the surgical implantation. In four out of five cases they have reported an incomplete recovery after the operation, and wounds were reopened. They support force-feeding instead.

Subcutaneously

When implanting the transmitter under the skin, a several millimetre long longitudinal incision is usually made dorsolaterally at the lower third of the snake, then the device is placed caudally and the antenna threaded in anterior direction without cutting tissues (MADSEN 1984, NAULLEAU 1987, 1989, PETERSON 1987, ÚJVÁRI & KORSÓS 1997). There are very weak connective tissues between the skin and the lateral muscles of snakes. For the antenna, WEATHERHEAD and ANDERKA (1984) used a brass threading needle 25 cm long and 1.5 mm in diameter. It was drawn under the skin with the antenna wire in its cavity, then removed with a new incision on the skin at the end of the length of the antenna. The snake has to be completely unconscious during the operation. (For the immobilisation methods, see the following section.) First we used a similar technique in our study (ÚJVÁRI & KORSÓS 1997) with a steel needle of 8 cm length, but the relatively rigid antenna (type Holohil BD-2GT) could not be placed smoothly and the remaining loop later pierced the skin of the snake. Using a flexible plastic catheter the problem was avoided and only two incisions were needed at the beginning and the end of the antenna wire (ÚJVÁRI *et al.* 1999).

During the implantation the usual veterinary hygiene should be applied (disinfecting by ethanol, Betadine, or Pulsaureo powder (= 2% chlortetracycline-hydrochloride), (NAULLEAU 1987). The wound should be covered with surgical tape or plastic wound spray (e. g. Nobecutane = etoxy metacryl polymer plastic wound spray (MADSEN 1984), or Topozone furazolidone spray (PETERSON 1987). Sewing up the wound with one or two suture could also be recommended. Implantation carried out just before shedding is not recommended, since the peeling skin can remove the surgical cover and hence reopen the wound (WEATHERHEAD & ANDERKA 1984). Even 1.5 months after the operation, shedding difficulties may appear around the wound. Transmitters remaining longer in the snake may be encapsulated in tissues, but removal does not seem problematic (WEATHERHEAD & ANDERKA 1984). Although it seems that the most effective method for attaching the radio transmitter to the snake is the subcutaneous implantation, with small body size it still can cause troubles during the movement or alter the behaviour of the animal.

METHODS OF IMMOBILISATION

Anaesthesia of snakes

To implant a transmitter under the skin the snake has to be immobilised. The anaesthesia of snakes needs special training since these animals have a number of specialities with regards to their breathing. The trachea is narrow and long, making up to one-fifth of the length of the body (GANS 1976), its opening is situated at the front of the mouth and is freely movable from one side to the other. Another special anatomical feature is that only the right lobe of the lung is developed to the two-fifth of the total body length, whereas the left lobe is almost missing. Snakes have no diaphragm; their cerebral regulation is weak. Spinal neuroregulation has more influence; metabolism is generally low and depends in a great extent upon the environmental temperature.

During the anaesthesia of snakes all these anatomical features must be taken into consideration. Due to the low metabolism the influence of the anaesthetics builds up slowly, and the awakening may be delayed as well. In order to achieve total immobilisation of the snake the spinal reflex must be inhibited, but this – especially in the case of a largely vegetatively neuroregulated animal –

may cause death in extreme cases. Anaesthesia may block the muscles between the ribs, and because snakes have no diaphragm it might stop the respiration completely (Betz 1962).

Inhalation agents – The first reports on anaesthesia of snakes were published at the end of the 1930s. They were all connected to research on the venom glands and venom production of poisonous snakes (Clark 1937, Kellaway 1937, Tait 1938). In these experiments mainly chloroform, and later a mixture of ether and air were used as an inhalation anaesthetic agents, which made the animal motionless during the operation of the venom gland. Ten years later a new inhalation agent called Fluothane or Halothane (= $C_2HBrClF_3$; 2-bromo-2-chloro-1, 1, 1-trifluoroethane) appeared on the market. This volatile fluid has five times higher influence than ether, it is not inflammable, and does not irritate the respiratory tracks (Hackenbrock & Finster 1963). It is heavier than the air which needs to be considered when applying and hence it is important to prevent the snake lifting its head out of the gas. For a short anaesthesia (5–20 minutes) of big rattle snakes about 5 cm^3 Fluothane proved to be enough, and awakening did not take more than 10 minutes. Reinert and Cundall (1982) invented a simple technique for anaesthesia of snakes. A small piece of textile saturated with Halothane, Methoxyflurane or Isoflurane is placed together with the animal into a glass tank, and when the snake is sleeping, it is pulled into a plastic tube which is plugged at one end by a cotton with anaesthetics. Inhalation during the operation can be controlled simply by removing the cotton plug when necessary.

For implantation of the radio transmitter we have also successfully used Halothane as an inhalation agent. In our experiments (Újvári & Korsós 1997, Újvári *et al.* 1999) we used a proper anaesthetic equipment appeared in human and veterinary medical treatment. It was a little bit modified for snakes, i. e. instead of the inhalation mask used for large mammals, a thin rubber membrane was placed at the end of the inhalation pipe with a narrow hole in it. The head of the small sized Meadow viper (*Vipera ursinii rakosiensis*) was placed here until anaesthesia took effect. At the beginning of the operation pure Halothane, later a mixture of Halothane and oxygen was given, the ratio depending on the status of the animal. The inhalation pipe was transparent for the continuous control of the snake. The operation (implantation of a radio transmitter) lasted about 20 minutes, and following the fixation of the wound the snake woke up almost immediately due to the pure oxygen given. The technique also worked well with the common Grass snake (*Natrix natrix*) (Nagy & Korsós 1999).

Injectable agents – The cumbrous application of ether and chloroform in the 1950s was replaced by three other injectable agents Pentothal sodium, Nembutal and MS-222 (Karlstrom & Sherburne 1955). They were introduced into the organism in exact doses, and all three were found to be uniformly effective in 26 individuals of 7 snake species. Betz (1962) tested two agents (Nembutal and Surital) in 18 specimens of *Natrix rhombifera* and found them to be equally effective, although the heartbeat rhythm of the animals in anaesthesia with Surital was a little lower. Reinert and Cundall (1982) reported that in their experiments when using only MS-222 they found 7–17% mortality due to the stop of heart after the injection of the agent.

Inhalation + injectable agents – Hackenbrock and Finster (1963) were the first to recommend that Fluothane can be used as a preparative anaesthetics for longer anaesthesia with Nembutal or other agent. Reinert and Cundall (1982) used the combination of 125–300 mg/kg M. S. 222 intraperitoneal injection and inhalation of Halothane to immobilise *Crotalus horridus* and *Agkistrodon contortrix*. The method was tried in 55 cases on 38 specimens of snakes without a single case of mortality.

Cold immobilisation and local anaesthesia – It is a widespread method to cool the snakes before anaesthesia, because it makes the handling of animals easier. Weatherhead and Anderka (1984) put the snakes into a refrigerator of 5°C for 45 minutes before injecting the agent (80 mg/kg Ketaset) intramuscularly in four different parts of the body. When anaesthesia took effect they placed the snakes back into the fridge for another 15 minutes just before the operation. Naulleau (1987) also placed his animals (Aesculapian snakes, *Elaphe longissima*) into 5°C refrigerator for one hour before injecting the local anaesthetics (2% Hostacin or Laocaine S2). After 15–20 minutes the operation was started. MADSEN (1984), however, reported unsuccessful cooling in Grass snakes (*Natrix natrix*), which reacted vividly even at +1°C to the pinprick. Thirty minutes before the operation (implantation of a radio transmitter) he used the intrapleuroperitoneal injection of Ketalar (100 mg/kg) and Rompun (20 mg/kg), then Xylocaine (lidocaine chloride) as local anaesthetics (16 mg/kg) during the operation.

Control of anaesthesia and summary – The work of BETZ (1962) initiated a new period in the anaesthesia of reptiles. He gave a comprehensive summary of the effects of the different agents, and also evaluated for the first time the behavioural criteria of the control of anaesthesia. It was already known by earlier authors (BRAZENOR & KAYE 1953, KAPLAN & TAYLOR 1957, KARLSTROM & COOK 1955, TAIT 1938) that the lack of certain spontane movements, like the tongue reflex, or of the reaction to external stimuli, like the tail reflex, are signs of deep anaesthesia. During inhalation of ether, spinal reflexes were used for control, but this has its disadvantages as mentioned earlier. According to BETZ (1962) it is enough to get an anaesthesia until the tail reflex disappear, the lack of tongue movements is a sign of a deeper influence, which is not necessary. MADSEN (1984) had an opposite opinion: he immobilised the snakes with the injection of Ketalar (100 mg/kg) and Rompun (20 mg/kg), when the tongue reflex had already disappeared the tail reflex was still present. In order to avoid overdosis later he only used local anaesthetics (Xylocaine 16 mg/kg).

Among the inhalable anaesthetics ether is inflammable, chloroform is cardiotoxic and inhibits liver and bile function. It proved to be carcinogen in human medicine, too. Halothane and Methoxyflurane are four to eight times more effective than chloroform and ether, and furthermore, they do not irritate the respiratory system. They are the most recommended agents in herpetological anaesthesia (AIRD 1978). There is a good summary on reptile anaesthesia by MCDONALD (1976).

During the implantation of transmitters into snakes we recommend the application of Halothane as an inhalable agent and the use of a proper anaesthetic equipment. It has the disadvantage of being bound to a veterinary hospital, but the possibility of the control during the whole operation puts it in balance. You have to keep in mind, however, that all the anaesthetic agents have the danger that in case of overdosis there is no antidote against them (BETZ 1962).

Control following implantation

It is necessary to devote a several day observation period to study the animal after the surgical operation. The length of the period depends on the implantation and immobilisation technique used, but it should last at least 1–2 days to establish safely the recovery of the specimen. It is recommended to monitor continuously the snake's behaviour in a terrarium, give warmth and drink as necessary. It may take as long as two days to recover from the deep unconsciousness for a surgically operated snake (MADSEN 1984). In the case of animals force-fed with radio transmitters, release and data collection can follow immediately the intervention.

LOCATION AND OTHER RESULTS

The snakes, depending on the type of the habitat, can be radio tracked by walking or from a boat, in the case of aquatic species (SHINE & LAMBECK 1985, TIEBOUT & CARY 1987). Car and aerial tracking is usually out of question, even in the case of large snakes, since their movement rarely reaches the magnitude of kilometres, which is still easily covered by walking. In most studies the relative undisturbance of the animals is a primary consideration, which can be tested against sudden movement (escaping), or long hiding. Ideally, the purpose is to locate the snake's position without its perception. This, of course, can change by species and environmental conditions. In a study by TIEBOUT and CARY (1987), the position could be identified by 0.5 metre precision from a distance of 3–6 metres without actually seeing the animal.

Direct tracking

In this case the observer follows the strongest radio signal until the animal eventually can be seen and found. This technique is primarily used when the habitat terrain does not allow remote sensing and the researcher has no idea where to search for the snake and hence location starts from a large distance. Direct tracking can support detailed visual behavioural and/or ecological observations, when the disturbance of the animal is not so important.

Triangulation

Triangulation is based on signal search from two or three more-or-less rectangular directions. First the exact direction of the strongest signal is determined and then the point of intersection gives the locality of the transmitting animal. Since handhold antennas used for radiotracking snakes have an accuracy of ca 5 degrees, the estimated locality of the animal is actually not a point but a small area identified by the overlap of the sensing strips (error polygon). TIEBOUT and CARY (1987) recorded the localities with 0.5 metre bias and calculated the size of activity range later from the map. Movement between two consecutive measurements was compared to the side of the error polygon: if the first was smaller, then the movement was considered zero, because it could not be decided whether it actually happened or it was the error of the method. With this concept, unfortunately, the relatively small daily movements are almost impossible to track.

Actual location of a snake with a radio transmitter is usually the result of the combination of the two methods: direct tracking and triangulation. Search is started far away with a handhold Yagi antenna, where triangulation is usually inapplicable because of the large distance and the shadow effects of the terrain. The error polygon would also be too large and even two rectangular measuring points are too remote from each other to walk. Exact direction determination is difficult. Approaching to the locality the signal is strengthening, and the triangulation method becomes easier. From a closer distance the Yagi antenna becomes clumsy, and precise location is impossible because the signal comes from everywhere with the same strength. A small loop antenna can help in this case, and the snake with the transmitter can be found step by step, almost centimetre by centimetre. If so exact location is not necessary, the square metre that the snake occupies is easily determined without disturbing the animal (LANDRETH 1973, ÚJVÁRI & KORSÓS 1997).

Frequency of observations is adjusted to the aim of the study, and the seasonal and daily activity dynamics of the snake in focus. Data should cover the whole study period and also should be frequent enough to describe the movements of the animals, taken densely and in relatively equal intervals. Examples show measurements in every 48 hours, week, or two weeks (REINERT *et al.* 1984). Daily activity can be sampled by every hour, two or six hours, or continuously 24 hours long. Locations in every hour are, in our opinion, extremely disturbing and hence to be avoided, since this could result in permanent escape or shelter of the snakes. Vipers need at least two hours after disturbance to retain their original behaviour (ÚJVÁRI & KORSÓS 1997). The shorter the interval between two locations, the more likely the subsequent one is influenced by the previous one. Frequency of the observations should therefore be selected according to the independence of data. Several formulae were developed in order to test independence of data (see WHITE & GARROTT 1992 for more details).

Movements and home range

Development of research technology in radiotelemetry of snakes was accompanied by forming a conceptual system for the description of their activity. There are numerous definitions in the literature describing the range of animal movements. MOHR and STUMPF (1966) considered the terms home region, home range, home area to be synonymous when individuals remain around, and use a home more than 24 hours. In their opinion the territories make part of the home range, some apparently fill out the entire home range and others consist of small areas within the home range. The home range of snakes and movements within it were first reported by BROWN and PARKER (1976). Snake movements perceived as seasonal pulses away from hibernaculum each spring and toward it each fall (TIEBOUT & CARY 1987) was given the term total range (HAMILTON *et al.* 1967, HIRTH *et al.* 1969, TIEBOUT & CARY 1987). ROSE (1982) in her review of lizard home ranges extended the term to the whole area where an individual occurred. HAYNE (1949) differentiated the points with the highest activity as the home site. MOORE (1978) introduces the term core area for practically the same concept. DIXON and CHAPMAN (1980) defined the centre of activity as the geographical location within the home range which has the points of greatest activity.

The background of the movements between two consecutive locations (reasons, dynamics, etc.), i.e. the pattern of activity was first dealt by TIEBOUT and CARY (1987). Radiotelemetry is a useful tool to identify other information than movements of snakes: habitat and substrate preference, hibernation sites, movement frequencies, and reasons for moving. When identifying an exact place where a particular snake specimen is staying, plenty of other ecological and behavioural observations can be gained.

Behaviour, prey utilisation

Especially with direct tracking, radiotelemetry gives an opportunity to observe the behaviour of the snake. Details of feeding, such as sit and wait or active foraging strategies, sheltering, shedding, courting, copulation, etc. can be collected. The food of the snakes can be identified by excrement analysis during the active intervention (transmitter implantation, battery change) or in the field, based on insect chitin cuticle, mammal hair or bone remnants (REINERT *et al.* 1984). There are a number of peculiar environmental conditions, when the behavioural aspects of the given species can hardly be studied in any other way than radiotelemetry. For example the investigation of the behaviour of the aquatic arafura filesnake (*Acrochordus arafurae*) was almost impossible because of the muddy water full with crocodiles. Its daily activity, including temperature regulation, was only available for study by the technique of radiotelemetry (SHINE & LAMBECK 1985).

Orientation

Although radiotelemetry could be a useful tool in the study of orientation of snakes, relatively few research has been devoted to it. BROWN and PARKER (1976), for instance, have observed that specimens of *Coluber constrictor*, when returning to their hibernation site, have used the same route every year in the two-third of their journey. LANDRETH (1973) built a large outdoor test arena and found that rattlesnakes (*Crotalus atrox*) use the solar cues in orientation.

Habitat preference

Radio tracking of snakes can be useful in determining their habitat and substrate choice, which is an important factor in their ecology. TIEBOUT and CARY (1987) suggest two different statistical methods for calculation: proportional similarity index (PSI) and the well-known Chi-square test.

Hibernation

There are several examples showing that snakes frequently use a common hibernation site, sometimes years after years (ALEKSIUK 1976, BURGER *et al.* 1988, JACOB & PAINTER 1980). If tracking a specimen supplied with radio transmitter is successful until it finds the hibernation site, actually the wintering den of the whole population can be found. CIOFI and CHELAZZI (1991) found that specimens of *Coluber viridiflavus* are faithful to their hibernation sites and return to it not only every autumn, but also for hiding in their active period.

BIOTELEMETRY

Biotelemetric studies are aimed at studying various physiological, ecological and behavioural parameters. In the first period of using biotelemetry, implanted radio transmitters provided data on the temperature relationship of the digestion of snakes. Naulleau (1979) gave a good summary on the beginning and development of the investigation of temperature regulation. Before the advent of radiotelemetry, quick-recording mercury thermometers were put into the cloaca of snakes and the body temperature of snakes was measured during different activities (Kitchell 1969). In this way continuous temperature regulation is difficult to follow, since measurements are interrupted and always go together with the disturbance of the behaviour. Later the thermosonda (telethermometer) was invented but it considerably restricts the animal's activity, too (Regal 1966, Spellerberg & Phelps 1975).

Invention of radiotelemetry made possible for the first time to monitor the animals without actually disturbing them. The technique was introduced by McGinnis (1967) in the USA, and was later widely applied to turtle, lizard and snake species around the world. The first biotelemetric transmitters were force-fed together with the food or on its own, hence placed in the intestinal system (McGinnis & Moore 1969, Naulleau 1979, Naulleau & Marques 1973). Later the position of the implantation was influenced by the study purpose: whether to measure temperature dynamics of digestion, hibernation or environmental effects.

Planning a biotelemetric study

Measuring can be done in several different ways. In laboratory a short range receiver is enough, and measurements can be taken automatically or by hand at regular intervals. In the field usually long distance receivers are needed, and automatic data collection is more costly. If finances or safety conditions do not allow automatic data processing, an omnidirectional whip antenna or a hand-held Yagi antenna can do a good service for manual signal recording. In both cases the main purpose is to not disturb the animals' natural activity.

The principle of most temperature sensitive transmitters is to give signals at different pulse rates according to the change of temperature. A calibration diagram is usually provided by the manufacturer to identify the proper temperature from the regular time length (in milliseconds) between the individual signals. The degree of deviation is generally not more than 2°C. A simple receiver cannot directly show the intersignal period, in this case counting the number of signals during a certain time interval (e. g. 10 seconds) can help to calculate it. Modern transmitters display the intersignal period in milliseconds. To understand the body temperature changes of the snake, it is recommended to monitor continuously the ambient environmental factors like soil, air and vegetation temperature, light or radiation intensity, wind speed, etc.).

Frequency of recording is usually determined by the environmental factors and the study conditions. NAULLEAU and MARQUES (1973) e. g. made notes in every 5 minutes when the temperature change was faster and in every 15 minutes if it slowed down. LILLYWHITE (1980) adjusted the measuring intervals to an average of 20 minutes, but sometimes faster or slower, according to the daily activities of five Australian snake species. We have found that a measurement in every hour during a 24 hours period is quite appropriate to record the activity pattern of a temperate species. Automatic systems can be adjusted to any desired recording interval. Data processors built into the receiver can record temperature measurements for a long time (depending on battery life) and data may be transmitted into a computer weekly.

Terminology

Parallel with the development of biotelemetry a set of special expressions became also widespread among researchers. NAULLEAU (1987*a*) proposed six values of body temperature which are effected by the ambient temperature: (1) lethal minimum is the temperature when a snake dies, (2) critical minimum when its movement is blocked, (3) temporarily tolerable minimum induces the snake to stay in its shelter, (4) preferred temperature is what the snake actively chooses to regulate its own body, (5) temporarily tolerable maximum can be tolerated for a short time, but the snake searches for another place if it is possible, (6) critical maximum which is too hot to tolerate even for short period and the snake is paralysed, unable to move, and dies soon. LILLYWHITE (1980) suggested two factors to identify critical minimum temperature: (1) inability of the animal to right itself or to twist the body when turned ventral side up, and (2) the cessation of tongue flicks. The snakes were put on ice rocks and kept cool as long as both criteria fulfilled.

MOORE (1978) determined the temperature categories on the basis of the snakes' daily activity pattern. Preferred temperature (PT) was defined as the mean of all body temperatures recorded within the normal activity period, it represents the mean voluntary temperature of an active individual. Voluntary minimum (Vmin) was defined as the lowest body temperature recorded in an active individual; whereas voluntary maximum (Vmax) was the same at the higher end. Hence the relationship between the three is obvious: normal activity range (NAR) is the range of body temperatures of active individuals from voluntary minimum to voluntary maximum temperatures.

Biotelemetry is often connected to the observations on movements, home ranges, territories or hibernation sites of the snakes. However, with biotelemetry temperature sensing is always in focus, which can give hints on the mobility as well. Night movements, for example, are sometimes indicated by temperature change, and activity at night can be determined by the varying strength of the transmitter signal being received as the snakes crawled from one place to another (MOORE 1978).

DATA EVALUATION AND ANALYSIS

To determine the home range or range of activity of a snake many factors should be taken into consideration already at the planning stage of a study. The first and perhaps the most important is the sampling frequency. It is extremely important to gain even information from the different activity periods of the animal, selecting an appropriate sampling interval can be crucial to the success of the investigation. There is a conflict between the number of individual observations, which should be as dense and as many as possible, and the disturbance of the snake's behaviour, which should be, on the other hand, as low as possible. The length of a sampling procedure should be relatively short, but enough to collect the maximum information about the given locality. With the increasing number of observations the size of the home range and the accuracy of its estimation is generally increasing, too. Sampling frequency should differ in the breeding period, before, after and during hibernation and in other relatively passive periods. Range of activity is a function of the size, age and sex of the specimen as well as of its feeding, shedding and other behavioural or social habits. Individual movements of males are usually larger than that of the females, and in copulation time it can even exceed their energetic requirements. Juvenile snakes have usually smaller home ranges than the adults, which is the result of the sexual and intraspecific interactions of the latter. It was observed in the case of lizards (ROSE 1982), that males have extended their home ranges after sexual maturity to meet more females, which, on the other hand, occupy overlapping areas. The size of the home range may also depend on the density of the population, as an antagonistic relation. Home range size should be regarded also dynamically, a given individual can change its range of activity according to the presence or absence of conspecific competitors, lack of food, changing environmental conditions, etc.

It is important to make a difference between the error of measurement and the real movement of the animal. WHITE and GARROTT (1990) considered only differences larger than 5 metres as sign of activity. Sampling frequency depends on species and habitats, so it should be defined a priori by the researcher. As a starting point, one could consult the work of MACCARTNEY *et al.* (1988), who published home range measurement methods of 40 snake species beginning from the fifties.

Trackogram

This is the simplest and most recommended method in the case of relatively few data collected at constant frequency during a short period. Estimation of exact home range size is difficult, but daily movements and activity pattern is easy to follow. The technique is made up of putting the different locations on the map and simply connecting them in time sequence (FUISZ 1995, SZEMETHY 1995).

Polygon methods

Convex polygon – This method is based on the work by JENNRICH and TURNER (1969) who drew the smallest convex polygon containing all of the capture points. Locations are described in a two-dimensional co-ordinate system, in which the convex polygon also appears when connecting all the outermost points (ROSE 1982). The disadvantage of the method is that it takes into consideration all locations regardless their possible biological meanings, and that it does not differentiate between points with various capture probabilities. The area of the polygon is an estimate for the home range size, and can be calculated with co-ordinate geometrical formula (see WHITE & GARROTT, 1990), or manually by dissecting into triangles.

The advantage of the convex polygon technique is that it has historical prominence, graphical simplicity, and exhibits reasonably good statistical stability (JENNRICH & TURNER 1969). WHITE and GARROTT (1990) added flexibility of shape as an advantage, too. There are relatively many drawbacks, on the other hand, brought up in the literature. In addition to the two mentioned above, the main problem is that the estimated size of the polygon depends largely on the number of observations. Increasing sampling frequency extends the home range size, which is not in accordance with the biological meaning. Estimation does not only consider regular movements, but the whole area covered by locations, so the polygon includes areas that were actually not visited by the animal. Reasons why certain points are far from the "core" area cannot be revealed with this method.

To decrease bias resulting from the number of superfluous observations the 95% convex polygon method was introduced, which simply means that locations contributing mostly to the undesired increase of the area are left out from the calculation. The limit is drawn at 5% of all the capture points. Knowledge on the ecology of the given species can also support certain type of selections when the estimating the home range of the aquatic *Acrochordus arafurae* by the convex polygon method, terrestrial habitats inside the polygon were left out for the snake never goes onto the dryland (SHINE & LAMBECK 1985).

MADSEN (1984) calculated home ranges by two different ways using convex polygons. Total home range was defined by summarising all locations during the tracking period, while combined home range was got by adding the areas observed during the activity periods in each month.

Minimum polygon – Minimum polygon or minimum area method differs from convex polygon by restricting the connection of capture points to the more frequently repeated observations. Rarely (once) used points of occurrence are excluded from the polygon and hence the estimated area is much smaller than in the case of convex polygon. The advantage of this method that it is less dependent on the number of locations. Graphical evaluation is also easier, since it becomes geometrically difficult as the number of capture points increases. Algebraic evaluation is simple (JENNRICH & TURNER 1969). A drawback of the technique that the area drawn is less accurate and its shape is largely affected by the sequence of the observations (ROSE 1982). With a great number of locations several different minimum polygons can be figured (JENNRICH & TURNER 1969). Statistical stability of the method is weak, and, according to JENNRICH and TURNER (1969), it was not described precisely originally. The technique was adopted by FITCH and SHIRER (1971) and CIOFI and CHELAZZI (1991), among others.

Parametric statistic estimates

This family of methods uses the probability density function, which calculates statistical parameters of an assumed distribution of the actual observations (ROSE 1982). Home range size estimation depends on the statistical methods applied.

Recapture radius – The distribution of the locations is approximated by the normal (Gauss) distribution. First the geometric centre is defined by averaging all point co-ordinates, then the distance of every point from the centre is calculated. The average of these distances is taken as a radius of the estimated home range. The recapture radius method gives usually slightly bigger area than the convex polygon method. Estimations can disperse very much if the shape of the actual home range is far from a circle. Individual variations may also destroy the accuracy of the radius method. Several authors recommend the determinant method instead (JENNRICH & TURNER 1969, ROSE 1982).

Bivariate normal models – It is true for all of the home range estimation methods that the randomness of observations is assumed. It is also true in the majority of cases, that the capture probability of the specimen in the geographical middle of its activity range is supposed to be higher than in the peripheries.

In order to avoid the bias of the previous methods JENNRICH and TURNER (1969) invented the determinant estimator which is based on the radius method but using covariant matrix. The method is also called JENNRICH-TURNER estimator (WHITE & GARROTT 1990), or confidence ellipse method (REINERT 1992). It operates with a bivariate normal distribution and allows an elliptic home range shape, too. The size of the activity range is determined by a certain confidence interval, within which the occurrence of the animal has a high probability value. For the ultimate calculations see JENNRICH and TURNER (1969) or WHITE and GARROTT (1990). The main advantage of the method that it does not depend on the sample size, so different results can easily be compared. Its drawback, however, that for a reliable estimation relatively high number of observations is needed. At 20% covariance level the minimum is 100 samples (WHITE & GARROTT 1990).

The weighted bivariate normal estimator is an improved JENNRICH-TURNER estimator. The difference lies in the weighting procedure of all data by the distance from the average centre.

Non-parametric approaches – Grid methods

With the non-parametric methods the normal distribution of data is not a condition and they do not have a demand for minimal data set. Apart from the following two, there are several other parametric and non-parametric methods such as multiple ellipses, Dunn estimator, Fourier series smoothing, etc. (WHITE & GARROTT 1990), but because of their rare applications we do not go into details with these procedures.

Grid cell – The size of the activity range is determined with the help of a grid covering the observed area. Grid cell size is calculated with the average distance between consecutive locations, sometimes adjusted by the size of the study area. Home range estimation is made by including cells that have at least one occurrence. The area obtained may be a concave polygon, but it may also consist of several disjunct forms. If relative frequencies of the occurrences are also considered, the use of the different parts of the home range can also be estimated ("core areas"). The overlap in time and space between different individuals of the same population is easy to follow and depict. Using background information, such as vegetation maps habitat preferences can also be investigated.

Harmonic mean – The method was invented by DIXON and CHAPMAN (1980). In herpetology, it is perhaps the most widespread for estimating the area used by reptiles (REINERT & ZAPPALORTI 1988, SECOR 1994, TIEBOUT & CARY 1987). The calculation starts again with fitting a grid to the study area. Distances of every localities from all grid corners are measured, then the localities are categorised according to the harmonic mean values of these distances. Points in the same category are connected and form an isopleth. The isopleths delimit areas used with equal probabilities by the animal (REINERT & ZAPPALORTI 1988).

Summary of data evaluation

Summarising the different home range size estimation methods described above, the convex polygon can be recommended in most cases where sample size is reasonably high (ROSE 1982). Its main disadvantage is that the size of the estimated area increases with the sample size. From the statistical methods grid cell and harmonic mean are the most widespread (REINERT *et al.* 1984). The advantage of the grid cell method is that it gives information on the locations that are the result of accidental movements and occupy peripheral places. It is also suitable for analysing overlapping patterns and habitat preferences. Its drawback lies in the dependence on the realisation. Harmonic mean calculates only with the areas really occupied by the animal and can represent home ranges of any kind of shape. The areas limited by the isopleths are determined by the intensity of the activity. Selecting the different isopleths, different home range parts can be defined: 95% isopleths to represent total home range or total activity range, 50% isopleths to represent a core area, or area of most intense use, 75% intermediate range can be calculated for comparative purposes. The core areas represent on average only about 7.7–9% of the total home range size (REINERT & CUNDALL 1982, REINERT & ZAPPALORTI 1988, SECOR 1994, TIEBOUT & CARY 1987). The harmonic mean is also well-suited to time-series analysis used to detect shifts in activity centres (TIEBOUT & CARY 1987). SECOR (1994) compared convex polygon and harmonic mean methods and has found several hectares difference to the advantage of the former.

With the development of computer programs a PC software package was made for estimating home range sizes with minimum convex polygon and harmonic mean methods (Micro-computer Programs for the Analysis of Animal Locations – McPAAL Ver. 1.21, Michael Stuwe, National Zoological Park of the Smithsonian Institution, Front Royal, Virginia).

RADIOTELEMETRY OF VIPERA URSINII RAKOSIENSIS: A CASE-STUDY

The main problem with radiotracking small sized vipers is to select an appropriate transmitter. If temperature sensing is a demand (as usual) then a transmitter with reasonably long lifespan (13–20 weeks) weights 2–2.2 g and measures 15–18 × 6–9 mm. Transmitters smaller than this have short (11 weeks) or very short (3 weeks) lifespan that makes them less useful for ecological studies. The conflict between the transmitter size and the length of the observation often ends in a compromise to decrease the study period.

Force-fed transmitter is not an option in the case of the small grassland vipers since they feed mainly on insects. CIOFI and CHELAZZI (1991) recommend their external attaching method, which is good when one has to replace the battery or repair the transmitter, but we have reservations with the drastic way of fixing the device to the vertebral column with a plastic thread. Even if it is only on the tail, it can cause serious troubles to the snake when moving between the dense tussocks in the grass and stays open to infection due to the permanent movement.

In our opinion the best method to attach a transmitter is the subcutaneous implantation. For immobilisation during surgery we recommend halothane anaesthesia using a professional respiration machine. With the machine respiration can be regulated and anaesthesia maintained at the edge of cessation of tongue flicks. With the proper dose of the narcotic and the oxygen the risk can be minimised and awakening shortened only to several minutes. Despite this, indoor control of the vipers in the following one or two days is always necessary.

Before selecting a transmitter for implantation it is wise to ask information about the size, lifespan, and effective range from the manufacturers on the market. Although companies can come and go, a useful selection of present manufacturers can be found in Table 1 of this paper. If it is possible, a trial of a sample transmitter could also be extremely beneficial in the choice of the different trademarks.

In our study we selected the transmitters produced by Holohil Systems Ltd. Ontario, Canada (type BD-2GT) to study the movements and temperature relationships of the Hungarian Meadow viper (*Vipera ursinii rakosiensis*) (ÚJVÁRI & KORSÓS 1997, 1999, ÚJVÁRI *et al.* 1999). The temperature sensitive transmitters weighted 2 g, with a length of 16 mm, width of 9 mm, emitting frequency around 152 MHz. Their life span was announced to be around 7–8 months, depending on the environmental temperature. Average body mass of the vipers is about 40 g, length 35–40 cm. A transmitter which was implanted subcutaneously made up to 4% of the body mass of the snake.

About one month after the implantation, the antenna wires of the transmitters pierced the skin of the snakes. In one specimen a loop came out where the wire was originally threaded, in the other the end of the wire pierced the cuticle. The antennas were put back into the animals and the openings were fixed with surgical tapes. Another one month later the animals were in proper conditions regarding the implanted transmitters. Later one transmitter was found on its own on the ground (it was probably pushed out of the animal). The other gave normal signals 4.5 months after the implantation, but then suddenly indicated unbelievable high body temperatures and stopped to function in the next week. We have lost both the animals and the transmitter inside. Another female viper received a switchable transmitter from the same set ordered from Holohil in 1995, but stopped to function in only 1.5 month. Our inquiries both about the wire rigidity and the expected lifespan remain unresponded by the manufacturer.

The signals of the transmitters in the field were received by a two- or three-element Yagi antenna, a handy loop antenna and a simple radio receiver apparatus. For biotelemetric purposes more advanced receivers (with built-in data processor) and an omnidirectional whip antenna can also be useful. Small grassland vipers are sit and wait predators (FARRELL *et al.* 1995) and have a relatively small activity range. They usually spend a lot of time in or near a rodent hole or a grass tussock. Their regular movements hardly exceeds several metres at once, but time to time they may move a larger distance (a couple of hundred metres) to find another suitable hunting area and shelter (CIOFI & CHELAZZI 1991, NAULLEAU 1989, ÚJVÁRI & KORSÓS 1997). A Yagi antenna for the remote search and a loop for more accurate location seem to be satisfactory for a simple preliminary study.

It is very much recommended to compile a good map on the study area or even combine it with a vegetation map with precise borders of the different plant associations (grasslands may have extremely important vegetation microstructure which is hard to identify and describe without the help of a botanist!). With the aid of a good map we can immediately determine our position (and that of the viper) in our co-ordinate (or other reference) system.

Measurements (locations) can be more frequent (say every second day) in the higher activity periods (after and before hibernation, during copulation, birth, etc.), and relatively scarce (once every week) in the more passive periods (summer "aestivation", shedding, digestion, etc.). The habitat of the Hungarian meadow viper is altogether only several hectares, so locations were taken every week not to disturb the animals. Successful locations were marked with a pole and next time search could be started from that point. To record their daily activity and temperature regulation, we conducted several 24–hour long continuous monitoring, when locations were omitted, only body temperatures by remote sensing were collected in every hour. During fast changes (early morning and late afternoon) half an hour or even more frequent recordings are recommended. During the day or especially at night, on the other hand, the temperature of the vipers is relatively stable or only oscillates around a certain point, so two hours recording intervals may prove to be adequate. Sudden but in their extent small temperature changes, however, can indicate movements like sheltering in a hole, so "stability" should always be handled carefully.

Evaluation of the data collected depends on the sample size, observation frequency and the aim of the study. In a poorly known species even few data and the compilation of a simple trackogram can provide many useful and new information (see more details: ÚJVÁRI & KORSÓS 1997, 1999, ÚJVÁRI *et al.* 1999). For home range analysis with more locations we recommend the harmonic mean method. Biotelemetric data (i. e. temperature regulation) should be evaluated in connection with the environmental factors.

Summarising all the information available for us from the literature and from our own experiences, we can conclude that radiotelemetry is an extremely useful method in the ecological study of snakes. In the case of large species it is very useful to follow their movements, to describe the seasonal and daily activity patterns, estimating home range dynamics, and many other ecological and behavioural aspects. In small snakes its applicability is limited to a certain degree by the size of the transmitter, but the method can still provide extremely useful and missing information on the biology of the animals, which otherwise would almost be impossible to study.

*

Acknowledgements – We are grateful to Dr. GÖRAN NILSON (Göteborg, Sweden), BALÁZS FARKAS (Budapest, Hungary) and GERGELY BABOCSAY (Jerusalem, Israel) who made improvements in earlier versions of this manuscript. The preparation of the paper was financially supported by the Hungarian National Scientific Research Fund (OTKA Nos 16608, 23454), by the SOROS Fund (No. 230/1/821), and by the "A Magyar Tudományért" fund of the Hungarian Credit Bank.

REFERENCES

AIRD, S. D. (1986) Methoxyflurane anesthesia in Crotalus: comparisons with other gas anesthetics. *Herpetological Review* **17**(4): 82–84.

ALEKSIUK, M. (1976) Reptilian hibernation: evidence of adaptive strategies in Thamnophis sirtalis parietalis. *Copeia* **1976**(1): 170–178.

AUDET, D. & THOMAS, D. W. (1996) Evaluation of the accuracy of body temperature measurement using external radio transmitters. *Can. J. Zool.* **74**: 1778–1781.

BETZ, T. W. (1962) Surgical anesthesia in reptiles, with special reference to the water snake, Natrix rhombifera. *Copeia* **1962**(2): 284–287.

BRAZENOR, C. W. & KAYE, G. (1953) Anesthesia for reptiles. *Copeia* **1953**(3): 165–170.

BROWN, W. S. & PARKER, W. S. (1976) Movement ecology of Coluber constrictor near communal hibernacula. *Copeia* **1976**(2): 225–242.

CAFFREY, M., DOIG, V., GARBER, S. D., LAURO, B., MIKOVSKY, M., SAFINA, C. & SALIVA, J. (1988) Hibernacula and summer den sites of pine snakes (Pituophis melanoleucus) in the New Jersey Pine Barrens. *J. Herpetology* **22**(4): 425–433.

CIOFI, C. & CHELAZZI, G. (1991) Radiotracking of Coluber viridiflavus using external transmitters. *J. Herpetology* **25**(1): 37–40.

CLARK, H. (1937) Embryonic series in snakes. *Science* **85**: 569–570.

DIXON, K. R. & CHAPMAN, J. A. (1980) Harmonic mean measures of animal activity areas. *Ecology* **61**(5): 1040–1044.

FARRELL, T. M., MAY, P. G. & PILGRIM, M. A. (1995) Reproduction in the rattlesnake, Sistrurus miliarius barbouri, in Central Florida. *J. Herpetology* **29**(1): 21–27.

FITCH, H. S. & SHIRER, H. W.(1971) A radiotelemetric study of spatial relationships in some common snakes. *Copeia* **1971**(1): 118–128.

FLEURY, F. & NAULLEAU, G. (1987) Activité locomotrice de Vipera aspis L. (Reptilia, Viperidae) soumis a différentes thermopériodiques durant l'hivernage. *C. R. Acad. Sc., Paris* **3**(1): 304.

FUISZ, T. I. (1995) Rádiós nyomkövetés és biotelemetria használata az ornitológiában. [The use of radiotracking and radiotelemetry in ornithology.] *Ornis Hungarica* **5**: 33–64. [In Hungarian with English abstract]

GANS, C. (ed.) (1976) *Biology of the Reptilia, Vol. 5, Physiology A.* Academic Press, London, N.Y., San Francisco, pp. 43–53.

GENT, A. H. & SPELLERBERG, I. F. (1993) Movement rates of the smooth snake Coronella austriaca (Colubridae): A radio-telemetric study. *Herpetological Journal* **3**: 140–146.

GILMER, D. S., KUECHLE, V. B. & BALL, I. J., Jr. (1971) A device for monitoring radio-marked animals. *J. Wildlife Managment* **35**(4): 829–832.

HACKENBROCK, C. R. & FINSTER, M. (1963) Fluothane: a rapid and safe inhalation anesthetic for poisonous snakes. *Copeia* **1963**(2): 440–441.

HUEY, R. B., PETERSON, C. R., ARNOLD, S. J. & PORTER, W. P. (1989) Hot rocks and not-so-hot rocks: retreat-site selection by garter snakes and its thermal consequences. *Ecology* **70**(4): 931–944.

IKEDA, K. & OSHIMA, M. (1971) A wireless tracking system for behavioral studies of snakes. *The Snake* **3**:14–19. [In Japanese with English summary]

JACOB, J. S. & PAINTER, C. W. (1980) Overwinter thermal ecology of Crotalus viridis in the North-central Plains of New Mexico. *Copeia* **1980**(4): 799–805.

JENNRICH, R. I. & TURNER, F. B. (1969) Measurement of non-circular home ranges. *J. Theor. Biol.* **22**: 227–237.

KAPLAN, H. M. & TAYLOR, R. (1957) Anesthesia in turtles. *Herpetologia* **13**: 43–58.

KARLSTROM, E. L. & COOK, S. F. Jr. (1955) Notes on snake anesthesia. *Copeia* **1955** (1): 57–58.

KELLAWAY, C. H. (1937) The results of the excision of the venom glands of the Australian tiger snake (Notechis scutus). *Austr. Jour. Exper. Biol. & Med. Sci.* **15**: 212–230.

KEPHART, D. G. (1980) Inexpensive telemetry techniques for reptiles. *J. Herpetology* **14**(3): 285–290.

KITCHELL, J. F. (1969) Thermophilic and thermophobic responses of snakes in a thermal gradient. *Copeia* **1969**(1): 189–191.

LANDRETH, H. F. (1973) Orientation and behavior of the rattlesnake, Crotalus atrox. *Copeia* **1973**(1): 26–31.

LILLYWHITE, H. B. (1980) Behavioral thermoregulation in Australian elapid snakes. *Copeia* **1980**(3): 452–458.

LUTTELSCHMIDT, W. I. & REINERT, H. K. (1990) The effect of ingested transmitters upon the temperature preference of the northern water snake, Nerodia s. sipedon. *Herpetologica* **46**(1): 39–42.

MACARTNEY, J. M., GREGORY, P. T. & LARSEN, K. W. (1988) A tabular survey of data on movements and home ranges of snakes. *J. Herpetology* **22**: 61–73.

MADSEN, T. (1984) Movements, home range size and habitat use of radio-tracked grass snakes (Natrix natrix) in Southern Sweden. *Copeia* **1984**(3): 707–713.

MCDONALD, H. S. (1976) Methods for the physiological study of reptiles. Pp. 19–126. *In* GANS, C. & DAWSON, W. R. (eds): *Biology of the Reptiles, Vol. 5*, Academic Press, London.

MCGINNIS, S. M. & MOORE, R. G. (1969) Thermoregulation in the Boa constrictor. *Herpetologica* **25**(1): 38–45.

MCGINNIS, S. M. (1967) The adaptation of biotelemetry techniques to small reptiles. *Copeia* **1967**(2): 472–473.

MERTENS, D. (1994) Some aspects of thermoregulation and activity in free-ranging grass snakes (Natrix natrix L.). *Amphibia-Reptilia* **15**: 322–326.

MOHR, C. O. & STUMPF, W. A. (1966) Comparison of methods for calculating areas of animal activity. *J. Wildlife Management* **30**(2): 293–304.

MONTGOMERY, G. G. & RAND, A. S. (1978) Movements, body temperature and hunting strategy of a Boa constrictor. *Copeia* **1978**(3): 532–533.

MOORE, R. G. (1978) Seasonal and daily activity patterns and thermoregulation in the southwestern speckled rattlesnake (Crotalus mitchelli pyrrhus) and the Colorado desert sidewinder (Crotalus cerastes laterorepens). *Copeia* **1978**(3): 439–442.

NAGY, Z. T. & KORSÓS, Z. (1999): Data on movements and thermal biology of grass snake (Natrix natrix L.) using radiotelemetry. In MIAUD, C. & R. GUYÉTANT (eds): *Current studies in Herpetology, Le Bourget du Lac (SEH)*, pp.339–343.

NAULLEAU, G. & MARQUES, M. (1973) Étude biotélémetrique préliminaire de la thermorégulation de la digestion chez Vipera aspis. *C. R. Acad. Sci.* **276**: 3433–3436.

NAULLEAU, G. (1979) Étude biotélémetrique de la thermorégulation chez Vipera aspis (L.) elevée on conditions artificielles. *J. Herpetology* **13**(2): 203–208.

NAULLEAU, G. (1987) Étude biotélémetrique des déplacements et de la tempértature chez la couleuvre d'esculape, Elaphe longissima (Squamata, Colubridae) en zone forestiere. *Bull. Soc. Herp. Fr.* **52**: 45–53.

NAULLEAU, G. (1987*a*) Use of biotelemetry in the study of free ranging snakes: example of Elaphe longissima. *In* GELDER, J. J. VAN, STRIJBOSCH, H. & BERGERS (eds): *Proc. Fourth Ord. Gen. Meet. S. E. H., Nijmegen*, pp. 289–292.

NAULLEAU, G. (1987*b*) Les serpents de France. *Revue francaise d'aquariologie (herpetologie) Extrait*, 1984, 2. ed., **11**(3–4): 5.

NAULLEAU, G. (1989) Étude biotélémetrique des déplacements et de la température chez la couleuvre d'Esculape Elaphe longissima (Squamata, Colubridae) en zone forestiere. *Bull. Soc. Herp. Fr.* **52**: 45–53.

NULAND, G. J. VAN & CLAUS, P. F. H. (1981) The development of a radio tracking system for anuran species. *Amphibia-Reptilia* **2**: 107–116.

OLDERS, J. H. J., GELDER, J. J. VAN & KRAMMER, J. (1985) A thermo-sensitive transmitter for radio tracking small animals. *Netherlands J. Zool.* **35**(3): 479–485.

OLDHAM, R. S. & SWAN, M. J. S. (1992) Effects of ingested radio transmitters on Bufo bufo and Rana temporaria. *Herpetological J.* **2**: 82–85.

OSGOOD, D. W. (1970) Thermoregulation in water snakes studied by telemetry. *Copeia* **1970**(3): 568–571.

PARKER, W. S. & BROWN, W. S. (1972) Telemetric study of movements and oviposition of two female Masticophis t. taeniatus. *Copeia* **1972**(4): 892–895.

PETERSON, C. R. (1987) Daily variation in the body temperatures of free-ranging garter snakes. *Ecology* **68**(1): 160–169.

PLUMMER, M. V. & CONGDON, J. D. (1994) Radiotelemetric study of activity and movements of racers (Coluber constrictor) associated with a Carolina Bay in South Carolina. *Copeia* **1994**(1): 20–26.

PRIEDE, I. G. & SWIFT, S. M. (1992) *Wildlife telemetry: Remote monitoring and tracking of animals.* Ellis Horwood. Devon, UK.

REGAL, P. J. (1966): Thermophilic response following feeding in certain reptiles. *Copeia* **1966**(3): 588–590.

REINERT, H. K. & KODRICH, W. R. (1982) Movements and habitat utilization by the massasauga (Sistrurus catenatus catenatus). *J. Herpetology* **16**: 162–171.

REINERT, H. K. & CUNDALL, D. (1982) An improved surgical implantation method for radio-tracking snakes. *Copeia* **1982**(3): 702–705.

REINERT, H. K. & ZAPPALORTI, R. T. (1988) Timber rattlesnake (Crotalus horridus) of the Pine Barrens: their movement patterns and habitat preference. *Copeia* **1988**(4): 964–978.

REINERT, H. K., CUNDALL, D. & BUSHAR, L. M. (1984) Foraging behavior of the timber rattlesnake, Crotalus horridus. *Copeia* **1984**(4): 976–981.

REINERT, K. H. (1992) Radiotelemetric field studies of pitvipers: data acquisition and analysis. Pp. 185–197. *In* CAMPBELL, J. A. & BRODIE, E. D., Jr. (eds): *Biology of the pitvipers.* Tyler, Texas, Selva.

ROLAND, J., MCKINNON, G., BACKHOUSE, C. & TAYLOR, P. D. (1996) Even smaller radar tags on insects. *Nature* **381**: 6324.

ROSE, B. (1982) Lizard home ranges: methodology and functions. *J. Herpetology* **16**(3): 253–269.

SECOR, S. M. (1994) Ecological significance of movements and activity range for the sidewinder, Crotalus cerastes. *Copeia* **1994**(3): 631–645.

SHINE, R. & LAMBECK, R. (1985) A radiotelemetric study of movements, thermoregulation of Arafura filesnakes (Serpentes: Achrochordidae). *Herpetologica* **41**(3): 351–361.

SPELLERBERG, I. F. & PHELPS, T. E. (1975) Voluntary temperatures of the snake, Coronella austriaca. *Copeia* **1975**(1): 183–185.

SZEMETHY, L. (ed.) (1995) A rádiótelemetria alkalmazásának gyakorlati kérdései. [Practical questions in the use of radiotelemetry.] GATE, Gödöllő, 80 pp. [In Hungarian]

TAIT, J. (1928) Surgical removal of the poison glands of rattlesnakes. *Copeia* **1928**(1): 10–13.

TIEBOUT, H. M. & CARY, J. R. (1987) Dynamic spatial ecology of the water snake, Nerodia sipedon. *Copeia* **1987**(1): 1–18.

TOMKO, D. S. (1972) Telemetric study of movements and oviposition of two female Masticophis t. taeniatus. *Copeia* **1972**(4): 892–895.

ÚJVÁRI, B. & KORSÓS, Z. (1997) Thermoregulation and movements of radio-tracked Vipera ursinii rakosiensis in Hungary. Pp. 367–372. *In* BÖHME, W., BISCHOFF, W. & ZIEGLER, T. (eds): *Herpetologia Bonnensis.* Bonn (SEH).

ÚJVÁRI, B. & KORSÓS, Z. (1999): First observation in situ on the hibernation of the Hungarian Meadow Viper (Vipera ursinii rakosiensis). Pp. 435–438. *In* MIAUD C. & R. GUYÉTANT (eds): *Current studies in Herpetology*, Le Bourget du Lac (SEH).

ÚJVÁRI, B., SÁTORHELYI, T. & MEZŐSI, L. (1999) Kígyók altatása. *Magyar Állatorvosok Lapja* **121**(8): 482–486. [In Hungarian, with English summary]

WADA, Y., TANAKA, H., OGUMA, Y., SASA, M., IKEDA, K., MOTOI, E., KAWAI, J. & ONO, T. (1971) Radio-tracking of movement of habu, Trimeresurus flavoviridis. *The Snake* **3**: 20–23. [In Japanese with English summary]

WEATHERHEAD, P. J. & ANDERKA, F. W. (1984) An improved radio transmitter and implantation tecnhique for snakes. *J. Herpetology* **18** (3): 264–269.

WHITE, G. C. & GARROTT, R. A. (1990) *Analysis of wildlife radio-tracking data.* Academic Press, New York, 384 pp.

Revised version received 21st April, 2000, accepted 30th June, 2000, published 24th July, 2000

Acta Zoologica Academiae Scientiarum Hungaricae 46 (2), pp. 147–153, 2000

NEW ORIBATID MITES (ACARI: ORIBATIDA) OF THE GENERA PROTORIBATES AND PROTEREMAEUS FROM MONGOLIA

B. BAYARTOGTOKH

Department of Zoology, Faculty of Biology
National University of Mongolia, Ulaanbaatar 210646, Mongolia

Two new oribatid species, *Protoribates bayanicus* sp. n. and *Proteremaeus punctulatus* sp. n. are described from Central Mongolia.

Key words: *Protoribates*, *Proteremaeus*, new species, Mongolia

INTRODUCTION

BALOGH and BALOGH (1984) published a systematic design of the superfamily Oribatuloidea with a review of all known families and genera. Two new families (Xylobatidae and Protoribatidae) were established with the type genera *Xylobates* JACOT, 1929 and *Protoribates* BERLESE, 1908, respectively. Later, WEIGMANN *et al.* (1993) redescribed *Protoribates dentatus* (BERLESE, 1883), and redefined the genus *Protoribates*. They compared this genus with *Xylobates*. According to WEIGMANN *et al.* (1993) the last mentioned genus is a junior synonym of *Protoribates*. Also they did not recognize the familial status of either Xylobatidae or Protoribatidae, because these groups are not sufficiently differentiated from other families, such as Haplozetidae, Oribatulidae and Scheloribatidae. I have described below a new species from the dry steppe of Mongolia, which must belong to this genus according to the last mentioned authors' concept.

PIFFL (1965) established the genus *Proteremaeus*, of which the type species is *Proteremaeus jonasi* PIFFL, 1965. Subsequently, KRIVOLUTSKY and RYABININ (1975) established a genus *Sibiremaeus* with the type species *Sibiremaeus elongatus* RYABININ et KRIVOLUTSKY, 1975, from the Far East of Russia. BEHAN-PELLETIER & RYABININ (1991) compared this genus with *Proteremaeus* and they considered *Sibiremaeus* a junior synonym of the former genus. The genus *Proteremaeus* is a small group of oribatid mites with a total of eight species, which have been described from the northwest of Pakistan (HAMMER 1977, PIFFL 1965), Russian Far East (BEHAN-PELLETIER 1982, BEHAN-PELLETIER & RYABININ 1991, KRIVOLUTSKY & RYABININ 1975), and from Mongolia (GOLOSOVA 1983). I have found a new species from the Central Mongolia, which is described in the present paper.

All measurements are given in micrometers (µm). Average measurement is given in brackets after the range.

DESCRIPTIONS OF NEW SPECIES

Protoribates bayanicus sp. n.

(Figs 1–4)

Colour: Light brown.

Measurements. – Body length 316–363 (342), width 173–201 (184).

Prodorsum: Rostrum rounded; rostral setae arising laterally, smooth, extending beyond tip of rostrum and a little shorter than distance between their bases. Lamellar setae inserted a short distance medially to the anterior end of the lamellae (Fig. 3), subequal in length to *ro*, and about 1.8 times shorter than distance between their bases. Interlamellar setae also smooth, as long as rostral and lamellar setae, but slightly thicker than the former. Lamellae relatively long, reaching from the bothridial region over half the prodorsum. In their whole length they cover the lateral sides of the prodorsum. Sensillus bending toward posterolateral direction, bearing a lanceolate head, which has one arched margin, the other being almost straight (Figs 3–4); the proximal part the capitulum set with barbs and having an acuminate tip. Bothridium directed anterolaterad, its posterior part concealed under anterior margin of notogaster.

Notogaster: Shape of notogaster elongate oval, the ratio of notogastral length to width (excluding pteromorphae) being 1.46. The anterior margin is weakly arched medially. Whole surface of notogaster and prodorsum covered with very small irregularly scattered granules. Four pairs of areae porosae relatively small and rounded; area porosa A_3 located between notogastral setae p_1–p_1. Lyrifissure *im* fairly long, aligned nearly transversely and situated anterolaterally to area porosa A_1. A number of light spots arranged medially to area porosa *Aa*. Ten pairs of short and fine notogastral setae present. Numerous sigillae scattered along lateral margin of notogaster. Pteromorphae small, curved downward and movable on base (Fig. 1).

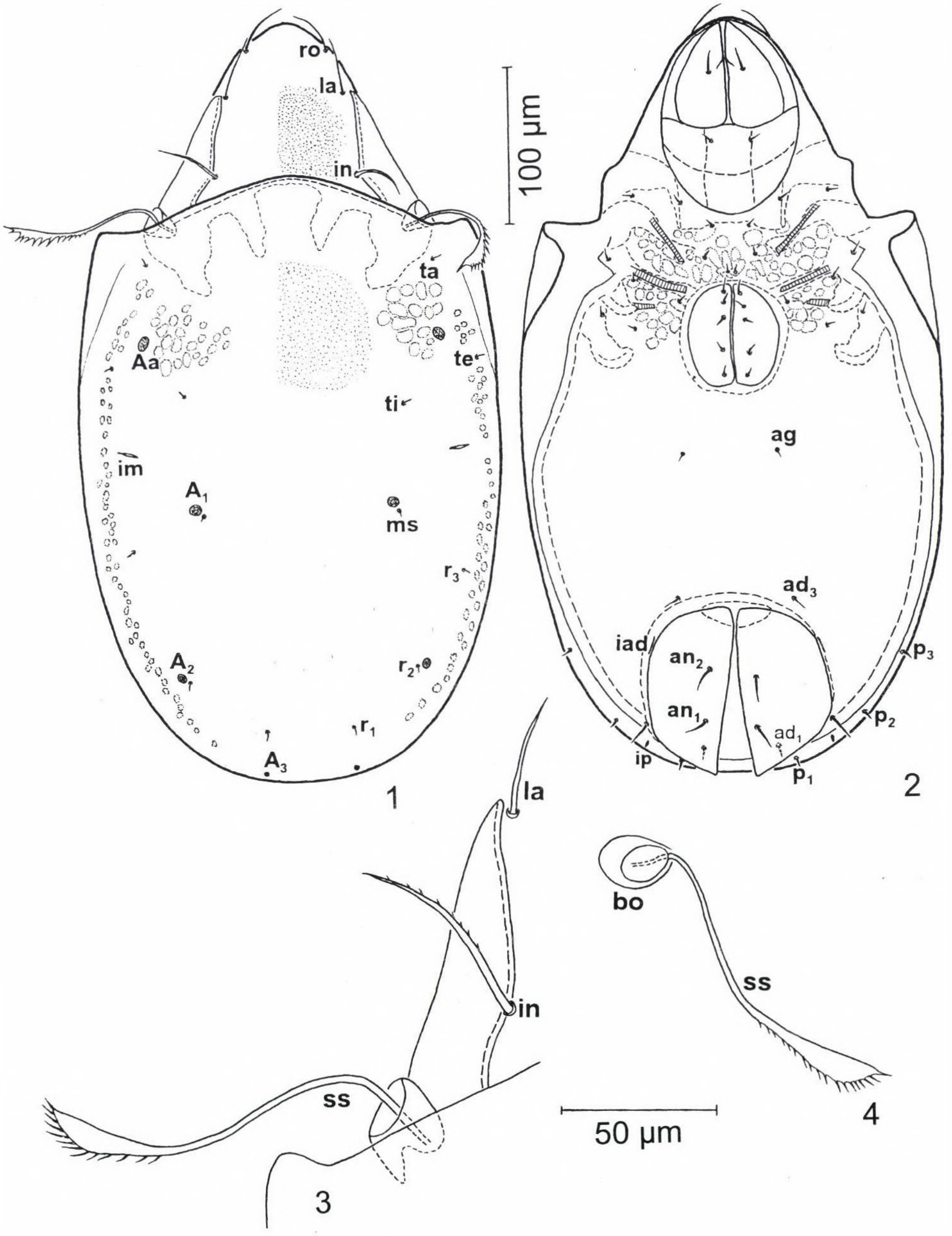
Epimeral region: Surface of epimeral region covered with irregularly spaced, round or oval sigillae. Apodemata *apo.2* and *apo.sj* well developed, aligned obliquely; *apo.3* short, aligned transversely. Epimeral setal formula 3:1:3:3, all setae very short and fine.

Ano-genital region: Genital aperture oval, longer than wide; anal aperture nearly as long as wide. Surface of ano-genital region smooth, distance between anal and genital apertures about twice longer than length of the latter. Both apertures surrounded by sclerotized rings. Five pairs of genital, one pair of aggenital, two pairs of anal and three pairs of adanal setae present. All genital setae inserted along sub-median margin of genital plate. Distance of aggenital setae from genital aperture being as long as distance between their bases. Adanal setae ad_1 inserted under posterior part of anal plates; ad_2 subequal in length to anal setae and distinctly longer than setae ad_1 and ad_3. Seta ad_3 located preanally, just in front of anterior corner of anal aperture. Adanal lyrifissure *iad* situated paraanally at a short distance from the lateral margin of anal plate (Fig. 2).

Legs: All tarsi monodactylous; legs I and II stronger than III and IV. Tibia I with a short distal process. Tarsus I with a long, thin solenidion and a short thick one. There are no spine-shaped hairs on the legs, which are normal for the genus.

Type series: Holotype and twenty five paratypes: District Bayan, Central Province, grassland steppe (*Cleitogenes squarosa* + *Agropyron cristatum*), 107°30'N, 47°10'E, 28–VI-1990. leg. B. BAYARTOGTOKH. The holotype and twenty one paratypes are preserved in the Acarology collection of the Department of Zoology, National University of Mongolia and four paratypes are deposited in the collection of National Science Museum, Tokyo, Japan.

Remarks: Among the known species of the genus *Protoribates*, *P. seminudus* (HAMMER, 1971), *P. monodactylus* (HALLER, 1884), *P. gracilis* (AOKI,



Figs 1–4. *Protoribates bayanicus* sp. n.: 1 = dorsal side, 2 = ventral side, 3 = left side of prodorsum, 4 = variations of sensillus

1982), and *P. brevisetosus* (FUJITA, 1989) resemble the new species in some respects, particularly in having minute notogastral setae, long and barbed sensilli with a more or less swollen apical portion. But the new species, *Protoribates bayanicus*, differs from any of the species mentioned above in having smooth and relatively short interlamellar setae. In addition, *P. monodactylus* and *P. seminudus* differ from the new species in the long and distinctly barbed lamellar and rostral setae and comparatively narrow swollen portion of sensilli. *P. brevisetosus* is distinguishable from the new species by the shorter and wider shape of the notogaster, the relatively long prodorsum and short lamellar setae (seta *la* shorter than *ro*). *P. gracilis* is readily distinguished from the new species by the distinctly narrowed shape of the notogaster, the longer prodorsum, distinctly barbed rostral, lamellar and interlamellar setae, the presence of a longitudinal ridge extending from the lamella, and minutely barbed and strongly swollen head of the sensillus.

Etymology: The specific name *bayanicus* refers to the type locality of this species.

Proteremaeus punctulatus sp. n.
(Figs 5–10)

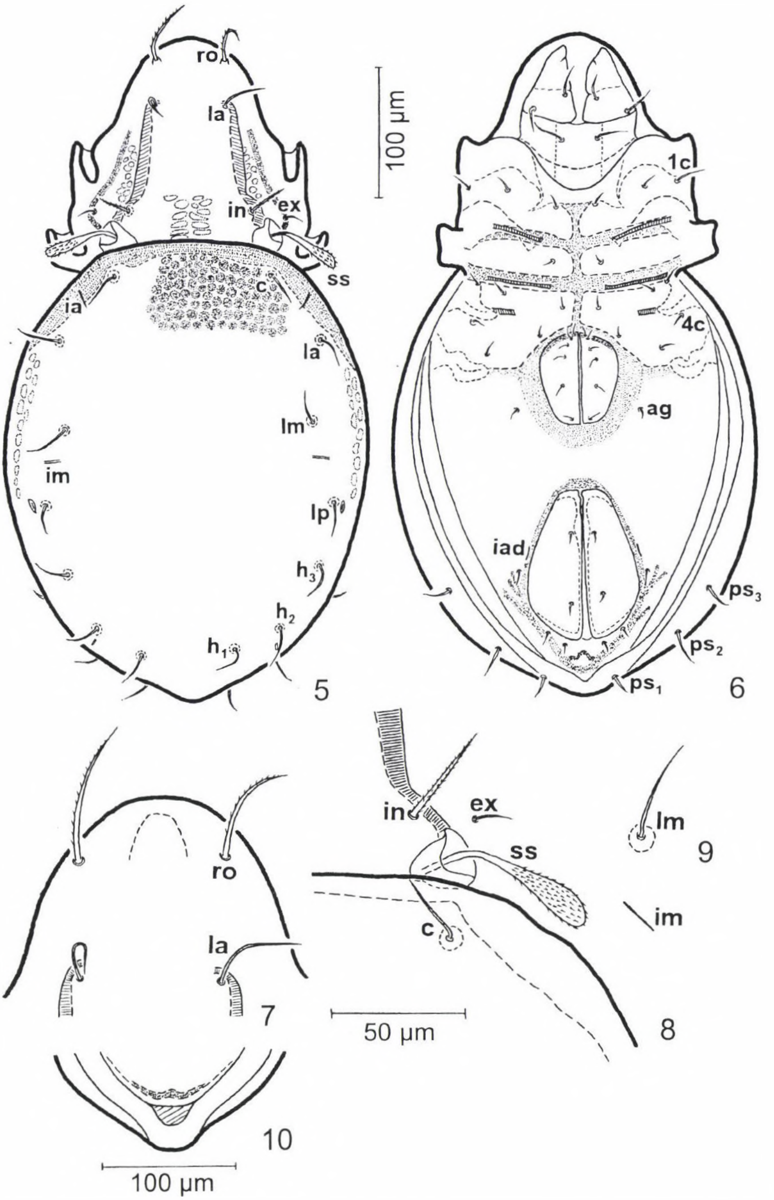
Colour: Yellowish to light brown.
Measurements: Body length 471–540 (509), width 265–294 (283).

Prodorsum: Rostrum broadly rounded, without indentations laterally. Rostral setae finely barbed unilaterally, nearly as long as distance between their bases; their alveoli situated dorsally on the rostral surface (Fig. 7). Lamellar costulae narrow, almost parallel to each other, occupying 3/4 of the length of prodorsum; carinae extending from bases of lamellae to bothridia. Lamellar setae smooth, a little shorter than distance between their bases and not reaching to the tip of rostrum. Prodorsal surface outside of lamellar costulae with a number of small areoles. Also outside the costulae on each side is found a dark longitudinal ridge (Fig. 5). Interlamellar setae finely barbed, nearly as long as lamellar seta, about 2.8 times shorter than distance between their bases. Exobothridial setae short, slender, glabrous, but distinctly developed, inserted anterolaterally to each bothridium. Bothridium directed anterolaterad, its posterior part concealed under anterior margin of notogaster. A number of muscle sigillae present in interbothridial region. Sensillus rather long, with a smooth stalk, which expands gradually to a fusiform to slightly clavate head (Fig. 8). Pedotecta I and II developed in the form of curved laminae.

Notogaster: Longer than wide, ratio 1.3 : 1. Shape of notogaster oval, distinctly tapering posteriorly, ending in a small protuberance; whole surface of notogaster covered with a weakly pigmented round to oval dark granules and a few sigillae scattered along lateral margin of notogaster (Fig. 5). Dorsosejugal suture almost straight, only slightly arched. Ten pairs of notogastral setae arising from lightly pigmented, slightly sunken alveoli (Figs 5, 9). All setae thin and smooth. Lyrifissures *ia*, *im* and *ip* clearly seen in dorsal view; lateroabdominal gland-opening *gla* located laterally to seta *lp*.

Epimeral region: Surface of epimeral region nearly smooth. Epimeral ridges *I*, *II* and *SJ* well developed, coxisternal ridges *III* and *IV* absent. Apodemata *apo.2* and *apo.sj* fairly long, aligned obliquely, almost parallel to each other, while *apo.3* short, aligned transversely (Fig. 6). Epimeral setal formula 3:1:3:3.

Ano-genital region: Surface of ano-genital region smooth, without subcuticular reticular structure. Anal and genital apertures relatively large, located close to each other and both apertures surrounded by well sclerotized rings. Six pairs of genital, one pair of aggenital, two pairs of anal and three pairs of adanal setae present. All ano-genital setae short and fine. Distance between bases



Figs 5–10. *Proteremaeus punctulatus* sp. n.: 5 = dorsal side, 6 = ventral side, 7 = rostral region, 8 = bothridial region, 9 = notogastral seta *lm* and lyrifissure *im*, 10 = posterior part of ventral plate

of aggenital setae nearly equal to that of ad_3–ad_3. Adanal lyrifissure *iad* located just in front of seta ad_3. Posterior end of ventral plate bearing a distinct rounded protuberance (Fig. 10).

Legs: All legs tridactylous with approximately subequal claws. Seta *d* on genua and tibiae always thin and closely associated with corresponding solenidion. All legs of approximately the same length, and normal for the genus. Dorsal surface of claws finely barbed.

Type series: Holotype and paratype: Mt. "Zorgol Khairkhan", District Bayan-Unjuul, Central Province, mountain steppe (*Stipa glareosa*), 46°30'N, 105°40'E, 10–X-1990, and ten paratypes: Mt. "Ikh Gazryn Chuluu", District Gobi-Ugtaal, Middle Gobi Province, desert steppe (*Caragana microphyla* + *Stipa gobica*), 45°50'N, 107°10'E, 16–IX-1991. Leg. B. BAYARTOGTOKH. The holotype and eight paratypes are preserved in the Acarology collection of the Department of Zoology, National University of Mongolia and three paratypes are deposited in the collection of the National Science Museum, Tokyo, Japan.

Remarks. In the shape of sensilli and notogaster the new species is somewhat similar to *P. mongolicus* (GOLOSOVA, 1983) and *P. macleani* BEHAN-PELLETIER, 1982. However, the new species differs from the former in having 1) smooth and relatively short lamellar and notogastral setae (lamellar and notogastral setae of GOLOSOVA's species are rather long and distinctly barbed unilaterally); 2) a weakly arched shape to the anterior margin of notogaster; 3) no transverse ridge between lamellar costulae, and 4) a far smaller body size. *P. punctulatus* sp. n. can be distinguished from the *P. macleani* by 1) the number of notogastral setae (BEHAN-PELLETIER's species bears eleven pairs of notogastral setae), 2) the distinctly barbed interlamellar setae, 3) the slightly converging shape of the lamellar costulae, and 4) the location of genital setae g_2–g_6 and adanal lyrifissure *iad*. The new species is easily distinguishable from *P. chadaevae* GOLOSOVA, 1983, described from the Central Mongolia by 1) the distinctly narrowed shape of the posterior part of notogaster, 2) the relatively wide rostrum, and 3) the relatively short lamellar and notogastral setae. Other known species of the genus *Proteremaeus* differ from the new species in the shape of sensilli and rostrum, the presence of transverse and longitudinal ridges between and anterolaterad (along lateral margin of prodorsum) of lamellar costulae.

Etymology: The name of this new species refers to the weakly pigmented round to oval granules on the notogaster.

* * *

Acknowledgements – I would like to express my sincere gratitude to Dr. J. AOKI, professor of Yokohama National University, Yokohama, Japan, for his valuable advice and many helpful comments on the manuscript.

REFERENCES

BALOGH, J. & BALOGH, P. (1984) A review of the Oribatuloidea Thor, 1929 (Acari: Oribatei). *Acta zool. hung.* **30**(3–4): 257–313.

BEHAN-PELLETIER, V. M. (1982) Descriptions of new species and a new genus of Oribatei (Acari) from the Soviet Subarctic. *Can. Ent.* **114**: 855–871.

BEHAN-PELLETIER, V. M. & RYABININ, N. A. (1991) Taxonomy and biogeography of *Proteremaeus* (Acari: Oribatida: Eremaeidae). *Can. Ent.* **123**: 559–565.

GOLOSOVA, L. D. (1983) Three new species of the Oribatei from Mongolia. *Zool. Journ.* **62**: 1902–1904. [in Russian]

HAMMER, M. (1977) Investigations on the oribatid fauna of North-West Pakistan. *Biol. Skr. Dan. Selsk., Copenhagen* **21**: 1–71.

KRIVOLUTSKY, D. A. & RYABININ, N. A. (1975) Relict elements in the oribatid mite fauna of Siberia. *Dokl. Akad. Nauk, SSSR.* **224**: 1226–1229. [in Russian]

PIFFL, E. (1965) Eine neue Diagnose für die Familie der Eremaeidae (Oribatei-Acari) nach zwei neuen Arten aus dem Karakorum. *Ost. Akad. Wissensch. Mathem.-Naturw. Kl.*, Abt. I. **174**: 363–385.

WEIGMANN, G., MIKO, L. & NANNELLI, R. (1993) Redescription of Protoribates dentatus (Berlese, 1883) with remarks about the genus Protoribates (Acarina, Oribatida). *Redia* **76**(1): 39–55.

Revised version received 14th February, 2000, accepted 30th June, 2000, published 24th July, 2000

The oribatid species described by Berlese (Acari)

MAHUNKA, S. and L. MAHUNKA-PAPP

The authors had the opportunity for years to study the Oribatid species described by Berlese currently deposited in the Istituto Sperimentale per la Zoologia Agraria at Florence. The results of this series of studies are summarized in this volume.

The volume begins with an essay-like Introduction heavily relying on subjective opinions discussing the general questions of Oribatology. The following section lists Berlese's species placed in the modern system helping the specialists with morphological notes and many drawings; here also the condition of the specimens is discussed and lectotypes are designated.

The third, large section is the catalogue proper, wherein all the species are listed in the systematic order together with their combination and synonymic names. Here one may find all the literature data, usually missing from ordinary works, with reference to Description and Taxonomy, Distribution, with special emphasis on Catalogues whose references are partly unreliable. Where it was deemed necessary further information are added under the heading of Remarks. The volume closes with a very detailed list of literature.

ISBN 963 7093 27 3
325 pages with several figures. Soft bound.
© Hungarian Natural History Museum, Budapest, 1995
Price: 40 US dollars excl. p. & p.

Order should be sent
to the Hungarian Natural History Museum, Library
Baross u. 13., Budapest, H–1088 Hungary
Fax: (36–1) 3171669

Acta Zoologica Academiae Scientiarum Hungaricae 46 (2), pp. 155–179, 2000

TAXONOMICAL REVIEW OF THANATUS SPECIES (PHILODROMIDAE, ARANEAE) OF HUNGARY

SZITA, É. and F. SAMU*

Eötvös Loránd University of Sciences, Department of Systematic Zoology and Ecology
H-1088 Budapest, Puskin u. 3, Hungary
E-mail: h7208szi@ella.hu
**Plant Protection Institute of the Hungarian Academy of Sciences*
H-1525 Budapest, P.O. Box 102, Hungary
E-mail: h2367sam@ella.hu

The spider genus *Thanatus* is one of the most difficult groups of the family Philodromidae. As opposed to many other members of the family, all *Thanatus* species are epigeic. The following six species of the genus can be found in Hungary: *Th. arenarius* THORELL, 1872, *Th. atratus* SIMON, 1875, *Th. formicinus* (CLERCK, 1757), *Th. pictus* L. KOCH, 1881, *Th. sabulosus* (MENGE, 1875), *Th. striatus* C. L. KOCH, 1845. The occurrence of two further species: *Th. coloradensis* KEYSERLING, 1880, *Th. vulgaris* SIMON, 1870 is not proven. As both might occur in Hungary, they are included in the present study. For each species description, illustrations and distributional maps are provided. The examination is based on the collection of the Hungarian Natural History Museum, Budapest, as well as on materials from several museums and arachnologists from Hungary and Europe, and on our own collections. *Th. atratus* was regarded as a subspecies of *Th. vulgaris* until 1983, when it was raised to the level of a full species. After the examination of all Hungarian specimens available, only the occurrence of *Th. atratus* was established for the country. *Apollophanes babaly* LOGUNOV, 1996 is a junior synonym of *Th. pictus* L. KOCH, 1837.

Key words: *Thanatus*, Hungary, Central Europe, phenology, taxonomy

INTRODUCTION

The family Philodromidae is a comparatively little known group of spiders and presents many taxonomical problems. The genus *Thanatus* is not an exception. Reports on the genus were mostly limited to the publications of faunistical data (HÄNNGI *et al.* 1995). Identification books (LOCKET & MILLIDGE 1951, HEIMER & NENTWIG 1991, ROBERTS 1995) and earlier revisions (DONDALE *et al.* 1964, SCHICK 1965, LEVY 1977) do not cover all Hungarian species and illustrations are not available for every species (CHYZER & KULCZYNSKI 1891, 1897, ROEWER 1928, HEIMER & NENTWIG 1991).

Our main "source" of *Thanatus* specimens was the collection of the Hungarian Natural History Museum. In addition we examined *Thanatus* specimens from several other collections. Therefore we had the opportunity to enlarge our knowledge about the intraspecific variability of these species (genitalic characters, spination etc.).

In previous literature from Hungary six species were reported: *Thanatus arenarius*, *Th. atratus*, *Th. formicinus*, *Th. pictus*, *Th. sabulosus*, *Th. striatus* (SAMU & SZINETÁR 1999). Two further species (*Thanatus coloradensis*, *Th. vulgaris*) may probably occur in Hungary. The *Thanatus* species of Hungary belong to four species groups, *formicinus* group (*Th. formicinus*, *Th. coloradensis*), *sabulosus* group (*Th. arenarius*, *Th. sabulosus)*; *striatus* group (*Th. atratus*, *Th. striatus*, *Th. vulgaris)*, *pictus* group (*Th. pictus*).

All *Thanatus* species are of small and medium size. The length and width of the prosoma is nearly the same. The posterior median eyes are equidistant from each other and the lateral eyes. The lateral eyes are hardly larger than the median ones. Both eyerows are recurved, the anterior row less than the posterior. The opisthosoma is the widest at the middle with a conspicuous cardiac mark. The coloration generally brownish or yellowish.

Members of the genus are epigeic diurnal hunting spiders. The data about their occurrence come mainly from pitfall trap studies. They do not use web neither for catching prey, nor for shelter. Courtship is simpler than in some other diurnal hunters (eg. Lycosidae or Salticidae). After drumming with the pedipalps the male waits for a certain period (two minutes to one and a half hour) and then jumps upon the female. The female is cataleptic during mating. The male uses his palps alternately, while turning from one side to another he "dances" on the dorsum of the female. This so called "dance" might contain species-specific elements, such as acoustic signals during the waiting period, but these questions will need further examination. After mating the male leaves the female quickly and the female recovers from her cataleptic state within a few seconds. Sexual cannibalism did not occur in the 13 matings observed by us. The female lays her eggs under stones and cavities of rocks, and guards them until hatching. She may lay further (2–3 in total) cocoons after spiderlings from the previous ones hatched. The first instar larvae stay together inside the cocoon until their first moulting. From each coccoon 20–50 spiderlings hatch 2–3 weeks after egglaying. After leaving the cocoon *Th. striatus* has seven developmental stages (7th is the adult) (SCHAEFER 1977).

MATERIALS AND METHODS

We examined altogether 203 specimens from Hungary and 270 individuals from other countries. The spiders were either collected in the field or borrowed from the following museums and arachnologists: AMNH – American Museum of Natural History, New York, USA, N. PLATNICK; BDT – Berzsenyi Dániel Teacher's Training College, Szombathely, Hungary, CS. SZINETÁR; BGU

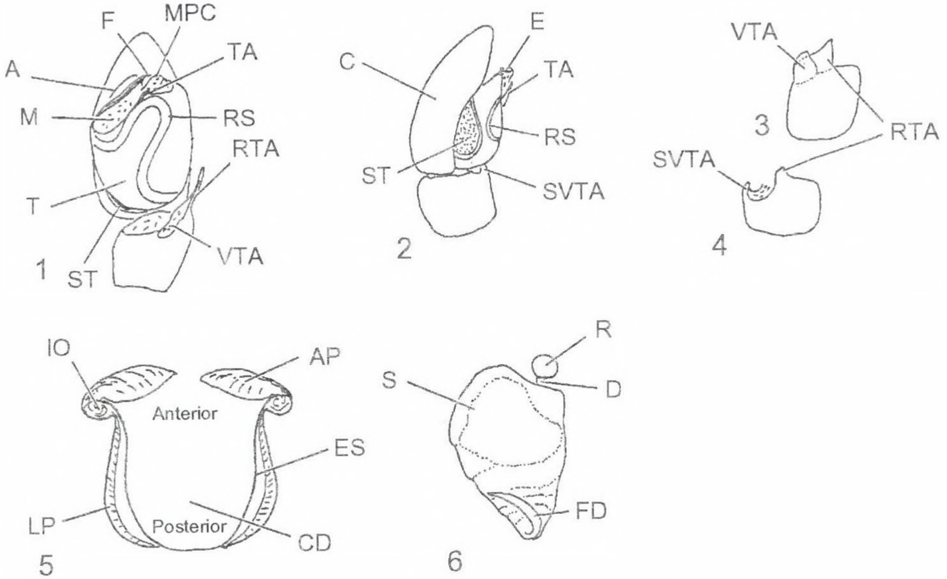
– Ben Gurion University, Sede Boquer, Israel, Y. Lubin; EB – Schweinfurt, Germany, E. Bauchhenss; ELU – Eötvös Loránd University of Sciences, Budapest, Hungary, K. Szathmáry; ESA – Sociedad Entomologica Aragonesa, Zaragoza, Spain, A. Melic-Blas; GUA – Gödöllő University of Agricultural Sciences, Gödöllő, Hungary, F. Tóth; HNHM – Hungarian Natural History Museum, Budapest, Hungary, S. Mahunka; IEC – Institute of Entomology, Czech Academy of Sciences, Ceske Budejovice, Bohemia, V. Ruzicka; IZB – Institute of Zoology Bulgarian Academy of Sciences, Sofia, Bulgaria, S. Lazarov and C. Deltshev; MG – Muséum d'Historie Naturelle, Geneva, Switzerland, V. Manhert; MNB – Museum für Naturkunde, Berlin, Germany, J. Dunlop; NMB – Naturhistorisches Museum Bern, Switzerland, C. Kropf; NMBA – Naturhistorisches Museum Basel, Switzerland, A. Hänngi; PPI – Plant Protection Institute, Budapest, Hungary, F. Samu and É. Szita; UA – University of Aarhus, Aarhus, Denmark, S. Toft; UB – Universität Bern Zoologisches Institut, Bern, Switzerland, W. Nentwig; UI – Kolozsvár, Romania, I. Urák; UK – Univerzita Karlova, Prague, Bohemia, J. Buchar; VZ – Innsbruck, Austria, V. Zingerle.

Field collected spiders were caught by handsampling. Since many of them were juvenile and needed to be reared to maturity, in the list of material examined there are two dates, first the collecting date, followed by the date of maturity (e.g. 12/05/97 ad 28/05/97). The system used by Toft (1976) was adopted for presentation of phenological data.

Measurements were made on ten individuals of each species when enough specimens were available. All measurements in millimetre. Presentation of leg spination according to Ono (1988).

For lists of synonyms see (Roewer 1954*a*, *b*, Bonnet 1945, 1959, Platnick 1989, 1993, 1997, Logunov 1996).

The terminology of genital morphology of *Thanatus* and related genera was worked out by Schick (1965) and Logunov (1996). In this study the following terms and abbreviations were used in the text (Figs 1–6): A – alveolus; ad – adult; ALE – anterior lateral eye; AME – anterior median eye; AME-ALE – distance between AME and ALE; AME-AME – distance between AME-s; AP –



Figs 1–6. Genitalia of *Thanatus* spp.: 1 = *Th. formicinus* – male palpus, ventral view, 2, 4 = *Th. striatus* – male palpus, 3 = *Th. pictus* – tibia of male palpus retrolateral view, 5= ditto – epigyne, 6= *Th. arenarius* – spermatheca

anterior guide pocket; C – cymbium; CD – central division; d – dorsal; D – duct of spermathecal organ; E – embolus; ES – epigynal suture; f – female; FD – fertilisation duct; IO – introductory orifice; LP – lateral guide pocket; m – male; M – membranea; MOA – median ocular area; MOA-L – length of MOA; MOA-WA – anterior width of MOA; MOA-WP – posterior width of MOA; MPC – membranous philodromid conductor; pl – prolateral; PLE – posterior lateral eye; PME – posterior median eye; PME-PLE – distance between PME and PLE; PME-PME – distance between PME-s; R – spermathecal organ; rl – retrolateral; RS – receptaculum seminis; RTA – retrolateral tibial apophysis; S – spermatheca; ST – subtegulum; SVTA – secondary ventral tibial apophysis; T – tegulum; TA – tegular apophysis; v – ventral; VTA – ventral tibial apophysis.

RESULTS AND DISCUSSION

Taxonomic notes

An examination of the figures of genitalia of *Apollophanes babaly* LOGUNOV, 1996 revealed that *A. babaly* should be regarded as a junior synonym of *Thanatus pictus* L. KOCH, 1881. It seemed necessary to re-examine the generic place of *Th. pictus*. The *Apollophanes* and *Thanatus* genera are closely related, and were distinguished by DONDALE *et al.* (1964), SCHICK (1965), DONDALE and REDNER (1975). For deciding the taxonomical position of *Th. pictus*, genital and somatic characters of five *Apollophanes* species (AMNH) were examined.

By the characters mentioned in Table 1 *Th. pictus* should be placed into the genus *Thanatus*.

Another problematic group within the *Thanatus* genus is the *vulgaris* species complex. This complex consists of several subspecies, all of them described from small regions of Europe e.g. Madeira, Crete (KULCZYNSKI 1903), Sweden (TULLGREN 1942). In previous publications usually the subspecies were lumped together, and most faunistical data refer only to the nominate species *Th. vulgaris*. However, recently *Th. atratus* has been raised to the rank of species by KRONESTEDT (1983), and it is possible that *Th. vulgaris* will be split into further species. It is very likely that *Thanatus vulgaris brevipes* should be regarded as a

Table 1. Taxonomic differences and similarities between the genera *Thanatus* and *Apollophanes*

	typical *Thanatus*	*Thanatus pictus*	typical *Apollophanes*
Number of spines on pl side of metatarsus I	0	0	2 or 3
Relative length of male palpal tibia	short	short	long
VTA	–	+	+
TA	+	+	–
Wrinkleness of spermatheca	strong	strong	poor
Position of spermathecal organ	apical	apical	lateral

junior synonym of *Thanatus atratus* (Hansen 1995, Pozzi & Hänngi 1998) but this problem needs further investigations.

All the *Th. vulgaris* material from Hungary examined belong to *Th. atratus*.

KEY TO THE THANATUS SPECIES OF HUNGARY

Males

1 Ventral tibial apophysis (VTA) conspicuous and slightly sclerotised (Figs 28–30). *Th. pictus*

– VTA inconspicuous 2

2 Secondary ventral tibial apophysis (SVTA) present 3

– SVTA absent 5

3 SVTA long, flattened; tip of embolus flagellum-like in lateral view (Figs 13–15). *Th. striatus*

– SVTA short with wide base 4

4 Tegular apophysis (TA) small, slightly rounded; curve of embolus continuous (Figs 37–39). *Th. atratus*

– TA conspicuous and sharp, curve of embolus broken, its tip perpendicular (Figs 40–42). *Th. vulgaris*

5 Retrolateral tibial apophysis (RTA) flattened and slightly twisted, its end bilobate (Figs 7–9). *Th. arenarius*

– RTA different 6

6 RTA slim and sharp, with curved tip from retrolateral view (Figs 10–12). *Th. sabulosus*

– Base of RTA wide, triangular (Figs 22–24). *Th. formicinus*

– RTA curving laterally, apical part of tegulum significantly widened (Figs 25–27). *Th. coloradensis*

Females

1 Lateral guide pocket semicircular 2

– Lateral guide pocket not as above 3

2 Posterior part of central division (CD) separates clearly the LP-s from each other (Figs 43–44). *Th. atratus*

– Posterior part of CD concave (Figs 45–46). *Th. vulgaris*

3 Epigynal sutures are divergent anteriorly 4

– Epigynal sutures are convergent anteriorly 6

4 LP-s arise at the posterior end of epigynal suture, the area between the PL-s lyra shaped 5

– Lateral guide pocket does not arise at the posterior end of the epigynal suture, therefore LP-s auriculate; around the introductory orifice the sclerotisation is rhombus-like (Figs 18–19). *Th. sabulosus*

5 LP wide, around the introductory orifice round sclerotisation, duct of spermathecal organ hardly visible in dorsal view (Figs 31–32). *Th. formicinus*

– LP wide, no sclerotisation around IO, duct of spermathecal organ clearly visible at apical part of spermatheca (Figs 33–34). *Th. coloradensis*

– LP narrow, anterior guide pocket conspicuous, nearly perpendicular to LP (Figs 35–36). *Th. pictus*

6 Rounded sclerotisation around IO, spermathecae generally not separated (Figs 16–17). *Th. arenarius*

– Anterior end of LP angular, spermathecae separated (Figs 20–21). *Th. striatus*

Thanatus arenarius THORELL, 1872
(Figs 7–9, 16–17, 47–48)

Hungary: Fülöpháza 2f, 45m 20/05/1997;1m 16/05/1997; BDT – Romhány: 1f 22/04/1994, 1f 01/04/1995; Juliannamajor: 1f 18/05/1994, 1f 24/05/1993; Farkas-hegy: 1f 19/04/1997 ad 04/05/1997; 1m 19/04/1997 ad 01/05/1997; 1f 24/04/1997 ad 06/05/1997; 2f 1m 05/05/1997 ad 12/05/1997; 3f 05/05/1997 ad 18/05/1997; 1m 05/05/1997; 1m 05/05/1997 ad 08/05/1997; 1m 05/05/1997 ad 15/05/1997; 3f 19/05/1997; 1f 10/06/1997 ; Odvas-hegy: 1m 24/04/1997; 1f 19/05/1997 ad 25/05/1997; 1f 19/06/1997; 1f 02/07/1997, PPI – unknown collecting conditions: 1f, 5m; – Ágasegyháza: 1f, 1m 06/05/1932; Bugac: 1f 1934; Algyógy: 1f, HNHM – unknown collecting conditions: 1m, ELU – Józsefmajor: 3m 29/06/1994; 1m 08/06/1994; 1m 22/06/1994, GUA

As *Th. formicinus*: collecting conditions unknown: 2f; Gyömrő: 1m aug-32; Buda: 1f 1875, HNHM

Comparative material: Germany: Tals 2f, 3m 1986, EB – Transylvania (Romania): Kolozsvár 1f, 7m 10/07/1997, UI; Pöstyén: 1f, 1m 1909, HNHM – Bulgaria: Sredna Gora 8m 02/08/1997; North Black Sea coast 1m 26/06/1996, IZB

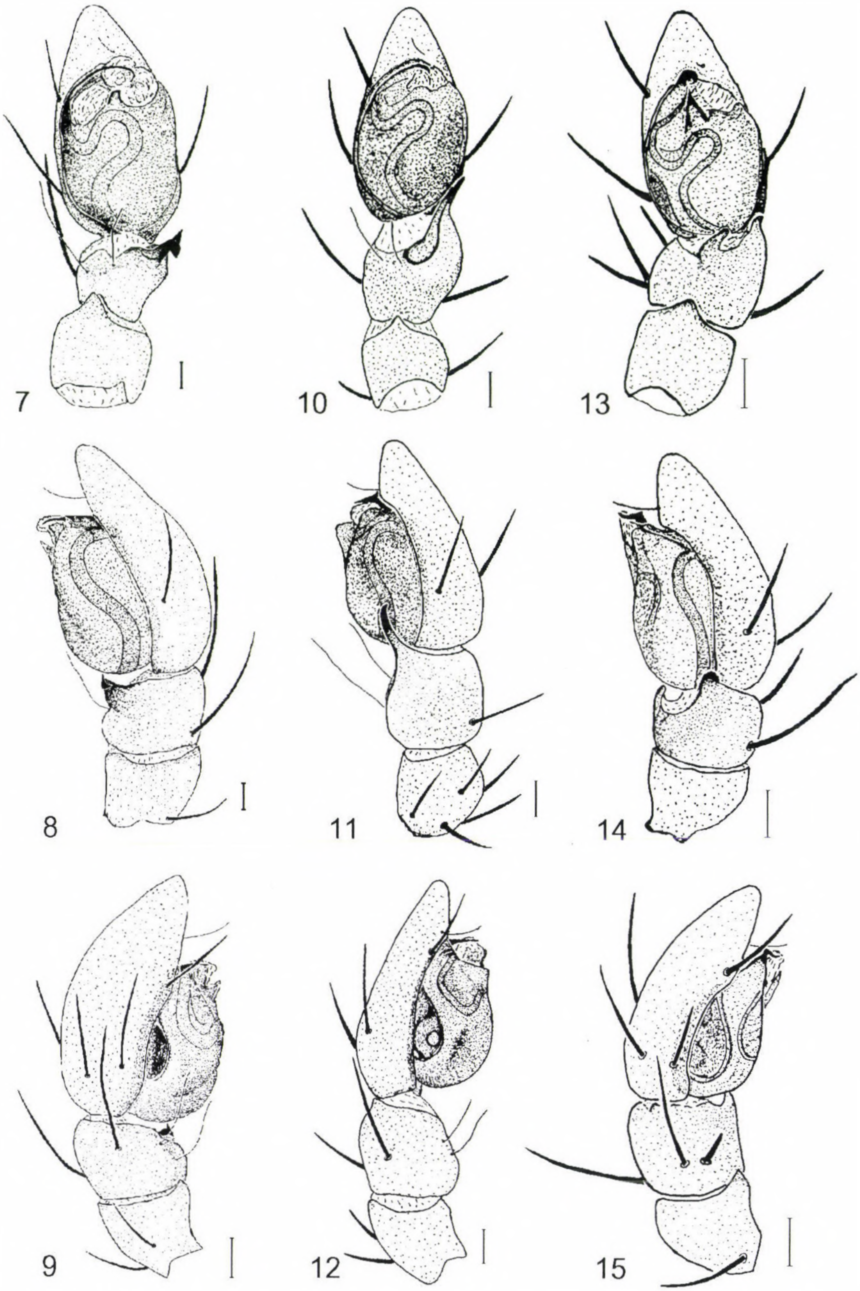
Male: prosoma and legs reddish brown, opisthosoma light brown to ash-grey, pattern as in Fig. 47. Palpus (Figs 7–9): RTA flat, twisted, with bilobate end. Measurements : prosoma length: 2.16–2.97, width: 2.00–2.70, opisthosoma length: 2.10–3.15 width: 1.34–2.07. Distances between eyes: AME-AME: 0.13–0.19, AME-ALE: 0.06–0.10, PME-PME: 0.23–0.34, PME-PLE:˙0.21–0.31, MOA-WA: 0.26–0.37, MOA-WP: 0.38–0.52, MOA-L: 0.38–0.49. Length of segments:

	femur	patella	tibia	metatarsus	tarsus	Σ
leg I	1.77–2.47	0.73–1.15	1.32–1.93	1.14–1.70	0.95–1.54	6.81–9.35
leg II	2.16–2.78	0.79–1.30	1.53–2.23	1.43–1.91	1.08–1.61	7.62–10.37
leg III	1.95–2.80	0.79–1.08	1.48–2.03	1.30–1.86	1.01–1.48	7.29–9.60
leg IV	2.17–3.10	0.66–1.17	1.84–2.53	1.63–2.45	1.26–1.76	8.85–11.30

Spination of leg I: femur: d 0–1–1 or 0–1–1–1ap; pl 0–1–1–1ap; rl 1or 0–1–1; tibia: pl and rl 1–1–1; v 0–2–2–2ap; metatarsus: v 2–2–0

Female: body light brown to ash-grey. pattern as in Fig. 48. Epigyne (Figs 16–17): CD nearly round, around the IO with round sclerotisation, spermathecae not separated. Measurements: prosoma length: 2.10–2.92, width: 1.84–2.85, opisthosoma length: 3.42–5.07, width: 2.21–2.89. Distances between eyes: AME-AME: 0.14–0.16, AME-ALE: 0.08, PME-PME: 0.23–0.27, PME-PLE: 0.23–0.24, MOA-WA: 0.28–0.31, MOA-WP: 0.39–0.44, MOA-L: 0.38–0.43. Length of segments:

	femur	patella	tibia	metatarsus	tarsus	Σ
leg I	1.72–2.70	0.73–1.22	1.36–2.04	0.98–1.62	0.86–1.38	6.54–9.58
leg II	2.04–2.94	0.76–1.42	1.53–2.31	1.20–1.90	0.92–1.49	7.26–10.66
leg III	1.76–2.78	0.71–1.17	1.05–2.06	1.12–1.60	0.87–1.32	6.42–9.39
leg IV	2.05–3.05	0.67–1.17	1.41–2.44	1.38–2.05	0.98–1.58	7.20–10.68



Figs 7–15. Male genitalia of *Thanatus* species. 7–9: *Th. arenarius*: 7 = ventral view, 8 = retrolateral view, 9 = prolateral view; 10–12 = *Th. sabulosus*: 10 = ventral view, 11 = retrolateral view, 12 = prolateral view; 13–15 = *Th. striatus*: 13 = ventral view, 14 = retrolateral view, 15 = prolateral view [bar= 0.1 mm]

Spination of leg I: femur: d 0–0–1–1ap or 0–1–0; pl 0–1–1–1ap or 0–1–1; tibia: pl 1–1; rl 0–1; v 0–2–2–2ap; metatarsus: v 2–2–0

Distribution: Palaearctic. Further localities in Hungary: Pócsmegyer (BALOGH & LOKSA 1946), Sas-hill (BALOGH 1935, BALOGH 1938*b*), Nagymaros (BALOGH 1938*c*), Kőszegi-mountains (BALOGH 1938*a*), Szeged (KOLOSVÁRY 1928), Budapest, Kalocsa, Sátoraljaújhely, Tokaj, Szerencs (CHYZER & KULCZYNSKI 1896), Bugac (KEREKES 1988), Buda (MARGÓ & FRIVALDSZKY 1879).

Habitat: frequent in dry and semiarid steppe areas (STEINBERGER 1990), at sea shore (KROGERUS 1932), in sand- and salt-marshes.

Phenology: adults can be found from late April to early July, hibernation in juvenile stage (Fig. 59).

Thanatus sabulosus (MENGE, 1875)

(Figs 10–12, 18–19, 49)

Hungary: Barcs: 1f 1975 BDT – collecting conditions unknown: 1f HNHM.

Comparative material: Germany: Berlin, 2f UB – Switzerland: Tettlinsen 1m UB; Golzow 01/07/1993; Britzlkbeswalde 1f, 4m 11/05/1994; 1f 10/08/1994, NMB – Bulgaria: Sredna Gora Mountains, Chavdar village 2m 05/07/1997, IZB – Transylvania (Romania): Torjai büdös 1m 12/06/1895; Zlatiska 1f 07/07/1886, HNHM.

Male: prosoma and opisthosoma brownish yellow with dark brown pattern, legs brown. Palpus (Figs 10–12): RTA thin and sharp, subtegulum clearly visible. Measurements: prosoma length: 1.42–1.76, width: 1.40–1.80, opisthosoma length: 1.61–2.14, width: 1.13–1.53. Distances between eyes: AME-AME: 0.13–0.14, AME-ALE: 0.04–0.06, PME-PME: 0.19–0.23, PME-PLE: 0.19–0.23, MOA-WA: 0.26–0.27, MOA-WP: 0.36–0.37, MOA-L: 0.34–0.36. Length of segments:

	femur	patella	tibia	metatarsus	tarsus	Σ
leg I	1.25–1.53	0.54–0.64	0.91–1.21	0.79–1.09	0.70–0.86	4.47–5.37
leg II	1.42–1.68	0.54–0.79	1.03–1.36	0.84–1.25	0.61–0.89	4.75–5.92
leg III	1.35–1.62	0.40–0.78	0.76–1.21	0.84–1.31	0.63–0.95	4.17–6.09
leg IV	1.51–1.76	0.56–6.99	0.74–1.39	0.95–1.31	0.59–0.95	4.72–6.09

Spination of leg I: femur: d 0–1–1; pl 0–1–1–1; tibia: pl 0–0–1; v 2–2–2; metatarsus: v 2–2–0

Female: coloration as in male, pattern as in Fig. 49. Epigyne (Figs 18–19): LP-s ear-like, rhombus shape sclerotisation around IO. Measurements: prosoma length: 1.53–1.86, width: 1.56–1.81, opisthosoma length: 2.69–3.41, width: 1.90–2.30. Distances between eyes: AME-AME: 0.16–0.18, AME-ALE: 0.07–0.08, PME-PME: 0.23–0.24, PME-PLE: 0.21–0.24, MOA-WA: 0.29–0.31, MOA-WP: 0.39–0.42, MOA-L: 0.36–0.37. Length of segments:

	femur	patella	tibia	metatarsus	tarsus	Σ
leg I	1.27–1.71	0.53–0.78	1.05–1.35	0.79–1.13	0.64–0.78	4.81–6.26
leg II	1.13–1.74	0.48–0.85	0.93–1.54	0.77–1.09	0.56–0.83	4.12–5.95
leg III	1.16–1.66	0.47–0.79	1.05–1.18	0.80–0.96	0.63–0.77	4.76–5.43
leg IV	1.41–1.83	0.63–0.76	1.08–1.39	1.03–1.23	0.69–0.86	5.45–6.07

Spination of leg I: femur: d 1; pl 0–0–1; tibia: v 2–2–0; metatarsus: v 2–2–0

Distribution: Palaearctic. Further localities in Hungary: Kalocsa (CHYZER & KULCZYNSKI 1896).

Habitat: rare species, occurring in clearings and along the edges of xerothermic woods (BUCHAR 1979, THALER 1985, STEINBERGER 1988, 1990)

Phenology: Not enough data available for a correct estimation.

Thanatus formicinus (CLERCK, 1757)

(Figs 22–24, 30–32, 51–52)

Hungary: Jeli: 7f 08/1932; Gönyű: 1f 07/09/1933, HNHM – Hegymagos: 1f 23/06/1997; Odvas-hegy: 1f 19/04/1997, 1m 24/04/1997; Odvas/Út-hegy: 1m 05/09/1997, ad 09/02/1998; Csákvár: 1f 13/05/1997, ad 17/08/1997, 2m 13/05/1997, ad 05/02/1998; 1f 17/08/1997, ad 17/02/1998; Kecskehát: 1f 22/08/1997; 1m 12/08/1997, ad 09/02/1998; 1f 17/09/1997; 1f 17/09/1997, ad 17/02/1998, 2m 17/09/1997, ad 05/02/1998; 3m 20/02/1998, ad 24/02/1998; 1m 20/02/1998, ad 02/03/1998; Hegymagas, Tapolca: 1f 23/08/1997, ad 28/08/1997; Farkas-hegy: 1f 27/08/1997, ad 20/10/1997; 1m 27/08/1997, ad 05/02/1998; 1m 06/08/1997, ad 12/02/1998; 1f 27/08/1997, ad 12/02/1998, 1m 27/08/1997, ad 30/01/1998, PPI – Barcs: 1f 1975, BDT – József-major: 1f 20/04/1994, GUA; collecting conditions unknown: 1f, 1m

As *Th. alpinus* – Jeli: 1f 23/06/1932, HNHM

Comparative material: Germany: 1f, 1m 1985, EB – Austria: 1f, 1m Wiener Neustadt, UB; Graz 1f 29/04/1995, NMB – Switzerland: Aistnik 1f 08/05/1995; Leibnitz 2f, 1m 27/03/1995, NMB ; Mte Generoso, Pree 1f 04/06/1988, 1f 01/07/1988, 1m 04/10/1988, 4m 19/04/1989, 1f 07/16/1989, 4m 13/11/1989; Val Blenio, Brinzosca 1f 01/05/1989, 1f 14/08/1989, 2f, 2m 27/04/1990; Val Morobbio, Melera 7m 15/04/1989, 1m 18/05/1989, 1m 23/08/1989; Centovalli, Palagnedra 2m 30/04/1990; Centovalli, Lionza 1f, 1m 22/05/1989, 1f 20/07/1989, 1m 28/03/1990; Mte S Giorgrio, Paruscera 2m 12/05/1988, 2m 20/04/1989; Mte s Giorgio, Forello 2m 09/09/1988, 1m 28/09/1988 NMBA–Bulgaria: Sredna Gora Mountains, Bratiya 1f, 8m 10/06/1997; Milevska Mountains 1f 20/08/1997 IZB – Finland: .Turku 1f 04/09/1978, UA – Transylvania (Romania): Brassó 1m; Szamosújvár: 1f; Mármaros: 1f; Szalánc: 1f, HNHM

Male: body and legs light brown to light reddish brown, pattern as in Fig. 51. Palpus (Figs 22–24): RTA triangular with wide base. Measurements: prosoma length: 2.73–4.02, width: 2.15–3.61, opisthosoma length: 2.46–3.37, width: 1.91–2.66. Distances between eyes: AME-AME: 0.13–0.23, AME-ALE: 0.06–0.09, PME-PME: 0.25–0.36, PME-PLE: 0.23–0.29, MOA-WA: 0.36–0.52, MOA-L: 0.36–0.53. Length of segments:

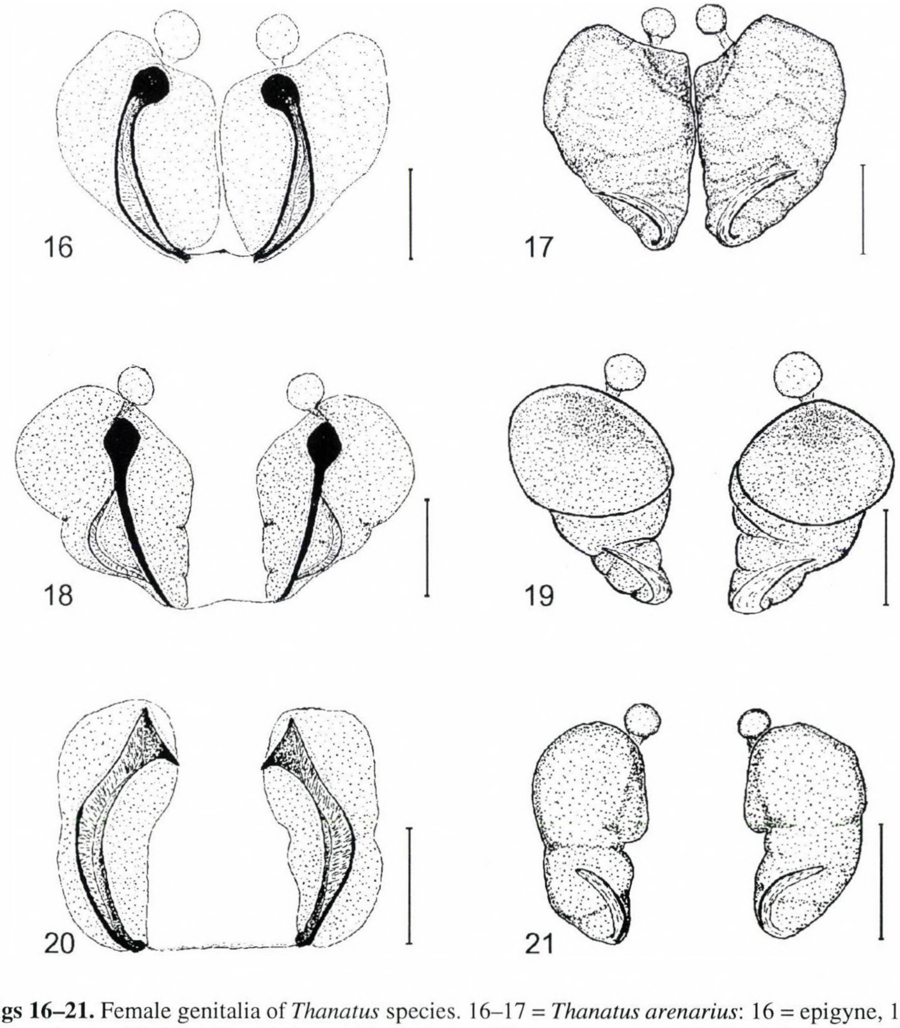
	femur	patella	tibia	metatarsus	tarsus	Σ
leg I	2.87–3.57	1.07–1.63	2.05–2.74	1.71–2.56	1.53–1.99	9.57–12.97
leg II	2.73–4.18	1.26–1.84	2.21–3.30	2.07–2.64	1.57–2.10	9.57–14.60
leg III	2.51–3.84	1.33–1.38	1.60–3.03	1.88–2.45	1.24–1.98	9.20–13.01
leg IV	2.81–3.99	1.26–1.56	2.30–3.13	2.12–3.21	1.58–2.07	9.79–14.59

Spination of leg I: femur: d 0–1–1 or 1–1–1; pl and rl 0–1–1–1ap; tibia: pl and rl 1–1–1; v 0–2–2–2ap; metatarsus: v 2–2–0

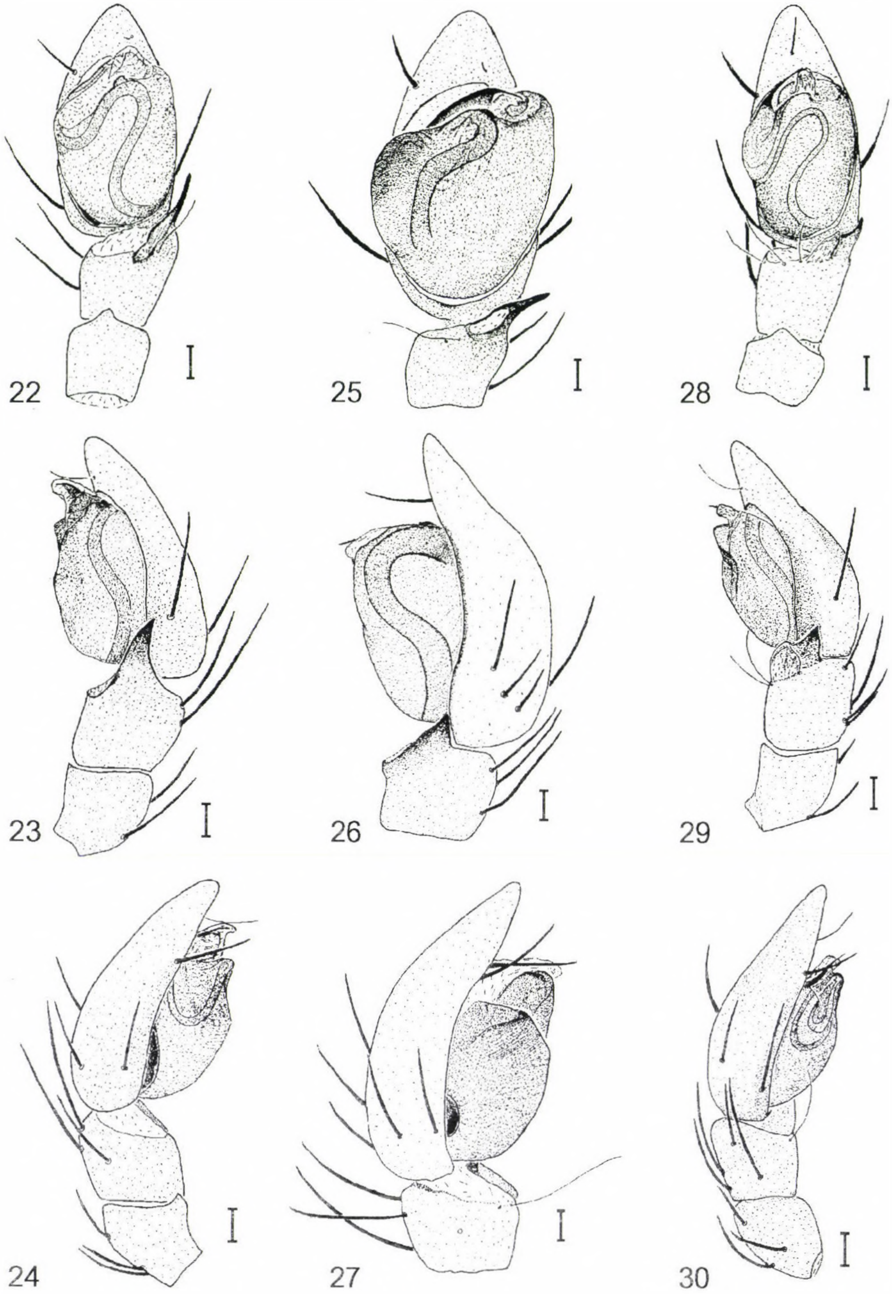
Female: Coloration as in male (Fig. 52). Epigyne: round sclerotisation around IO, spermathecae wrinkled, duct of spermathecal organ hardly visible in dorsal view (Figs 31–32). Measurements: prosoma length: 3.04–4.66, width: 2.68–4.19, opisthosoma length: 3.91–7.27, width:

2.48–4.46. Distances between eyes: AME-AME: 0.13–0.23, AME-ALE: 0.06–0.09, PME-PME: 0.24–0.36, PME-PLE: 0.23–0.29, MOA-WA: 0.24–0.39, MOA-WP: 0.36–0.52, MOA-L: 0.36–0.52. Length of segments:

	femur	patella	tibia	metatarsus	tarsus	Σ
leg I	2.79–3.88	1.20–1.91	1.99–2.76	1.49–2.38	1.03–1.89	9.40–13.10
leg II	3.13–4.34	1.42–1.98	2.33–3.14	1.93–2.68	1.18–2.05	9.98–14.67
leg III	2.50–4.11	1.18–1.74	2.02–2.70	1.44–2.27	1.23–1.63	9.12–12.76
leg IV	2.95–3.94	1.05–1.77	2.36–3.07	1.51–2.52	1.44–1.98	9.46–13.56



Figs 16–21. Female genitalia of *Thanatus* species. 16–17 = *Thanatus arenarius*: 16 = epigyne, 17 = spermathecae; 18–19 = *Th. sabulosus*: 18 = epigyne, 19 = spermathecae; 20–21 = *Th. striatus*: 20 = epigyne, 21 = spermathecae [bar = 0.1 mm]



Figs 22–30. Male genitalia of *Thanatus* species. 22–24 = *Th. formicinus*: 22 = ventral view, 23 = retrolateral view, 24 = prolateral view; 25–27 = *Th. coloradensis*: 25 = ventral view, 26 = retrolateral view, 27 = prolateral view; 28–30 = *Th. pictus*: 28 = ventral view, 29 = retrolateral view, 30 = prolateral view [bar= 0.1 mm]

Spination of leg I: femur: d 0–1–1 or 1; pl 0–1–1–1ap or 0–1–1; tibia: pl 0–1; v 0–2–2–2ap; metatarsus: v 2–2–0

Distribution: Holarctic. Further localities in Hungary: Sas-hegy (BALOGH 1935, 1938*b*), Tihany (BALOGH 1933), Kőszegi-hegység (BALOGH 1938*a*), Budapest, Kalocsa, Veszprém (CHYZER & KULCZYNSKI 1896), Csabrendek (KASPER 1992), Simontornya (PILLICH 1911), Kaposvár (SZINETÁR 1992), Bugac (KEREKES 1988), Jeli (KOLOSVÁRY 1936), Pilisszentkereszt (LOKSA 1991*b*), Apátistvánfalva, Ritkaháza, Magyarszombatfa, Szaknyér, Szőce (SZINETÁR 1995)

Habitat: frequent in dry and semidry meadows and xerothermic wood steppes.

Phenology: Adults generally appear in early March, although some individuals may reach adulthood in the same year they hatched. Hibernate in subadult or adult stages (Fig. 58).

Thanatus coloradensis KEYSERLING, 1880

(Figs 25–27, 33–34, 53)

Examined material: Austria: Edelweis Spitze 1m 23/07/1997; Großglockner 3m 22/07/1997, PPI; Dolomites Nature Park, Puez Geisler 1m 29/07/1995, VZ

Male: body coloration light brown, pattern as for female. Palpus (Figs 25–27): RTA curves strongly laterally, apical part of tegulum wide. Measurements: prosoma length: 2.86–2.91, width: 2.60–2.85, opisthosoma length: 3.14–3.51, width: 1.89–2.08. Distances between eyes: AME-AME: 0.14–0.18, AME-ALE: 0.06–0.09, PME-PME: 0.23–0.28, PME-PLE: 0.23–0.26, MOA-WA: 0.33–0.36, MOA-WP: 0.37–0.46, MOA-L: 0.37–0.49. Length of segments:

	femur	patella	tibia	metatarsus	tarsus	Σ
leg I	2.45–3.12	1.90–1.32	1.90–1.32	1.85–2.02	1.47–1.60	9.35–10.56
leg II	3.05–3.22	1.05–1.34	2.36–2.65	1.95–2.17	1.60–1.67	1.46–11.56
leg III	2.83–3.04	1.05–1.28	2.11–1.24	1.87–1.93	1.45–1.57	9.90–10.49
leg IV	3.00–3.42	1.07–1.20	2.22–2.64	2.34–2.49	1.75–1.93	10.83–12.02

Spination of leg I: femur: d 1–1–1; pl and rl 0–1–1–1; tibia: pl and rl 1–1–1; v 0–2–2–2ap; metatarsus: v 2–2–0

Female: coloration as in male, pattern as in Fig. 53. Epigyne (Figs 33–34): no strongly sclerotised area around the IO, spermathecae wrinkled, duct of spermathecal organ runs through of the anterior part of spermatheca. Measurements: prosoma length: 3.24, width: 3.21, opisthosoma length: 4.89 width: 3.28. Distances between eyes: AME-AME: 0.19, AME-ALE: 0.11, PME-PME: 0.33, PME-PLE: 0.29, MOA-WA: 0.39, MOA-WP: 0.57, MOA-L: 0.56. Length of segments:

	femur	patella	tibia	metatarsus	tarsus	Σ
leg I	2.98	1.28	2.32	1.83	1.61	10.62
leg II	3.40	1.31	2.74	2.11	1.75	11.70
leg III	3.13	1.35	2.26	1.78	1.56	10.44
leg IV	3.65	1.33	2.67	2.21	1.47	11.88

Spination of leg I: femur: d 0–1–1; pl 0–1–1–1; tibia: pl and rl 1–1–1; v 0–2–2–2ap; metatarsus: v 2–2–0

Distribution: Holarctic.

Habitat: frequent in alpine meadows (PUNTSCHER 1980, THALER 1982, DETHIER 1983), at.

Thanatus pictus L. KOCH, 1881
(Figs 28–30, 35–36, 54)

Apollophanes babaly LOGUNOV, 1996 New synonymy

Hungary: collecting conditions unknown: 1f; Örkény: 4f, 3m 07/09/1931; 1f, 2m 06/10/1931; Darány: 1f 24/09/1932, HNHM

As *Th. formicinus* – Buda 2f, HNHM

Comparative material: Germany: Niesky 2f syntype 25/05/1886; Rotenburg 1m 1886, MNB – Switzerland: Brandenburg 1m 19/09/1994, NMB – Transylvania (Romania): Vacs: 1f 20/09/1886, HNHM

Male: prosoma and legs yellowish brown, opisthosoma greyish brown, pattern as in Fig. 54. Palpus (Figs 28–30): SVTA conspicuous, embolus long. Measurements: prosoma length: 1.85–2.35, width: 1.77–2.46, opisthosoma length: 2.18–3.54, width: 1.30–1.89. Distances between eyes: AME-AME: 0.12–0.13, AME-ALE: 0.05–0.08, PME-PME: 0.18–0.23, PME-PLE: 0.14–0.21, MOA-WA: 0.24–0.29, MOA-WP: 0.33–0.37, MOA-L: 0.37–0.42. Length of segments:

	femur	patella	tibia	metatarsus	tarsus	Σ
leg I	2.19–2.71	0.87–1.15	1.56–2.06	1.40–1.77	1.17–1.56	7.40–9.71
leg II	2.41–2.95	0.88–1.22	1.90–2.36	1.70–2.13	1.34–1.53	8.61–10.60
leg III	2.15–2.75	0.86–1.00	1.51–2.30	1.61–1.96	1.11–1.45	7.64–9.73
leg IV	2.50–3.53	0.74–1.06	1.66–2.82	2.04–2.64	1.45–1.82	9.39–12.22

Spination of leg I: femur: d 0–1–1; pl 0–1–1–1; tibia: pl 0–1–1; v 0–2–2–2ap; metatarsus: v 2–2–0

Female: body coloration as in male. Epigyne: anterior guide pocket is nearly perpendicular on LP (Figs 35–36). Measurements: prosoma length: 2.01–2.80, width: 2.01–2.80, opisthosoma length: 2.73–5.28, width: 1.27–2.70. Distances between eyes: AME-AME: 0.13–0.16, AME-ALE: 0.06–0.09, PME-PME: 0.21–0.28, PME-PLE: 0.18–0.24, MOA-WA: 0.28–0.34, MOA-WP: 0.37–0.44, MOA-L: 0.46–0.49. Length of segments:

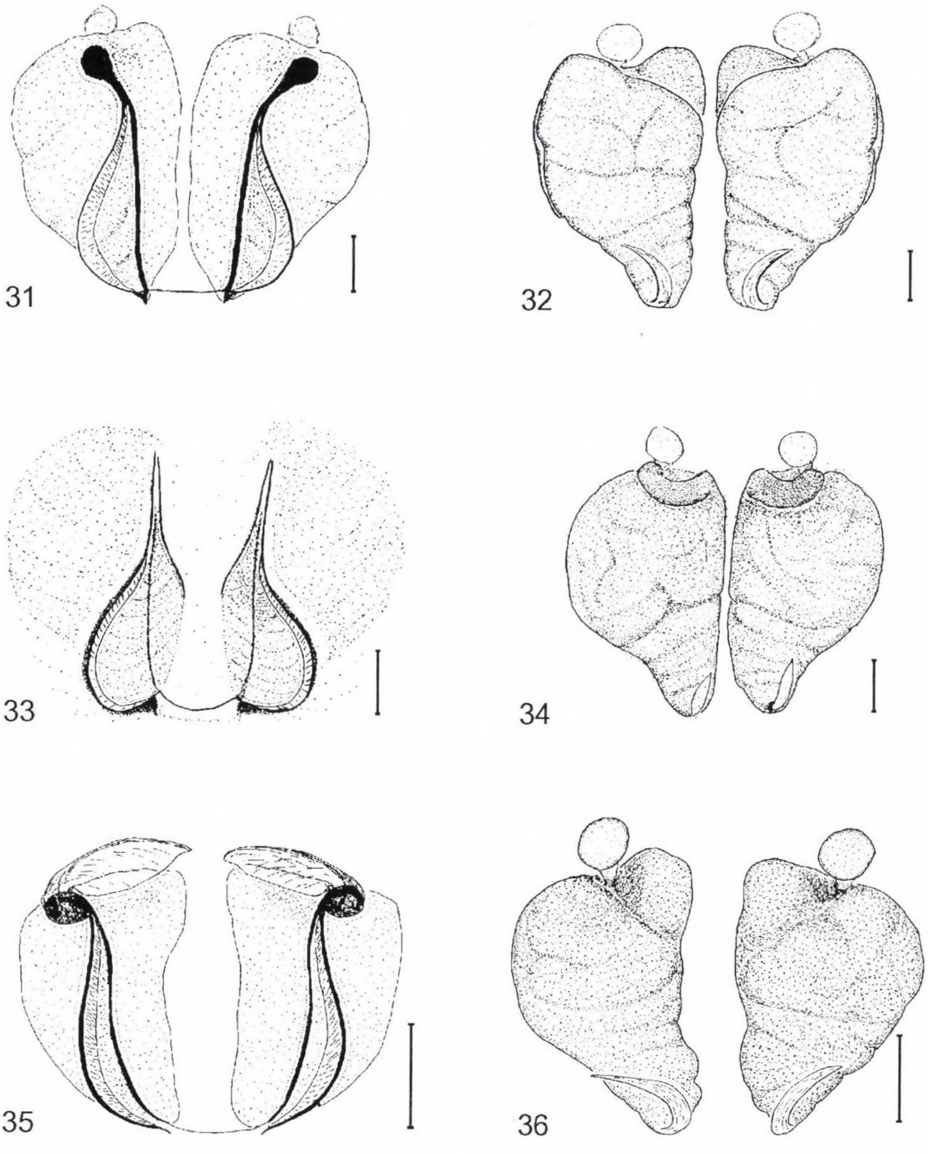
	femur	patella	tibia	metatarsus	tarsus	Σ
leg I	2.01–2.70	0.90–1.24	1.59–2.03	1.21–1.76	1.03–1.54	7.24–9.61
leg II	2.10–3.04	0.96–1.36	1.72–2.41	1.42–1.96	1.16–1.60	7.99–10.53
leg III	2.07–2.77	0.80–1.16	1.59–2.13	1.18–1.69	0.88–1.43	7.04–9.58
leg IV	2.33–3.10	0.80–1.19	1.95–2.59	1.60–2.17	1.07–1.70	8.33–11.26

Spination of leg I: femur: d 1; pl 0–1–1; tibia: pl 0–0–1; v 0–2–2–2ap; metatarsus: v 2–2–0

Distribution: Palearctic. Further localities in Hungary: Pócsmegyer (BALOGH & LOKSA 1946). Szigetmonostor (BALOGH & LOKSA 1948), Budapest, Monor, Isaszeg, Kecskemét (CHYZER & KULCZYNSKI 1896), Bátorligeti láp (LOKSA 1991*a*), Jeli (KOLOSVÁRY 1935).

Habitat: meadows with dominant *Festuca* and *Bromus* vegetation (BALOGH & LOKSA 1948, MALICKY 1972).

Phenology: according to BALOGH and LOKSA (1948) same life history pattern probably as in *Th. arenarius* (Fig. 59).



Figs 31–36. Female genitalia of *Thanatus* species. 31–32 = *Th. formicinus*: 31 = epigyne, 32 = spermathecae; 33–34 = *Th. coloradensis*: 33 = epigyne, 34 = spermathecae; 35–36 = *Th. pictus*: 35 = epigyne, 36 = spermathecae [bar= 0.1 mm]

Thanatus striatus C. L. KOCH, 1845
(Figs 13–15, 20–21, 50)

Hungary: Juliannamajor: 1f 17/06/1994, PPI – Kartal: 1f 04/07/1992, GUA – Tata: 1f 22/08/1997, ad 09/02/1998; 1m nov-96; 1m 22/08/1997, ad 05/02/1998; 1m 31/08/1997, ad 09/02/1998, PPI – unknown collecting conditions: 2f; Kecskemét: 1m, HNHM

As *Th. vulgaris*: unknown collecting conditions 1f, HNHM

Comparative material: Germany: Altmühl 1f, 1m 1986, EB – Bohemia: Stará Hlina 6f 09/07/1979; 1f, 1m 04/06/1979; Trebo 3m 22/05/1979, IEC – Switzerland: Marburg 1f, 1m, UB; Brandenburg, Friedrichsthal 4f 24/05/1995, NMB – Denmark: Amtspl. v. Rarvig 2f 04/05/1968; Tastrup Sugefalde 1f, 8m 17/05/1976; 1f 25/06/1972; 1m 11/05/1974, UA

Male: body and legs sandy coloured with indistinct pattern of brownish spots. Palpus (Figs 13–15): SVTA long and flattened, tip of embolus curved, its appearance in lateral view flagellum like. Measurements: prosoma length: 1.39–1.98, width: 1.31–1.67, opisthosoma length: 1.64–2.22, width: 1.18–1.65. Distances between eyes: AME-AME: 0.11–0.14, AME-ALE: 0.04–0.06, PME-PME: 0.19–0.23, PME-PLE: 0.17–0.21, MOA-WA: 0.23–0.26, MOA-WP: 0.33–0.37, MOA-L: 0.30–0.36. Length of segments:

	femur	patella	tibia	metatarsus	tarsus	Σ
leg I	1.24–1.54	0.47–0.74	0.91–1.25	0.79–1.04	0.68–0.88	4.59–5.39
leg II	1.40–1.62	0.56–0.84	1.07–1.32	0.88–1.17	0.65–0.96	5.11–6.33
leg III	1.25–1.51	0.50–0.69	0.81–1.21	0.73–0.94	0.57–0.79	4.46–5.55
leg IV	1.35–1.77	0.57–0.70	0.95–1.30	0.85–1.39	0.75–0.84	4.81–6.25

Spination of leg I: femur: d 0–1–1; pl 0–0–1–1–1; tibia: pl and rl 0–0–1 or 0–1–1; v 2–2–2ap; metatarsus: v 2–2–0

Female: coloration as in male (Fig. 50). Epigyne (Figs 20–21): anterior end of LP angular, CD round. Spermathecae separate. Measurements: prosoma length: 1.32–2.01, width: 1.48–2.02, opisthosoma length: 2.58–4.17 width: 1.90–2.99. Distances between eyes: AME-AME: 0.14–0.18, AME-ALE: 0.06–0.08, PME-PME: 0.23–0.29, PME-PLE: 0.19–0.24, MOA-WA: 0.28–0.33, MOA-WP: 0.34–0.46, MOA-L: 0.33–0.44. Length of segments:

	femur	patella	tibia	metatarsus	tarsus	Σ
leg I	1.09–1.58	0.52–0.72	0.92–1.32	0.76–1.11	0.56–0.88	4.14–5.65
leg II	1.27–1.75	0.66–0.84	0.99–1.38	0.80–1.13	0.59–0.91	4.22–6.06
leg III	1.08–1.45	0.53–0.79	0.85–1.16	0.62–1.07	0.51–0.83	3.80–5.25
leg IV	1.40–1.76	0.56–0.77	0.92–1.30	0.75–1.18	0.64–0.93	4.23–5.80

Spination of leg I: femur: d 1; pl 0–1–1; tibia: v 2–2–2 or 2–2–0; metatarsus: v 2–2–0

Distribution: Holarctic. Further localities in Hungary: Kecskemét, Balatonlelle (CHYZER & KULCZYNSKI 1896), Simontornya (PILLICH 1911), Bátorligeti láp (LOKSA 1991*b*), Kartal (TÓTH *et al.* 1996).

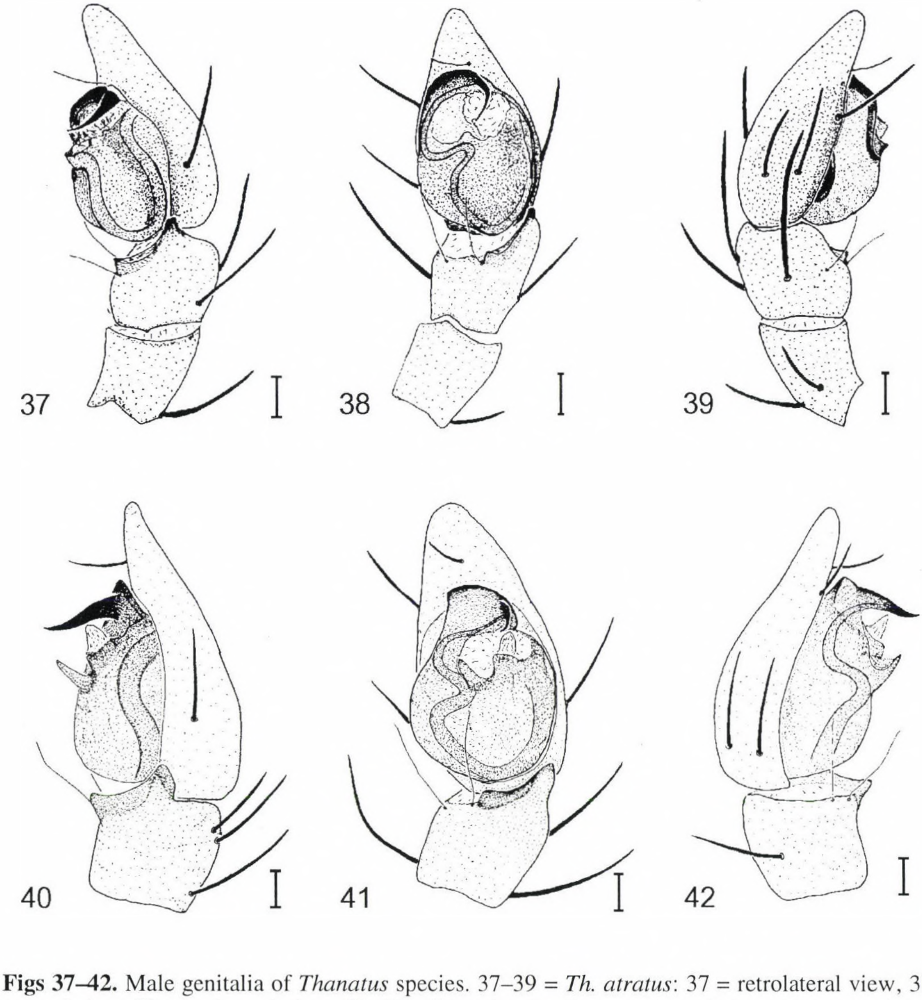
Habitat: Fairly frequent in wet meadows (MERRETT 1967, ALMQUIST 1973, HÄNNGI 1987), on seashores (ALMQUIST 1973) and on marshy areas (LOKSA 1991*a*).

Phenology: Life history pattern as in *Th. formicinus* (Fig. 58)

Thanatus atratus SIMON, 1875
(Figs 37–39, 43–44, 55–56)

Hungary: As *Th. atratus* – Csákvár: 1f 13/05/1997, ad 30/06/1997; Farkas-hegy: 1f 10/06/1997, ad 14/07/1997; 1f 10/06/1997, ad 20/06/1997; 1f 06/08/1997; 1m 10/06/1997, ad 12/06/1997; 1m 10/06/1997, ad 18/06/1997; 1m 19/06/1997; Odvas/Út-hegy: 4f 19/06/1997; 3f 25/06/1997; 1f 25/06/1997, ad 02/07/1997; 2f 02/07/1997; 1m 10/06/1997, ad 10/07/1997; 1m 19/06/1997; Gánt: 1f 15/08/1997, PPI

As *Th. vulgaris* – locality unknown: 1f, 1m 1887; Körtvélyes 1f; Pécs 1f 26/06/1887, HNHM



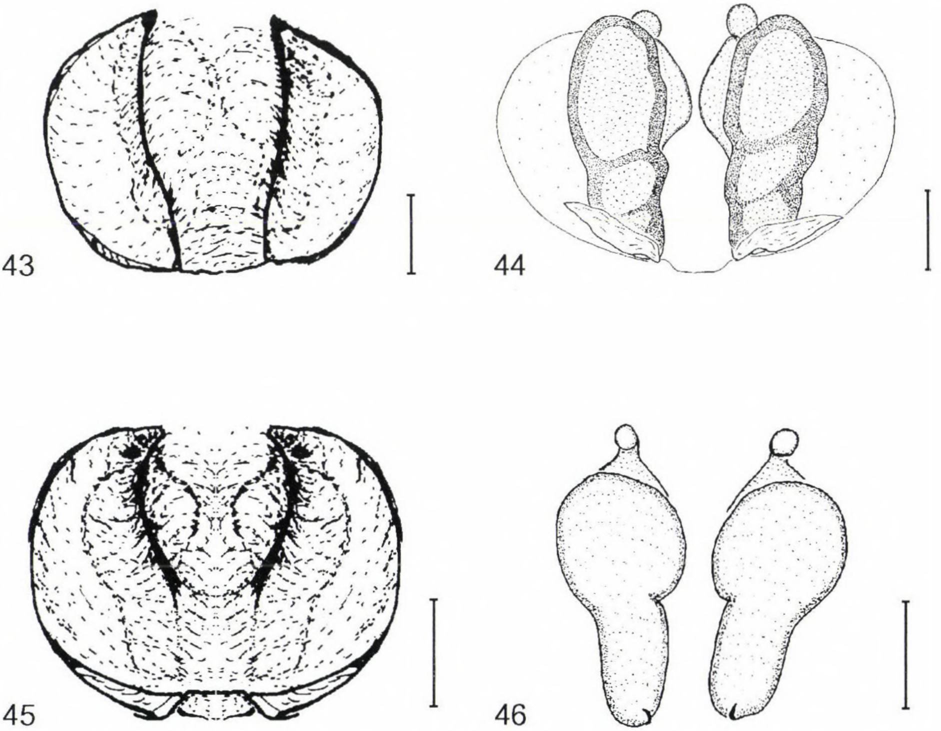
Figs 37–42. Male genitalia of *Thanatus* species. 37–39 = *Th. atratus*: 37 = retrolateral view, 38 = ventral view, 39 = prolateral view; 40–42 = *Th. vulgaris*: 40 = retrolateral view, 41 = ventral view, 42 = prolateral view [bar= 0.1 mm]

Comparative material: As *Th. atratus* – unknown locality: 1m 11/07/1994, NMB; Switzerland: Mte Generoso, Pree 2f, 10m 01/08/1988, 2m 24/08/1988, 1f, 44m 06/07/1989, 1f 13/08/1989, 9f, 2m 05/09/1989, 1f 13/11/1989 NMBA

As *Th. vulgaris* – Bulgaria: Albena, North Black Sea coast 1f, 5m 15/10/1997; Sredna Gora, Bratiya 10m 15/07/1997, IZB; Burgas 1f 26/06/1966, MNB; Primorsko 1m 06/1963, UK – France: 1f, AMN – Bohemia: 7m, Cicov-Mt. 4f 08/07/1964; Pálava Mts 1f 08/09/1965; Mikulov "Stavy kopacek"-Mt. 2m, 1f jún-59; Raná-Mt. 3m, 2f 07/1963, UK – Croatia: Fiume 5f, 1m 30/06/1887; Zengg 1f 25/06/1887, HNHM

Male: body grayish or light brown, legs of same colour with spots, coloration as in Fig. 55. Palpus (Figs 37–39): tegular apophysis small, slightly rounded, the curve of embolus continuous. Measurements: prosoma length: 1.58–2.04, width: 1.46–1.93, opisthosoma length: 1.52–2.69, width: 0.97–1.90. Distances between eyes: AME-AME: 0.11–0.13, AME-ALE: 0.05–0.06, PME-PME: 0.19–0.21, PME-PLE: 0.18–0.21, MOA-WA: 0.26–0.28, MOA-WP: 0.33–0.39, MOA-L: 0.32–0.41. Length of segments:

	femur	patella	tibia	metatarsus	tarsus	Σ
leg I	1.39–1.80	0.66–0.76	1.12–1.37	0.91–1.19	0.68–0.95	4.99–6.33
leg II	1.55–1.94	0.64–0.85	1.27–1.68	1.17–1.42	0.74–1.08	5.84–7.32
leg III	1.50–1.78	0.55–0.86	1.13–1.38	0.87–1.30	0.64–0.94	5.06–6.24
leg IV	1.75–2.01	0.57–0.80	1.30–1.58	1.21–1.65	0.78–1.01	5.98–7.39



Figs 43–46. Female genitalia of *Thanatus* species. 43–44 = *Th. atratus*: 43 = epigyne, 44 = spermathecae. 45–46 = *Th. vulgaris*: 45 = epigyne, 46 = spermathecae [bar = 0.1 mm]

Spination of leg I: femur: d 1–1–1; pl and rl 0–1–1–1ap; tibia: pl and rl 1–1–1; v 0–2–2–2ap; metatarsus: v 2–2–0

Female: Coloration as in male, pattern as in Fig. 56. Epigyne (Figs 43–44): central division separating LP-s, spermathecal organ hardly visible. Measurements: prosoma length: 1.76–2.32, width: 1.84–2.07, opisthosoma length: 2.82–3.70, width: 1.18–2.52. Distances between eyes: AME-AME: 0.13–0.16, AME-ALE: 0.06–0.08, PME-PME: 0.23–0.29, PME-PLE: 0.19–0.28, MOA-WA: 0.28–0.34, MOA-WP: 0.37–0.44, MOA-L: 0.35–0.43. Length of segments:

	femur	patella	tibia	metatarsus	tarsus	Σ
leg I	1.48–1.85	0.66–0.94	1.12–1.48	0.91–1.27	0.76–1.00	5.61–6.77
leg II	1.68–2.13	0.71–0.91	1.40–1.74	1.07–1.31	0.69–1.06	5.89–7.49
leg III	1.48–1.79	0.62–0.85	1.17–1.37	0.91–1.25	0.66–0.90	5.56–6.46
leg IV	1.64–2.03	0.54–0.80	1.36–1.63	1.06–1.48	0.81–1.00	5.69–7.34

Spination of leg I: femur: d 0–1–1; pl 0–1–1–1ap or 1ap; rl 0 or 1ap; tibia: pl 1–1–1;rl 0 or 1–1–1; v 0–2–2–2ap; metatarsus: v 2–2–0

Distribution: Palearctic. Further localities in Hungary: Balatonalmádi, Pécs, Tokaj, Körtvélyes (CHYZER & KULCZYNSKI 1896), Bugac (KEREKES 1988), Sas-hegy (BALOGH 1935), Szigetmonostor (BALOGH & LOKSA 1948).

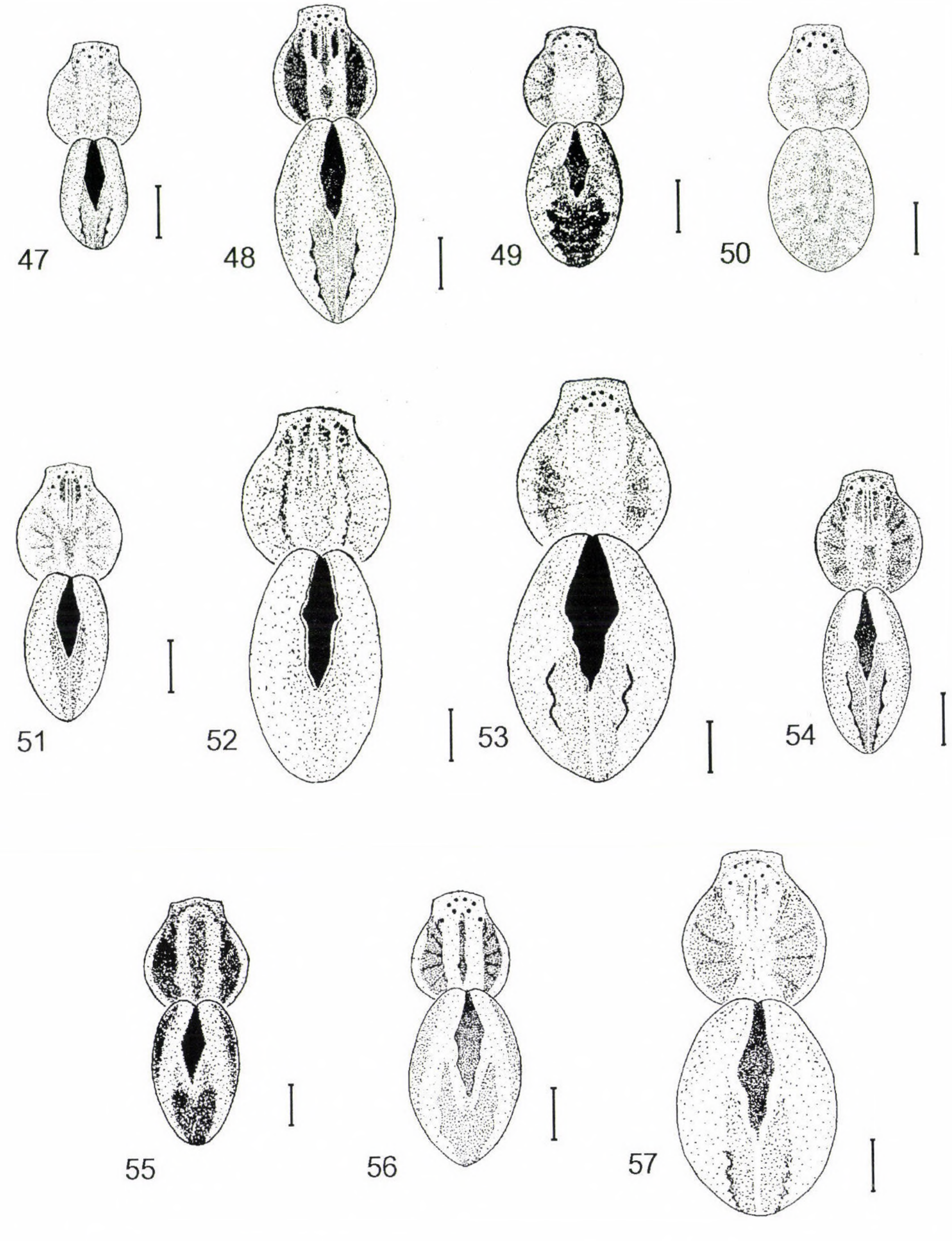
Habitat: same as described in *Th. arenarius*.

Phenology: Adults occur from end of June to mid August, hibernation in juvenile stage (Fig. 60).

Thanatus vulgaris SIMON, 1870
(Figs 40–42, 45–46, 57)

Examined material: Bulgaria: Albena, North Black Sea coast 1f 15/10/1997, IZB; Albena 1m 02/07/1966, MNB – Israel: Jerusalem 2f 1992; 1m 21/07/1991; Nizzauna Radon 1m 01/05, BGU – U.S.A.: Nayarit, Tepic: 1f 07/08/1955; Hattiesburg, Miss 1f 1946; Sonora, Desemboque 2f 31/07/1953; Las Vegas, Nevada 1f 1944; Rodhiss , N.C 19f 02/10/1934; Tucson, Ariz 1f, 2m aug-37; Bear Lake, Idaho 1f 14/08/1931; St. George, Utah 2f, 1m 07/07/1931; Prattsburg, Georgia 2f, 1m 13/10/1945; Friant, Calif 1m 1913; Las Vegas, Nevada 1m 1913; Bakersfield, Calif 1m 14/11/1951, AMN – Mexico: Isla Cedros 1f 25/05/1945; Santa Barbara, Chihua alt 1f 20/01/1947; Hacienda La Oaxaquena 1m 15/10/1939, AMN – Spain: Agua Dulce, Almeria 2m 20/05/1924, AMN, Zaragoza: 1f 5/21/1994; 1f 7/17/1994; 1m 17/06/1995; 1m 03/06/1995; 1f, 2m 20/06/1991; 1m 6/7/1991; 2m 28/06/1990; 1f 5/28/1990; 1m 23/06/1989; Huesca: 1f 03/1995; 3f 06/1995; Orsene: 1f 06/1995; 1f 7/7/1996, ESA – France: Corsica, Ostriconi 1m 06/1984 MG; collecting conditions unknown 1m, AMN

Male: body and legs yellowish brown with spots. Palpus (Figs 40–42): tegular apophysis conspicuous and sharp, curve of embolus broken, so tip of embolus projecting. Measurements: prosoma length: 1.74–2.65, width: 2.23–2.52, opisthosoma length: 1.97–3.11, width: 1.39–1.94. Distances between eyes: AME-AME: 0.13–0.23, AME-ALE: 0.05–0.11, PME-PME: 0.23–0.36, PME-PLE: 0.17–0.36, MOA-WA: 0.31–0.44, MOA-WP: 0.36–0.56, MOA-L: 0.36–0.52. Length of segments:



Figs 47–57. Body colouration of *Thanatus* species: 47–48 = *Th. arenarius* 47 = male, 48 = female; 49 = *Th. sabulosus*, female; 50 = *Th. striatus*, female; 51 = *Th. formicinus*, male, 52 = female; 53 = *Th. coloradensis*, female; 54 = *Th. pictus*, male; 55 = *Th. atratus*, male, 56 = female; 57 = *Th. vulgaris*, female [bar = 0.1 cm]

	femur	patella	tibia	metatarsus	tarsus	Σ
leg I	3.14–3.20	1.16–1.21	2.68–2.78	2.42–2.56	1.50–1.70	10.90–11.45
leg II	3.96–4.18	1.28–1.52	3.21–3.26	2.95–3.15	1.78–1.90	12.86–14.23
leg III	3.24–3.49	1.08–1.17	2.36–2.45	2.27–2.47	1.34–1.55	10.61–11.38
leg IV	3.64–3.83	0.93–1.13	2.80–3.04	2.73–3.02	1.53–1.63	11.69–12.74

Spination of leg I: femur: d 1–1–1 or 0–1–1; pl and rl 0–1–1–1; tibia: pl and rl 1–1–1; v 2–2–2ap; metatarsus: v 2–2–0

Female: coloration as in males, pattern as in Fig. 57. Epigyne (Figs 45–46): posterior part of central division concave, spermathecal organ easily seen at anterior part of spermatheca. Measurements: prosoma length: 3.11–3.35, width: 3.02–3.59, opisthosoma length: 4.03–5.93, width: 2.84–4.15. Distances between eyes: AME-AME: 0.16–0.21, AME-ALE: 0.08–0.13, PME-PME: 0.29–0.37, PME-PLE: 0.28–0.37, MOA-WA: 0.39–0.42, MOA-WP: 0.46–0.57, MOA-L: 0.44–0.56. Length of segments:

	femur	patella	tibia	metatarsus	tarsus	Σ
leg I	3.71–4.04	1.49–1.64	2.87–3.13	2.34–2.63	1.55–1.67	12.51–13.68
leg II	3.98–4.73	1.88–1.91	3.27–3.59	2.78–2.95	1.72–1.81	14.21–15.60
leg III	3.64–3.92	1.56–1.66	2.48–3.02	2.29–2.50	1.34–1.45	11.66–12.86
leg IV	3.79–4.49	1.39–1.48	2.91–3.26	2.77–2.89	1.45–1.65	12.90–14.18

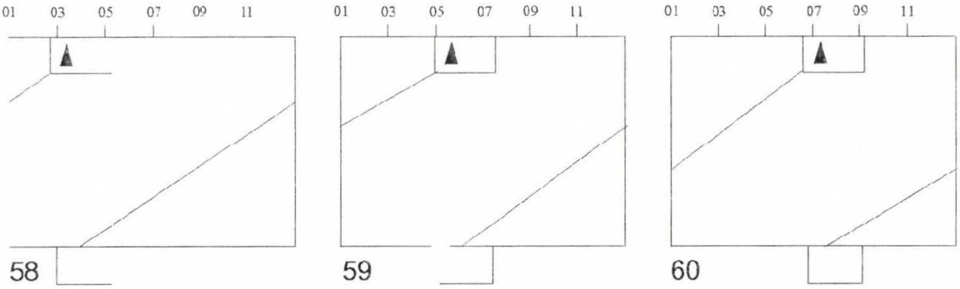
Spination of leg I: femur: d 1–1–1 or 0–1–1; pl and rl 0–1–1–1; tibia: pl and rl 1–1–1; v 2–2–2ap; metatarsus: v 2–2–0

Distribution: Holarctic.

Habitat: dry stony steppe (LOGUNOV 1996).

Distinguishing the species

Th. arenarius, *sabulosus* and *striatus* are easily distinguishable from all other *Thanatus* of Hungary.



Figs 58–60. Phenology of *Thanatus* species. 58 = *Th. formicinus* and *Th. striatus*, 59 = *Th. arenarius* and *Th. pictus*, 60 = *Th. atratus*. Each figure covers one year. Small rectangle at the upper part of the figure = period of adulthood, the triangle in it = time of copulation. Small rectangle at the bottom = egg-laying period. Solid line = rate of development

Th. formicinus and *Th. coloradensis* are closely related, so their identification requires more attention. Males can be easily distinguished by the retrolateral tibial apophysis. In the females the duct of spermathecal organ of the vulva is a good character. DONDALE *et al.* (1964) used femur I spination to separate them additionally – there are three spines in *coloradensis* and two in *formicinus*. In Hungary this character was not valid, since one third of the *Th. formicinus* population had three spines.

The female of *Th. pictus* can be distinguished by its anterior guide pocket of the epigyne from the two species mentioned above.

Th. atratus and *Th. vulgaris* are again closely related species. The males can be distinguished by the shape of their embolus – *Th. atratus* has a continuous curve of its embolus, but in *Th. vulgaris* the curve of embolus of is broken. Females of *Th. vulgaris* have a depressed central division of their epigynes, and their spermathecal organ is visible, while CD of epigyne of *Th. atratus* separates the LP-s from each other and the spermathecal organ is hardly visible. The epigynes of these two species usually become plugged after mating, and the characters mentioned above can be seen only after the removal of this plug.

*

Acknowledgement – We would like to express our thanks to Drs. S. MAHUNKA, CS. SZINETÁR, F. TÓTH, K. SZATHMÁRY, E. BAUCHHENSS, J. BUCHAR, C. DELTSHEV, J. DUNLOP, A. HÄNNGI, C. KROPF, S. LAZAROV, Y. LUBIN, V. MANHERT, A. MELIC-BLAS, W. NENTWIG, N. PLATNICK, V. RIKA, S. TOFT, I. URÁK and V. ZINGERLE for the opportunity to examine some material under their care. J. GÁL helped us to digitize figures. Finally we wish to thank Drs. D. LOGUNOV and K. MIKHAILOV for their helpful criticism and discussions. This paper is a contribution to OTKA research T 32209.

REFERENCES

ALMQUIST, S. (1973) Spider associations in coastal sand dunes. *Oikos* **24**: 1–14.

BALOGH, J. I. (1933) Beiträge zur Kenntnis der Spinnenfauna des Balaton-Gebietes. *Arb. ung. biol. Forsch.-Inst.* **6**: 133–141.

BALOGH, J. I. (1935) *A Sashegy pókfaunája. Faunisztikai, rendszertani és környezettani tanulmány.* Sárkány-Nyomda Rt, Budapest.

BALOGH, J. I. (1938*a*) A Kőszegi-hegység pókfaunájának alapvetése. *A Kőszegi Múzeum Közleményei* **1**: 256–262.

BALOGH, J. I. (1938*b*) Biosoziologische Studien über die Spinnenfauna des Sashegy (Adler-Berg bei Budapest). *Festschr. Strand* **4**: 464–497.

BALOGH, J. I. (1938*c*) Nova data Arachnologica e montibus Börzsöniensis. *Fragm. Faun. Hung.* **1**: 16–17.

BALOGH, J. & LOKSA, I. (1946) Symbola ad faunam Aranearum Hungariae cognoscendam. *Fragm. Faun. Hung.* **9**: 11–16.

BALOGH, J. I. & LOKSA, I. (1948) Quantitativ-biosoziologische Untersuchung der Arthropodenwelt Ungarischer Sandgebiete. *Arch. Biol. Hung.* **2**: 65–100.

BONNET, P. (1945) *Bibliographia Araneorum.* Toulouse.

BONNET, P. (1959) *Bibliographia Araneorum, (T-Z).* Toulouse.

BUCHAR, J. (1979) Arachnofauna aus dem Tale Brna nad Labem. *Faun. Bohem. Septentrionalis* **4**: 77–92.

CHYZER, K. & KULCZYNSKI, L. (1891) *Araneae Hungariae. Tomus I: Salticoidae, Oxyopoidae, Lycosoidae, Heteropodoidae, Misumenoidae, Euetrioidae, Tetragnathoidae, Uloboroidae, Pholcoidae, Scytodoidae, Urocteoidae, Eresoidae, Dictynoidae.* Academie Scientiarum Hungaricae, Budapest.

CHYZER, K. & KULCZYNSKI, L. (1896) Ordo Araneae. Pp. 33. *In* PASZLAVSZKY, J. (ed.): *A Magyar Birodalom Állatvilága. III. Arthropoda.* Kir. Magyar Term. tud. Társ., Budapest.

CHYZER, K. & KULCZYNSKI, L. (1897) *Araneae Hungariae. Tomus II. pars posterior: Zodarioidae, Agalenoidae, Drassoidae, Zoropseoidae, Dysderoidae, Filistatoidae, Calommatoidae, Theraphosoidae.* Academie Scientiarum Hungaricae, Budapest.

DETHIER, M. (1983) Araignées et opilions d'une pelouse alpine au Parc National Suisse. *Ber. natruwiss. med. Ver. Innsbruck* **70**: 67–91.

DONDALE, C. D. & REDNER, J. H. (1975) Revision of the spider genus Apollophanes (Araneida: Thomisidae). *Can. Ent.* **107**: 1175–1192.

DONDALE, C. D., TURNBULL, A. L. & REDNER, J. H. (1964) Revision of the Nearctic Species of Thanatus C. L. Koch (Araneae: Thomisidae). *Can. Ent.* **96**: 636–656.

HÄNNGI, A. (1987) Die Spinnenfauna der Feuchtgebiete des Grossen Mooses, Kt. Bern.- Beurteilung des Naturschutzwertes naturnaher Standorte anhand der Spinnenfauna. *Mitt. naturf. Ges. Bern* **44**: 157–185.

HÄNNGI, A., STÖCKLI, E. & NENTWIG, W. (1995) Habitats of Central European spiders. *Misc. Faun. Helvet.* **4**: 1–460.

HANSEN, H. (1995) Über die Arachniden-Fauna von urbanen Lebensräumen in Venedig- III. Die epigäischen Spinnen eines Stadtparkes (Arachnida: Araneae). *Boll. Mus. civ. Stor. nat. Venezia* **44**: 7–36.

HEIMER, S. & NENTWIG, W. (1991) *Spinnen Mitteleuropas.* Paul Parey, Berlin.

KASPER, Á. (1992) Adatok Csabrendek és környéke pókfaunájának (Araneae) ismeretéhez. *Fol. Mus. Hist. Nat. Bakonyiensis* **11**: 247–254.

KEREKES, J. (1988) Faunistic studies on epigeic spider community on sandy grassland (KNP). *Act. Univ. Szeged. Act. Biol.* **34**: 113–117.

KEYSERLING (1880) *Die Spinnen Amerikas. Laterigradae.* Nürnberg.

KOCH, C. L. (1845) *Die Arachniden..* Nürnberg.

KOCH, L. (1881) Beschreibungen neuer von Herrn Dr Zimmermann bei Niesky in der Oberlausitz entdeckter Arachniden. *Abh. naturf. Ges. Görlitz* **17**: 41–71.

KOLOSVÁRY, G. (1928) Die Spinnen-Faune von Szeged (Ungarn). (Eine faunistische Studie). *Acta lit. sci. Univ. Hung.* **3**: 41–54.

KOLOSVÁRY, G. (1935) Neue Beiträge zur Biologie der Tierwelt der ungarländischen Junipereten. *Fol. Zool. Hydrobiol.* **7**: 203–216.

KOLOSVÁRY, G. (1936) Ein Versuch zur Einteilung der Karpathischen länder mit Berucksichtigung der spinnenfaunistischen Angaben und ein Beitrag zum Rassenkreisproblem bei Spinnen. *Fol. Zool. Hydrobiol.* **9**: 92–114.

KROGERUS, R. (1932) Über die Ökologie und Verbreitung der Arthropoden der Triebsbandgebiete an den Küsten Finlands. *Acta Zool. Fenn.* **12**: 1–308 [Spinnen, p. 130].

KRONESTEDT, T. (1983) Spindlar pa Ölands Stora alvar. *Ent. Tidskr.* **104**: 183–212.

KULCZYNSKI, L. (1903) Aranearum et Opilionum species in insula Creta a comite Dre Carolo Attems collectae. *Bull. Acad. Cracovie* **1903**: 32–58.

LEVY, G. (1977) The philodromid spiders of Israel (Araneae, Philodromidae). *Isr. J. Zool.* **26**: 193–229.

LOCKET, G. H. & MILLIDGE, A. F. (1951) *British Spiders.* The Ray Society, London.

LOGUNOV, D. (1996) A critical review of the spider genera Apollophanes O. P. Cambrige, 1898 and Thanatus C. L. Koch, 1837 in North Asia (Araneae, Philodromidae). *Rev. Arachnol.* **11**: 133–202.

LOKSA, I. (1991*a*) The spider (Araneae) fauna of the Bátorliget Nature Reserves (NE Hungary). Pp. 691–704. *In* MAHUNKA, S. (ed): *The Bátorliget Nature Reserves – after forty years 2.* Hung. Nat. Hist. Mus., Budapest.

LOKSA, I. (1991*b*) Über einige Arthropoden-Gruppen aus dem Pilis-Biosphären-Reservat (Ungarn). 2. Die Diplopoden, Chilopoden, Weberknechte und Spinnen aus dem Gebiet zwischen Kakas-Berg (Pilisszentkereszt) und Ispán-Wiese (Mikula-haraszt). *Opusc. Zool.* **24**: 129–141.

MALICKY, H. (1972) Vergleichende Barberfallenuntersuchungen auf den Apetloner Huteweiden (Burgerland) und im Wiener Neustadt Steinfels (Niederöst): Spinnen (Araneae). *Wiss. Arbeit. Burgenland* **48**: 109–123.

MARGÓ, T. & FRIVALDSZKY, J. (1879) *Budapest és környéke állattani tekintetben*, Budapest.

MENGE, A. (1875) Preussische Spinnen. VII. Abtheilung. *Schr. naturf. Ges. Danzig, (N. F.)* **3**: 375–422.

MERRETT, P. (1967) The phenology of spiders on heathland in Dorset I. Families Atypidae, Dysderidae, Gnaphosidae, Clubionidae, Thomisidae and Salticidae. *J. Anim. Ecol.* **36**: 363–374.

ONO, H. (1988) *A revisional study of the spider family Thomisidae (Arachnida, Araneae) of Japan.* National Science Museum, Tokio.

PILLICH, F. (1911) Adatok Simontornya pókfaunájához. *Rovartani Közlemények* **11**: 88–89.

PLATNICK, N. I. (1989) *Advances in spider taxonomy 1981–1987. A supplement to Brignoli's Catalogoue of the Araneae.* Manchester University Press, Manchester.

PLATNICK, N. I. (1993) *Advances in Spider Taxonomy 1988–1991. With Synonymies and Transfers 1940–1980.* New York Ent. Soc., New York.

PLATNICK, N. I. (1997) *Advances in spider taxonomy 1992–1995, With redescriptions 1940–1980*, New York.

POZZI, S. & HÄNNGI, A. (1998) Araignées nouvelles ou peu connues de la Suisse (Arachnida: Araneae). *Bull. Soc. Entom. Suisse* **71**: 33–47.

PUNTSCHER, S. (1980) Verteilung und Jahresrhythmik von Spinnen im zentralalpinen Hochgebirge (Obergurgl, Ötztaler Alpen). Pp. 75–80. *In* GRUBER, J. (ed.): *Verhandlungen. 8th Internat. Congr. Arachnol.*, Vienna.

ROBERTS, M. J. (1995) *Spiders of Britain and Northern Europe.* Harper Collins, London.

ROEWER, C. F. (1928) Araneae, Echte oder Webespinnen. Pp. 1–144, with 1583 figures. *In* BROHMER, P., EHRMANN, P. & ULMER, G. (eds): *Die Tierwelt Mitteleuropas, Band III*, Leipzig.

ROEWER, C. F. (1954*a*) *Katalog der Araneae von 1758 bis 1940, bzw. 1954.* Institut Royal des Sciences naturelles de Belgique, Bruxelles.

ROEWER, C. F. (1954*b*) *Katalog der Araneae von 1758 bis 1940, bzw. 1954.* Institut Royal des Sciences naturelles de Belgique, Bruxelles.

SAMU, F. & SZINETÁR, C. (1999) Bibliographic check list of the Hungarian spider fauna. *Bull. Br. Arachnol. Soc.* **11**: 161–184.

SCHAEFER, M. (1977) Untersuchungen über das Wachstum von zwei Spinnenarten (Araneida) im Labor und Freiland. *Pedobiologia* **17**: 189–200.

SCHICK, R. X. (1965) The crab spiders of California (Araneida, Thomisidae). *Bull. Amer. Mus. Nat. Hist.* **129**: 1–180.

SIMON, E. (1870) Araneides nouveaux ou peu connus du midi de l'Europe. *Mém. Soc. roy. sci. Liége* **2**: 271–358.

STEINBERGER, K. H. (1988) Epigäische Spinnen an 'xerothermen' Standorten in Kärnten (Arachnida : Aranei). *Carinthia II. Mitt. naturhist. Landes-mus. Kärten. Klagenfurt* **2**: 503–513.

STEINBERGER, K. H. (1990) Phenology and habitat selection of "xerothermic" spiders in Austria (Lycosidae, Gnaphosidae). Pp. 325–333. *In* CELERIER, M.-L., HERTAULT, J. & ROLLARD, C. (eds): *XII. Coll. europ. Arachnol.*, Paris. Bull. Soc. Eur. Arachnol. Hors Ser. 1.

SZINETÁR, C. (1992) A Boronka-melléki Tájvédelmi Körzet pókfaunája. *Dunántúli Dolgozatok Természettudományi Sorozat* **7**: 331–345.

SZINETÁR, C. (1995) Data to the Araneae fauna of Őrség (Western Hungary). *Savaria – Vas Megyei Múzeumok Értesítője* **22**: 245–251.

THALER, K. (1982) Fragmenta Faunistica Tirolensia – V (Arachnida: Aranei, Crustacea: Isopoda, Oniscoidea, Myriapoda: Diplopoda; Insecta: Saltatoria). *Ber.nat.-med.* **69**: 53–78.

THALER, K. (1985) Über die epigaische Spinnenfauna von Xerothermstandorten des Tiroler Inntales (Österreich) (Arachnida. Aranei). *Veröff. Mus. Ferdinandeum (Innsbruck)* **65**: 81–103.

TOFT, S. (1976) Life-histories of spiders in a Danish beech wood. *Nat. Jutl.* **19**: 5–40.

TÓTH, F., KISS, J., SAMU, F., TÓTH, I. & KOZMA, E. (1996) Az őszibúza fontosabb pókjai (Araneae) talajcsapdás gyűjtésre alapozva (előzetes közlemény). [Description of important spider species (Araneae) of winter wheat in pitfall trap catches.] *Növényvédelem* **32**: 235–239. [in Hungarian]

TULLGREN, A. (1942) Bidrag till kännedomen om den svenska spindelfaunan. I. *Entom. Tidskr.* **63**: 217–234.

Revised version received 1st June, 2000, accepted 30th June, 2000, published 24th July, 2000

The Fauna of the Bükk National Park

VOLUME I

Edited by
S. MAHUNKA and L. ZOMBORI

The seventh part of the series "Natural History of the National Parks of Hungary" comprises a collection of papers written by thirty-seven Hungarian and foreign experts. This is the first volume which discusses a large share of the scientifically elaborated material deriving from the territory of the Bükk National Park (North Hungary).

The book opens with a preface written by Dr. J. Tardy, deputy secretary of state, who gives his "Reflections on nature conservation in Hungary, 1993", followed by an editorial Introduction having a detailed list of all the larger administrative and also minor locality names, some of which are amply shown in a map. The volume proper is divided into two sections: Mollusca and Arthropoda. The latter, by far the biggest section, is a collection of scientifically highly valuable contributions on the following groups of animals: Mallophaga (4 pp), Heteroptera (4 pp), Homoptera (8 pp), Coleoptera (80 pp), Lepidoptera (162 pp), Diptera (82 pp), Siphonaptera (6 pp), Hymenoptera (42 pp), Acari (5 pp). The book closes with an Index to Authors.

The volume published by the Hungarian Natural History Museum in 1993.

ISBN 963 7093 206. Soft bound,
456 pages with several figures and tables.
Price: 30 US dollars excl. p. & p.

Order should be sent
to the Hungarian Natural History Museum, Library
Baross u. 13., Budapest, H–1088 Hungary
Fax: (36–1) 1171-669

ACTA ZOOLOGICA ACADEMIAE SCIENTIARUM HUNGARICAE

An international journal of animal taxonomy and ecology

Instruction to authors

Submission of a paper implies that it has not been published previously, that is not under consideration for publication elsewhere, and that if accepted for the Acta Zoologica Hungarica, the authors will transfer copyright to the Hungarian Academy of Sciences/the Hungarian Natural History Museum as is customary. Articles and illustrations become the property of the HAS/HNHM.

Papers must be in English with British spelling, and be original contributions in the field of animal taxonomy, systematics, zoogeography and ecology. All manuscripts must be submitted to one of the editors (editor, assistant editor).

Entire manuscripts must be submitted on IBM compatible floppy disk and in duplicate printed copies and the author should retain a copy. In the case of multiple authors, the corresponding author should be indicated. Series of numbered papers will not be considered.

Manuscripts must be printed with double spacing (including the reference list), and with wide margins (30–35 mm) on the left side of the paper only. Authors are requested to keep their communications as concise as possible. Footnotes should be avoided or minimized, and italics should not be used for emphasis. A running head of not more than 30 letters should be supplied.

The manuscript should contain the following information:

Title should be followed by the name and full address of the author(s). Where possible, the fax and/or e-mail number of the corresponding author should be supplied with the manuscript, for use by the publisher.

Abstract should be a brief summary of the contents and conclusions of the paper, and should not be longer than 200 words and should not contain references.

Key words should not be more than five (exceptionally 6) key word entries.

Introduction should contain a brief survey of the relevant literature and the reasons for doing the work.

Materials and Methods supply sufficient information to permit repetition of the experimental or field work. The technical description of methods should be given only when such methods are new.

Results should be presented concisely. Only in exceptional cases will it be permissible to present the same set of results in both table and a figure. The results section should not be used for discussion.

Discussion should be separate from the results section and should deal with the significance of the results and their relationship to the object of the work (and, this is the place of the identification key in taxonomic revisions).

Acknowledgements (at most in 10 lines).

References. In principle the Harvard system is to be followed. References should be detailed in the following order: authors' names and initials, date of publication (in parentheses), the title of the article, the name of the journal as abbreviated in the World List of Scientific Periodicals (4th edn 1963), the volume, and the first and last pages of the article, e.g.

NORRBOM, A. L. and KIM, K. C. (1985) Taxonomy and phylogenetic relationships of Copromyza Fallén (s.s.) (Diptera: Sphaeroceridae). *Ann. Entomol. Soc. Am.* **78**: 331–347.

For books the author's names, date of publication, title, edition, page reference, publisher's name and the place of publication should be given, e.g.

HINTON, H. E. (1981) *Biology of insect eggs*, vol. 2. Pergamon Press, New York, 234 pp.

or

MCALPINE, J. F. (1981) Morphology and terminology, adults. Pp. 9–63. *In* MCALPINE *et al.* (eds) *Manual of Nearctic Diptera*, vol. 1. Agriculture Canada, Ottawa.

In the text references should be given as MARSHALL (1992) or (MARSHALL 1992). When a citation includes more than two authors, e.g. GREY, BLACK and WHITE, the paper should be referred to in the text as GREY *et al.*, provided that this not ambiguous. If papers by the same author(s) in the same year are cited, they should be distinguished by the letters, *a, b, c,* etc., e.g. MARSHALL (1992*a*).

References to papers "in press" must mean that the article has been accepted for publication. References to "personal communications" and unpublished work are permitted in the text only: references to papers in preparation or submitted are not permissible.

All necessary **illustrations** should accompany the manuscript, but should not be inserted in the text. All photographs, graphs and diagrams should be numbered consecutively in Arabic numerals in the order in which they are referred to in the text. Glossy photographs or positive prints should be sent unmounted wherever possible and should be kept to a minimum. Figures should be of good quality. Explanation of lettering and symbols should be given in the figure caption and only exceptionally in the figures. Lettering and symbols to appear on the illustration should be of sufficient size to allow for considerable reduction where necessary (usually proper for a 50% reduction in size). Scales must be indicated on micrographs, not by magnifications in the legends. Figure size must not exceed 24×30 cm. On the back of each illustration should be indicated the author's name, the figure number (in Arabic numerals), and the top of the illustration, where this is not clear. Halftones should be included only when they are essential. Details and quotation of publication of colour plates should be made to the editors. The following symbols should be used on line drawing: ● ■ ○ □ ▲ ◆ ♦ etc.

Legends to figures should be typed on a separate sheet. They should give sufficient data to make the illustration comprehensible without reference to the text.

Tables and appendices should be constructed so as to be intelligible without reference to the text, numbered in Arabic numerals and typed on separate sheets. Every table should be provided with an explanatory caption and each column should carry an appropriate heading. Units of measure should always be indicated clearly (metric units are preferred). All tables and figures must be referred to in the text.

Only standard **abbreviations** should be used. Arbitrary abbreviations and jargon will not be accepted.

The Latin names should be given for all species used in the investigation, although taxonomic affiliation and authority need not be provided in the title.

Page proofs will be sent to the author (or the first-mentioned author in a paper of multiple authorship) for checking. Corrections to the proofs must be restricted to printers' errors. Any substantial alterations other than these may be charged to the author. Authors are particularly requested to return their corrected proofs as quickly as possible in order to facilitate rapid publication. Please note that authors are urged to check their proofs carefully before return, since late corrections cannot be guaranteed for inclusion in the printed journal.

Fifty reprints free of charge will be sent to the first author; extra copies of the issue (at a specially reduced rate) can be ordered on the form which will accompany the proofs. These should be returned to: The Editorial Office of the Acta Zoologica, Hungarian Natural History Museum, Budapest, Baross u. 13, H–1088, Hungary

The **page charge** required from authors outside Hungary is USD 15 per printed page. In exceptional cases, the page charge may be waived. Please contact the editor in before submitting a paper if you ask for a waiver. Authors of papers exceeding 16 printed pages are asked to pay USD 40 (or HUF equivalent) for each such page, i.e. all costs of publication (irrespective of their nationality).

FOR FURTHER INFORMATION PLEASE CONTACT US
The Editorial Office of the Acta Zoologica
H–1088 Budapest, Baross u. 13, Hungary
Fax: (36–1) 3171669
http://actazool.nhmus.hu/
E-mail: perego@zoo.zoo.nhmus.hu

SUBSCRIPTION INFORMATION

Orders should be addressed to

Editorial Office of the Acta Zoologica
Hungarian Natural History Museum
H–1088 Budapest, Baross u. 13, Hungary
Fax: (36–1) 3171669
E-mail: perego@zoo.zoo.nhmus.hu

Typeset: Pars Ltd., Budapest.
Printed by Mondat Ltd., Hungary

CONTENTS

HU ISSN 1217–8837

Acta Zoologica

Academiae Scientiarum Hungaricae

VOLUME 46 - NUMBER 3 - 2000

HUNGARIAN NATURAL HISTORY MUSEUM, BUDAPEST

ACTA ZOOLOGICA ACADEMIAE SCIENTIARUM HUNGARICAE

AN INTERNATIONAL JOURNAL OF ANIMAL TAXONOMY AND ECOLOGY

Acta Zoologica Academiae Scientiarum Hungaricae is published quarterly from February 1994 (other issues in May, August and November) by the Hungarian Natural History Museum and the Biological Section of the Hungarian Academy of Sciences with the financial support of the Hungarian Academy of Sciences.

For detailed information (contents, journal status, instructions for authors, subscription, and from Volume 40 onward title, author, authors' addresses, abstract, keywords and a searchable taxon index) please visit our website at

http://actazool.nhmus.hu/

Acta Zoologica Academiae Scientiarum Hungaricae 46 (3), pp. 181–195, 2000

DEVELOPMENTAL BIOLOGY AND LARVAL MORPHOLOGY OF CHROMATOMYIA FUSCULA (ZETTERSTEDT) (DIPT., AGROMYZIDAE)

DARVAS, B.[1], A. ANDERSEN[2], A. SZAPPANOS[3] and L. PAPP[3]

[1]*Plant Protection Institute, Hungarian Academy of Sciences*
Budapest, PO Box 102, H-1525, Hungary
[2]*Norwegian Crop Research Institute, Plant Protection, Fellesbygget, N-1432 Ås, Norway*
[3]*Hungarian Natural History Museum, Budapest, PO Box 137, H-1431, Hungary*

The egg stadium of *Chromatomyia fuscula* (ZETTERSTEDT, 1838) (collected in Southern Norway) takes 4.5 days to hatch in June. The first instar larva (4.5–6.5 days) is metapneustic and the 2nd instar (6.5–9.5 days) is amphipneustic. The third instar has a pair of fan-like anterior spiracles with 18–20 digits each and a pair of posterior spiracles with 5–8 pores, each arranged in 2 rows. Pupariation takes place between the 12.5th and 15th day. During sclerotization and melanization firstly blackish "V" shape stripes develop on the ventral puparial side which enlarge later and merge to a wide black spot, but the dorsal side remains usually yellowish and transparent. Pupal moult occurs within the puparial shell 2–3 days after the white pre-puparial phase. After 4 days, the imaginal transformation takes place. After a further 5 days, the pharate phase adult with white eyes turns to the orange eye phase. The following day, the red eye phase occurs. The next day bristle formation takes place: wings and bristles are greyish, later turn to black. During the following 1–2 days, the procuticle phase adult emerges. Adults are not attracted to either young or old spring barley plants, but look for a sheltered, humid place. A very long imaginal aestivation and hibernation period starts, which is a very uncommon overwintering strategy among agromyzid flies.

Key words: *Chromatomyia fuscula*, Agromyzidae, morphology, developmental stages

INTRODUCTION

Chromatomyia fuscula (ZETTERSTEDT, 1838) is the most serious agromyzid pest of spring barley (*Hordeum vulgare*) in Scandinavia (ANDERSEN 1989, 1991; DARVAS & ANDERSEN, 1996). It also occurs on different cereals in other parts of Europe, but usually does not cause significant losses (DARVAS *et al.* 1981; DARVAS & PAPP 1985), likely because of the high rate of its parasitization (DARVAS *et al.* 1999).

The morphology of the 3rd instar larvae of "*C. fuscula*" has been published by different authors: DE MEIJERE (1926, 1937, 1938) found that its anterior spiracle has 8–9 digits and posterior spiracle has 4–6 pores; SPENCER (1973, 1976) found 8 digits (anterior spiracle) and 4–6, rarely 10 (posterior spiracle) pores respectively. Checking the last larval stage of *C. fuscula* (confirming it on r genitalia) living in Norway we found no similar morphological characters. The aim of this study was to follow the postembryonic development of *C. fuscula* (DARVAS & FÓNAGY 2000).

MATERIALS AND METHODS

June 5, 1992 when the female: male ratio in the population was 3: 1, approx. 500 overwintered adults of *C. fuscula* were collected in Ås (Norway), put into an isolator (0.65 x 1.54 x 0.8 m) containing 4 pots of spring barley plants (*Hordeum vulgare* var. Tyra) under field condition. This year was unusually hot in Norway (DARVAS & ANDERSEN 1996). After 8 hours oviposition, adults were removed from the isolator, and then at least 25 leafmines and larvae or puparia were checked and measured twice a day. Lactic acid and Berlese-Hoyer solution were used to prepare the larvae. After the pupal head eversion (i.e., phanerocephalic phase) the puparial case flaps (*operculum*) of 16 puparia were carefully removed and metamorphic changes were noted. The terminology of HINTON (1946), SIVASUBRAMANIAN & BIAGI(1983),ŽDÁREK & FRIEDMAN (1986), and DARVAS & FÓNAGY (2000) was used to describe the postembryonic development. Measurements on mines and larvae were made under microscopes.

RESULTS

Egg stadium

Females (Fig. 1) preferred to make feeding punctures and to lay eggs in the laminae of the upper 2 leaves. Sheaths of leaves were never used for egg laying or larval mining. In this case, overwintered gravid females of *C. fuscula* made an average of 3–4 feeding punctures and laid one egg per hour. *C. fuscula* females fed particularly on the tips of the youngest, rounded laminae of leaves. The female, using her pseudo-ovipositor, made a feeding hole (less than 1 mm diameter) on the upper surface of the epidermis, then moved backwards to feed on the exuding plant sap. Males fed at the feeding punctures, which had been produced by the females. Some *Cerodontha denticornis* (PANZER, 1806) (Dipt., Agromyzidae) females were also present on the plants. Females of this species made an approx. 1–3 mm long feeding puncture removing the full epidermis.

For oviposition, the *C. fuscula* females visited the apical third and curled part of the laminae of the youngest leaves. A small tunnel (0.6 mm), not longer than 1.5 times the length of the egg, was made under the epidermis in the mesophyllic tissue and a single egg was laid in it (Fig. 2A). The epidermis was not removed from the tunnel by the female. This tunnel prevented the egg from drying. The egg stadium or embryonic development of *C. fuscula* lasted approx. 4.5 days in June of 1992.

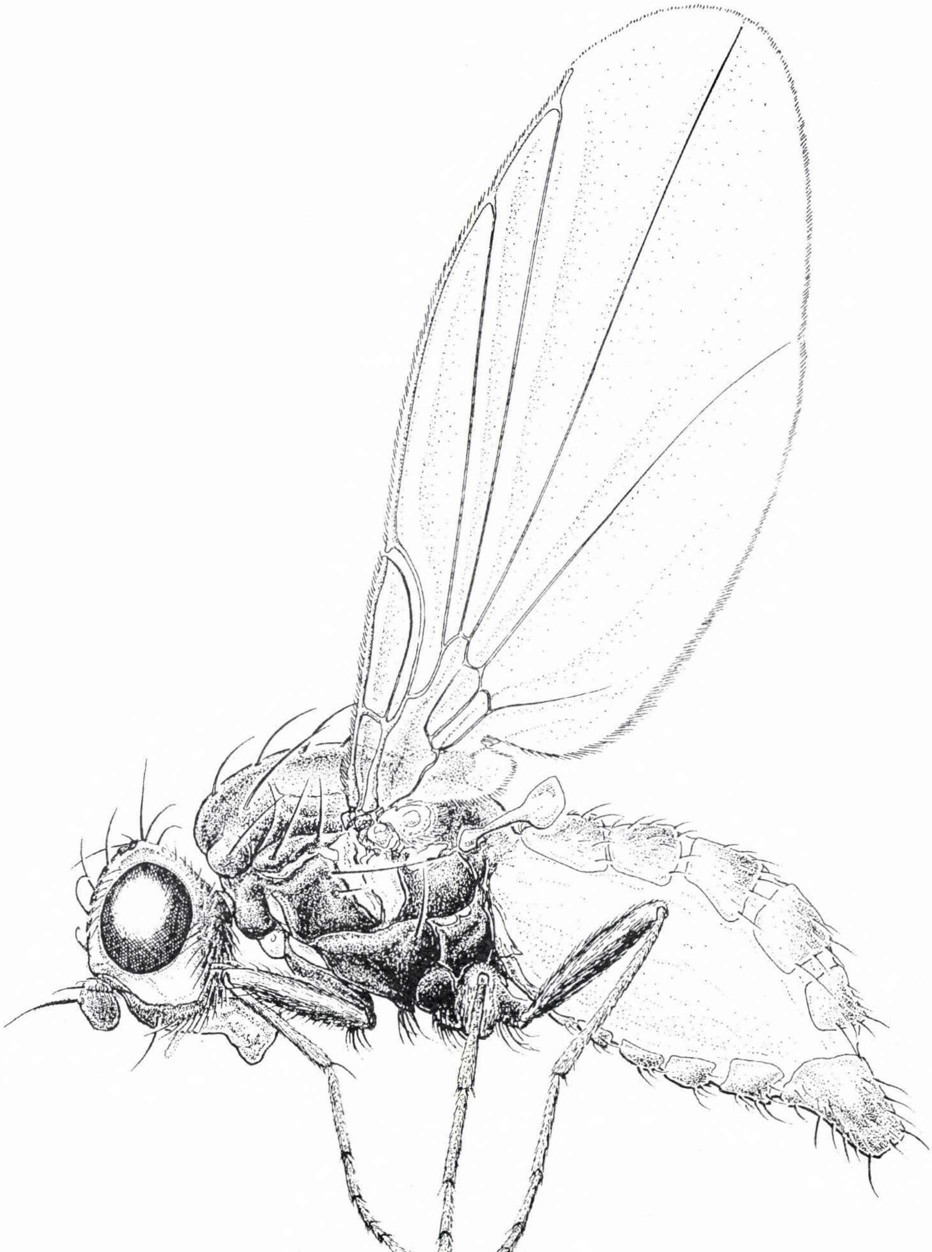


Fig. 1. *Chromatomyia fuscula* (ZETTERSTEDT, 1838), adult female (del. A. SZAPPANOS)

First larval stadium

The first instar larva fed in the upper layer of the mesophyll (mainly parenchyma containing numerous chloroplasts) causing a small whitish linear mine in one side of the leaf lamina. The larva creates a mine between 2 leaf-veins under the epidermis between 8–12 mm long and 0.15 mm wide (Figs 2B-3) in one side

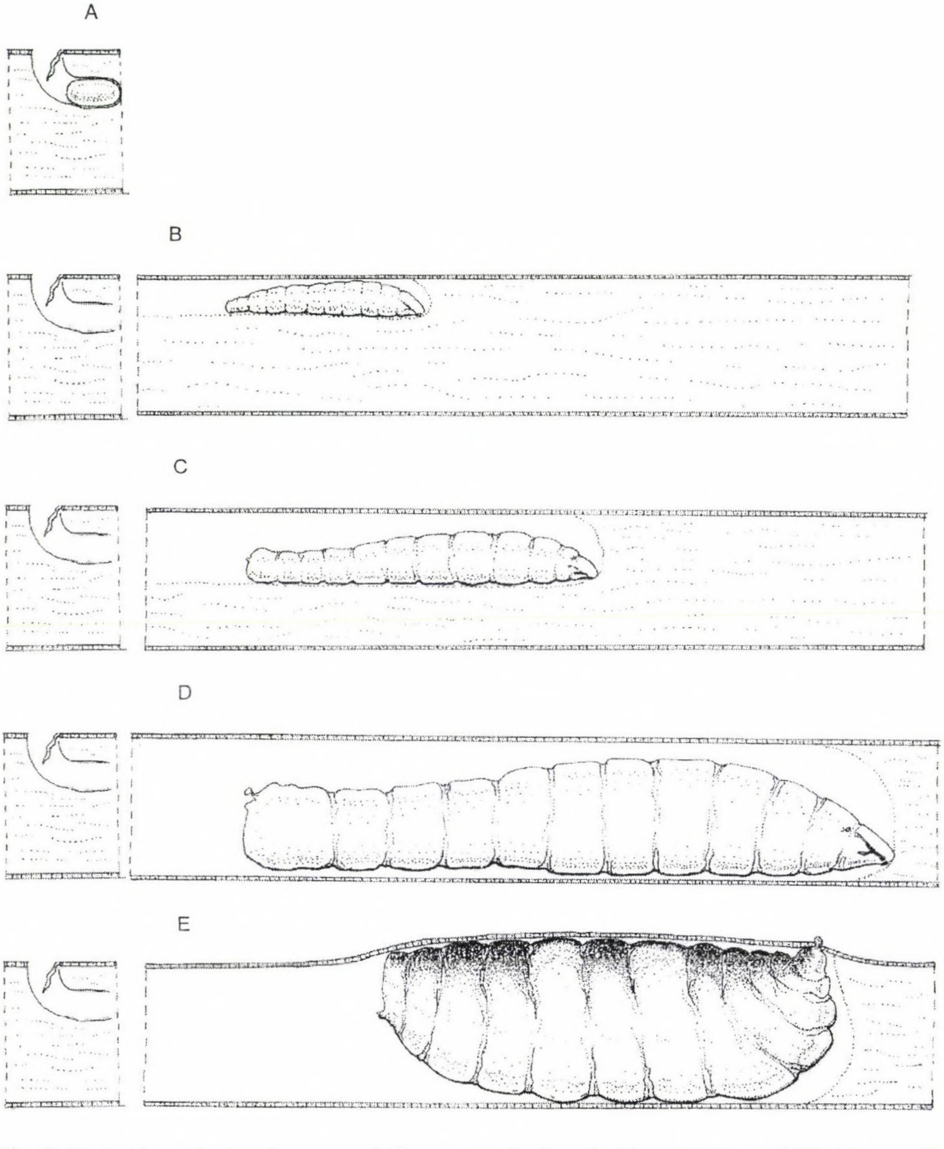


Fig. 2. Postembryonic development of *Chromatomyia fuscula* (ZETTERSTEDT, 1838) (A: egg, B: first instar larva, C: second instar larva, D: third instar larva, E: puparium)

of the leaf lamina. The first instar larva (4.5–6.5 days old) is no longer than 1.35 mm and has no anterior spiracle (i.e., metapneustic larval type). Posterior spiracles are hardly visible. The cephaloskeleton is no longer than 0.16 mm (Fig. 6). In the larval terminology we follow COURTNEY *et al.*'s (2000) summary. Mouthhook asymmetrical (in all stadia), compact, short with two teeth: anterior one very large, posterior (lower) one much smaller; intermediate sclerite and basal sclerite fused (i.e., not separated or divided at all): dorsal cornu comparatively large and broad with uneven sclerotization; ventral cornu with a small "window" dorsobasally (Fig. 6).

Second larval stadium

The second instar larva extended the length of the mine to 34–50 mm and its width to 1 mm in the upper layer of the mesophyll. The second instar larva fed usually in the upper layers but sometimes changed direction and continued the

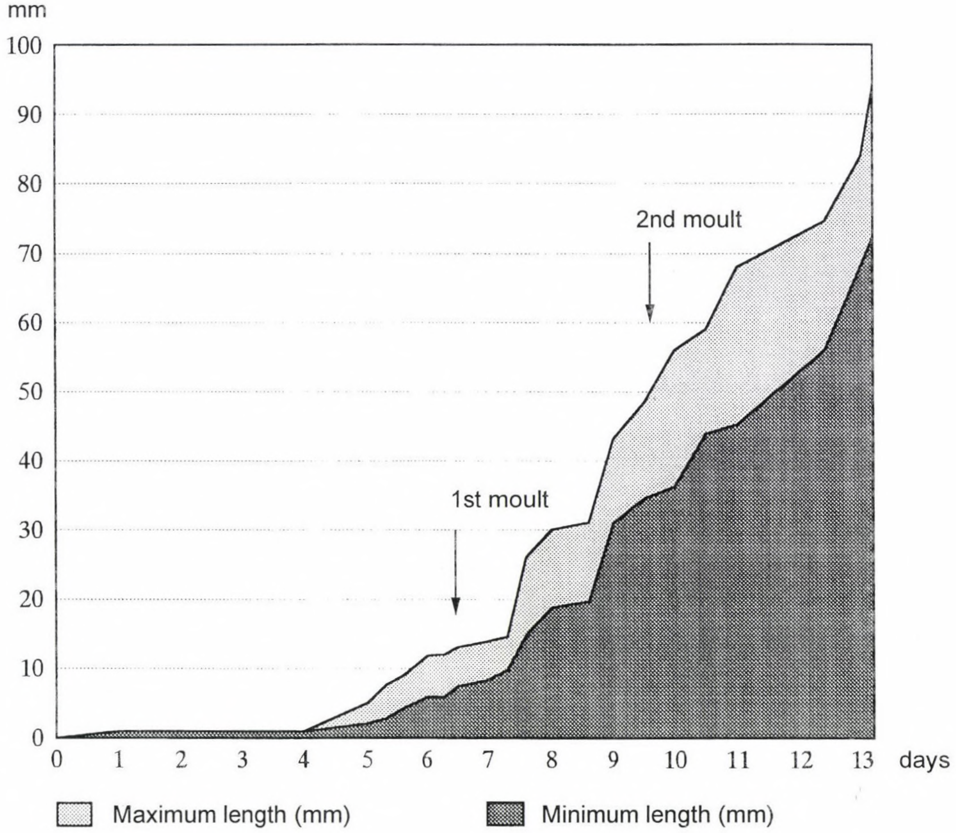
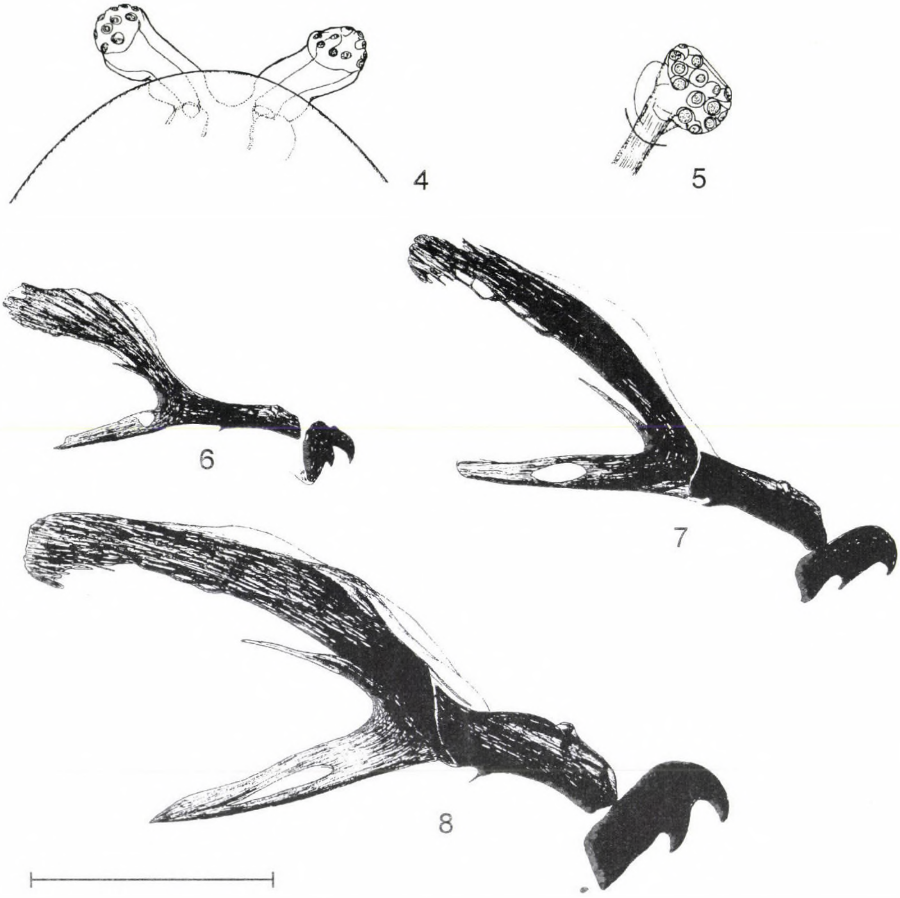


Fig. 3. Length of *Chromatomyia fuscula* leafmine during larval development.

mine under the lower epidermal surface, feeding in the lower mesophyllic tissues (mainly parenchyma containing numerous chloroplasts and near the vessels sclerenchymatous tissue without chloroplasts) (Figs 2C-3). The second instar larva (6.5–9.5 days old) is no longer than 2.5 mm nor wider than 0.4 mm, and has barely visible anterior and posterior spiracles (i.e., amphipneutic larval type). The cephaloskeleton is no longer than 0.24 mm (Fig. 7). Mouthhook short and high with two subequal teeth; intermediate sclerite robust, rather long, separable from basal sclerite, though not completely divided; dorsal cornu less high than in the first stadium subapically with a reticulate sclerotization; there is a long thin pigmented appendage between dorsal and ventral cornua; ventral cornu rather long but shorter than dorsal one, with a large central "window" (Fig. 7).



Figs 4–8. *Chromatomyia fuscula* (ZETTERSTEDT, 1838), larvae. 4 = L3, anterior spiracles, sagittal-subdorsal view, 5 = one of the anterior spiracles, sublateral view. 6–8 = cephaloskeleton, lateral view: 6 = first instar, 7 = second instar, 8 = third instar. Scale: 0.1 mm for all

Third larval stadium

The third instar larva fed only in one side of the lamina, causing a long (72–95 mm) and widening (2 mm) mine near the upper or sometimes the lower epidermal surface of the lamina (Figs 2D-3). The mine was sometimes secondarily blotchy in the cases of the first 2 small leaves or heavy infestation on the upper leaves. Faeces were deposited as widely separated particles and were clearly visible in both side of the leaf mine. The third instar larva (9.5–13 days old) is no longer than 4.5 mm nor wider than 0.8 mm and has a pair of fan-like anterior spiracles with 18–20 digits each, which are set close together dorsally on the prothoracic segment (Figs 4–5). The pair of fan-like posterior spiracles with 5–8 pores each is arranged in 2 rows on the anal segment. The cephaloskeleton (no longer than 0.34 mm) is composed of mandibles (i.e., a pair of mouthhooks), intermediate sclerite (hypopharyngeal, H-shaped sclerite) and basal sclerite (tentoropharyngeal, pharyngeal sclerite). The ventral cornua are fused with each other ventrally. Mouthhooks have one accessory tooth, joined at their bases and elongated in a vertical plane. Dorsal and ventral cornua are not divided (Fig. 8). Mouthhook short and high, rather similar to that of the second stadium with two subequal teeth and with a rather sharp ventral projection; intermediate sclerite long and large, thinly but distinctly separated from basal sclerite with a dorsal and a ventral subbasal small projection each; dorsal cornu large, unevenly sclerotized, i.e., apical part ventrally with some “fringe”, which is probably a consequence of pigmentation only (border of sclerotization is smoother); there is a thin long appendage between dorsal and ventral cornua, like in the second larval stadium; ventral cornu shorter with a long but lower “window” centrally (Fig. 8).

The puparial phase of the 3rd larval stadium started at 12.5 days, but the last part of the larval population reached this phase at 16 days after egg laying (Fig. 2E). Approximately 70% of the larval population pupariated in the leafmine at the upper side, and 30% at the under side of the lamina. The half-contracted (i.e., before the anterior part contracted) larva turned toward the epidermis and opened it with its mouthhooks. During the contraction of the anterior part, the anterior spiracles protruded through the epidermis to the outside. The contracted larva secreted a sticky drop of faeces to attach itself on the dorsal surface to the greenish internal side of the leafmine. Usually on the same day the contracted larva becomes a barrel-shaped white prepupa. Shortly after the white pre-puparium, the cuticle starts to sclerotize and melanize. Blackish “V” shape stripes develop on the ventral puparial side which later enlarge and merge to a wide black spot. The dorsal side usually remains yellowish and transparent. The pupal moult takes place within the puparial shell. The average weight of a freshly scelerotized puparium is 6.9±0.7 mg.

The total area of an average *C. fuscula* leaf mine is approx. 80 mm^2 and is formed in either the upper or the lower mesophyllic tissues. Some of the completely infested lamina contained approximately 50 puparia.

Pupal stadium in the puparial shell

Pupal moult occurred within the puparial shell 2–3 days after the white prepuparial phase (Fig. 2E). The larval cephalopharyngeal skeleton moults from the pupal head and remains attached to the puparial shell. A cryptocephalic phase (i.e., inside the puparial shell and pupal cuticle with uneverted head and partly invaginated legs and wings) and a phanerocephalic phase (i.e., inside the puparial shell and pupal cuticle with everted imaginal head and invaginated thoracic appendages, i.e., imaginal disks migration are completed) were clearly recognised.

Pharate phase imago in the puparial shell

During the following 4 days, the imaginal transformation takes place. The imaginal integument is not a moulting consequence of the mostly polyploid larval/pupal one, but is rebuilt – like a mosaic – from the imaginal discs. The contour of the pharate phase adult is visible inside the puparial shell and pupal cuticle. The number of visible puparial segments is 11. The head localises in 1–3, the thorax in 4–6, and the abdomen in 7–11 puparial segments. Wing buds were found between 5–6 puparial segments. After 2 days, the wing buds enlarge and set up between segments 5 and 8. Five days after the imaginal transformation the pharate phase adult with white eye changes to the orange eye phase. The next day the red eye phase appears. A day later bristle formation occurs. Wings and bristles are greyish, later turning to black.

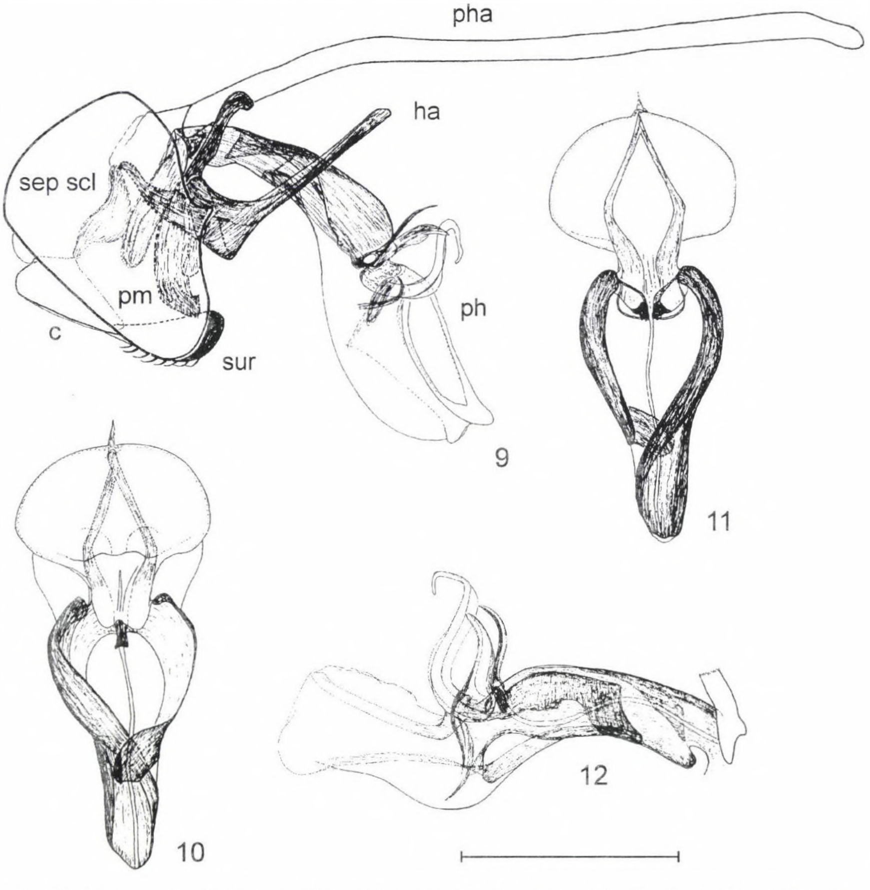
Early adult stadium

One or 2 days after bristle formation the procuticle phase adult opens the puparial case flaps with the pulsation of haemolymph in its *ptilinum* and emerges from the puparial shell. The *ptilinum* is a pharate phase adult organ, the ptilinal integument in the head. After emergence, the ptilinal sack retracts and the lunula of the head closes. Haemolymph presses toward the wing buds and expands them. Sclerotized and melanized adults (Fig. 1) were not interested in feeding. They were not attracted by young or old spring barley plants but were looking for a sheltered humid place in the isolator chamber in which to hibernate. An imaginal aestivation and hibernation period started here.

Male genitalia: cerci rather large of an unspecific shape (Fig. 9). Surstylus short, rather ventrally placed and basally fused to the epandrium (Fig. 14) but this fusion is well behind (lateral to) the medial edge of epandrium. Subepandrial sclerites (Fig. 15) long but narrow and rather laterally placed. Hypandrium (Figs 9, 17) with long cranial part and with processes to join the epandrium, subepandrial sclerite and parameres. The body of the basiphallus composed of two asymmetrical sclerites (Figs 10–12) as usual in the species of the genera *Napomyza*, *Phytomyza* and *Chromatomyia*. Distiphallus bulbous (Figs 10–11) with a pair of thin dorsal supporting sclerites and with three dorsal appendages on about the border between the distiphallus and basiphallus (Fig. 12).

DISCUSSION

Chromatomyia species living in monocotyledons are hard to distinguish. GRIFFITHS (1980) described *Chromatomyia fuscula* superspecies to which *C. fuscula* and the boreal species *Chromatomyia puccinelliae* (SPENCER, 1969), *Chro-*

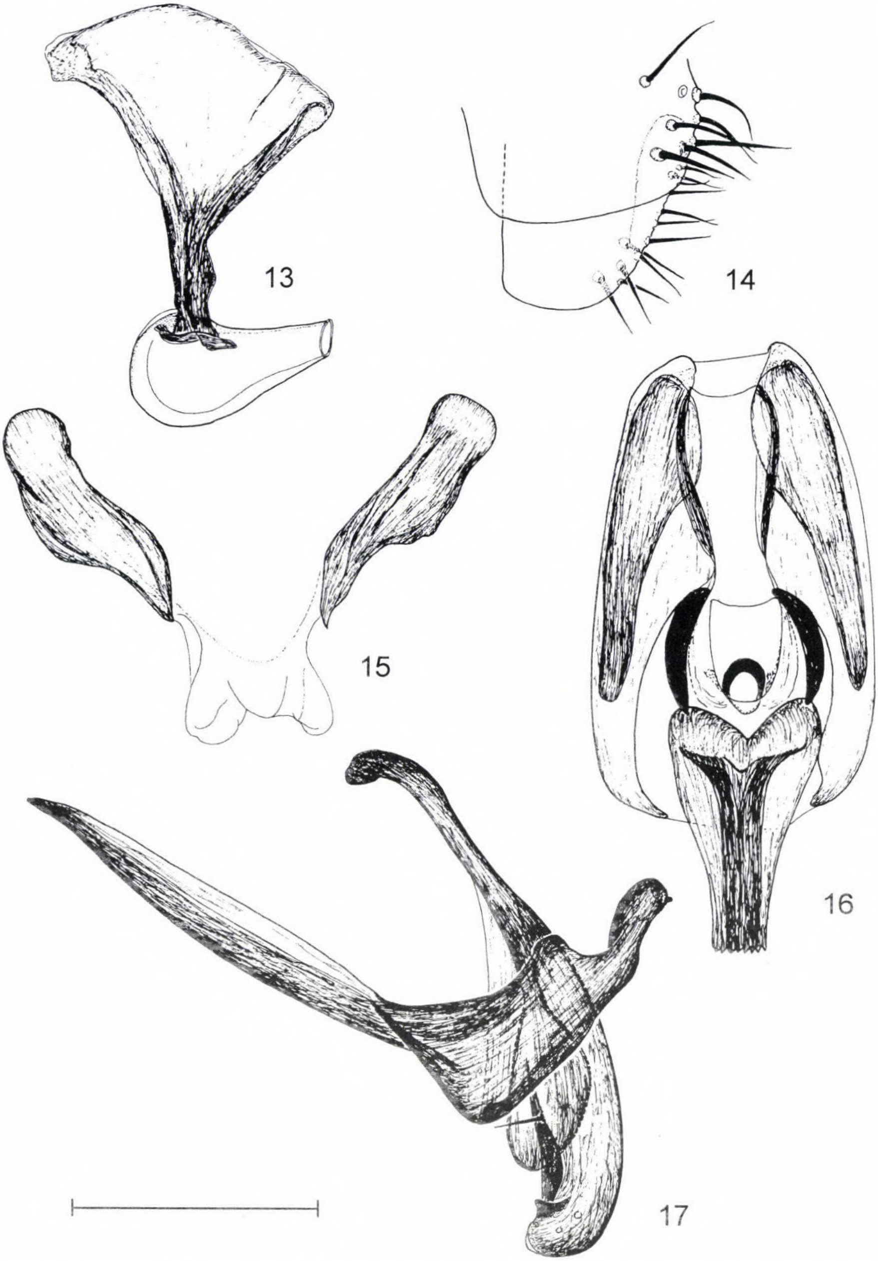


Figs 9–12. *Chromatomyia fuscula* (ZETTERSTEDT, 1838), male genitalia. 9 = inner and outer genitalia, lateral view; 10–12 = phallus: 10 = ventral, 11 = dorsal, 12 = lateral view (c: cercus, ha: hypandrium, ph: phallus, pha: phallapodeme, pm: paramere, sep scl: subepandrial sclerite, sur: surstylus). Scale: 0.2 mm for all

matomyia poae GRIFFITHS, 1980 and *Chromatomyia alopecuri* GRIFFITHS, 1980 belong. In the early literature different synonyms of *C. fuscula* are found such as *Phytomyza affinis* FALLÉN *var. obscurifrons* STROBL, 1910, *Phytomyza avenae* DE MEIJERE, 1926 and *Phytomyza dura* CURRAN, 1931. A part of "*C. fuscula*" was reclassified later as *C. puccinelliae*. In the case of *C. fuscula* from Norway, the most basal appendage of the phallus is thin and better sclerotized, the medial one thick and unevenly sclerotized. In lower magnification it looks as if two appendages were there, cf. DARVAS and PAPP 1985: Fig. 14. The most anterior (cranial) appendage is long, less sclerotized and strongly but rather angulately proclinate (Fig. 12). GRIFFITHS' figure (1980: Fig. 51) of the distiphallus is good except for the dorsal, more basal projections (cf. our Fig. 12). The aedeagal apodeme (phallapodeme) is extremely long and thin (Fig. 9). Parameres (postgonites) have an intricate structure (Fig. 17): with a long (high) dorsal appendage and a broad medial (cranial) lobe, apex rather widely rounded but subapically with a small acute process. Epiphallus (Figs 9, 16) longish scutiform, rather large but not very thick in lateral view with definite lateral sclerotizations. Ejaculatory apodeme (Fig. 13) flabeliform with a short robust stalk; basal bulbous part without any distinct pigmentation. The ejaculatory apodeme in SPENCER (1973: Fig. 439) is too simplified, i.e., not usable for identification. However, GRIFFITHS (1980: Fig. 54) depicted the ejaculatory apodeme rather precisely and distinguishable from its closest relatives.

Given the difficulties in determining species based on male genitalia, uncertainty may exist in determining their larvae. The minimum, maximum and average numbers of the digits and pores of the agromyzid larval anterior and posterior spiracles have their respective values. The *C. fuscula* (18–20 digits and 5–8 pores) living in Norway differed from "*C. fuscula*" (8–9 digits and 4–10 pores) found by DE MEIJERE (1926) and SPENCER (1973, 1976). Anterior spiracles have 18–20 digits but since they are placed on a spherical surface, it is impossible to depict all of them: 14 digits are visible on our Fig. 5.

Of the 15 Palaearctic species with known hosts in Poales, discussed by GRIFFITHS (1980) and SPENCER (1990), most were selective in the choice of hosts, feeding on from one to 4 genera; the 2 common species *C. fuscula* and *Chromatomyia nigra* (MEIGEN, 1830) (18–22 digits and 10–13 pores) had a far wider host range and were recorded on 20–46 genera, respectively (Table 1). In addition to this the highly polyphagous *Chromatomyia horticola* (Goureau, 1851) has an extremely wide host range, feeding mainly on dicotyledonous species (DARVAS *et al.* 1988), but also accepts *Allium* species (GRIFFITHS 1980). GRIFFITHS (1980) divided *C. nigra* into different forms: European – *Chromatomyia cinereofrons* HARDY, 1849, Madeira, Baltic, Kamchatka – *Chromatomyia nigra obscuripes* (HENDEL, 1935), Japanese and North American (Pacific Coast). The larval morphology of most of the grass-feeding *Chromatomyia* "species group",



Figs 13–17. *Chromatomyia fuscula* (ZETTERSTEDT, 1838), male genitalia. 13 = ejaculatory apodeme, widest extension, 14 = surstylus and apex of epandrium, ventral view, 15 = subepandrial sclerite, ventral view, 16 = epiphallus ("genital hood"), caudal view, 17 = hypandrium and left paramere, lateral view. Scale: 0.1 mm

Table 1. Graminaceous host plants of the Palaearctic *Chromatomyia* species

Scientific names	*Aegilops*	*Agropyron*	*Agrostis*	*Aira*	*Alopecurus*	*Ammophila*	*Anthxanthum*	*Apera*	*Arcagrostis*	*Arrhenatherum*	*Avena*	*Beckmannia*	*Brachypodium*	*Briza*	*Bromus*	*Calamagrostis*	*Catapodium*	*Chaetopogon*	*Cinna*	*Cornucopia*	*Cynosurus*	*Dactylis*	*Deschampsia*	*Desmazeria*	*Eleusine*	*Festuca*	*Gaudinia*	*Glycerina*
C. beigerae GRIFFITHS																												
C. fuscula (ZETTERSTEDT)		+			+					+	+	+			+				+		+	+			+			+
C. horticola (GOREAU)																												
C. luzulae (HERING)																												
C. milii (KALTENBACH)			+																									
C. nigra (MEIGEN)	+	+	+	+	+	+	+	+		+	+		+	+	+	+	+	+		+	+	+	+	+	+	+	+	+
C. norwegica (RYDÉN)									+							+			+				+					
C. opacella (HENDEL)																												
C. pseudomilii GRIFFITHS			+																				+					

	Helictotrichon	*Hierochloe*	*Holcus*	*Hordeum*	*Lagurus*	*Lamarkia*	*Lepturus*	*Lolium*	*Melica*	*Milium*	*Molinia*	*Nardus*	*Phalaris*	*Phleum*	*Pholiurus*	*Poa*	*Polypogon*	*Secale*	*Sesleria*	*Setaria*	*Trisetum*	*Triticum*	*Vulpia*	*Zea*	Others*	Anterior spiracle	Posterior spiracle	Superspecies**
C. beigerae GRIFFITHS																									LU	20	19-23	CL
C. fuscula (ZETTERSTEDT)	+		+	+				+	+	+			+	+		+		+			+	+				18-20	5-8	CF
C. horticola (GOREAU)																									AL	6-9	8-10	CS
C. luzulae (HERING)																									LU	15-18	18-25	CL
C. milii (KALTENBACH)			+							+						+										14-25	25	CM
C. nigra (MEIGEN)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		18-22	10-13	CN
C. norwegica (RYDÉN)																										20	25	CM
C. opacella (HENDEL)																			+		+					?		CO
C. pseudomilii GRIFFITHS																									CA	20	25	CM

species and "subspecies" is not known (e.g., *Chromatomyia rhaetica* GRIFFITHS, 1980, *Chromatomyia spenceriana* GRIFFITHS, 1980, *Chromatomyia tschirnhausi* GRIFFITHS, 1980, *Chromatomyia furcata* GRIFFITHS, 1980, *Chromatomyia isicae* (HERING, 1962), *Chromatomyia styriaca* GRIFFITHS, 1980, *Chromatomyia glacialis* (GRIFFITHS, 1964)). It is possible that DE MEIJERE (1926) and SPENCER (1973, 1976) described the larval characters of *Chromatomyia* species other than *C. fuscula*.

Agromyzid species usually overwinter in the puparial shell (as prepupa, pupa or pharate adult). It was surprising when ANDERSEN (1991) published that *C. fuscula* overwinters in the adult stadium. Our results suggest this same uncommon overwintering strategy as well; none of the adults from the new generation were interested in feeding. SPENCER (1973) supposed *C. fuscula* has at least 2 generations. DARVAS and PAPP (1985) found 2 flight periods for adults, from May to June and from August to October in Hungary. They also suggested it has 2 generations, although the 2 flying periods might also mean an imaginal overwintering. Based on our earlier results (DARVAS & ANDERSEN 1996) it may also be stated that this species had only one generation in Scandinavia. Overwintered adults mate from the second half of April to the first half of June and lay eggs from the second half of May to the end of June. Larvae of *C. fuscula* were found from June to the first half of July. Puparia might be found from June to the end of July (ANDERSEN 1991). Although the embryonic and postembryonic development of *C. fuscula* is no longer than 29 days (i.e., 8% of the life-cycle), because of the relatively long egg laying period and the individually different developmental speeds, the non-adult stages of *C. fuscula* populations can be found between May and July in Southern Norway. Although the imaginal overwintering strategy is not known in other agromyzid species, KAMM (1977) found that the reproductive rate of *C. nigra* was drastically reduced by warm temperature (21°C) and short nights (D:L = 8:16).

Yield losses of barley caused by heavy infestation of *C. fuscula* larvae did not exceed (ANDERSEN 1989) that caused by *Agromyza megalopsis* HERING, 1933 (Dipt., Agromyzidae) larvae (DARVAS *et al.* 1983). The shape of their leafmines explains the differences: (i) an *A. megalopsis* female lays eggs near each other in the basal third of the lamina; the blotchy pseudo-polylarval mine moves toward the tip and usually reaches the edge of the lamina. The larvae completely eat the mesophyll and therefore the remaining non-damaged lamina declines as well in the direction of the tip. Thus, *A. megalopsis* larvae cause more losses due to the extent and effect of their mines, (ii) a *C. fuscula* female lays one egg in the

---

Notes: edited after GRIFFITHS (1980), DARVAS *et al.* (1988), SPENCER (1990) and data of the authors
*AL: *Allium*, CA: *Carex*, LU: *Luzula*
**CF: *C. fuscula*, CL: *C. luzulae*, CM: *C. milii*, CN: *C. nigra*, CO: *C. opacella*, CS: *C. syngenesiae*

apical third of the lamina; the single narrow linear mine created by the larva mostly moves toward the base. The leafmine is no wider than 2 mm and never reaches the edge of the lamina. Except the last instar the earlier larval instars eat only a part of the mesophyll (Figs 2B-D, 3). Thus *C. fuscula* larvae cause less damage to the leaf from their mines. Nevertheless, barley belongs to Poales has unifacial (i.e., both sides of leaf have similar tissue structure) and distichous leaves (i.e., they inserted on the stem at 180 degrees from one another; DAHLGREN & CLIFFORD 1982) which have advantages using the energy of insolation for photosynthesis. In a single leaf, although the sheath has similar tissue structure as lamina *A. megalopsis* and *C. fuscula* never attacks sheath. Thus, in the case of a "total" laminae damage caused by these 2 species a significant assimilation capacity remains in the sheaths (DARVAS & ANDERSEN 1996).

*

Acknowledgements – This work was supported by Agricultural Research Council of Norway (Grant No: 565021). The authors thank R. MEADOW (Norwegian Crop Research Institute, Plant Protection) for the critical reading of the manuscript.

REFERENCES

ANDERSEN, A. (1989) Yield losses in spring barley caused by *Chromatomyia fuscula* (Zett.) (Dipt., Agromyzidae). *J. Appl. Entomol.* **108**: 306–311.

ANDERSEN, A. (1991) Life-cycle of *Chromatomyia fuscula* (Zett.) (Dipt., Agromyzidae), a pest in Norwegian cereal fields. *J. Appl. Entomol.* **111**: 190–196.

COURTNEY, G. W., SINCLAIR, B. J. & MEIER, R. (2000) Morphology and terminology of Diptera larvae. Pp. 85–161. *In* PAPP, L. & DARVAS, B. (eds) *Contributions to a Manual of Palaearctic Diptera*, vol. 1. Science Herald, Budapest.

DAHLGREN, R. M. T. & CLIFFORD, H. T. (1982) *The Monocotyledones: a Comparative Study*. Academic Press, London.

DARVAS, B. & ANDERSEN, A. (1996) *Chromatomyia fuscula* (ZETTERSTEDT) (Diptera: Agromyzidae) host plant, feeding and oviposition site preferences. *J. Appl. Entomol.* **120**: 23–27.

DARVAS, B. & FÓNAGY, A. (2000) Postembryonic and imaginal development of Diptera. Pp. 283–363. *In* PAPP, L. & DARVAS, B. (eds) *Contributions to a Manual of Palaearctic Diptera*, vol. 1. Science Herald, Budapest.

DARVAS, B. & PAPP, L. (1985) The morphology of agromyzid pests on wheat and barley in Hungary (Diptera: Agromyzidae). *Acta zool. hung.* **31**: 97–110.

DARVAS, B., ANDERSEN, A. & THURÓCZY, CS. (1999) Generalist hymenopteran miner parasitoids of *Chromatomyia fuscula* (Dipt.: Agromyzidae). *J. Nat. Hist.* **33**: 1089–1105.

DARVAS, B., DRASKOVITS, A. D., PAPP, L., HEGEDŰS, I., LESZNYÁK, M. & SZEŐKE, K. (1981) Dipterous pests of winter wheat. I. Damage assessment, swarming dynamics. *Növényvédelem* **17**: 97–108.

DARVAS, B., KOCZKA, F. & PAPP, L. (1983) Agromyzid pests on two-rowed barley and their natural regulation by Hymenoptera. Pp. 87– 91. *In* DARVAS, B., TÓTH, M. & VAJNA, L. (eds) *P. Int. Conf. Integr. Plant Prot.*, vol. 4. Kertészeti Egyetem Nyomda, Budapest.

DARVAS, B., SZARUKÁN, I., ELEKESNÉ-KAMINSZKY, M. & DULINAFKA, GY. (1988) Occurrence of *Chromatomyia horticola* (Goureau) (Dipt.: Agromyzidae) in sunflower. *Növényvédelem* **24**: 399–404.

DE MEIJERE, J. C. H. (1926) Die Larven der Agromyzinen (Fortsetzung und Schluss). *Tijdschr. Entomol.* **69**: 227–317.

DE MEIJERE, J. C. H. (1937) Die Larven der Agromyzinen. Dritter Nachtrag. *Tijdschr. Entomol.* **80**: 167–243.

DE MEIJERE, J. C. H. (1938) Die Larven der Agromyzinen. Vierter Nachtrag. *Tijdschr. Entomol.* **81**: 61–116.

GRIFFITHS, G. C. D. (1980) Studies on boreal Agromyzidae (Diptera) XIV *Chromatomyia* miners on Monocotyledones. *Entomol. Scandinavica Suppl.* **13**: 1–61.

HINTON, H. E. (1946) Concealed phases in the metamorphosis of insects. *Nature* **157**: 552–553.

KAMM, J. A. (1977) Seasonal reproduction and parasitism of a leafminer *Phytomyza nigra*. *Environ. Entomol.* **6**: 592–594.

SIVASUBRAMANIAN, P. & BIAGI, M. (1983) Morphology of the pupal stages of the fleshfly, *Sarcophaga bullata* (Parker) (Diptera: Sarcophagidae). *Int. J. Insect Morphol. Embryol.* **12**: 355–359.

SPENCER, K. A. (1973) *Agromyzidae (Diptera) of Economic Importance*. Pp. 280–282. Dr. W. Junk B. V. The Hague.

SPENCER, K. A. (1976) *The Agromyzidae (Diptera) of Fennoscandia and Denmark*. Pp. 421–423. Scandinavian Science Press Ltd. Klampenborg.

SPENCER, K. A. (1990) *Host Specialization in the World Agromyzidae (Diptera)*. Kluwer Academic Publisher, Dordrecht.

ŽDÁREK, J. & FRIEDMAN, S. (1986) Pupal ecdysis in flies: mechanism of evagination of the head and expansion of the thoracic appendages. *J. Insect Physiol.* **32**: 917–923.

Revised version received 11th August, 2000, accepted 21st August, 2000,
published 21st September, 2000

Catalogue of Palaearctic Diptera

edited by Á. SOÓS and L. PAPP

Volume 13
Anthomyiidae–Tachinidae

The Catalogue contains the basic taxonomic, nomenclatorial and distribution data of all species occurring in the Palaearctic Region with the fundamental morphological features for the majority of the fly groups.

Volume 13 lists the names of 460 genera, 38 subgenera and 2389 species assigned to three families. Furthermore, 672 synonymous generic and 2477 specific names, 1807 emendations, errors, nomina dubia and doubtful genera and species are listed. The period of the Catalogue extends from 1758 to 31 December, 1982.

Contents: Explication to distribution. Type-species designations in Volume 13. New name proposed in Volume 13. Families: Anthomyiidae (Á. DELY–DRASKOVITS). Rhinophoridae (B. HERTING). Tachinidae (B. HERTING and Á. DELY–DRASKOVITS). Bibliography. Index.

December 15, 1993. 624 pages
US$ 85.00 plus US$ 8.00 for package and postage
(and an extra US$ 5.00 if you want it air mail)
ISBN 963 70 9321 4

Order should be sent
to the Hungarian Natural History Museum, Library
Baross u. 13., Budapest, H–1088 Hungary
Fax: (36–1) 1171669

Acta Zoologica Academiae Scientiarum Hungaricae 46 (3), pp. 197–229, 2000

REVISION OF NEWSTEADIA OF THE AUSTRALIAN AND PACIFIC REGIONS, WITH DESCRIPTION OF ELEVEN NEW SPECIES (HOMOPTERA: COCCOIDEA, ORTHEZIIDAE)

KOZÁR, F. and ZS. KONCZNÉ BENEDICTY

Plant Protection Institute, Hungarian Academy of Sciences
H-1525 Budapest, Pf. 102, Hungary
E-mail: h2405koz@ella.hu

Eleven new species of *Newsteadia* are described, and the already known four species are redescribed from the regions studied. A key is presented for the identification of 15 species currently included in the genus from these regions. A modified concept of the genus is presented and several new characters are given as diagnostic of the genus. The genus *Transnewsteadia* is synonymized. The zoogeography of the genus is discussed.

Key words: Homoptera, Coccoidea, Ortheziidae, *Newsteadia*, Australia, Pacific Region

INTRODUCTION

The Ortheziidae is considered to be one of the oldest families of the Coccoidea (KOTEJA 1985). Research on the classification and distribution of the family may provide further insight into the origin and phylogeny of the Coccoidea. According to WILLIAMS and WATSON (1990), the family may have originated in Africa and/or South America. The most detailed analyses of the Ortheziidae were presented by MORRISON (1925, 1952), and covered the entire World fauna, which now contains about 120 species. The *Newsteadia* genus was studied in detail by MORRISON (1925, 1952), WILLIAMS and WATSON (1990), and others. It now contains 15 species including one fossil species. A similar genus (*Transnewsteadia*) was described recently by RICHARD (1990).

The purpose of the present work is to provide a comprehensive revision of the genus *Newsteadia* including descriptions of new species from the Australian and Pacific Regions.

MATERIALS AND METHODS

The insects described in this study were collected mostly by using Berlese funnels and are from zoological sample collecting expeditions of soil arthropods. The specimens studied are from the Collection of Arachnida, Hungarian Natural History Museum, Budapest, Hungary (HNHM), Collection of Arachnida, Loránd Eötvös University, Budapest, Hungary (LEU), from the scale insect collections of the British Museum (Natural History) London, England (BMNH), and from the Australian National Insect Collection, Canberra, Australia (ANIC), and the Transvaal Museum, South Africa, Pretoria.

The insects studied were mounted on microscope slides, or preserved in alcohol. The holotypes of new species are deposited in the Hungarian Natural History Museum, Budapest (HNHM), Plant Protection Institute, Hungarian Academy of Sciences, Budapest (PPI), except the species from the collection of the BNHM, London, and ANIC, Canberra. The paratypes are deposited in the following collections: British Museum (Natural History) (BMNH); Hungarian Natural History Museum (HNHM), Plant Protection Institute, Hungarian Academy of Sciences (PPI), and National Museum of Natural History, Washington, D.C. (USNM).

The locality data was copied from the slides, or from the collected materials.

Terminology follows that of MORRISON (1925, 1952), except for some new characters found in the present work. The type specimens of earlier described species were studied for comparison.

RESULTS

Newsteadia tasmaniensis sp. n.

(Fig. 1).

Material examined: Holotype, female, Australia, Gleneagle, Canning Catchment, under *Casurina*, (No. 39) (Coll. Arachnida, HNHM).

Paratypes: 1 female from the same collection as the holotype; 3 females, Australia, Gleneagle, Bedfordale, under *Malus* and Jarrah (No. 40) (Coll. Arachnida, HNHM).

Other material: 1 female,.Australia, Tasmania, Hartz Mts, 600 m, Waratah Lookout, 7–12. 1986, No. 22A (J. BALOGH). Deposited in the BMNH. One poorly stained specimen, which differs from the holotype by its short 3rd antennal segment, therefore is not included into the type series.

Description of adult female. Mounted specimen (Fig. 1). Holotype, adult female 1.8 mm long, 1.3 mm wide. Length of segments and setae in µm: Antennae 6-segmented, 1st segment 208, 2nd segment 179, apical segment 272, with 5 hair-like setae, 34, on segment 1, with 3 spines on apical segment, apical seta 93, subapical seta absent, medial sensory seta 29.

Venter. Length of body parts in µm: Labium 192. Stylet loop as long as labium. Legs: 1st coxa 144, trochanter-femur 548, tibia-tarsus 688, claw 54, claw digitules 14; 2nd coxa 160, trochanter-femur 572, tibia-tarsus 713, claw 50, claw digitules 14; 3rd coxa 170, trochanter-femur 630, tibia-tarsus 830, claw 55, claw digitules 17; with hair-like setae; without flagellate sensory setae near tibial sensorium; trochanter with 4 sensory pores on each surface. Ovisac band complete; wax plates present in wide bands between legs; wax plate on head complete. Coxal depressions weekly developed, mesad of each coxa, separate, with cluster of hair-like setae, wax spines, and quadrilocular pores. Anterior thoracic spiracles with cluster of 5–10 quadrilocular pores, 4 µm in the atrium of spiracles, diameter of anterior thoracic spiracles 38. Hair-like setae few, scattered in medial areas of thorax, with several setae near anterior and lateral edge of ovisac band, and no segmental rows in ovisac band. Quadrilocular pores 4 µm in diameter; tubular quadrilocular pores long, protruding from derm, associated with wax plates; quadriloculars present in narrow bands within ovisac band and scattered between wax plates. Abdominal spiracles in five pairs.

Dorsum. Length of body parts in µm: Wax plates cover most of the surface. Spines at margin of wax plates; elongate, with apically rounded apex, 22. Hair-like setae present in marginal clusters near posterior edges of marginal wax plates, and near anterolateral and anteromedial edge of each dorsomedial wax plate. Quadrilocular pores scattered between wax plates, long tubular

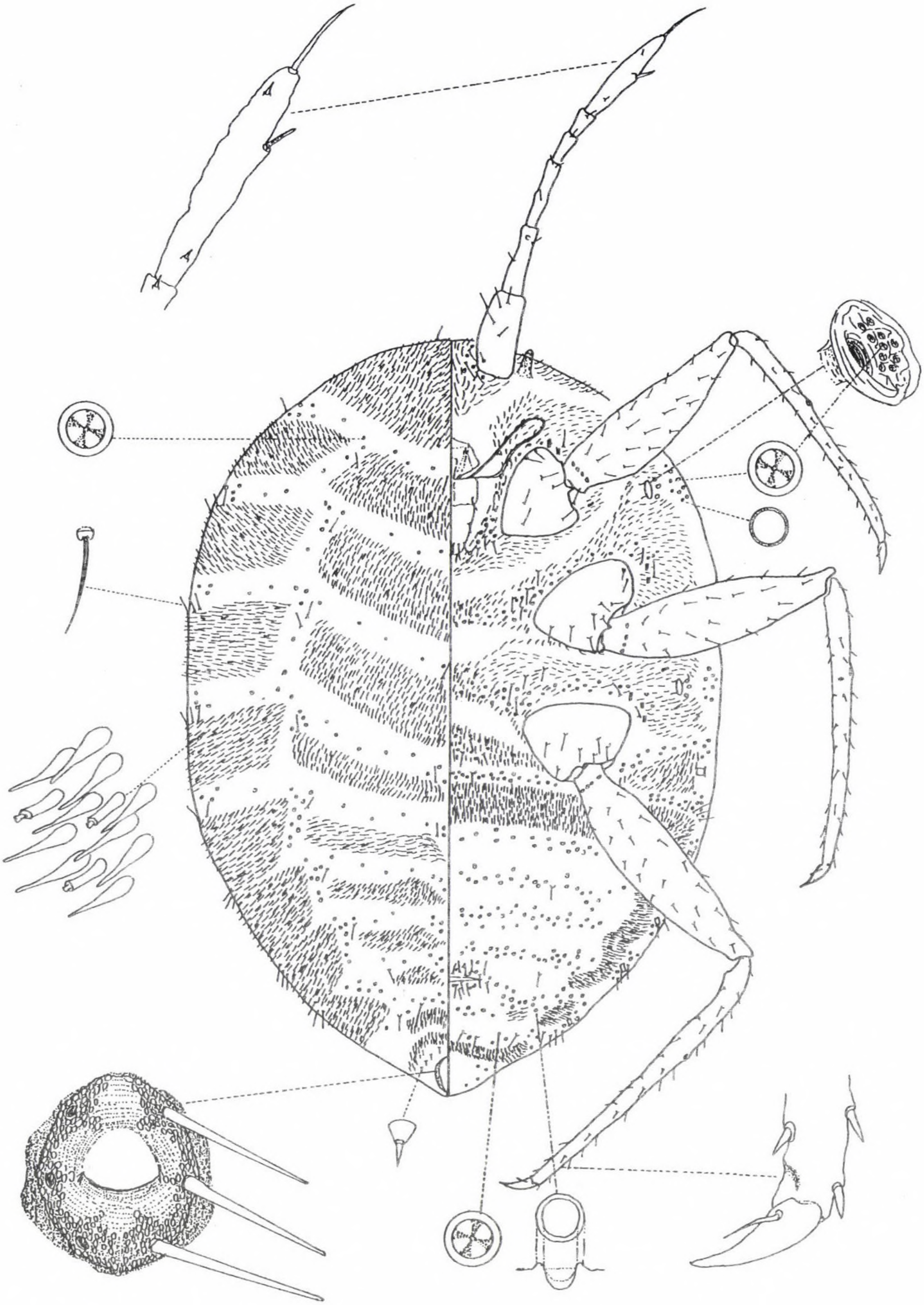


Fig. 1. *N. tasmaniensis* sp. n.

ducts present in wax plates. Anal ring with pore rows; longest anal ring seta 50, shorter than length of anal ring; ring 83 wide and 78 long.

The species is named after the collecting place.

Comments. *N. tasmaniensis* is similar to *N. samoana*. The difference is in the presence of long tubular ducts in wax plate bands, and the presence of short, stout anal ring setae in case of *N. tasmaniensis*.

Newsteadia australiensis sp. n.

(Fig. 2)

Material examined: Holotype (marked with red colour), female, Australia, Ginini Flats, Brindabellas, ACT, Sphagnum moss, 10. 01. 1989 (M. CARVER and D. C. F. RENTZ), with one paratype on the same slide (ANIC).

Paratypes: 1 female from the same collection as the holotype; 2 females, Australia, NSW, Monga State Forest, 732 m a.s.l (above sea level), *Eucryphila moorei* and *Eucalyptus*, with tree ferns, rain forest, 02. 04. 1987, (P. J. GULLAN); 2 females, Australia, NSW, Brown Mt, rainforest litter, 1000 m a.s.l, ANIC No. 9, C.I.E. 9624. A.2603 BM 1971–1 (R. W. TAYLOR); 1 female, Australia, Canberra, moss, 30.07.1968, Can. B.17 (Coll. Arachnida, LEU); 3 females, Australia, Canberra, *Eucalyptus* forest, litter, 31.07.1968, CAN B.23, J. BALOGH (Coll. Arachnida, LEU); 3 females, Australia, Canberra, fern litter, 03.08. 1968, CAN B.35, J. BALOGH (Coll. Arachnida, LEU); 4 females, Australia, Canberra, 03.08. 1968, CAN B.39 (Coll. Arachnida, LEU); 2 females, Australia, Tikkinbilla Nature Reserve 600–900 m a.s.l, ACT, 21.11. 1986 (J. BALOGH); 11 females, Australia, NSW, Kioloa State Forest, Depot Beach, 19. 12. 1986 (J. BALOGH) (No 42b), 3 females, Australia, Hobart Mt. Nelson, 12. 12. 1986 (No 35a) (J. BALOGH); 4 females, Australia, Tasmania, Harts Mt. Huon River, 150 m, a.s.l., 07. 12. 1986, (No 21a) (J. BALOGH); 2 females, Australia, Mt Wellington, "prairie", 1200 m, a.s.l., (No 19a), (J. BALOGH); 1 female Australia, Gleneagle BL67 (No. 2); 3 female, Australia, Manjimup GV71 (No 23); 5 females, Australia, Shannon HP81 (No 26), (Coll. Arachnida, HNHM); 1 female, Australia, NSW, Clyde, rainforest, leafmould, 800 m a.s.l., 24.12.1966, No. ANIC 2; 2 females, Australia, NSW, Clyde, Mt. WET Schlero, a.s.l. 800 m, 24. 12. 1966, No. ANIC 3; 3 females, Australia, NSW, Clyde, Mt. WET Schlero, 800 m a.s.l., 21.03. 1967, No. ANIC 19; 1 female, Australia, Cairns, (AC), 12.07, 1969, leaf litter, No. B18, J. BALOGH (Coll. Arachnida, LEU).

Other materials: 1 female, Australia, NSW, Blue Mt., Megalong Valley, 900 m, a.s.l., 25.12.1986, 49a (J. BALOGH). The specimen is different from the type having higher number of setae in wax bands on the venter of thorax, because of this, it is not included in the type material.

Description of adult female. Mounted specimen (Fig. 2). Holotype, adult female 1.2 mm long, 0.8 mm wide. Length of segments and setae in µm: Antennae 6-segmented, 1st segment 122, 2nd segment 90, apical segment 147; with hair-like setae on 1st and 2nd segments, with 5 setae on apical segment; apical seta 83, subapical seta 25, medial sensory seta 28; remaining setae spine-like.

Venter. Length of body parts in µm: Labium 163. Stylet loop as long as labium. Legs: 1st coxa 91, trochanter-femur 275, tibia-tarsus 326, claw 35, claw digitules 5; 2nd coxa 96, trochanter-femur 294, tibia-tarsus 357, claw 34, claw digitules 5; 3rd coxa 108, trochanter-femur 326, tibia-tarsus 457, claw 38, claw digitules 7; with spine-like setae; with a flagellate sensory seta near tibial sensorium on the 3rd leg; trochanter with 4 sensory pores on each surface. Ovisac band complete; wax plates bands interrupted between legs; wax plate on head complete. Coxal depressions developed, mesad of each coxa, separate, with a cluster of hair-like setae, and quadrilocular pores. Anterior thoracic spiracles with some quadrilocular pores, 4 µm in diameter, anterior thoracic spiracles 22 µm in diameter. Hair-like setae, scattered in medial areas of thorax, with several setae near anterior and lateral edge of ovisac band, and segmental rows in ovisac band. Quadrilocular pores 4 µm in diameter; tubular quadrilocular pores long, protruding from derm, associated with wax plates; quadriloculars and simple pores present in wide bands within ovisac band and scattered between wax plates elsewhere. Abdominal spiracles in five pairs.

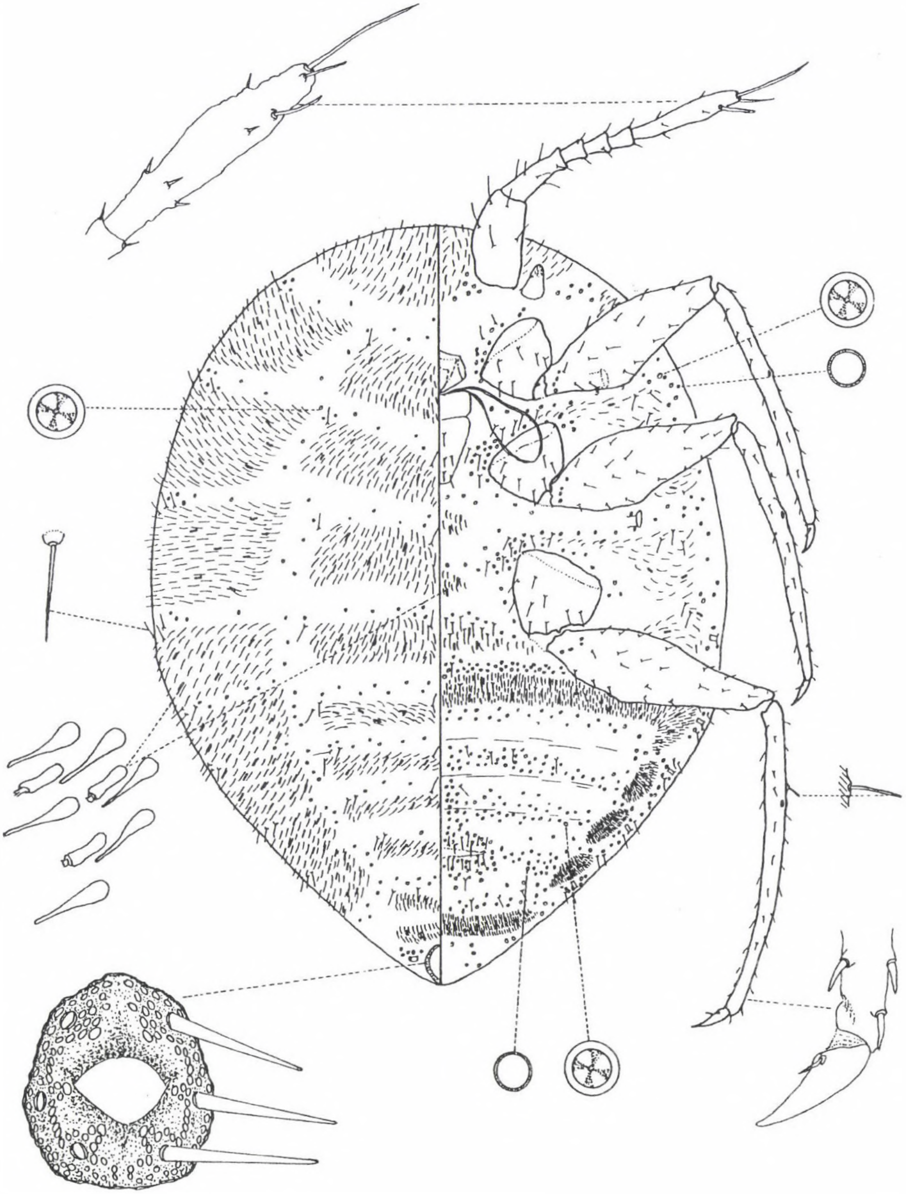


Fig. 2. *N. australiensis* sp. n.

Dorsum. Wax plates cover only partly the surface. Spines at margin of wax plate elongate 12 µm long. Hair-like setae present in marginal clusters near posterior edges of marginal wax plates, and near anterolateral and anteromedial edge of each dorsomedial wax plate. Quadrilocular pores scattered between wax plates; tubular ducts long, present in wax plates. Anal ring with rows of pores; longest anal ring seta 34, shorter than diameter of rounded anal ring (50).

The species is named after the country of origin of the samples.

Comments. *N. australiensis* is similar to *N. endroedyi*, but differs from it by having a sensory seta close to tibial sensorium, and large groups of quadrilocular and discoidal pores on the margin and on the dorsum.

Newsteadia gullanae sp. n.

(Fig. 3)

Material examined: Holotype, female (marked with red), Australia, Tasmania, Barrow Creek Mt. *Notophagus* litter, 08.12. 1982. No 4874 (Au 101) (S. Y. ENDRŐDY), with one paratype female from the same collection, on the same slide (PPI).

Paratypes: 1 female from the same collection as the holotype; 2 females, Australia, NW Tasmania, Savage River, Pipeline Road, 22 mi. N of mine, Site 3, *Callidendrous* rainforest, 20.04. 1989, (P. GREENSLADE); 3 females, Australia, Victoria, found in a mine at 300 ft level (C. FRENCH); 2 females, Australia, Victoria, *Nothofagus* litter, N. nitas, 12. 1963, CIE A11409, BM 19 (T. M. HOWARD); 3 females, Australia, Brindabella Mt., Lee's spring, 21. 12. 1986, (No. 45) (J. BALOGH); 2 females, Australia, Tasmania, Harts Mt., 600 m, Waratak Lookout, 07. 12. 1986, (No 22a) (J. BALOGH); 1 female, Australia, Tasmania, Harts Mt., Huon River, 150 m, 07. 12. 1986, (No 21a) (J. BALOGH); 2 females, Australia, NSW Brown Mt., 11. 04. 1967, (ANIC, Berl. No. 24) (R. W. TAYLOR and R. J. BARTELL); Australia, NSW Cabbage Tree Creek, 21. 02. 1969, (ANIC, Berl. No. 135) (S. MISKO).

Other materials: 2 females, New Guinea, Wau, Nami Creek, moss, 19. 08. 1968, B 2, J. BALOGH (Coll. Arachnida, LEU). The tubular ducts longer than the type, because of this not included in the type series.

Description of adult female. Mounted specimen (Fig. 3). Holotype, adult female 2 mm long, 1.1 mm wide. Length of segments and setae in µm. Antennae 7-segmented, 1st segment 198, 2nd segment 150, apical segment 217, with hair-like setae on all segments, with 5 hair-like setae on apical segment, apical seta 102, subapical 43, medial sensory seta 54.

Venter. Length of body parts in µm: Labium 314. Stylet loop as long as labium. Legs: 1st coxa 144, trochanter-femur 498, tibia-tarsus 647, claw 64, claw digitules 10; 2nd coxa 173, trochanter-femur 514, tibia-tarsus 664, claw 65, claw digitules 8; 3rd coxa 198, trochanter-femur 589, tibia-tarsus 822, claw 72, claw digitules 11, partly with spine-like setae; without flagellate sensory setae near tibial sensorium; trochanter with 3 sensory pores on each surface. Ovisac band complete; wax plate bands interrupted between legs; wax plate on head complete. Coxal depressions weakly developed, mesad of each coxa, separate, with a cluster of hair-like setae, and quadrilocular pores. Anterior thoracic spiracles with some quadrilocular pores, diameter of anterior thoracic spiracles 38. Hair-like setae, scattered in medial areas of thorax, with several setae near anterior and lateral edge of ovisac band, no segmental rows in ovisac band. Quadrilocular pores 4 µm in diameter; tubular quadrilocular pores short, protruding from derm, associated with wax plates; quadrilocular and simple pores scattered between wax plates elsewhere, abundant within ovisac band. Abdominal spiracles in five pairs.

Dorsum. Length of body parts in µm: Wax plates cover mostly all the surface. Spines at margin of wax plate elongate 20 µm long. Hair-like setae present in marginal clusters near posterior edges of marginal wax plates, and near anterolateral and anteromedial edge of each dorsomedial wax plate. Numerous quadrilocular pores between wax plates; tubular ducts short, present in wax plates. Anal ring with rows of pores; longest anal ring seta 73, shorter than length of anal ring; ring 78 wide and 88 long.

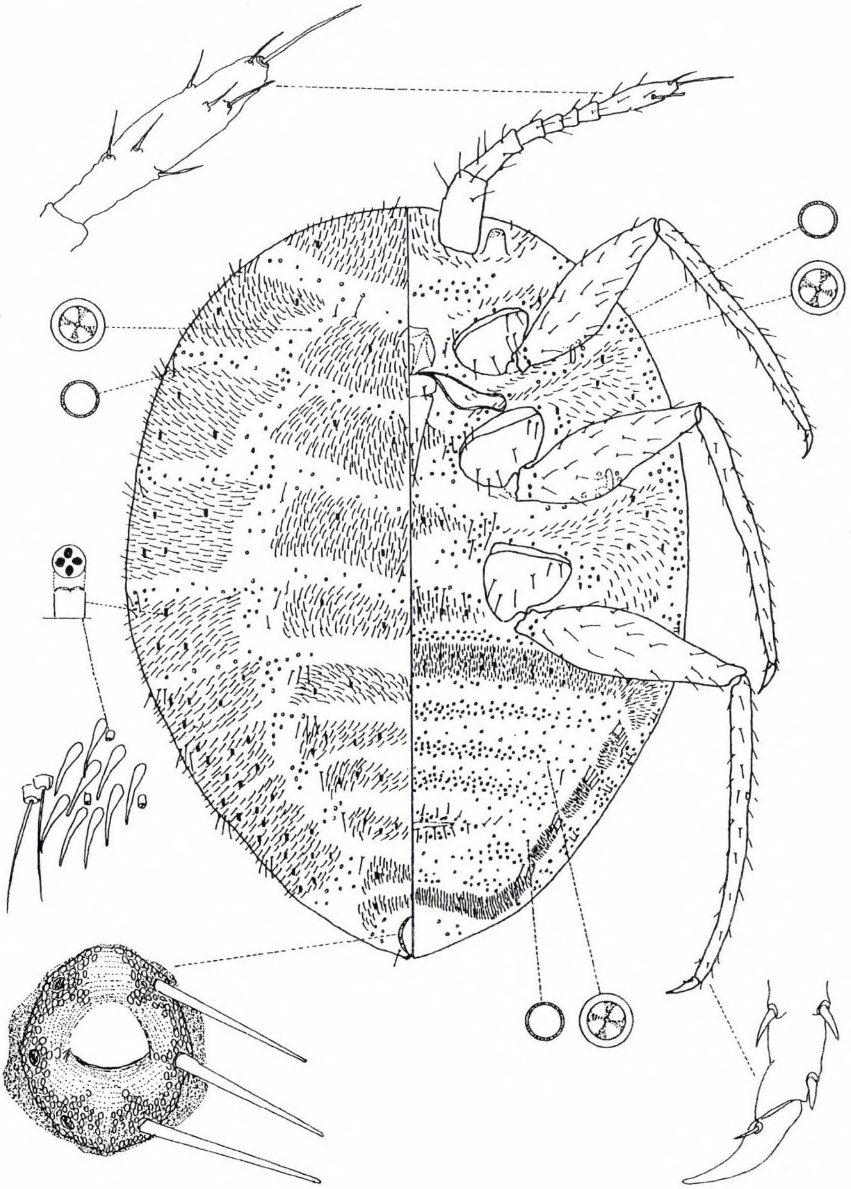


Fig. 3. *N. gullanae* sp. n.

The species is named after Dr. PENNY GULLAN who collected several ortheziids from Australia, and helped with the loan of earlier collected materials.

Comments. The two collections from Victoria (Australia) were identified (the name of the person, who made the determination is not shown) as *N. floccosa*. MORRISON (1925) supposed that it was an accidental introduction of *N. floccosa* to Australia. Although on one of the slide envelopes there is a pencil remark from JHM (JON MARTIN, BMNH) questioning the correctness of that identification. *N. gullanae* is different from the other *Newsteadia* species in Australia by having hair-like setae on the antennae. It is similar to *N. kanayana* TAKAGI, 1971, but differs from it by having long, hair-like seta on the apical segment of the antennae, and the sensory seta on the apical segment of the antenna situated near the apical seta.

Newsteadia endroedyi sp. n.

(Fig. 4)

Material examined: Holotype, female, Australia, Tasmania, Corricumley Mt., 12.12. 1982, under palms, No 4834 (S. Y. ENDRŐDY) (PPI).

Paratypes: 4 females from the same collection as the holotype.

Description of adult female. Mounted specimen (Fig. 4). Holotype, adult female 1.4 mm long, 1.0 mm wide. Length of segments and setae in µm: Antennae 6-segmented, 1st segment 186, 2nd segment 160, apical segment 234, with hair-like setae on first two segments, with setose setae on 3–5th segments and spine-like on 6th segment with 5 setae on apical segment, apical seta 99, subapical 48, medial sensory seta 42.

Venter. Length of body parts in µm: Labium 179. Stylet loop as long as labium. Legs: 1st coxa 118, trochanter-femur 398, tibia-tarsus 548, claw 36, claw digitules 7; 2nd coxa 124, trochanter-femur 423, tibia-tarsus 581, claw 41, claw digitules 8; 3rd coxa 166, trochanter-femur 465, tibia-tarsus 664, claw 40, claw digitules 8, partly with spine-like setae; without flagellate sensory setae near tibial sensorium; trochanter with 4 sensory pores on each surface. Ovisac band interrupted on the body margin; wax plates band only at coxal margin; only small groups of wax plates on head. Coxal depressions weakly developed mesad of each coxa, separate, with a cluster of hair-like setae, and quadrilocular pores. Anterior thoracic spiracles with a high number of quadrilocular pores on the margin, diameter of anterior thoracic spiracles 28 µm. Hair-like setae, scattered in medial areas of thorax, with several setae near anterior and lateral edge of ovisac band, with segmental rows in ovisac band. In one paratype the ovisac band interrupted in the middle. Quadrilocular pores 6 µm in diameter; tubular quadrilocular pores long, protruding from derm, associated with wax plates; quadrilocular pores and discoidal pores present in wide bands within ovisac band, and scattered between wax plates elsewhere. Abdominal spiracles in five pairs.

Dorsum. Length of body parts in µm: Wax plates only partly cover the surface. Spines at margin of wax plate elongate, 13. Hair-like setae present in marginal clusters near posterior edge of marginal wax plates, and near anterolateral and anteromedial edge of each dorsomedial wax plate. Quadrilocular pores numerous between wax plates, long tubular ducts present in wax plates. Anal ring with rows of pores; longest anal ring seta 52, shorter than length of anal ring; ring 57 wide, and 54 long.

The species is named after late Dr. YOUNGA SEBASTIAN ENDRŐDY, acknowledging his help to us to study his collections in the Transvaal Museum that provided the specimens.

Comments. *N. endroedyi* is somewhat similar to *N. australiensis*. The differences are discussed under that species.

Newsteadia martini sp. n.

(Fig. 5)

Material examined. Holotype, female, Australia, Cairns, Evelyn, Water Point, 12. 07. 1969, No. 69/16, J. BALOGH (Coll. Arachnida, LEU).

Paratypes: one female from the same collection as the holotype.

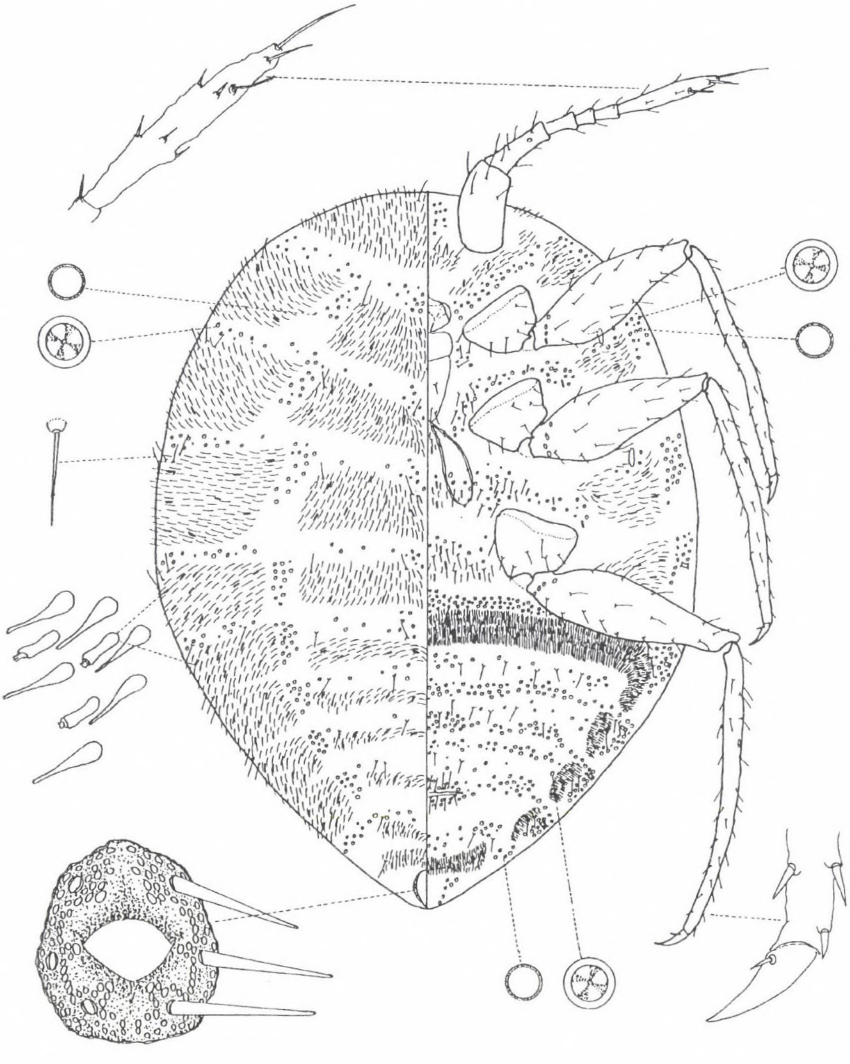


Fig. 4. *N. endroedyi* sp. n.

Description of adult female. Mounted specimen (Fig. 5). Holotype, adult female 1.1 mm long, 0.8 mm wide. Length of segments and setae in µm: Antennae 4-segmented, 1st segment 98, 2nd segment 57, apical segment 126, with spine-like setae on all segments, apical seta 110, subapical seta absent, medial sensory seta 23.

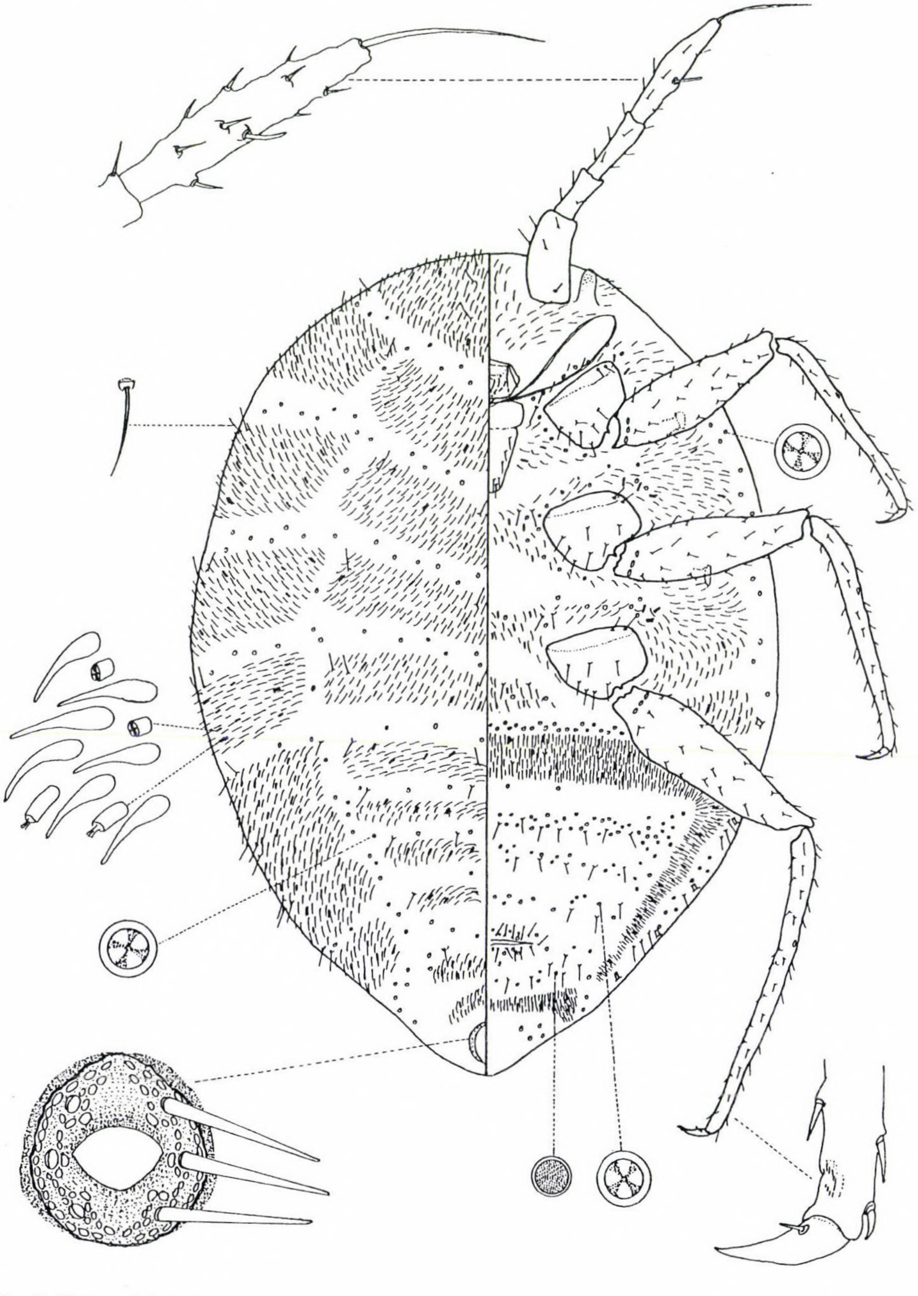


Fig. 5. *N. martini* sp. n.

Venter. Length of body parts in μm: Labium 141. Stylet loop as long as labium. Legs: 1st coxa 78, trochanter-femur 230, tibia-tarsus 315, claw 35, claw digitules 4; 2nd coxa 84, trochanter-femur 240, tibia-tarsus 324, claw 36, claw digitules 4; 3rd coxa 102, trochanter-femur 282, tibia-tarsus 349, claw 38, claw digitules 6, with spine-like setae; without flagellate sensory setae near tibial sensorium; trochanter with 3 sensory pores on each surface. Ovisac band not interrupted on the body margin; wax plate band connected in midventer, complex wax plates on head. Coxal depressions weakly developed mesad of each coxa, separate, with small number of hair-like setae, and quadrilocular pores. Anterior thoracic spiracles without quadrilocular pores, diameter of anterior thoracic spiracles 19. Hair-like setae, scattered in medial area of thorax, with several setae near anterior and lateral edge of ovisac band, with segmental rows in ovisac band. Quadrilocular pores 4 μm in diameter; tubular quadrilocular pores protruding from derm, associated with wax plates; quadrilocular pores with discoidal pores, 2 μm in diameter, present in bands within ovisac band and scattered between wax plates elsewhere.

Dorsum. Length of body parts in μm: Wax plates only partly cover body surface. Spines at margin of wax plate elongate, 12. Hair-like setae present in marginal clusters near posterior edges of marginal wax plates, and near anterolateral and anteromedial edge of each dorsomedial wax plate. Few quadrilocular pores between wax plates; tubular ducts, and tubular quadrilocular present in wax plates. Anal ring with rows of pores; longest anal ring seta 32 μm long, shorter than length of anal ring; ring 36 μm wide and 38 μm long.

The species is named after JON MARTIN, acknowledging his help in the loan of materials from the BMNH.

Comments. *N. martini* is similar to *N. biroi*, but differs from it by having rows of hair-like setae inside of the ovisac band, and long tubular ducts in dorsal wax plate bands, and by the absence of wide wax plate bands on the venter of the thorax, and also by the presence of tibial sensory setae.

Newsteadia monikae sp. n.
(Fig. 6)

Material examined: Holotype, female (marked with red), New Caledonia, Nouméa, Mt. Koghi, 11. 07. 1987, NC87 B36, J. BALOGH (Coll. Arachnida, LEU), with one paratype on the same slide (HNHM).

Paratypes: 8 females from the same collection as the holotype.

Description of adult female. Mounted specimen (Fig. 6). Holotype, adult female 1.4 mm long, 1.1 mm wide. Length of segments and setae in μm: Antennae 3-segmented, 1st segment 192, 2nd segment 128, apical segment 606, with hair-like setae on all segments, apical seta 96, subapical seta absent, sensory seta 37.

Venter. Length of body parts in μm: Labium 218. Stylet loop as long as labium. Legs: 1st coxa 126, trochanter-femur 465, tibia-tarsus 523, claw 47, claw digitules 10; 2nd coxa 132, trochanter-femur 481, tibia-tarsus 506, claw 47, claw digitules 11; 3rd coxa 138, trochanter-femur 531, tibia-tarsus 681, claw 43, claw digitules 11; partly with spine-like setae on the end of tibia-tarsus; without flagellate sensory setae near tibial sensorium; trochanter with 4 sensory pores on each surface. Ovisac band complete; wax plate band only at margin, on head and near to coxa. Coxal depressions weakly developed, mesad of each coxa, separate, with cluster of hair-like setae, and quadrilocular pores. Anterior thoracic spiracles without quadrilocular pores, diameter of anterior thoracic spiracles 23 mm. Long, hair-like setae numerous in medial area of thorax, with several setae near anterior and lateral edge of ovisac band, without segmental rows within ovisac band.

Quadrilocular pores 4 µm in diameter; tubular quadrilocular pores protruding from derm, associated with wax plates; quadrilocular pores and discoidal pores present in wide bands within ovisac band and scattered between wax plates elsewhere.

Dorsum. Length of body parts in µm: Wax plates only partly cover the surface. Spines at margin of wax plate elongate 19. Hair-like setae present in marginal clusters near posterior edges of

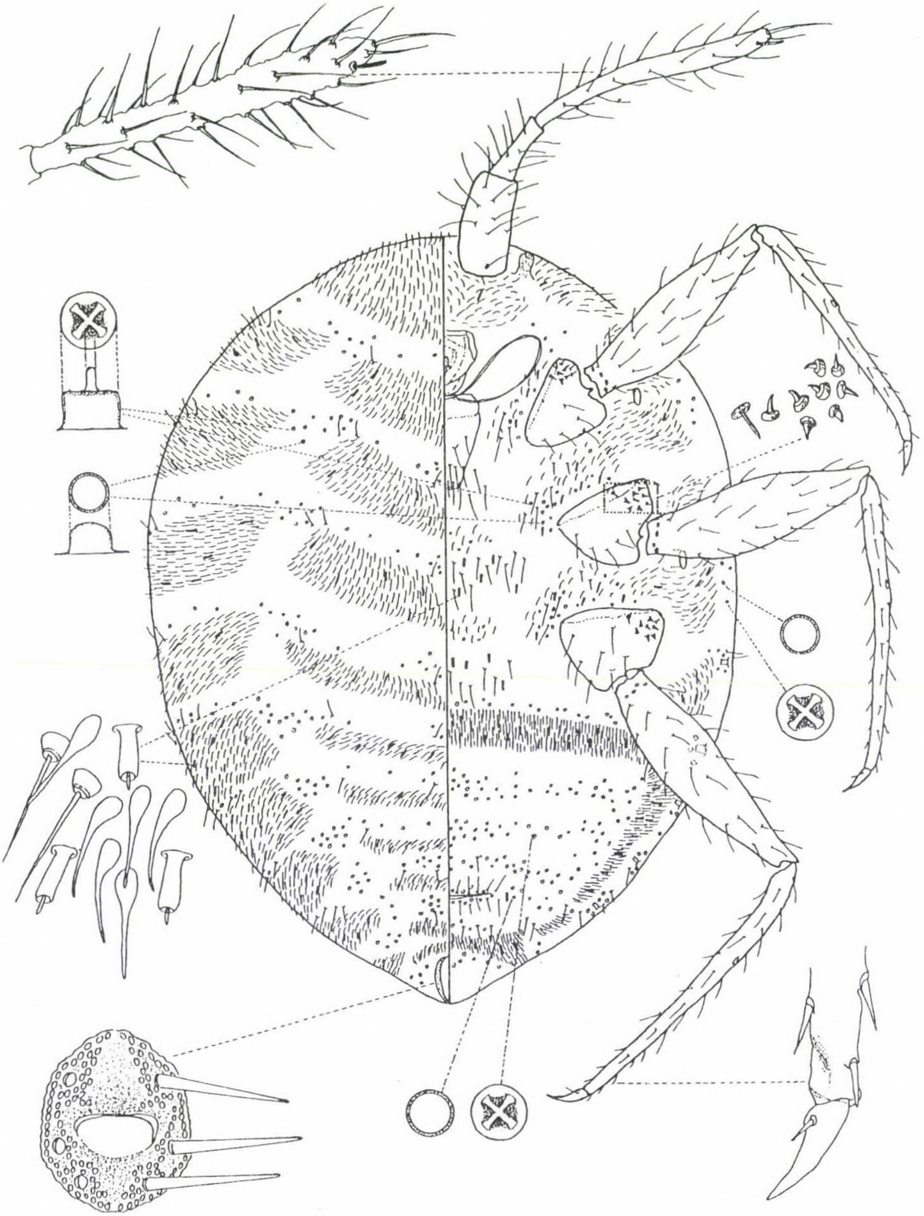


Fig. 6. *N. monikae* sp. n.

marginal wax plates, and near anterolateral and anteromedial edge of each dorsomedial wax plate. Quadrilocular pores scattered between wax plates, long tubular ducts present in wax plates. Anal ring with rows of pores; longest anal ring seta 34, shorter than length of anal ring; ring 62 wide and 60 long.

The species is named after the daughter of the second author, Mónika Horváth.

Comments. *N. monikae* differs from all known *Newsteadia* species by having a group of very stout spines on the coxa.

Newsteadia caledoniensis sp. n.

(Fig. 7)

Material examined: Holotype, female, New Caledonia, Ile des Pins, litter, 18. 05. 1986, NC86-12, J. BALOGH (Coll. Arachnida, HNHM).

Paratypes: 5 females from the same collection as the holotype.

Description of adult female. Mounted specimen (Fig. 7). Holotype, adult female 0.9 mm long, 0.7 mm wide. Length of segments and setae in µm: Antennae 4-segmented, 1st segment 108, 2nd segment 72, apical segment 186, with spine-like setae on all segments; apical seta 74, subapical seta absent, sensory seta absent.

Venter. Length of body parts in µm: Labium 115. Legs: 1st coxa 84, trochanter-femur 230, tibia-tarsus 317, claw 31, claw digitules 15; 2nd coxa 98, trochanter-femur 240, tibia-tarsus 324, claw 31, claw digitules 15; 3rd coxa 115, trochanter-femur 282, tibia-tarsus 398, claw 30, claw digitules 15, with spine-like setae; with flagellate sensory setae near tibial sensorium; trochanter with 4 sensory pores on each surface. Ovisac band complete; wax plate band only at margin of coxa; wax plates on head. Coxal depressions weakly developed, mesad of each coxa, separate, with cluster of hair-like setae, and quadrilocular pores. Anterior thoracic spiracles with some quadrilocular pores, diameter of anterior thoracic spiracles 23. Hair-like setae, in small number in medial areas of thorax, with several setae near anterior and lateral edge of ovisac band, with segmental rows within ovisac band. Quadrilocular pores 4 µm in diameter; tubular quadrilocular pores protruding from derm, associated with wax plates; quadrilocular pores and discoidal pores present in wide transverse bands within ovisac band and scattered between wax plates elsewhere.

Dorsum. Length of body parts in µm: Wax plates only partly cover the surface. Spines at margin of wax plate elongate, 12. One hair-like seta present in marginal clusters near posterior edges of marginal wax plates, and near anterolateral and anteromedial edge of each dorsomedial wax plate. Quadrilocular pores present in wax plates, but absent between wax plates, tubular ducts absent from wax plates. Anal ring with rows of pores; longest anal ring seta 35, shorter than length of anal ring; ring 37 wide and 36 long.

The species is named after the country of origin.

Comments. *N. caledoniensis* similar to *N. baloghi*, but differs from latter by the absence of quadrilocular pores between wax plates on the dorsum of the thorax, and the long tubular ducts in wax plate bands. The ovisac band is not interrupted in the middle.

Newsteadia baloghi sp. n.
(Fig. 8)

Material examined: Holotype, female, New Caledonia, Maré, 26. 05. 1987, NC87 25–6–7, J. BALOGH (HNHM).

Paratypes: 5 females from the same collection as the holotype (B12, B1, B 16–7, B 25–6–7).

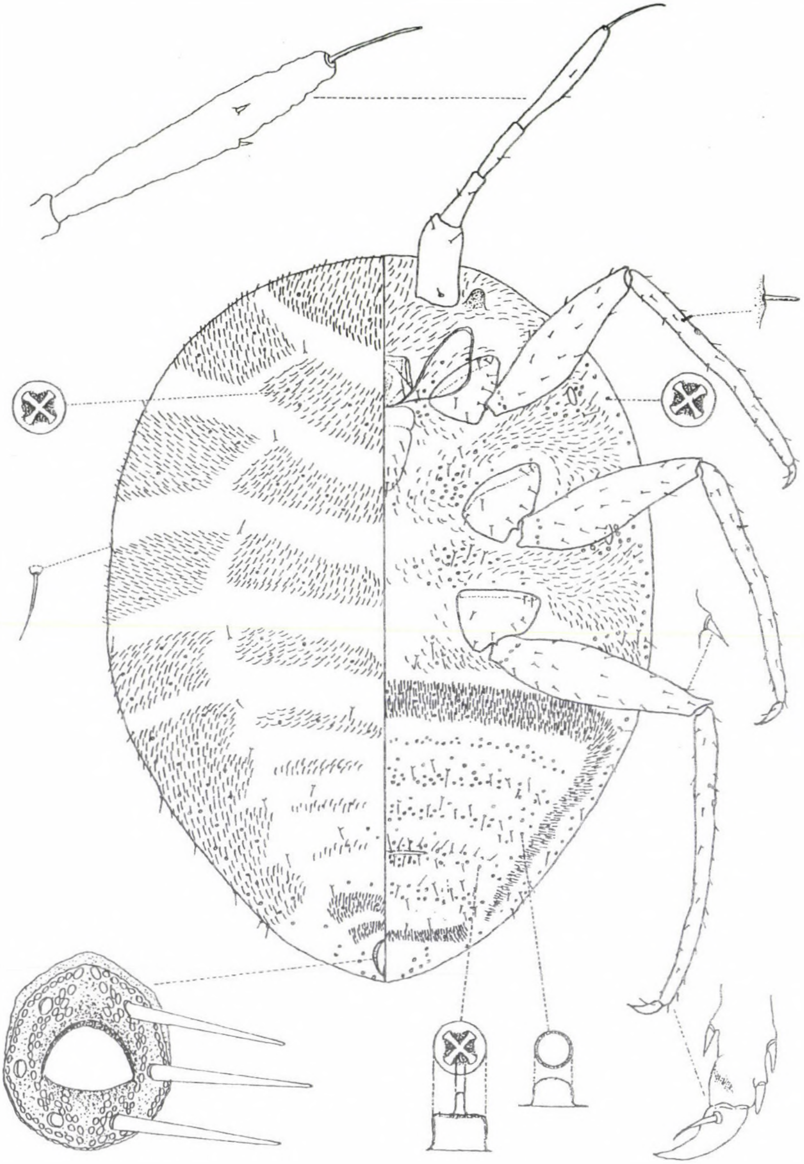


Fig. 7. *N. caledoniensis* sp. n.

Other materials: 2 females, New Caledonia, Ile des Pins, Gajdi Forests, *Archemorus* forest litter, 18–24. 05. 1987, NC87 B-7, J. BALOGH (Coll. Arachnida, LEU). Because of the deformed, and variable number of the segments of the antennae, not included in the type series.

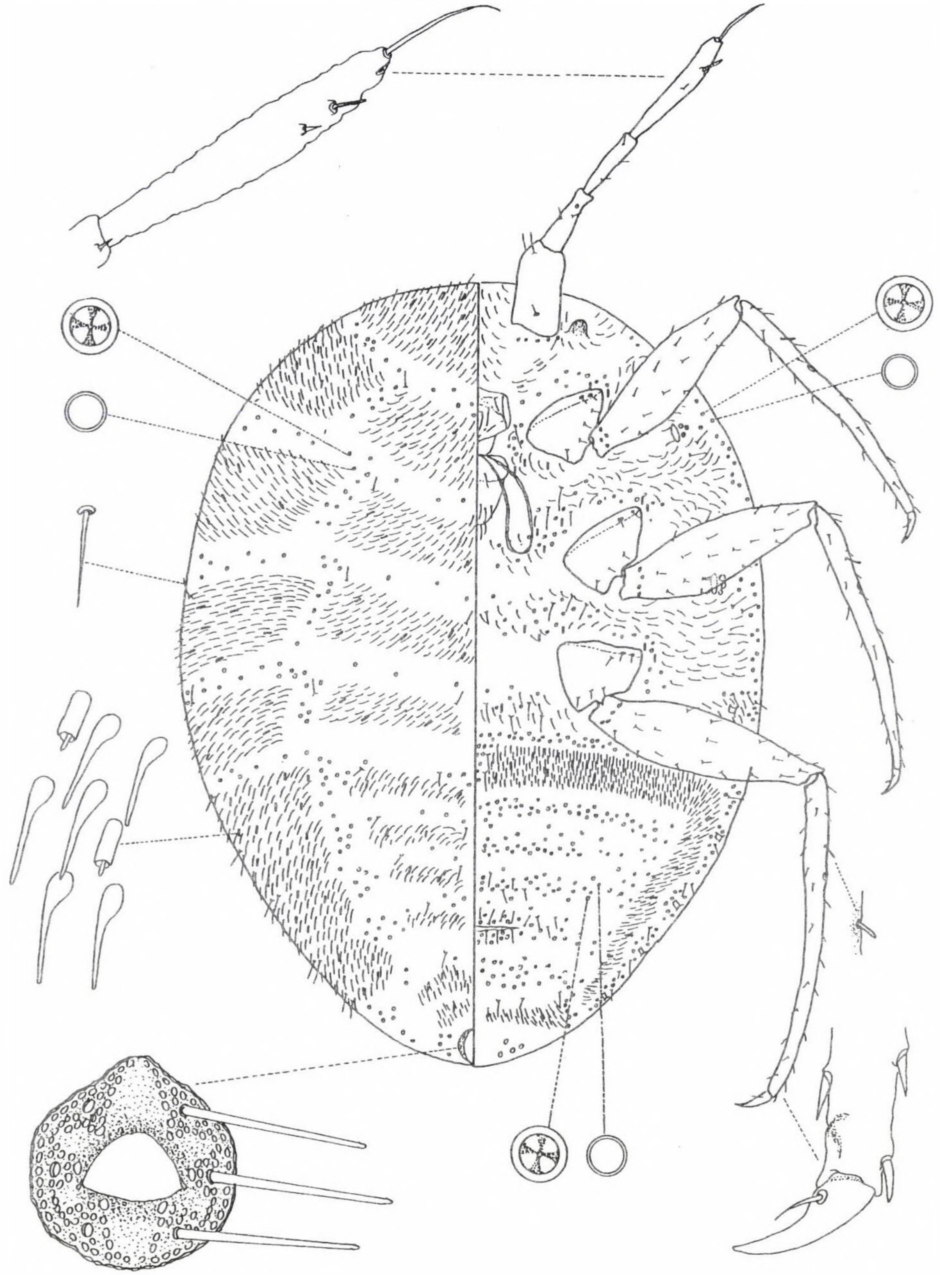


Fig. 8. *N. baloghi* sp. n.

Description of adult female. Mounted specimen (Fig. 8). Holotype, adult female 1.3 mm long, 1.0 mm wide. Length of segments and setae in µm: Antennae 4-segmented, 1st segment 122, 2nd segment 108, apical segment 211, with spine-like setae on all segments, apical seta 76 µm long, subapical seta absent, sensory seta 19.

Venter. Length of body parts in µm: Labium 147. Legs: 1st coxa 96, trochanter-femur 349, tibia-tarsus 448, claw 35, claw digitules 10; 2nd coxa 114, trochanter-femur 374, tibia-tarsus 498, claw 34, claw digitules 10, 3rd coxa 126, trochanter-femur 398, tibia-tarsus 564, claw 36, claw digitules 10; with spine-like setae; without flagellate sensory setae near tibial sensorium; trochanter with 4 sensory pores on each surface. Ovisac band interrupted in the middle; wax plate band only at margin of coxa; wax plates on head. Coxal depressions weakly developed, mesad of each coxa, separate, with cluster of hair-like setae, and quadrilocular pores. Anterior thoracic spiracles with some quadrilocular pores, diameter of anterior thoracic spiracles 67. Hair-like setae, in small number in medial areas of thorax, with several setae near anterior and lateral edge of ovisac band, without rows in ovisac band. Quadrilocular pores 5 µm in diameter; tubular quadrilocular pores protruding from derm, associated with wax plates; quadrilocular pores and discoidal pores 3 µm in diameter present in bands within ovisac band and scattered between wax plates elsewhere.

Dorsum. Length of body parts in µm: Wax plates only partly cover the surface. Spines at margin of wax plate elongate 16. One hair-like seta present in marginal clusters near posterior edges of marginal wax plates, and near anterolateral and anteromedial edge of each dorsomedial wax plate. Quadrilocular and discoidal pores scattered between wax plates, tubular ducts present in wax plates. Anal ring with rows of pores; longest anal ring seta 37, shorter than length of anal ring; ring 50 wide and 48 long.

The species is named after Professor Dr. JÁNOS BALOGH, acknowledging his great help in offering his arachnological collection for study.

Comments. *N. baloghi* is similar to *N. caledoniensis*, the differences are discussed under that species. It differs from all other *Newsteadia* species by the interrupted ovisac band.

Newsteadia biroi sp. n.

(Fig. 9)

Material examined: Holotype, female, New Guinea, Mt. Kaindi, 2300 m a.s.l., moss, 14. 08. 1977. NG K7, J. BALOGH) (HNHM).

Paratypes: 3 females from the same collection as the holotype.

Description of adult female: Mounted specimen (Fig. 9). Holotype, adult female 1.1 mm long, 0.76 mm wide. Length of segments and setae in µm: Antennae 4-segmented, 1st segment 105, 2nd segment 72, 3rd segment 84, apical segment 157, with spine-like, but long setae on all segments, apical seta 112, subapical seta absent, sensory seta 30.

Venter. Length of body parts in µm: Labium 134. Legs: 1st coxa 90 at the basis with special tubercles (which may be present in other species too, however, not in every case is visible), trochanter-femur 246, tibia-tarsus 374, claw 37, claw digitules 6; 2nd coxa 96, trochanter-femur 253, tibia-tarsus 382, claw 38, claw digitules 7; 3rd coxa 108, trochanter-femur 288, tibia-tarsus 440, claw 42, claw digitules 7, with spine-like setae; with 24 flagellate sensory setae near tibial sensorium; trochanter with 3 sensory pores on each surface. Wax plate bands developed on the thorax. Coxal depressions not developed. Anterior thoracic spiracles with some quadrilocular pores, diameter of anterior thoracic spiracles 20 µm. Hair-like setae, in small number in medial areas of thorax, with several setae near anterior and lateral edge of ovisac band, without rows in ovisac band. Quadrilocular and discoidal pores 3–5 µm in diameter present in bands within ovisac band, short tubular quadrilocular pores protruding from derm, associated with wax plates.

Dorsum. Length of body parts in µm: Wax plates cover the surface. Spines at margin of wax plate elongate, 11. Two-three hair-like setae present in marginal clusters near posterior edges of marginal wax plates, and near anterolateral and anteromedial edge of each dorsomedial wax plate,

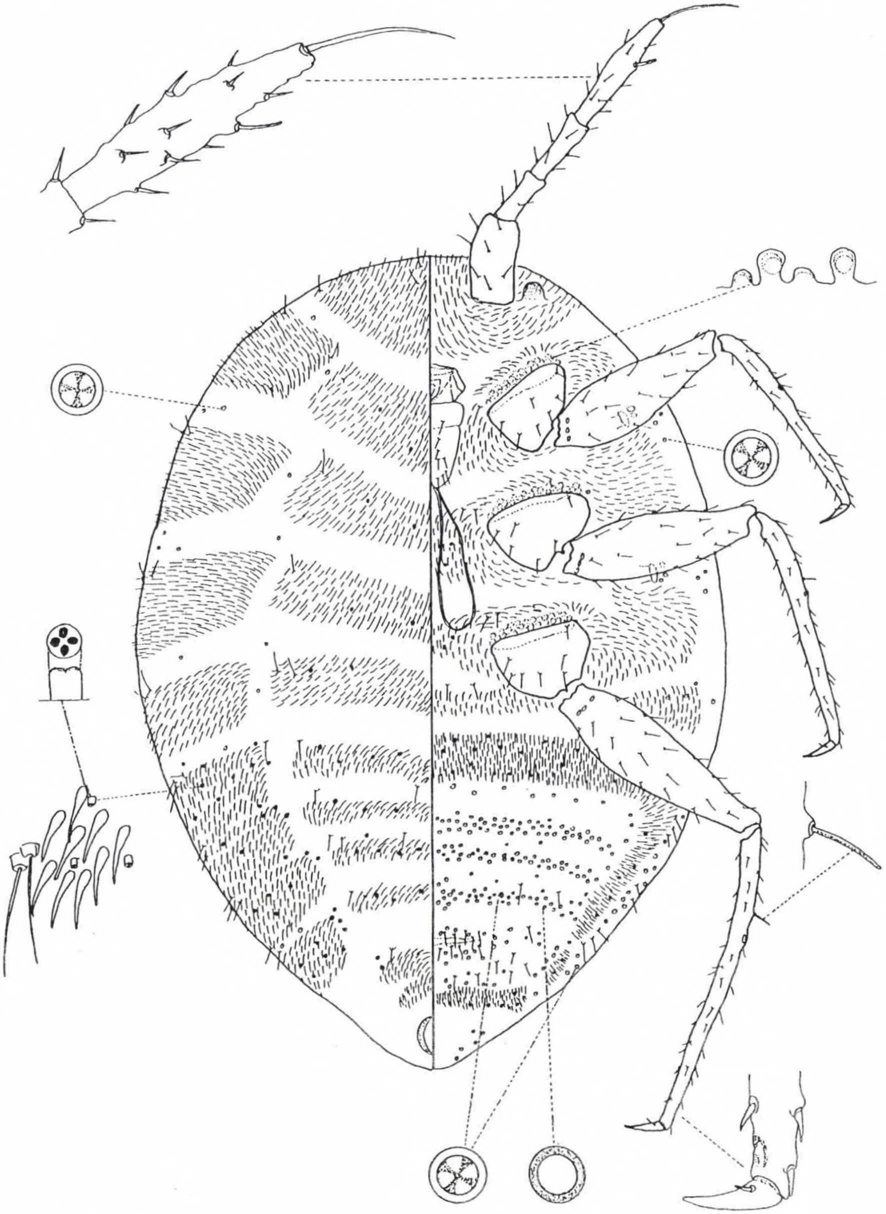


Fig. 9. *N. biroi* sp. n.

12. Quadrilocular pores scattered between wax plates; short tubular quadrilocular ducts present in wax plates. Long tubular ducts absent. Anal ring hardly seen; longest anal ring seta 43 µm long shorter than length of anal ring.

The species is named after LAJOS BÍRÓ, Hungarian entomologist who worked in these regions between 1895–1901.

Comments. *N. biroi* is similar to *N. martini*, the differences are discussed under the latter species.

Newsteadia guineensis sp. n.
(Fig. 10)

Material examined: Holotype, female (marked with red), New Guinea Mt. Kaindi, moss, 27. 08. 1968. NG B29 (J. BALOGH) (HNHM).

Paratypes: 2 females from the same collection as the holotype, on the same slide.

Description of adult female: Mounted specimen (Fig. 10). Holotype, adult female 0.96 mm long, 0.67 mm wide. Length of segments and setae in µm: Antennae 3-segmented, 1st segment 120, 2nd segment 84, apical segment 326, with hair-like setae on all segments, apical seta 60, subapical seta absent, sensory seta 22.

Venter. Length of body parts in µm: Labium 128. Stylet loop as long as labium. Legs: 1st coxa 84, trochanter-femur 310, tibia-tarsus 423, claw 31, claw digitules 8; 2nd coxa 94, trochanter-femur 320, tibia-tarsus 465, claw 34, claw digitules 8; 3rd coxa 98, trochanter-femur 346, tibia-tarsus 506, claw 37, claw digitules 9, with hair-like and spine-like setae; without flagellate sensory setae near tibial sensorium; trochanter with 4 sensory pores on each surface. Wax plate bands developed on the thorax. Coxal depressions weakly developed, mesad of each coxa, separate, with cluster of hair-like setae, and quadrilocular pores. Anterior thoracic spiracles with some quadrilocular pores, diameter of anterior thoracic spiracles 18. Few hair-like setae present in medial areas of thorax, with several setae near anterior and lateral edge of ovisac band, not forming rows within ovisac band. Quadrilocular pores 3 in diameter; tubular ducts associated with wax plates. Quadrilocular pores and discoidal pores 2–3 in diameter present in bands and aggregated groups within ovisac band, and scattered between wax plates elsewhere.

Dorsum. Length of body parts in µm: Wax plates only partly cover the surface. Spines at margin of wax plate elongate, 16. Two-three hair-like setae present in marginal clusters near posterior edges of marginal wax plates, and near anterolateral and anteromedial edge of each dorsomedial wax plate. Quadrilocular pores scattered between wax plates, long tubular ducts present in wax plates. Anal ring with two, incomplete rows of pores; longest anal ring seta 30, shorter than length of anal ring; ring 45 wide and 37 long.

The species is named after the country of origin.

Comments. *N. guineensis* is similar to *N. milleri* by having three-segmented antennae in both. It differs by having hair-like setae on apical segment of the antennae, and by the absence of strong seta on the base of the trochanter. It differs from all other *Newsteadia* species by the presence the grouped quadrilocular and simple pores.

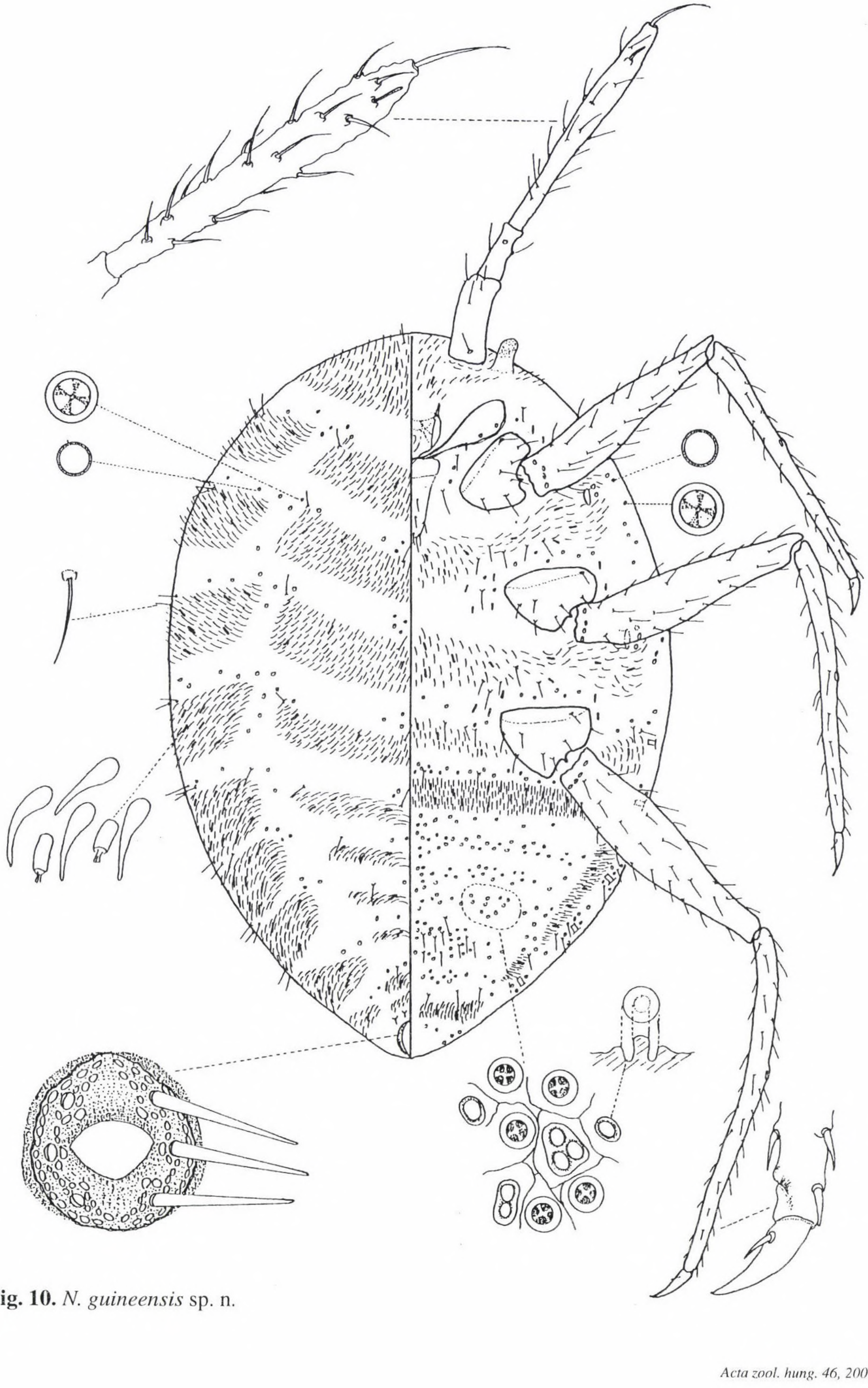


Fig. 10. *N. guineensis* sp. n.

Newsteadia milleri sp. n.

(Fig. 11)

Material examined: Holotype, female, New Guinea, Wau (Kilolo Creek), 900 m a.s.l., from litter, 23. Aug. 1968, NG W B.15, J. BALOGH (HNHM).

Description of adult female. Mounted specimen (Fig. 11). Holotype, adult female 1.3 mm long, 1.0 mm wide. Length of segments and setae in µm: Antennae 3-segmented, 1st segment 192, 2nd segment 205, apical segment 481, with spine-like setae on all segments, apical seta 64, subapical seta absent, sensory seta 24.

Venter. Length of body parts in µm: Labium 243 µm long. Legs: 1st coxa 112, trochanter-femur 432, tibia-tarsus 614, claw 38, claw digitules 10; 2nd coxa 128, trochanter-femur 465, tibia-tarsus 647, claw 41, claw digitules 10; 3rd coxa 138, trochanter-femur 498, tibia-tarsus 730, claw 48, claw digitules 14; with spine-like setae; without flagellate sensory setae near tibial sensorium; trochanter with 3 sensory pores on each surface. At the basis of trochanter-femur a strong seta situated. Wax plates not developed on the thorax. Coxal depressions not developed. Anterior thoracic spiracles with some quadrilocular pores, diameter of anterior thoracic spiracles 29. On the ventral margin four and five locular pores, and simple discoidal pores numerous. Hair-like setae, few in medial area of thorax, with several setae near anterior and lateral edge of ovisac band, without rows in ovisac band. Quadrilocular and discoidal pores 3–4 in diameter present in bands within ovisac band.

Dorsum. Length of body parts in µm: Wax plates only partly cover the surface. Spines at margin of wax plate elongate, 25. Two-three hair-like setae present in marginal clusters near posterior edges of marginal wax plates, and near anterolateral and anteromedial edge of each dorsomedial wax plate, 30. Quadrilocular and discoidal pores scattered between wax plates, long tubular ducts present in wax plates. Anal ring hardly seen; longest anal ring seta 40 µm long shorter than length of anal ring.

The species is named after Dr. DOUGLASS R. MILLER, acknowledging his help in my coccidological work and for the loan of materials from the USNM.

Comments. *N. milleri* is similar to *N. guineensis*, the differences are discussed under the latter species. *N. milleri* differs from all *Newsteadia* species by having a strong spine at the base of each trochanter.

Newsteadia myersi GREEN, 1929

(Fig. 12)

Material examined: New Zealand, Ohakuna, ("Type"), 13. 01. 1924, from leaf mould, Leg. J. G. MYERS, one "co-type" from the same collection, (BMNH).

Other new material: This species was found in our collection from the following places: New Zealand, Waipona Forest, 06.01.1967 (NZ 2); LUXTON 1965 (NZ 14); Forster, Totara Res., 19.01. 1964 RRF, (NZ 16); Mt. Holdsworth, 03.08. 1966, CLW, (NZ 39) J. BALOGH (Coll. Arachnida, LEU).

Description of adult female: Mounted specimen (Fig. 12). Holotype, adult female 1.3 mm long, 0.9 mm wide. Length of segments and setae in µm: Antennae 5–6-segmented, 1st segment 120, 2nd segment 96, apical segment 204, with spine-like setae on all segments, apical seta 70, subapical seta absent, sensory seta 19.

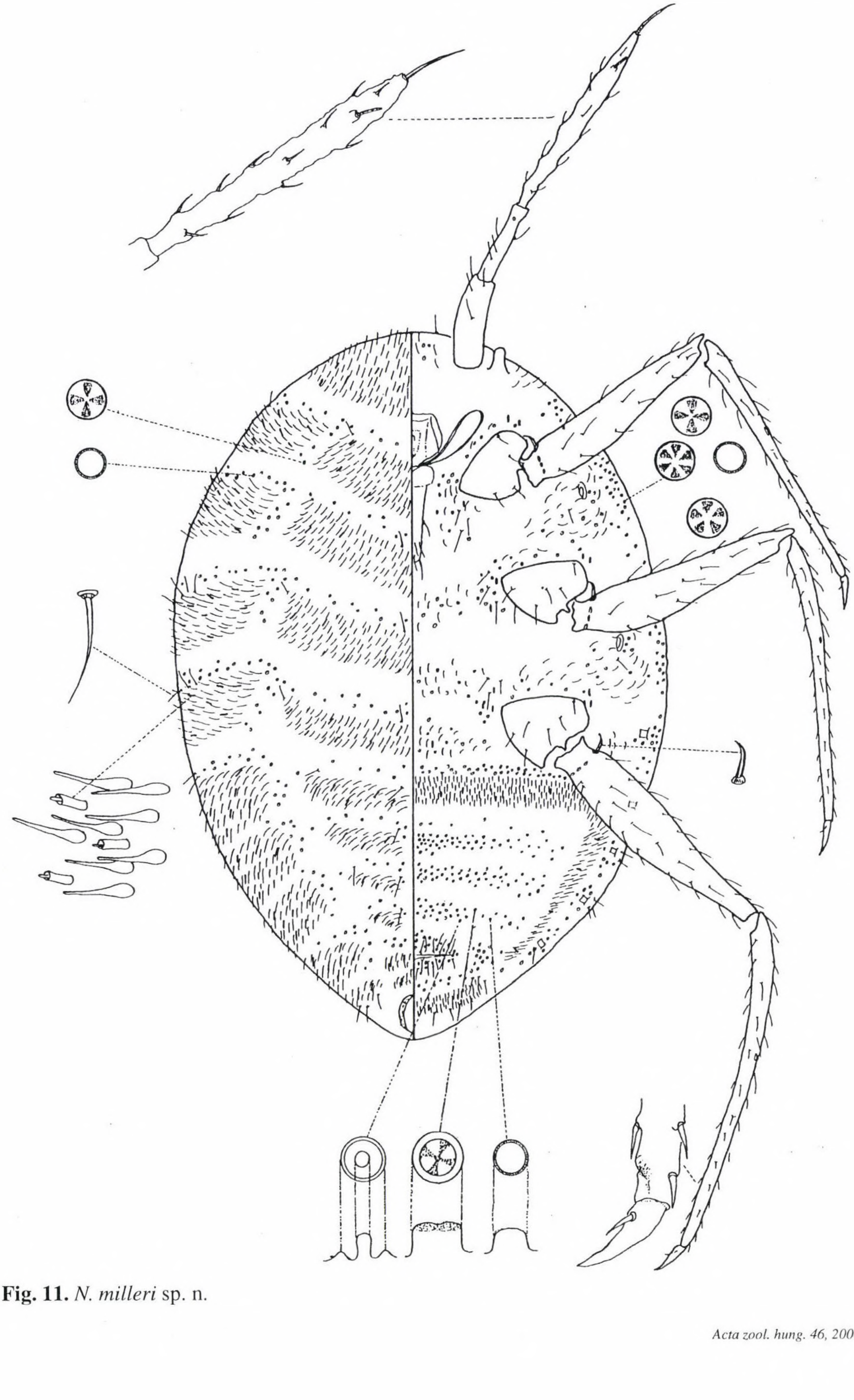


Fig. 11. *N. milleri* sp. n.

Venter. Length of body parts in µm: Labium 160. Legs: 1st coxa 102, trochanter-femur 349, tibia-tarsus 465, claw, and claw digitules hardly seen; 2nd coxa 124, trochanter-femur 390, tibia-tarsus 498, claw 40, claw digitules 16; 3rd coxa 144, trochanter-femur 415, tibia-tarsus 654, claw 40, claw digitules 17, with spine-like setae; with one flagellate sensory setae, 16 near tibial sensorium; trochanter with 4 sensory pores on each surface. Wax plates in big groups on the thorax.

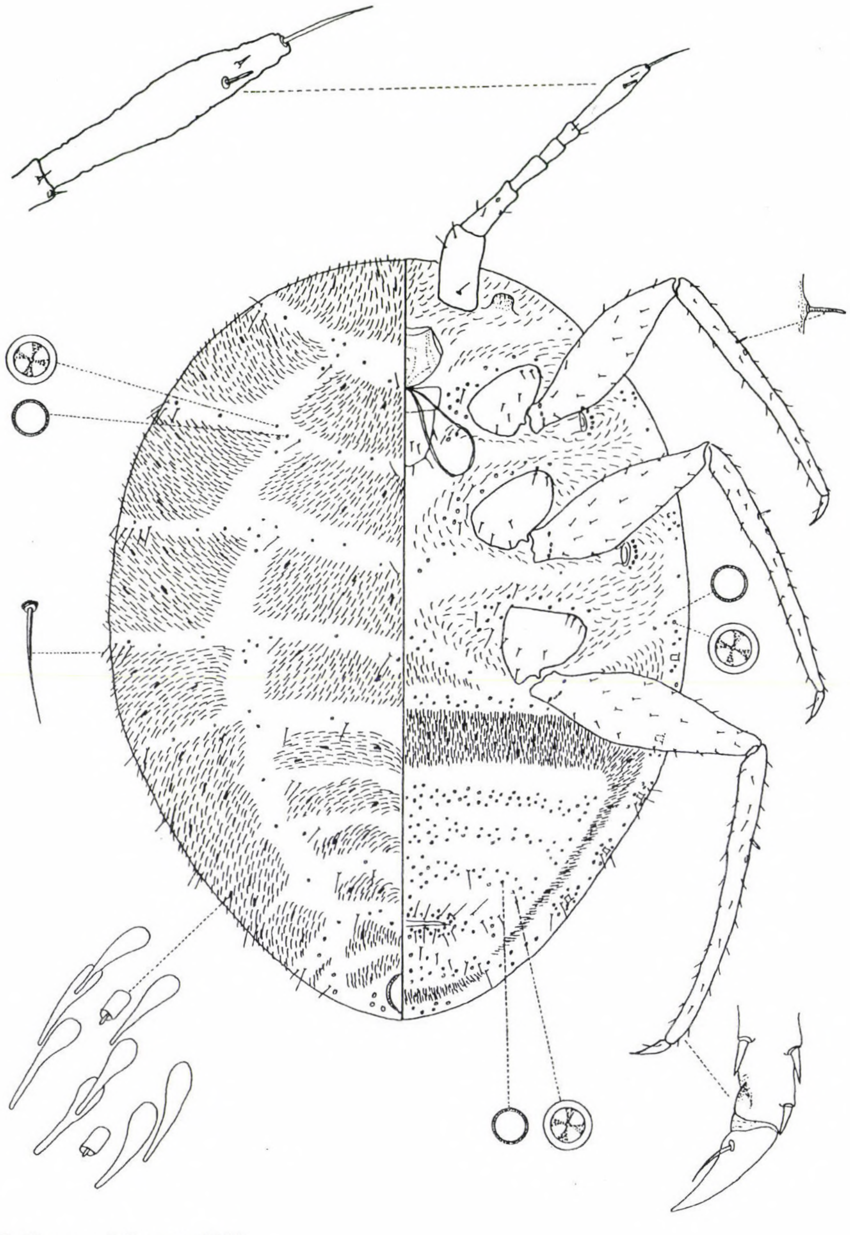


Fig. 12. *N. myersi* GREEN, 1929

Coxal depressions not developed. Anterior thoracic spiracles with a group of quadrilocular pores, diameter of anterior thoracic spiracles 25. Ventral margin with scattered quadrilocular and simple discoidal pores. Hair-like setae, in small number in medial areas of thorax, without rows in ovisac band. Quadrilocular and discoidal pores 4–5 in diameter, present in transverse bands within ovisac band.

Dorsum. Length of body parts in µm: Wax plate bands cover the surface. Spines at margin of wax plate elongate, 16. Two to four hair-like setae present in marginal clusters near posterior edges of marginal wax plates, and near anterolateral and anteromedial edge of each dorsomedial wax plate, 20. Quadrilocular and discoidal pores scattered between wax plates, long tubular ducts present in wax plates. Anal ring hardly visible.

Comments. *N. myersi* is similar to *N. australiensis* and *N. endroedyi*, but differs from it by having only few setae on the apical segment of the antennae. *N. myersi* differs from *N. tasmaniensis* and *N. samoana* in having no quadrilocular pores in the atrium of spiracles. GREEN (1929) found also specimens with four-segmented antennae, however, he thought, that the normal number of segments is six.

Newsteadia zimmermani MORRISON, 1952

(Fig. 13)

Material examined: Fiji, Nandarivatu, Viti Levu, 07, 09, 1938 (paratype), Leg. E. ZIMMERMAN (USNM).

Description of adult female: Mounted specimen (Fig. 13). Holotype, adult female 1.7 mm long, 1.1 mm wide. Length of segments and setae in µm: Antennae 6-segmented, 1st segment 120, 2nd segment 126, apical segment 205, with blunt setae on all segments, apical seta 64, subapical seta absent, sensory seta 25.

Venter. Length of body parts in µm: Labium 160. Legs: 1st coxa 128, trochanter-femur 415, tibia-tarsus 515, claw 44, and claw digitules 16; 2nd coxa 141, trochanter-femur 431, tibia-tarsus 565, claw 46, claw digitules 16; 3rd coxa 154, trochanter-femur 481, tibia-tarsus 647, claw 46, claw digitules 17. Legs are partly with blunted setae and with spine-like setae near to the end; without flagellate sensory setae, trochanter with 4 sensory pores on each surface. Wax plates in wide bands on the thorax. Coxal depressions not developed. Thoracic spiracles with some quadrilocular pores in the atrium, diameter of anterior thoracic spiracles 35 µm. On the body margin quadrilocular, and simple discoidal pores in groups. Hair-like setae, in small number in medial areas of thorax, without rows in ovisac band. Quadrilocular and discoidal pores 4–5 in diameter present in bands within ovisac band.

Dorsum. Length of body parts in µm: Wax plate bands cover most of the surface. Spines at margin of wax plate elongate, 19. Two to four hair-like setae present in marginal clusters near posterior edges of marginal wax plates, and near anterolateral and anteromedial edge of each dorsomedial wax plate, 26. Quadrilocular and discoidal pores forms groups between wax plates, long tubular ducts, 6, and microtubular ducts, 1, present in wax plates. Anal ring hardly visible.

Comments. *N. zimmermani* is similar to *N. guadalcanalia*, by having blunt setae on the antennae and legs. Venter of thorax of *N. zimmermani* with wide bands of wax plates, and the wax plate bands are not interrupted on the median of dorsum. There are groups of quadrilocular pores on the margin of the venter. No further collections have been made since the original specimens were collected (WILLIAMS & WATSON 1990).

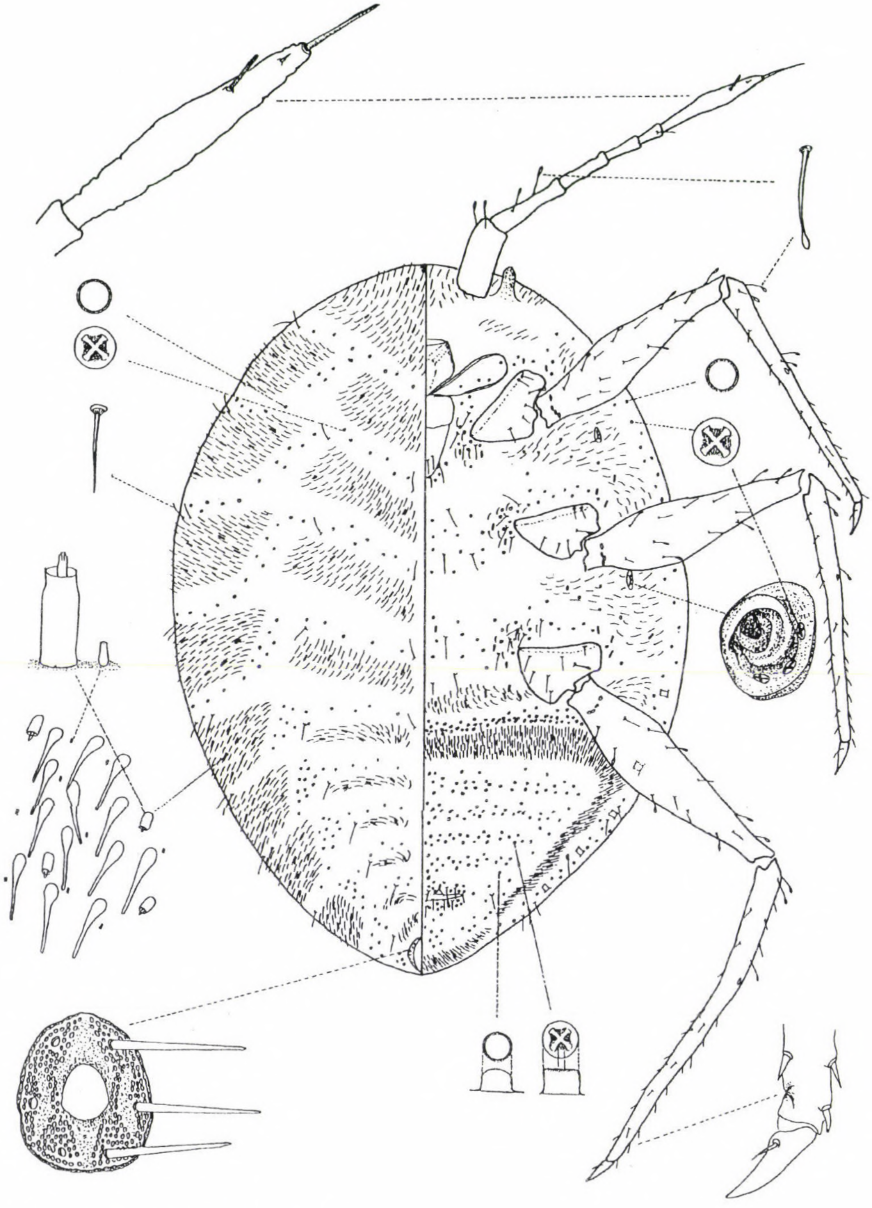


Fig. 13. *N. zimmermani* MORRISON, 1952

Newsteadia samoana MORRISON, 1952
(Fig. 14)

Material examined: Samoa, Tiavi, Upolu, 06, 21,1940, (4 paratypes on 2 slides), on *Angispteris*, 700 m a.s.l., Leg. E. Zimmerman, Samoa, Pica, Tutuila, 29. 08, 1940, 600 m a.s.l., (one paratype), Leg. E. ZIMMERMAN (USNM).

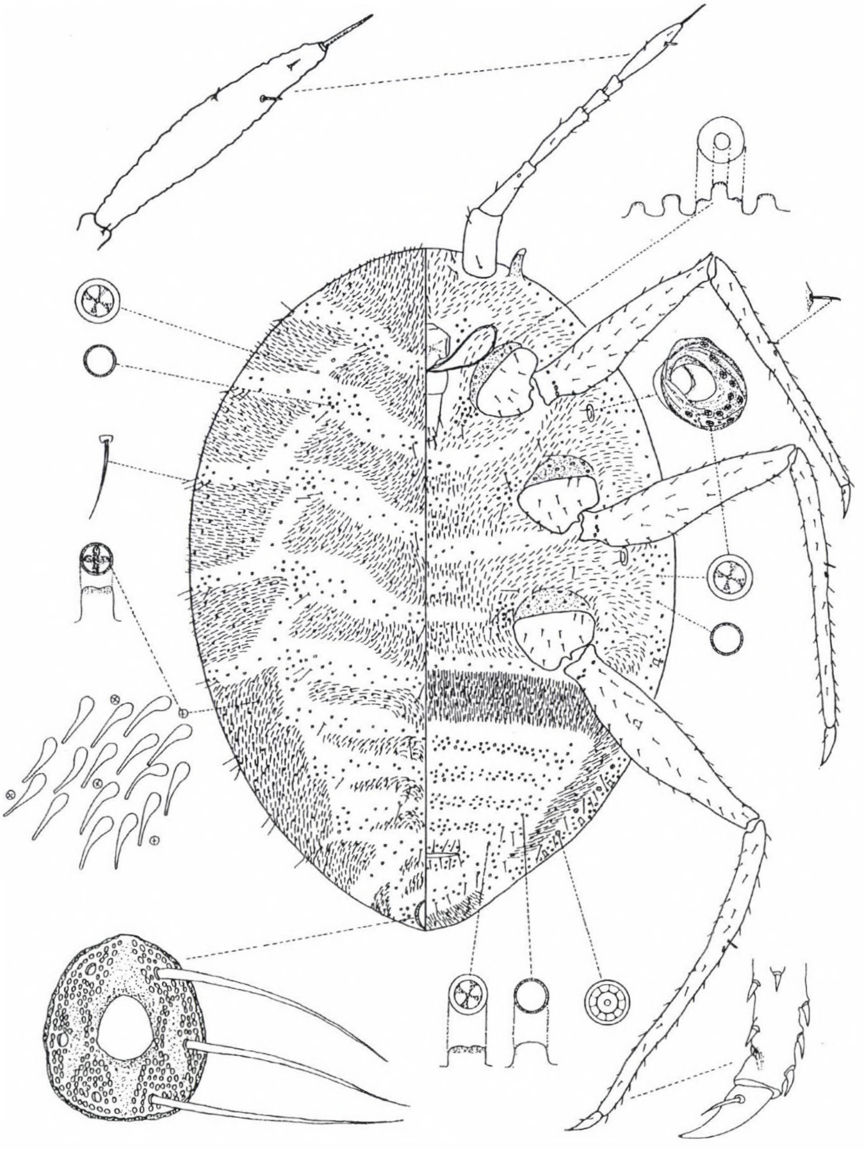


Fig. 14. *N. samoana* MORRISON, 1952

Description of adult female: Mounted specimen (Fig. 14). Holotype, adult female 1.6 mm long, 1.1 mm wide. Length of segments and setae in µm: Antennae 5 or 6-segmented, 1st segment 173, 2nd segment 182, apical segment 236, with spine-like setae on all segments, apical seta 67, subapical seta absent, sensory seta 22.

Venter. Length of body parts in µm: Labium 186. Legs: 1st coxa 160, trochanter-femur 581, tibia-tarsus 730, claw 53, and claw digitules 23; 2nd coxa 173, trochanter-femur 623, tibia-tarsus 764, claw 52, claw digitules 24; 3rd coxa 192, trochanter-femur 664, tibia-tarsus 872, claw 55, claw digitules 26, with spine-like setae; with one flagellate sensory setae, 19 near tibial sensorium; trochanter with 4 sensory pores on each surface. The base of the coxae with unusual structures (not pore, not duct, not seta, which may be present in case of other species, but covered by coxa). Many wax plates on the thorax. Coxal depressions not developed. Anterior thoracic spiracles with a large group of quadrilocular pores in the atrium, diameter of anterior thoracic spiracles 35. On the ventral margin quadrilocular, and simple discoidal pores scattered. Few hair-like setae, in small number in medial areas of thorax, without rows within ovisac band. Quadrilocular and discoidal pores 5 in diameter present in bands within ovisac band. Some ten-locular pores present on the margin.

Dorsum. Length of body parts in µm: Wax plate bands cover the surface. Spines at margin of wax plate elongate, 14. Two to four hair-like setae present in marginal clusters near posterior edges of marginal wax plates, and near anterolateral and anteromedial edge of each dorsomedial wax plate, 16 µm long. Quadrilocular and discoidal pores scattered between wax plates, long tubular ducts absent in wax plates. Anal ring with several bands of pores, on both sides with an elongated empty band between pores. The anal ring 48 µm wide and 58 µm long, with 78 µm long hair-like setae.

Comments. *N. samoana* is similar to *N. martini*, and *N. milleri* having spine-like seta on the antennae and legs, but *N. samoana* differs from both by having long hair-like setae on the claws, and few setae on apical segment of the antennae. The similarity with *N. tasmaniensis* is discussed under that species. WILLIAMS and WATSON (1990) mentioned the presence of this species in Solomon Is. and on Vanuatu, too. MORRISON (1952) remarked about some differences of the paratype from Pica. According to present analyses these differences belong to individual variations of the mentioned characters.

Newsteadia guadalcanalia MORRISON, 1952
(Fig. 15)

Material examined: Solomon Is. North Guadalcanal, (Holotype) 1944, Leg. L. LIPORSKY (USNM).

Description of adult female: Mounted specimen (Fig. 15). Holotype, adult female 1.2 mm long, 0.8 mm wide. Length of segments and setae in µm: Antennae 6-segmented, 1st segment 118, 2nd segment 150, apical segment 176, with blunt setae on all segments, apical seta 64, subapical seta absent, sensory seta 32.

Venter. Length of body parts in µm: Labium 108. Legs: 1st coxa 101, trochanter-femur 357, tibia-tarsus 481, claw 35, and claw digitules 8; 2nd coxa 18, trochanter-femur 398, tibia-tarsus 523, claw 36, claw digitules 8; 3rd coxa 120, trochanter-femur 440, tibia-tarsus 564, claw 36, claw digitules 9. Legs are partly with blunt setae and with spine-like setae near to the end; without flagellate sensory setae; trochanter with 4 sensory pores on each surface. Wax plates absent in the middle of thorax. Coxal depressions developed with some seta, quadrilocular pores and tubular ducts. Thoracic spiracles with some quadrilocular pores in the atrium, diameter of anterior thoracic spiracles

26. On the ventral margin quadrilocular, and simple discoidal pores scattered. Hair-like setae few in medial areas of thorax, without rows within ovisac band. Quadrilocular and discoidal pores 3–5 in diameter present in bands within ovisac band.

Dorsum. Wax plate bands only partly cover the surface. The bands are interrupted in the middle of the dorsum. Spines at margin of wax plate elongate, 17 µm long. Two to four hair-like setae present in marginal clusters near posterior edges of marginal wax plates, and near anterolat-

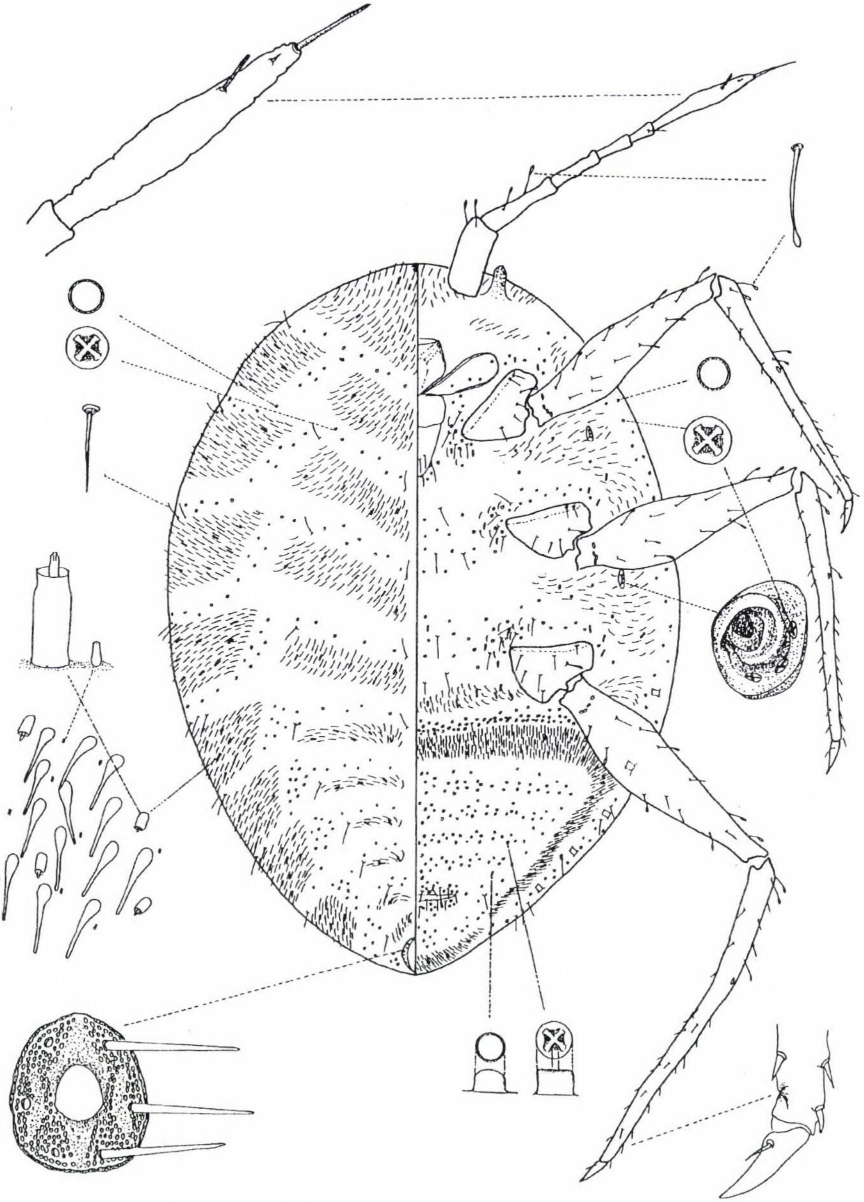


Fig. 15. *N. guadalcanalia* MORRISON, 1952

eral and anteromedial edge of each dorsomedial wax plate, 23. Quadrilocular and discoidal pores form small groups between wax plates, long tubular ducts, 6 µm long, and microtubular ducts, 1 µm long, present in wax plates. Anal ring 55 long, and 55 wide, anal ring setae 38.

Comments. *N. guadalcanalia* is similar to *N. zimmermani*, the differences are discussed under the latter species. WILLIAMS and WATSON (1990) gave some new records on the distribution of this species in the Solomon Islands.

KEY TO ADULT FEMALES OF NEWSTEADIA FOUND IN THE REGIONS

1 Coxa with a group of stout spines **N. monikae** sp. n.

– Coxa without group of stout spines 2

2 Bases of trochanter-femur with a strong spine **N. milleri** sp. n.

– Bases of trochanter-femur without strong spine 3

3 Antennal setae long, slender and blunt 4

– Antennal setae not blunt 5

4 Dorsal wax bands not interrupted, with groups of quadrilocular pores *N. zimmermani* MORRISON, 1952

– Dorsal wax bands interrupted, without groups of quadrilocular pores *N. guadalcanalia* MORRISON, 1952

5 Antennae three-segmented; with an aggregation of pores on the venter of abdomen **N. guineensis** sp. n.

– Antennae more than 3-segmented 6

6 Antennae 4-segmented 7

– Antennae more than 4-segmented 10

7 Apical segment of the antennae with more than ten setae 8

– Apical segment of the antennae less than five setae 9

8 Long tubular ducts in wax plate bands present; sensory seta on legs absent **N. martini** sp. n.

– Long tubular ducts in wax plate bands absent; sensory seta on legs present **N. biroi** sp. n.

9 Wax plate bands without long tubular ducts; ovisac band not interrupted in the middle **N. caledoniensis** sp. n.

– Wax plate bands with long tubular ducts; ovisac band interrupted in the middle **N. baloghi** sp. n.

10 Antennae 6-segmented 11

– Antennae 7-segmented **N. gullanae** sp. n.

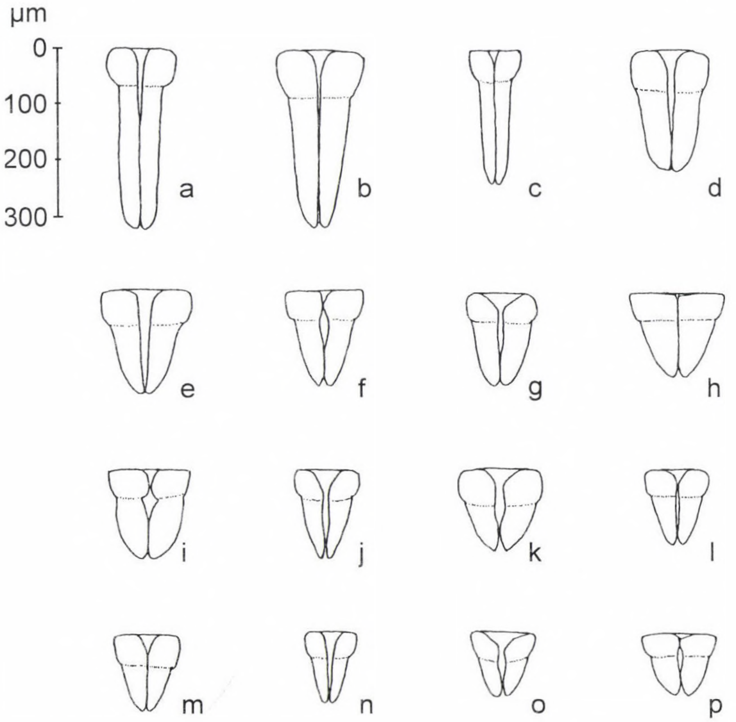


Fig. 16. The labium of the species found in the region studied in comparison with *N. nepalensis*: a = *N. nepalensis*; b = *N. gullanae* sp. n.; c = *N. milleri* sp. n.; d = *N. monikae* sp. n.; e = *N. tasmaniensis* sp. n.; f = *N. samoana* MORRISON, 1952; g = *N. endroedyi* sp. n.; h = *N. zimmermani* MORRISON, 1952; i = *N. myersi* GREEN, 1929; j = *N. australiensis* sp. n.; k = *N. baloghi* sp. n.; l = *N. martini* sp. n.; m = *N. biroi* n. sp.; n = *N. guineensis* sp. n.; o = *N. caledoniensis* sp. n.; p = *N. guadalcanalia* MORRISON, 1952

11 Apical seta of the antennae with more than eight setae 12

– Apical seta of the antennae with less than five setae 13

12 Margin of venter and dorsum only with scattered quadrilocular pores **N. australiensis** sp. n.

– Margin of venter and dorsum with large groups of quadrilocular pores **N. endroedyi** sp. n.

13 Atrium of spiracles without a group of quadrilocular pores *N. myersi* GREEN, 1952

– Atrium of spiracles with a group of quadrilocular pores 14

14 Wax plate bands with long tubular ducts **N. tasmaniensis** sp. n.

– Wax plate bands without long tubular ducts *N. samoana* MORRISON, 1952

SOME TAXONOMIC CONSIDERATIONS

The *Transnewsteadia* genus was established on the basis of one character, the length of the labium. Analysing the species from the Australian and the Pacific Region it was found that the size of the labium is highly variable among the different species of the genus *Newsteadia* (Fig. 16). There is also a considerable variation in size, and shape of the labium among different species of *Newsteadia*. The variations in the lengths of the labium (in microns): *N. gullanae* 224–314, *N. milleri* 243, *N. tasmaniensis* 198–208, *N. australiensis* 138–179, *N. milleri* 243, *N. myersi* 154–224, *N. zimmermani* 160, *N. guadalcanalia* 108, *N. samoana* 179–189, *N. endroedyi* 176–185, *N. martini* 131–141, *N. monikae* 208–230, *N. caledoniensis* 106–118, *N. baloghi* 138–166, *N. biroi* 128–134, *N. guineensis* 128–134. In the original description of the *Transnewsteadia* genus the range of the labium size was between 300–340 µm (RICHARD, 1990). The length of the labium of two paratypes (Goropani, Nepal, 3 100 m a.s.l., 07. 10, 1983, on Rhododendron, Leg. L. LÖBL and A. SMETANA (MNHN) of *T. nepalensis* RICHARD 1990, studied by us, was 320 µm. There is no other character to separate this genus from *Newsteadia*, so *Transnewsteadia* RICHARD, 1990 is proposed to be a junior subjective synonym of the genus *Newsteadia*.

NOTES ON THE PRESENCE OF *N. FLOCCOSA* (DE GEER, 1778) IN AUSTRALIA

According to MORRISON (1925) and WILLIAMS (1991) this species was probably introduced to Australia. MAMET (1947) had an opposite view, according to him perhaps this species was introduced from Australia to Europe and North America, and he proposed that it has a subtropical origin. However, the distribution records show that this species lives in colder parts, and usually at higher elevation of the Palaearctic region. The species from Australia was determined by GREEN (1902) (describing it as a new subgenus *Newsteadia*). All the specimens studied here found in the BMNH (including the specimen seen by GREEN, too) and in ANIC belong to *N. gullanae* species described above, and not to *N. floccosa* (as it was also indicated on some slides by JHM – JON H. MARTIN in pencil). *N. floccosa* differs by having long tubular ducts in the wax plate bands, and a large sensory seta in the middle of the apical seta of antennae. As for the question of introduction, there are well recorded data beginning from 1914, in the USA, that this species was many times accidentally introduced from Europe. From that time the establishment was never recorded (D. R. MILLER pers. comm.). According to these records the introduction and establishment of the European *N. floccosa* in Australia is highly unlikely.

ZOOGEOGRAPHIC CONSIDERATIONS

MORRISON (1925) suggested that this genus has a Holarctic distribution. Later MAMET (1947) describing new species from Africa proposed a tropical origin bordered by the Indian Ocean. According to him the Palaearctic and Nearctic distribution results from introduction by humans. He considered that all species are tropical, or subtropical in origin. MORRISON (1952) with descriptions of new species, questioned this view of distribution, and origin. WILLIAMS (1991), WILLIAMS and WATSON (1990) also thought, that endemic species are absent in Australian and the Pacific Regions, and the species found there may be the result of recent introductions.

With our results and considering earlier reports, the species number in the Australian and the Pacific Regions has increased to 15, which is the highest regional number in the World at this time (Fig. 17).

Sixteen (one of them as fossil) species were previously described from all regions of the World. In the present paper eleven new species were added to this list, and the total number has now increased to 27. Further new species are under description from the Ethiopian Region (MILLER & KOZÁR, in prep.), and even further species are awaiting description from the Oriental and Neotropical Re-

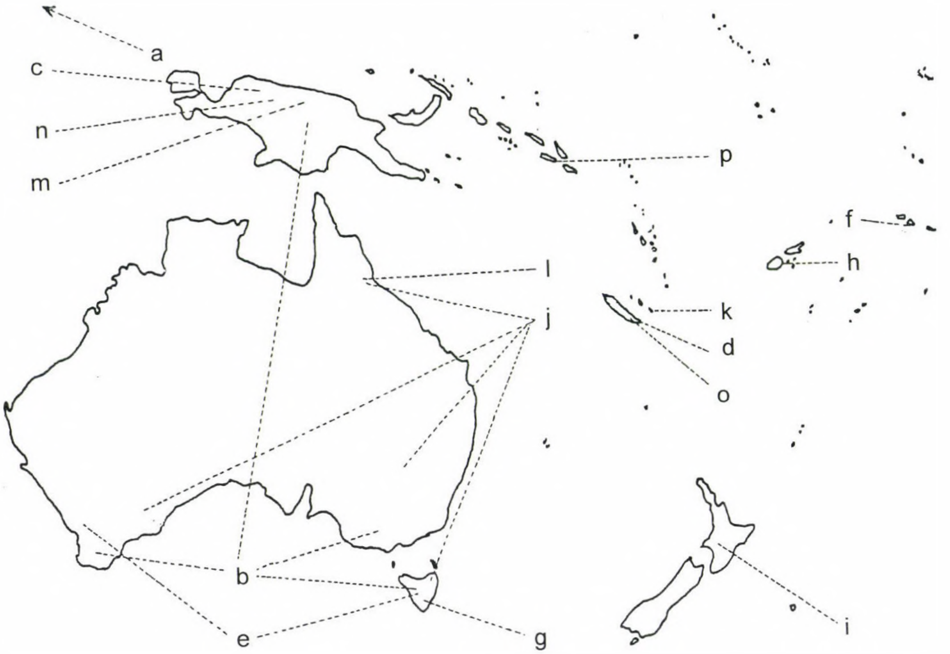


Fig. 17. Distribution of the known *Newsteadia* species in the region: a = *N. nepalensis*; b = *N. gullanae* sp. n.; c = *N. milleri* sp. n.; d = *N. monikae* sp. n.; e = *N. tasmaniensis* sp. n.; f = *N. samoana* MORRISON, 1952; g = *N. endroedyi* sp. n.; h = *N. zimmermani* MORRISON, 1952; i. *N. myersi* GREEN, 1929; j. *N. australiensis* sp. n.; k = *N. baloghi* sp. n.; l = *N. martini* sp. n.; m = *N. biroi* n. sp.; n = *N. guineensis* sp. n.; o = *N. caledoniensis* sp. n.; p = *N. guadalcanalia* MORRISON, 1952

gions. It is remarkable too, that the *Newsteadia* genus in the present sense was found in Baltic amber (about 34 million years old), it means that the genus is very old (KOTEJA & ZAK-OGAZA 1988). All of these records prove, in contrary to the earlier attempts, that the present knowledge is yet inadequate to establish the centre for origin of this genus.

*

Acknowledgements – The authors would like to thank the OTKA (Hungarian Scientific Research Fund, Nos T 022005 and 025796) for financial support of this project, and especially to Dr. S. MAHUNKA (Hungarian Natural History Museum, Budapest), Professor Dr. J. BALOGH (Loránd Eötvös University, Budapest), and to the late Dr. SEBESTYÉN ENDRŐDY-YOUNGA (Transvaal Museum, Pretoria, South Africa) who made their material from their Collection of Arachnida and Coleoptera available for us to study. Many thanks to JON MARTIN and DOUGLAS J. WILLIAMS (The Natural History Museum, London), to DANIELE MATILE FERRERO (Natural History Museum, Paris) and D. R. MILLER (USDA, Beltsville) for providing type specimens on loan. Thanks are due to Professor Dr. MIHÁLY KOSZTARAB for the important scientific and linguistic help, and to Drs CHRIS MALUMPHY and FERENC SAMU for some corrections in the English text.

REFERENCES

GREEN, E. E. (1902) Note on Orthezia floccosa, De Geer. *Entomologist's mon. Mag.* **13**: 284–285.

KOTEJA, J. (1985) Essay on the prehistory of the scale insects (Homoptera, Coccinea). *Ann. Zool.* **38**: 321–328.

KOTEJA, J. & ZAK-OGAZA, B. (1988) Newsteadia succini sp. n. (Homoptera, Coccinea) from Baltic amber. *Ann. Zool.* **41**: 329–333.

MAMET, R. (1947) On the probable centre of dispersion of the genus Newsteadia Green (Homoptera, Coccoidea). *Proc. R. ent. Soc. Lond. A* **22**: 49–51.

MORRISON, H. (1925) Classification of scale insects of the subfamily Ortheziinae. *J. Agricult. Res.* **30**: 97–154.

MORRISON, H. (1952) Classification of the Ortheziidae. Supplement to Classification of scale insects of the subfamily Ortheziinae. *United States Department of Agriculture, Technical Bulletin* **1052**: 1–80.

RICHARD, C. (1990) Transnewsteadia nepalensis, n. gen., n. sp., et Ortheziola loebli, n. sp., Ortheziidae de forét litiére népaslaise (Homoptera: Coccoidea–Archeococcoidea). *Annls ent. Soc. Fr. (N. S.)* **26**: 223–230.

WILLIAMS, D. J. (1991) *Superfamily Coccoidea*. Pp. 457–464. In: CARVER, M., GROSS, G. F. & T. E. WOODWARD (eds): The Insects of Australia. 2nd ed., CSIRO, Melbourne Univ. Press, Melbourne.

WILLIAMS, D. J. & WATSON, G. W. (1990) *The Scale Insects of the Tropical South Pacific Region (Part 3). The soft scales (Coccidae) and other families.* CAB International, Institute of Entomology, London, 267 pp.

Revised version received 31st August, 2000, accepted 4th September, 2000, published 21st September, 2000

The oribatid species described by Berlese (Acari)

MAHUNKA, S. and L. MAHUNKA-PAPP

The authors had the opportunity for years to study the Oribatid species described by Berlese currently deposited in the Istituto Sperimentale per la Zoologia Agraria at Florence. The results of this series of studies are summarized in this volume.

The volume begins with an essay-like Introduction heavily relying on subjective opinions discussing the general questions of Oribatology. The following section lists Berlese's species placed in the modern system helping the specialists with morphological notes and many drawings; here also the condition of the specimens is discussed and lectotypes are designated.

The third, large section is the catalogue proper, wherein all the species are listed in the systematic order together with their combination and synonymic names. Here one may find all the literature data, usually missing from ordinary works, with reference to Description and Taxonomy, Distribution, with special emphasis on Catalogues whose references are partly unreliable. Where it was deemed necessary further information are added under the heading of Remarks. The volume closes with a very detailed list of literature.

ISBN 963 7093 27 3
325 pages with several figures. Soft bound.

Price: 40 US dollars excl. p. & p.

Order should be sent
to the Hungarian Natural History Museum, Library
Baross u. 13., Budapest, H–1088 Hungary
Fax: (36–1) 3171669

Acta Zoologica Academiae Scientiarum Hungaricae 46 (3), pp. 231–238, 2000

THREE NEW SPECIES OF MALCUS STÅL, 1859 (HETEROPTERA, MALCIDAE) FROM VIETNAM

E. KONDOROSY

Department of Zoology, University of Veszprém
Georgikon Faculty of Agricultural Sciences, H-8360 Keszthely, Hungary

Descriptions of three new *Malcus* species, *M. vasarhelyii*, *M. spinosus* and *M. stysi* from Vietnam are given. Data of the *Malcus* specimens preserved in the Hungarian Natural History Museum, identified by the author, are also presented.

Key words: new species, *Malcus*, Malcidae, Heteroptera, Vietnam

INTRODUCTION

The genus *Malcus* as the only representative of the subfamily Malcinae is closely related with the family Lygaeidae in which it has been included for a long time (see SLATER 1964). Its nearest relative is the small subfamily Chauliopinae with a few Oriental and Ethiopian species. Both subfamilies have been united by ŠTYS (1967) in the family of Malcidae. This family is quite near to the family Colobathristidae and the Cyminae of the polyphyletic family Lygaeidae (ŠTYS 1967).

The genus *Malcus* was erected by STÅL (1859) and until the 1960s only three species had been known (SLATER 1964). ŠTYS (1967) published a large monograph with sixteen new species. Later another seven new species were described by ZHENG *et al.* (1979). The *Malcus* species, living in China, were keyed by ZHENG and ZOU (1981) and some additional new species were recorded from China by ZHENG (1999). A phylogenetic study based on 18 Chinese *Malcus* species was prepared by ZHENG (1998).

The *Malcus* specimens of the Hungarian Natural History Museum (HNHM) were examined by the author. In this mostly undetermined material (partly determined by ŠTYS in the 1960s), some specimens from Vietnam have been found, which do not belong to any known species. This paper presents descriptions of three new species, followed by the data of the other determined specimens. All specimens are deposited in the HNHM.

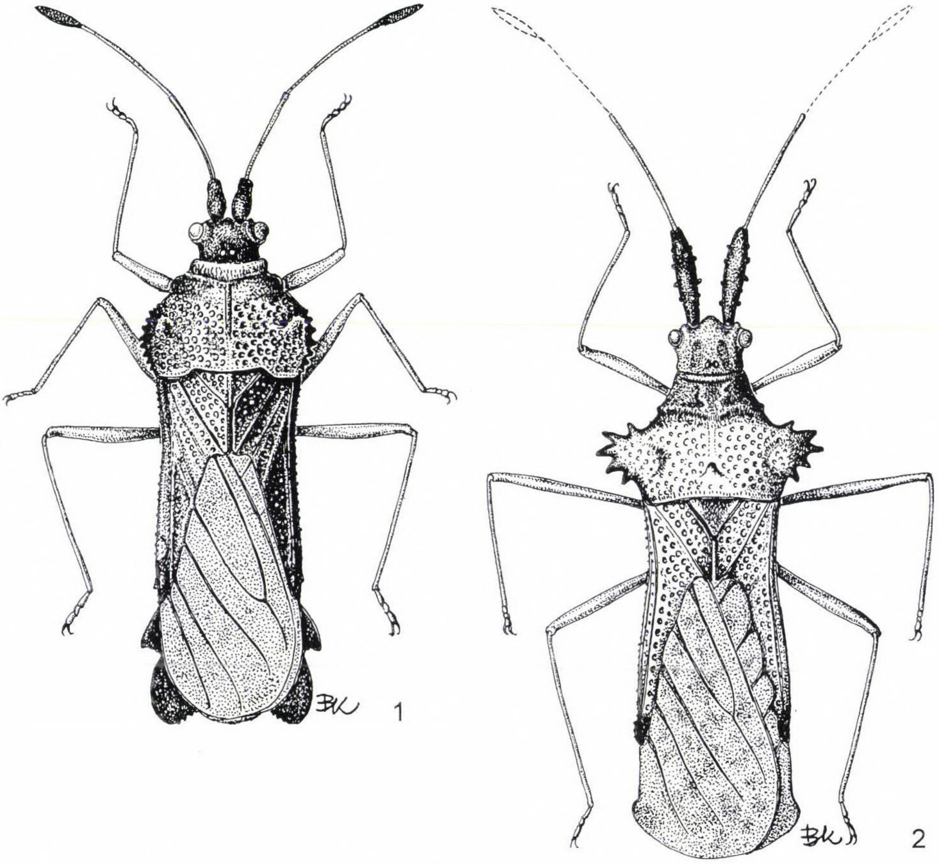
TAXONOMIC PART

Malcus vasarhelyii sp. n.
(Figs 1, 4, 7)

Description. Large, moderately elongated, black (Fig. 1). Anterior margin of pronotum, basal half of hemelytra and parts of sternum dark brown, two spots on hemelytra (one on the middle of corium and one anterior to corial tubercle) yellowish.

Hairs of body uniform, quite short, adpressed and are curved glandular hairs. Body with tomentose spots: on head only at base of antenna; on pronotum behind callar region on both side of median keel (little spots before callar region, too); on mesoscutellum two little spots at base; ventral side of body with relatively few spots.

Eyes – as in other *Malcus* species – laterally protruding and far from apex of pronotum. Antenna long, first segment quite thick, blackish brown with erect hairs, second and third segments very thin, pale yellow, fourth segment thicker and darker. Pronotum declivent, with quite prominent posteromedial tubercle continued in strong median keel to callar region. Posterolateral tuber-



Figs 1–2. 1 = *Malcus vasarhelyii* sp. n., 2 = *M. spinosus* sp. n.

cles large, projecting upwards (Fig. 4); lateral margin of pronotum only slightly dentate. Mesoscutellum prominent, with keel-like margins. Hemelytra externally concave, slightly longer than abdomen; end of corium with small quadrangular tubercle, which is about twice as long as wide and a little higher than thickness of hind tibia. Membrane dark brown with a few small light spots, behind corial end first straight, then rounded. All the five veins of membrane (subcosta (Sc), radius (R), sector radii (Rs), media (M) and cubitus (Cu)) nearly parallel with each other on base, Sc and R approaching each other at base and in apical part directed backwards, not parallel with others; M and Cu distally united. Ventral laterotergite V small, VI larger and strongly curved posteriorly, VII very large and rounded (Fig. 7). Rostrum quite short, reaching middle of mesosternum, its 1st segment reaching anterior margin of prosternum, 2nd segment reaching middle of fore coxae, 3rd segment reaching end of prosternum. Ventrite VIII and pygophore normally formed. Legs long and thin, yellowish.

Measurements. Length of body: 4.68 mm. Length of first segment of antenna: 0.46 mm; second 0.97 mm; third 1.20 mm and fourth 0.60 mm; total length of antenna 3.23 mm. Width of first segment of antenna: 0.18 mm. Width of head with eyes 0.80 mm; maximum width of pronotum 1.71 mm; minimum width of hemelytra (near base) 1.26 mm. For calculated ratios see Table 1.

Holotype: male, Vietnam, Lao Cai, "17 km Dang khao", no. 159., 29.XI.1971, leg. Topál and Matskási (coll. HNHM).

Diagnosis. Closely allied to *M. japonicus* Ishihara et Hasegawa (in ŠTYS's key it runs to *japonicus*) but smaller and a little less slender, with first segment of antenna a bit shorter (in *M. japonicus* ratio of length of body: first segment is nearly 9.2, so *M. vasarhelyii* has the shortest first antennal segment in the genus), and with posterolateral tubercles more prominent than in *japonicus*. *M. japonicus* lives in Japan and in Middle China.

Table 1. Calculated ratios in new *Malcus* species

	vasarhelyii	*spinosus*	stysi
Length of body: length of antenna	1.44	?	0.85–0.89
Length of body: 1st antennal segment	10.17	5.25	3.58–4.54
Length of membrane: length of body	0.54	0.50	0.43–0.50
Length of membrane: width of hemelytra	2.02	2.14	1.51–1.77
Length of body: width of hemelytra	3.71	4.23	3.46–3.55
Width of pronotum: width of hemelytra	1.36	1.81	1.25–1.37
Width of pronotum: width of head	2.14	2.45	1.58–1.70
3rd antennal segment: width of pronotum	0.70	?	1.17–1.30
3rd antennal segment: 2nd ant.segment	1.24	?	1.60–1.67
Length of body: max. width of pronotum	2.73	2.34	2.56–2.84
Length: width of first antennal segment	2.56	4.37	4.17–4.93

width of pronotum: maximum width on posterior lobe

width of hemelytra: minimum width of combined hemelytra near base

width of head: with eyes

Etymology. This species is dedicated to Dr. TAMÁS VÁSÁRHELYI, curator of the Heteroptera collection in HNHM. His help in making for the first steps of the author into the world of Heteroptera is much appreciated also herewith.

Malcus spinosus sp. n.

(Figs 2, 5, 8)

Description. Relatively large, moderately elongated, brown (Fig. 2). Posteromedial tubercle of pronotum, scutellum and corial tubercle black, callar region and venter dark brown, both corial spots mentioned for *M. vasarhelyii*, second segment of antenna and legs yellow.

Head and anterior part of pronotum with erect long hairs which are much longer than eye width. Hairs on other parts of the body much shorter, adpressed and curved. First segment of antenna with curved glandular hairs and on tubercles with semi-erect longer hairs (shorter than long hairs of head). Body with tomentose spots: head fully excluding vertex on both side of ocelli, base of antennal segment I; anterior part of pronotum excluding collar and callar region (any little spots on posterior part, too); on mesoscutellum two little spots at base; ventral side of body extensively tomentose.

First antennal segment outside with well visible small tubercles (very seldom in the genus, author knows only one other species with such tubercles – an undetermined species near *elevatus* ZHENG, ZOU et HSIAO). Pronotum declivent, prominent posteromedial tubercle without strong median keel directed forwards. In callar region near median with a pair of small spines, lacking in the other species known to the author. Posterolateral tubercles very large, protruding laterally, with 4–5 strong spines (any of them finger-like) (Fig. 5). Corial tubercles quadrangular, about three times as long as wide and significantly higher than width of hind tibia. Membrane behind end of corium straight, posteriorly abruptly widened, pale, mottled with brown. Veins of membrane nearly parallel with one another, Sc and R not approaching each other at base. Ventral laterotergites V and VI very narrow, laterotergite VII also narrow, crescentiform, with very minute teeth (Fig. 8). First and second segments of antenna relatively short (third and fourth segments missing). Rostrum quite long, reaching hind coxae; its 1st segment reaching nearly the middle of prosternum; 2nd segment reaching the end of prosternum; 3rd segment reaching the middle of mesosternum. Venter dark brown. Ventrite VIII and pygophor of normal shape.

Measurements. Length of body: 4.36 mm. Length of first segment of antenna: 0.83 mm; second 1.31 mm; third and fourth segments missing. Width of first segment of antenna: 0.19 mm. Width of head with eyes 0.76 mm; maximum width of pronotum 1.86 mm (without lateral teeth 1.69 mm) and minimum width of hemelytra 1.03 mm.

Holotype: female, Vietnam, Cuc phuong, prov. Ninh binh, no. 268., 7.V.1966, leg Topál (coll. HNHM).

Diagnosis. In structure of pronotal posterolateral tubercles it is more or less similar to *M. dentatus* ŠTYS, *M. thoracicus* ŠTYS, *M. denticulatus* ZHENG, ZOU et HSIAO, *M. elevatus* ZHENG, ZOU et HSIAO and *M. gibbus* ZHENG, ZOU et HSIAO. *M. dentatus* (living in Malaysia) is smaller (4 mm) and narrower (body length: hemelytra width 4.77) having a much narrower pronotum (1.4 mm); *M. thoracicus*, *M. denticulatus* and *M. elevatus* all have much wider laterotergites, no posteromedial tubercle, much shorter 1st antennal segment (ratio body: 1st segment about 7.6, 7.6 and 7.0), etc.; *M. gibbus* has also no posteromedial tubercle and different laterotergites V and VI, in spite of its larger body, shorter 2nd antennal segment, and narrower pronotum (for example body length: pronotal width 2.3).

Etymology. The name of the new species refers to the attractive spines of the pronotum.

Malcus stysi sp. n.
(Figs 3, 6, 9)

Description. Small, long oval, light brown (Fig. 3). Callar region, scutellum, and corial tubercle dark brown; hemelytra, 2nd and 3rd segments of antenna and legs yellowish brown.

Head and anterior part of pronotum with erect long hairs which are nearly as long as eye's width. Hairs on other parts of body much shorter, adpressed and curved. First segment of antenna with curved glandular hairs and on outer side with semi-erect short hairs. Body with tomentose spots: head fully tomentose with a few non-tomentose spots; anterior part of pronotum in the middle intensively tomentose, posterior part without spots; on mesoscutellum two little spots at base; ventral surface intensively tomentose.

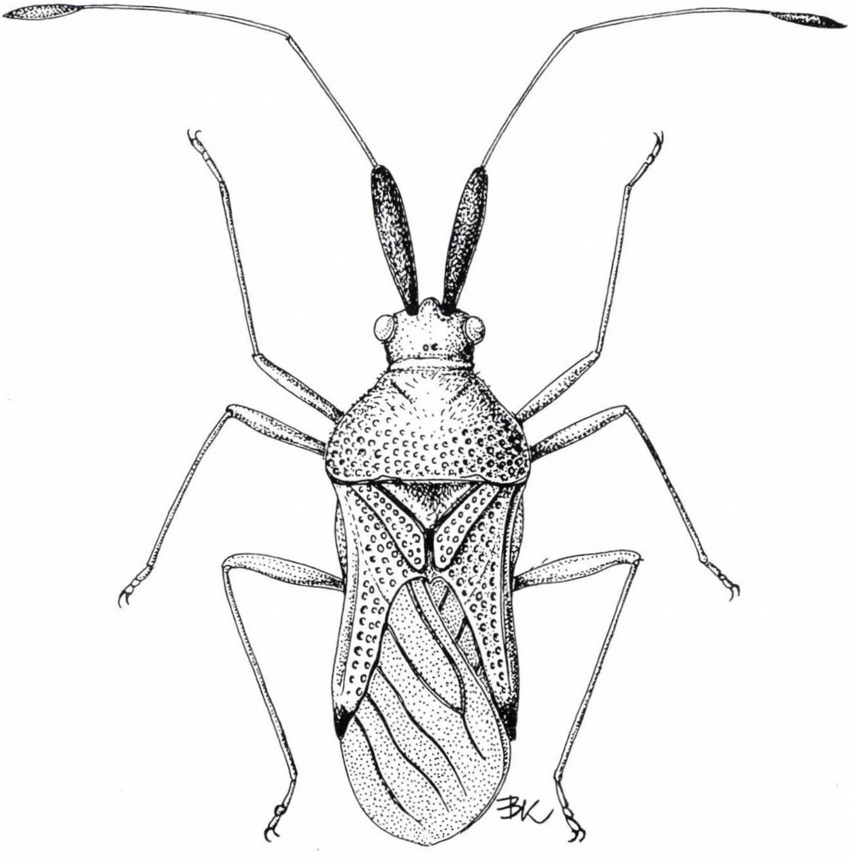


Fig. 3. *Malcus stysi* sp. n.

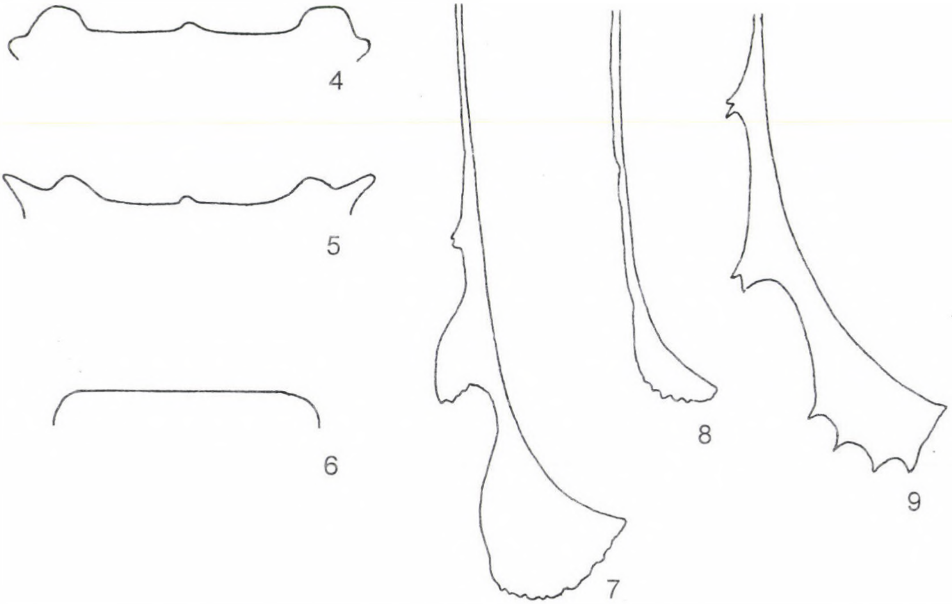
Pronotum without posteromedial or posterolateral tubercles (Fig. 6), its lateral margin with very minute teeth. Corial tubercle triangular, about one and half as long as wide and not higher than width of hind tibia. Membrane pale with compact brown spots between veins. Veins of membrane are nearly parallel with one another, Sc and R approaching at base. Ventral laterotergite V quite narrow; VI is larger and slightly curved posteriorly; VII produced posteriorly and with well developed teeth, itsposteromedial margin without teeth, straight (like in *M. mishmi* ŠTYS) (Fig. 9). Antenna very long, first segment very thick and large. Rostrum reaching end of middle coxae, 1st segment reaching base of head; 2nd segment the middle of fore coxae and 3rd segment the middle of mesosternum. Metapleura gibbous, so in superior view only external part of ostiolar peritreme visible (by other species, known by author, metapleura quite flat, so ostiolar peritreme well-visible). Ventrite VIII on both side apparently with two dull points. Pygophor of normal shape.

Measurements. Length of body: 3.27–3.40 mm. Length of first segment of antenna: 0.74–0.95 mm; second 0.90–1.00 mm; third 1.50–1.60 mm and fourth 0.51–0.55 mm; total length of antenna 3.68–4.00 mm. Width of first segment of antenna: 0.15–0.21 mm. Width of head with eyes 0.73–0.80 mm; maximum width of pronotum 1.15–1.33 mm, minimum width of hemelytra 0.92–0.97 mm.

Holotype: male, Vietnam, Luc yen, prov. Yen bai, 300 m, no. 246., 6.XII.1971, leg Topál and Matskási (coll. HNHM).

Paratypes: one male and one female, same data as for holotype.

Diagnosis. In many characters very similar to *M. flavidipes flavidipes* STÅL but quite different in the structure of metapleura and laterotergite VII. The very large 1st segment of antenna is also a very good distinctive character (ratio body



Figs 4–9. 4–6 = Pronotal outline from backwards: 4 = *Malcus vasarhelyii* sp. n., 5 = *M. spinosus* sp. n., 6 = *M. stysi* sp. n.; 7–9 = Ventral laterotergites V–VII: 7 = *M. vasarhelyii* sp. n., 8 = *M. spinosus* sp. n., 9 = *M. stysi* sp. n.

length: 1st antennal segment is by *M. flavidipes flavidipes* on average 5.6). The last character is very distinctive from the other species, too: this ratio is the lowest in *M. dentatus* ŠTYS and *M. setosus* ŠTYS (both 5.03) and *M inconspicuus* ŠTYS (on average 5.13), but these species are not similar to the new species.

Etymology. The new species is dedicated to Dr. P. ŠTYS. He has published an excellent monograph on Malcinae providing an essential work for the present study.

The list of the identified species is as follows

M. flavidipes flavidipes STÅL, 1859 (21 specimens) – Malaysia, Pahang, Pulau Tioman, trail between Juara and Tekek, lowland rainforest, swept and beaten, No. 9., 10–17.III.1995, leg. O. Merkl (1 ex.); Malaysia, Pahang, Pulau Tioman, 2 km S of Kampung Juara, secondary growth, swept and beaten, No. 28., 15.III.1995, leg. O. Merkl (10 ex.); Thailand, River Kwai, Kanchona Buri, No. 8–9., 14.VII.1987, leg. B. Molnár (3 ex.); Lao P.D.R., Vientiane Prov., Vang Vieng, near Poukham Cave, 300 m, swept, No. 5., 21.III.1998, leg. O. Merkl & G. Csorba (2 ex.); Vietnam, Tam Dao, 1200 m, swept, No. 49., 14.X.1986, leg. T. Vásárhelyi (1 ex.); Vietnam, Muong son, prov. Yen bai, 300 m, No. 273., 8.XII.1971, leg. Gy. Topál & I. Matskási (2 ex.); Vietnam, Cuc phuong, prov. Ninh binh, No. 293., 8.V.1966, leg. Gy. Topál (1 ex.); India, West Bengal, Darjeeling Distr., 3 km S of Ghum, beaten material, No. 341., 19.IV.1967, leg. Gy. Topál; India, Orissa, Jajpur-Keonjhar Distr., Doitah, sifted decaying, No. 941, 25.XI.1967, leg. Gy. Topál (1 ex.).

M. elongatus ŠTYS, 1967 (2 specimens) – Vietnam, Duc me, 15 km S of Bao Loc, 700 m, collected at light, No. 372., 23.X.1988, leg. T. Vásárhelyi (1 ex.); Vietnam, Da Lat, Thac Prenn waterfall, No. 759., 10.XII.1994, leg. S. Mahunka, Gy. Sziráki et L. Zombori (1 ex.).

M. subauriculatus ZHENG, ZOU et HSIAO, 1979 (13 specimens) – India, West Bengal, Darjeeling Distr., Goomti, 1250 m, extracted, No. 419, 27.V.1980, leg. Gy. Topál (3 ex.); India, West Bengal, Darjeeling, beaten, No. 838, 16.X.1967, leg. Gy. Topál (1 ex.); India, West Bengal, Darjeeling Distr., Kurseong, beaten material, No. 849, 18.X.1967, leg. Gy. Topál (8 ex.); India, West Bengal, Darjeeling Distr., Lopchu, beaten material, No. 857, 20.X.1967, leg. Gy. Topál (1 ex.).

M. idoneus Horváth, 1914 (8 specimens) – India, West Bengal, Darjeeling Distr., Ghum, 2200 m, beaten material, No. 772, 7.X.1967, leg. Gy. Topál (4 ex.); India, West Bengal, Darjeeling Distr., Ghum, 2200 m, beaten material, No. 779, 8.X.1967, leg. Gy. Topál (2 ex.); India, West Bengal, Darjeeling Distr., 3 km S of Ghum, sifted moss samples, No. 340, 19.IV.1967, leg. Gy. Topál; India, West Bengal, Darjeeling Distr., Debrapani, 1650 m, netted, No. 438, 31.V.1980, leg. Gy. Topál (2 ex.).

The specimens examined are very similar in all features to *M. idoneus* but their place of origin is far from Taiwan where *M. idoneus* was known to occur earlier. Recently ZHENG and ZOU (1981) recorded specimens of *M. idoneus* from the Yunnan Province near the Vietnamese border. The author cannot find any distinctive character to separate the specimens of the HNHM and *M. idoneus* (types or other specimens). So recently this species seems to have the second widest distribution within the genus, following *M. flavidipes flavidipes* STÅL.

? *M. nigrofasciatus* ŠTYS, 1967 (8 specimens) – Vietnam, Da Lat, Cam Ly area, No. 735., 8.XII.1994, leg. S. Mahunka, Gy. Sziráki et L. Zombori (1 ex.); Lao P.D.R., Champassak Prov., Dong Hua Xao National Biodiversity Conservation Area, 2 km S of Nong Luang Village, bank of Touay-Guai stream, 15°4'N, 106°13'E, 800 m, swept, No. 23., 1–5.IV.1998, leg. O. Merkl & G. Csorba (7 ex.). – Discussion see under *M. arcuatus*.

? *M. arcuatus* ZHENG, ZOU et HSIAO, 1979 (5 specimens) – Vietnam, Da Lat, Cam Ly area, rainforest, swept and beaten, No. 691., 4.XII.1994, leg. S. Mahunka, Gy. Sziráki et L. Zombori (1 ex.); Vietnam, Da Lat, Cam Ly area, No. 734., 8.XII.1994, leg. S. Mahunka, Gy. Sziráki et L. Zombori (1 ex.); Vietnam, Da Lat, Cam Ly area, No. 735., 8.XII.1994, leg. S. Mahunka, Gy. Sziráki et

L. Zombori (1 ex.); Vietnam, Da Lat, Cam Ly area, No. 775., 11.XII.1994, leg. S. Mahunka, Gy. Sziráki et L. Zombori (2 ex.).

Specimens of the last two species are highly similar, apparently belonging to *M. arcuatus* or *M. nigrofasciatus*. They are distributed far from these two species and may also be conspecific. It is not excluded that they belong to a new species.

*

Acknowledgements – The author's grateful thanks are due to Mrs KRISZTINA BÍRÓ for the excellent illustrations and to Dr. TAMÁS VÁSÁRHELYI in providing opportunity to work on the *Malcus* material.

REFERENCES

SLATER, J. A. (1964) *A Catalogue of Lygaeidae of World* I-II. University of Connecticut, Storrs. 1668 pp.

STÅL, C. (1859) Hemiptera species novas descriptsit. *Konglika Svenska Fregattens Eugenies resa omkring jorden under Befäl af C. A. Virgin åren 1851–1853.* III (Zoologi, Insekter) pp. 219–298.

ŠTYS, P. (1967) Monograph of Malcinae, with reconsideration of morphology and phylogeny of related groups (Heteroptera, Malcidae). *Acta ent. Mus. natn. Pragae* **37**: 351–516.

ZHENG, L.-Y. (1998) A study on the phylogeny and biogeography of the genus *Malcus* Stål (Hemiptera: Malcidae). *Acta zootax. sin.* **23**(Suppl.): 167–178. [in Chinese]

ZHENG, L.-Y. (1999) Genus Malcus in China, with description of phallic structures (Hemiptera–Heteroptera: Malcidae). *Acta Soc. Zool. Bohem.* **63**: 267–278.

ZHENG, L.-Y., ZOU, H.-G. & HSIAO, T.-Y. (1979) New species of Chinese Lygaeidae (I) Malcinae (Hemipt.-Heteropt.). *Acta zootax. sin.* **4**(3): 273–280. [in Chinese]

ZHENG, L.-Y. & ZOU, H.-G. (1981) Lygaeidae. Pp. 1–215. *In* HSIAO, T.-Y. (ed.): *A Handbook for the determination of the Chinese Hemiptera-Heteroptera* II. Science Press, Beijing. [in Chinese]

Revised version received 15th August, 2000, accepted 21st August, 2000,
ublished 21st September, 2000

Acta Zoologica Academiae Scientiarum Hungaricae 46 (3), pp. 239–248, 2000

TWO NEW AUSTRALIAN SPECIES OF CROTONIA (ACARI: ORIBATIDA), WITH NEW RECORDS OF CROTONIOIDEA FROM THE AUSTRALIAN REGION

Z. OLSZANOWSKI

Department of Animal Taxonomy and Ecology, A. Mickiewicz University
Szamarzewskiego 91 A, 60–569 Poznan, Poland
E-mail: olszanow@main.amu.edu.pl

New oribatid mite species, *Crotonia ovata* sp. n. and *C. tryjanowskii* sp. n. are described from Australia (Tasmania and New South Wales respectively) from temperate rain forest and *Nothofagus moorei* forest. An identification key for adults of the six *Crotonia* species of Australia is included. New records of some species of crotonioid mites (Crotonioidea) from the Australian region are given. The first record of *Holonothrus artus* OLSZANOWSKI from the eastern Hemisphere (so far only noticed in Chile) is worthy of notice.

Key words: Australian region, Acari, Oribatida, Crotonioidea, taxonomy, zoogeography

INTRODUCTION

The recently issued interactive key to the oribatid mites of Australia (HUNT *et al.* 1998) names 320 formally described species, of which only 17 species (5.3%) belong to the superfamily Crotonioidea. However, in the whole Australian region, nearly 70 species from this superfamily have been found, over half of this number in the area of New Zealand, which comprises almost 1/5 of all crotonioid mites of the world.

Species of the genus *Crotonia* exhibit of the so-called 'Gondwanan' distribution, i.e. with presumed origin from the ancient Gondwana land mass (HAMMER & WALLWORK 1979). From among over 30 species of the genus *Crotonia* hitherto described, the majority occur in the Australian region (a few species were described from Africa and from South America). Descriptions of two species new to science from this genus are given below. New data on the distribution of different species belonging to the superfamily Crotonioidea and recorded by the author in the Australian region are also included. The presented work is a continuation and completion of previous research made by the author on the crotonioid mites of the Australian region (OLSZANOWSKI 1997).

The material on which the present study is based originates from the Canadian National Collection, Ottawa, Canada, the Hungarian Natural History Museum, Budapest, Hungary and The Natural History Museum, London, England to whom I am indebted. Abbreviations used in the text:

CNCIAN – Canadian National Collection of Insects, Arachnids and Nematodes, Centre for Land and Biological Resources Research, Ottawa, Canada; DATE – Department of Animal Taxonomy and Ecology, A. Mickiewicz University, Poznan, Poland; CSIRO – Commonwealth Scientific and Industrial Research Organisation, Division of Entomology, Canberra, Australia.

DESCRIPTIONS OF NEW SPECIES

Crotonia ovata sp. n.
(Figs 1–13)

Body length: 1300–1330 µm; maximum body width: 600–655 µm.

Colour: brown.

Body covered with cerotegument with some dirt and debris and, in posterior part, usually with fragments of tritonymphal exuvium.

Prodorsum (Figs 1, 3–5) – Rostrum with flattened 'nose'. Two pairs of sclerified ridges present on dorsal part: one pair runs anteromedially from near bothridia, bears setae *in* and almost reaches bases of setae *le*; the other runs posteromedially from bothridia to be distally semicircularly joined. Prodorsal surface porose. Rostral setae (*ro*) straight, smooth, situated on small tubercles (Fig. 4). Lamellar setae (*le*) curved, finely serrated, sitting on long apophyses, that are slightly curved medially (Fig. 5); tips of apophyses distinctly extend beyond rostrum. Interlamellar setae (*in*) smooth, bent medially, situated on short apophyses, their tips almost reach bases of rostral setae.

Notogaster (Figs 1–3, 6–9) – Notogaster oval; broadest at level between setae *cp* and e_2. Dorsal plate flat, with pair of distinct longitudinal ridges that run outside of setae d_2 for almost full length of shield. Surface finely porose, posterior part and along the inner margins of ridges with small, round areoles. With 13 pairs of notogastral setae (setae c_2, d_1 and e_1 absent). Distance c_1–c_3 < c_3–cp; c_1–c_1 > c_1–c_3. Setae of the rows *f* and *h* on short apophyses, slightly broader proximally and indistinctly serrated; other notogastral setae narrow and smooth. Apophyses of setae f_1 and row *h* situated close together, forming two groups, distinctly separated between apophyses of setae h_1 (Fig. 9). Setae of row *ps* inserted in small tubercles. Five pairs of lyrifissures in normal position for the genus; opisthosomal gland opening (*gla*) situated between bases of setae e_2 and f_2.

Ventral region (Fig. 2) – Coxisternal pairs fused medially, surface distinctly porose. Coxisternal setation: 3–1–2–3, setae short, spiniform. Number of pairs of genital setae: 7–8, all near medial margin of plate. Two pairs of aggenital setae; aggenital shield divided by furrow running between setae ag_1 and ag_2. Anal and adanal plates usually with 3 pairs of setae (4 pairs in holotype).

Legs – Tarsi homotridactylous, setation not studied in detail.

Immatures (Figs 10–13)

Measurements: deutonymph 775×330 µm, tritonymph: 1150×460 µm. Colour whitish to light brown, darker where sclerotized.

Prodorsum (Fig. 11) – Features generally similar to those of adult; interlamellar setae longer (their tips reaching rostrum as in adult). Sensillus and bothridium as in adult.

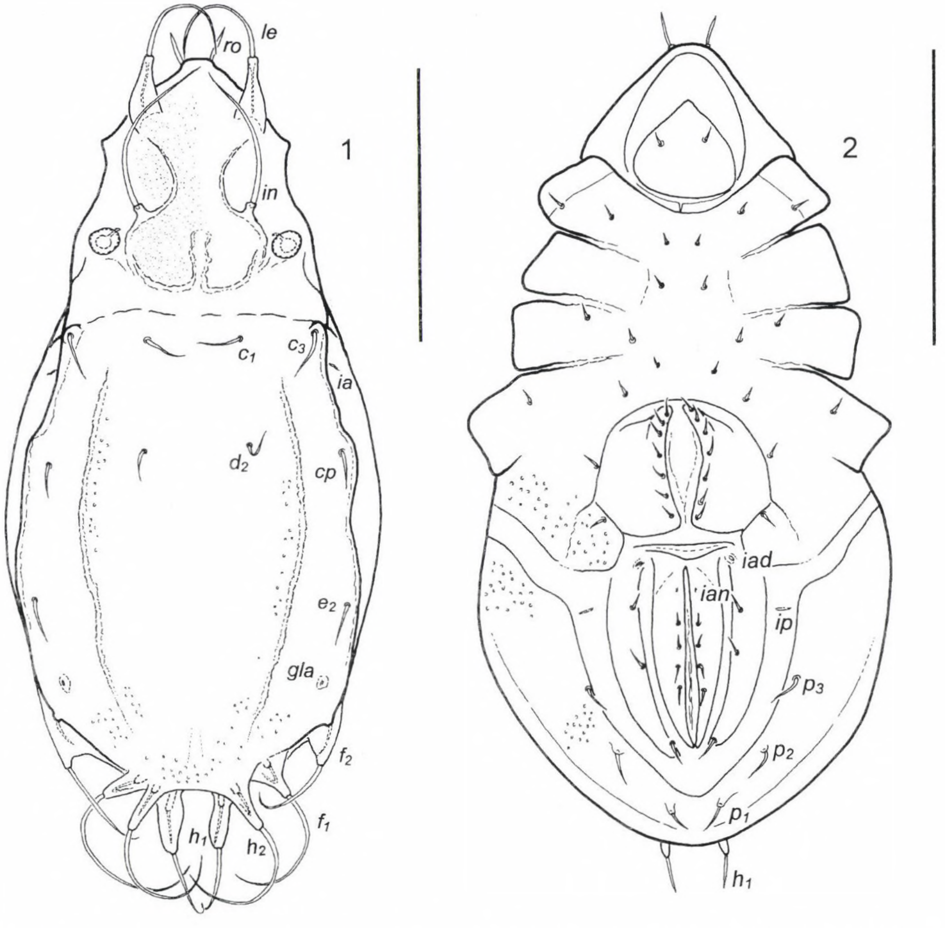
Notogaster (Figs 11–12) – With five pairs of porose plates dorsally bearing setae c_1, c_3, *cp*, e_2 and f_2, respectively. Setae d_2 without plate. Except for plates, cuticle irregularly striate, and covered with alveoli (Fig. 12). Setae f_1 and *h* row on distinct apophyses. Setae of row *p* (ventrally located) on distinct tubercles; those of p_1 not longer than others.

Ventral region (Figs 10, 13) – Epimeral setation: larva: (1–2)-1–2, protonymph: 2–1–2–1, deutonymph: 3–1–2–2, tritonymph: 3–1–2–3. Number of genital, aggenital, anal and adanal setae (from proto- to tritonymph, respectively): 1–4–7, 0–1–2, 0–0–3, 0–3–3. Legs not studied in detail.

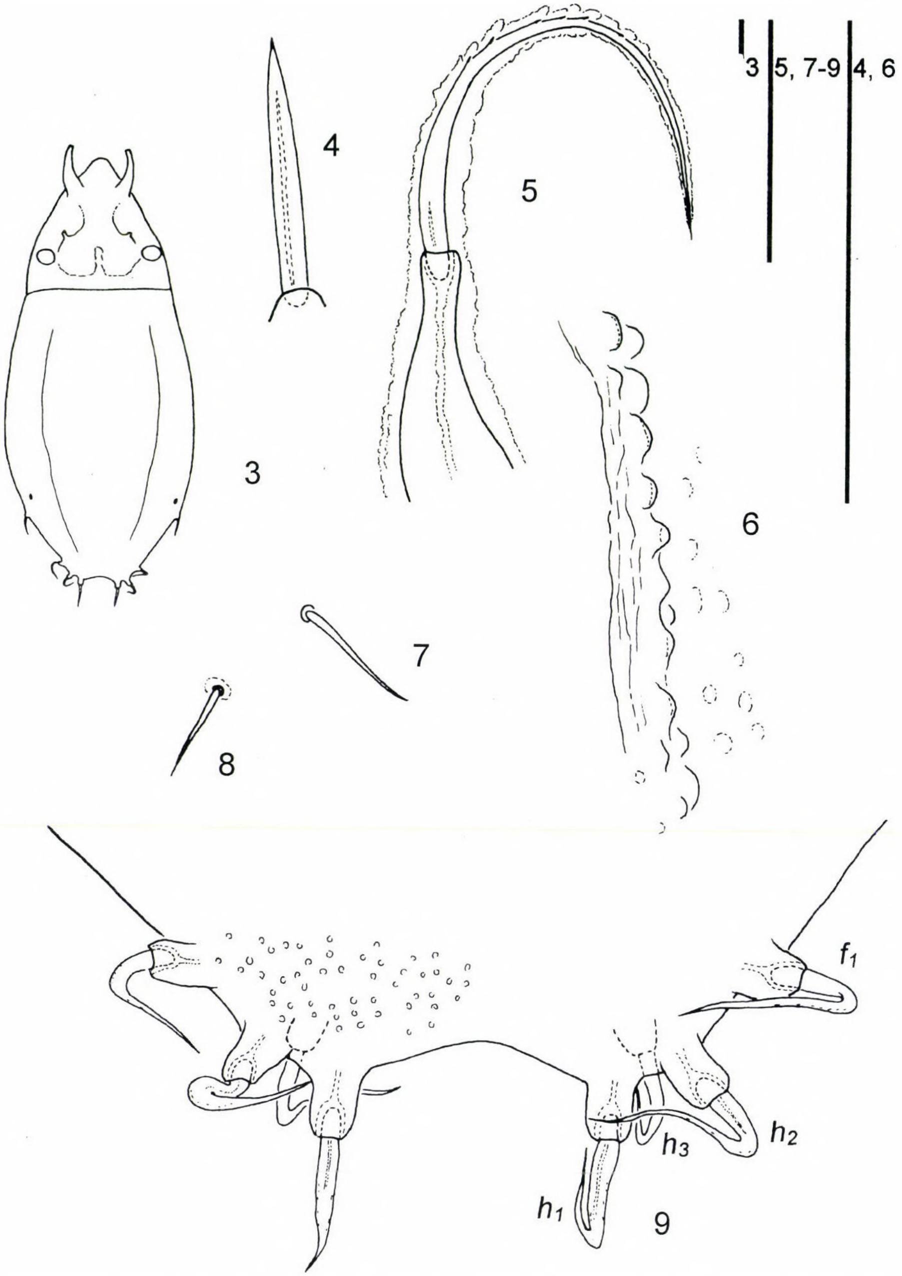
Material examined: holotype (adult female) and paratypes (1 adult, 1 tritonymph, 1 deutonymph) were collected from: Australia: Tasmania, Hellyer River gorge, temperate rain forest, Jan.11.1984, L. MASNER. Holotype is deposited in CSIRO, Canberra; paratypes in CNCIAN, Ottawa.

Etymology – The specific epithet is derived from the Latin *ovatus* meaning 'oval' referring to the body shape.

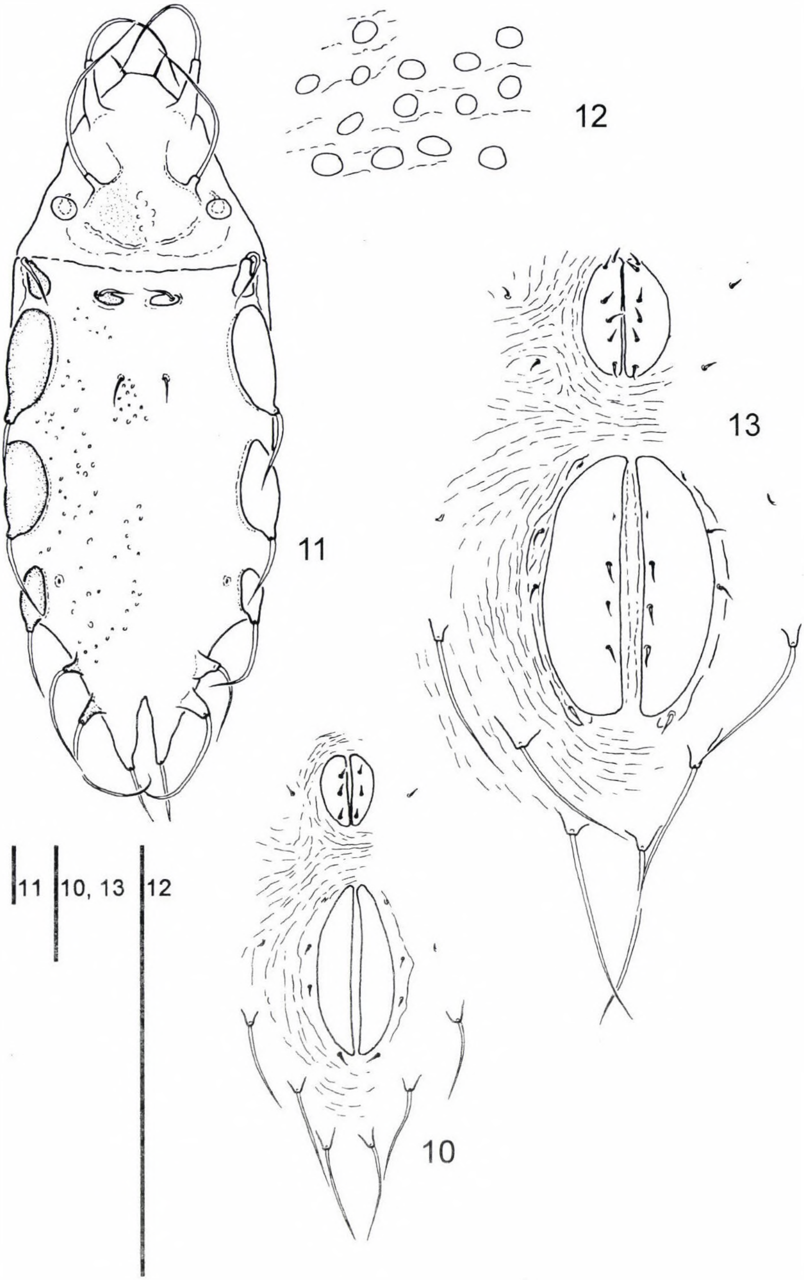
Remarks – In the body shape and arrangement of posterior notogastral setae the species is close to *C. brassicae* WALLWORK, 1978 from the St. Helen Island; the most profound differences are the longer lamellar apophyses and the presence of longitudinal ridges on the notogaster. From another Australian species *C. jethurmerae* LEE, 1985, with which it shares the feature of deficiency of setae c_2, it differs by the significantly shorter apophyses of setae h_1, of the same length as apophyses f_1 and h_2, and by the hysterosomal ornamentation.



Figs1–2 *Crotonia ovata* sp. n., holotype, female, 1 = dorsal view, 2 = ventral view. Scale bar = 500 µm



Figs 3–9. *Crotonia ovata* sp. n., holotype (4–8) and paratype (3, 9), dorsal view: 3 = specimen without of fragments of tritonymphal exuvium; 4 = seta *ro*; 5 = seta *le*; 6 = fragment of left notogastral row on the level of setae e_2; 7 = seta c_1; 8 = seta d_2; 9 = posterior caudal region of notogaster. Scale bar = 100 µm



Figs 10–13. *Crotonia ovata* sp. n., immature stages: 10 = deutonymph, anogenital region; 11 = tritonymph, dorsal view; 12 = tritonymph, microsculpture of notogaster; 13 = tritonymph, anogenital region. Scale bar = 100 μm

Crotonia tryjanowskii sp. n.
(Figs 14–24)

Body length: 1150–1360 µm; maximum body width: 710–800 µm.

Colour: dark brown.

Body covered with cerotegument with some dirt and debris; in some specimens posterior part of body covered with fragments of tritonymphal exuvium.

Prodorsum (Figs 14, 16–18) – Rostrum flattened. Two pairs of sclerified ridges present on dorsal part: one pair runs anteromedially from near bothridia and bears setae *in*, the other runs posteromedially from bothridia to be distally joined (its posteromedial parts almost parallel to anterior edge of notogastral shield, but slightly bent). Prodorsal surface porose. Rostral setae (*ro*) straight, finely serrated, situated on small tubercles (Fig. 17). Lamellar setae (*le*) curved, in some specimens indistinctly serrated, on long, slightly medially curved apophyses (Fig. 18); tips of apophyses distinctly extend beyond rostrum. Interlamellar setae (*in*) situated on shorter apophyses, smooth, bent medially; their tips extend beyond distal parts of lamellar apophyses.

Notogaster (Figs 14–16, 19–24) – Notogaster distinctly enlarged posterodorsally; broadest at level of setae e_2. Dorsal plate flat, without longitudinal ridges, surface finely porose, with two parallel lines of tuberculation on each side. With 14 pairs of notogastral setae (setae c_2 and e_1 absent,

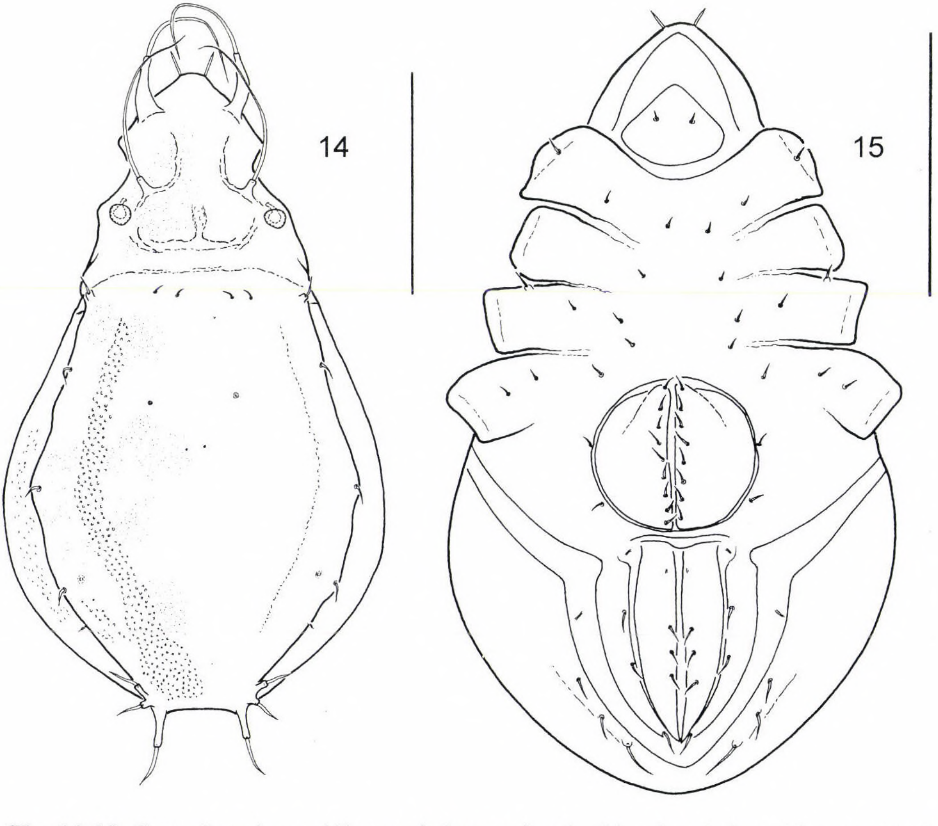
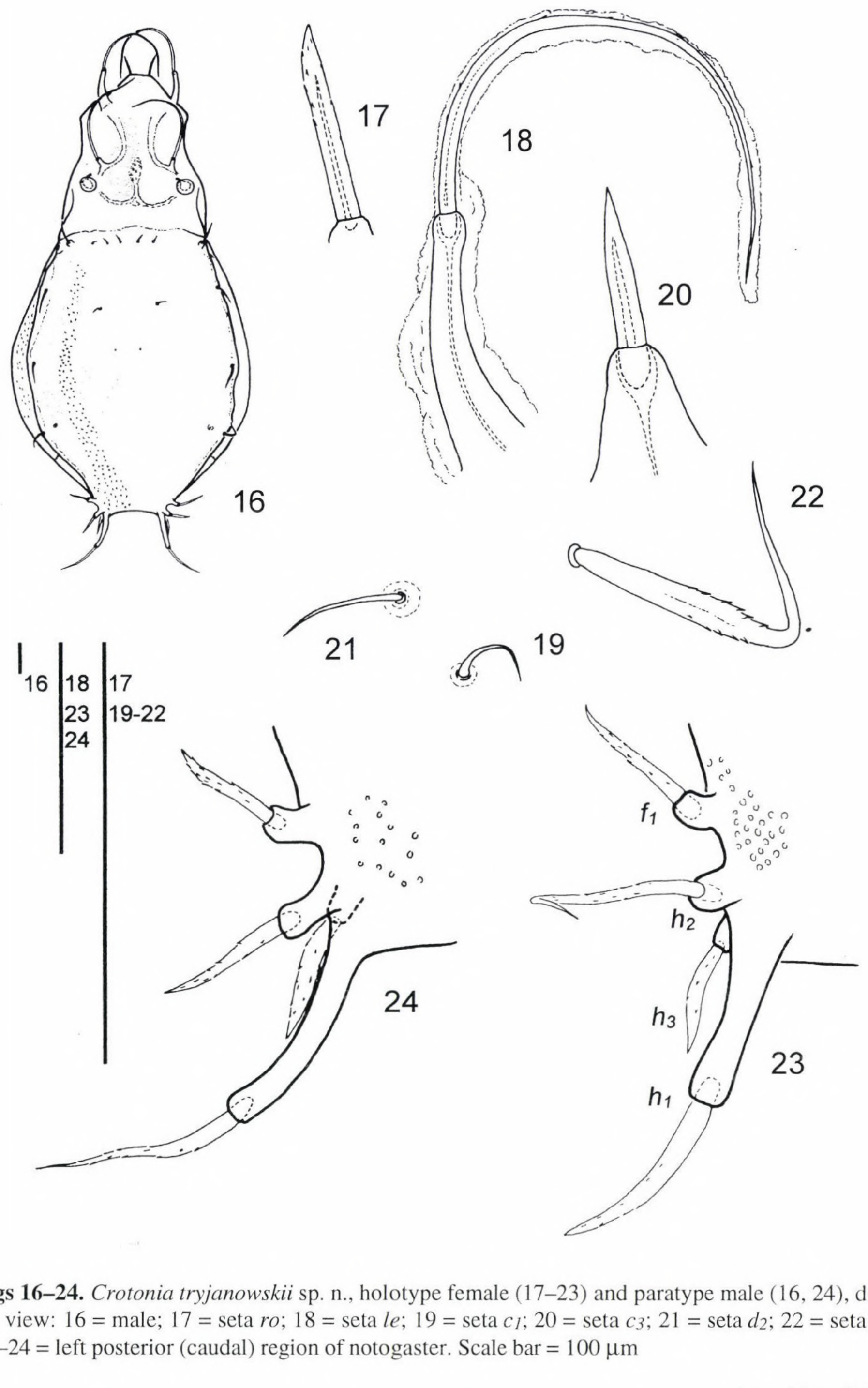


Fig. 14–15. *Crotonia tryjanowskii* sp. n., holotype, female, 14 = dorsal view, 15 = ventral view. Scale bar = 500 µm



Figs 16–24. *Crotonia tryjanowskii* sp. n., holotype female (17–23) and paratype male (16, 24), dorsal view: 16 = male; 17 = seta *ro*; 18 = seta *le*; 19 = seta c_1; 20 = seta c_3; 21 = seta d_2; 22 = seta f_2; 23–24 = left posterior (caudal) region of notogaster. Scale bar = 100 μm

the latter represented only by vestigial pores), setae d_2 broken on holotype. Setae c_1, c_2 and d_2 short and slender; setae on lateral margins slightly larger and thicker; setae of rows *f* and *h* distinctly larger than others, slightly serrated, form two groups, distinctly separated between apophyses of setae h_1 (Figs 23–24). Setae c_3, and row *p* situated on distinct tubercles; f_1 and of row *h* on apophyses (those of setae h_1 more than twice longer than others). Distance c_1–c_2 < c_2–c_3. Setae of row *ps* inserted on small tubercles; ps_1 slightly longer than ps_2 and ps_3. Five pairs of lyrifissures in normal position for genus; opisthosomal gland opening (*gla*) near the base of setae f_2.

Ventral region (Fig. 15) – Coxisternal pairs fused medially, surface distinctly porose. Coxisternal setation: 3–1–(3–4)-(2–3), setae short, spiniform. Genital setae: 7–9 pairs, all near medial margin of plates. Two pairs of aggenital setae; shield without furrow. Anal and adanal plates each with 3 pairs of setae.

Legs – Tarsi homotridactylous, setation not studied in detail.

Material examined: holotype and two paratypes (all adult females) were collected from: Australia, New South Wales, New England N.P., 1600 m, Feb.12.1984, *Nothofagus moorei* forest, ferns, L. MASNER. Other paratype (adult male): Australia, NSW, New England N.P., 1300–1500 m, Feb.13.1984, L. MASNER, ex: *Eucalyptus* wet forest, ferns along creek. Holotype is deposited in CSIRO, Canberra; one paratype in CNCIAN, Ottawa; one paratype in DATE, Poznan.

Etymology – This species is named in honour of Dr. PIOTR TRYJANOWSKI, a prominent Polish ornithologist and ecologist.

Remarks – The species resembles *C. jethurmerae* LEE, 1985, from which it differ by the presence of setae c_2 and shorter setae c_1 not set on apophyses. *Crotonia tryjanowskii* is also morphologically similar to the African species *C. pauropelor* COLLOFF, 1990; the differentiating features are wider distance between apophyses of setae h_1 and similar length of setae c_1 and c_2 in the new species.

KEY TO THE AUSTRALIAN SPECIES OF CROTONIA

1 Setae c_2 absent 2

– Setae c_2 present 3

2 (1) Apophyses of setae h_1 more than twice as long as those of f_1 and h_2 *C. jethurmerae* LEE, 1985

– Apophyses of setae h_1 short, similar to those of f_1 and h_2 **C. ovata** sp. n.

3 (1) Posterior apophyses grouped on a single, conspicuous, stem-like extension; setae c_1, c_2 and c_3 extremely long and whip-like *C. borbora* LUXTON, 1987

– Posterior apophyses not arising from a single, conspicuous, stem-like extension 4

4 (3) Bases of apophyses h_1 very close, the distance between them less than the length of the apophyses 5

– Bases of apophyses h_1 distant, the distance between them more than the length of the apophyses **C. tryjanowskii** sp. n.

5 (4) Setae d_2 absent; lamellar apophyses more than 100 µm in length *C. capistrata* LUXTON, 1987

– Setae d_2 present; lamellar apophyses less than 50 µm in length *C. ardala* LUXTON, 1987

NEW RECORDS OF CROTONIOID SPECIES FROM THE AUSTRALIAN REGION

Platynothrus major HAMMER, 1966 – Material examined – New Zealand: Lake Monk, beach litter. 28.1.1960. R. R. FORSTER (1 adult); School Creek, 13.2.966. J. SOUTHERLAND (4 adults); Waituhi, Nr. Taumaranui, 10.1.1967. R. R. FORSTER (2 adults); Norsewood, Motor Camp, 14.3.1966. R. R. FORSTER. (10 adults); Lowe Portobello, 1966.Jan., ex: old manuka leaf mould. B. BEATSON (30 adults); Ross Creek, 29.1.1966. J. SOUTHERLAND (30 adults); Evansdale Glen, 11.6.1966. R. R. FORSTER (4 adults); Foot of Mt. Holdsworth, 3.8.1966. R. R. FORSTER (6 adults). Specimens deposited in DATE. Distribution – New Zealand (LUXTON 1985).

Heminothrus traversus HAMMER, 1966 – Material examined – New Zealand: Waiperi Gorge, 19.11.1966. R. R. FORSTER (1 adult, deposited in DATE). Distribution – New Zealand (LUXTON 1985).

Crotonia caudalis (HAMMER, 1966) – Material examined – New Zealand: Te Wharau, 5.3.1967, R. R. FORSTER (20 adults); Lake Monk, beach litter. 28.1.1960. R. R. FORSTER (1 adult); School Creek, 13.2.1966. J. SOUTHERLAND (1 adult); Carawea Wast, 28.9.1966. R. R. FORSTER (2 adults); Waituhi, Nr. Taumarunni, 10.1.1967. R. R. FORSTER (3 adults); Norsewood, Motor Camp, 14.3.1966. R. R. FORSTER. (10 adults); Waiperi Gorge, 19.11.1966. R. R. FORSTER (7 adults). Specimens deposited in DATE. Distribution – New Zealand (LUXTON 1985).

Crotonia cervicorna LUXTON, 1982 – Material examined – New Zealand: Arthur's Pass, 900 m, Dec.31.1983, L. MASNER (3 adults, deposited in CNCIAN); Waipona Forest, 6.1.1967. R. R. FORSTER (1 adult, deposited in DATE). Distribution – New Zealand (LUXTON 1985).

Crotonia cophinaria (MICHAEL, 1908) – Material examined – New Zealand: Te Wharau, 5.3.1967, R. R. FORSTER (10 adults); Cascade cr, 16.8.1966, ex: moss, R. R. FORSTER and WILTON (2 adults); Apiti, 22.12.1966. R. R. FORSTER (1 adult); Norsewood, Motor Camp, 14. 3. 1966. R. R. FORSTER (10 adults); Waiperi Gorge, 19.11.1966. R. R. FORSTER (1 adult). Specimens deposited in DATE. Distribution – New Zealand (LUXTON 1985)

Crotonia tuberculata LUXTON, 1982 – Material examined – New Zealand: Waipoua Kauri Forest, Dec.11/12.1983, L. MASNER (1 adult, deposited in CNCIAN, Ottawa). – Distribution – New Zealand (LUXTON 1985).

Holonothrus artus OLSZANOWSKI, 1999 – Material examined – Solomon Islands: Guadalcanal Popamanasiu; 6.XI.1965; moss forest; Roy. Soc. Exped. Brit. Mus. (2 adults); Kolombangara summit; moss forest, moss on trees; Roy. Soc. Exped. Brit. Mus. (1 adult). Specimens deposited in DATE. Previous findings – Chile (OLSZANOWSKI 1999). Remarks – The specimens from the Solomon Islands show practically no morphological differences from the type material from Chile, despite a significant distance separating the two populations. They share an interesting feature of the presence of a solenidion on the genua of legs IV (as in *H. venetiolanus* and species of *Crotonia*) and the palpal, genital and epimeral setation are as in holotype. In a number of specimens lamellar apophyses were a bit narrower and longer, in some specimens their position can be interpreted as more anterior relative to the holotype drawing (compare OLSZANOWSKI 1999, Fig. 47). This feature may vary depending on the prodorsum position relative to the notogaster, so on observation the angle of prodorsal inclination with respect to the microscope slide may be different. Body length: 658–832 µm; body width: 283–353 µm.

Holonothrus pulcher HAMMER, 1966 – Material examined – Australia: New South Wales, New England, 1600 m, Feb.12.1984, *Nothofagus moorei* forest, ferns, L. MASNER (2 adults, deposited in CNCIAN). Distribution – New Zealand (LUXTON 1985).

*

Acknowledgements – The author wishes to express sincere thanks to V. BEHAN-PELLETIER, Biosystematic Research Centre, Ottawa; J. BALOGH, Department of Zootaxonomy and Ecology, Eötvös Loránd University, Budapest, Hungary and S. MAHUNKA, Department of Zoology, Hungarian Natural History Museum, Budapest, Hungary for the loaned material.

Financial support of the State Committee for Scientific Research (grant no. 6 P205 064 06) is gratefully acknowledged.

REFERENCES

COLLOFF, M. (1990) New species of Crotonia (Acari: Oribatida) from South Africa. *Zool. J. Linnean Soc.* **100**: 403–419.

HAMMER, M. & WALLWORK, J. A. (1979) A review of the world distribution of oribatid mites (Acari: Cryptostigmata) in relation to continental drift. *K. danske Vidensk. Selsk. Biol. Skr.* **22**: 1–31.

HUNT, G. S., COLLOFF, M. J., DALLWITZ, M. J. & WALTER, D. E. (1998) *Oribatid Mites: An Interactive Key to Oribatid Mites of Australia.* CD-ROM. CSIRO Publishing, Melbourne.

LEE, D. C. (1985) Sarcoptiformes (Acari) of South Australian soils. 4. Primitive oribatid mites with an extensive, unfissured hysteronotal shield and aptychoid. *Rec. S. Aust. Mus.* **19**: 39–67.

LUXTON, M. (1982) Species of the genus Crotonia (Acari: Cryptostigmata) from New Zealand. - *Zool. J. Linnean Soc.* **76**: 243–271.

LUXTON, M. (1985) Cryptostigmata – a concise review. *Fauna of New Zealand* **7**: 1–106.

LUXTON, M. (1987) New mites of the family Crotoniidae (Acari: Cryptostigmata) from Northern Queensland. *Acarologia* **28** (4): 381–388.

OLSZANOWSKI, Z. (1997) On the genus Holonothrus (Acari: Oribatida) in the Australian Region. *Acarologia* **38** (4): 385–402.

OLSZANOWSKI, Z. (1999) Three new species of Holonothrus from the Neotropical region (Acari: Oribatida). *J. nat. Hist.* **33**: 233–253

Revised version received 21th August, 2000, accepted 23st August, 2000,
published 21st September, 2000

Acta Zoologica Academiae Scientiarum Hungaricae 46 (3), pp. 249–257, 2000

TWO NEW SPECIES OF DROSOPHILIDAE (DIPTERA) FROM CENTRAL EUROPE

L. PAPP

Department of Zoology, Hungarian Natural History Museum
H-1431 Budapest, Pf. 137, Hungary

Leucophenga hungarica L. PAPP, sp. n. and *Stegana (Steganina) consimilis* L. PAPP et MÁCA, sp. n. are described from the 1999 collectings from Hungary (additional specimens are from the Czech and the Slovak Republics). With 20 original figures.

Key words: *Leucophenga, Stegana (Steganina)*, new species, Drosophilidae, Hungary

In the frame of the project "Large blank spots in the Diptera fauna of Hungary" species representing dipterous families formerly not recorded from Hungary are to be collected and published. Furthermore, species representing not recorded genera are also targets of our activity.

In 1999, the first year of the project, these collectings resulted in capturing specimens of numerous genera and species new for the fauna of Hungary. Very much to our surprise, also two species of Drosophilidae new to science were captured.

Specimens below are preserved in the Diptera collection of the Department of Zoology, Hungarian Natural History Museum, Budapest (below: HNHM), if not specified otherwise. The specimens were mostly collected by LÁSZLÓ PAPP, so this name is not given below, only if I collected them together with ZSUZSANNA BAJZA or ALBERT SZAPPANOS. The year 1999 is also omitted. The months are given as on the collection labels, i.e., May: május, 5., June: június, 6., July: július, 7.; on labels which are written in Hungarian, months come first. The following Hungarian words are on numerous labels: "patak fölött": over the brook, "patak fölött és mellett": over and along/beside the brook.

Some abbreviations used also on collection labels: TK: Tájvédelmi Körzet [Landscape Protection Area], TT: Természetvédelmi Terület [Nature Reserve], p., patak [brook], v., völgy [valley].

Abbreviations used in the text are: *dc*: dorsocentral setae, *ifr*: interfrontal bristles, *kepst*: katepisternal setae/hairs, *ors*: upper orbital setae, M: medial vein, R: radial veins, S: abdominal sternite, T: abdominal tergite.

Leucophenga (L.) hungarica L. PAPP, sp. n.
(Figs 1–5, 7–9)

Holotype male (HNHM): [Hungary], K-Mecsek TK: Óbánya, Óbányai-völgy, tapló korhadt bükkön [tinder fungus on mouldy oak] – patak fölött, 1999. május 29., leg. PAPP LÁSZLÓ.

Paratypes: Hungary: 9 males, 23 females (HNHM): same as for the holotype; 1 male: K-Mecsek TK: Komló, Zobákpuszta, Hidasi-völgy, Petasitetum, május 28.; 1 female (HNHM): ibid., patak fölött, május 26.; 21 males, 45 females (HNHM; 1 male, 1 female in the Zoologisches Museum, Universität Zürich, 1 female in the Muséum d'Histoire naturelle Genève): Zempléni TK: Regéc, Ördög-v., patak fölött korhadó bükkön tapló [tinder fungus on mouldy oak], június 8., PAPP L., SZAPPANOS A.; 2 females: ibid., patak fölött; 1 female: ibid., patak fölött, június 29., PAPP L., BAJZA ZS.: 1 female: Nagyhuta, Senyő-völgy, patak fölött és mellett, június 9., PAPP L., SZAPPANOS A.; 3 females: Nagyhuta [correctly: Regéc], Vajda-v., patak fölött, június 8., PAPP L., SZAPPANOS A.

Czech Republic (coll. J. MÁCA): 1 male: Bohemia mer., Hluboká n. Vlt., JAN MÁCA leg., 23. 6. 99; 1 male: Moravia sept., Hradec u Opavy env., J. ROHÁCEK leg. – on rotting tree trunks, 31. 5. 1990; 1 male: Moravia sept., Silhorovce, Cerny les (distr. Opava), J. ROHÁCEK leg. – on rotting tree trunks, 10. 7. 1991.

Slovak Republic (coll. J. MÁCA): 1 male: Slovakia or., Nová Sedlica env., Stuzica reserve, J. ROHÁCEK leg. – on tree fungi, 10. 7. 1973, F3; 1 female: ibid., sweeping undergrowth of deciduous forest, 10. 6. 1994.

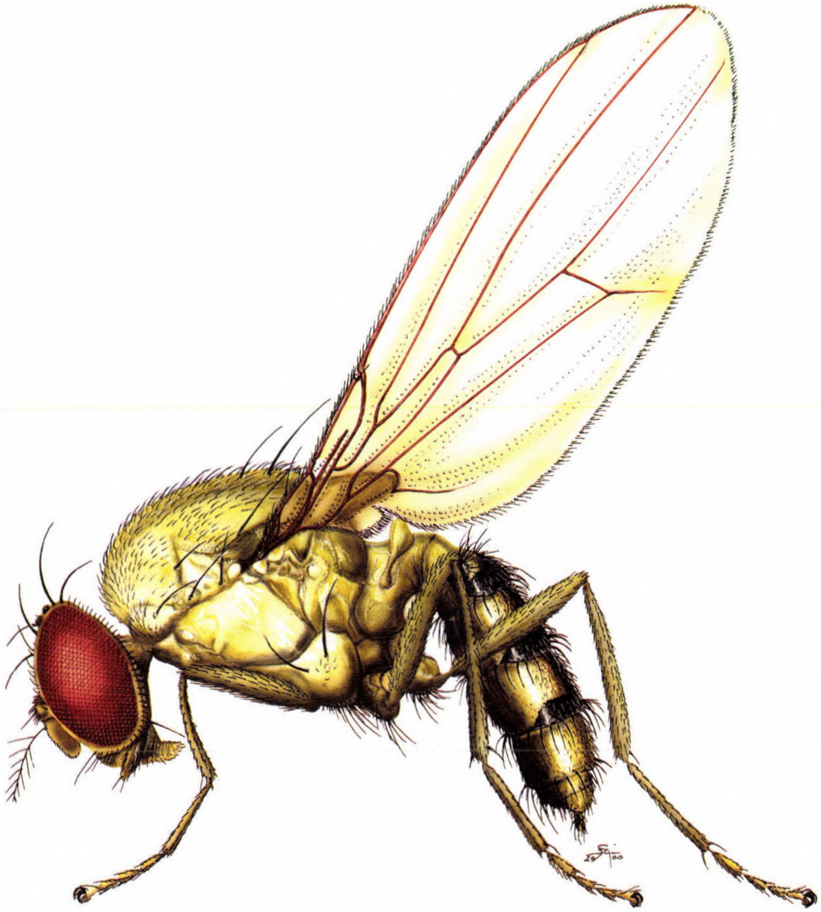


Fig. 1. *Leucophenga hungarica* sp. n., paratype male (del. A. SZAPPANOS)

One female (seriously damaged, left wing lost) with label data "Slovakia or., Stakcín env. (distr. Humenné), J. Rohácek leg. – sweeping undergrowth of deciduous forest, 20. 6. 1986" was also seen but not included in the type series.

Measurements in mm: body length 3.67 (holotype), 2.71–4.13 (paratype males), 3.54–4.33 (paratype females), wing length 4.37 (holotype), 3.80–4.71 (paratype males), 4.01–4.96 (paratype females), wing width 1.56 (holotype), 1.38–1.80 (paratype males), 1.54–1.85 (paratype females).

Body colour honey-yellow, eyes vivid red (Fig. 1), legs unicolourous, somewhat greyish yellow, abdominal segments 2–4 with black (dark brown) caudal marginal crossbands and with a sagittal longitudinal band of the same colour. The dark marginal band on tergite 2 is extended anteriorly near the lateral side of abdomen and so the dark colour forms a transverse "E" on this tergite.

Frons at middle 0.38 times as broad as head (holotype) or 0.44 times as broad (females); lateral sides of orbits more or less parallel, i.e. frons not narrowed anteriorad.

Frontal chaetotaxy peculiar (cf. BÄCHLI 1998): proclinate fronto-orbital almost as long as posterior *ors*, the second (reclinate) *ors* placed caudally (well behind) and slightly laterally to the proclinate one; anterior reclinate *ors* half as long as posterior *ors*; posterior reclinate fronto-orbital definitely nearer to anterior one than to inner vertical (Fig. 1). Some short unpaired *ifr* and some other similar short hairs over lunule. Orbitalia with some additional short hairs, postoculars stronger, uniserial. Ocellars long and strong, ocellar triangle with a pair of lateroclinate hairs, postocellars long and crossing, vertical pairs long and thick. Vibrissal pair strong but peristomials short, compatively thin and uniserial. Gena very narrow, 0.22–0.028 mm below longitudinal axis of eye. Gena posteriorly with 1 strong ventrally directed seta.

Scape and pedicel with short thin hairs, pedicel with a pair of long hairlike setae. First flagellomere covered with short thin ca. 0.011 mm long cilia. Arista with long branches: 6–7 dorsal and 4(5) ventral branches, ventral ones not shorter than dorsal ones. Palpi with 1(2) medium long (0.056–0.073 mm) apical and 3–4 other short setae.

Two pairs of *dc*; ca. 8 badly arranged rows of acrostichals, prescutellar pair comparatively strong, 2/5 length of posterior *dc*. Scutellum rather convex with 2 pairs of strong scutellars, otherwise bare.

Two strong katepisternals, and some minute *kepst* hairs, pleura otherwise bare.

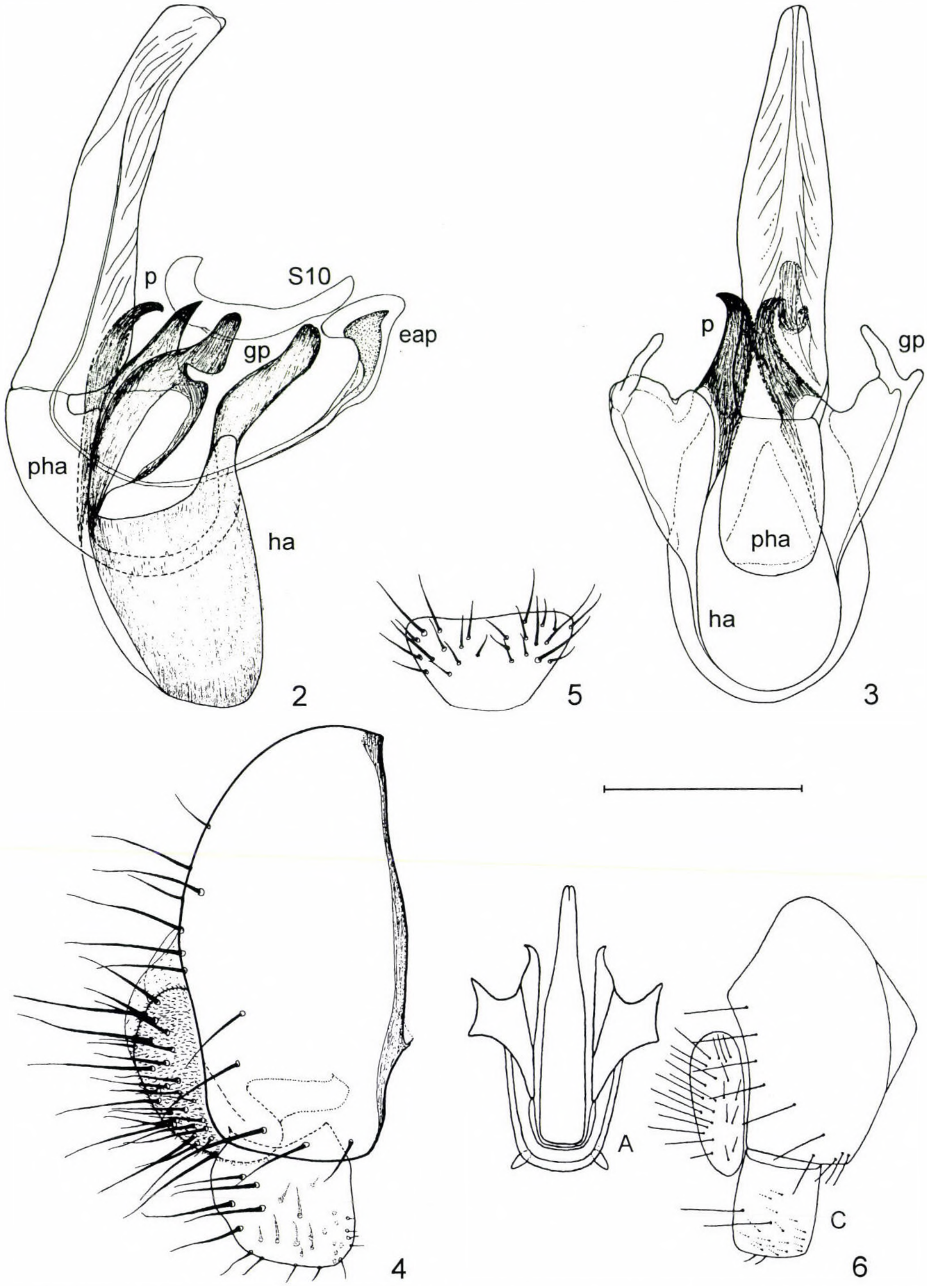
Legs incl. tarsi long, tibiae with weak dorsal preapicals, but without any more special armature. Mid tarsi posterodorsally with a row of small peg-like bristles, but no such row on hind tarsi (contrary to a majority of the species in the subfamily Steganinae, e.g. to *L. maculata*).

Wings clear yellowish without any darker hue anywhere (e.g. not even on the cross-veins), veins ochreous yellow. Costa reaching apex of M; stronger fringe on costa between R_{2+3} and R_{4+5} is on its 11/16 to 2/3; thornlike spines below costa absent as in *Paraleucophenga*, though this new species definitely belongs to *Leucophenga*. Discal and second basal cells confluent as in other species of *Leucophenga*.

Abdomen comparatively small. Male genitalia rather small, female postabdomen strongly telescopizing (Fig. 1).

Male genitalia: pregenital sternite (S6) simple, trapezoidal (Fig. 5); epandrium small compared to the preabdomen, short and rounded dorsally; cerci (Fig. 4) rather ventrally placed with numerous long setae and covered with trichia; surstylus (Fig. 4) short, comparatively very broad, apex widely rounded; long surstylar setae on caudal half of the lateral surface only, medial surface with some medium-long setae. Hypandrium with large lateral walls but open ventrally (Figs 2–3); gonopods ventrally fused to hypandrium, comparatively short, tip remains behind that of the parameres; parameres (paraphyses) subsymmetrical, long and slender with slightly curved and sharp apex; phallus comparatively long and robust, medial part as broad as basal part (Fig. 3), contrary to that of *L. sorii*; phallapodeme (aedeagal apodeme) widely curved from phallobase to over the gonopods; ejaculatory apodeme distinct though less sclerotized.

Female tergite 8 rather small (Fig. 7), epiproct not divided, itself slightly, its armature strongly asymmetrical. Sternite 8 (Fig. 8) short and broad, not divided with stronger setae on its



Figs 2–6. 2–5. *Leucophenga hungarica* sp. n., paratype male. 2 = inner genitalia, lateral view, 3 = same, ventral view, 4 = epandrium, cercus and surstylus, lateral view, 5 = pregenital sternite. 6 = *Leucophenga sorii* KANG, LEE et BAHNG, 1965, inner genitalia, ventral view (A) and epandrium with cercus and surstylus, lateral view (C) (abbreviations: eap: ejaculatory apodeme, gp: gonopod, ha: hypandrium, p: paramere, pha: phallapodeme, S10: decasternum; 6 after KANG *et al.*). Scale: 0.2 mm for Figs 2–4, 0.4 mm for Fig. 5

caudal margin only, covered with minute hairlets. Cerci long and slender, well-sclerotized, with several long setae and with an extremely long pair of dorsal subapical setae. Spermathecae (Fig. 9) long, slender, two- or rather tripartite, proximal part black, very long without annulation (cf. BÄCHLI 1971: Fig. 10 h-t), proximal half of medial part also black, distal half of medial part brown, distal part yellow, weakly sclerotized with inner annulation.

L. hungarica sp. n. is a peculiar species; in keys for drosophilid genera (e.g. BÄCHLI 1998) it keys out to the subfamily Drosophilinae as regards the position of fronto-orbitals. It is without a close relative in the western Palaearctic fauna. Its closest relative is probably *Leucophenga sorii* KANG, LEE et BAHNG, 1965 (Fig. 6) known from South Korea. However, as seen on Fig. 6, the surstylus of this species is longer and more quadrate (Fig. 6: "C") when compared to the new species; its cerci seem comparatively larger and also inner genitalia are different. KANG et al. (1965) did not demarcate phallus and phallapodeme but the apical half of the phallus seems thinner in *L. sorii*; as for the parameres (paraphyses), those of the *L. hungarica* are more slender in their medial portion; the ratio of the hypandrium and gonopods to the phallus is convincingly different (Figs 2–3, cf. Fig. 6: "A"). *L. sorii* has always a dark band on its 5th tergite, though medially interrupted. It is seldom that the caudal margin of the 5th tergite is somewhat darked in *L. hungarica* but this difference in colour is probably not a safe character that would make it possible to differentiate these two species.

Stegana (Steganina) consimilis L. PAPP et MÁCA, sp. n.
(Figs 10–21)

Holotype male (HNHM): Zempléni TK: Nagyhuta, Vajda-v., Kemence-patak fölött és mellett, 1999. június 28., PAPP L., BAJZA ZS.

Paratypes: Hungary (HNHM): 7 males: data as for the holotype; 3 males: ibid., patak fölött, június 8., PAPP L., SZAPPANOS A.; 5 males: Zempléni TK: Regéc, Ördög-v., patak fölött és mellett, 1999. június 28., PAPP L., BAJZA ZS.; 1 male: ibid., június 8., PAPP L., SZAPPANOS A.; 1 male: ibid., Füzér: Alsó-patak fölött és mellett, június 29.; 1 male: K-Mecsek TK: Óbánya, Óbányai-völgy, patak fölött és mellett, május 28.; 1 male: ibid., Komló, Zobákpuszta, Hidasi-völgy, patak fölött, május 26.; 1 male: ibid., Kisújbánya, patak fölött és mellett, május 30.; 1 male: Melegmányi-völgy TT: Pécs: Nagy-mély-völgy, patak fölött, május 27. 1 male: Börzsöny TK: Szokolya, Szén-patak fölött, július 4.

Slovak Republic (coll. JAN MÁCA): 1 male: Slovakia or., Vihorlat Mt., Sninsky kamen Mt., J. ROHÁCEK leg. – sweeping undergrowth of deciduous forest, 21. 6. 1983; 1 male: Slovakia or., Stakcin env. (distr. Humenne), J. ROHÁCEK leg. – sweeping undergrowth of deciduous forest, 20. 6. 1986.

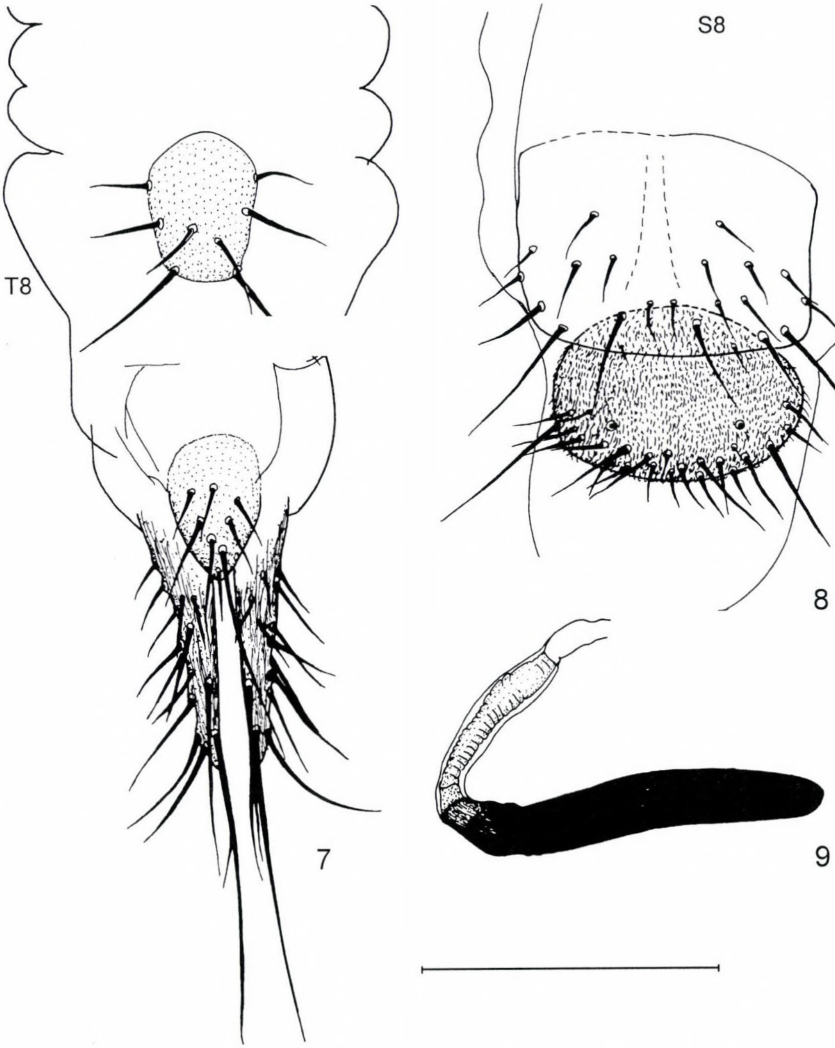
Measurements in mm: body length: 2.79 (holotype), 2.50–3.00 (paratypes), wing length 2.96 (holotype), 2.63–3.21(paratypes), wing width 1.28 (holotype), 1.21–1.49 (paratypes). That is, as a mean same as *S. similis*.

In most body characters it is similar to *S. similis* LAŠTOVKA et MÁCA, 1982, and this new species keys out to *S. similis/S. wheeleri* in the key of LAŠTOVKA and MÁCA (1982). The differences found (incl. some of the male genitalia) are tabulated as follows:

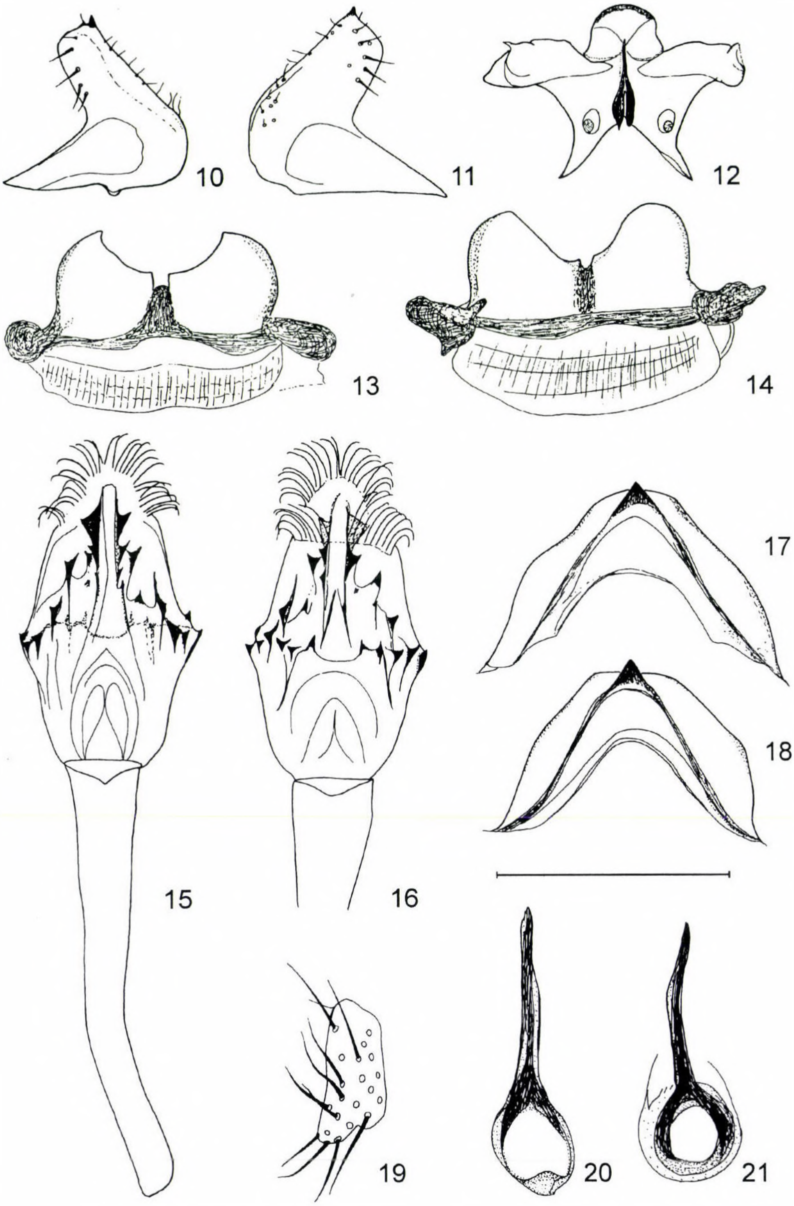
	S. similis	*S. consimilis*
first flagellomere	shorter, dorsal length/max. width ratio: 18:12, 17: 12	longer, dorsal length/max. width ratio: 21:13, 21:14.5
arista	6–7(8) ventral rays with long ventral rays also in basal third aristal rays in medial third > 2nd dorsal apical ray	4–5 ventral rays only without long ventral rays in basal third aristal rays in medial third ≤ 2nd dorsal apical ray
gena	medial height < 1st flagello-mere width	medial height > 1st flagello-mere width
genal setae	short behind and above posterior seta	much longer behind and above posterior seta
surstylus	as in L. et M.'s Fig. 42: medial edges 90°, tapering apically with a lower apical tooth	medial edges smaller than 90° (Figs 10–11), broader, also apex rather broad ± truncated
ejaculatory apodeme	with short robust stalk	with very long slender stalk
paramere	short broad without a medial apex	anterior margin deeply emar-ginate, posterior margin with a triangular process bent caudally
legs	yellow, or fore "knees" and apical part of f2 and basal part of t2 darkened to brown	a subapical ring of f2 and a broad apical ring of t2 *dark* brown

While *S. consimilis* sp. n. is similar to *S. similis* LAŠTOVKA et MÁCA, 1982 in its body characters, its genitalia show a peculiar set of characters, where the different genital structures are similar to those of different species. This is why we do not think that *S. consimilis* would be a sister-species of *S. similis*.

Male cerci (Fig. 19) tend to be bilobed ventrally (apically). Surstyli subsymmetrical (Figs 10–11), broad, medial edges smaller than 90, apex rather broad and truncated; all in all surstyli are more similar to those of *S. nigrithorax* (see Fig. 48 of LAŠTOVKA & MÁCA (1982)), than to those of *S. similis* or *S. wheeleri*, which are probably more closely related. Decasternum (Fig. 12) not similar to that of the two species (cf. LAŠTOVKA & MÁCA (1982): Figs 58–59) and distinctly differs from any of the known species. Hypandrium (Figs 13–14) broad and comparatively short, less characteristic. Phallapodeme (Fig. 15) was found as slightly asymmetrically curved in all the specimens prepared. Phallus short and broad (Figs 15–16) with strongly sclerotized teeth on both dorsal and ventral surface, apically and ventrally-subapically with numerous curved hairlike setae as characteristic for the *Steganina* spp; phallus again not similar to that of *similis* or *wheeleri* but reminiscent to that of *S. longifibula* (cf. Figs 72, 74 to Fig. 79, and Figs 84, 86 to Fig. 90 of LAŠTOVKA et MÁCA (1982)). Paramere (paraphyses) (Figs 17–18) with cranial margin deeply emarginate, caudal margin with a triangular (caudally bent) process, similar to that of *S. longifibula* TAKADA (see Fig. 98 of LAŠTOVKA & MÁCA (1982)); paramere of both *S. similis* and *S. wheeleri* are short, broad, without a medial apex). The stalk of the ejaculatory apodeme is the longest (most slender) among the Holarctic species of *Steganina*



Figs 7–9. *Leucophenga hungarica* sp. n., paratype female. 7 = postabdomen, dorsal view, 8 = sternites 7 and 8, ventral view, 9 = one of the spermathecae. Scale: 0.2 mm for all



Figs 10–21. *Stegana* (*Steganina*) *consimilis* L. PAPP et MÁCA, sp. n., paratype males. 10 = left surstylus, broadest extension, 11 = right surstylus, broadest extension, 12 = decasternum, ventral view, 13 = hypandrium, anterior view, Regéc: Ördög-völgy, 14 = hypandrium, anterior view, Nagyhuta, 15 = aedeagus and aedeagal apodeme, dorsal view, 16 = aedeagus, ventral view, 17 = paramere, dorsal view, Slovakia, 18 = paramere, dorsal view, Nagyhuta, 19 = cercus (anal plate), broadest extension, 20 = ejaculatory apodeme, Nagyhuta, 21 = ejaculatory apodeme, Slovakia (not the same view). Scale: 0.2 mm for all

(Figs 20–21); that of both *S. similis* and *wheeleri* is short and thicker; the ejaculatory apodeme of the new species resembles that of *S. dentifera* (Fig. 115 of LAŠTOVKA & MÁCA (1982)).

Female not known (at least we did not dare identify females captured together with males of *S. similis* and *S. consimilis*).

*

Acknowledgements – I am very grateful to Dr GERHARD BÄCHLI (Zoologisches Museum, Universität Zürich, Switzerland) for advice when finding the new species of *Leucophenga.* I owe a great debt of gratitude to Dr JAN MÁCA (Ceské Budejovice, Czech Republic) for sending me his specimens of the two species, which also he recognized as new.

This study was supported by the Hungarian Scientific Research Fund (OTKA grant no. T30242).

REFERENCES

BÄCHLI, G. (1971) Leucophenga und Paraleucophenga (Diptera Brachycera) Fam. Drosophilidae. *Explor. Parc Nat. Upemba, Miss. G. F. de Witte* **71**: 1–192 + 38 figs.

BÄCHLI, G. (1998) 3.45. Family Drosophilidae. Pp. 503–513. *In* PAPP, L. & Darvas, B. (eds): *Contributions to a Manual of Palaearctic Diptera,* Vol. 3. Science Herald, Budapest.

KANG, Y. S., LEE, T. J. & BAHNG, K. W. (1965) Two new species of the Drosophilidae from Korea. *Annotnes zool. jap.* **38**: 97–100.

LAŠTOVKA, P. & MÁCA, J. (1982) European and North American species of the genus Stegana (Diptera, Drosophilidae). *Annot. zool. bot., Bratislava* **149**: 1–38.

Revised version received 11th August, 2000, accepted 21st August, 2000,
published 21st September, 2000

Contributions to a MANUAL OF PALAEARCTIC DIPTERA

edited by L. PAPP and B. DARVAS

Volume 2

Nematocera and Lower Brachycera

In the bulky volumes of the "*Contributions to a Manual of Palaearctic Diptera*" morphological, physiological, genetical, ecological and economic up-to-date knowledge of dipterous species (midges and flies), which have significant importance in genetics as model organisms, in plant cultivation as pests or beneficial parasitoids, in animal husbandry and human health as vectors of serious illnesses and which are important for ecosystem function, are treated. Morphological keys (with excellent figures) for adults and larvae, which help readers with identification of dipterous pests and parasitoids are provided, while readers in field of applied dipterology will find suitable environmentally friendly methods against pests or biological control methods, among others. Time table of series: 1997 – Volume 2, 1998 Volume 3 (Higher Brachycera), 1999 – Volume 1 (General and Applied Dipterology) and Appendix Volume.

The 2nd volume contains 38 dipterous family chapters by 23 specialists from 12 countries. with 1895 figures on 258 plates.

November 30, 1997, 592 pages
ISBN 963 04 8836 1 (Series)
ISBN 963 04 8837 x (Volume 2)
Foundation for the Publicity of the Hungarian Science
Publisher: Science Herald, Budapest

Order should be sent to
E. W. Classey Ltd.
Natural History Publisher & Bookseller
Oxford House, 6 Marlborough Street, Faringdon
Oxon SN7 7JP, UK
Facsimile: (44)-1367 244800
E-mail: bugbooks@classey.demon.co.uk

Acta Zoologica Academiae Scientiarum Hungaricae 46 (3), pp. 259–264, 2000

ESTABLISHING MICROSATELLITE ANALYSIS FOR LOCALLY ENDANGERED POPULATIONS OF ROOT VOLE (MICROTUS OECONOMUS)

PAPP, T.[1], GUBÁNYI, A.[2] and RÁCZ, G.[3]

[1] *Veterinary Medical Research Institute, Hungarian Academy of Sciences*
H-1143 Budapest, Hungária krt. 21, Hungary, E-mail: tpapp@novell.vmri.hu
[2] *Department of Zoology, Hungarian Natural History Museum*
1088 Budapest, Baross u. 13, Hungary, E-mail: gubanyi@zoo.zoo.nhmus.hu
[3] *Museum of Southwestern Biology, Biology Department*
The University of New Mexico Albuquerque, NM-87131, USA

The root voles (*Microtus oeconomus*) is endangered in Hungary; the monitoring of its fragmented and isolated populations is necessary for an effective nature conservation management. Analysing of microsatellite DNA has been shown to be an efficient method to assess genetic variability among a wide variety of organisms. The present paper describes how this technique can be used to study populations of root voles. Two different DNA sampling and extraction methods and 10 heterologous primer pairs were tested. From these 10 primer pairs, 6 were found appropriate for microsatellite analysis of this species. Sequence analysis of the amplified PCR products raised the problem that length polymorphism may be the result of variation of a compound microsatellite locus.

Key words: *Microtus oeconomus*, microsatellite analysis, sequence analysis, Hungary

INTRODUCTION

The probability of extinction of isolated populations shows negative correlation with population size (SOULE 1987). Natural demographic fluctuation and variation in environmental conditions may strongly affect the genetic parameters of populations and can lead to genetic erosion, hence making the structure of populations more fragile (GAINES & WHITTAM 1980, BIJLSMA & LOESCKE 1997). For this reason, the screening of genetic variation has a great importance in effective conservation measures of the targeted populations (CIOFI *et al.* 1998).

The root vole (*Microtus oeconomus* [PALLAS, 1776]) is the rarest vole species in Hungary according to the Red Data Book (RAKONCZAY 1989). The populations in the Carpathian Basin are enlisted as a local subspecies of root vole (*Microtus oeconomus méhelyi* [ÉHIK, 1928]) and their scattered populations are considered as a glacial relicts (JÁNOSSY 1986). The species has a Holarctic distribution with 23 distinguished subspecies (Online database http://www.funet.fi/pub/sci/bio/life/mammalia/rodentia/arvicolidae/microtus) and is a common rodent in Alaska, Siberia, and Northern Europe (TAST 1982). The variability of the Northern European populations has already been estimated by using morphometric methods (MARKOWSKY 1980, MARKOWSKY & OTSBYE 1992), isoenzyme and allozyme analysis (ENGEL *et al.* 1970, TAMARIN & KREBS 1969, LEIJS *et al.* 1998) and DNA fingerprinting (STACY *et al.* 1994).

Although the Hungarian subspecies is under strict protection, its ecological demands, the size of populations, and its genetic diversity are still obscure because previous studies have only been concerned with its distribution (ÉHIK 1928, TOPÁL 1963) and parasite infection (MATSKÁSI *et al.* 1992). Today, there are only four areas in West-Hungary (Szigetköz, Hanság, Fertő-tó, Kis-Balaton) where populations remained. However, suitable habitats are continuously shrinking mainly as consequences of human disturbance. The best known example of habitat deterioration is the drying off wetlands in the Szigetköz area, which is a result of the diversion of the Danube river.

For the above mentioned reasons, further investigation of local populations of root voles is essential. Our ongoing research is about to estimate the average genetic variability within and between populations using microsatellite markers. Microsatellite analysis is more likely to detect considerable genetic variation compared to other methods (PATKEAU *et al.* 1995). The feasibility of two different sampling methods for DNA extraction and the applicability of 10 heterologous primer pairs for the PCR amplification of presumably polymorphic microsatellite loci are described below.

MATERIALS AND METHODS

Sample collection

Root voles were collected using wooden live traps from 5 localities of three different living areas in Hungary during the years 1997 and 1998 Altogether 86 root vole individuals and a few specimen of 3 reference murine species (see later) were sampled. Tissues of different origin, such as pieces of tail and uprooted hair, were collected in order to compare PCR yields. Tail cutting (REIJS *et al.* 1998) proved to be relatively harmless, and it also helped to avoid resampling. Pieces of tail were frozen in liquid nitrogen until storage at -50°C. Tufts of hair were air-dried and then stored at +4°C. Samples were given unique idenfication codes generated from the year of collection, species names abbreviation, first letter of the locality and the ordinal number of the specimen (the numbering skipped when an animal was recaptured). E.g. (98)MoL2 is the second *Microtus oeconomus* in 1998 collected at Lipót.

DNA extraction and primer selection

Two different DNA extraction methods were applied using small pieces from the tail: either a standard phenol/chloroform extraction (MANIATIS *et al.* 1982) or a simplified DNA isolation procedure (LAIRD *et al.* 1991). For tufts of hair we tested the standard protocol used for human hairs at the Hungarian Forensic Research Institute (FÜREDI pers. comm.). This method concentrates the phenol/chloroform extracted DNA on a Micron 100 (Amicon) membrane filter.

Ten heterologous DNA primer pairs were tested for amplifying polymorphic microsatellite loci using PCR. Five commercially available 'mouse primer pairs' (Murine Screening Set, 410

Mouse MapPairs™, Research Genetics, Inc., Huntsville, AL, USA), and one which had been previously described in the grey red-backed vole, *Clethrionomys rufocanus bedfordiae* (ISHIBASHI *et al.* 1995) all worked well in with meadow vole (*Microtus pennsylvanicus*) samples (MONCRIEF *et al.* 1997). Furthermore, we tested four of the eight primer pairs recently described in the Japanese field vole *Microtus montebelli* (ISHIBASHI *et al.* 1999). ‘Mouse primers’ were purchased from Research Genetics while the ‘vole primers’ were synthesized (EastPort Ltd., Csertex Ltd.).

Microsatellite analysis

PCR reactions were carried out using the thermal cycler PDR-91 (Biochemical Laboratory Service) in either 10 µl reaction mix covered with oil or in 50 µl mixture by Hot Start. The optimised mixtures for mouse/vole primers were respectively, as follows: 50 mM KCl, 10 mM Tris-HCl (pH8.3), 3 mM/1.5 mM MgC12, 300 µM/200 µM dNTP, 0.2 µM/0.15 µM of each primer, 0.5 U Taq DNA polymerase (Sigma), and 10–100 ng genomic DNA. After denaturation at 95°C /93°C for 5 min, the reaction was carried out in 30/35 cycles under the following conditions: mouse primers, 94°C for 45s, 57°C for 45s, 72°C for 60s; vole primers, 90°C for 30s, 54°C for 20s, 72°C for 20s; both finally ended by 72°C for 5 min. To check the presence of products, 10 µl of the amplicon was horizontally electrophoresed in 1.5% agarose gel.

PCR products were separated by size on 5% non-denaturing polyacrilamide gel (530×250×0.4 mm) and visualised by silver staining (MANIATIS *et al.* 1982). The DNA sequence of the purified PCR products (primer MSCRB-5) of three individuals was determined by using PRISM Ready Reaction Dye Deoxy Cycle sequencing protocol (Pelkin-Elmer) and an ABI 373A automated DNA sequencer (Applied Biosystems). Nucleotide sequences were assembled using the Lasergene program package (DNASTAR) and compared against GenBank sequences using the BLAST search program (ALTSCHUL *et al.* 1990).

RESULTS AND DISCUSSION

Feasibility of sampling methods

Tail-tips and tufts of hair were simultaneously tested as a useful source of DNA. As expected, hair produced a smaller yield of DNA (10–100 ng) compared to tail tips (1–10 µg). The amount of DNA from hair was just enough to produce an amplification product that resulted in a very weak signal on agarose-gel electrophoresis. Such results suggest that hair originated PCR products could not be analysed by the silver staining method. Still, if it was necessary, these amplicons could be separated in automated sequencers after fluorescent dye labelling.

Applicability of primers

Two out of five of the ‘mouse primers’ yielded characteristic PCR products with root vole samples. These primers were D8Mit13 and D5Mit 10 and they worked in a very narrow range of reaction conditions. The other three ‘mouse primer pairs’ (D9Mit64, D9Mit248, DXMit64) did not give distinct PCR products, although they amplified house mouse (*Mus musculus*) and striped field mouse (*Apodemus agrarius*) which were used as reference samples (PAPP & GUBÁNYI unpubl. data).

Amplification of root vole samples by 'vole-primers' MSCRB-5, MSMM-2, MSMM-3 and MSMM-4 also yielded specific products. These primers worked in a wider range of reaction conditions and most of them gave products with bank vole (*Clethrionomys glareolus*) samples as well. Primer pair MSMM-1 did not give a distinct PCR product for the examined species, nor did they amplify bank vole reference samples (PAPP & GUBÁNYI unpubl. data).

Presently, the number of alleles in root voles at these microsatellite loci has not been completely determined, although we have shown two loci MSCRB-5 and MSMM-2 to be polymorphic. Investigations continue to estimate the extent of variability of these loci.

Sequence analysis

The sequence analysis of PCR products obtained by primer MSCRB-5 (Fig. 1) has revealed a possible problem. The polymorphism of a locus might be the result of the repeat variation of more than one repetitive region close to each other. In the GenBank Report (ISHIBASHI *et al.* 1995) eight repetitive regions of dimers and tetramers were described from the identical locus of the grey red-backed vole

```
Crb(GenBank)  CTCCTGGTAA TTTTCATCTT ACCTATATGT GTAAGTTTTA ACGTCTGGGT      50

(98)MoL2                                                 TCTGGGT      50
(97)MoV8      CTCCTGGTAA TTTTCATCTT ACCNGNGTGT GTATGTTTTA AAGTCTGGGT      50
(98)MoS4      CTCCTGGTAA TTTTCATCTT ACCGGAGTGT GTATGTTTTA AAGTCTGGGT      50

              TTTACATCTG AGAGAAAACA TGCAGTGTGT GTATGTGTAT GTGTGTACGT     100

              TTTACATCTG AGAGAAAACA TGCAGTGTGT GTGTGTGTGT ATGT--ACAT      98
              TTTACATCTG AGAGAAAACA TGCAGTGTGT GTGTGTGTGT ATGT--ACAT      98
              TTTACATCTG AGAGAAAACA TGCAGTGTGT GTGTGTGTGT NTNTNTACAC     100

              ACATAATACA TTTTTGCACG TACGTATATT TGTGTGTGTG TGTGTGTATG      150

              ACAC-ATAT- GTAC-GCATA CATATATATT T--------- -----GCATG      131
              ACAC-ATAT- GTAC-GCATA CATATATATT T--------- -----GCATG      131
              ACAN-ATNT- NTNC-ACACA NATATATATA T--------- -----GCNCN      133

              TATGTATGTG TGTATGTATG TATGTATTTC CTAAATGCAA ACACCAACC       199

              CAT------- -----GTATG TATGTATTTC CTAAATGCAA ACACCAACCA A    170
              CAT------- -----GTATG TATGTATTTC CTAAATGCAA ACACCAACCA A    170
              CNN------- -----GTGTA TATNTNTATC CCAAANGCNN ANACNANANA CA   173
```

Fig. 1. The alignment of three root vole PCR products (primer MSCRB-5) in comparison with the most homologous sequence of GenBank, grey red-backed vole (Crb) microsatellite locus MSCRB-5. The repeat motifs are printed in bold face, the one responsible for length polymorphism is shown in the small box. Individuals (98)MoL2 and (97)MoV8 are homozygous and identical for this locus. While (98)MoS4 is heterozygous and thus read sequence is the result of two overlapping products. N=uncertain, – deletion/insertion,

(GenBank accession number D37836). We have found six presumptive microsatellite repeat motif close to each other in this region. These are the following (with positions of starting base): (27)GT 3 times, (60)GA 3 times, (75)GT 8 times, (116)AT 4 times, (127)GCAT 2 times, (135)GTAT 3 times. Thus, similar allele lengths may arise from different combinations of repeat motif patterns. Obviously, we had to determine which one of the above mentioned motifs is responsible for the polymorphism of our PCR products. Fortunately, the animal coded (98)MoS4 was a heterozygote for this locus. By analysing the DNA sequence and separating the two alleles, it became apparent that the '(75)GT n times' was the repeat mainly responsible for length polymorphism [in the case of (98)Mos4 n=8 and n=11 on homologous chromosomes]. Therefore, locus MSCRB-5 is applicable for population genetic studies, since allele length depends only on the repeat number of one satellite. Nevertheless, situations such as this indicate the importance of sequencing at least a few PCR products of each locus to avoid misinterpretation of allele length polymorphism. The possibility of the presence of null alleles should be considered as well (PEMBERTON *et al.* 1995).

In conclusion, we have successfully extracted and amplified root vole DNA samples with the help of six primer pairs. The analysis of length polymorphism for each locus and the evaluation of the variability at these loci are both in progress.

*

Acknowledgements – We thank our collegues at the Veterinary Medical Research Institute for their everyday help, namely B. HARRACH, M. BENKŐ, A. DÁN, P. ÉLŐ and K. URSU. For his advice on extaction methods and sizing we grately appreciate the help of S. FÜREDI at the Forensic Research Institute. We also thank the staff of the Fertő–Hanság and the Balaton Uplands National Parks for their assistance in field work. Our research was supported by the Hungarian Scientific Research Fund (Nos T030073, T023876 and A312).

REFERENCES

ALTSCHUL, S. F., GISH, W., MILLER, W., MYERS, E. W. & LIPMAN, D. J. (1990) Basic local alignment tool. *J. Mol. Biol.* **215**: 403–410.

BIJLSMA, R. & LOESCHKE, V. (eds) (1997) *Environmental Stress, Adaptation and Evolution*. Birkhäuser Verlag, Basel. 344 pp.

ENGEL, W. (1970) The Genetics of 6–PGD (EC;1.1.1.44) in various mammals. I. Studies on 6 species of Microtinae, Rodentia, Isoenzyme polymorphism and family studies in Microtus oeconomus and Microtus ochrogaster. *Humangenetik* **2**: 151–157.

ÉHIK, J. (1928) Einige Daten zur Saugertierkunde Ungarns. *Annls hist.-nat. Mus. natn. hung.* **25**: 195–203.

GAINES, M. S. & WHITTAM, T. S. (1980): Genetic changes in fluctuating vole populations: selective vs. non-selective forces. *Genetics* **96**: 767–778.

ISHIBASHI, Y., SAITOH, T., ABE, S. & YOSHIDA, M. C. (1995) Polymorphic microsatellite DNA markers in the grey red-backed vole Clethrionomys rufocanus bedfordiae. *Mol. Ecol.* **4**: 127–128.

ISHIBASHI, Y., YOSHINAGA, Y., SAITOH, T., ABE, S., IIDA, H. & YOSHIDA, M. C. (1999) Polymorphic microsatellite DNA markers in the field vole Microtus montebelli. *Mol. Ecol.* **8**: 163–164.

JÁNOSSY, D. (1986) *Pleistocene vertebrate faunas of Hungary*. Akadémiai Kiadó, Budapest, 208 pp.

CIOFI, C., FUNK, S. M., COOLE, T. CHEESMAN, D. J., HAMMOND, R. L., SACCHERI, I. J. & M. W. BRUFORD (1998) Genotyping with microsatellite markers. Pp. 195–205. *In* KARP, A., ISAAC, P. G. & INGRAM, D. S. (eds) *Molecular Tools for Screening Biodiversity. Plants and animals*. Chapman and Hall, London.

LAIRD, P. W., ZINDERVELD, A., LINDERS, K., RUDNICKI, M. A., JAENISCH, R. & A. BERNS (1991) Simplified mammalian DNA isolation procedure. *Nucleic Acid Research* **19**(15): 4243.

LEIJS, R., APELDOORN, VAN, R. C. & BIJLSMA, R. (1998) Low genetic differentiation in north-west European populations of the locally endangered root vole, Microtus oeconomus. *Biol. Conserv.* **87**: 39–48.

MANIATIS, T., FRITSCH, E. F. & SAMBROOK, J. (1982) *Molecular Cloning. A Laboratory Manual.* Cold Spring Harbour Laboratory, Cold Spring Harbour. E3-E4, 18.56–18.57

MARKOWSKI, J. (1980) Morphometric variability in a population of the root vole. *Acta Theriol.* **25**: 155–211.

MARKOWSKI, J. & OSTBYE, E. (1992) Morphological variability of a root vole population in high mountain habitats, Hardangervidda, South Norway. *Acta Theriol.* **37**: 117–139.

MONCIEF, N. D., COCKETT, N. E., NEFF, A. D., THOMAS, W. L. & DUESER, R. D. (1997) Polymorphic microsatellites in the meadow vole Microtus pennsylvanicus: conservation of loci across species of rodents. *Mol. Ecology* **6**: 299–301.

MATSKÁSI, I., MÉSZÁROS, F., MURAI, É. & DUDICH, A. (1992) On the parasite fauna of Microtus oeconomus ssp. méhelyi [Éhik, 1928] in Hungary (Trematoda, Cestoda, Nematoda, Siphonaptera). *Miscnea zool. hung.* **7**: 9–14.

PAETKAU, D., CALVERT, W., STIRLING, I. & STROBECK, C. (1995) Microsatellite analysis of population structure in Canadian polar bears. *Mol. Ecology* **4**: 347–354.

PEMBERTON, J. M., SLATE, J., BANCROFT, D. R. & BARRET, A. (1995) Nonamplifying alleles at microsatellite loci: a caution for parentage and population studies. *Mol. Ecology* **4**: 249–252.

RAKONCZAY, Z. (ed.) (1989) *Vörös Könyv. A Magyarországon kipusztult és veszélyeztetett növény- és állatfajok.* (Hungarian Red Data Book) 2nd ed., Akadémiai Kiadó, Budapest [in Hungarian]

STACY, J. E., REFSETH, U. H., THORESEN, M., IMS, R. A., STENSETH, N. C. & JAKOBSEN, K. S. (1994) Genetic variability among root voles (Microtus oeconomus) from different geographic regions: populations can be distinguished by DNA fingerprinting. *Biol. J. Linnean Soc.* **52**: 273–286.

SOULE, M. (ed.) (1987) *Viable Populations for Conservation.* Cambridge Univ. Press, Cambridge, 206 pp.

TAMARIN, R. & KREBS, C. (1969) Microtus population biology II. Genetic changes at the transferrin locus in fluctuating populations of two vole species. *Evolution* **2**: 183–211.

TAST, J. (1982) Microtus oeconomus Nordische Wühlmaus, Sumpfmaus. Pp. 374–396. *In* NIETHAMMER, J. & F. KRAPP (eds): *Handbuch der Saugetiere Europas. Rodentia.*

TOPÁL, GY. (1963) Újabb adatok a Microtus oeconomus méhelyi magyarországi előfordulásához, és a Tisza menti (Sasér) előfordulás cáfolata. *Vertebrata Hungarica* **1–2**: 159–165.

Revised version received 14th August, 2000, accepted 21st August, 2000,
published 21st September, 2000

ACTA ZOOLOGICA ACADEMIAE SCIENTIARUM HUNGARICAE

An international journal of animal taxonomy and ecology

Instruction to authors

Submission of a paper implies that it has not been published previously, that is not under consideration for publication elsewhere, and that if accepted for the Acta Zoologica Hungarica, the authors will transfer copyright to the Hungarian Academy of Sciences/the Hungarian Natural History Museum as is customary. Articles and illustrations become the property of the HAS/HNHM.

Papers must be in English with British spelling, and be original contributions in the field of animal taxonomy, systematics, zoogeography and ecology. All manuscripts must be submitted to one of the editors (editor, assistant editor).

Entire manuscripts must be submitted on IBM compatible floppy disk and in duplicate printed copies and the author should retain a copy. In the case of multiple authors, the corresponding author should be indicated. Series of numbered papers will not be considered.

Manuscripts must be printed with double spacing (including the reference list), and with wide margins (30–35 mm) on the left side of the paper only. Authors are requested to keep their communications as concise as possible. Footnotes should be avoided or minimized, and italics should not be used for emphasis. A running head of not more than 30 letters should be supplied.

The manuscript should contain the following information:

Title should be followed by the name and full address of the author(s). Where possible, the fax and/or e-mail number of the corresponding author should be supplied with the manuscript, for use by the publisher.

Abstract should be a brief summary of the contents and conclusions of the paper, and should not be longer than 200 words and should not contain references.

Key words should not be more than five (exceptionally 6) key word entries.

Introduction should contain a brief survey of the relevant literature and the reasons for doing the work.

Materials and Methods supply sufficient information to permit repetition of the experimental or field work. The technical description of methods should be given only when such methods are new.

Results should be presented concisely. Only in exceptional cases will it be permissible to present the same set of results in both table and a figure. The results section should not be used for discussion.

Discussion should be separate from the results section and should deal with the significance of the results and their relationship to the object of the work (and, this is the place of the identification key in taxonomic revisions).

Acknowledgements (at most in 10 lines).

References. In principle the Harvard system is to be followed. References should be detailed in the following order: authors' names and initials, date of publication (in parentheses), the title of the article, the name of the journal as abbreviated in the World List of Scientific Periodicals (4th edn 1963), the volume, and the first and last pages of the article, e.g.

NORRBOM, A. L. and KIM, K. C. (1985) Taxonomy and phylogenetic relationships of Copromyza Fallén (s.s.) (Diptera: Sphaeroceridae). *Ann. Entomol. Soc. Am.* **78**: 331–347.

For books the author's names, date of publication, title, edition, page reference, publisher's name and the place of publication should be given, e.g.

HINTON, H. E. (1981) *Biology of insect eggs*, vol. 2. Pergamon Press, New York, 234 pp.

or

MCALPINE, J. F. (1981) Morphology and terminology, adults. Pp. 9–63. *In* MCALPINE *et al.* (eds) *Manual of Nearctic Diptera*, vol. 1. Agriculture Canada, Ottawa.

In the text references should be given as MARSHALL (1992) or (MARSHALL 1992). When a citation includes more than two authors, e.g. GREY, BLACK and WHITE, the paper should be referred to in the text as GREY *et al.*, provided that this not ambiguous. If papers by the same author(s) in the same year are cited, they should be distinguished by the letters, *a, b, c,* etc., e.g. MARSHALL (1992*a*).

References to papers "in press" must mean that the article has been accepted for publication. References to "personal communications" and unpublished work are permitted in the text only: references to papers in preparation or submitted are not permissible.

All necessary **illustrations** should accompany the manuscript, but should not be inserted in the text. All photographs, graphs and diagrams should be numbered consecutively in Arabic numerals in the order in which they are referred to in the text. Glossy photographs or positive prints should be sent unmounted wherever possible and should be kept to a minimum. Figures should be of good quality. Explanation of lettering and symbols should be given in the figure caption and only exceptionally in the figures. Lettering and symbols to appear on the illustration should be of sufficient size to allow for considerable reduction where necessary (usually proper for a 50% reduction in size). Scales must be indicated on micrographs, not by magnifications in the legends. Figure size must not exceed 24×30 cm. On the back of each illustration should be indicated the author's name, the figure number (in Arabic numerals), and the top of the illustration, where this is not clear. Halftones should be included only when they are essential. Details and quotation of publication of colour plates should be made to the editors. The following symbols should be used on line drawing: ● ■ ❍ ❑ ▲ ◆ ♦ etc.

Legends to figures should be typed on a separate sheet. They should give sufficient data to make the illustration comprehensible without reference to the text.

Tables and appendices should be constructed so as to be intelligible without reference to the text, numbered in Arabic numerals and typed on separate sheets. Every table should be provided with an explanatory caption and each column should carry an appropriate heading. Units of measure should always be indicated clearly (metric units are preferred). All tables and figures must be referred to in the text.

Only standard **abbreviations** should be used. Arbitrary abbreviations and jargon will not be accepted.

The Latin names should be given for all species used in the investigation, although taxonomic affiliation and authority need not be provided in the title.

Page proofs will be sent to the author (or the first-mentioned author in a paper of multiple authorship) for checking. Corrections to the proofs must be restricted to printers' errors. Any substantial alterations other than these may be charged to the author. Authors are particularly requested to return their corrected proofs as quickly as possible in order to facilitate rapid publication. Please note that authors are urged to check their proofs carefully before return, since late corrections cannot be guaranteed for inclusion in the printed journal.

Fifty reprints free of charge will be sent to the first author; extra copies of the issue (at a specially reduced rate) can be ordered on the form which will accompany the proofs. These should be returned to: The Editorial Office of the Acta Zoologica, Hungarian Natural History Museum, Budapest, Baross u. 13, H–1088, Hungary

The **page charge** required from authors outside Hungary is USD 15 per printed page. In exceptional cases, the page charge may be waived. Please contact the editor in before submitting a paper if you ask for a waiver. Authors of papers exceeding 16 printed pages are asked to pay USD 40 (or HUF equivalent) for each such page, i.e. all costs of publication (irrespective of their nationality).

FOR FURTHER INFORMATION PLEASE CONTACT US
The Editorial Office of the Acta Zoologica
H–1088 Budapest, Baross u. 13, Hungary
Fax: (36–1) 3171669
http://actazool.nhmus.hu/
E-mail: perego@zoo.zoo.nhmus.hu

SUBSCRIPTION INFORMATION

Orders should be addressed to

Editorial Office of the Acta Zoologica
Hungarian Natural History Museum
H–1088 Budapest, Baross u. 13, Hungary
Fax: (36–1) 3171669
E-mail: perego@zoo.zoo.nhmus.hu

Typeset: Pars Ltd., Budapest.
Printed by Mondat Ltd., Hungary

CONTENTS

HU ISSN 1217–8837

Acta Zoologica

Academiae Scientiarum Hungaricae

VOLUME 46 - NUMBER 4 - 2000

HUNGARIAN NATURAL HISTORY MUSEUM, BUDAPEST

ACTA ZOOLOGICA ACADEMIAE SCIENTIARUM HUNGARICAE

AN INTERNATIONAL JOURNAL OF ANIMAL TAXONOMY AND ECOLOGY

Acta Zoologica Academiae Scientiarum Hungaricae is published quarterly from February 1994 (other issues in May, August and November) by the Hungarian Natural History Museum and the Biological Section of the Hungarian Academy of Sciences with the financial support of the Hungarian Academy of Sciences.

For detailed information (contents, journal status, instructions for authors, subscription, and from Volume 40 onward title, author, authors' addresses, abstract, keywords and a searchable taxon index) please visit our website at

http://actazool.nhmus.hu/

Acta Zoologica Academiae Scientiarum Hungaricae 46(4), pp. 265–274, 2000

THE RELATIVE IMPORTANCE OF EDAPHIC FACTORS ON THE DISTRIBUTION OF SOME TERRESTRIAL GASTROPOD SPECIES: AUTECOLOGICAL AND SYNECOLOGICAL APPROACHES

J. HERMIDA[1], M. P. ONDINA[1] and T. RODRIGUEZ[2]

[1]*Departamento de Bioloxía Animal. Facultade de Bioloxía. Universidade de Santiago 15706 Santiago de Compostela (A Coruña). Spain. E-mail: basec@usc.es*
[2]*Departamento de Bioloxía Animal. Facultade de Veterinaria. Universidade de Santiago Campus de Lugo (Lugo), Spain*

An autecological method (ecological profiles analysis) and a synecological method (canonical correspondence analysis) were used to investigate relationships between edaphic factors and the distribution of terrestrial gastropods in northwest Spain. Gastropods were sampled from 177 sites in this region. In general, the two methods of analysis yielded similar results. The results show the importance of the influence of soil texture (clay, coarse sand and gravel content), pH, calcium, magnesium, moisture, porosity, nitrogen and carbon on the distribution of terrestrial gastropod species in the studied area.

Key words: land snails, edaphic factors, autecology, synecology

INTRODUCTION

BRUIJINS *et al.* (1959) stated that, apart from climate, the most important factors governing the distribution of terrestrial gastropods are edaphic factors. The influence of edaphic factors on the distribution of terrestrial gastropods is well documented. Several authors discussed the relationship between environmental characteristics – edaphic factors (pH, soil moisture, calcium, soil texture, etc.) and biotope types – and the distribution of gastropods (ATKINS & LEBOUR 1923, BOYCOTT 1934, SOUTH 1992, OUTEIRO *et al.* 1993, ONDINA *et al.* 1995). Magnesium and, principally, calcium storage compartments in slugs and snails include the shell, the calcium cells in the digestive glands, the integument and the connective tissue; so these elements are very important for the growth of the shell and other physiological processes (SOUTH 1992). The soil texture (gravel, porosity, clay, sand, silt, etc.) is also important in determining the distribution of gastropods distribution because gastropods have limited capacity for burrowing into the soil where it lays its eggs or seeks refuge (BOYCOTT 1934). With respect to the humidity, snails and principally slugs are restricted in their habitats by the need to avoid desiccation; consecuently they are more active at night or in wet weather. On the other hand, the association of snail-faunas, characterised by high abundance and diversity, with alkaline or acid soils is well known (ATKINS & LEBOUR 1923, BOYCOTT 1934).

Various statistical methods are available for investigating relationships between edaphic factors and species distributions within a given area. Some of those methods are based on an autecological approach (i.e., independent analysis of the distribution of each species), and others on a synecological approach (i.e., analysis of the effects of each factor on the distribution of the species set).

In the work reported here, we investigated the influence of edaphic factors on the distribution of terrestrial gastropods in northwest Spain, and compared the results obtained using an autecological approach (ecological profiles analysis), described by DAGET and GODRON (1982), and a synecological approach (canonical correspondence analysis). The development of synecological methods is linked to multivariate statistical analysis. These analyses have been greatly improved in recent years, with the introduction of techniques specifically designed for ecology, one of which is canonical correspondence analysis (TER BRAAK 1986).

MATERIAL AND METHODS

Terrestrial gastropods were sampled at 177 sites in the Provinces of Asturias, León, Zamora and Salamanca in northwest Spain. Terrestrial gastropods were sampled in 59 areas of this region by wet sieving (WILLIAMSON 1959) of the top 5 cm of litter and soil from an area of 0.5 m^2. At each site, soil samples were also collected, for subsequent determination of 20 physical and chemical properties (as described by GUITIÁN & CARBALLAS 1976): soil moisture, porosity, aeration, gravel, coarse sand, fine sand, coarse silt, fine silt, clay, carbon, nitrogen, carbon/nitrogen ratio, sodium, potassium, calcium, magnesium, aluminium, pH of soil in water, pH of soil in KCl and pH of litter in water.

Species/site data were analysed by canonical correspondence analysis (CCA) and ecological profiles analysis. A synecological study allowed us to investigate the relationships between environmental factors and the distribution of species groups, and conversely aid identification of species groups with similar distributions in environmental hyperspace (TER BRAAK 1986). The data were analysed by CCA (in CANOCO version 3.1; TER BRAAK 1988), with Monte Carlo testing to evaluate the statistical significance of the outcome.

An autoecological study allows us to analyze each species´ individual response in order to detect their preferences for specific intervals of the factors measured. The most appropriate technique for this is ecological profiles analysis. Ecological profiles have greater power of discrimination, which makes it possible to see the species´ preferences for either low, average or high values of a factor, as well as indifference to a particular factor. Class intervals were determined in terms of inflection points on the curve of accumulated frequencies (DAGET & GODRON 1982); therefore we have obtained a similar number of samples in each class. Corrected frequencies (C(K)) were calculated for the different snail species as follows:

$$C(K) = \frac{\dfrac{U(K)}{R(K)}}{\dfrac{U(E)}{NR}}$$

where U(K)=occurrences of species E in factor class K, U(E)= total number of occurrences of species E, R(K)= number of samples for factor class K and NR=total number of samples. Chi^2-tests were carried out to determine whether the observed profile distributions in relation to factors deviated significantly from uniformity.

RESULTS

A total of 73 species were identified in our samples. The morphology of the shell and genital system were the characters used for the diagnosis of the gastropods. For determining specimens all the available literature has been reviewed and considered. In what follows, we consider only those species present in at least 10% of samples, namely *Arion intermedius* NORMAND, 1852, *Acanthinula aculeata* (MÜLLER, 1774), *Cochlicopa lubrica* (MÜLLER, 1774), *Aegopinella nitidula* (DRAPARNAUD, 1805), *Nesovitrea hammonis* (STRÖM, 1765), *Punctum pygmaeum* (DRAPARNAUD, 1801), *Toltecia pusilla* (LOWE, 1831), *Vitrina pellucida* (MÜLLER, 1774), *Vallonia pulchella* (MÜLLER, 1774) and *Vitrea contracta* (WESTERLUND, 1871).

The biplot of species and soil factors produced by CCA is shown in Table 1. The first two axes explain 59,5% of total variance in the data. Monte Carlo permutation testing (as per HOPE 1968, in TER BRAAK 1988) of the outcome of CCA indicate that axis I is significant at the 99% level (F ratio= 13.03; $p<0.01$) and axis two at the 95% level (F ratio= 6.19; $p< 0.05$); axis III was not significant. Interset correlation coefficients are listed in Table 1: the factors that are most closely correlated with axis I are Mg, Ca, pH, C, N, gravel and clay content, moisture and porosity; the factors that are most closely correlated with axis II are gravel and coarse sand content.

On the basis of the ordination plot in figure 1 we observed that *Cochlicopa lubrica* and *Nesovitrea hammonis* show preferences for high clay content, moisture, porosity, C and N, and low coarse sand content; Toltecia pusilla shows preferences for high calcium, magnesium, pH and coarse sand content, and low C, N, porosity, moisture and clay content; Vallonia pulchella exhibits preference for high values of Ca, Mg and pH, and low gravel content; *Punctum pygmaeum*, *Acanthinula aculeata* and *Aegopinella nitidula* show preference for high gravel content, and low Ca, Mg, and pH values; *Vitrina pellucida* has got preference for high

Table 1. Interset coefficients of correlation between edaphic factor values and sample scores on the first two axes extracted by canonical correspondence analysis of the ten species data set. HUM = soil moisture (% w/w), POR = porosity (% v/v), AIR = aeration (% v/v), MM2 = gravel (% w/w), GRU = coarse sand (% w/w), FIN = fine sand (% w/w), LIG = coarse silt (% w/w), LIF = fine silt (% w/w), ARC = clay (% w/w), C = carbon (% w/w), N = nitrogen (% w/w), C/N = carbon/nitrogen ratio, Na = sodium (meq per 100 g), K = potassium (meq per 100 g), Ca = calcium (meq per 100 g), Na = magnesium (meq per 100 g), Al = aluminium (meq per 100 g), pHH = pH of soil in water, pHK = pH of soil in KCl, pHV = pH of litter in water.

	AXIS I	AXIS II
Mg	0.446	–0.081
PHH	0.425	–0.128
PHV	0.393	–0.043
PHK	0.363	–0.173
Ca	0.362	–0.180
GRU	0.152	0.287
LIF	0.117	–0.156
C/N	0.102	0.192
AIR	0.091	0.221
K	0.077	0.221
FIN	0.047	0.066
LIG	–0.061	–0.234
Na	–0.162	–0.115
Al	–0.162	0.197
MM2	–0.363	0.278
ARC	–0.373	–0.189
POR	–0.399	–0.031
C	–0.410	–0.038
N	–0.442	–0.155
HUM	–0.483	–0.177

coarse sand content, and *Arion intermedius* and *Vitrea contracta*, located close to the origin, not show clear preferences for any factor.

Figure 2 shows those ecological profiles that differ significantly ($p<0.05$) from uniform; class intervals for each factor are given in Table 2 (five classes were established). This approach indicates that *Cochlicopa lubrica* shows a preference for medium-high moisture content (27.1–80.0%), clay content (11.6–55.0%) and N (0.23–1.4%) and medium C (2.6–4.5%); *Nesovitrea hammonis* shows a preference for high values of moisture (33.6–80.0%), N (0.46–1.4%) and C (3.3–14.0%) and medium-high of clay content (11.6–55.0%) and porosity (67.1–97.0%); *Acanthinula aculeata* shows a preference for medium-high values for gravel content (6.1–78.0%) and medium-high values of N (0.23–1.4%) and C (2.6–14%);

Table 2. Classes and intervals for each edaphic factor. 1–4 and 5: class intervals (low and high limit of each class), and (N): number of samples in each class for each edaphic factor considered, as defined for ecological profiles analysis. (See Table 1 for key to abbreviations.)

	Class				
Factor	1 (N)	2 (N)	3 (N)	4 (N)	5 (N)
HUM	6.0–19.5 (39)	19.6–27.0 (40)	27.1–33.5 (42)	33.6–42.8 (32)	42.9–80.0 (24)
POR	37.0–55.9 (22)	56.0–67.0 (44)	67.1–72.5 (34)	72.6–81.0 (45)	81.1–97.0 (32)
GRU	1.0–9.0 (31)	9.1–21.0 (44)	21.1–36.0 (40)	36.1–47.0 (34)	47.1–84.0 (28)
ARC	0.0–7.0 (31)	7.1–11.5 (43)	11.6–16.5 (41)	16.6–23.0 (34)	23.1–55.0 (28)
C	0.0–1.56 (32)	1.57–2.5 (41)	2.6–3.25 (34)	3.26–4.5 (35)	4.6–14.0 (35)
N	0.0–0.13 (33)	0.14–0.22 (43)	0.23–0.3 (38)	0.4–0.45 (38)	0.46–1.4 (25)
Ca	0.0–3.0 (31)	3.1–6.5 (43)	6.60–11.0 (32)	11.1–18.5 (38)	18.6–50.0 (33)
Mg	0.0–0.7 (28)	0.8–1.5 (37)	1.6–2.5(45)	2.6–5.5 (44)	5.6–20.0 (23)
MM2	0.0–1.8 (34)	1.9–6.0 (42)	6.1–15.5 (40)	15.6–31.0 (34)	31.1–78.0 (27)
PHH	3.0–4.8 (31)	4.9–5.5 (39)	5.6–6.5 (39)	6.6–7.5 (37)	7.6–9.0 (31)
PhK	2.0–4.3 (37)	4.4–5.0 (37)	5.1–6.1 (38)	6.2–7.0 (34)	7.1–9.0 (31)
PHV	3.0–4.8 (37)	4.9–5.6 (42)	5.7–6.6 (39)	6.7–7.4 (34)	7.5–9.0 (29)

Aegopinella nitidula shows a preference for medium-high values for gravel content (6.1–78.0%), medium-low values for Mg (0.0–2.5 meq/100 g) and low pHH (4.8–5.5); *Punctum pygmaeum* shows a preference for high values of gravel content (15.6–78%) and medium-high values of N (0.23–1.4%) and C (2.6–14%); *Toltecia pusilla* shows a preference for high values of Mg (5.6–20 meq/100 g), Ca (11.1–50.0) and coarse sand (47.1–84.0%) and low values of clay (0.57–16.5%), moisture (6.27–33.5%), C (0.12–2.5%), porosity (37–67%), and gravel content (0-6.0 %); *Vallonia pulchella* shows a preference for medium-high values of Ca (6.6–50.0 meq/100 g), pHV (4.8–8.9) and pHH (5.5–8.6) and high values of Mg (2.6–20.0 meq/100 g); *Vitrea contracta* shows significant preferences for medium-high clay content (11.5–55.0%) and N (0.23–1.4%) and low values of coarse sand content (1.0–21.0%); *Arion intermedius* and *Vitrina pellucina* do not show preferences with respect to any of the factors considered.

DISCUSSION

Ecological profiles is an autoecological method, which allow us to determine which edaphic factors are probably more important for each species; also it is possible to determine the species' preference for mean values of the factor and indicates the intervals of the factor values in which the species is present (Fig. 2). The adventage of canonical correspondence is that it shows us, with only one graph, the behaviour of the community in terms of the factors measured; it also allows us to establish associations of species having similar behaviour with the total group of factors, for example *C. lubrica* and *N. hammonis* or *P. pygmaeum, A. aculeata* and *A. nitidula* (Fig. 1) (OUTEIRO *et al.* 1993) Therefore the two techniques are complementary and the use of the two together will provide information on both the community as a whole and on each individual species.

Direct comparison of our results with those of related previous studies is difficult, partly because the studied species occur in a wide range of community types, and partly because a number of relevant edaphic factors (particularly texture factors) have received very little attention to date. The only previous study that simultaneously used CCA and ecological profiles analysis is that of OUTEIRO *et al.* (1993). These authors likewise obtained similar results with the two techniques,

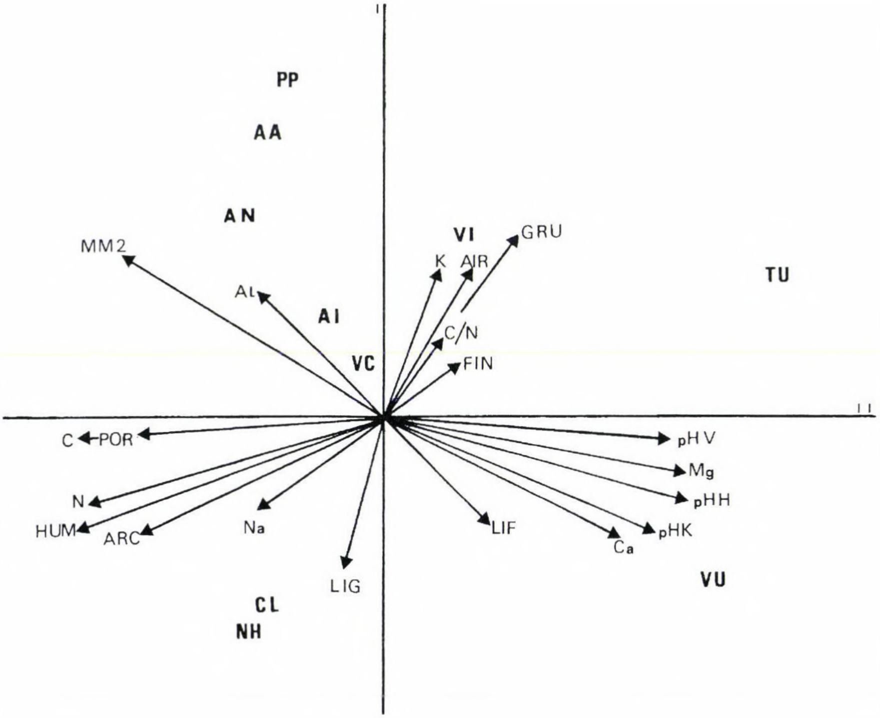


Fig. 1. Plot of species and factor weightings on the first two axes extracted by canonical correspondence. CL (*C. lubrica*), NH (*N. hammonis*), TU (*T. pusilla*), VU (*V. pulchella*), PP (*P. pygmaeum*), AA (*A. aculeata*), AN (*A. nitidula*), AI (*A. intermedius*), VC (*V. contracta*) and VI (*V. pellucida*). (See Table 1 for key to abbreviations.)

and concluded that soil texture and litter pH are the most important edaphic factors affecting the distribution of terrestrial gastropods. The results of the present study indicate that, in addition to these three factors, humidity, C, N, Ca and Mg content are also important. ONDINA *et al.* (1995), in a study about relationships of terrestrial gastropods and soil factors, comment that the factors that explain better species distribution are: moisture, Ca, Mg, Al and factors related with the soil texture.

Although the results of CCA (Fig. 1) indicate that *V. contracta* doesn't show clear preferences for any factor (probably its distribution may be affected by the soil factors loading heavily on axes I and II but in a bimodal or multimodal fashion not revealed by the ordination) while ecological profiles (Fig. 2) suggests that this species show preference for certain soil texture charateristics (low contente of coarse sand and medium-high clay and nitrogen content). RIBALLO (1990) reported that *V. contracta* occurs in soils with high clay, nitrogen and silt content and low coarse sand content.

The ordination of the other nine species, according to their preferences for high or low values of a factor, are similar in both analysis. Ecological profiles and CCA show similar results for *C. lubrica* and *N. hammonis* (preference for soils with high values of carbon, nitrogen, moisture, and clay). *C. lubrica* is considered by several authors as a typical species of wet places (WÄREBORN 1969, CAMERON 1978, MARQUET 1983); besides shows preferences for high values of pH and calcium (WÄREBORN 1969). ONDINA *et al.* (1992) considered this species as typical of moist and wet meadows, with high values of clay, slime, calcium and pH. *N. hammonis* is considered a species bound to moist places with low values of gravel content and coarse sand, and high values of clay and porosity (RIBALLO 1990). On the other hand, we found *C. lubrica* and *N. hammonis* typical of soils with low values of C/N ratio (like ONDINA *et al.* 1992) and high values of nitrogen. This results indicate that these species prefer mull soils; such soils typically have well-developed humus and are rich in hydrosoluble organic compounds which are readily assimilated by soil-dwelling organisms.

P. pygmaeum is considered by several authors as a species tolerant to acid soils and typical of moist woodland (PAUL 1978, MARQUET 1983). OUTEIRO *et al.* (1989) found this species in soils with medium–high values of gravel, C, N and porosity. RIBALLO *et al.* (1985) and SOLHÖY (1981) found *A. nitidula* in soils with low pH values. RIBALLO (1990) found this species in soils with low values of magnesium and medium values of gravel (13–24.4%) and clay (12.5–19.9%). *A. aculeata* is considered typical of wet places with preferences for acid soils (OUTEIRO 1988, RIBALLO *et al.* 1985). OUTEIRO (1988) found this species in soils of coarse texture and with high nitrogen and calciun values. We have found these species in soils with high values of gravel content, it suggests that the limited ca-

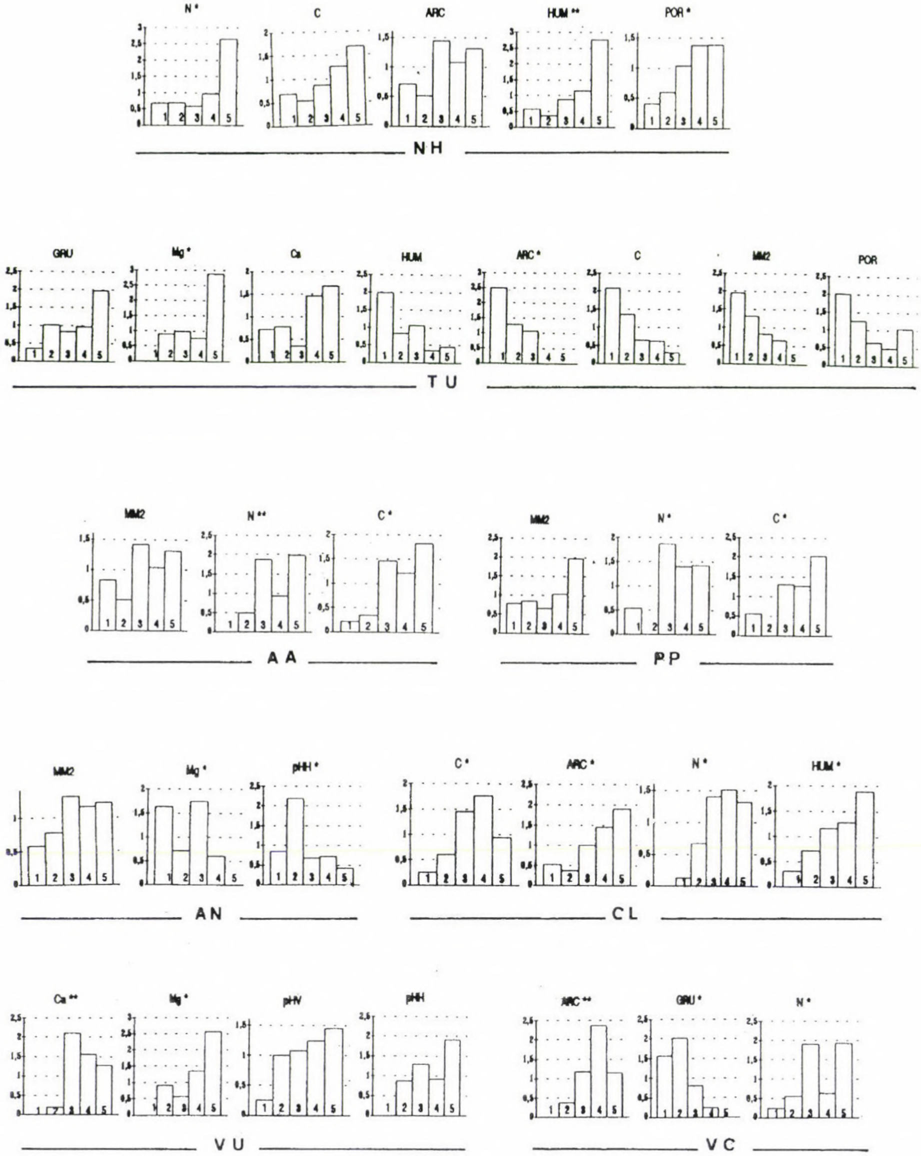


Fig. 2. Ecological profiles for those factors to which at least one species showed a significantly non-uniform distribution. Class intervals and factor codes are listed in table II. Species codes are listed in the Figure 2. Profile values of 1 indicate uniform distribution; values greater than 1 indicate preference. * = $p < 0.05$, ** = $p < 0.001$ (differences with respect to uniform profile).

pacity of displacement of these species is helped for coarse sand texture. In this kind of soils, the smaller sized species can burrow easier in order to lay eggs or to seek refuge.

V. pulchella is a common species of moist places, typical of meadows (MEIER 1987, CAMERON 1978).We found concordance in the results of both analysis; this species appears in soils with high values of pH, magnesium and calcium. OUTEIRO (1988) found *T. pusilla*, principally, in meadows with high calcium values and medium-high pH of litter values (5.6–8.9), besides our results show that this species appear in soils whit high values of magnesium and coarse sand content and low values of moisture, clay, carbon and porosity content.

The fact that *A. intermedius* and *V. pellucida* were plotted close to the origin of the 10 species CCA ordination (Fig. 1) indicates that their distribution is affected by edaphic factors, which were not recorded or which do not load heavily on axes I and II. But these species don't show preferences with respect to any factors considered in ecological profiles suggesting that the distribution of *A. intermedius* and *V. pellucida* within the study area may be genuinely independent of soil factors considered here. We have found *A. intermedius* and *V. pellucida* in almost all samples. This is in accordance with previous reports of these species' very wide habitat range (SOLHÖY 1981, MARQUET 1983, MEIER 1987).

In conclussion, the two techniques used here are complementary and the use of the two together will provide information on both the community as a whole and on each individual species. On the other hand, the results refer exclusively to the study area, as the intervals of the factor values may change in other locations, thereby affecting the species differently.

REFERENCES

ATKINS W. R. G & LEBOUR M. V. (1923) The hydrogen ion concentration of the soil and natural water in relation to the distribution of snails. *Scientific Proceedings, Royal Dublin Society* **17**: 234–240.

BOYCOTT, A. E. (1934) The habitat of land Mollusca in Britain. *J. Ecol.* **12**: 1–38.

BRUIJINS, M. F. M., ALTENA, C. O. R. & BUTOT, L. J. M. (1959) The Netherlands as an environment for land Mollusca. *Basteria* **23**: 132–162.

BRAAK, TER C. J. F. (1986) Canonical correspondence analysis: a new eigenvector technique for multivariate direct gradient analysis. *Ecology* **67**: 1167–1179.

BRAAK, TER C. J. F. (1988). *CANOCO – a Fortran program for canonical community ordination by (partial) (detrended) (canonical) correspondence analysis (ver. 2.1).* Agricultural Mathematics Group. Box 100, 6700 A.C. Wageningen. The Netherlands.

CAMERON, R. A. D. (1978) Terrestrial snail faunas of the Malham area. *Field Studies* **4:** 715–728.

DAGET, P. & GODRON, M. (1982) *Analyse fréquentielle de l`ecologie des espéces dans les communautés.* Ed. Masson, Paris.

GUITIÁN, F. & CARBALLAS, T. (1976) *Técnicas de análisis de suelo.* Ed. Pico Sacro, Santiago de Compostela (A Coruña, Spain).

MARQUET, R. (1983) An interesting molluscan fauna in Bevercé (Belgium), with notes on Acicula polita (Hartmann, 1840), new to the Belgian fauna (Mollusca: Gastropoda). *Annls Soc. Roy. Zool. Belgique* **1**: 81–86.

MEIER, T. (1987) Die landschnecken im Alpstein und seiner Umgebung. *Mitt. Deutsch. Malakozool. Ges.* **40**: 1–19.

ONDINA, P. OUTEIRO, A. & BRIONES, M. J. I. (1992) Some ecological aspects of terrestrial snail Cochlicopa lubrica. *Abstract 11th Intern. Malacol. Congr.* Siena, Italy, p. 470.

ONDINA, P. MATO, S. & HERMIDA, J. (1995) Relationships terrestrial gastropods and soil factors using Detrended Canonical Correspondence Analysis. *Abstract 12th Intern. Malacol. Congr.* pp. 225–226. Vigo, Spain.

OUTEIRO, A. (1988) *Gasterópodos de O Courel. Lugo.* Doctoral Thesis. University of Santiago de Compostela. Spain.

OUTEIRO, A., ONDINA, P., RODRÍGUEZ, T. & CASTILLEJO, J. (1989) Estudio autoecológico de Punctum (Punctum) pygmaeum (Draparnaud, 1801) (Gastropoda, Pulmonata) en la Sierra de O Courel (Lugo, España). *Revue d'Écol. Biologie du Sol* **26**(4): 515–525.

OUTEIRO, A., AGÜERA, D. & PAREJO, C. (1993) Use of ecological profiles and canonical correspondence analysis in a study of the relationship of terrestrial gastropods and environmental factors. *J. Conchology* **34**: 365–375.

PAUL, C. R. C. (1978) The ecology of Mollusca in ancient woodland. 2 Analysis of distribution and experiments in Haley Wood, Cambridgeshire. *J. Conchology* **29**: 281–294.

RIBALLO, M. I. (1990). *Gasterópodos terrestres de Rubio-Boqueixón Cernán-Rois (La Coruña).* Doctoral Thesis, University of Santiago de Compostela. Spain.

RIBALLO, M. I., DÍAZ COSÍN, D. J. & CASTILLEJO, J. (1985) Taxocenosis de microgasterópodos del Bosque de los Cabaniños (Sierra de Ancares, Lugo). *Trabajos Compostelanos de Biología* **12**: 99–119.

SOLHÖY, T. (1981) *Terrestrial invertebrates of the Faroe Island: IV. Slugs and snails (Gastropoda). Checklist, distribution and habitats.* Fauna Norvegica, Ser. A2: 14–24.

SOUTH, A. (1992) *Terrestrial slugs. Biology, ecology and control.* Chapman & Hall, London.

WÄREBORN, I. (1969) Land molluscs and their environments in an oligotrophic area in Southern Sweden. *Oikos* **20**: 461–479.

WILLIAMSON, M. H. (1959) The separation of molluscs from woodland leaf-litter. *J. Anim. Ecol.* **28:** 153–155.

Revised version received 3rd May, 2000, accepted 20th December, 2000, published 15th May, 2001

Acta Zoologica Academiae Scientiarum Hungaricae 46(4), pp. 275–290, 2000

EDGE EFFECT ON WEEVIL AND SPIDER COMMUNITIES AT THE BÜKK NATIONAL PARK IN HUNGARY

HORVÁTH, R.[1], MAGURA, T.[1,2], PÉTER, G.[3] and K. BAYAR[3]

[1]*Department of Zoology, Debrecen University, P. O. Box 3. H-4010 Hungary*
E-mail: magura@tigris.klte.hu
[2]*Hortobágy National Park Directorate, Debrecen, P. O. Box 216. H-4002 Hungary*
[3]*Department of Plant Protection, Gödöllő University of Agricultural Sciences, Gödöllő, H-2100 Hungary*

The edge effect on weevil and spider communities was tested along a meadow-forest transect using sweep-net samples at the Bükk National Park in Hungary. For weevil communities the species richness of the forest edge was higher than that of meadow, but the difference was statistically not significant. The species richness of the forest edge and the meadow was significantly higher than that of forest interior. The high species richness of the weevil communities in the forest edge may be explained by the high densities of the food-plants of weevil species and by the specific abiotic and biotic environmental factors that characterise the forest edge. For spider communities the species richness was significantly higher at the forest edge than either in the meadow or in the forest interior. The high species richness of the forest edge may be explained by the habitat heterogeneity that contributes to the special microclimatic and environmental conditions. Our results based on two invertebrate groups functioning on different trophic levels suggest that forest edge play a crucial role in the nature conservation.

Key words: forest edge, weevil communities, spider communities, species richness, nature conservation

INTRODUCTION

Recently, there is an increasing interest in studying transitional areas (like ecotones). Ecotone is a transition zone between plant associations. It may vary in nature and structure from abrupt discontinuities to broad and gentle gradients depending on the scale of observation. In a landscape its most striking and easily recognisable forms are the forest edges which occur as contact zones between forest stands and treeless areas. Forest edges are a type of ecotones, which are interpreted on the meso-spatial scale and on the community level (HOLLAND *et al.* 1991, MURCIA 1995). Nowadays, forest edges are in the focus of both ecological researches and conservation purposes, because progressive destruction and fragmentation of habitats have led to the increasing number of forest edges (SAUNDERS *et al.* 1991), whereas in other areas they have disappeared due to recent plantations or abandonment of adjacent agricultural areas. The ecological relationships that exist at the contact of different habitats form the edge effect hypothesis. This hypothesis states that species richness increases at the borders between different habitats (ODUM 1971).

Studies of edge effect on invertebrates usually are aimed only at one trophic level (MADER & MÜHLENBERG 1981, HEUBLEIN 1983, BAUER 1989, BLICK & BLISS 1991, BEDFORD & USHER 1994, ASTERAKI *et al.* 1995, DOWNIE *et al.* 1996, MAGURA & TÓTHMÉRÉSZ 1997, 1998). Sometimes species from different trophic levels are pooled in these studies (e.g. BÁLDI & KISBENEDEK 1994). Research including organisms functioning on different trophic levels is limited (e.g. HELLE & MUONA 1985). However, studies examining edge effect on animals functioning on different trophic levels are very important in order to explore whether forest edges have the same effect on them.

In the present paper we analysed the edge effect on two invertebrate taxonomic group, which operate at different trophic levels, however there is trophic relation between them. We studied the weevil communities (Coleoptera: Curculionoidea), as a phytophagous group, and spider communities (Araneae), as a predator group.

MATERIAL AND METHODS

Study area and sampling

The study was conducted in the southern part of the Bükk-Mountain, Hungary, near the village Noszvaj on the research area of 'Sikfőkút Project' (JAKUCS 1985). The 330–340 meter (a.s.l.) high hill between the settlements of Eger and Noszvaj morphologically belong to the foothills of the Bükk-Mountain (HEVESI 1985). The base rock of the area is limestone which is covered by black rendzina soil (PAPP 1985). The sampling points were located on the north-eastern part of the research area of 'Sikfőkút Project' where an oak forest (*Quercetum petraeae-cerris*) is connecting a meadow (*Calamagrostietum epigeii*). Samplings were carried out along a transect in each habitat. On the research area three habitats were studied:

(1) Oak forest (*Quercetum petraeae-cerris*). It is approximately 90 years old and was not managed by forestry in the past 40 years. In the tree layer of the forest the dominant species were *Quercus petraea* and *Quercus cerris*. In the shrub layer *Ligustrum vulgare*, *Euonymus europaeus*, *Euonymus verrucosus*, *Cornus sanguinea*, *Acer tataricum*, *Acer campestre* and *Cornus mas* were dominant. The herbaceous layer was also dense. The area of the forest is 60-70 ha.

(2) Forest edge of the oak forest (its width is approximately 10 meter). In the thick shrub layer the following species are frequent: *Acer tataricum*, *Cornus sanguinea*, *Euonymus verrucosus*, *Ligustrum vulgare*, *Cornus mas*, *Prunus spinosa*, *Crataegus oxyacantha*, *Viburnum lantana*, *Frangula alnus*, *Rubus idaeus*, *Carpinus betulus*, *Berberis vulgaris*. Saplings of tree species (*Quercus petraea* and *Quercus cerris*) were also found in the shrub layer. In the herbaceous layer species characteristic of the meadow prevail (*Calamagrostis epigeios*, *Agropyron repens*, *Agrostis sp.*, *Achillea millefolium*, *Calamintha clinopodium*, *Coronilla varia*, *Dactylis polygama*, *Fragaria vesca*, *Lithospermum purpureo-coeruleum*, *Linaria vulgaris*, *Melampyrum nemorosum*, *Plantago media*, *Pulmonaria mollis-*

sima, Origanum vulgare, Scabiosa ochroleuca, Stellaria holostea, Veronica chamaedrys) (MÉSZÁROS 1988).

(3) Meadow (*Calamagrostietum epigeii*) that developed on the deforested area of the oak forest. Earlier the clear-cut area was ploughed. But it has not been cultivated for 15 years. Frequent herbaceous species are the same as the ones mentioned above, at the forest edge. The area of the meadow is approximately 10 ha.

In the herbaceous layer from May to September three-weekly sweep-net samples were taken from the forest interior, the forest edge, and from the meadow along a transect running perpendicular to the forest edge. At each habitat the samples were taken in an area covered 10×10 meter. Each sample consisted of 50 sweeps. The distance of the sweeping area of the forest interior and the meadow were at least 50–70 meter from the forest edge. Sampling took place during the late morning hours in still, dry weather. The samples were taken in the same sweeping area of each habitat during the study year, therefore pooled samples were used for the numerical analysis.

Data analyses

To test edge effect on weevil and spider communities the species richness from the three habitats were compared with each other. The sample size of both the weevil and the spider assemblages differed in the three studied habitats. To correct the effect of the different sample size in comparing species richness, we estimated the number of species in subsamples of 70 individuals from each habitat using ES(m) diversity. The size of the subsamples is recommended to be the 80–90% of the smallest sample. In our study the smallest sample size was 80 individuals, therefore was calculated the ES(m) diversity for a subsample containing 70 individuals. ES(m) diversity is a statistical method for estimating the number of species expected in a random subsample drawn from a larger sample (HURLBERT 1971, SMITH & GRASSLE 1977, TÓTHMÉRÉSZ 1995). ES(m) diversity is defined as:

$$ES(m) = \sum_{i=1}^{S} \left\{ 1 - (1 - p_i)^m \right\}$$

where m is an integer and p_i is the relative abundance of the i-th species of the community.

The resulting value can be interpreted as a diversity index because the method take into account both species richness and relative abundances. ES(m) diversity is an accepted and reliable statistical method studying species richness of invertebrate communities with different sample size (e.g. NIEMELÄ *et al.* 1993). ES(m) diversity was calculated by the DivOrd program package (TÓTHMÉRÉSZ 1993*a*). Test of the differences in the ES(m) diversity was based on the normal approximations published by TONG (1983). Similarity of the species composition was calculated by Matusita similarity. The similarity structure was displayed by cluster analysis using the Ward-Orlóci fusion method. The similarity was calculated by the NuCoSA program package (TÓTHMÉRÉSZ 1993*b*).

RESULTS

During the study 70 weevil species (817 individuals) were collected (Appendix 1). In the forest edge we sampled *Omiamima mollina* (BOHEMAN, 1842), which species proved to be new for the Hungarian fauna. The following species occurred exclusively in the forest edge: *Stomodes gyrosicollis* BOHEMAN, 1843, *Omiamima mollina* (BOHEMAN, 1842), *Brachysomus villosulus* (GERMAR, 1824), *Lixus brevipes* CH. BRISOUT, 1866, *Rhynchaeus lonicerae* (HERBST, 1795), *Miarus distinctus* (BOHEMAN, 1845), *Brachytarsus nebulosus* (FORSTER, 1771), *Ceratapion gibbirostre* (GYLLENHAL, 1813), *Protapion nigritarse* (KIRBY, 1808), *Protapion fulvipes* (FOURCROY, 1785), *Oxystoma craccae* (LINNÉ, 1767), *Eutrichapion ervi* (KIRBY, 1808). *Pseudoperapion brevirostre* (HERBST, 1797) was the most abundant in the forest edge (Appendix 1).

We sampled 29 spider species and 14 taxa that can be identified only to genera level (Appendix 2). *Enoplognatha latimana* (HIPPA & OKSALA, 1982), *Theridion nigrovariegatum* SIMON, 1873, *Neriene chlalrata* (SUNDEVALL, 1830), *Tetragnatha* sp., *Cyclosa conica* (PALLAS, 1772), *Zilla dioida* (WALCKENAER, 1802) and *Philodromus longipalpis* SIMON, 1870 were sampled exclusively in the forest edge. *Gibbaranea bituberculata* (WALCKENAER, 1802) and *Heliophanus cupreus* (WALCKENAER, 1802) were the most abundant in the forest edge (Appendix 2).

The expected number of species (ES(70) diversity) of the weevil community of forest edge was the highest followed by the community of the meadow and the lowest was that of the forest interior (Fig. 1*a*). The ES(70) diversity (expected number of species in a random subsample of 70 individuals) of the weevils communities of forest edge and meadow were not different significantly, while the differences between these and the assemblage of the forest interior were significant (Hutcheson's t-test, df>120, p<0.05).

The ES(70) diversity of the spider community of forest edge was the highest followed by the assemblage of forest interior and the community of meadow (Fig. 1*b*). The expected number of species of the community of forest edge was significantly higher than that of the assemblages of forest interior and meadow (Hutcheson's t-test, df>120, p<0.05), whereas the other difference in the ES(70) diversity was not significant.

Composition of the weevil communities of the forest edge and the meadow were similar to each other, and the weevil assemblage of the forest interior differed considerably from the two above communities (Fig. 2*a*). The cluster analysis showed a different division for the spider data. Composition of the spider community of forest edge were more similar to the assemblage of forest interior than to the community of the meadow (Fig. 2*b*).

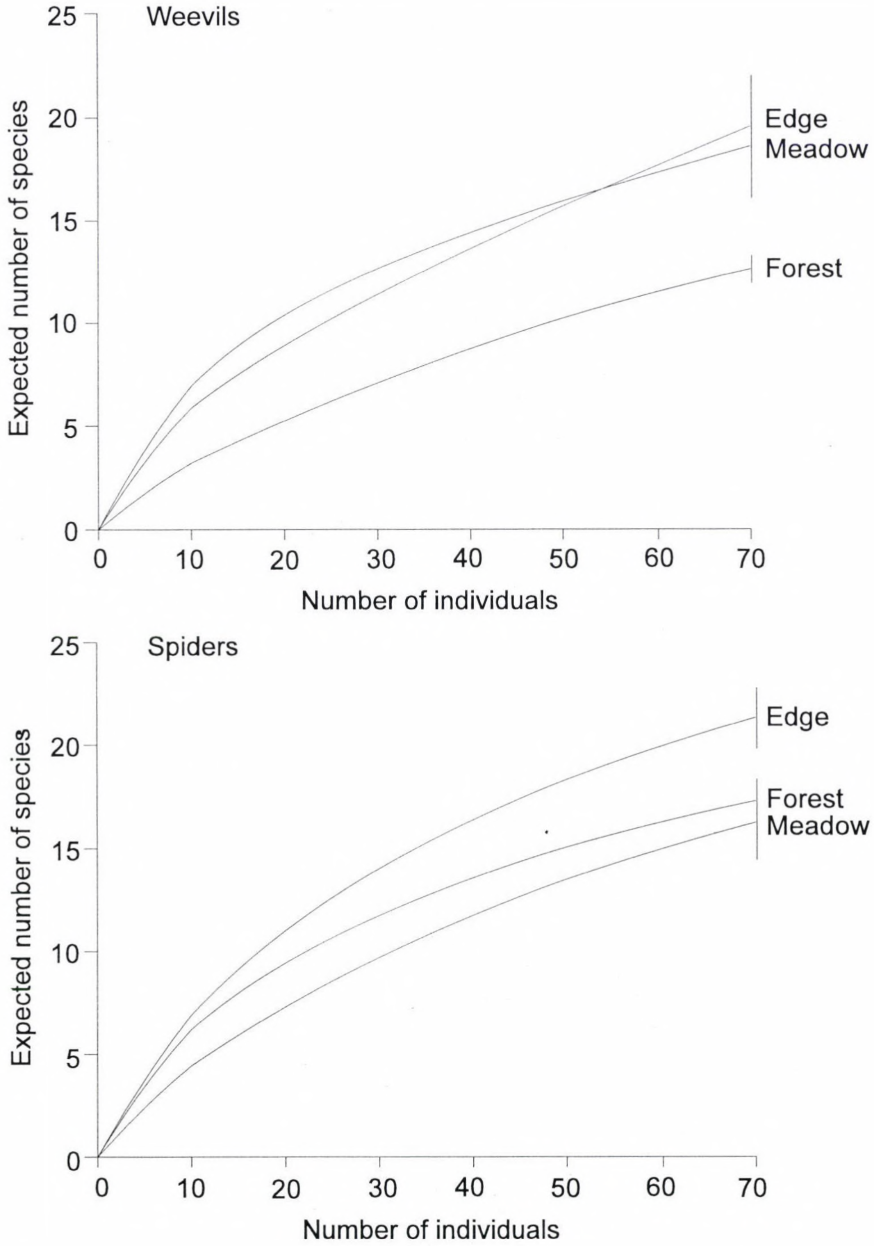


Fig. 1. Expected number of species estimated for 70 individuals (± S.D.) for the weevil and spider communities in the three habitats

DISCUSSION

Edge effect on weevils

Our study proved that the weevil community of forest edge was the most species rich. Although the species richness of weevil assemblage of the forest edge and the meadow did not differ significantly, these communities were significantly richer in species than the assemblage of forest interior. Therefore, it can be concluded that there is an edge effect on weevil communities in the studied area (Fig. 1*a*).

Previous studies pointed out that there is a positive correlation between the species richness of weevil community and the cover of herbs (WITKOWSKI 1978, BROWN & HYMAN 1986). With the increasing of the coverage of the herbs the spectrum of weevils' food-plants may also increase, thus more and more weevil species can find their food-plants (WITKOWSKI 1975). In the studied forest edge and the meadow the cover of herbs was the highest and the cover of herbs in these

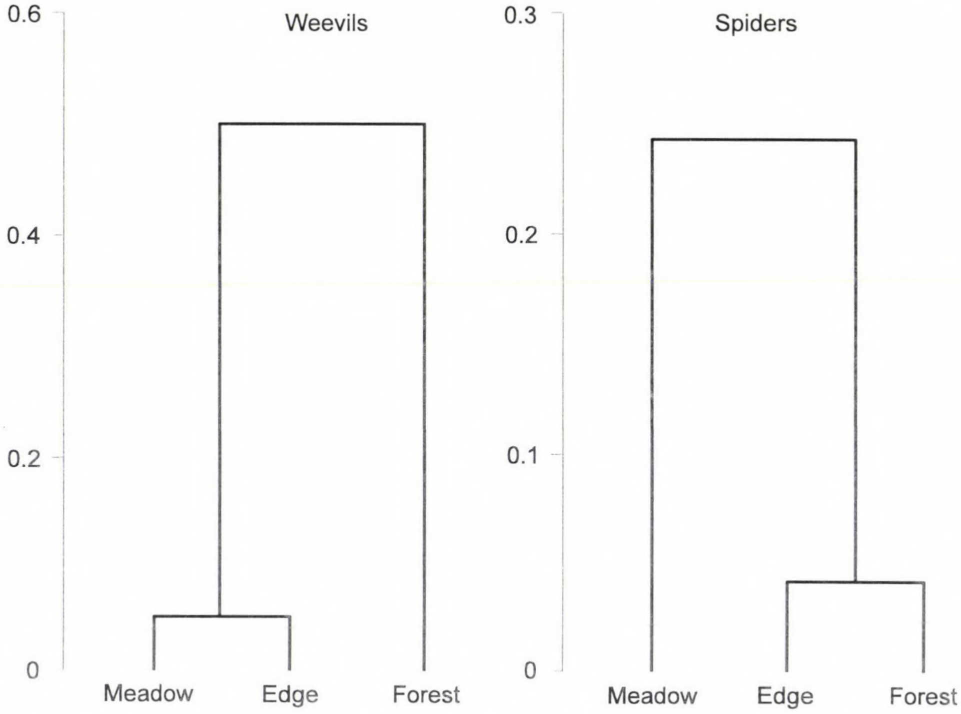


Fig. 2. Similarity structure of the studied weevil and spider communities by cluster analysis using the Matusita similarity index and the Ward-Orlóci fusion method

habitats was significantly higher than in the forest interior. It may explain the high species richness we observed at the forest edge and the meadow. For example *Phyllobius vespertinus* (FABRICIUS, 1792) occurred exclusively in the meadow and its food-plants (*Achillea*, *Dactylis* and *Fragaria* species) can be also found in large number in the meadow. In the forest edge the most frequent occurrence of *Otiorrhynchus fullo* (SCHRANK, 1781) can be explained with the abundant presence of its food-plants (e.g. *Prunus spinosa*, *Crataegus* sp.). As the food-plants (*Achillea* sp.) of *Eusomus ovulum* GERMAR, 1824 were frequent both in the meadow and in the forest edge, this weevil species was also captured in both habitats. With the decreasing of the canopy cover herbs typical of meadow can also penetrate into the forest edge and thus species composition of the herbaceous layer of the forest edge and the meadow become more similar (MÉSZÁROS 1988). Similarity of the species composition of herbaceous plants can explain both the higher similarity of weevil communities of the forest edge and the meadow (Fig. 2*a*) and the statistically not significant difference in species richness (Fig. 1*a*).

However, many polyphagous weevils (18.6 % of the sampled species and 47.2% of the species captured in the forest edge) occurred exclusively in the forest edge (Appendix 1). This fact cannot be explained by the presence of the food-plants but rather with the special abiotic (microclimate) and biotic environmental factors (e.g. competition, predation) that characterise the forest edge. Namely, proximity of two structurally dissimilar habitats (meadow and forest) results in special abiotic environmental conditions (e.g. air moisture, air temperature, light conditions, etc.) at the forest edge, which can also influence both the abundance, microsite preference, distribution of species and the species interactions, such as predation, competition, etc. (MURCIA 1995).

Edge effect on spiders

HEUBLEIN (1982, 1983), BLICK and BLISS (1991) and DOWNIE *et al.* (1996) studying spider communities of a forest and the adjacent grass, also reported that species richness was the highest in the forest edge. Our results also corroborate that there is a significant edge effect on the spider assemblages, that is the species richness is significantly higher in the forest edge than in the adjacent habitats (Fig. 1*b*).

Many previous works demonstrated that structural diversity of habitats and its derived changes in the abiotic environmental conditions are likely to be some of the most important factors structuring spider communities (MAELFAIT *et al.* 1990, BLICK 1995, LUCZAK & DABROWSKA-PROT 1995, BERGTHALER 1996). Greater structural diversity (heterogeneity) of habitat accompanied higher spider species richness (MÜHLENBERG *et al.* 1977, HATLEY & MACMAHON 1980, ROBINSON

1981). In the studied forest edge the leaf litter, the herbs and the shrubs contribute to the structural diversity and heterogeneity of the habitat. Moreover, habitat heterogeneity support the development of microhabitats, which also promote higher spider species richness. Increasing cover of the leaf litter, the herbs and the shrubs may support the presence of decomposers, phytophagous and predatory invertebrates available prey for spiders, which also increase spider species richness (RIECHERT 1976, WISE 1993).

At the studied spatial scale dispersal between adjacent habitats may also influence species richness. HEUBLEIN (1982) reported that by unfavourable environmental conditions (microclimate, food conditions, etc.) spiders migrate in habitat with favourable conditions. Furthermore, ontogeny of some spider species may undergo in different habitats. HEUBLEIN (1982) pointed out that juveniles of *Pisaura mirabilis* (CLERCK, 1757) are abundant in the open habitats, while adults in the forest edge and in the forest. This fact can explain the dominance of *Pisaura mirabilis* (CLERCK, 1757) both in the meadow and in the forest in our research (Appendix 2). VLIJM and KOSSLER-GESCHIESE (1967) reported that males of some spider species moved in the periphery of the habitat following copulation, in order to avoid cannibalism and intraspecific competition. The mentioned dispersal processes may also contribute the observed high species richness in the forest edge and perhaps the similarity of the spider communities of the forest and the forest edge (Fig. 2*b*) is due to these movements. DOWNIE *et al.* (1996) also reported that spider composition of forest edge was more similar to the forest interior than to the grass.

Implication for conservation

Our results are in accord with previous studies analysing edge effect on invertebrates (HEUBLEIN 1982, 1983, HELLE & MUONA 1985, BAUER 1989, DUELLI *et al.* 1990, BÁLDI & KISBENEDEK 1994, BEDFORD & USHER 1994, MAGURA & TÓTHMÉRÉSZ 1997, 1998) and revealed that there are significant edge effects on the studied phytophagous and predator invertebrate groups. Our results proved that forest edge have the same effect on the species richness of both of the studied invertebrate groups. It stresses that forest edges may have a crucial role in the maintaining of biodiversity, therefore their conservation is essential.

The high species richness observed in the forest edge is due to the presence of species characteristic of each of the adjacent habitats (meadow and forest interior) plus edge-associated species. Forest edge with specific abiotic and biotic environmental conditions may insure suitable feeding, hibernation and reproduction habitat for species (HEUBLEIN 1982, MURCIA 1995). It is recordable, that forest edges have viable invertebrates from the adjacent habitats. This indicates that forest edges are supposed to be "source" habitats (PULLIAM 1988) for small scale movements, contributing to recovery of species in the adjacent habitats destroyed for example through tillage, burning, logging and creating plantation ("sink" habitats, sensu PULLIAM 1988). Therefore forest edges encourage the regeneration and recovery of assemblages of adjacent disturbed habitats. This character of forest edges is also applied for nature management practices. For example in forests with poorly developed edges (e.g. plantation or managed forest) management schemes attempt to create a diverse edge vegetation by sowing or planting herbs and shrubs and by cutting marginal forest trees to reduce shading (KÖGEL et al. 1993, KRÜSI *et al.* 1996). Moreover, other management practices widen and shape the existing edge of forests (ANDERSON & CARTER 1987).

However, only a detailed study, based on ecological knowledge and analysing more trophic levels, would be able to determine the general management guidelines for conservation and maintenance of biological diversity.

*

Acknowledgements – The authors are thankful to Prof. Dr. ZOLTÁN VARGA for proposing the research problem and for his valuable suggestions. We are grateful to Dr. CSABA SZINETÁR for helping in the identification of the problematic spider species. Special thanks is to be given to Dr. LÁSZLÓ SZABÓ for his invaluable directions during sampling and identification period. The research was supported by the Pro Regione Fund and the Pro Renovanda Cultura Hungariae Fund.

REFERENCES

ANDERSON, M. A. & CARTER, C. I. (1987) Shaping ride sides to benefit wild plants and butterflies. *In* JARDINE D. C. (ed.): *Wildlife Management in Forests.* Institute of Chartered Forests, Lancaster, pp. 66–80.

ASTERAKI, E. J., HANKS, C. B. & CLEMENTS, R. O. (1995) The influence of different types of grassland field margin on carabid beetle (Coleoptera, Carabidae) communities. *Agriculture, Ecosystems and Environment* **54**: 195–202.

BÁLDI, A. & KISBENEDEK, T. (1994) Comparative analysis of edge effect on bird and beetle communities. *Acta zool. hung.* **40**: 1–14.

BAUER, L. J. (1989) Moorland beetle communities on limestone "habitat island". I. Isolation, invasion and local species diversity in carabids and staphylinids. *J. Anim. Ecol.* **58**: 1077–1098.

BEDFORD, S. E. & USHER, M. B. (1994) Distribution of arthropod species across the margins of farm woodlands. *Agriculture, Ecosystems and Environment* **48**: 295–305.

BERGTHALER, J. G. (1996) Preliminary results on the colonization of a newly planted hedgerow by epigeic spiders (Araneae) under the influence of adjacent cereal fields. *Revue suisse Zool.* **1**: 61–70.

BLICK, T. & BLISS, P. (1991) Spinnentiere und Laufkäfer am Waldrand (Arachnida: Araneae, Opiliones, Pseudoscorpiones; Insecta: Coleoptera: Carabidae). *Bull. Soc. neuchätel. Sci. nat.* **116**: 25–34.

BLICK, T. (1995) Initial spider succession at managed forest borders. *Proc. 15th Colloquium of Arachnology*. p. 207.

BROWN, V. K. & HYMAN, P. S. (1986) Successional communities of plants and phytophagous Coleoptera. *J. Ecol.* **74**: 963–975.

DOWNIE, I. S., COULSON, J. C., BUTTERFIELD, J. E. L. (1996) Distribution and dinamics of surface-dwelling spiders across a pasture-plantation ecotone. *Ecography* **19**: 29–40.

DUELLI, P., STUDER, M., MARCHAND, I. & JACOB, S. (1990) Population movements of arthropods between natural and cultivated areas. *Biol. Conserv.* **54**: 193–207.

HATLEY, C. L. & MACMAHON, J. A. (1980) Spider community organization: seasonal variation and the role of vegetation architecture. *Environ. Entomol.* **9**: 632–639.

HELLE, P. & MUONA, J. (1985) Invertebrate numbers in edges between clear-fellings and mature forests in northern Finland. *Silva Fennica* **19**: 281–294.

HEUBLEIN, D. (1982) *Die epigäische Spinnenfauna eines Wald – Wiesen – Ökotons Untersuchungen zum Randeffekt (edge effect).* Inaugural – Dissertation zur Erlangung der Doktorwürde der Fakultät für Biologie der Albert-Ludwigs-Universität Freiburg 1. Br.

HEUBLEIN, D. (1983) Räumliche Verteilung, Biotoppräferenzen und kleinräumige Wanderungen der epigäischen Spinnenfauna eines Wald-Wiesen-Ökotons; ein Breitag zum Thema "Randeffekt". *Zool. Jb. Syst.* **110**: 473–519.

HEVESI, A. (1985) Landscape description of the Bükkalja. *In* JAKUCS, P. (ed.): *Ecology of an oak forest in Hungary.* Akadémiai Kiadó, Budapest, p. 15.

HOLLAND, M. M., RISSER, P. G. & NAIMAN, R. J. (1991) *Ecotones. The role of landscape boundaries in the management and restoration of changing environments.* Chapman and Hall, London.

HURLBERT, S. H. (1971) The nonconcept of species diversity: a critique and alternative parameters. *Ecology* **52**: 57–586.

JAKUCS, P. (1985) *Ecology of an oak forest in Hungary – Results of "Síkfőkút Project" 1.* Akadémiai Kiadó, Budapest.

KÖGEL, K., ACHTZIGER, R., BLICK, T., GEYER, A., REIF, A. & RICHERT, E. (1993) Aufbau reichgegliederter Waldränder - ein E+E-Vorhaben. *Natur und Landschaft* **68**: 386–394.

KRÜSI, B. O., SCHÜTZ, M. & TODOW, S. (1996) Wie bringt man Vielfalt in den Waldrand? *Informationsblatt des Forschungsbereiches Landschaftsökologie WSL* **31**: 3–6.

LUCZAK, J. & DABROWSKA-PROT, E. (1995) Araneae communities and the functioning of prey-predator system (dipterans-spiders) in the devastated Karkonosze mountain forest. *Proc. 15th Colloquium of Arachnology*. pp. 116–124.

MADER, H. J. & MÜHLENBERG, M. (1981) Artenzusammensetzung und Ressourcenangebot einer kleinflächigen Habitatinsel, untersucht am Beispiel der Carabidenfauna. *Pedobiologia* **21**: 46–59.

MAELFAIT, J. P., SEGERS, H. & BAERT, L. (1990) A preliminary analysis of the forest floor spiders of Flanders (Belgium). *Bull. Soc. europ. Arachnol., hors série* **1**: 242–248.

MAGURA, T. & TÓTHMÉRÉSZ, B. (1997) Testing edge effect on carabid assemblages in an oak-hornbeam forest. *Acta zool. hung.* **43**: 303–312.

Magura, T. & TÓTHMÉRÉSZ, B. (1998) Edge effect on carabids in an oak-hornbeam forest at the Aggtelek National Park (Hungary). *Acta Phytopath. et Entom. Hung.* **33**: 363–371.

MÉSZÁROS, I. (1988) Strukturális és ökofiziológiai jellemzők másodlagos szegélyekben. [Structural and ecophysiological characteristics in a secunder forest edge.] Thesis, Debrecen.

MURCIA, C. (1995) Edge effects in fragmented forests: implications for conservation. *TREE* **10**: 58–62.

MÜHLENBERG, M., LEIPOLD, D., MADER, H. J. & STEINHAUER, B. (1977) Island ecology of Arthropods. I. Diversity, niches, and resources on some Seychelles Islands. *Oecologia* **29**: 117–134.

NIEMELÄ, J., LANGOR, D. & SPENCE, J. R. (1993) Effects of clear-cut harvesting on boreal ground-beetle assemblages (Coleoptera: Carabidae) in western Canada. *Conserv. Biol.* **7**: 551–561.

ODUM, E. P. (1971) *Fundamentals of ecology*. Saunders, Philadelphia, London, Toronto.

PAPP, S. (1985) Soils of Bükkalja. *In* Jakucs, P. (ed.): *Ecology of an oak forest in Hungary*. Akadémiai Kiadó, Budapest, pp. 16–17.

PULLIAM, H. R. (1988) Sources, sinks, and population regulation. *Am. Nat.* **132**: 652–661.

RIECHERT, S. E. (1976) Web-site selection in the desert spider Agelenopsis aperta. *Oikos* **27**: 311–315.

ROBINSON, J. V. (1981) The effect of architectural variation in habitats on a spider community: an experimental field study. *Ecology* **62**: 73–80.

SAUNDERS, D. A., HOBBS, R. J. & MARGULES, C. R. (1991) Biological consequences of ecosystem fragmentation: a review. *Conserv. Biol.* **5**: 18–32.

SMITH, W. & GRASSLE, F. J. (1977) Sampling properties of a family of diversity measures. *Biometrics* **33**: 283–292.

TÓTHMÉRÉSZ, B. (1993*a*) DivOrd 1.50. A Program for Diversity Ordering. *Tiscia* **27**: 33–44.

TÓTHMÉRÉSZ, B. (1993*b*) NuCoSA 1.0: Number Cruncher for Community Studies and other Ecological Applications. *Abstracta Botanica* **17**: 283–287.

TÓTHMÉRÉSZ, B. (1995) Comparison of different methods for diversity ordering. *J. Veget. Sci.* **6**: 283–290.

TONG, Y. L. (1983) Some distribution properties of the sample species-diversity indices and their applications. *Biometrics* **39**: 999–1008.

VLIJM, L. & KESSLER-GESCHIERE, A. M. (1967) The phenology and habitat of Pardosa monticola, P. nigriceps and P. pullata (Araneae, Lycosidae). *J. Anim. Ecol.* **36**: 31–56.

WISE, D. H. (1993) *Spiders in ecological webs*. Cambridge University Press, Cambridge, 328 pp.

WITKOWSKI, Z. (1975) The ecology and succession of weevils (Coleoptera: Curculionidae) on mowed meadows in the Zabrierzów area (Poland). *Studia Naturae A*. **12**: 1–81.

WITKOWSKI, Z. (1978) Correlates of stability and diversity in weevil communities. *Oecologia* **37**: 85–92.

Revised version received 17th March, 2000, accepted 20th December, 2000, published 15th May 2001

Appendix 1. Weevil species and individuals captured in the studied habitats

Species	Forest interior	Forest edge	Meadow
CURCULIONIDAE			
Otiorrhynchinae			
Omiamima mollina	0	1	0
Omias rotundatus	0	2	57
Otiorrhynchus fullo	2	15	0
Otiorrhynchus ligustici	0	0	1
Phyllobius vespertinus	0	0	31
Phyllobius argentatus	2	18	51
Phyllobius maculicornis	0	0	8
Phyllobius oblongus	0	24	29
Phyllobius pyri	0	27	100
Phyllobius scutellaris	0	0	1
Stomodes gyrosicollis	0	1	0
Trachypholeus spinimanus	0	0	1
Brachyderinae			
Brachysomus villosulus	0	1	0
Eusomus ovulum	0	43	44
Parafoucartia squamulata	2	10	11
Polydrusus tereticollis	0	1	0
Sitoninae			
Mesagroicus obscurus	2	5	15
Sitona lineatus	0	3	34
Sitona sulcifrons	0	3	62
Sitona suturalis	0	0	3
Tanymecinae			
Tanymecus palliatus	0	1	2
Cleoninae			
Larinus turbinatus	0	0	3
Lixus brevipes	0	1	0
Lixus elegantulus	0	0	4
Lixus filiformis	0	1	1
Rhynchophorinae			
Sphenophorus striatopunctatus	0	0	1
Ceutorhynchinae			
Amalus scortillum	0	1	5
Ceutorrhynchus erysimii	0	1	3
Ceutorrhynchus floralis	0	0	5
Glocianus moelleri	0	0	1

Appendix 1 (continued)

Species	Forest interior	Forest edge	Meadow
Rhinonchus castor	0	0	1
Sirocalodes nigrinus	0	0	1
Stenocarus ruficollis	0	0	2
Barinae			
Baris artemisiae	0	0	1
Baris coerulescens	0	0	2
Curculioninae			
Curculio elephas	0	1	0
Curculio pyrrhoceras	1	0	0
Acalyptinae			
Acalyptus carpini	0	0	1
Anthonominae			
Anthonimus rubi	0	1	0
Tychiinae			
Tychius flavus	0	1	1
Tychius breviusculus	0	0	2
Tychius junceus	0	0	2
Tychius quinquepunctatus	0	0	6
Erirhininae			
Notaris maerkeli	0	0	2
Smicronyx reichi	0	0	1
Rhynchaeninae			
Rhynchaenus quedenfeldti	0	0	1
Rhynchaeus lonicerae	0	1	0
Gymnetrinae			
Gymnetron labile	0	0	1
Miarus distinctus	0	1	0
Hyperinae			
Hypera venusta	0	1	0
ANTHRIBIDAE			
Brachytarsus nebulosus	0	1	0
APIONIDAE			
Acanephodus onopordi	1	1	0
Ceratapion gibbirostre	0	1	0
Cyanapion columbinum	2	0	4
Cyanapion platalea	2	0	0
Diplapion detritum	0	0	2
Eutrichapion ervi	0	1	0

Appendix 1 (continued)

Species	Forest interior	Forest edge	Meadow
Eutrichapion melancholicum	1	0	0
Holotrichapion aestimatum	1	0	0
Omphalapion dispar	0	0	1
Omphalapion hookeri	0	2	1
Oxystoma cerdo	2	0	0
Oxystoma craccae	0	1	0
Oxystoma opeticum	1	0	0
Protapion fulvipes	0	1	0
Protapion nigritarse	0	1	0
Pseudoperapion brevirostre	0	33	22
Pseudostenapion simum	4	1	0
Squamapion flavimanum	57	0	0
RHYNCHITIDAE			
Involvulus pubescens	0	1	0

Appendix 2. Spider species and individuals captured in the studied habitats

Species	Forest interior	Forest edge	Meadow
THERIDIDAE			
Dipoena melanogaster	2	0	0
Enoplognatha latimana	0	1	0
Enoplognatha sp.	2	0	0
Theridion nigrovariegatum	0	1	0
LINYPHIIDAE			
Linyphia hortensis	2	0	0
Linyphiidae sp.	3	0	2
Linyphia triangularis	13	7	0
Neriene chlatrata	0	1	0
Neriene radiata	2	0	0
TETRAGNATHIDAE			
Metellina mengei	2	0	0
Tetragnatha sp.	0	1	0
ARANEIDAE			
Agalanetea redii	0	0	1
Argiope bruennichi	1	0	3
Cyclosa conica	0	1	0
Gibbaranea bituberculata	1	5	0
Gibbaranea sp.	0	4	0
Mangora acalypha	10	5	2
Zilla dioida	0	1	0
PISAURIDAE			
Pisaura mirabilis	6	1	5
AGELENIDAE			
Agelena sp.	0	0	3
DICTYNIDAE			
Dictyna arundinacea	0	0	1
Dictyna sp.	0	3	0
CLUBIONIDAE			
Cheiracanthium sp.	1	2	0
PHILODROMIDAE			
Philodromus dispar	31	27	2
Philodromus longipalpis	0	1	0
Philodromus sp.	3	3	0
Tibellus oblongus	0	2	56
Tibellus sp.	0	9	15

Appendix 2 (continued)

Species	Forest interior	Forest edge	Meadow
THOMISIDAE			
Misumena vatia	0	2	2
Runcinia graminicola	0	0	2
Synaema globosum	0	3	1
Tmarus piger	6	7	3
Tmarus sp.	2	0	0
Xysticus cristatus	0	1	1
Xysticus kochi	0	0	3
Xysticus sp.	2	2	7
SALTICIDAE			
Evarcha arcuata	0	0	2
Evarcha falcata	1	0	0
Evarcha sp.	3	2	0
Heliophanus cupreus	0	3	1
Heliophanus flavipes	0	0	1
Heliophanus sp.	1	0	0
Salticidae sp.	0	0	2

Acta Zoologica Academiae Scientiarum Hungaricae 46(4), pp. 291–303, 2000

REVIEW OF THE GENUS LIBNETIS FROM LAOS (COLEOPTERA, LYCIDAE)

M. BOCÁKOVÁ

Regional Museum Olomouc
nám. Republiky 5, CZ-771 73 Olomouc, Czech Republic
E-mail: mbocakova@vmo.cz

Libnetis species from Laos are treated. Eight new species are described: *Libnetis laosensis* sp. n., *L. merkli* sp. n., *L. viti* sp. n., *L. jendeki* sp. n., *L. holzschuhi* sp. n., *L. dentifer* sp. n., *L. montanus* sp. n., and *L. sausai* sp. n.. Species *L. opacus* PIC, 1921, *L. thai* KASANTSEV, 1993, and *L. vietnamicus* (KASANTSEV, 1993) are recorded from Laos for the first time.

Key words: Lycidae, Platerodinae, Libnetini, taxonomy, key, new species, Oriental Region

INTRODUCTION

Libnetis WATERHOUSE, 1878 contains over 60 species and is the largest genus of Libnetini. Its distribution is predominantly limited to the Oriental Region, with some transcendence to the Palaearctic Region – Japan, Taiwan, southern China, and the Himalayas (Burma, Sikkim, Nepal, India).

Most of the *Libnetis* species were described by PIC (1911, 1917, 1921) and KLEINE (1926, 1928). Lately it were KASANTSEV (1993*a, b*) and BOCÁKOVÁ (2000) who appended other species.

Libnetis encompasses small, yellow to brown species having pronotum with a slight median longitudinal carina in the anterior half, on the elytra only primary costae present, secondary costae and reticulate cells absent. The genus is strongly homogenous in external characters. Conversely, diversification of male genitalia is very high, and therefore, the taxonomy of *Libnetis* is based on genitalia in a large extent. These characters are often in high congruence with the shape of mouthparts (especially mandibles and terminal palpomeres of both palpi), and can be used as a basis for inferring the relationships.

MATERIAL AND METHODS

Specimens were examined and illustrated using an Olympus SZX-12 stereoscopic microscope, with the magnification up to 90×, and illustrated using pictures made by an Olympus DP-10 digital camera.

All measurements are in millimetres. The eye diameters were measured in lateral view at the widest point, interocular distances from above at the narrowest point. Male genitalia were dissected and figured after having been boiled in 10% KOH solution.

Depositories – BMNH – The Natural History Museum, London; HNHM – Hungarian Natural History Museum, Budapest; ZMPA – Zoological Institute and Museum, Warszawa; LMBC – author's collection.

SYSTEMATIC PART

Libnetis WATERHOUSE, 1878

Libnetis WATERHOUSE, 1878: 104. (Type species: *Libnetis pumilio* WATERHOUSE, 1878, by monotypy).

Libnetomimus KLEINE, 1927: BOCÁKOVÁ (2001): 67.

Type material. Syntype of *Libnetis pumilio*, female (BMNH) Ceylon, Thwaites (bearing WATERHOUSE's label male); syntype, female, the same data (BMNH). Holotype of *Libnetomimus setosus* Kleine, male "Luzon, Mt. Makiling, Baker" (ZMPA).

Diagnosis. Small beetles, antennae filiform in both sexes, antennomere 3 long, usually longer than 3/4 of antennomere 4, one of antennomeres 4–7 occasionally provided with a short lamella. Mouth-parts sometimes elongate ventrally, in these species mandibles strongly triangularly reduced, and terminal palpomeres almost apically pointed. If mouth-parts short, then mandibles arcuate, and terminal palpomeres mostly widened distally and provided with distal papillae, sometimes apically pointed without papillae. Pronotum with a slight median longitudinal carina in anterior half. Elytra flat, each elytron with 4 longitudinal costae, secondary costae and reticulate cells absent, male genitalia with shortened paramerae, ventrally fused. Mesosternum strongly transverse. Male terminal sternum provided with proximal enlargements to which projections of tergum 9 are attached. Female terminal sternum provided with two short projections proximally. Male genitalia with short phallobase, paramerae shortened, ventrobasally fused. Female genitalia with short, medially emarginate coxites, valvifers basally widened. Body length: 3.4–5.3 mm.

Remark: A more detailed description was given in a previous paper (BOCÁKOVÁ 2001).

Distribution. S China, Taiwan, the Philippines, Thailand, Laos, Vietnam, Burma, Nepal, India, Sri Lanka, Malaysia, Sumatra, Java, Borneo, Bali.

Key to males of *Libnetis* from Laos

1. Antennomere 4 provided with a lamella as long as the antennomere itself *Libnetis vietnamicus* (KASANTSEV)
– Antennae filiform, antennomere 4 simple, without lamella 2

2. Terminal palpomeres of both maxillary and labial palpi with tapering apex, almost apically pointed, distal papillae absent 3
– Terminal palpomeres of both maxillary and labial palpi securiform, widened apically, their apical margins provided with 4–7 distal papillae 6

3. Eyes large, about 1.8 times interocular distance 4
– Eyes small, at most 1.3 times interocular distance 5

4. Ventrobasal process of phallus provided with a simple spinose projection heading lateroapically *L. thai* KASANTSEV
– Ventrobasal process of phallus provided with a wide oblong projection with two lateroapical spines *L. opacus* PIC

5. Mandibles strongly reduced, trianguloid, paramerae with distal thorns (Figs 14–15) *L. dentifer* sp. n.
– Mandibles arcuate, distal portion of paramerae simple (Figs 12–13) *L. sausai* sp. n.

6. Paramerae long, reaching distal quarter of phallus (Figs 1–2) *L. laosensis* sp. n.
– Paramerae as long as half of phallus 7

7. Apical margin of phallus emarginate (Figs 16–17) *L. montanus* sp. n.
– Apical margin of phallus simple 8

8. Ventral margin of paramerae provided with two apical spines (Figs 10–11) *L. jendeki* sp. n.
– Ventral margin of paramerae without spines 9

9. Ventral fusion of paramerae almost straight (Figs 3–4) *L. holzschuhi* sp. n.
– Ventral fusion of paramerae deeply emarginate or V-shaped 10

10. Ventral fusion of paramerae V-shaped (Figs 5–6) *L. viti* sp. n.
– Ventral fusion of paramerae deeply emarginate (Figs 7–9) *L. merkli* sp. n.

Libnetis laosensis sp. n.
(Figs 1–2, 18, 26, 32)

Holotype: male, N Laos, 5–30 May 1997, 20 km NW Louang Namtha, 21.09°N 101.19°E, 900 m, C. HOLZSCHUH lgt. (LMBC).

Paratypes: 2 males, Laos south, Attapu prov. 800 m, Bolaven Plateau, 18–30.IV.1999, 15 km SE of Ban Houaykong, Nong Lom lake, N 15°02', E 106°35', E. JENDEK, O. ŠAUŠA leg.; 3 males, Laos c., Bolikhamsai prov., Ban Nok env., alt 220 m, Route No. 8, 9–14. 5. 1999, N18°08.7', E104°28.1', E. JENDEK, O. ŠAUŠA leg. (LMBC, HNHM).

Etymology. Named in reference to the range of distribution.

Diagnosis. Closely related to *Libnetis soppongensis* BOCÁKOVÁ, 2000 from which it differs in having much longer and apically pointed paramerae.

Description. Whole body dark brown, sometimes margins of pronotum light brown to yellow. Head with large eyes, eye diameter 1.2 times longer than interocular distance. Antennae filiform, reaching elytral midlength. Mandibles arcuate, labrum transverse, maxillary palpi with terminal palpomeres provided with 6–7 distal papillae. Labial palpi short, terminal palpomere also with distal papillae. Pronotum trapezoidal, transverse (Fig. 18), anterior margin arcuate, sides elevated, straight. Posterior angles sharp. Scutellum oblong, slightly apically emarginate. Elytra elongate, almost parallel-sided, 2.9 times as long as humeral width, 1.25 times wider than pronotum. Each elytron with 4 weak costae, reticulate cells absent. Mesosternum transverse. Distal margin of abdominal sternum 8 straight, male sternum 9 elongate, proximally widened. Legs slender, compressed, tibiae straight, trochanters elongate. Male genitalia stout, phallus with two spines ventromedially, paramerae apically pointed, long, reaching apical quarter of phallus (Figs 1–2). Body length: 5.1 mm, humeral width: 1.3 mm.

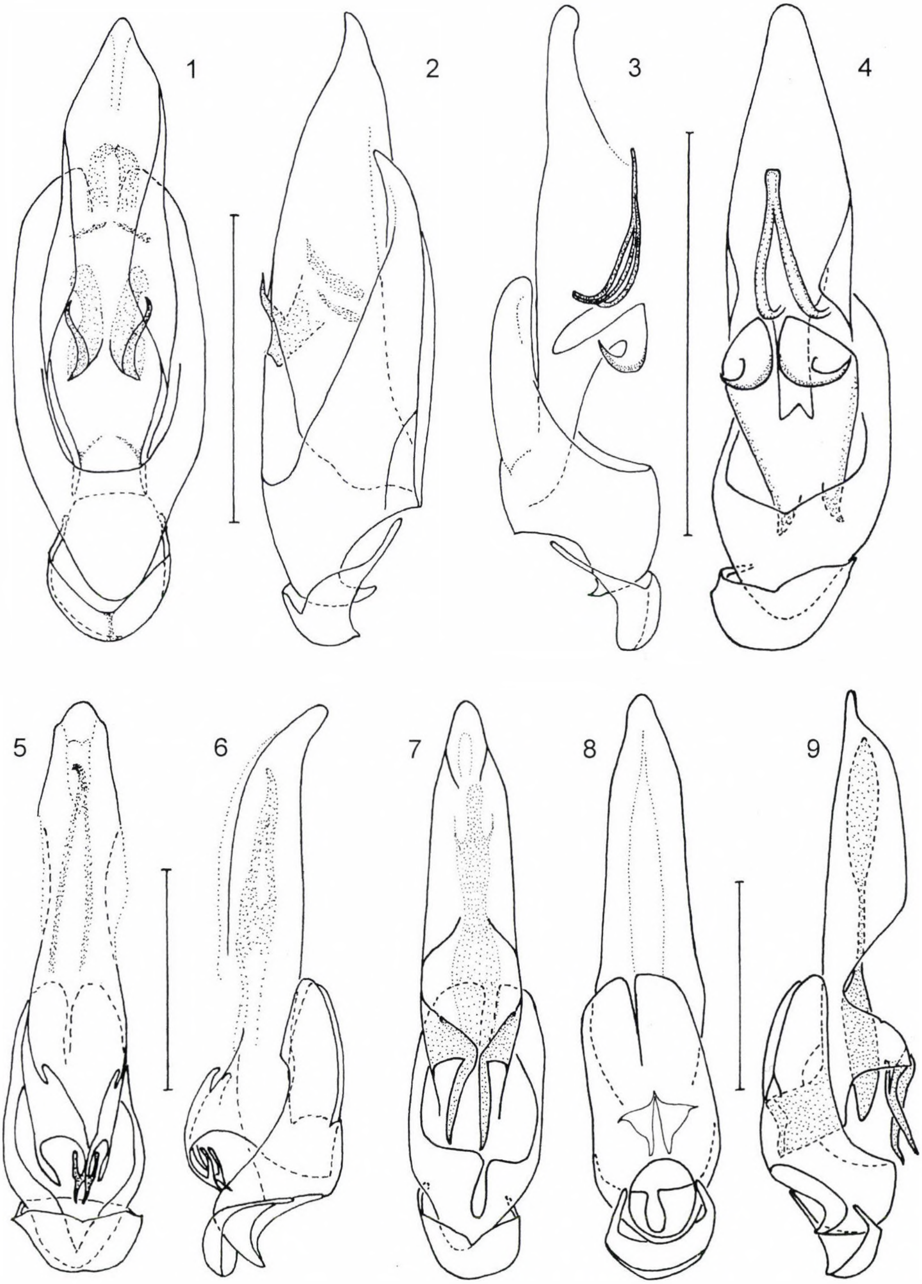
Libnetis merkli sp. n.
(Figs 7–9, 19)

Holotype: male, Laos, Champasak Prov., Dong Hua Xao NBCA, 2 km S of Ban Nong Luang, bank of Touay-Guai stream, 15°4'N 106°13'E, 800 m, swept, No. 23, 1–5. IV. 1998, leg. O. MERKL & G. CSORBA (HNHM).

Etymology. Named in honour of the collector, Dr. O. MERKL (Budapest).

Diagnosis. Closely related to *Libnetis fodingshanensis* BOCÁKOVÁ, 2000 from which it differs in larger body size and in the shape of aedeagus (much smaller ventroproximal projections of phallus, ventral spines strongly reduced, hardly visible, lateral projections of internal sac originating in its apical fifth).

Description. Whole body dark brown. Head with large eyes, eye diameter 1.3 times longer than interocular distance. Antennae filiform, reaching elytral midlength, antennomere 1 stout, 2



Figs 1–9. Male genitalia. 1–2 = *Libnetis laosensis* sp. n., 3–4 = *L. holzschuhi* sp. n., 5–6 = *L. viti* sp. n., 7–9 = *L. merkli* sp. n. Scale = 0.5 mm

small, 3 as long as 4. Mandibles arcuate, labrum transverse, terminal palpomeres of maxillary and labial palpi provided with distal papillae. Pronotum trapezoidal, transverse, widest at basal margin, anterior margin weakly produced forwards, sides elevated. Posterior angles projected obliquely backwards. Scutellum oblong, with a shallow arcuate apical notch. Elytra elongate, subparallel-sided, about 3 times humeral width, 1.25 times wider than pronotum. Each elytron with 4 weak costae, reticulate cells absent. Mesosternum transverse. Abdominal sternum 8 with small arcuate distal emargination, male sternum 9 elongate, proximally widened. Legs slender, trochanters elongate. Phallus ventromedially emarginate, provided with two long ventroproximal projections, lateral projections of internal sac short. Ventral fusion of paramerae partial (Fig. 7). Body length: 5.1 mm, humeral width: 1.3 mm.

Libnetis viti sp. n.
(Figs 5–6, 20, 27, 33)

Holotype: male, Laos, Louangnamtha pr., 21°09'N, 101°19'E, Namtha – Muang Sing, 5–31. v. 1997, VÍT KUBÁŇ leg. (LMBC).

Etymology. Named in honour of the collector, Mr. V. KUBÁŇ (Brno, Czech Republic).

Diagnosis. Related to *L. merkli* sp. n. from which it differs especially in having distal portion of phallus curved dorsally, V-shaped ventral fusion of paramerae and in having remarkably ramose ventrobasal projections of phallus.

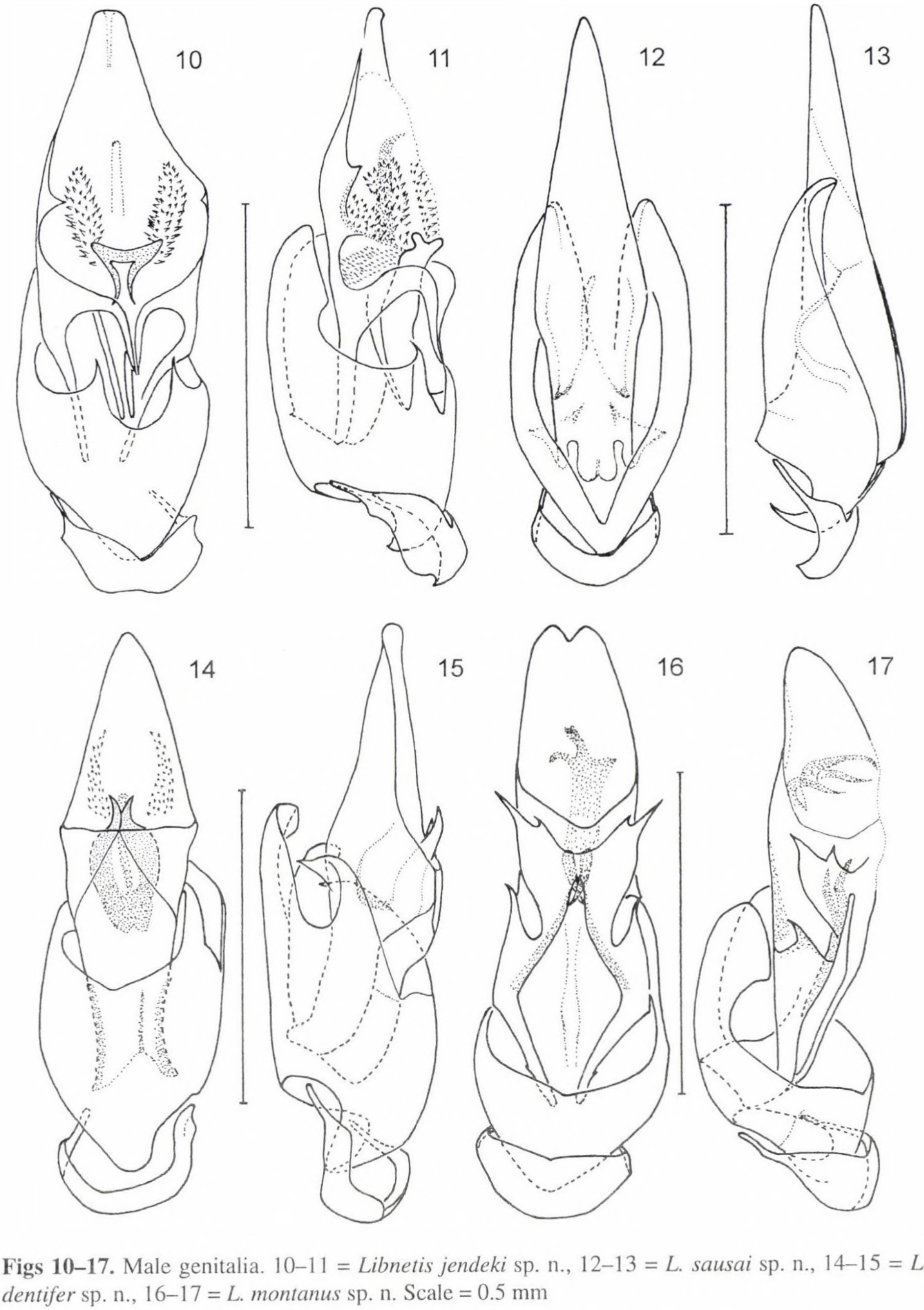
Description. Body dark brown to black. Head with medium eyes, eye diameter 1.1 times longer than interocular distance (Fig. 20), antennae more or less filiform, reaching over elytral midlength. Mandibles arcuate, labrum transverse, terminal palpomeres of maxillary and labial palpi provided with distal papillae. Pronotum almost rectangular, transverse, widest at basal margin, anterior margin slightly produced forwards, sides elevated. Posterior angles sharp. Scutellum apically emarginate. Elytra elongate, subparallel-sided, 3.3 times as long as humeral width and 1.2 times wider than pronotal base. Each elytron with 4 weak costae, reticulate cells absent. Mesosternum transverse. Abdominal sternum 8 arcuately emarginate both distally and proximally, male sternum 9 elongate, weakly widened proximally. Legs slender, compressed, tibiae straight, trochanters elongate. Male genitalia with phallus dorsally curved distally, provided with bifurcate ventrobasal projections. Ventral fusion of paramerae short, V-shaped (Fig. 5). Body length: 4.4 mm, humeral width: 1.1 mm.

Libnetis jendeki sp. n.
(Figs 10–11, 21, 28, 34)

Holotype: male, Laos south, Attapu prov., 800 m, Bolaven Plateau, 18–30. IV. 1999, 15 km SE of Ban Houaykong, Nong Lom lake, N 15°02', E 106°35', E. JENDEK, O. ŠAUŠA leg. (LMBC).

Paratype: male, Laos c., Bolikhamsai prov., Ban Nok env., alt 220 m, Route No. 8, 9–14. 5. 1999, N 18°08.7', E 104°28.1', E. JENDEK, O. ŠAUŠA leg. (LMBC).

Etymology. Named in honour of the collector, Mr. E. JENDEK (Slovakia).



Figs 10–17. Male genitalia. 10–11 = *Libnetis jendeki* sp. n., 12–13 = *L. sausai* sp. n., 14–15 = *L. dentifer* sp. n., 16–17 = *L. montanus* sp. n. Scale = 0.5 mm

Diagnosis. *Libnetis jendeki* is easily distinguishable from all other *Libnetis* species in the shape of its broad aedeagus with two lateral projections of internal sac transformed in spinose vesicles, paramerae provided with two ventrodistal spines (Figs 10–11).

Description. Whole body dark brown. Head with small eyes, eye diameter as long as interocular distance. Antennae filiform, reaching over elytral midlength. Mandibles arcuate, labrum transverse, terminal palpomeres of maxillary and labial palpi with distal papillae. Pronotum trapezoidal, strongly transverse, widest at basal margin, anterior margin produced forwards, slightly emarginate medially. Lateral margins emarginate, posterior angles sharp. Scutellum apically emarginate. Elytra elongate, almost parallel-sided, about 2.9 times as long as humeral width and 1.2 times wider than pronotum. Each elytron with 4 costae, reticulate cells absent. Abdominal sternum 8 with slightly trianguloid distal emargination, male sternum 9 elongate. Legs slender, trochanters elongate. Male genitalia stout, ventral fusion of paramerae incomplete, provided with two distal spines. Phallus broad, with two long proximal projections ventrally and with two lateral projections of internal sac transformed in spinose vesicles. Body length: 3.4 mm, humeral width: 1.05 mm.

Libnetis holzschuhi sp. n.

(Figs 3–4, 22, 29, 35)

Holotype: male, N Laos, 5–30 May 1997, 20 km NW Louang Namtha, 21.09°N 101.19°E, 900 m, C. HOLZSCHUH lgt. (LMBC). Paratype, Laos-N, 24.iv.–16.v.1999, Louang Phrabang prov., 20°33–4'N 102°14'E, Ban Song Cha (5 km W),1200 m, VÍT KUBÁŇ leg. (LMBC).

Etymology. Named in honour of the collector, Mr. C. HOLZSCHUH (Austria).

Diagnosis. It seems to be related to *L. merkli* and *L. viti* from which it differs in the shape of ventroproximal projections of phallus which are laterally oriented, in the shape of internal sac, and in having distal margin of ventral fusion of paramerae almost straight, not emarginate (Figs 3–4).

Description. Whole body dark brown. Head considerably hidden by pronotum, eyes medium-sized, eye diameter 1.15 times longer than interocular distance, antennae filiform, reaching elytral midlength. Mandibles arcuate, labrum transverse, maxillary palpi long, terminal palpomere with 5 distal papillae, labial palpi short, also with distal papillae. Pronotum trapezoidal, widest at basal margin, anterior margin arcuate, produced forwards, sides elevated, slightly emarginate. Scutellum distinctly emarginate apically. Elytra, subparallel-sided, about 2.9 times as long as humeral width and 1.15 times wider than pronotum. Each elytron with 4 weak costae, reticulate cells absent. Abdominal sternum 8 triangularly emarginate proximally, male sternum 9 elongate, slightly widened proximally. Legs rather slender, compressed, tibiae straight, trochanters elongate. Male genitalia with ventroproximal projections of phallus laterally oriented, its distal projection proximally bifurcate, distal margin of ventral fusion of paramerae almost straight. Body length: 3.35 mm, humeral width: 1mm.

Libnetis dentifer sp. n.
(Figs 14–15, 23, 30, 36)

Holotype: male, Laos, Louangnamtha prov., 21° 09'N 101°19'E, Namtha-Muang Sing, 5–31. v.1997, 900–1200 m, VÍT KUBÁŇ leg. (LMBC).

Paratype: male, Laos-N, 24. iv.–16.v.1999, Louang Phrabang prov., 20°33–4'N 102°14'E, Ban Song Cha (5 km W), 1200 m, VÍT KUBÁŇ leg. (LMBC).

Etymology. Named in reference to the shape of aedeagus bearing thorns both on phallus and paramerae.

Diagnosis. Related to *Libnetis soppongensis* BOCÁKOVÁ, 2000 from which it differs in having much stouter male genitalia, provided with distal thorns of paramerae, ventral projections of phallus laterally oriented.

Description. Whole body dark brown. Head with small eyes, eye diameter as long as interocular distance, antennae filiform, reaching elytral midlength. Mouthparts ventrally prolonged, mandibles almost straight, labrum ventrally elongate, maxillary and labial palpi with terminal palpomeres simple, without papillae, tapering apex. Pronotum almost trapezoidal, transverse, widest at basal margin, anterior margin medially emarginate. Posterior angles sharp. Scutellum apically emarginate. Elytra elongate, subparallel-sided, about 3 times longer than humeral width and 1.2 times wider than pronotal base. Each elytron with 4 weak costae, reticulate cells absent. Male sternum 9 elongate, strongly widened proximally (Fig. 30). Legs slender, compressed, tibiae straight, their spurs small, slender and sharp, trochanters elongate. Male genitalia with stout phallus, provided with two median projections ventrally (Figs 14–15). Paramerae with strong distal thorns. Female unknown. Body length: 3.9 mm, humeral width: 1.1 mm.

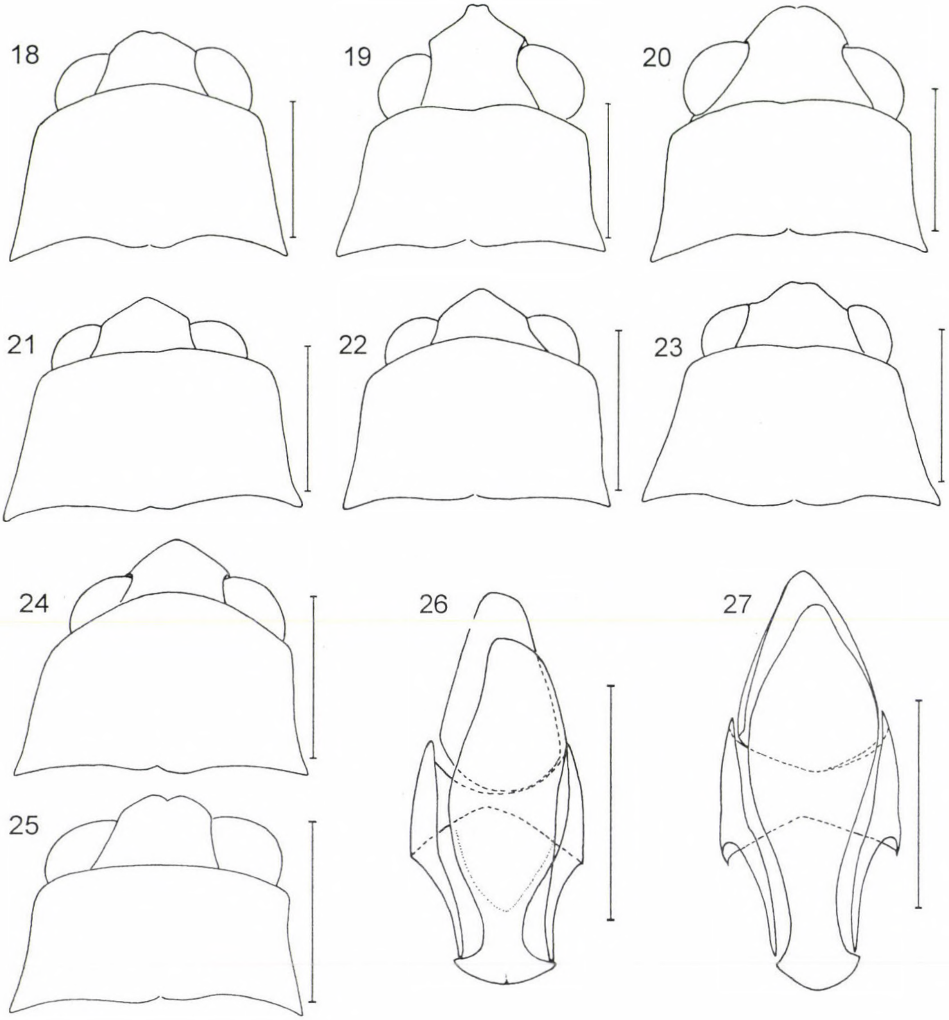
Libnetis montanus sp. n.
(Figs 16, 17, 23, 37)

Holotype: male, Laos N, 24.iv.–16.v.1999, Louang Phrabang prov., 20°33–4'N 102°14'E, Ban Song Cha (5 km W), 1200 m, VÍT KUBÁŇ leg. (LMBC).

Etymology. Named in reference to the mountainous type locality.

Diagnosis. Closely related to *Libnetis yunnanensis* BOCÁKOVÁ, 2000 from which it differs in having considerable spinose ventral projections in median portion of phallus.

Description. Whole body dark brown to black. Head with prominent eyes, eye diameter as long as interocular distance, antennae filiform, reaching over elytral midlength. Mandibles short, arcuate, their apices partly overlap each other. Labrum transverse, maxillary palpi long, palpomere 2 is three times longer than 3, terminal palpomeres of both maxillary and labial palpi provided with distal papillae. Pronotum trapezoidal, transverse, anterior margin produced forwards, sides emarginate, posterior angles sharp (Fig. 24). Scutellum oblong, apically emarginate. Elytra elongate, slightly divergent in posterior half, about 3 times as long as humeral width and 1.2 times wider than pronotum. Each elytron with 4 weak costae, reticulate cells absent, wing venation with 1st CuA cell elongate. Mesosternum transverse, male sternum 9 elongate, slightly widened proximally. Legs slender, compressed, their spurs small, sharp. Male genitalia minute, phallus provided with a complex of ventral projections, paramerae emarginate laterally (Figs 16–17). Body length: 3.8 mm, humeral width: 1.05 mm.



Figs 18–25. 18–25: Head and pronotum. 18 = *Libnetis laosensis* sp.n., 19 = *L. merkli* sp. n., 20 = *L. viti* sp. n., 21 = *L. jendeki* sp. n., 22 = *L. holzschuhi* sp. n., 23 = *L. dentifer* sp. n., 24 = *L. montanus* sp. n., 25 = *L. sausai* sp. n., 26–27. Male terminal abdominal segments. 26 = *L. laosensis* sp. n., 27 = *L. viti* sp. n.. Scale = 0.5 mm

Libnetis sausai sp. n.
(Figs 12–13, 25, 31, 38)

Holotype: male, Laos north., 13–24. V. 1999, 15 km NW Louang Namtha, N21°07.5', E101°21.0', alt. 750 m, E. Jendek, O. ŠAUŠA leg. (LMBC).

Etymology. Named in honour of the collector Mr. O. ŠAUŠA (Slovakia).

Diagnosis. Related to *Libnetis kubani* BOCÁKOVÁ, 2000 (N Thailand) from which it differs in having broader paramerae and phallus laterally constricted in median portion.

Description. Whole body dark brown. Head with large eyes, eye diameter 1.2 times longer than interocular distance, antennae filiform, reaching elytral midlength. Mandibles arcuate, their apices slightly overlap, labrum transverse. Terminal palpomeres of both maxillary and labial palpi without papillae, nearly apically pointed. Pronotum trapezoidal, strongly transverse, widest at basal margin, anterior margin almost straight, lateral margins slightly emarginate, posterior angles sharp. Scutellum apically emarginate. Elytra elongate, subparallel-sided, 3 times longer than humeral width and 1.2 times wider than pronotum. Each elytron with 4 costae, reticulate cells absent. Male abdominal sternum 9 elongate, strongly widened proximally. Legs slender, compressed, tibiae straight, their spurs sharp, trochanters elongate. Male genitalia with broad paramerae reaching apical 2/5 of phallus. Ventral fusion of paramerae V-shaped (Figs 12–13). Proximal third of phallus laterally constricted. Body length: 3.2 mm, humeral width: 0.9 mm.

Libnetis opacus PIC, 1921

Material examined: 6 males, Laos c., Bolikhamsai prov., Ban Nok env., alt 220 m, Route No. 8, 9–14. 5. 1999, N18°08.7', E 104°28.1', E. JENDEK, O. ŠAUŠA leg. (LMBC); 2 males, Laos south, Attapu prov. 800 m, Bolaven Plateau, 18–30.IV. 1999, 15 km SE of Ban Houaykong, Nong Lom lake, N 15°02', E 106°35', E. JENDEK, O. ŠAUŠA leg. (LMBC).

Remark: It is the first record of *Libnetis opacus* from Laos. Male genitalia of this widely distributed species were illustrated by KASANTSEV (1993*a*).

Libnetis thai KASANTSEV, 1993

Material examined: male, Laos north., 24–30. V. 1997, 20 km NW Louang Namtha, N21°09' E101°18.7', alt. 900 m, E. JENDEK, O. ŠAUŠA leg. (LMBC); male, Laos, Louangnamtha pr., 21°09'N, 101°19'E, Namtha – Muang Sing, 5–31 v. 1997, VÍT KUBÁŇ leg. (LMBC).

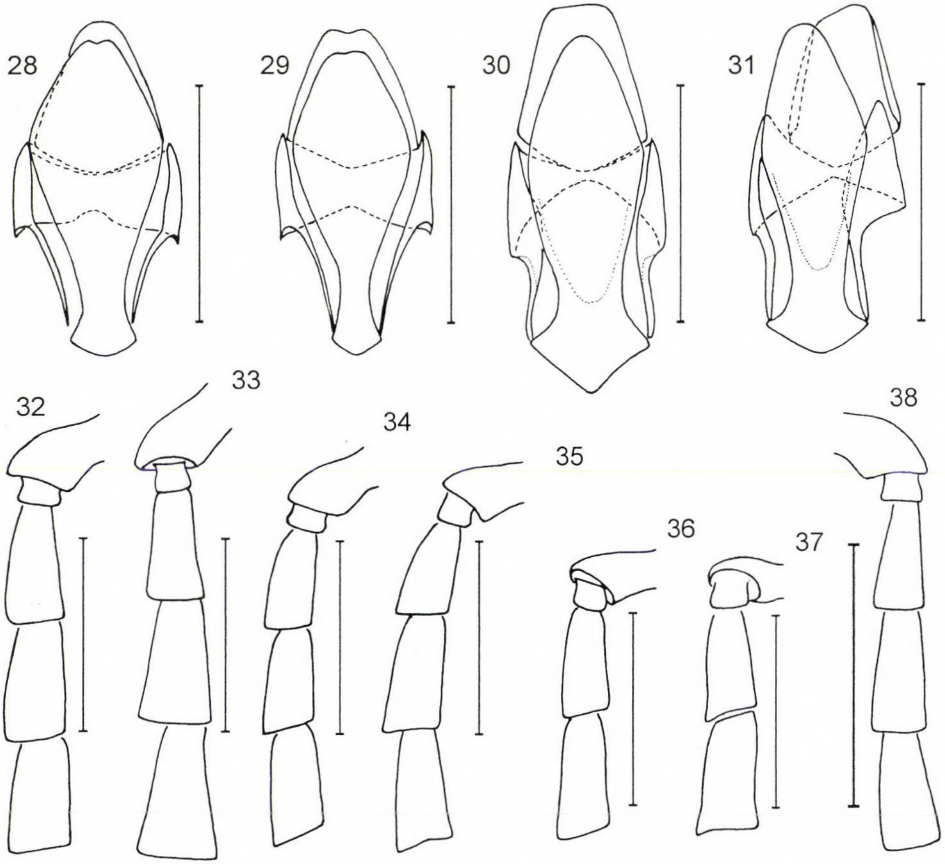
Remark: It is the first record of *Libnetis thai* from Laos. This species was illustrated by KASANTSEV (1993*a*).

Libnetis vietnamicus (KASANTSEV, 1993)

Libnetomimus vietnamicus KASANTSEV, 1993*b*: 65.

Material examined: male, Laos south, Attapu prov. 800 m, Bolaven Plateau, 18–30.IV.1999, 15 km SE of Ban Houaykong, Nong Lom lake, N 15°02', E 106°35', E. JENDEK, O. ŠAUŠA leg. (LMBC); male, Laos south, Champasak prov., Bolaven Plateau, 10–18.IV 1999, Route Pakse-Pakson, 800 m, Banitou env., N15°10' E106°06', E. JENDEK, O. ŠAUŠA leg. (LMBC).

Remark: It is the first record of *Libnetis vietnamicus* from Laos. Male genitalia were figured by KASANTSEV (1993*b*).



Figs 28–31. 28–31: Male terminal abdominal segments. 28 = *Libnetis jendeki* sp. n., 29 = *L. holzschuhi* sp. n., 30 = *L. dentifer* sp. n., 31 = *L. sausai* sp. n. 32–38: Basal antennomeres, 32 = *L. laosensis* sp. n., 33 = *L. viti* sp. n., 34 = *L. jendeki* sp. n., 35 = *L. holzschuhi* sp. n., 36 = *L. dentifer* sp. n., 37 = *L. montanus* sp. n., 38 = *L. sausai* sp. n. Scale = 0.5 mm

Acknowledgements – I would like to express my thanks to Dr. O. MERKL (Hungarian Natural History Museum, Budapest), Mr. M. KERLEY, (The Natural History Museum, London), and to Mr. T. HUFLEJT (Zoological Institute and Museum, Warszawa) for loans of material to be examined. This study has been supported by a grant no. RK99P03OMG011 from the Ministry of Culture of the Czech Republic.

REFERENCES

BOCÁKOVÁ, M. (2000) Review of the genus Libnetis from China with descriptions of several species from Thailand (Coleoptera, Lycidae). *Acta Soc. Zool. Bohem.* **64**: 223–234.

BOCÁKOVÁ, M. (2001) Revision and phylogenetic analysis of the subfamily Platerodinae (Coleoptera, Lycidae). *European J. Entomol.* **98**: 53–85.

KASANTSEV, S. (1993*a*) New species of the genus Libnetis (Coleoptera, Lycidae) from Indochina and adjacent regions. *Russian Entomol. J.* **2**(3–4): 67–74.

KASANTSEV, S. (1993*b*) Lycidae nouveaux ou peu connus de l'Indochine (Coleoptera). *Bull. Mus. natl. Hist. nat.*, ser. A **15**(1–4): 49–68.

KLEINE, R. (1926) Die Lyciden der Philippinen-Inseln. *Philipp. Journ. Sc. Manila.* **31**: 33–114.

KLEINE, R. (1927) Libnetomimus eine neue Lyciden gattung von den Philippinen-Inseln. *Soc. Ent.* **42**: 1–2.

KLEINE, R. (1928) Neue Indische Lycidae nebst faunistischen Bemerkungen. *Ind. Forest Rec.* **13**: 221–268.

PIC, M. (1911) Coléoptères exotiques nouveaux ou peu connus. *L'Echange* **322**: 172–174.

PIC, M. (1917) Descriptions abregees diverses. *Mélanges Exot. Entomol.* **23**: 6.

PIC, M. (1921) Nouveautés diverses. *Mélanges Exot. Entomol.* **33**: 1–32.

WATERHOUSE, C. O. (1878) On the different forms occurring in the coleopterous family Lycidae, with description of new genera and species. *Trans. Ent. Soc. London*, pp. 95–118.

Accepted 20th December, 2000, published 15th May 2001

The Fauna of the Bükk National Park

VOLUME I

Edited by
S. MAHUNKA and L. ZOMBORI

The seventh part of the series "Natural History of the National Parks of Hungary" comprises a collection of papers written by thirty-seven Hungarian and foreign experts. This is the first volume which discusses a large share of the scientifically elaborated material deriving from the territory of the Bükk National Park (North Hungary).

The book opens with a preface written by Dr. J. Tardy, deputy secretary of state, who gives his "Reflections on nature conservation in Hungary, 1993", followed by an editorial Introduction having a detailed list of all the larger administrative and also minor locality names, some of which are amply shown in a map. The volume proper is divided into two sections: Mollusca and Arthropoda. The latter, by far the biggest section, is a collection of scientifically highly valuable contributions on the following groups of animals: Mallophaga (4 pp), Heteroptera (4 pp), Homoptera (8 pp), Coleoptera (80 pp), Lepidoptera (162 pp), Diptera (82 pp), Siphonaptera (6 pp), Hymenoptera (42 pp), Acari (5 pp). The book closes with an Index to Authors.

The volume published by the Hungarian Natural History Museum in 1993.

ISBN 963 7093 206. Soft bound,
456 pages with several figures and tables.
Price: 30 US dollars excl. p. & p.
Order should be sent
to the Hungarian Natural History Museum, Library
Baross u. 13., Budapest, H–1088 Hungary
Fax: (36–1) 3171-669

Acta Zoologica Academiae Scientiarum Hungaricae 46(4), pp. 305–308, 2000

A NEW SPECIES OF CEUTORHYNCHUS GERMAR, 1824 LIVING ON CARDARIA DRABA IN SOUTHEASTERN EUROPE (COLEOPTERA, CURCULIONIDAE)

B. A. KOROTYAEV

Zoological Institute, Russian Academy of Sciences
Universitetskaya nab.1, St. Petersburg 199034, Russia
e-mail: kba@spb.sitek.net

A new species, *Ceutorhynchus merkli* sp. n., very closely related to and often confused with *C. ignitus* GERMAR, 1824, is described from Hungary, Moldova, the Ukraine, and southwestern Russia. The new species is apparently monophagous on a ruderal crucifer *Cardaria draba* LINNAEUS, whereas *C. ignitus* is associated with *Berteroa incana* LINNAEUS. With 2 figures.

Key words: Coleoptera, Curculionidae, *Ceutorhynchus*, Southeastern Europe, *Cardaria draba*, new species

The new species described hereunder was previously misidentified by the author (KOROTYAEV & CHOLOKAVA 1989) as *C. suturellus* GYLLENHAL, 1837, the latter name placed in synonymy with *C. ignitus* GERMAR, 1824 by the late L. DIECKMANN (1979). Re-examination of the lectotype of *C. suturellus* has shown it to be different from the species living in southwestern Russia and adjacent Eastern European countries on *Cardaria draba*. The lectotype belongs actually to a species very similar to *C. pervicax* WEISE, 1883 and *C. barbareae* SUFFRIAN, 1847 and somewhat intermediate in characters between these two. It is fairly common in southern Ukraine and plain Northern Caucasus on *Cardamine* at shores and in the forests. The species from Southeastern Europe living on *Cardaria draba* is here described as new.

The following acronyms are used for indicating depositories of the specimens: DEI – Deutsche Entomologische Institut, Eberswalde, Germany; HNHM – Hungarian Natural History Museum, Budapest, Hungary; PPCB – A. PODLUSSÁNY's private collection, Budapest, Hungary; RPCB – I. ROZNER's private collection, Budapest, Hungary; USNM – United States National Museum, Washington, D. C., USA; ZIN – Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia.

Ceutorhynchus merkli sp. n.
(Fig. 1)

Holotype. ♂, Russia, Krasnodar Territory, 32 km SE of Krasnodar, Kuban' River, right bank upstream of the Starokorsunskaya vill., on *Cardaria draba*, 12.V.1985, leg. B. A. KOROTYAEV (ZIN).

Paratypes. Hungary. Budapest, Óbuda, *Lepidium draba*, 12.V.1985, leg. O. MERKL (1 ♀, HNHM); Budapest, Káposztásmegyer, 100 m, homokos rét [sandy meadow], fűhálózva [swept], 100 m, 20.V.1984, leg. O. MERKL (1 ♀, HNHM); same locality and collector, 7.V.1983 (3 ♂, PPCB); Budapest, Cséri-telep, *Lepidium draba*, 7.V.1985, leg. O. MERKL (1 ♂, HNHM); Budapest környéke [environs of Budapest], Kamaraerdő, coll. H. DIENER (1 ♀, HNHM); Rómaifürdő, 14.VIII.1952, coll. Dr. D. RÉVY, leg. D. RÉVY (1 ♂, HNHM); Békásmegyer, 30.VIII.1974, leg. A. PODLUSSÁNY (1 ♂, 1 ♀, PPCB); Budapest, Pestlőrinc, 19.IV.1992, leg. Gy. LADÁR (1 ♂, PPCB); Érd, bei Budapest, auf *Lepidium draba*, 11.V.1975, leg. L. DIECKMANN (1 ♂, 1 ♀, DEI); Csepel-sziget, Ráckeve, 9.V.1936, leg. TÓTH (1 ♂, HNHM); Pest m., Szigetbecse, 100 m, nedves rét [wet meadow], fűhálózás [sweeping], 30.IV.1983, leg. O. MERKL (1 ♂, HNHM); Pest m., Csomád, Magas-hegy, fűhálózás [sweeping], 23.IV.1994, leg. O. MERKL (1 ♂, HNHM); Pest m., Tahitótfalu, Pokolcsárda, 19.III.1981, leg. L. ÁDÁM (1 ♀, PPCB); Pilisvörösvár, Vörös-hegy, hálózva [netted], 6.V.1954, leg. GYŐRFFY (1 ♀, HNHM); Kiskunsági N. P. [Kiskunság National Park], Csévharaszt, nyíres [birch wood], erdőszél [forest margin], fűhálózás [sweeping], 6.V.1982, leg. O. MERKL (1 ♂, HNHM); Hajós, coll. EHMANN, «*Ceutorhynchus barbareae*, det. Hajóss», coll. Dr. R. STREDA (1 ♂, HNHM); Hungaria occ., Velencei-tó, Velence Park, 13.V.1951, leg. A. SOÓS (1 ♀, HNHM); Hungaria occ., Ercsi, 1.V.1950, leg. GYŐrffy (1 ♂, HNHM); Siófok, leg. LICHTNECKERT (25 ♂, 25 ♀, HNHM, 1 ♂, 1 ♀, ZIN); Balaton-felvidék, Tihany, 17.IV.1983, leg. A. PODLUSSÁNY (1 ♂, 1 ♀, PPCB, 1 ♂, 1 ♀, ZIN); same locality and date, leg. I. ROZNER (2 ♀, RPCB); Veszprém m., Balatonszöllős, 15.IV.1979, leg. A. PODLUSSÁNY (1 ♂, PPCB); Veszprém m., Kiliántelep, 21.V.1979, leg. A. OROSZ (1 ♂, PPCB); Veszprém m., Zánka, 4.IV.1978, leg. A. PODLUSSÁNY (1 ♂, PPCB); Martonvásár, 20.V.1923, leg. J. HAJÓSS (1 ♂, HNHM); Northern Hungary, Bükk-hegység, Beller-völgy, fűhálózva [swept], 18.IV.1953, leg. Hámoriné (1 ♂, HNHM); Hortobágy N. P. [National Park], Egyek, Ohati halastó [fish pond], fűhálózás [sweeping], 9.IV.1975, leg. BITSKEY (1 ♀, HNHM); Békés m., Battonya, 15.IV.1998, leg. A. PODLUSSÁNY (1 ♀, PPCB); Békés m., Bélmegyer, 15.IV.1999, leg. A. PODLUSSÁNY (1 ♀, PPCB); Békés m., Kétegyháza, 23.IV.1979, leg. L. ÁDÁM (1 ♂, PPCB); same locality, 1.V.1978, leg. A. Podlussány (2 ♀, PPCB).

Moldova. Kishinev, Arboretum, 8.VI.1997, leg. A. A. POIRAS (1 ♂, ZIN); Plot', old park, 19.V.1960, leg. V. I. TALITSKY (1 ♀, ZIN).

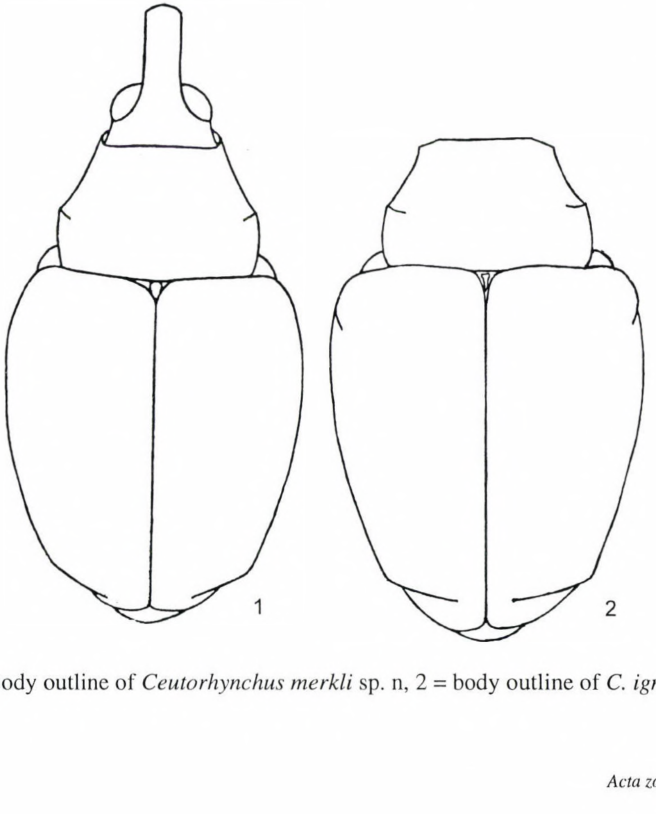
The Ukraine. Lugansk Prov., Derkul, 29.V.1952, leg. K. V. ARNOLDI (1 ♂, 1 ♀, ZIN); Krivoi Rog, 21.V and 11.VI.1987, leg. E. I. LAPIN (3 ♀, ZIN); Botanical Garden of the Teachers Institute, on *Cardaria draba*, 20.IV.1989, leg. S. IZRAILEVICH (6 ♂, 2 ♀, ZIN); Crimean Prov., Kerch, 28.III.1900, leg. YATSENTKOVSKIY (1 ♂, ZIN); 21.IV.1901, leg. Al. N. KIRITSHENKO (1 ♀, ZIN); virgin steppe at the sea coast, 11.IV.1995, leg. A. G. KIREJTSHUK (2 ♂, ZIN).

Russia. Rostov Prov.: Shakhty District, Gornoye village, the Don Forestry, 1.VI.1951, leg. K. V. ARNOLDI, (1 teneral ♀, ZIN); Rostov-na-Donu, Chkalova village, 5.VI.1987, leg. Yu. G. ARZANOV (1 ♀, ZIN); Novo-Sadkovka Farm, 9.V.1979, leg.Yu. G. ARZANOV (2 ♂, 1 ♀, ZIN); Persianovka, 23.V.1989, leg. Yu. G. ARZANOV (1 ♀, ZIN); Aksai District, 3 km S of Schepkino Farm, 25.V.1988, leg. V. Yu. SAVITSKY (1 ♀, ZIN); Veselovskoye Reservoir, Krasnyi Manych, 6.V.1989, leg. Yu. G. ARZANOV (1 ♀, ZIN). Volgograd Prov., Volga River delta, Oranzhereinyi Promysel, 1.V.1911, LUKASH (1 ♀, ZIN). Krasnodar Territory: Krasnodar, Staraya Kuban', 8.V.1985, leg. B. A. KOROTYAEV (1 ♀, ZIN); 32 km SE of Krasnodar, Kuban', right bank upstream of the Starokorsunskaya village, on *Cardaria draba*, 12.V.1985, leg. B. A. KOROTYAEV (1 ♂, 1 ♀, HNHM, 1 ♂, USNM, 1 ♀, ZIN); Temryuk, Voyennaya Gorka, 27.VI.1987, leg. B. A. KOROTYAEV (2 ♀, ZIN); Taman', 19.VI.1978, leg. B. A. KOROTYAEV (1 ♂, 1 teneral ♀, ZIN); 27.IV.1980, leg. B. A. KOROTYAEV (3 ♀, ZIN); ravine 10 km N of Taman', on *Cardaria draba*, 1.VI.1999, leg. B. A. KOROTYAEV, A. S. KONSTANTINOV, and S. LINGAFELTER (3 ♀, 1 of them teneral, ZIN, 2 ♀, USNM); 5 km W of Ust'-Labinsk, Kuban', right bank upstream of Voronezhskaya village, steppe slope, on

Cardaria draba, 8.VI.1988 and 10.V.1990, leg. B. A. KOROTYAEV (1 ♂, 2 ♀, ZIN); boundary between Krasnodar and Stavropol Territories, E of Temizhbekskaya village, 14.VI.1982, leg. B. A. KOROTYAEV (1 teneral ♂, ZIN); same locality, 15.V.1985, leg. B. A. KOROTYAEV (1 ♂, 2 ♀, ZIN). Adygea: 10 km S of Krasnodar, forest margin south of Enem village, on *Cardaria draba*, 19.IV–5.V.1980, leg. B. A. KOROTYAEV (3 ♂, 2 ♀, ZIN); Maikop, 9.V.1929, collector not stated (1 ♂, ZIN). Stavropol Territory, Novoaleksandrovsk District, 2 km E of Novoaleksandrovsk, right bank of Rasshevatka River upstream ov Vinogradnyi village, steppe slope, on *Cardaria draba*, 10-11.VI.1996, leg. B. A. KOROTYAEV (1 ♂, ZIN); same locality and collector, 13.V.1997 (1 ♀, ZIN); same locality and collector, 24.IV.1998 (1 ♀; 1 ♂: minute, 1.85 mm long, very narrow, with pubescence on dorsal side almost completely abraded; looking like *C. levantinus* SCHULTZE, 1898, ZIN); same locality and collector, 26.IV.1998 (1 ♂, ZIN); Stavropol, leg. V. LUTSHNIK (1 ♂, ZIN); Pyatigorsk, Mashuk Mt., IV.1928, leg. RYSAKOV (2 ♀, ZIN); same locality, 8.V.1928, leg. RYSAKOV (2 ♀, ZIN); Kislovodsk, Skalistyi Range, 25.VI.1980, leg. Yu. G. ARZANOV (1 ♀, ZIN).

Daghestan. Tarumovskii District, Kochubei, sparse *Salix* grove along river, on *Cardaria draba*, 6.V.1992, leg. B. A. KOROTYAEV (1 ♂, 1 ♀, ZIN); Kizlyar, park, 8.V.1992, leg. M. Sh. ISMAILOVA (1 ♀, ZIN).

Diagnosis. Very similar to *C. ignitus* GERMAR (Fig. 2), but rostrum somewhat longer, elytra narrower (Fig. 1) with shoulders and apical prominences more rounded; pubescence noticeably raised and slightly longer, producing greyish appearance of dorsal surface. Femoral teeth smaller, than in *C. ignitus* GERMAR.



Figs 1–2. 1 = Body outline of *Ceutorhynchus merkli* sp. n, 2 = body outline of *C. ignitus* GERMAR, 1824

Mucro on male fore tibia missing or inconspicuous, whereas it is always distinct in *C. ignitus* GERMAR. Pronotum more noticeably differing in colour from elytra, disc usually black with bronze shine. Size as in *C. ignitus* GERMAR, but small specimens occur more often and are sometimes very narrow.

Remarks. In the specimens from the Ukraine and southern Russia, humeral prominences are strongly smoothed and pubescence slightly longer than in Hungarian specimens. All specimens collected by the author were swept from *Cardaria draba*.

This new species is dedicated to Dr. OTTÓ MERKL, Curator of Coleoptera of the HNHM.

*

Acknowledgements – I cordially thank Dr. O. MERKL for providing material of HNHM for examination, Mr. L. BEHNE for providing an opportunity of examination of material deposited in the DEI, Mr. A. PODLUSSÁNY (Budapest) and Mr. I. ROZNER (Budapest) for providing material of their collections, the late Dr. P. LINDSKOG of the Museum of Natural History, Stockholm, for the opportunity of examination of the lectotype of *Ceutorhynchus suturellus* GYLLENHAL. I greatly acknowledge here a kind invitation of Dr. M. CRISTOFARO (Rome), Dr. A. S. KONSTANTINOV and Dr. S. LINGAFELTER (Washington, D. C.) to take part in the expedition to Krasnodar Territory, Russia, in 1999, which provided additional material. The study was supported by the Russian Foundation for Basic Research (grant Nos 98–04–49763 and 00–04–81093).

REFERENCES

DIECKMANN, L. (1979) Neue paläarktische Arten aus der Unterfamilie Ceutorhynchinae. *Reichenbachia* **17**: 49-56.

KOROTYAEV, B. A. & CHOLOKAVA, A. O. (1989) Review of weevils of the subfamily Ceutorhynchinae (Coleoptera, Curculionidae) of Georgia. *Ent. Obozr.* **78**(1): 154–177. [In Russian. English translation published in *Entomol. Review* (1989) **68** (4): 117–140.]

Accepted 20th December, 2000, published 15th May, 2001

Acta Zoologica Academiae Scientiarum Hungaricae 46(4), pp. 309–313, 2000

SUPPLEMENT TO THE KNOWLEDGE OF THE PSELAPHINAE (COLEOPTERA: STAPHYLINIDAE) OF NORTH KOREA*

I. LÖBL

Muséum d'histoire naturelle, rte de Malagnou 1, CH-1208 Genève, Switzerland
E-mail: ivan.lobl@mhn.ville-ge.ch

Bryaxis kumgangsanensis sp. n. and *Bryaxis merkli* sp. n. are described from the People's Republic of Korea and additional records are given for a few species of pselaphines.

Key words: Coleoptera, Staphylinidae, Pselaphinae, North Korea, taxonomy

INTRODUCTION

The Pselaphinae are with some 1800 species one of the larger groups of Palaearctic beetles. Many species are flightless either only in female, or in both sexes, and have consequently reduced areals. The proportionally high rate of narrow endemics renders the group interesting for biogeographical and taxonomical studies. The last account of the pselaphines of the People's Republic of Korea was given by LÖBL (1977), with 26 species listed. Within a collection examined recently three additional species are represented. Two are new and described below. One, an unidentified species of *Pselaphogenius*, is the first record of this genus from Korea. New locality data of a few previously described species are also given.

SYSTEMATICS

Bryaxis kumgangsanensis sp. n.
(Fig. 1)

Holotype: male, North Korea, Kangwon Prov., Mts Kumgang-san to Manmulsang Rocks, 800 m, 19.IX.1980, leg. TOPÁL & FORRÓ, no. 712 (HNHM, Budapest).

Description. Length 1.52 mm. Body and scape ochreous. Legs, palpi and antennal segments 2 to 11 distinctly lighter than body. Pubescence long and semi-erect on head, pronotum and elytra. Abdominal pubescence consisting of fairly short, recumbent setae and long semi-erect setae.

Head 0.29 mm long (without neck), with eyes 0.30 mm wide. Frontal lobe 0.16 mm wide. Frontal impression impunctate posteriorly, finely punctate anteriorly, with sharp V-shaped posterior margin. Anterior frontal edge not well delimited. Frontoclypeus very steep, almost vertical, rounded

---

* Zoological Collectings by the Hungarian Natural History Museum in Korea, No. 127.

mesally. Vertex slightly convex, lacking sulci, with low mesal ridge extending from neck up to line of tentorial pits. Anterior margin of tentorial pits at level with anterior eye margins. Antennal tubercles smooth. Punctation on vertex irregular, mostly very fine, very shallow, with few punctures larger than puncture intervals. Eyes small, weakly prominent, with 18 or 19 facets, about as long as tempora in dorsal view. Tempora rounded. Gular impression delimited anteriorly by transverse, bidentate ridge, not delimited posteriorly.

Maxillary palpi with apical portion of segment 2 and entire segment 3 tuberculate ventrally; segment 4 about 3 times as long as wide.

Antennae with short pubescence but dorsal side of pedicel with one conspicuously long seta. Scape cylindrical, 0.08 mm long in dorsal view, 0.06 mm wide. Pedicel 0.10 mm long, as wide as long, swollen, expanded mesally and with robust, blunt and rounded carina occupying middle part of mesal margin. Segment 3 slightly longer than wide. Segments 4 to 8 hardly wider than long, each as wide as segment 3. Segments 9 and 10 each much wider than long.

Pronotum 0.35 mm long, 0.40 mm wide. Discal punctation irregular, very shallow, not clearly delimited, sparse and fine. Puncture intervals much larger than puncture diameters.

Elytra 0.61 mm long at suture, combined 0.68 mm wide, with lateral margins almost evenly arcuate. Adsutural area flat. Humeral protuberances absent. Punctation consisting of well delimited, fairly fine punctures. Puncture diameters distinctly smaller than puncture intervals.

Legs slender. Protibiae straight, outer side with subapical notch bearing setal comb. Mesotibiae lacking apical denticle. Metatibiae curved in apical half, with small, blunt denticle at apex of ventral side.

Aedeagus (Fig. 1) 0.30 mm long. Parameres narrow, with sinuate outer margins, truncate apex, each bearing three subapical setae. Internal sac entirely membranous.

Comments. This new species appears to be closely related to *Bryaxis validicornis* LÖBL. Both species share the form of the median lobe and parameres, and have the internal sac of the aedeagus simple, completely lacking sclerotized structures or, in *B. validicornis* from Russian Far East (KURBATOV 1994), the internal sac has a minute, very slender apical rod. In addition, these two species have similar male scapes and pedicels. *Bryaxis kumgangsanensis* may be readily distinguished from *B. validicornis* by the much sparser and finer punctation on pronotum and head. *Bryaxis validicornis* differs from *B. kumgangsanensis* also by the vertexal carina strongly reduced, the scape shorter (the scapal length given by LÖBL, 1974 is that of the entire segment), the antennal segments 4 to 8 each distinctly wider than long, the elytra with humeral protuberances, the pedicel and abdomen lacking long setae, the protibiae lacking subapical notch and comb, and the apical margin of the internal sac almost evenly arcuate.

Etymology. The name refers to the type locality.

Bryaxis merkli sp. n.

(Fig. 2)

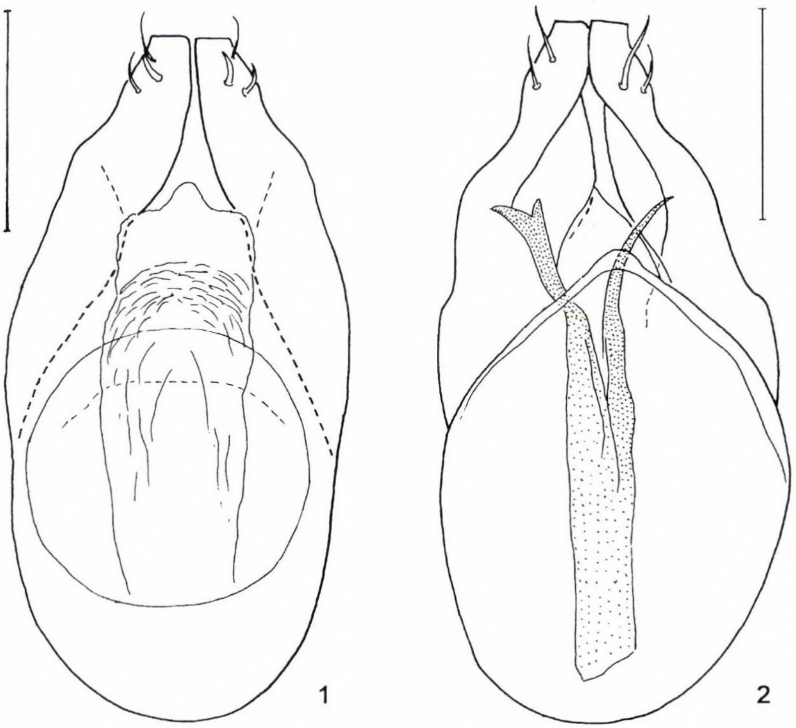
Holotype: male, North Korea, Pyongyang City, Ryongak-san, No. 1043, 14.X.1987, Z. KORSÓS & L. RONKAY (HNHM, Budapest).

Description. Length 1.45 mm. Body and scape ochreous. Legs, palpi and antennal segments 2 to 11 distinctly lighter than body. Pubescence fairly long and semi-erect on head, pronotum and elytra, recumbent on abdomen. Particular, long setae absent.

Head 0.30 mm long (without neck), with eyes 0.31 mm wide. Frontal lobe 0.18 mm wide. Frontal impression impunctate posteriorly, coarsely punctate anteriorly, with posterior margin arcuate, not clearly delimited. Anterior frontal edge not well delimited. Frontoclypeus very steep, almost vertical, rounded mesally. Vertex slightly convex, lacking sulci, with low mesal ridge extending from neck up to line of tentorial pits. Anterior margin of tentorial pits level with anterior eye margins. Antennal tubercles smooth. Punctation on vertex irregular, mostly fairly coarse, with punctures larger than puncture intervals. Eyes small, weakly prominent, with 14 or 15 facets, about as long as tempora in dorsal view. Tempora rounded. Gular impression delimited anteriorly by transverse, bidentate ridge, not delimited posteriorly.

Maxillary palpi with segment 2 lacking tubercles, segment 3 finely tuberculate ventrally; segment 4 about 2.7 times as long as wide.

Antennae with short pubescence. Scape cylindrical, 0.11 mm long in dorsal view, 0.06 mm wide. Pedicel 0.085 mm long, 0.10 mm wide, swollen, expanded mesally, with blunt, rounded carina occupying middle fourth of mesal margin. Segment 3 distinctly longer than wide. Segments 4 and 5 hardly longer than wide, segments 6 and 7 about as long as wide, segment 8 slightly wider than long. Segments 9 and 10 each much wider than long.



Figs 1–2. Aedeagi, ventral view; 1 = *Bryaxis kumgangsanensis* sp. n.; 2 = *B. merkli* sp. n. Scale bars = 0.1 mm

Pronotum 0.36 mm long, 0.40 mm wide. Discal punctation irregular, dense and coarse on centre of disc, coarse and very dense near base, fine near anterior margin and on lateral humps.

Elytra 0.55 mm long at suture, combined 0.66 mm wide, with lateral margins almost evenly arcuate. Adsutural area flat. Humeral protuberances absent. Punctation consisting of well delimited, fairly fine punctures. Puncture diameters distinctly smaller than puncture intervals.

Legs slender. Protibiae straight, lacking subapical notch and setal comb. Mesotibiae lacking apical denticle. Metatibiae curved in apical half, lacking apical denticle.

Aedeagus (Fig. 2) 0.33 mm long. Parameres narrow, with sinuate outer margins, truncate apex, each bearing two subapical setae. Internal sac with sclerotized stalk bifurcate apically to form slender and curved left rod and more robust, bifid right rod.

Comments. This species resembles *B. validicornis* LÖBL, in particular by the male antennae. The aedeagal characters indicate close relationships to *B. asciicornis* KURBATOV and *B. sichotensis* KURBATOV. These two species share with *B. merkli* the robust sclerotized stalk of the internal sac joined to a pair of apical, slender rods. *Bryaxis merkli* may be distinguished notably by the shape of the rods, the parameres with only two subapical setae, and the large, acute medio-apical lobe of the median lobe.

Etymology. The species is named in honour of Dr. OTTÓ MERKL, HNHM, Budapest.

NEW RECORDS

Batriscenellus japonicus vicarius LÖBL – North Korea, Pyongan Prov., Myohyang-san, 25.V.1991, leg. RONKAY & VOJNITS, 2 males (HNHM, Budapest and Geneva).

Bryaxis koltzei (REITTER) – North Korea, Chagang Prov., Mts. Myohyang-san, Chongchon river valley, extracted, 12.IX.1980, leg. TOPÁL & FORRÓ, no 648, 1 specimen; Chagang Prov., Mts. Myohyang-san, 13.IX.1980, leg. TOPÁL & FORRÓ, no 656, 1 specimen (HNHM, Budapest and Geneva).

Bryaxis validicornis LÖBL – North Korea, Kangwon Prov., Kumgang-san, no. 1059, 21.X.1987, no. 1059, Z. KORSÓS & L. RONKAY, 1 male (HNHM, Budapest).

Rybaxis lamellifer LÖBL – North Korea, Nampo, Vaudo, 60 km SW Pyongyan 400–500 m, 3.VII.1977, no. 338 extracted Berlese, leg. DELY & DRASKOVITS, 7 specimens (HNHM, Budapest and Geneva).

Pilopius mroczkowskii (LÖBL) – North Korea, Nampo, Vaudo, 60 km SW Pyongyan 400–500 m, 3.VII.1977, no. 338 extracted Berlese, leg. DELY & DRASKOVITS, 3 specimens (HNHM, Budapest).

Tyraphus nitidus RAFFRAY – North Korea, South Pyongong Prov., Lake Sa-gam,15.IX.1979, leg. H. STEINMANN & T. VÁSÁRHELYI, 1 specimen (HNHM, Budapest).

Pselaphogenius sp. – North Korea, Kangwon Prov., Kumgang-san, 21.X.1987, no 1059, leg. Z. KORSÓS & L. RONKAY, 1 female (HNHM, Budapest). – Comments. *Pselaphogenius* is speciose, widely distributed in the Palaearctic and Afrotropical realms and reported also from New Zealand. The genus was not yet recorded from Korea. The members of this genus are defined by the male sexual characters. Therefore the Korean specimen cannot be identified to species level.

Acknowledgements – My thanks are due to Dr. OTTÓ MERKL, Museum Budapest, for making the material available for study.

REFERENCES

KURBATOV, S. A. (1994) Les Bryaxis de l'Etrême-Est de la Russie (Coleoptera, Pselaphidae). *Russian Entomol. J.* **3**: 39–47.

LÖBL, I. (1974) Beitrag zur Kenntnis der Pselaphidae (Coleoptera) der Koreanischen Volksdemokratischen Republik. *Acta Zool. Cracov.* **19**: 91–104.

LÖBL, I. (1977) Weitere Pselaphidae (Coleoptera) von der Koreanischen Volksdemokratischen Republik. *Bull. Acad. Polonaise Sci., Sér. Sci. Biol. Cl. V,* **25**: 235–241.

Accepted 20th December, 2000, published 15th May 2001

Contributions to a Manual of Palaearctic Diptera

edited by L. PAPP and B. DARVAS

Volume 2. Nematocera and Lower Brachycera

In the bulky volumes of the "*Contributions to a Manual of Palaearctic Diptera*" morphological, physiological, genetical, ecological and economic up-to-date knowledge of dipterous species (midges and flies), which have significant importance in genetics as model organisms, in plant cultivation as pests or beneficial parasitoids, in animal husbandry and human health as vectors of serious illnesses and which are important for ecosystem function, are treated. Morphological keys (with excellent figures) for adults and larvae, which help readers with identification of dipterous pests and parasitoids are provided, while readers in field of applied dipterology will find suitable environmentally friendly methods against pests or biological control methods, among others.

The 2nd volume contains 38 dipterous family chapters by 23 specialists from 12 countries. with 1895 figures on 258 plates.

November 30, 1997, 592 pages
ISBN 963 04 8836 1 (Series)
ISBN 963 04 8837 x (Volume 2)
Foundation for the Publicity of the Hungarian Science
Publisher: Science Herald, Budapest

Order should be sent to
E. W. Classey Ltd.
Natural History Publisher & Bookseller
Oxford House, 6 Marlborough Street, Faringdon
Oxon SN7 7JP, UK
Facsimile: (44)–1367 244800
E-mail: bugbooks@classey.demon.co.uk

Acta Zoologica Academiae Scientiarum Hungaricae 46 (4), pp. 315–317, 2000

DESCRIPTION OF A NEW SPECIES OF SCHIMMELIUS PLATIA, 1994 WITH A KEY TO THE KNOWN SPECIES (COLEOPTERA, ELATERIDAE: SYNAPTINI)

PLATIA, G.[1] and I. GUDENZI[2]

[1]*Via Molino Vecchio, 21, 47030 Gatteo (Forlí), Italy, E-mail: pinoplatia@libero.it*
[2]*Via Corbari, 32, 47100 Forlí, Italy, E-mail: ivogudenzi@libero.it*

Schimmelius tertius sp. n. (Coleoptera, Elateridae, Synaptini) from Malaysia is described.

Key words: Elateridae, *Schimmelius*, Malaysia, new species

Among the material of click-beetles from South-east Asia, received for study by the courtesy of Dr. O. MERKL of the Hungarian Natural History Museum, Budapest we have discovered a new species of the genus *Schimmelius* PLATIA, 1994 which we describe hereunder.

The genus was established to accomodate one species (*ochraceus* PLATIA, 1994) of the tribe Synaptini from Thailand; recently in the Candèze collection (IRSNB) we have examined a female specimen of this species from Sumatra (Pangherang, Pisang, X.1880-III.1881, leg. E. MODIGLIANI previously det. *Glyphonyx* sp. by SCHWARZ). Actually, our German colleague R. SCHIMMEL has also described a second species (*ingridae* SCHIMMEL, 1998) from Thailand. The third species, that we will name *tertius* sp. n. comes from the Malayan Peninsula and was collected at light in a montane rain forest.

We give a key to identify the three known species of the genus.

List of abbreviations: CPG – collection of G. PLATIA, Gatteo, Italy; HNHM – Hungarian Natural History Museum, Budapest, Hungary; IRSNB – Institut Royal des Sciences Naturelles de Belgique, Bruxelles.

KEY TO SPECIES

1 Antennae longer exceeding the posterior angles of pronotum 2
– Antennae shorter not reaching the posterior angles of pronotum (Thailand, Sumatra) *ochraceus* PLATIA
2 Colour of body yellow-ochreous; pronotal sides subparallel with apices of posterior angles not divergent (Thailand) *ingridae* SCHIMMEL
– Colour of body ferrugineous with blackish shade; pronotal sides regularly arcuate with apices of posterior angles clearly divergent (Malay Peninsula) **tertius** sp. n.

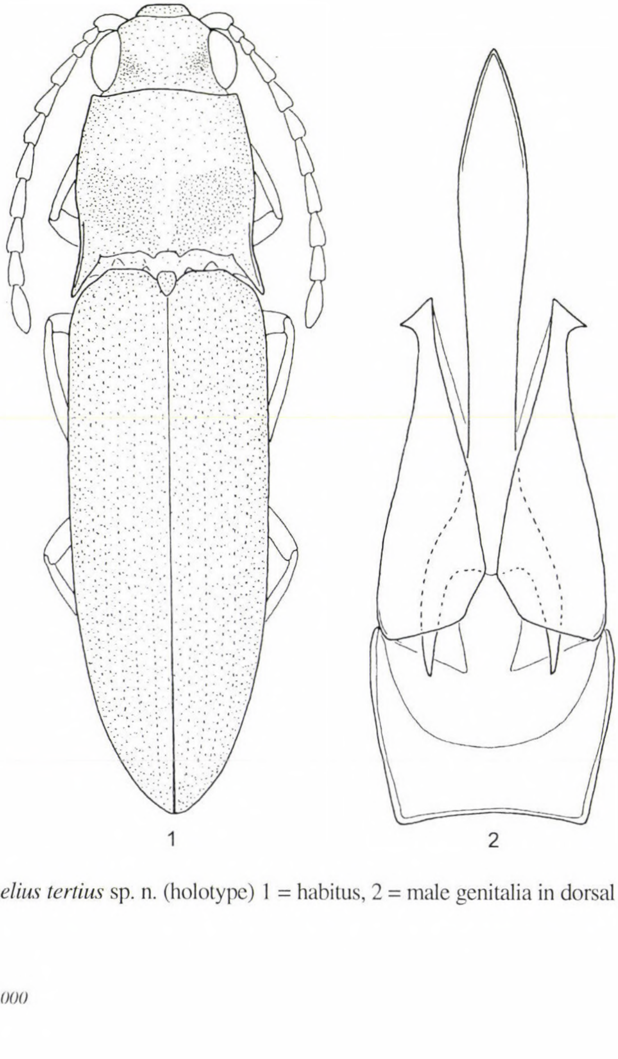
Schimmelius tertius sp. n.
(Figs 1–2)

Holotype: male, Malaysia: Pahang, Cameron Highlands, 2 km S Tanah Rata on Tapah Road, 28.III.1995, leg. O. MERKL & I. SZIKOSSY (HNHM).

Paratype: male, same data as holotype (CPG).

Description. Length 3.7–3.8 mm; width 1 mm. Colour entirely ferrugineous with blackish shade on frons and posterior half of pronotum; covered with dense, golden-yellow pubescence, particularly apparent on elytra.

Frons convex with anterior margin substraight; punctures coarser, superficial, clearly umbilicate, with very narrow and shiny intervals.



Figs 1–2. *Schimmelius tertius* sp. n. (holotype) 1 = habitus, 2 = male genitalia in dorsal view

Antennae exceeding by 1 segment the apices of posterior angles of pronotum; segments II and III subcylindrical, subequal, II and III combined as long as IV; IV-X serrate, much longer than wide; XI ellipsoidal.

Pronotum as long as wide, strongly convex on disk; sides regularly arcuate, elongate sinuate near the posterior angles; the apices are long, acuminate and divergent, with a feeble carina, very near and parallel to the lateral margin, the latter complete; surface with punctures much lighter, just visible, irregular and very sparse.

Scutellum longer than wide, flat and with smooth surface. Elytra 3.1–3.3 times longer than pronotum and 2.7 times longer than wide; sides suboval, widest at half; striae well marked and punctured from base to apex; interstriae flat with finer punctures.

Tarsal segments simple from II to IV gradually decreasing in length; claws pectinate.

Aedeagus as shown in Figure 2.

Female unknown.

REFERENCES

PLATIA, G. (1994) Description of a new genus of click-beetles with pectinate claws from South Thailand (Coleoptera Elateridae). *Lambillionea* **94**(4): 602–604.

SCHIMMEL, R. (1998) Neue und wenig Bekannte Elateriden sowie eine neue Gattung, Acumenator n. gen., aus südostasien (Insecta: Coleoptera, Elateridae). *Mitt. Pollichia* **85**: 235–259.

Accepted 20th December, 2000, published 15th May, 2001

The oribatid species described by Berlese (Acari)

MAHUNKA, S. and L. MAHUNKA-PAPP

The authors had the opportunity for years to study the Oribatid species described by Berlese currently deposited in the Istituto Sperimentale per la Zoologia Agraria at Florence. The results of this series of studies are summarized in this volume.

The volume begins with an essay-like Introduction heavily relying on subjective opinions discussing the general questions of Oribatology. The following section lists Berlese's species placed in the modern system helping the specialists with morphological notes and many drawings; here also the condition of the specimens is discussed and lectotypes are designated.

The third, large section is the catalogue proper, wherein all the species are listed in the systematic order together with their combination and synonymic names. Here one may find all the literature data, usually missing from ordinary works, with reference to Description and Taxonomy, Distribution, with special emphasis on Catalogues whose references are partly unreliable. Where it was deemed necessary further information are added under the heading of Remarks. The volume closes with a very detailed list of literature.

ISBN 963 7093 27 3
325 pages with several figures. Soft bound.
Hungarian Natural History Museum, Budapest, 1995
Price: 40 US dollars excl. p. & p.

Order should be sent
to the Hungarian Natural History Museum, Library
Baross u. 13., Budapest, H-1088 Hungary
Fax: (36–1) 3171669

Acta Zoologica Academiae Scientiarum Hungaricae 46 (4), pp. 319–331, 2000

REVISION OF THE CLEPTES ASIANUS AND TOWNESI GROUPS OF THE WORLD (HYMENOPTERA, CHRYSIDIDAE, CLEPTINAE)

L. MÓCZÁR

Szabolcska M. u. 1, H-1114 Budapest, Hungary

Eight *Cleptes* species were ranged among the *asianus*-group and one species was left in the original *townesi*-group within the subgenus *Cleptes* s. str. Two new species *Cleptes humerosus* sp. n. ♂ from Malaysia and *C. primorensis* sp. n. ♀ from Russia are described. A key and other information are given.

Key words: taxonomy, Hymenoptera, Chrysididae, *Cleptes* (*Cleptes* s. str.) *asianus* and *townesi*-groups

Following the publication of the fundamental work on the Chrysidid Wasps of the World (KIMSEY & BOHART 1991) eight smaller contributions were issued by the author regarding the revision of the subfamily Cleptinae (MÓCZÁR 1996*a*, *b*, 1997*a*, *b*, 1998*a*, *b*, *c*, 2000). The present paper contains an elaboration of 8+1 species in the subgenus *Cleptes* s. str. *asianus* and *townesi*-groups with key, distributional data and other information. Two new species *Cleptes humerosus* sp. n. ♂ from Malaysia and *C. primorensis* sp. n. ♀ from Russia are described. The treatment of the material remains unchanged similarly to the previours revisions. Thus, here only the new data are listed.

Deposition of materials of museums and institutions: HNHM – Hungarian Natural History Museum, Budapest; Gainesville – American Entomological Institute, Florida, USA; BMNH – The Natural History Museum, Department of Entomology, London; Osaka – Osaka Museum of Natural History, Japan; Ottawa – Canadian National Collection of Insects (former Agriculture and Agri-Food Canada, Research Branch), Canada.

The following symbols or abbreviations are used throughout this and preceding papers. F-I (II–III) = flagellomere I (or II–III), MS = malar space (measured across the narrowest interval (MÓCZÁR 1998*c*, Fig. 2) between the ventral eye margin and the ventral edge of malar space, between the two mandibular insertions), MOD = middle ocellus diameter transvesally, Ped = pedicellus (measured in its whole length, including the base, bending resembling a knee), PD = puncture diameter, T = T-I, II etc. tergum or tergite (the first segment dorsally of the abdomen etc.). The three dots … indicate parts left out from the original description.

Cleptes asianus-group

Cleptes (*Cleptes* s. str.) *asianus*-group MÓCZÁR, 1998c: 506.

Pronotum bisulcate, depressed anteriorly behind collar and posteriorly along posterior margin, usually with a row of 2 distinctly outlined punctures or with smaller, indistinct foveae; longitudinal sulcus medially not present. Torus distinctly present on T-I in some species. T-I impunctate, T-III-IV with double punctures, otherwise of two sorts, small and distincttly large punctures. Mesopleuron usually with scrobal-episternal sulcus. These characters were not ascertained only in *galloisi* and *venustus*, owing to want of types; the double punctures are found only on sternite in *thaiensis*, not as usual on tergite. Head, thorax entirely or largely, abdomen partly with green, greenish blue, violet-purple metallic highlights and with different reflections or tints. Abdomen, moreover, largely black or dark brown with insignificantly extended lighter colour on T-I-II.

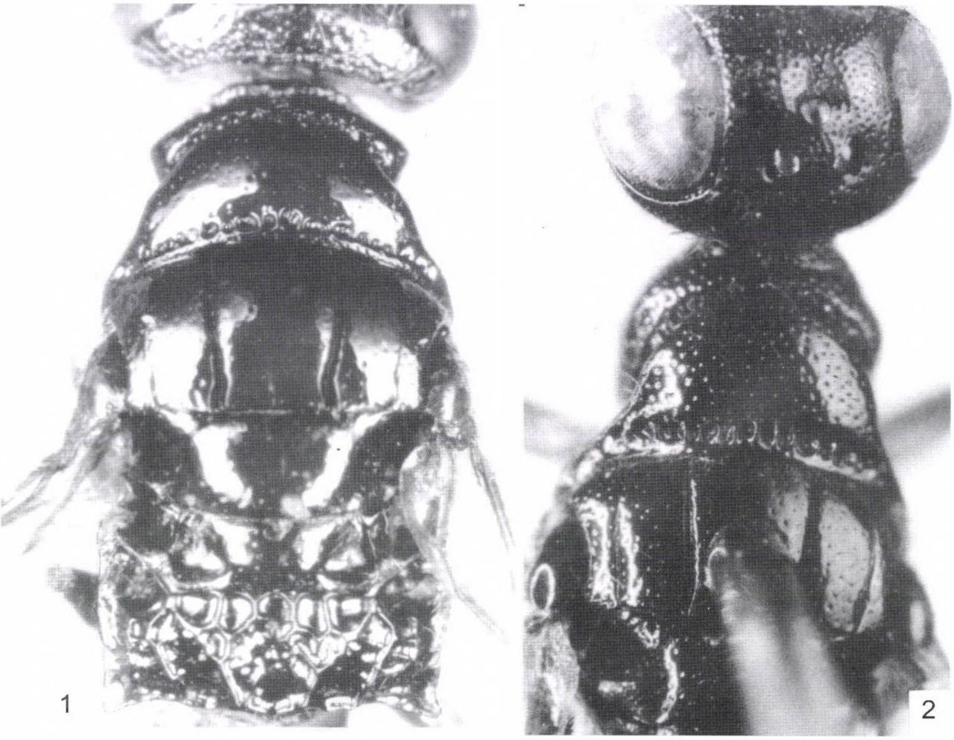
The species of *asianus*-group occur in the East Palaearctic (from East Russia) and in the Indomalayan (Oriental) Region across Japan, Korea, Taiwan, Thailand to Malaysia.

Checklist of species

Cleptes asianus KIMSEY, 1987 – Taiwan
Cleptes crassiceps TSUNEKI, 1959 – Japan
Cleptes galloisi UCHIDA, 1925 – Korea
Cleptes humerosus **sp. n.** – Malaysia
Cleptes primorensis **sp. n.** – Russia
Cleptes thaiensis TSUNEKI, 1961 – Thailand
Cleptes taiwanus TSUNEKI, 1982 – Taiwan
Cleptes venustus TSUNEKI, 1966 – Japan

KEY TO THE SPECIES

1 Mesonotum almost impunctate ... Clypeus strongly and roundly convex ... Pronotum with a row of some coarse punctures posteriorly ... Lateral angles of propodeum ... with tooth on both sides. ...Tergite I smooth polished, the remainder with dense and fine punctures except posterior margins. ...Face, clypeus, mandibles, scutellum, postscutellum, scape, pedicel, anterior and middle legs except tibiae and tarsi, hind legs except tarsi, green. ... Abdomen entirely violet. 6.5 mm." (According to Uchida) *galloisi* UCHIDA ♀



Figs 1–2. 1 = *Cleptes humerosus* sp. n. head, thorax and abdominal tergite I; 2 = *C. taiwanus* posterior part of head, pronotum and mesonotum (orig.)

– Mesonotum more or less punctured. Pronotum, colour different … 2

2 Pronotum with a transverse row of larger, deeper and well outlined pits across posterior margin only medially (Fig. 3), or distinctly elongate (Fig. 2). Body largely purple or greenish blue, green, partly black with violet reflections… 3

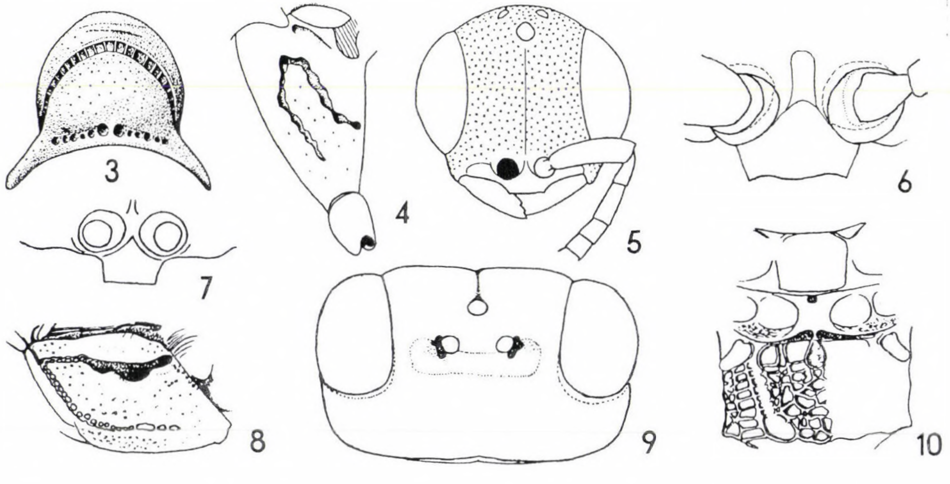
– Pronotum with a row of remarkably smaller, only partly shallower and rarely well (Figs 1–2) or mostly indistinctly outlined pits across posterior margin (Fig. 17). Body differently coloured, rarely concolorous… 5

3 Pronotum somewhat flattened in profile. Lateral angles of propodeum obtuse. The two medial pits in the posterior groove of pronotum markedly larger than the others (Fig. 3), all pits round. Mesopleuron (Fig. 4) with deeply impressed somewhat foveate scrobal sulcus, forming a loop with oblique mesopleural carina. Lower margin of clypeus truncate (Fig. 5). T-II-IV distinctly punctured,

T-III-IV with double punctures. Head, scape, pedicel, thorax, abdomen, femora, tibiae largely purple with greenish blue tints at some places, tegulae, tarsi brown, flagellum dark brown to black. 5 mm *asianus* KIMSEY ♀

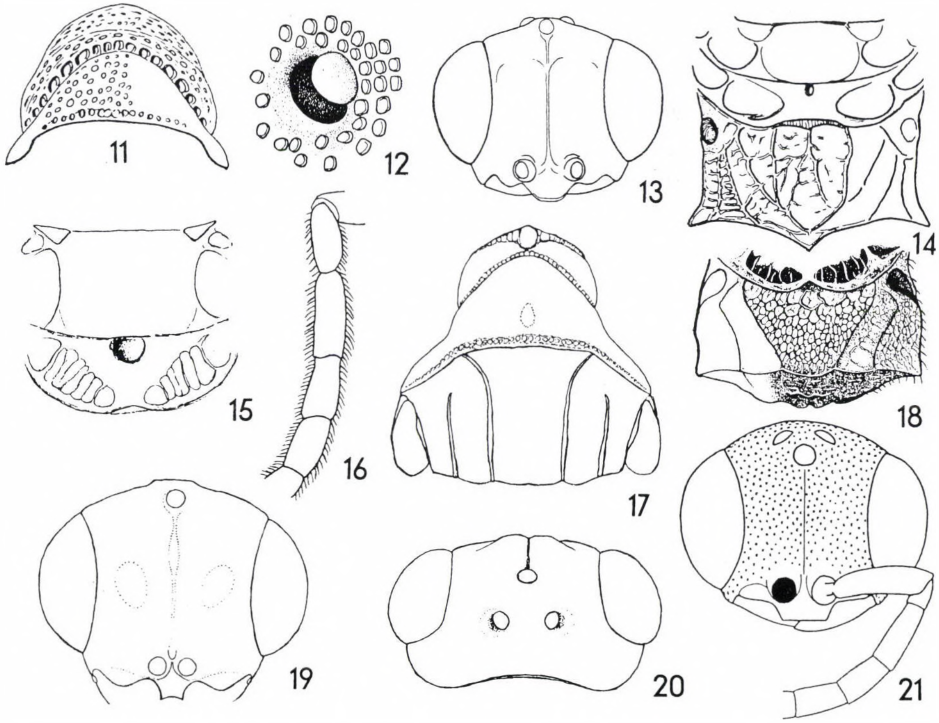
– Pronotum convex in profile. Lateral angles of propodeum small, very shortly produced. The two medial pits on pronotum not markedly larger than the others, similar to the lateral ones, only some pits round. Lateral angles of clypeus with minute tooth (Fig. 6), or obtuse (Fig. 7). T-II-IV with dense, distinct punctures. Body greenish-bluish, abdomen partly black, rarely with purple reflection … 4

4 Head behind eyes seen from above with occipital margin gently rounded. Ocelli in isosceles triangle. Posterior row of pronotum with narrow, distinctly elongate and sharply outlined pits (Fig. 2); pronotum sparsely puntured. Clypeus strongly raised toward lower margin, lateral angles with a minute tooth directed downwards (Fig. 6). Postscutellum with deep pit in front medially and deeply excavated on posterior margin. Lateral edge of propodeum somewhat convex at base and slightly concave before spine, latter short and obliquely produced. Mesonotum (Fig. 2), scutellum and postscutellum with remarkably fine small and sparse punctures. Head, thorax, abdominal sternite and T-I-IV laterally largely bright greenish blue, propodeum, partly mesonotum and partly T-I-IV purple. 6.5 mm *taiwanus* TSUNEKI ♀



Figs 3–10. 3–5 = *Cleptes asianus:* 3 = pronotum, 4 = mesopleuron with scrobal sulcus, 5 = head, front view of face; 6 = *C. taiwanus* clypeus; 7–10 = *C. crassiceps:* 7 = clypeus, 8 = mesopleuron with scrobal and praecoxal sulcus, 9 = head viewed from above, 10 = scutellum-propodeum (Figs 3–5: KIMSEY's original drawings, 6: authors's orig; 7–10: TSUNEKI's orig. drawings)

– ♀: Head behind eyes markedly thick, lateral margin slightly convergent (Fig. 9) nearly parallel. Ocelli in equilateral triangle. Posterior row of pronotum with oval or round, and deeper, moderately sharply outlined pits. Clypeus trapeziform (Fig. 7) with a medial protuberance. Postscutellum strikingly convex with larger deep pit at base medially (Fig. 10) and deeply emarginated on posterior margin. Mesopleuron with foveolate scrobal and praecoxal sulcus (Fig. 8). Lateral edge of propodeum with apical teeth small, broad, triangular and very shortly produced laterally (Fig. 10). Mesonotum-post scutellum with relatively denser, deeper and larger punctures. Head, pronotum greenish blue, mesonotum-postscutellum mostly green or partly purple. Abdomen black, posteriorly with pale purple tints. 8 mm



Figs 11–21. 11–14 = *C. thaiensis* 11 = pronotum, 12 = hind ocellar impression and punctures on vertex, 13 = head viewed in front, 14 = scutellum-propodeum; 15–20 = *C. venustus*: 15 = scutellum and postscutellum, 16 = pedicel and flagellomeres I-III, 17 = pronotum-mesonotum, 18 = postscutellum partly and propodeum, 19 = head viewed in front, 20 = head viewed from above; 21 = *C. townesi* head viewed in front (15–20 = TSUNEKI's orig. drawings, 21 = KIMSEY's orig. drawing.)

– "♂: Similar to ♀. F-I nearly twice as long as wide at apex. ...Postscutellum less strongly convex... Vertex, pronotum, mesonotum purple (in paratype bluish). Abdomen black, face, temples, scutellum-propodeum, mesopleuron, sides of abdomen mostly blue to bluish green. 4.3–5.5 mm". (Male according to TSUNEKI) *crassiceps* TSUNEKI

5 Pronotal groove different, with well outlined (Fig. 1), or shallow, possibly obscurely outlined row of pits across posterior margin. Head, thorax, entirely green or partly greenish blue 6

– Posterior groove of pronotum with very small pits or indistinctly outlined foveae (Fig. 17). Body colour: violet with greenish golden or bluish tints and abdomen entirely bluish green (*thaiensis*); or bluish green and black, partly with golden tints and abdomen black, sides at base of T-II-III with blue spots (*venustus*) 7

6 Pronotun with a conspicuous conical corner in front on humerus (Fig. 1). Body rather squat. Head convergent posteriorly behin eyes (Fig. 1) viewed from above. Head, thorax entirely bright green, propodeum with golden reflections. 5.4 mm **humerosus** sp. n. ♂

– Pronotum normal, without conical corners. Body slender. Head thickened posteriorly viewed from above. Head, thorax dark greenish blue, bluish green or partly black, without golden reflections. 5.9 mm **primorensis** sp. n. ♀

7 The transverse groove on pronotum anteriorly with well outlined row of pits, posterior one shallow and with rather indistinct punctures (Fig. 11), without a longitudinal impression medially. Lateral sides of propodeum nearly parallel, lateral angles triangular, distinctly produced laterally (Fig. 14). Clypeus trapezoidal (Fig. 13), strikingly raised toward lower margin. Hind ocellar impression crescentiform (Fig. 12) comparatively broad and markedly deep along external margins. Postscutellum with a small and deep pit at anterior margin (Fig. 14) and shallowly excavated posteriorly. 4.2–5.5 mm *thaiensis* TSUNEKI ♂

– Both transverse rows of pits similar to each other, distinctly foveolate, disc with an impression (Fig. 17) indistinctly outlined medio-posteriorly. Lateral sides of propodeum slightly divergent on basal half (Fig. 18), lateral angles subrectangular, with an obtuse apex. Clypeus subquadrate (Fig. 19), longitudinally raised in the middle, lower margin gently roundly emarginate. Impressions of ocelli normal (Fig. 20), external margin obtusely outlined. Postscutellum with a large and deep pit on anterior margin and hardly excavated posteriorly (Fig. 15). 4 mm *venustus* TSUNEKI ♂

Cleptes asianus KIMSEY, 1987
(Figs 3–5)

Cleptes asianus KIMSEY, 1987: 56, 1 ♀. Holotype ♀ ; Taiwan: Wushe (Gainesville).
Cleptes asianus: KIMSEY & BOHART 1990: 59 ♀ (*orientalis*-group)

Material examined: 1 ♀ holotype. Taiwan: "Wushe, Taiwan 1100 m V-15-83 Henry Townes", "Holotypes *Cleptes asiana* KIMSEY ♀" red label with author's writing, 1 ♀ (Gainesville).

Additions to the original diagnosis. Punctures of face distinct, moderately deep (small in KIMSEY). Pronotal punctures small and 2–3 PD apart. Malar space 1.2 MOD long (cf. Fig. 2 MÓCZÁR 1998*a*), Ped 2.2 times as long as broad, F-I length 2.1 times breadth, F-II 1.1 times as long as broad (Fig. 5). Nervulus antefurcal. Posterior margin of postscutellum with two oval foveae. T-II smooth basally and posteriorly, with dense, moderately deep punctures on its anterior two-thirds; T-III with moderately deep, very dense punctures, T-IV with distinctly deeper punctures and with tiny punctures basally, also double punctures. Body with blue tints especially along eyes and lateral sides of T-IV. Base of mandible purple. Tegulae brown.

Distribution. Taiwan (KIMSEY 1987).

Cleptes crassiceps TSUNEKI, 1959
(Figs 7–10)

Cleptes crassiceps TSUNEKI, 1959: 5, 7, 21 Figs 33–38 6 ♀ 3 ♂ ; Holotype ♀, Japan: Towada (Osaka).
Cleptes crassiceps: KIMSEY and BOHART 1990: 60 ♀ (Tsukuba, *satoi*-group).

Material examined: 1 ♀, Holotype ♀: "Towada N. Japan V.VII 1958 K. Shimoyama" printed label, "Cleptes crassiceps Tsuneki Holotype" red label, 1 ♀ (Osaka).

The original description agrees with the holotype, except only as follows: Anterior half of abdominal segments laterally greenish blue, below black with bluish tints and T-IV basally greenish blue, and not "sides of abdomen … green" (according to TSUNEKI); T-III to a small extent and T-IV mostly with double punctures and not "2 and 3 closely but posteriorly sparsely, 4 more sparsely punctured".

Addition to the description given in key and MS 1.6 MOD long, Ped 2.1 times, F-I 2.2 times, F-II 0.9 times and F-III 0.8 times as long as wide. Axillae broad, diverging backwards and semicircular basally, triangularly pointed apically, lower side strongly inclined posteriorly, and not "with sides slightly convergent straight backwards".

Variation. ♀ (from Nopporo, paratype): "Head and thorax aeneous green… with a shade of purple in part; scutellum … green golden… Abdomen black… femora dark brown". – ♂ : (from Koike, paratype) "Head, pronotum…dark purple. Mesonotum black with a faint shade very narrow and linear. Post-medial impression of main part of pronotum: in two paratypes this is definable, in another paratype it is not defined, only a median groove in the middle of the longitudinal line observed" (According to TSUNEKI).

Distribution. Japan (TSUNEKI 1959).

Cleptes galloisi Uchida, 1926

Cleptes galloisi UCHIDA, 1926 (38): 183, 185, 1♀. Holotype ♀; Korea: Seiryori(?).
Cleptes galloisi: TSUNEKI 1959: 5, 12 ♀.
Cleptes galloisi: KIMSEY and BOHART 1990: 60 (Japan, *orientalis*-group).

Material examined: –.

The type locality is unknown (TADACHI 1995). According to TSUNEKI (1959): The "description gives little information as to the specific distinctions… I could not have the chance of examining the specimen". I propose to place it in the *asianus*-group on the basis of the row of pits along the posterior margin on pronotum and the entirely metallic terga.

Cleptes humerosus sp. n.

(Fig. 1)

Holotype ♂ : Malaysia: "Malaya Kuala Lumpur. Nr: L.gardens, Coll. H. M. Pendlebury. Jan.4 15 1938.", "Ex F. M. S. Museum B.M. 1955–354", "Holotypus Cleptes humerosus sp.n. det. Móczár 1998 ♂" (London)

♂ – Length 5.4 mm. Head, thorax, including propodeum, partly scape, pedicel, coxae, femora, tibiae bright green with golden, partly bluish tints; flagellum and rest of legs brown; abdomen dark brown to black, partly with bluish green reflections. T-I posteriorly and T-II anteriorly with a transverse reddish brown and narrow streak. Disc on T-I extensively, T-II with less, T-III with stronger lateral, T-IV-V entirely with bluish green reflections. Wings weakly stained, nearly hyaline; discoidal cell open above, nervulus interstitial. Body with short white hairs.

Head 1.4 times as broad as long. Face and malar space very densely punctured. MS 1.0 MOD long, Ped 2.2 times as long as broad, length of F-I 2.2 times apical breadth, F-II and F-III 1.1 times as long as broad. Frontal sulcus narrow reaching from middle ocellus to clypeus. Lower margin of clypeus slightly emarginate, lateral sides remarkably convergent, corners obtuse. Ocellar triangle hardly acute, nearly rectangular; the pits beside hind ocelli connected by a sharp and narrow sulcus. Vertex with close punctures just before occipital carina; head remarkably convergent laterally behind eyes.

Pronotum short with conspicuously protruding conical corners in front (Fig. 1), surface slightly convex in profile; anterior diameter 1.6 times as broad across humerus as long between collar and posterior margin medially. Both transverse grooves with rather small but well outlined row of pits. The three middle pits slightly larger than the others in the posterior row. Surface of pronotal disc smooth, polished together with mesonotum, scutellum and postscutellum with very fine and scattered punctures. Notaulix deep and rather broad across mesonotum (Fig. 1), parapsidal line short. Scutellum and postscutellum distinctly broader than long. Postscutellum touching scutellum, anterior margin with a deep, large pit medially (Fig. 1) and twice emarginated on posterior margin. Propodeum short, lateral sides convex basally and concave toward the short spine (Fig. 1); surface irregularly and coarsely wrinkled (Fig. 1), horizontal part laterally and posteriorly sharply margined from the vertical part. Scrobal and epicnemo-praecoxal sulcus inside foveolated and with pits, outside with a raised edge, both joined to each other in front into on elongated V-shaped deepening (cf. Fig. 4). Abdominal tergites I and V impunctate, polished; T-II with fine and dense punctures 0.5–2 PD apart; T-III with close, T-IV deeper, both with double punctures.

This new species widely differs from all its related species by its conical corners of pronotum, the smoth and hardly puncturted pronotum-scutellum and its bright green colour.

Cleptes primorensis sp. n.

Holotype ♀: “Russia: Primorsky 30 km NE Vladivostok Tajvaza, FIT 29.VII-5.VIII.1992 B. D. Gill, coastal for.”, “Holotypus Cleptes primorensis sp. n. det. Móczár 1998 ♀” (Ottawa).

♀ – Length 5.9 mm. Head dark greenish blue, mesonotum, scutellum, postscutellum, mesopleuron, scape partly, pedicel, coxae, femora and spots on T-II-IV laterally bluish green; pronotum dark blue to black, with pale violet tints medially, propodeal disc on posterior two-thirds blue. Tibiae and tarsi yellowish brown, with some bluish green tint on upper edge of tibiae. T-I reddish brown basally, along posterior margin and partly T-II-IV posteriorly, remaining parts black. Wings slightly brownish stained below pterostigma, discoidal cell hardly indicated. Head, thorax with short, abdomen with longer white hairs.

Head round, 1.1 times as broad as long. Face partly smooth and with dense punctures; frontal sulcus distinctly developed only on posterior quarter above clypeus. Lateral sides of clypeus moderately converging apically, lower margin truncate, corners with minute spine directed downwards. Ocellar triangle distinctly acute without sulcus. MS 1.4 MOD long, Ped length 2.2 times of breadth, F-I 2.3 times as long as broad, F-II 1.3 times as long as broad, F-III length 1.2 times of breadth. Occiput margined above; head thickened behind ocelli, lateral sides parallel closely behind eyes, than gradually arcuate toward the middle.

Anterior diameter of pronotum 0.97 times as broad across humerus as length between collar and posterior margin medially. Posterior row of pits well outlined, excepting the smaller ones laterally, some pits are distinctly quadrangular, others oblong; surface of disc in profile slightly convex medially, with a short and shallow longitudinal depression on the second half posteriorly, not reaching the transverse row of pits; punctures on disc distinct, about 1–2 PD apart. Mesonotum finely punctured, 3–4 PD apart, as well as with minute punctures similar as on scutellum, here punctures about 2–3 PD apart, postscutellum with smaller punctures about 1–2 PD apart. Notaulix and parapsidal sulcus deep, the latter nearly reaching pronotum (cf. Fig. 2). Scutellum and postscutellum almost rectangular. Latter touches scutellum, anterior margin with a deep, small pit medially and twice deeply emarginated on posterior margin medially. Propodeum longer, lateral margins parallel, corners right-angled, surface of disc irregularly wrinkled. Mesopleuron with a V-shaped scrobal sulcus (cf. Fig. 4) similarly to that of *humerosus*, but deeper, foveae hardly perceptible at the bottom. T-I and T-II posteriorly impunctate, polished, T-III-IV with double, partly close punctures, T-IV with remarkably larger and deeper punctures.

This species is similar to *taiwanus* by its abdominal punctuation, and partly in its colour, in form of clypeus not truncate (Fig. 6) and not strongly raised towards lower margin, but differs mainly by the structure of pronotum, by the lateral edge of propodeum not convex at base and not slightly concave before spine, latter not short and obliquely produced.

Cleptes thaiensis TSUNEKI, 1961
(Figs 11–14)

Cleptes thaiensis TSUNEKI, 1961: 367, 3 ♂. Holotype ♂; Thailand: Doi Suthep (Osaka).
Cleptes thaiensis: TSUNEKI 1982: 1 ♂ (difference from *dipriovola* TSUNEKI).

Material examined: Thailand: "Doi Suthep Thailand 16.I.1958, K. Yoshikawa leg.", "Cleptes thaiensis Tsuneki, holotype", 1 ♂ (Osaka).

Further data are as follows. F-I 2.7 times as long as wide. Head, pronotum rather closely punctured, mesonotum-postscutellum more finely and sparsely punctured, T-II finely, rather densely punctate, posteriorly sparsely so T-III more closely punctate. Sternite double punctured.

Distribution. Thailand (TSUNEKI 1961).

Cleptes taiwanus TSUNEKI, 1982
(Figs 2, 6)

Cleptes taiwanus TSUNEKI, 1982: 2, 1 ♀. Holotype ♀: Taiwan: Pempuchi (Osaka).

Materal examined:1 ♀. Holotype ♀; Taiwan: "Formosa, Nantou Pref., Pempuchi 18.VIII.1980 T. Nambu leg.", "Cleptes taiwanus Tsuneki ♀ Holotype" orange label, 1 ♀ (Osaka).

Some corrections to the diagnosis are given in the key, and further more as follows: Ocelli in isosceles triangle, and not in equilateral triangle. T-II distinctly punctured, and not "G-2 ... finely punctate"; T-III closely, very densely punctured basally, with intensive double punctures, and not "G-3 similarly [to 2] but slightly more closely and distinctly punctured, with impunctate areas narrower"; tegulae greenish blue basally, brown apically with purplish tint, and not "strongly purplish". Addition to the diagnosis: pronotal disc distinctly and more deeply punctured (Fig. 2) than mesonotum and scutellum; pronotum squat, pronotum (Fig. 2) collar somewhat swollen to a small degree, anterior diameter of pronotum 1.2 times as – broad (across humerus) as longitudinal length (along collar and posterior margin medially). MS 1.0 MOD long, Ped 2.2 times as long as wide, F-I 2.3 times, F-II 1.3 times, T- III 1.0 times as long as wide. Nervulus antefurcal. Parapsidal line on mesonotum long, reaching pronotum (Fig. 2).T-I with a V-shaped brownish spot anteriorly; T-I and T-II with brownish and a hyaline streaks posteriorly.

Distribution. Taiwan (TSUNEKI 1982).

Cleptes venustus TSUNEKI, 1966
(Figs 15–20)

Cleptes venustus TSUNEKI, 1966: 19, 1 ♂. Holotype ♂; Japan: Shirahama, Hachinoché-City, Aomori Pref. (Osaka).
Cleptes venustus: KIMSEY and BOHART 1990: 64 (*satoi*-group)

Material examined: –.

Further data from the original description are as follows. Antenna: Fig. 16. "Punctures generally sparse ... uniform and fine, on vertex strong, on pronotum-postscutellum and mesopleuron scattered and sparsely with hair-bearing punctures... On abdomen 2nd [=T-II] sparsely and finely punctured on anterior than 2/3, 3rd and 4th wholly sparsely punctured."

Distribution. Japan (TSUNEKI 1966).

Cleptes townesi-group
(Fig. 21)

Cleptes townesi-group: KIMSEY and BOHART, 1990: 58, 64

Cleptes townesi KIMSEY, 1987: 58, 5 ♂ Figs 2, 6. Holotype ♂ ; Taiwan: Wu-feng (not Wushe in KIMSEY) (Gainesville).

Material examined: 1 ♂. Taiwan: "Wu-feng, Taiwan April 6, 1983 Henry Townes", "Holotype Cleptes ♂ townesi Kimsey" (red label) (Gainesville).

The original diagnosis of the group and the description of the species are completed as follows. Pronotum without "distinct" groove or pits etc., in fact pronotum with punctures 1–2 PD apart (in KIMSEY & BOHART), addendum: which continues more finely in the shallow depression along posterior margin, with trace of some minute, less outlined foveolae medially, and with some minute irregular punctures laterally. Malar space 0.3 MOD long, and not 0.8 (measured at the shortest distance [cf. Fig. 2 MÓCZÁR 1998*c*]). Ped 1.7 times as long as wide, F-II 2.2 (in KIMSEY 2.4, Fig. 21) times as long as wide. Pronotal disc remarkably more deeply punctured than face. Posterior margin of postscutellum twice deeply excavated. Scape, pedicel light brown. T-II with tiny, T-III-IV with fine, scattered, gradually denser punctures, partly with double punctures. Nervulus interstitial.

Abdomen brownish black, T-I partly and all segments laterally brown and posterior margins partly with narrow, lighter brownish streaks. Legs partly yellowish and light brownish. Middle legs, fore coxae, trochanters in front extensively white. Further data (in KIMSEY): face with metallic blue tints. Pronotum flattened in profile. Mesopleuron smooth with a small scrobal pit and deep punctures. Propodeum laterally and metapleuron entirely smooth, polished. T-V emarginate medially. 5.5 mm.

Distribution. Taiwan (KIMSEY 1987).

*

Acnowledgements – I should like to express my gratitude for the loan of holotypes to curators and technical staff of the following museums and institutes: M. I. KANAZAWA (Osaka), Dr. D. WAHL (Gainesville); Prof. S. SAKAI (Tokyo-Bunkyo) for the definition of the Japanese text and for arranging of the loan of holotypes from Japan; for the loaned material, Dr. L. MASNER (Ottawa), Miss S. LEWIS (London) and Dr. L. ZOMBORI (Budapest).

REFERENCES

KIMSEY, L. S. (1987) New species of Cleptes Latreille from Asia and North America. *Pan-Pac. Ent.* **63**(1): 56–59.

KIMSEY, L. S. & BOHART, R. M. (1990[1991]) *The Chrysidid Wasp of the World.* (Subfamily Cleptinae: 52–70). Oxford Univ. Press. 652 pp.

MÓCZÁR,L. (1996*a*) Additions to American Cleptinae. *In* Norden, B. B. & Menke, A. S.: Contribution on Hymenoptera and associated insects dedicated to Karl V. Krombein. *Mem. Ent. Soc. Washington* **17**: 153–160.

MÓCZÁR, L. (1996*b*) New data on the Subfamily Cleptinae. *Acta. zool. hung.* **42**(2): 133–144.

MÓCZÁR, L. (1997*a*) Revision of the Cleptes nitidulus group of the World. *Entomofauna, Linz* **18**(3): 25–44.

MÓCZÁR, L. (1997*b*) Revision on Cleptes (Leiocleptes) species of the World. *Folia ent. hung.* **58**: 89–100.

MÓCZÁR, L. (1998*a*) Revision of the Cleptes (Holcocleptes) species of the World. *Acta zool. hung.* **43**(4): 323–343.

MÓCZÁR, L. (1998*b*) Supplement to the revision of Cleptes (Leiocleptes) of the World. *Folia ent. hung.* **59**: 209–211.

MÓCZÁR, L. (1998*c*) Revision of the Cleptinae of the World. Genus Cleptes subgenera and species groups. *Entomofauna, Linz* **19** (31): 501–516.

MÓCZÁR, L. (2000) World revision of the Cleptes satoi group. *Annls hist.-nat. Mus. natn. hung.* **92**: 297–324.

TADASHI, T. (1995) A list of the type specimens described from Japan as new species or subspecies of the Chrysididae and the Cleptidae by Dr K. Tsuneki, and their preserved museums. *Entom. J. Fukui* **17**: 17–20.

TSUNEKI, K. (1959) Contribution to the knowledge of the Cleptinae and Pseninae fauna of Japan and Korea. *Mem. Fac. Lib. Arts, Fukui Univ. Ser. II. Nat. Sci.* **9**: 1–78.

TSUNEKI, K. (1961) Chrysididae collected by the Osaka City University Biological Expedition to Southeast Asia 1957–58. *Nat. Life Southeast Asia* **1**: 367–382.

TSUNEKI, K. (1966) Notes on some Chrysididae and Specidae in the Collection of the Osaka Museum of Natural History, with descriptions of three new species. *Bull. Osaka Mus. Nat. Hist.* **19**: 19–28.

TSUNEKI, K. (1982) Two new species of Cleptes from Thailand and Formosa. *Spec. Publ. Japan Hymenopterists Ass.* **23**: 1–2.

UCHIDA, T. (1926) Über die Bethyliden Japans. *Zool. Mag. Tokyo* **38**: 181–186. [Japanese with German abstract]

Revised version received 5th May, 2000, accepted 20th December, 2000, published 15th May 2001

Catalogue of Palaearctic Diptera

edited by Á. SOÓS, L. PAPP and P. OOSTERBROEK

Volume 1
Trichoceridae – Nymphomyiidae

The Catalogue contains the basic taxonomic, nomenclatorial and distribution data of all species occurring in the Palaearctic Region with the fundamental morphological features for the majority of the fly groups.

Contents: Introduction to Volumes 1–13 (Á. SOÓS and L. PAPP). History of the Catalogue of Palaearctic Diptera. Structure. Genera and their type-species. Species names, type-localities. Distribution. Literature data, references. Dates of publication. Readers. Acknowledgements and closing remarks. List of contributors (Vols 1–13). Type-species designations in Volume 1. New names proposed in Volume 1. Families: Trichoceridae (C. DAHL). Tanyderidae (R. WAGNER). Blephariceridae (P. ZWICK). Deuterophlebiidae (L. JEDLICKA). Tipulidae (P. OOSTERBROEK and BR. THEOWALD). Cylindrotomidae (Á. SOÓS and P. OOSTERBROEK). Limoniidae (E. N. SAVCHENKO, P. OOSTERBROEK and J. STARY). Ptychopteridae (R. ROZKOSNY). Nymphomyiidae (L. JEDLICKA). Bibliography. Index.

April 30, 1992. 520 pages
US$ 80.00 plus US$ 8.00 for package and postage
(and an extra US$ 5.00 if you want it air mail)
ISBN 963 7093 10 9

Order should be sent
to the Hungarian Natural History Museum, Library
Baross u. 13., Budapest, H–1088 Hungary
Fax: (36–1) 3171669

Acta Zoologica Academiae Scientiarum Hungaricae 46 (4), pp. 333–336, 2000

A NEW SPECIES OF THE GENUS LOPHOTERGES HAMPSON, 1906 FROM IRAN: L. MARIANNAE SP. N. (LEPIDOPTERA, NOCTUIDAE, CUCULLIINAE)

M. FIBIGER

Molbechs alle, 49, 4180 Sorø, Denmark

A new species *Lophoterges mariannae* from Iran is described.

Key words: Noctuidae, Cucullinae, *Lophoterges*, Iran, new species

INTRODUCTION

A council meeting of the SEL (Societas Europaeae Lepidopterologica) held in 1992 at the home of Dr SIGBERT WAGENER, Bocholt, Germany, provided the author with the opportunity to look at his large collection of Lepidoptera. The Noctuidae were of particular interest as many of them were collected from localities in Turkey and Iran. Among them was a short series of a *Lophoterges* species from Iran. Dr LÁSZLÓ RONKAY, who is currently revising this genus, was shown the specimens, and he immediately confirmed that it was an undescribed species, representing the most easterly member of the *L. millierei–L. hoerhammeri* species group.

Lophoterges mariannae sp. n.

Holotype: male, Iran, Prov. Mazandaran, Elburs, Harez-Rud-Tal, Pelur, loc. 79, 2200 m, 27.xi.1973 (leg. WAGENER & SCHMITZ), gen. prep. 2516; deposited in coll. M. FIBIGER (Sorø, Denmark).

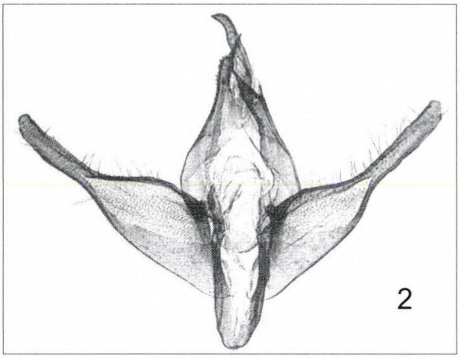
Paratypes. One male and two females, with the same data, one of the females, gen. prep. 4404 Ronkay; deposited in coll. S. WAGENER (Bocholt, Germany).

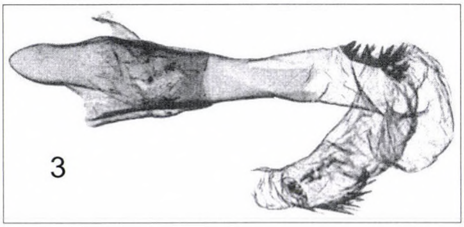
Description (Fig. 1). Wingspan: 29–30 mm. Antenna of male ciliate; of female filiform. Frons smooth. Labial palp porrect; the third segment half the length of the second; the former narrow; the latter tufted ventrally with long hair-like scales. Head and thorax brownish. Abdomen light brown/beige, with dorsal tufts of long brown scales. Forewing narrow, elongate. Ground colour brownish with costa light brown basally, interrupted by three black spots, the remnants of the basal, antemedian and postmedian lines. A narrow black basal streak present. The typical white *Lophoterges* stigmata present: orbicular elongate, flattened, oblique, fused with white outline of subcellular stigma; the reniform lunulate. Two black wedge-shaped marks near apex. Hindwing of male basally whitish, of female brownish, in both sexes gradually darker, brownish towards the dark brown terminal line. Fringes whitish. Underside unicolorous, slightly darker towards termen. Discal spot and terminal line on hindwing weakly marked.

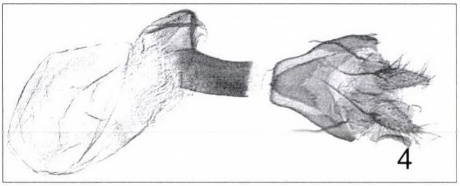
Male genitalia. Valva club-like (Fig. 2), broadest at clavus, tapered towards the middle of the valve; the distal part narrow, finger-like (width 1/3 of the basal part), with parallel sides. Clasper reduced to a sclerotised narrow bar, fused with the valva. Corona absent. Tegumen high, narrow, penicular lobes forming two pointed, asymmetrical, dentate, 'socii'-processes pointing towards uncus. The right socius-process (viewed ventrally) narrower and significantly longer. Juxta mouth-like (both lips together). Clavus a small, strong process with truncated apex, originating from a heavily sclerotised, narrow plate. Uncus prominent, distally flattened, hooked at apex. Aedeagus narrowest basally (Fig. 3). Carina double-peaked. A large subbasal membranous diverticulum projects to the left; the vesica projects dorsally, curving to the left with ductus ejaculatorius towards aedeagus; three clusters of short spinules: one subbasally on right side and two apically.

Female genitalia. Ovipositor weak, short, posterior papillae slightly elongated (Fig. 4); intersegmental gelatinous plate fine, less strongly developed. Ostium bursae calyculate with large sclerotised plates ventrally and dorsally, symmetrical, butterfly-like. Dorsal plate considerably smaller. Ventral side of ductus bursae heavily sclerotised anteriorly. A membranous bulb near the connection to corpus bursae. Distal part of corpus bursae rugulose, proximal part elliptical, membranous, finely scobinate. Appendix bursae rather short, conical, sclerotized, finely cristate.

Diagnosis. The new species belongs to the *L. millierei* species-group, consisting of four species: *L. millierei* (STAUDINGER, 1870), an undescribed species







Figs 1–4. *Lophoterges mariannae* sp. n. 1 = holotype, male; 2 = genital armature (gen. prep. 2516a FIBIGER); 3 = aedeagus and everted vesica (gen. prep. 2516b FIBIGER); 4 = female genitalia of *L. mariannae* (gen. prep. 4404 RONKAY)

from Northwest Africa (RONKAY & RONKAY 1995), *L. hoerhammeri* (F. WAGNER, 1931), and *L. mariannae* sp. n. It is rather remote from the other members of the species-group, its closest relative is *L. hoerhammeri*. *L. mariannae* superficially differs from all related taxa by its generally brownish forewing ground colour and less sharply defined lighter costal stripe and whitish stigmata.

In the male genitalia the conspicuous synapomorphic structure of the genus are the asymmetrical 'socii'-processes developed from the tegumen. The shape of the valva resembles that of the *L. centralasiae* species-group but the valves are less asymmetrical, the clasper is completely missing and the distal part of the valva is straight, not arcuate or curved. The penicular lobes of *L. mariannae* are strongly asymmetrical, with long, acute apical processes; those of *L. hoerhammeri* are significantly less asymmetrical, less dentate, and the apical processes are less expressed; those of *L. millierei* are similarly strongly asymmetrical but less strongly sclerotised and the apical processes are less differentiated, especially on the left side. The uncus of *L. mariannae* is stronger than those of the other members of the *L. millierei* species-group.

The everted vesica resembles those of the other species in the subgenus. The vesica of *L. mariannae* differs from those of *L. millierei* and *L. hoerhammeri* by the apically pointed subbasal diverticulum, and the longer spines of all three cornuti fields.

The generic apomorphic character of the female genitalia is the large sclerotised plates in ostium bursae: ventrally and dorsally with a symmetrical, butterfly-like sclerotisation. The female genitalia of *L. mariannae* differ from those of the other allied species by its narrower, higher, more trapezoidal ostium bursae with stronger, larger dorsal plate. The margins of the ductus bursae are almost parallel, not tapering caudally as in case of the related taxa.

The genitalia of *L. millierei* and *L. hoerhammeri* are also illustrated by DUFAY (1982).

Bionomics. The habitat for *L. mariannae* are the open, dry mountain slopes. The imagines are on the wing in June–July. The early stages are unknown.

Distribution. The new species is only known from the type locality.

Etymology. The species is named in honour of my patient wife, MARIANN FIBIGER, who, because of her continuous kind support, highly deserves a name in lepidopterology.

*

Acknowledgement – I wish to thank MARIANN FIBIGER and MARTIN HONEY, The Natural History Museum, London, for correcting the English text; Dr LÁSZLÓ RONKAY, Hungarian Natural History Museum, Budapest, for important discussions and suggestions to the description; GERT BROVAD, Zoological Museum, Copenhagen, for the photos; and Dr SIGBERT WAGENER, Bocholt, Germany, for kindly allowing access to his collection.

REFERENCES

DUFAY, C. (1982) Decouverte en Grece de Lophoterges hoerhammeri (F. Wagner), bona sp., espèce nouvelle pour l'Europe (Noctuidae, Cuculliinae). *Nota lepid.* **5**(2–3): 77–80.

RONKAY, G. & RONKAY, L. (1995) Cuculliinae II. *Noctuidae Europaeae*, Vol. 7. Entomological Press, Sorø, 224 pp.

Accepted 20th December, 2000, published 15th May 2001

Acta Zoologica Academiae Scientiarum Hungaricae 46(4), pp. 337–349, 2000

NEW EPIPSESTIS MATSUMURA, 1921 SPECIES (LEPIDOPTERA, THYATIRIDAE) FROM VIETNAM AND FROM NEPAL

LÁSZLÓ, GY. M.[1] and G. RONKAY[2]

[1]*H-8083 Csákvár, Gánti út 81, Hungary*
[2]*H-1137 Budapest, Szt. István krt 4, Hungary, E-mail: gronkay@zoo.zoo.nhmus.hu*

Descriptions of four new *Epipsestis* species, *E. niveifasciata* sp. n.; *E. bisociata* sp. n. and *E. vastaguncus* sp. n. from Vietnam and *E. peregovitsi* sp. n. from Vietnam and from Nepal are given. With 23 figures.

Key words: Thyatiridae, *Epipsestis*, new species, Vietnam, Nepal

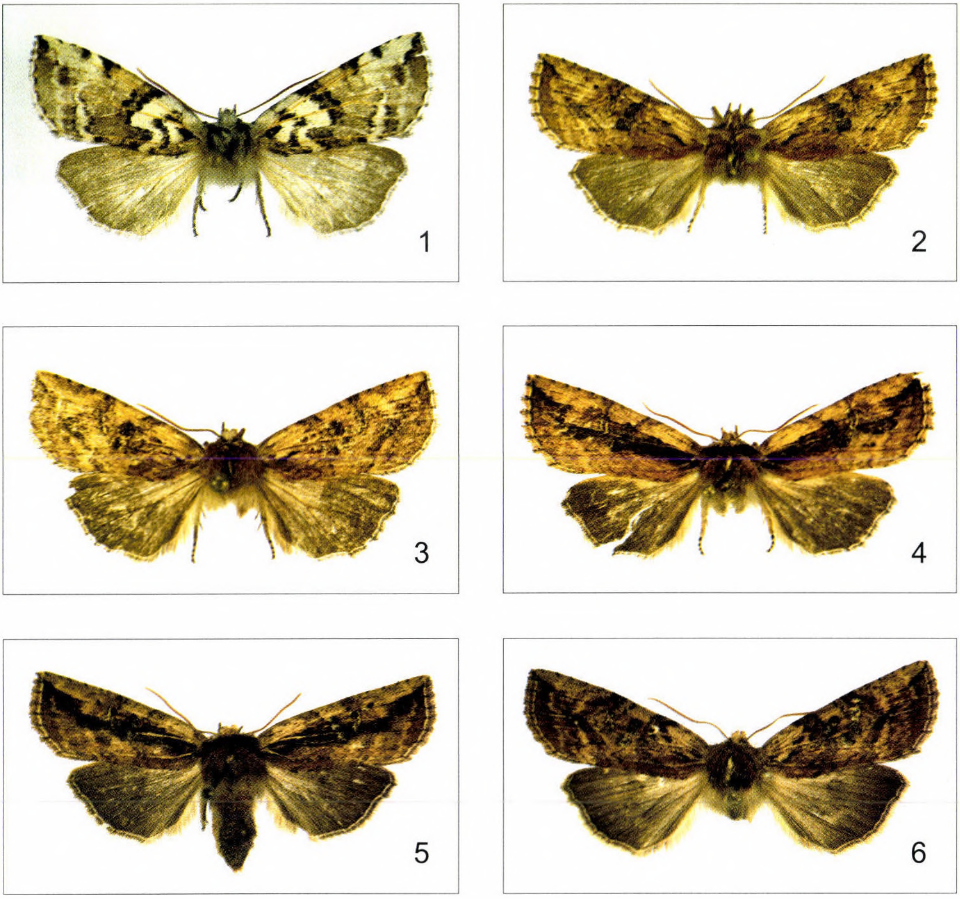
INTRODUCTION

Epipsestis MATSUMURA, 1921 is the largest genus of the thyatirid tribe Demopsestini, comprising more than a dozen of known species. The distribution of the genus is characteristically Himalayan, its range extending from the western Himalayas throughout the main chain to the northern extremities of Indochina and to Taiwan, and, a smaller portion of the species, is expanded northwards along the Pacific Coast to the Russian Far East, Korea and Japan.

About half of the recently known species was described in the last two decades, as a result of the intensification of the lepidopterological exploration of the southern Himalayas and the faunistic research in Taiwan (YOSHIMOTO 1982, 1983, 1984, 1988*a, b*, 1995). The species of the genus are typical of the late autumnal and winter aspects, and represent an interesting part of the so-called "winter fauna" of the Himalayan region.

In the framework of the research project of the Hungarian Natural History Museum on the winter fauna of northern Vietnam, the authors had the opportunity to study the *Epipsestis* material of the Fan-si-pan expeditions carried out in November–December, 1997 and in November, 1999. These expeditions were very successful, besides the large number of newly discovered Noctuidae species (HREBLAY *et al.* 1999), the material contained ten species of *Epipsestis*. Four of them were very unusual in their external appearance, differing strongly from all known taxa of the genus even for the first look. The more detailed studies revealed that these four species belong to four different phyletic lineages of the genus, and are not only new for the science, but display certain features in the genitalia (especially the males), which are unique within *Epipsestis*. During the survey of the Thyatiridae material of the Witt Museum, two of these species were repeatedly found. One of them was represented by a small series and from the same area, while a few specimens of the second species were found originating from the Kanchenjunga massiv, eastern Nepal.

The above mentioned other species found by the expedition are also interesting from taxonomic and biogeographical points of view and, with the exception of *E. nikkoensis* (MATSUMURA, 1921), they differ from the formerly described taxa in certain external and genital features. This fact indicates the importance of the northern mountainous areas of Indochina in the evolution of the genus (and also of the whole "winter fauna" of eastern Asia), and we believe that the discovery of additional new taxa of *Epipsestis* in this region is very probable.



Figs 1–6. 1 = *Epipsestis niveifasciata* sp. n., holotype; 2–6: *E. peregovitsi* sp. n.: 2 = holotype, Vietnam, 3–4 = paratype, male, Vietnam, 5–6 = paratype, female, Nepal

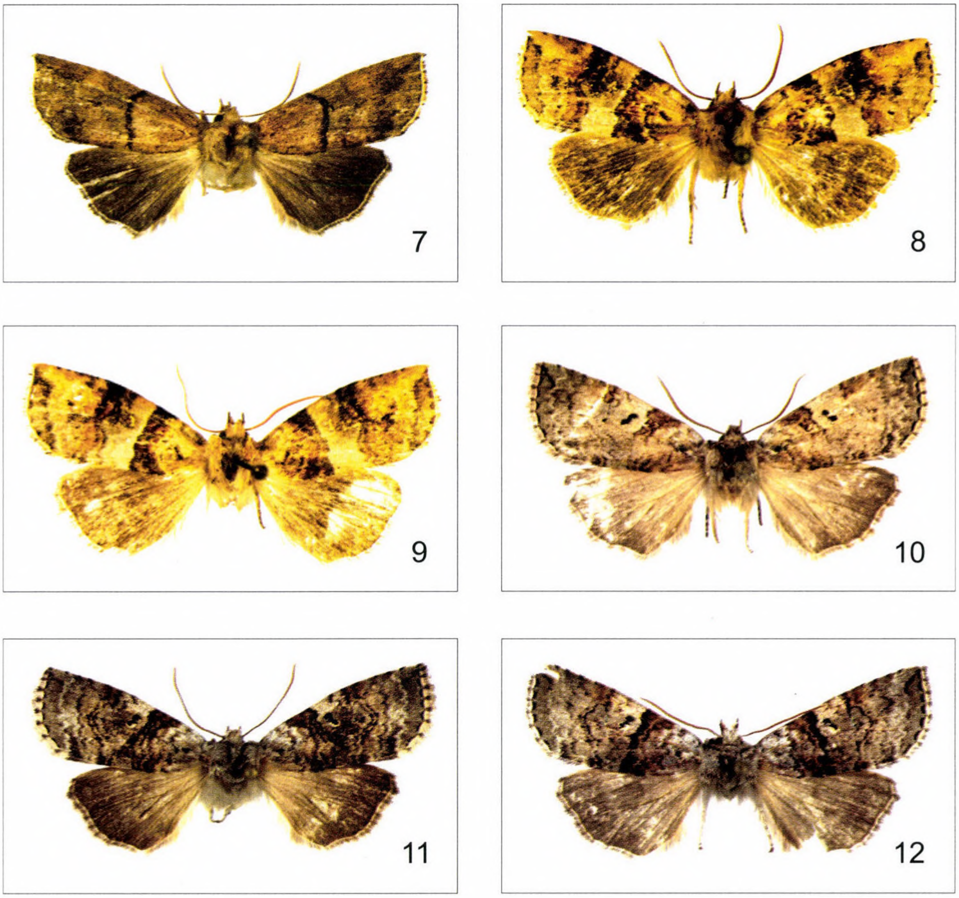
The present paper contains the descriptions of the four new species, the taxonomic analysis of the remaining taxa from Vietnam, with the survey of the *E. dubia* (WARREN, 1915) species-complex will be given in a separated article.

DESCRIPTIONS OF THE NEW SPECIES

Epipsestis niveifasciata sp. n.

(Figs 1, 13–17)

Holotype: male, “VIETNAM, Prov. Lao Cai, Fan Si Pan Mts, 2650 m, 22°18’89"N, 103°46’61"E, 19. XI. 1999, leg. A. Kun & L. Ronkay”, slide No. HLG1187; deposited in the HNHM, Budapest.



Figs 7–12. 7 = *Epipsestis bilineata* WARREN, male, Nepal; 8–9 = *E. bisociata* sp. n.: 8 = holotype, 9 = paratype, male, Vietnam; 10–12 = *E. vastaguncus* sp. n.: 10 = holotype, 11–12 = paratype, female, Vietnam

Paratypes: 1 female, with the same data as the holotype; 1 female, Vietnam, Prov. Lao Cai, 1900–2000 m, Fan-si-pan Mts, 14 km NW Sa Pa, 103°46,06'E, 22°20,9'N, 4–6.XII.1997, leg. L. PEREGOVITS & L. RONKAY (HNHM, Budapest and the Museum Witt, Munich).

Slide No. RL6275 (female).

Diagnosis: The new species is rather remote from all known species of the genus. Its external appearance is similar mostly to *E. stueningi* YOSHIMOTO, 1988, although the details of the wing pattern are rather strongly different: the antemedial line is broader, less distinct and less sinuous, the medial fascia is deeply angled inwards near the inner margin, the orbicular stigma is not spot-like but double, lunulate, the postmedial line has a much deeper curve at costal area and the subterminal line is less waved.

The male genitalia also show this position within the genus. Most of the typical characters may appear in a more or less similar form in certain *Epipsestis* taxa, but each of them in different species, like a mosaic from the genus and a part of the features is unique or very rare in *Epipsestis*. The uncus is longer, more slender than in the majority of *Epipsestis* species; the socius is rather *E. albidisca*-like but more robust, longer, broader; the tegumen is more or less quadratic; the fultura superior is relatively narrow, high, hat-like with fine, short, oblique medio-lateral fasciae and fine dentition at dorsal half. The valva is short, acutely triangular, the dorsal saccular crest is the longest within the genus, covering the full length of the dorsal margin of the sacculus, cristate but not spinulose, with stronger processi at costal and ventral edges. The aedeagus is angled between ostium ductus ejaculatorii and the ventral plate of the carina (this feature can be found in *Epipsestis* only in *E. renalis*); the plate of carina is long, strong, spoon-like, the cornuti of the cornuti field of vesica are attached strongly to the basal membrane.

The female genitalia are similar to those of *E. stueningi*, but the dorsal plate of the penultimate segment is much smaller, broad but short, not covering the papillae anales, the lamella antevaginalis is not sclerotized, the tubular part of corpus bursae is less swollen near the ductus bursae, and the signum is larger, not pyriform but cordiform, its teeth are arranged radially.

Description: Wingspan 32–35 mm, length of forewing 15–17 mm. Sexes similar. Head small, eyes large, palpi porrect, slender, white, lateral sides blackish. Frons, vertex and collar snow-white, marked with blackish grey hairs, antenna filiform, brown, with white scales on basal joints. Thorax ashy grey, tegulae white with broad, blackish margins, metathoracic tuft small, pale grey. Abdomen pale grey, covered with short hairs, dorsal crest absent. Forewing rather narrow, with apex pointed, outer margin evenly arcuate. Ground colour pale brownish grey with intense silvery sheen; median area suffused with pinkish brown and a few ochreous grey scales; basal area, apical field and fillings of postmedial and subterminal lines clean snow-white; tornal area bluish ashy grey. Crosslines broad, rather diffuse, blackish grey. Basal dash short, blackish, basal line simple, sinuous, antemedial double, strongly waved, with rather diffuse outer line, its filling pale grey. Postmedial line broad, slightly sinuous, blackish but rather diffuse, defined mostly by its strong, black costal triangles and white filling, median fascia invisible. Orbicular stigma black, lunulate, consisting of two spots, reniform hardly visible, fine, straight, pale greyish. Subterminal line diffuse, less sinuous, white, with fine, oblique, black apical streak. Terminal line blackish grey, consisting of fine arches, cilia whitish, chequered with blackish grey at veins. Hindwing slightly transparent, pale brownish grey, veins and marginal area somewhat darker. Terminal line indistinct, darker brown-grey, cilia pale whitish grey whith dark medial line. Underside of wings whitish grey with darker fumous grey suffusion, costa of forewing marked with white and black scales, traces of white forewing pattern also recognizable.

Male genitalia (Fig. 13): Uncus long, slender, slightly broader at base and at apical part. Socius rather large, angled and strongly dilated medially, basal neck and subapical part much narrower, apical end dilated, slightly folded. Tegumen more or less quadratic; fultura superior sclerotized, relatively narrow but high, hat-like, dorsal half covered with tiny teeth, medial third with two short, oblique lateral fasciae consisting of somewhat stronger teeth. Valva short, triangular, apically strongly tapering, with apex pointed; dorsal saccular crest very long, heavily sclerotized, cristate, without spinules, but terminating in strong processi at costal and ventral margins. Aedeagus long, angled at distal third between ostium ductus ejaculatorii and ventral plate of carina; plate of carina strong, lapathiform; cornuti field of vesica elliptical, narrow, cornuti medium-sized, being attached strongly to basal membrane.

Female genitalia (Fig. 17): Ovipositor short, broad, ventral plate of last segment sclerotized, more or less trigonical with weaker, more hyaline apical part, dorsal plate of last segment broader, membranous. Sclerotized dorsal plate of penultimate segment broad but short, caudally rounded, not covering papillae anales. Lamella antevaginalis not sclerotized, seventh segment with paired, scobinate, rounded ventral plates laterally. Ductus bursae short, with fine sclerotization at middle. Appendix bursae short, more or less tubular, tubular distal part of corpus bursae long, less swollen near ductus bursae. Proximal part of corpus bursae large, discoidal, membranous, signum large, cordiform, covered with radially arranged, small teeth.

Bionomics and distribution. Poorly known. The species inhabits, presumably, the highest forest regions of the Mts Fan-si-pan, two of the three known specimens were found along the edge of the montane primary forest and the elfin-forest zones while the third one was collected in a large forest clearing, at the edge of a less disturbed primary forest, at the end of a valley descending from the highest regions where the other two specimens were observed. The moths came to light rather early in the evening.

Etymology: The new species was named after its snow-white markings of the forewing.

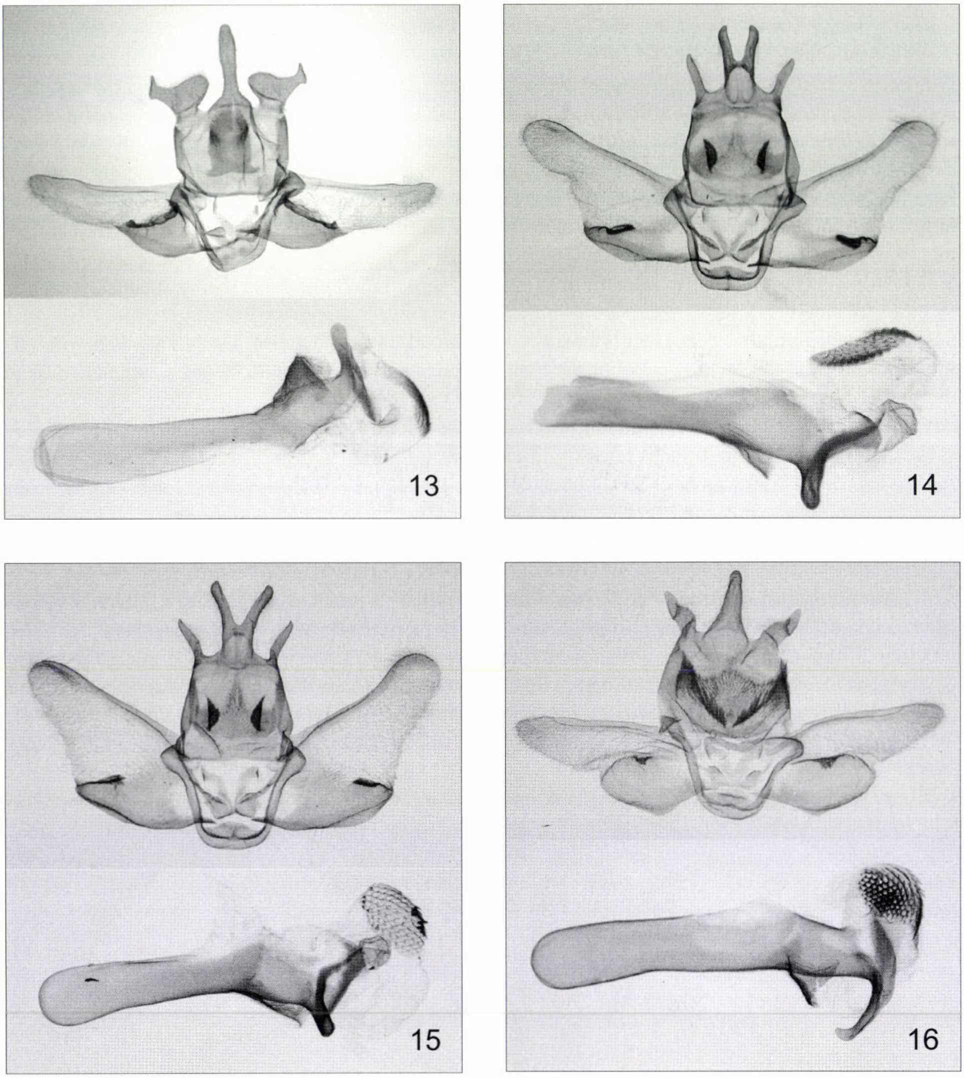
Epipsestis peregovitsi sp. n.

(Figs 2–6, 14–15, 18–19)

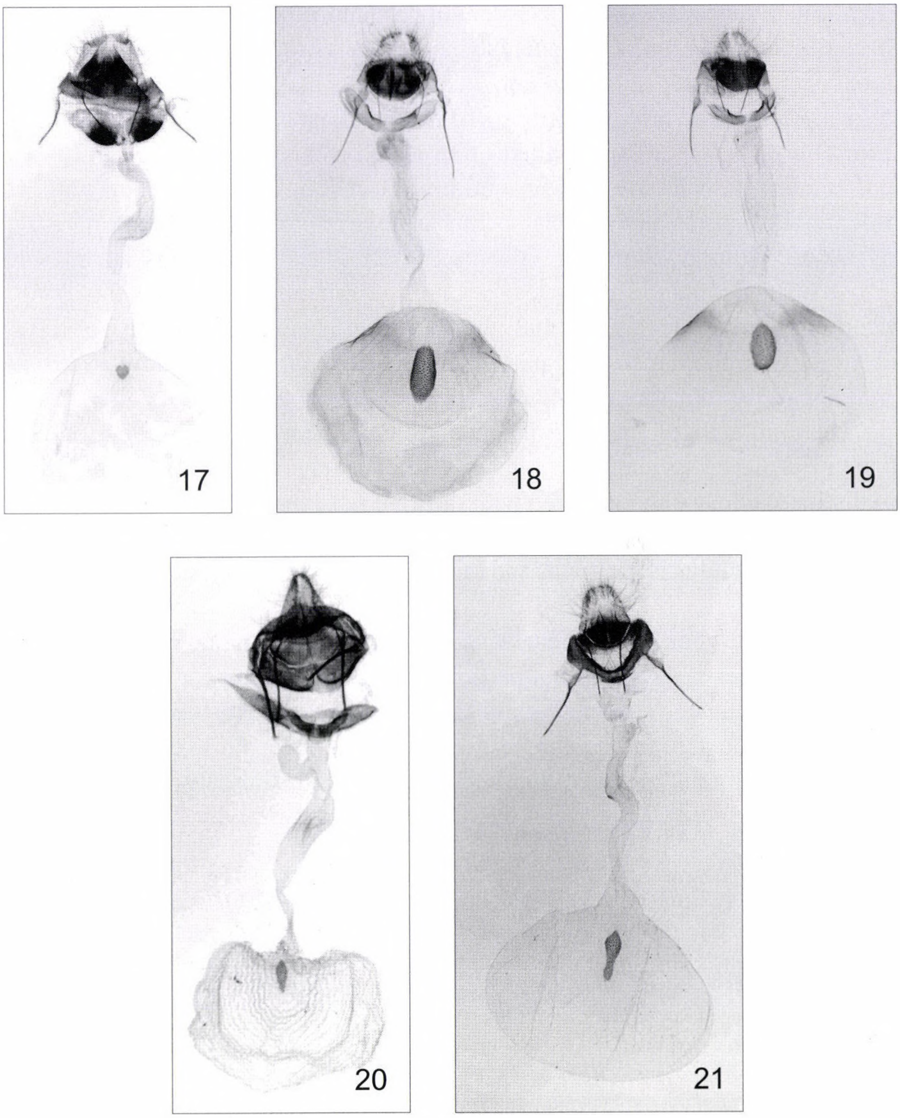
Holotype: female, "VIETNAM, Prov. Lao Cai, 1900–2000 m, Fan-si-pan Mts, 14 km NW Sa Pa, 103°46,06'E, 22°20,9'N, 8.XII.1997, leg. L. Peregovits & L. Ronkay", slide No. RL6272 (HNHM, Budapest).

Paratypes. Vietnam: 2 males, 2 females, with the same data as the holotype. Nepal. Koshi, Terhathum area: 4 females, Sirumani, 2950 m, 87°31'E, 27°15'N, 6.XI.1996; 1 female, Tshisopani, above Gorja, 2600 m, 87°37'E, 27°21'N, 5.XI.1996; 2 females, Tinjure Phedi, 2900 m, 87°27'E, 27°12'N, 7.XI.1996; 1 female, Chitre, 2500 m, 87°24'E, 27°05'N, 8.XI.1996, leg. GY. M. LÁSZLÓ and G. RONKAY; Mechi, Taplejung area: 2 males, 9 females, Surke Danda, 1 km W of Kesawa, 2000 m, 23.XI.1998; 1 male, 2 females, Deorali Danda, 6 km NW of Yamphudin, 19–20.XI.1998, leg. KARMA SHERPA (coll. HNHM and Museum Witt).

Slide Nos RL6261, RL6498, LG624 (W5175) (males), LG552 (W5171), RL6461 (W5170), RL6499, RL6500 (W5172) (females).



Figs 13–16. Male genitalia. 13 = *Epipsestis niveifasciata* sp. n., holotype; 14–15 = *E. peregovitsi* sp. n., paratype, male: 14 = Vietnam, 15 = Nepal; 16 = *E. bilineata pallida* YOSHIMOTO, male, Taiwan



Figs 17–21. Female genitalia. 17 = *Epipsestis niveifasciata* sp. n., paratype; 18–19 = *E. peregovitsi* sp. n., 18 = holotype, Vietnam, 19 = paratype, female, Nepal; 20 = *E. bilineata* WARREN, female, Nepal; 21 = *E. vastaguncus* sp. n., paratype, female, Vietnam

Diagnosis: The new species is similar externally to *E. bilineata* (WARREN, 1915), but is larger in size, the forewing ground colour is darker brown with ochreous irroration along the costa, the basal area is broader, the antemedial line is sinuous, arcuate, none of the ten known specimens have strong, straight, blackish antemedial line. The orbicular stigma of *E. peregovitsi* is not a fine, dark comma but an oblique-elliptical spot, filled often with blackish scales, the reniform is a small lunule with whitish-ochreous outline, a rounded claviform stigma with whitish-ochreous annulus and blackish centre is always present, this marking is regularly absent from *E. bilineata.* A smaller part of the specimens have a broad blackish brown or blackish grey fascia running from the base of the wing along the subcellular vein to the subterminal line, covering also the lower parts of the cell, then fused with the dark apical part of the subterminal line, forming a dark zone from the base of the wing to the apex.

The unique feature of the male genitalia of *E. peregovitsi* is the bifid uncus, all other *Epipsestis* species have single uncus. The other parts of the genitalia show also distinctive features compared with those of *E. bilineata* as the socii are longer, straight, the fultura superior is larger with strong lateral folds, the valva is more rounded, the sacculus is narrower and the cornuti field of the vesica consists of longer cornuti.

The female genitalia of the new species have also a unique character, the two sclerotized plates of the proximal part of the corpus bursae near the tubular distal part of corpus bursae. The other parts of the organ are most similar to those of *E. bilineata*, but the signum is significantly larger, stronger, the ventral plate of the penultimate segment is larger, rounded quadrangular, the ostium bursae is with stronger lateral sclerotization, and the ductus bursae is broader.

Description: Wingspan 30–35 mm, length of forewing 14–17 mm. Sexes similar. Head, frons, vertex and collar dark ochreous brown, sides of palpi, tufts of frons and base of collar marked with dark brown hair-scales, tip of collar more ochreous. Tegulae darker chestnut-brown, often mixed with fumous grey and black hairs, metathorax with pale ochreous tuft. Abdomen paler grey-brown, covered with short hair-scales, dorsal crest represented by small dark brown tufts. Forewing narrow, long, with pointed apex, outer margin evenly arcuate. Ground colour chestnut-brown, base of wing, costal and medial areas irrorated with pale ochreous and a few blackish grey; a broad blackish brown or blackish grey fascia, running from base of wing along subcellular vein to subterminal line and fused with dark apical part of subterminal line, may also present. Basal dash and a short streak above fine, black; crosslines fine, blackish grey, rather indistinct, sometimes obsolete. Basal and antemedial lines sinuous, double, filled with ochreous, postmedial line double, slightly sinuous, strongly angled outwards at vein m3, defined often by paler ochreous outer stripe. Median fascia absent or represented by its short, dark brown upper part. Stigmata fully developed, marked with prominent, blackish-grey and ochreous scales. Orbicular stigma rounded or elliptical, blackish, sometimes divided into two joining spots. Reniform narrow, straight, comma-like, blackish with incomplete ochreous outline, claviform rounded, often with ochreous annulus. Praeterminal line indistinct, diffuse, represented often by a few darker patches, subterminal also diffuse, sinuous, ochreous or pale brownish, termen with fine, oblique, black apical streak. Terminal line brownish, continuous, as ground colour, spotted with dark brown or dark grey. Hindwing dark greyish brown, veins and marginal area even darker, discal spot usually present but diffuse, large, rounded. Cilia pale ochreous grey whith dark medial line. Underside of wings dark ochreous grey with variably strong fuscous suffusion, costa of forewing spotted rather strongly, other elements of pattern diffuse or obsolete.

Male genitalia (Figs 14–15): Uncus medium-long, sclerotized, bifid, socii slightly shorter than uncus, more or less straight, acute. Fultura superior large, subtriangular, with strong, dentate lateral folds. Fultura inferior with rounded basal plates and V-shaped dorsal part with distally slightly dilated arms, vinculum very short, broadly U-shaped. Valva rather broad, apically rounded, sacculus narrow, sclerotized, with relatively short, dentated distal crest. Aedeagus tubular, carina with strong, broad, apically rounded ventral process and with two sclerotized ventro-lateral bars. Cornuti field of vesica large, armed with rather long, nail-shaped cornuti.

Female genitalia (Figs 18–19): Papillae anales membranous, rounded conical. Ventral plate of penultimate segment large, rounded quadrangular. Seventh segment with two narrow, relatively short lateral plates. Ostium bursae with stronger lateral sclerotization, ductus bursae short, rather broad. Appendix bursae very short, subconical, tubular distal part of corpus bursae relatively short, broad, finely scobinate. Proximal part of corpus bursae spacious, more or less drop-shaped, apical part with large, sclerotized lateral patches. Signum large, strong, elliptical, covered with strong teeth.

Bionomics and distribution. The Vietnamese specimens were collected at light in a large forest clearing between secondary and primary forest patches at about 2000 m a.s.l., surrounded by large, montane primary forest regions at the higher elevations. It is worth to mention that all five specimens were collected at the last, coolest night of the expedition (8th December) although the weather conditions were much better at the preceding week and, with the exception of the holotype, the specimens are not freshly emerged. The other population of the species was discovered in Eastern Nepal, in a medium-high chain between the valleys of the Arun and the Tamur rivers. The collecting habitats are large, dense, deciduous forests between 2500–3000 m altitude.

Etymology: The new species is dedicated to Mr LÁSZLÓ PEREGOVITS (HNHM, Budapest, collection of Lepidoptera), the Hungarian coordinator of the lepidopterological research project in Vietnam, one of the collectors of the new species.

Epipsestis bisociata sp. n.
(Figs 8–9, 22)

Holotype: male, "N. Vietnam, Mt. Fan-si-pan N Side, 2250 m, 22°17N, 103°44'E, primary forest, 1.–6.xi.1995., leg. V. Sinjaev & E. Afonin, ex coll. A. Schintlmeister", slide No. LG464 (W5168) (coll. Museum Witt).

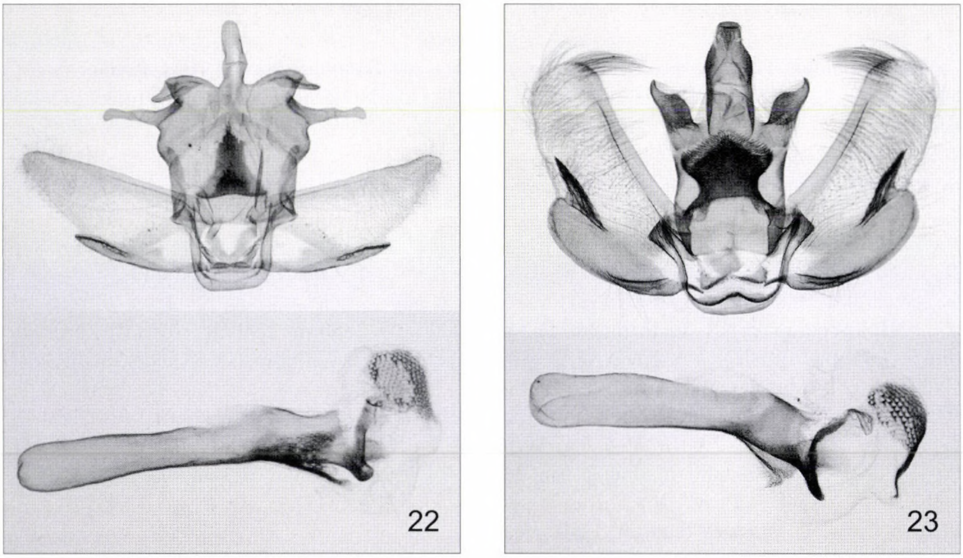
Paratypes: Vietnam: 6 males, with the same data as the holotype; 1 male, Cha-Pa, 2250 m, 22°15'N, 103°45'E, 28–29. III. 1995, leg. SINJAEV & local collector (coll. Museum Witt); 1 male, Prov. Lao Cai, 1900–2000 m, Fan-si-pan Mts, 14 km NW Sa Pa, 103°46,06'E, 22°20,9'N, 4–6.XII.1997; 3 males, Prov. Lao Cai, Fan-si-pan Mts, 3 km NW Cat Cat, 2000 m, 1.XII.1997, leg. L. PEREGOVITS & L. RONKAY (coll. HNHM).

Slide Nos LG448 (W5169), RL6267 (males).

Diagnosis: The new species resembles slightly to *E. castaneata* (WARREN, 1915) by its rather pale chestnut-brown forewing ground colour and whitish-grey median area, but it is easily distinguishable from its congener by the following features: the forewing ground colour is much paler, more ochreous-brown, the basal area is narrower, the antemedial line is stronger, oblique, almost straight, the median area is broader, more silvery grey, the orbicular and reniform stigmata are not blackish commas but indistinct ochreous-greyish annuli, often with darker filling, the lower half of the postmedial line is more waved, etc.

The male genitalia of *E. bisociata* differ from those of all known relatives by the bilobate socii with longer, straight proximal and bird-head-like, folded, pointed distal lobe. Comparing the other features with those of *E. castaneata*, the uncus is narrower, the fultura superior is heavily sclerotized, subtriangular, with strong spinules medially and medio-apically, the costa of the valva is straight, the saccular lobe of the sacculus is longer and covered with small, short spiculi, the cornuti field of the vesica is larger, stronger.

Description: wingspan 29–32 mm, length of forewing 14–16 mm. Male. Head, frons, vertex, collar and tegulae ochreous brown, frons whitish-ochreous, sides of palpi, tufts of frons, base and tips of collar and tegulae marked with darker brown hair-scales. Abdomen paler ochreous grey, dorsal crest represented by small dark brown tufts. Forewing relatively broad, with apex pointed, outer margin evenly arcuate. Ground colour pale ochreous brown with fine reddish shade, median area conspicuously unicolorous silvery grey below cell, other parts of wing irrorated with whitish-ochreous,



Figs 22–23. Male genitalia. 22 = *Epipsestis bisociata* sp. n., holotype; 23 = *E. vastaguncus* sp. n., holotype

darker grey and red-brown scales. Basal dash absent or reduced to a short, oblique, dark brown streak, crosslines rather indistinct except fine lines of ante- and postmedial lines bordering median area. Basal line arcuate, double, sinuous, dark brownish grey filled with ochreous, antemedial line less sinuous, oblique, filled with dark grey. Postmedial line double, slightly sinuous, oblique, dark grey filled with ochreous brown. Upper part of median area silvery grey irrorated with ochreous and reddish brown scales, orbicular and reniform stigmata present, narrow, straight, marked with prominent ochreous and dark grey scales. Praeterminal line indistinct, represented by a row of small, darker grey patches, subterminal stronger, sinuous, silvery-greyish defined with darker grey outer stripe. Apical streak less distinct, short, blackish grey. Terminal line interrupted, dark grey-brown, cilia as ground colour, spotted with dark brown or dark grey. Hindwing greyish brown, transverse line and discal spot usually present but diffuse. Underside of wings yellowish or ochreous, with variably strong brown or grey irroration, transverse lines and discal spots present but diffuse. Female unknown.

Male genitalia (Fig. 22): Uncus rather strong, medium-long, tegumen very broad, sclerotized, socii bilobate, proximal lobe longer, straight, distal lobe bird-head-like, folded, pointed. Fultura superior heavily sclerotized, subtriangular, with strong spinules medially and medio-apically, vinculum very short, strong, U-shaped. Valva elongated, relatively wide, with apex pointed, sacculus narrow, saccular lobe long, narrow, covered with small, short spiculi. Aedeagus long, tubular, carina with strong but relatively short, broad, apically rounded ventral process and with two short, sclerotized ventro-lateral bars. Cornuti field of vesica pear-shaped, medium-large, armed with short, chevron-shaped cornuti.

Bionomics and distribution. The specimens of the new species are known only from different primary forest parts of a rather small area of the Mts Fan-si-pan, near or above 2000 m altitude. *E. bisociata* is seemingly a species typical of the higher forest belt of this mountain system, a member of the late autumnal aspect.

Etymology: The specific name refers to the bilobate socii of the male clasping apparate of the new species.

Epipsestis vastaguncus sp. n.
(Figs 10–12, 21, 23)

Holotype: male, "VIETNAM, Prov. Lao Cai, 1900–2000 m, Fan-si-pan Mts, 14 km NW Sa Pa, 103°46,06'E, 22°20,9'N, 4–6.XII.1997, leg. L. Peregovits & L. Ronkay", slide No. RL6263 (HNHM, Budapest).

Paratypes: 1 female, with the same data as the holotype; 1 male, 1 female, from the same locality but collected at 8.XII.1997, leg. L. PEREGOVITS & L. RONKAY (coll. HNHM and Museum Witt).

Slide Nos RL6262 (male), RL6271, RL6274 (females).

Diagnosis: No similar *Epipsestis* species is known, resembles slightly the members of the *dubia* (WARREN, 1888) species-group. The male genitalia differ from all other species of the genus by their thick, robust, dorsally humped, apically obtuse uncus, strong, thick socii with rather strong, pointed dorso-lateral extension ("apex"), and by the narrow saccular lobe armed with very long, pointed spines. In addition, the fultura superior is huge, wide-based, sclerotized, covered with long spiculi, the valva is elongated, narrow, its apex extending over the tip of socius and the sacculus is rounded, sclerotized, with long, acute apical spines. In the female genitalia the ventral plate of the last segment is not sclerotized, while the dorsal plate is dentate-scobinate, the medial incision is very narrow, deep. The 8th sternite is narrow, half-ring-like, the tubular part of corpus bursae is very long, twisted, with small swollen portion near the ductus bursae and the signum is long, narrowly deltoidal.

Description: Wingspan 32–35 mm, length of forewing 15–17 mm. Sexes similar. Head pale grey, frons mixed with dark grey hairs, vertex whitish, collar and tegulae marked with dark brown-grey. Palpi whitish, lateral sides darker brown, antenna dark red-brown, male antenna thicker, slightly darker than that of female. Abdomen paler grey, dorsal crest represented by small dark brown tufts. Forewing relatively broad, with apex pointed, outer margin evenly arcuate. Ground colour pale ashy grey with fine silvery-pinkish hue, irrorated variably strongly with whitish, brown and fumous grey scales, scaling finely reticulate. Basal dash represented by small black (or orange-yellow) patch, basal area irrorated strongly with whitish-grey scales. Crosslines blackish grey or blackish brown, filled with whitish grey, basal and antemedial lines double, sinuous, rather indistinct, latter may defined by strong, oblique, straight blackish stripe. Postmedial line double, slightly sinuous, oblique, defined by a few blackish spots on veins, median fascia diffuse or obsolescent, costal part more distinct. Orbicular and reniform stigmata present, orbicular sharply defined, oblique, consisting of two or three, more or less fused black spots, defined by a few white scales below (in one specimen basal dash orange-yellow, orbicular stigma ochreous white). Reniform stigma hardly visible, represented by a few black and white grey scales forming a fine comma. Praeterminal line fine, slightly sinuous, diffuse grey stripe, subterminal line greyish white, sinuous, defined with a few darker grey scales on both sides. Apical streak short, oblique, dark grey, terminal line interrupted, consisting of small blackish grey arches, cilia whitish, chequered with dark grey. Hindwing brownish grey, transverse line broad, diffuse, usually hardly visible, marginal suffusion broad, somewhat darker than ground colour. Cilia ochreous or whitish, with brown medial line. Underside of wings pale ochreous grey, forewing and marginal area of hindwing with variably strong brownish grey suffusion, traces of transverse lines present, but diffuse.

Male genitalia (Fig. 23): Uncus thick, robust, dorsally humped, apically obtuse. Tegumen narrow, low, socii strong, thick, with rather strong, pointed dorso-lateral extension ("apex"). Fultura superior huge, wide-based, sclerotized, covered with long spiculi, vinculum short, broadly U-shaped. Valva elongated, projecting dorsally over tip of socius. Valval apex rounded, bearing a bundle of long setae, sacculus rounded, sclerotized, saccular lobe narrow, with very long, pointed spines. Aedeagus medium-long, tubular, carina with broad, apically rounded ventral process and with a short, broad and a narrow, long ventro-lateral bar. Cornuti field of vesica long, narrow, armed with chevron-like cornuti.

Female genitalia (Fig. 21): Ovipositor shortly conical, ventral plate of last segment not sclerotized, dorsal plate dentate-scobinate, medial incision very narrow, deep. 8th sternite narrow, sclerotized, half-ring-like. Ostium bursae membranous, cup-shaped, ductus bursae short, with fine lateral sclerotization. Appendix bursae small, subconical, tubular distal part of corpus bursae very long, twisted, with small swollen caudal portion near ductus bursae. Proximal part of corpus bursae large, discoidal-ovoid, signum long, narrow, deltoidal with broader caudal half.

Bionomics and distribution. The new species is another characteristic member of the late autumnal aspect, the collected two females freshly emerged at the first decade of December while the two males are relatively worn. The moths were collected at light, at the same site where the two other new species, *E. niveifasciata* and *E. peregovitsi*, have also been discovered.

Etymology: The specific name refers to the thick, robust uncus of the new species ("vastag" means "thick" in Hungarian).

*

Acknowledgements – The authors are indebted to Mr ANDRÁS KUN, Mr LÁSZLÓ PEREGOVITS and Dr LÁSZLÓ RONKAY for the opportunity to study the Vietnamese *Epipsestis* material of the HNHM, Budapest, and for the kind help and advices during the preparation of the material and the manuscript. We are indebted to Mr. THOMAS WITT for the possibility to work in his collection and for the loan of the material. Our special thanks to Mr IMRE RETEZÁR (Budapest) for the excellent colour transparencies.

REFERENCES

DALLA TORRE, K. W. VON (1921) *Cymatophoridae.* Junk, Lepidopterorum Catalogus **25**: 1–38.

GAEDE, M. (1930) Cymatophoridae. *In* SEITZ, A. (ed.): *Die Gross-Schmetterlinge der Erde*, Vol. 10, Stuttgart, pp. 658–663, pl. 85.

HAMPSON, G. F. (1896) *The fauna of British India, including Ceylon and Burma (Moths), Vol. 4*, London, 594 pp.

HOULBERT, C. (1921) *Revision monographique de la famille des Cymatophoridae. In* OBERTHÜR, CH.: *Études de Lépidopterologie Comparée* **18**(2): 23–252, pl. 488–489, 68 figs.

HREBLAY, M., PEREGOVITS, L. and RONKAY, L. (1999) New genera and species of Noctuidae from Vietnam, Thailand and Nepal (Lepidoptera). *Acta zool. hung.* **45**(1): 1–96.

SEITZ, A. (1933) Cymatophoridae. *In* SEITZ, A. (ed.): *Die Gross-Schmetterlinge der Erde, Vol.* 2 (suppl.), Stuttgart, pp. 187–195, 286, pl. 11, 14–16.

WARREN, W. (1912) Cymatophoridae. *In* SEITZ, A. (ed.): *Die Gross-Schmetterlinge der Erde* 2: pp. 321–333, pl. 49, 55, 56, Stuttgart.

YOSHIMOTO, H. (1982) Notes on the genus Epipsestis, with descriptions of three new species from Nepal (Lepidoptera: Thyatiridae). *Tyo to Ga* **32**(3–4): 117–137.

YOSHIMOTO, H. (1983) Thyatiridae from Nepal chiefly based on the collection of the Lepidopterological Research Expedition to Nepal Himalaya 1963 by the Lepidopterological Society of Japan. *Tyo to Ga* **34**(1): 21–33.

YOSHIMOTO, H. (1984) Notes on Epipsestis species (Thyatiridae) from Taiwan, with description of a new subspecies. *Japan Heterocerists' Journal* **128**: 33–34.

YOSHIMOTO, H. (1988) Further notes on the genus Epipsestis Matsumura, 1921 (Lepidoptera, Thyatiridae). *Tyo to Ga* **39**(1): 83–89.

YOSHIMOTO, H. (1988) A new Epipsestis (Lepidoptera, Thyatiridae) and records of some allies from China based on the Höne collection. *Bonner Zoologische Beiträge* **39**(4): 409–415.

YOSHIMOTO, H. (1995) Description of a new species of the genus Epipsestis Matsumura (Lepidoptera, Thyatiridae) from Taiwan. *Transactions Lepid. Soc. Japan* **46**(4): 241–243.

YOSHIMOTO, H. (1996) Records of Thyatiridae from Thailand (Lepidoptera). *Tinea* **14**(4): 279–286.

Received 15th January, 2000, accepted 20th December, 2000, published 15th May 2001

The Fauna of the Aggtelek National Park

VOLUME I–II

Edited by S. MAHUNKA

The seventh part of the series "Natural History of the National Parks of Hungary" comprises a collection of papers written by thirty-seven Hungarian and foreign experts. This is the first volume which discusses a large share of the scientifically elaborated material deriving from the territory of the Bükk National Park (North Hungary).

The book opens with a preface written by Dr. J. Tardy, deputy secretary of state, who gives his "Reflections on nature conservation in Hungary, 1993", followed by an editorial Introduction having a detailed list of all the larger administrative and also minor locality names, some of which are amply shown in a map. The volume proper is divided into two sections: Mollusca and Arthropoda. The latter, by far the biggest section, is a collection of scientifically highly valuable contributions on the following groups of animals: Mallophaga (4 pp), Heteroptera (4 pp), Homoptera (8 pp), Coleoptera (80 pp), Lepidoptera (162 pp), Diptera (82 pp), Siphonaptera (6 pp), Hymenoptera (42 pp), Acari (5 pp). The book closes with an Index to Authors.

The volume published by the Hungarian Natural History Museum in 1993.

ISBN 963 7093 206. Soft bound,
456 pages with several figures and tables.
Price: 30 US dollars excl. p. & p.

Order should be sent
to the Hungarian Natural History Museum, Library
Baross u. 13., Budapest, H–1088 Hungary
Fax: (36–1) 3171-669

Acta Zoologica Academiae Scientiarum Hungaricae 46(4), pp. 351–382, 2000

NEW AGROCHOLA HÜBNER, 1821 AND OWADAGLAEA HACKER ET RONKAY, 1996 SPECIES FROM CENTRAL ASIA AND INDOCHINA (LEPIDOPTERA, NOCTUIDAE, XYLENINI)*

RONKAY, G.[1] and L. RONKAY[2]

[1]*H-1137 Budapest, Szt. István krt. 4, Hungary; e-mail: gronkay@zoo.zoo.nhmus.hu*
Department of Zoology, Hungarian Natural History Museum
[2]*H-1088 Budapest, Baross u. 13, Hungary; e-mail: ronkay@zoo.zoo.nhmus.hu*

The species of the *Agrochola* (s. l.) *statira-* and *A. trapezoides*-groups are revised, three new species, *A. griseovariegata* sp. n. (Hissar Mts), *A. zoltanus* sp. n. and *A. deosaiensis* (Deosai Mts) are described, *A. leptographa* HACKER et RONKAY, 1990 is synonymized with *A. approximata* (HAMPSON, 1906). The taxa of the *Owadaglaea lucida* and *O. chloromixta* species-groups are discussed, three new species, *O. lexuancanhi* sp. n. (Fan-si-pan Mts), *O. hadasi* sp. n. (Karakoram Mts) and *O. siddiquii* sp. n. (Deosai Mts) are described. With 43 figures.

Key words: new species, Noctuidae, *Agrochola*, *Owadaglaea*, Central Asia, Vietnam

INTRODUCTION

The so-called "winter fauna" is one of the most characteristic faunal types of the Himalayan–Sino–Tibetan Noctuidae fauna (and also to some other lepidopteran families, e.g. Thyatiridae, Saturniidae, Geometridae, etc.). This faunal type represents one of the most important groups of the arboreal Noctuidae adapted to the northern temperate zone, mostly in the Palaearctic region, but also in North America. The species richness and the distribution pattern of the "winter fauna" are rather heterogeneous in the Holarctic region, the Himalayan subregion is very rich from this point of view, while vast areas in Central and Western Asia and in the largest part of North America harbour only a few genera and species. There are some smaller, secondary centres of speciation in the Western Palaearctic (e.g. in the Mediterranean range and in Asia Minor) and in the northern Pacific region, but the core area of this faunal type covers the mountainous territories of the southern Himalayas, the eastern Tibetan massif and the northern and central parts of Indochina.

From taxonomic point of view this faunal type comprises mostly two large tribes of the subfamily Hadeninae sensu lato, Orthosiini and Xylenini (this latter

---

* Results of the Lepidopterological Research Project of the Himalayan Wildlife Foundation and the Hungarian Natural History Museum for the exploration of the fauna of the Deosai National Park and the Northern Areas of Pakistan, No. 2.

tribe has long been placed into the subfamily Cuculliinae). On the other hand, numerous representatives of other trifine and quadrifine tribes and subfamilies can be found, often exclusively, in this period of the year, "associating to this faunal complex", though the majority of species of these taxonomic units is typical of the warmer, more humid aspects (e.g. characteristic groups of the subfamilies Plusiinae, Ipimorphinae, Amphipyrinae, etc.). The importance and the real diversity of the winter fauna became evident only in the very last years.

The intensification of the faunistic exploration of the wide sense Himalayan region started only at the second part of the sixties of this century. The research was focused mostly on the Nepal Himalaya. The most extensive expedition materials have been collected during the last decade, covering large areas of the western and southern ranges of the Himalayan chain (Pakistan, India, Nepal), the north-eastern confines of Indochina, especially of Thailand and Vietnam, and also of Taiwan, the fauna of which shows very close connections with those of the continental massifs of the region under discussion. The taxonomic results of the studies on the new materials and the revisions of the formerly described taxa have been continuously published since the beginning of the eighties, mostly by Japanese, German and Hungarian specialists, the most important works are listed in the references of HACKER (1990, 1996), HREBLAY and RONKAY (1998, 1999) and HREBLAY *et al.* (1999).

The present paper deals with the systematic survey of some central and eastern-south-eastern Asian species-groups of two characteristic genera of the winter Noctuidae, *Agrochola* HÜBNER, 1821 (s.l.) and *Owadaglaea* HACKER et RONKAY, 1996, including the descriptions of six new species. The majority of the new taxa was discovered during the last year in the course of expeditions to Pakistan. The field work was carried out in an effective and successful cooperation with the Himalayan Wildlife Foundation (HWF), based on the mutual understanding of the aims and requirements of the counterparts. The leaders of the HWF gave us not only permissions and guidelines for the studies in the Deosai National Park, but they also helped us to keep in mind the importance and the possible use of the taxonomic-faunistical research in the nature conservation management and vice versa. This attitude gave opportunity to gather systematical information about the Noctuidae fauna of the Northern Territories of Pakistan, resulting in the discovery of numerous new noctuid species in the formerly less explored areas. This article is the second part of the series containing the results of the joint project.

Abbreviations – AKM – Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn; BMNH – The Natural History Museum, London, formerly British Museum, Natural History; HNHM – Hungarian Natural History Museum, Budapest; ZSM – Zoologische Staatssammlung, Munich.

SYSTEMATIC PART

NEW SPECIES OF *AGROCHOLA* HÜBNER, 1821 (S. L.) FROM CENTRAL ASIA

The revision of the *Agrochola statira*-group

Species of the group
- *A. statira* BOURSIN, 1960
- *A. zoltanus* sp. n.
- *A. spectabilis* HACKER et RONKAY, 1990
- *A. griseovariegata* sp. n.

The overwhelming majority of the Central Asian *Agrochola* s.l. species belong to two large species groups of characteristic external appearance, the *A. statira* and the *A. trapezoides* (STAUDINGER, 1882) species-groups. The colouration and the wing pattern of the members of the two groups are rather dissimilar (see Figs 1–15), the configuration of the genitalia of both sexes show, however, their close relationship (Figs 25–35). The distribution patterns of the taxa of the two groups are also overlapping in several cases, reflecting the presumably similar processes of speciation, due to the effects and conditions of the same geographic regions and ages.

The *A. statira*-group comprises four medium-large species with slender body, long, narrow, acute forewing and small, more or less rounded hindwing. The eyes are rather small, globular, palpi very short, porrect or sligthly upturned, with scarce, long ventral hair-scales; the frons is smooth, slightly prominent. The antennae of both sexes are filiform, those of the males ciliate with long, fasciculate cilia, those of females with a few, scarce, short cilia. The forewing pattern is most often typical of the genus, the crosslines may become obsolescent, especially in *A. zoltanus* sp. n.; the ground colour is always grey or greyish. The male abdomen is slender, relatively short, abdominal coremata present or reduced; the abdomen of the female is stronger, thicker, the tip of the long ovipositor is hunging out from the abdomen.

The ground plan of the male genital capsula is very uniform, being common also with that of the *A. trapezoides*-group, the externally often strongly different species may have very similar clasping apparatus. On the other hand, the configuration of the vesica and the structure of the bursa copulatrix show conspicuous differences between the closely related taxa, the lineages within the group can easily be recognized by these features. The main characteristics are as follows: uncus medium-long, slender, tegumen weak, broad, with large, quadrangular penicular lobes, fultura inferior subdeltoidal, rather small, vinculum slender, V-or U-shaped. Valva narrow, elongate, slightly arcuate, costa sclerotized, with long, acute medial externsion and strongly serrate subapical plate, cucullus narrow, pointed, corona long. Clavi small, rounded, harpe long, slender, S-shaped. Aedeagus large, thick, cylindrical, arcuate, vesica very long, broadly tubular, basally coiled, recurved ventrally; its walls weakly membranous, finely scobinate. Basal and subterminal diverticula large, medial cornuti field long, narrow, consisting of short spinules, terminal cornutus relatively long, straight, thorn-like.

The female genitalia is characterized by the very long, narrow, rather weak ovipositor, the small, falciform or lyriform ostial plate, the medium-long, broadly tubular or trapezoidal ductus bursae, the large, often more or less bilobate bursa with large, spacious, partly heavily sclerotized cervix bursae and elliptical or discoidal, membranous corpus bursae, having a single, rounded or elliptical signum.

The differences between the genitalia of the *A. statira* and *A. trapezoides* species-groups can be summarized in the following table:

A. statira-group	*A. trapezoides*-group
MALE	
uncus longer, more slender	uncus shorter, thicker
valva longer, narrower	valva shorter
cucullus narrow	cucullus dilated, broader than medial part of valva
apex without acute dorsal process	apex may has acute dorsal process (*A. trapezoides*- and *A. approximata*-lineages)
corona situated along or near ventral margin of cucullus	corona situated near to middle of cucullus
costal plate longer, more serrate	costal plate shorter, less serrate
harpe longer, more slender, S-shaped	harpe shorter, more or less straight
vesica with long, narrow medial field of short spinules	vesica with considerably shorter medial field of stronger cornuti, sitting on small diverticulum
FEMALE	
ostium bursae with fine, falcate or lyriform sclerotized plate	ostium bursae calyculate or cup-shaped, with rather weak sclerotization
ductus bursae broader, stronger, flattened	ductus bursae weaker, narrower
cervix bursae situated at proximal end of bursa, with rounded, heavily sclerotized plate	cervix bursae situated at distal (caudal) end of bursa (except in *A. deosaiensis*), often with heavily sclerotized plate of irregular shape; bursa sometimes bilobate
corpus bursae with rounded or elliptical signum	corpus bursae without signum

The *A. statira*-group contains two lineages, both represented by allopatric twin species. The *A. statira*-line (*A. statira* and *A. zoltanus*) can be characterized by the reduced crosslines of the forewing and by the semiglobular, appendix-like cervix bursae situated at the fundus bursae. The species of the *A. spectabilis*-line (*A. spectabilis* and *A. griseovariegata*) have well defined, crosslines on the forewing, defined with whitish grey, smaller, not conspicuously prominent cervix bursae, situated at middle of the larger, more discoidal corpus bursae.

Bionomics and distribution. The species are restricted to deep rocky gorges and stream valleys, inhabiting shrubby and gallery forest patches along brooks and rivers at medium high and relatively high altitudes (2000–3500 m). The species are univoltine, the imagines are on wing late in autumn, between September–October, depending on the elevation of the locality and the climate of the actual year.

The species-group consists of stenochorous species of allopatric distribution, the range of the group extending from the north-western Himalayas to the western Hindukush, the Hissar Mts and to the eastern part of the Tien Shan massif.

Agrochola zoltanus sp. n.

(Figs 3–6, 27, 28)

Holotype: male, Pakistan, Kashmir, Himalaya Mts, Deosai Mts, Bubin valley, 3300 m, 75°02,7'E, 35°13,5'N, 15–17.X.1998, leg. GY.M. LÁSZLÓ and G. RONKAY (coll. G. RONKAY, in HNHM Budapest).

Paratypes: Pakistan: 44 males, 20 females, Kashmir, Himalaya Mts, Deosai Mts, Bubin valley, 3300 m, 75°02,7'E, 35°13,5'N, 15–17.X.1998, leg. GY.M. LÁSZLÓ and G. RONKAY; Bubin valley, 3150 m, 75°02,7'E, 35°13,5'N, 21–22.IX., 24–25.IX.1998, leg. P. GYULAI and A. GARAI; 12–16.X.1998, leg. GY.M. LÁSZLÓ and G. RONKAY; Bubin valley, near Dzhelkats village, 2900 m, 23–24.IX.1998, leg. P. GYULAI and A. GARAI (coll. HNHM, BMNH, B. BENEDEK, P. GYULAI, G. RONKAY).

Slide Nos RL6599, RL6720 (males), RL6653, RL6719 (females).

Diagnosis. *A. zoltanus* is the sister species of *A. statira*, the two species are, however, easily distinguishable by their external and genital features. The forewings of the new species are almost unicolorous, dark bluish grey, the crosslines are partly or fully reduced except most parts of subterminal line, the outlines of the stigmata are fine, often obsolescent, sometimes defined with whitish. *A statira* has somewhat more acute forewings with more variegated pattern, consisting of more sharply defined crosslines and stigmata (see Figs 1–6).

The most conspicuous difference between the male genitalia can be found in the medial part of the vesica, which is shorter in *A. zoltanus*, and the cornuti field is only about half as long as in *A. statira*. In addition, the fultura inferior of the new species has broader apical part, the clavi are smaller and the harpe is shorter, less S-shaped. The female genitalia of *A. zoltanus* have more calyculate ostium bursae with broader sclerotized plate than that of *A. statira*, its bursa is more bilobate, generally less sclerotized, with the heavily sclerotized lamina projecting more proximally.

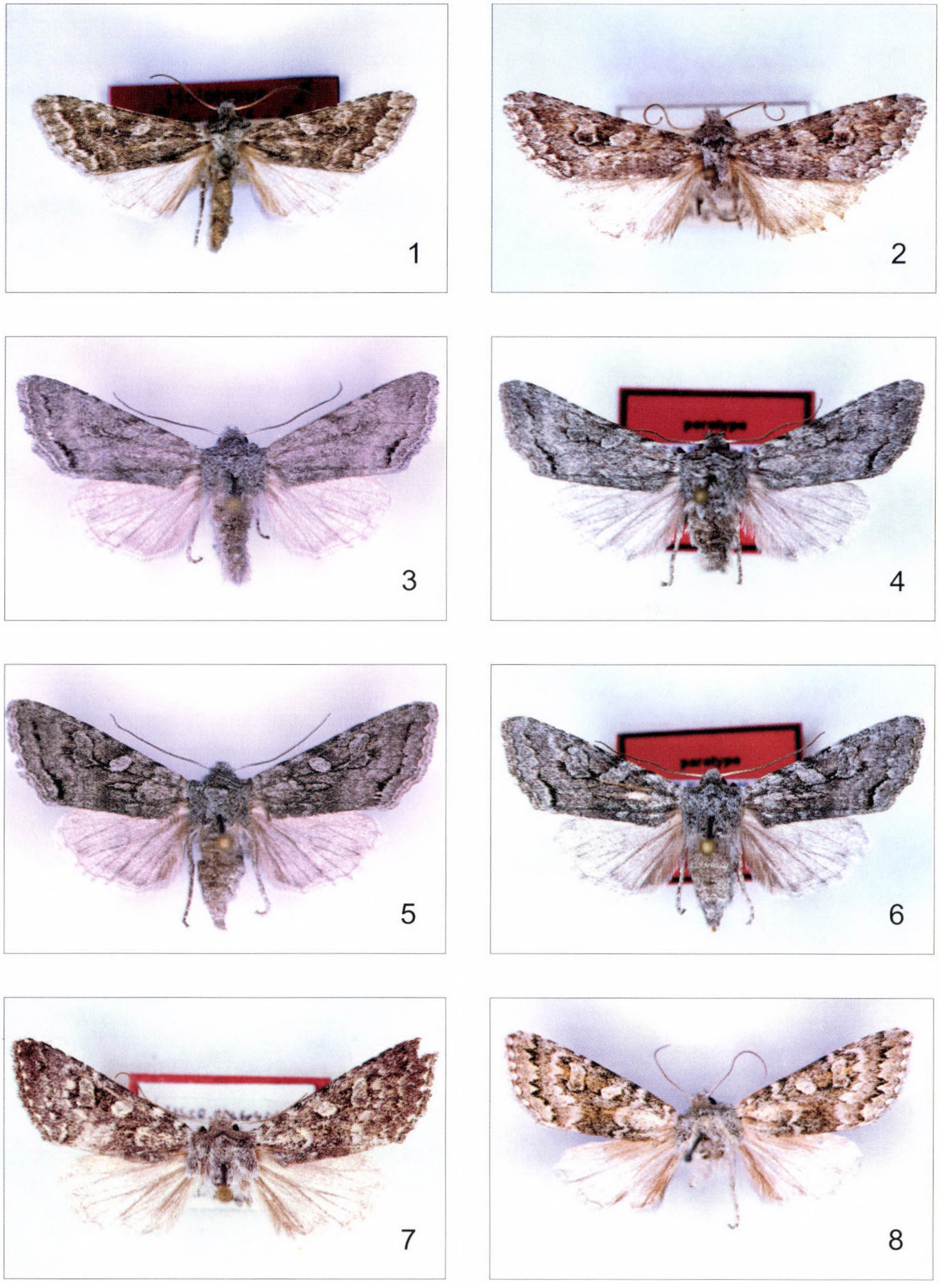
Description. Wingspan 33–38 mm, length of forewing 15–18 mm. Male. Pubescence of body dark bluish ash-grey, mixed with darker brownish hairs, sides of palpi darker grey. Antenna ciliate with fasciculate cilia, its base with whitish tuft. Tip of collar marked with dark grey line, defined with whitish hairs, thoracic tufts large; abdomen somewhat paler, more whitish mixed with light brownish hairs. Forewing long, narrow, with apex acute, outer margin slightly crenulate. Ground colour almost unicolorous, shining bluish ash-grey mixed with darker grey scales. Ante- and postmedial lines obsolete, former oblique, latter slightly waved; median fascia broad, diffuse, somewhat darker grey shadow. Stigmata most often present, orbicular and reniform relatively sharply defined, former oblique, latter elliptical, both encircled with fine blackish grey line, defined with a few whitish scales. Filling of orbicular whitish grey, that of reniform dark bluish grey. Claviform represented most often by its blackish apical arch, sometimes fully reduced. Subterminal line fine, whitish grey, strongly sinuous, interrupted, upper part with weak, lower half with strong, blackish inner stripe. Terminal line fine, sinuous, whitish, cilia as ground colour, slightly variegated with whitish. Hindwing whitish grey, suffused with pale brownish grey, veins covered with brownish, discal spot and submarginal line hardly traceable. Cilia whitish with darker grey, often interrupted inner line. Underside of wings whitish, forewing covered, hindwing strongly irrorated with pale ash-grey. Discal spots diffuse but well discernible, transverse lines absent or represented by short costal streaks. Female. Similar to male, antenna filiform, abdomen thicker, forewings somewhat broader, wing pattern more prominent, stigmata and subterminal line more sharply defined, hindwing also darker with stronger submarginal line.

Male genitalia (Fig. 27): Uncus medium-long, slender, tegumen weak, broad, with large, quadrangular penicular lobes, fultura inferior subdeltoidal, with rather broad, apically slightly dilated upper (dorsal) part, vinculum long, slender, V-shaped. Valva elongate, narrow, slightly arcuate, costa sclerotized, with long, acute medial extension and strongly serrate subapical plate. Cucullus narrow, pointed, corona long. Clavi small, rounded, harpe relatively long, slender, S-shaped. Aedeagus large, thick, cylindrical, arcuate, vesica very long, broadly tubular, basally coiled, recurved ventrally; its walls weakly membranous, finely scobinate. Basal and subterminal diverticula large, medial cornuti field long, narrow, consisting of short spinules, terminal cornutus relatively long, straight, thorn-like.

Female genitalia (Fig. 28): Ovipositor very long, narrow, rather weak, papillae anales small, conical, gonapophyses very long, fine. Ostium bursae calyculate, ostial plate broadly falcate, ductus bursae medium-long, broadly tubular, flattened, partly sclerotized. Bursa copulatrix large, more or less bilobate, cervix bursae large, spacious, proximo-lateral part heavily sclerotized, corpus bursae elliptical, membranous, with elongate-elliptical, rather strong signum.

Bionomics and distribution. The new species is found only in the high upper part of the Bubin valley, in a deep, stream valley with patches of gallery forests and shrubby mixed forests, surrounded by steep, dry, rocky walls. An univoltine, late autumnal species, the first adults were observed at the end of September, the peak of the flight was at the mid-October of the same year. All specimens were collected at light, none of them appeared around the sugar baits.

Etymology. The new species is dedicated to Prof. Dr ZOLTÁN S. VARGA, expert of the trifine Noctuidae fauna of Central Asia.



Figs 1–8. *Agrochola* imagines. 1–2 = *A. statira* BOURSIN, 1960: 1 = holotype, 2 = female, Afghanistan, Salang valley; 3–6 = *A. zoltanus* sp. n.: 3 = holotype, 4 = paratype, male, 5 = paratype, female, 6 = paratype, female; 7 = *Agrochola spectabilis* HACKER et RONKAY, 1990, holotype; 8 = *A. griseovariegata* sp. n., holotype female

Figs 9–16. 9 = *Agrochola griseovariegata* sp. n., paratype male; 10–11 = *A. approximata* (HAMPSON, 1906), Pakistan, Kaghan valley: 10 = male, 11 = female; 12–15 = *A. deosaiensis* sp. n.: 12 = holotype, 13 = paratype, male, 14 = paratype, male, 15 = paratype, female; 16 = *Owadaglaea reticulata* HREBLAY, PEREGOVITS et RONKAY, 1999, Vietnam, male

Figs 17–24. *Owadaglaea* imagines. 17 = *O. lexuancanhi* sp. n., holotype; 18 = *O. lucida* HREBLAY et RONKAY, 1998, Nepal, male; 19–20 = *O. siddiquii* sp. n.: 19 = holotype, 20 = paratype, female; 21–22 = *O. hadasi* sp. n.: 21 = holotype, 22 = paratype; 23–24 = *O. fuscopicta* HACKER et RONKAY, 1996, Pakistan, Murree Hills, females

Agrochola statira BOURSIN, 1960
(Figs 1, 2, 25, 26)

Agrochola statira BOURSIN, 1960, *Bulletin Mensuel de la Société Linnéenne de Lyon* **29**: 147.

Type material examined: holotype male, Afghanistan, Ferush Tagan, Khinjan valley, 1900 m, 25.IX.1952, J. KLAPPERICH leg. (coll. ZSM); 3 female paratypes, with the same data as the holotype (coll. ZSM).

Additional material examined: Afghanistan: 3 males, 1 female, Ejan, Salang valley, 11.X.1952, leg. J. KLAPPERICH (coll. ZSM); 1 male, Nuristan (coll. NAUMANN, AKM Bonn).

Slide Nos VZ4691 (male), RL3525 (female).

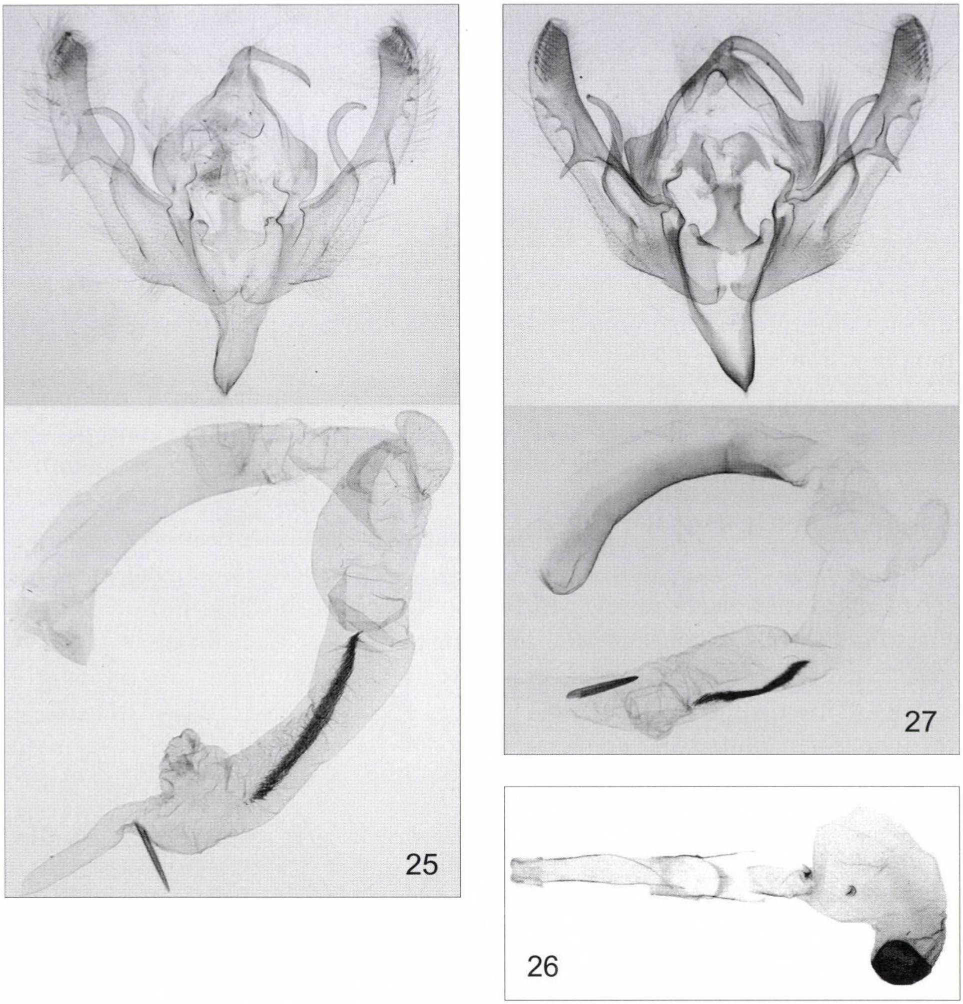
Diagnosis. The comparison of the two sister species, *A. statira* and *A. zoltanus* is given in detail in the diagnosis of the preceding species.

Description. Wingspan 33–38 mm, length of forewing 16–18 mm. Sexes similar, male antenna ciliate with fasciculate cilia, that of female filiform. Pubescence of body dark ash-grey, mixed with darker grey and brownish hairs, sides of palpi, collar and tegulae marked with dark grey lines and whitish hairs. Thoracic tufts large; abdomen more brownish. Forewing elongate, narrow, with apex acute, outer margin slightly crenulate. Ground colour dark ash-grey, irrorated strongly with dark brownish grey except in outer half of marginal area. Ante- and postmedial lines rather diffuse, double, darker grey filled with whitish grey, median fascia less conspicuous, diffuse. Orbicular and reniform stigmata sharply defined, former oblique, latter elliptical, both encircled with fine blackish and whitish-grey lines. Orbicular paler than ground colour, whitish grey, lower half of reniform dark blackish grey. Claviform obsolescent, represented most often by its darker apical arch and whitish inner definition. Subterminal line fine, strongly sinuous, whitish, defined with darker grey inner zone and fine, blackish grey chevron-like spots. Terminal line fine, sinuous, blackish, defined with whitish, cilia as ground colour, slightly variegated with whitish. Hindwing whitish grey, irrorated with pale brownish grey, veins slightly darker, cilia whitish. Underside of wings milky whitish, irrorated with pale grey, discal spots diffuse, but well discernible, transverse lines absent or represented by short costal streaks.

Male genitalia (Fig. 25): Uncus slender, fine, tegumen weak, broad, penicular lobes large, quadrangular, fultura inferior subdeltoidal, its upper (dorsal) part narrow, with lateral margins almost parallel; vinculum long, slender, V-shaped. Valva elongate, narrow, finely arcuate, costa with long, acute medial extension and strongly serrate subapical plate. Cucullus narrow, pointed, corona rather long. Clavi rounded, relatively strong, harpe long, slender, S-shaped. Aedeagus large, thick, cylindrical, arcuate, vesica very long, broadly tubular, basally coiled, recurved ventrally; membranous with fine scobination. Basal diverticulum large, laterally curved, medial cornuti field very long, narrow, consisting of short spinules, subterminal diverticulum large, semiglobular, terminal cornutus straight, thorn-like.

Female genitalia (Fig. 26): Ovipositor very long, narrow, papillae anales elongate, conical, weak, gonapophyses very long, fine. Ostium bursae cup-shaped, ostial plate narrow, falciform, ductus bursae tubular, flattened, partly sclerotized. Bursa copulatrix large, more or less bilobate, cervix bursae rather large, elliptical-rounded, lateral part heavily sclerotized; corpus bursae discoidal, with fine sclerotization, signum strong, rounded.

Bionomics and distribution. This species inhabits stream valleys, deep rocky gorges of the central part of the Hindukush Mts, occurring in medium high and higher altitudes. It is known from a rather small area in eastern Afghanistan (Khinjan valley, Salang valley, Nuristan). The imagines are on wing at late autumn (September–October).



Figs 25–27. 25–26 = *Agrochola statira* BOURSIN, 1960: 25 = male, Afghanistan, Nuristan, 26 = female, Afghanistan, Salang; 27 = *A. zoltanus* sp. n., male, paratype

Agrochola griseovariegata sp. n.
(Figs 8–9, 30–31)

Holotype: female, Hissar Mts, Kondara, 1100 m, 29.X.1954, leg. SHCHETKIN (coll. P. GYULAI).

Paratypes: Tadjikistan. 80 males, 5 females, Hissar Mts, Gushary, 1400 m, 1–28.X.1965, leg. SHCHETKIN (coll. P. GYULAI, G. RONKAY and HNHM Budapest); 1 male, 1 female, Hissar Mts, Maichura, Charamkul, 2800 m 20.IX.–10.X.1994, leg. SHCHETKIN (coll. P. GYULAI and G. RONKAY).

Additional paratypes from the Hissar Mts (in coll. ZM Helsinki, B. HERCZIG, etc.).

Slide Nos RL6651 (male), RL6652 (female).

Diagnosis. The external appearance of *A. griseovariegata* and *A. spectabilis* is rather similar, but the ground colour of the new species is paler, ochreous-greyish, the pattern is more extensive, but less conspicuous due to the paler ground colour; the crosslines are less interrupted, broader, the definition of the stigmata is weaker than in *A. spectabilis*.

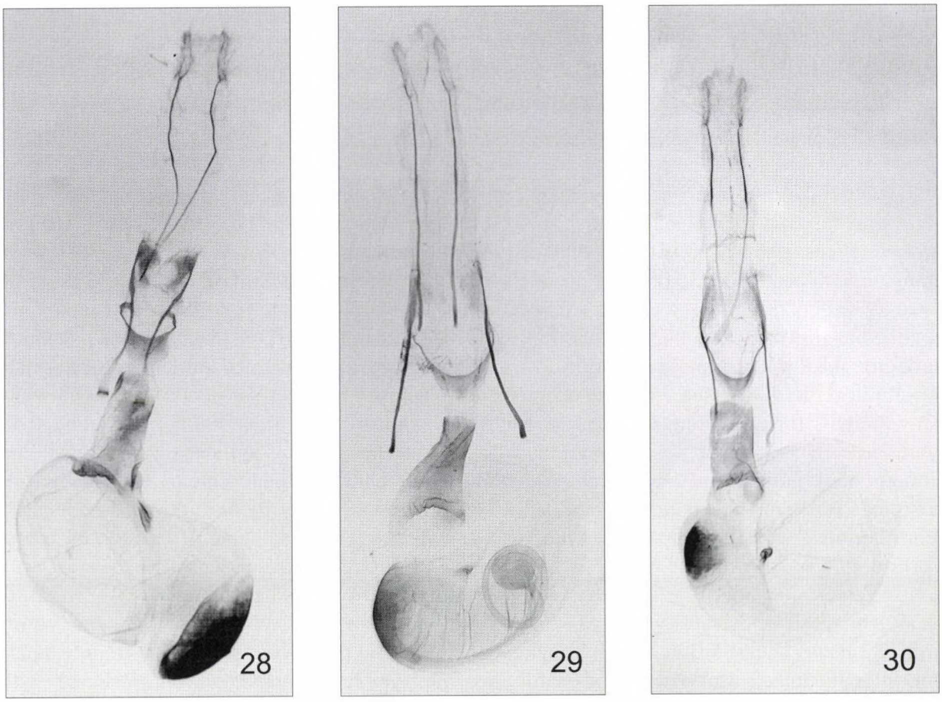
The female genitalia of *A. griseovariegata* differ from those of *A. spectabilis* by its longer, narrower ostium bursae, narrower ductus bursae with almost parallel lateral margins and by its smaller, elliptical medio-lateral sclerotized plate of the cervix bursae.

The male genitalia of *A. griseovariegata* is similar also to those of *A. zoltanus* and *A. statira,* differing from the former by their smaller, less angular penicular lobes, narrower apical (dorsal) part of fultura inferior, broader, more U-shaped vinculum, thicker harpe and stronger, longer, broader medial cornuti field of vesica, from the latter by their broader valva with more sinuous ventral margin, shorter, thicker harpe and shorter medial field of cornuti. The differences between the female genitalia of the two lineages of the *A. statira* group are discussed in the characterization of the species-group (see above).

Description. Wingspan 37–40 mm, length of forewing 17–19 mm. Male. Pubescence of body pale bluish grey, mixed with brownish and ochreous hairs, sides of palpi darker grey. Antenna ciliate with fasciculate cilia, its base with whitish tuft. Frons ochreous, tip of collar and tegulae marked with dark grey lines, thoracic tufts large; abdomen somewhat paler, more whitish mixed with light brownish hairs. Forewing elongate with apex acute, outer margin finely crenulate. Ground colour pale, ochreous slate-grey mixed with darker grey and ochreous scales. Basal area irrorated with darker grey, veins partly blackish grey. Wing pattern rather strong, ante- and postmedial lines broad, double, strongly sinuous, dark grey filled with pale ochreous grey; median fascia diffuse, darker grey shadow. Orbicular and reniform stigmata relatively weakly defined, former rounded, latter elliptical, both encircled with fine ochreous and blackish grey lines. Filling of orbicular whitish-ochreous, that of reniform dark bluish grey, especially at lower third. Claviform absent or represented by its weak apical arch. Subterminal line fine, whitish-ochreous, strongly sinuous, defined with stronger blackish grey chevrons at inner side. Terminal line fine, sinuous, blackish, with whitish dots, cilia whitish-ochreous, variegated with grey. Hindwing whitish-ochreous, inner area suffused weakly with pale brownish grey, discal spot absent, submarginal line hardly traceable. Terminal line sinuous, fine, dark brown, cilia whitish. Underside of wings patternless milky whitish, forewing covered, hindwing irrorated sparsely with pale grey. Female. Similar to male, antenna filiform, body somewhat stronger.

Male genitalia (Fig. 31): Uncus slender, fine, tegumen broad, with smaller, rounded penicular lobes, fultura inferior subdeltoidal, with narrow, apically slightly tapering dorsal part; vinculum long, more or less U-shaped. Valva elongate, narrow, ventral margin slightly sinuous, costa with long, straight medial extension and strongly serrate subapical plate. Cucullus narrow, pointed, corona rather long, clavi relatively large, rounded lobes, harpe strong, S-shaped. Aedeagus large, thick, cylindrical, arcuate, vesica very long, broadly tubular, basally coiled, recurved ventrally. Basal diverticulum large, dorso-lateral arm laterally curved, medial cornuti field long, relatively broad, consisting of short spinules, subterminal diverticulum semiglobular, terminal cornutus straight, thorn-like.

Female genitalia (Fig. 30): Ovipositor very long, narrow, papillae anales elongate, narrow, weak, gonapophyses very long, fine. Ostium bursae deeply calyculate, ostial plate falcate-lyriform, ductus bursae medium-long, broadly tubular, flattened, sclerotized. Bursa copulatrix large, slightly bilobate, cervix bursae rather narrow, elongate, its heavily sclerotized plate small, elliptical, situated medio-laterally, corpus bursae large, discoidal, with fine sclerotization, signum strong, elongate.



Figs 28–30. 28 = *A. zoltanus* sp. n., female, paratype; 29 = *A. spectabilis* HACKER et RONKAY, 1990, female, holotype; 30 = *A. griseovariegata* sp. n., female, holotype

Bionomics and distribution. The species is restricted to the medium-high and higher parts of the Hissar Mts. A late autumnal species, its flight period extends from the end of September to the end of October.

Etymology. The specific name refers to the intense pale greyish forewing pattern of the species.

Agrochola spectabilis HACKER et RONKAY, 1990
(Figs 7, 29)

Agrochola spectabilis HACKER et RONKAY, 1990, *Esperiana* **1**: 387.

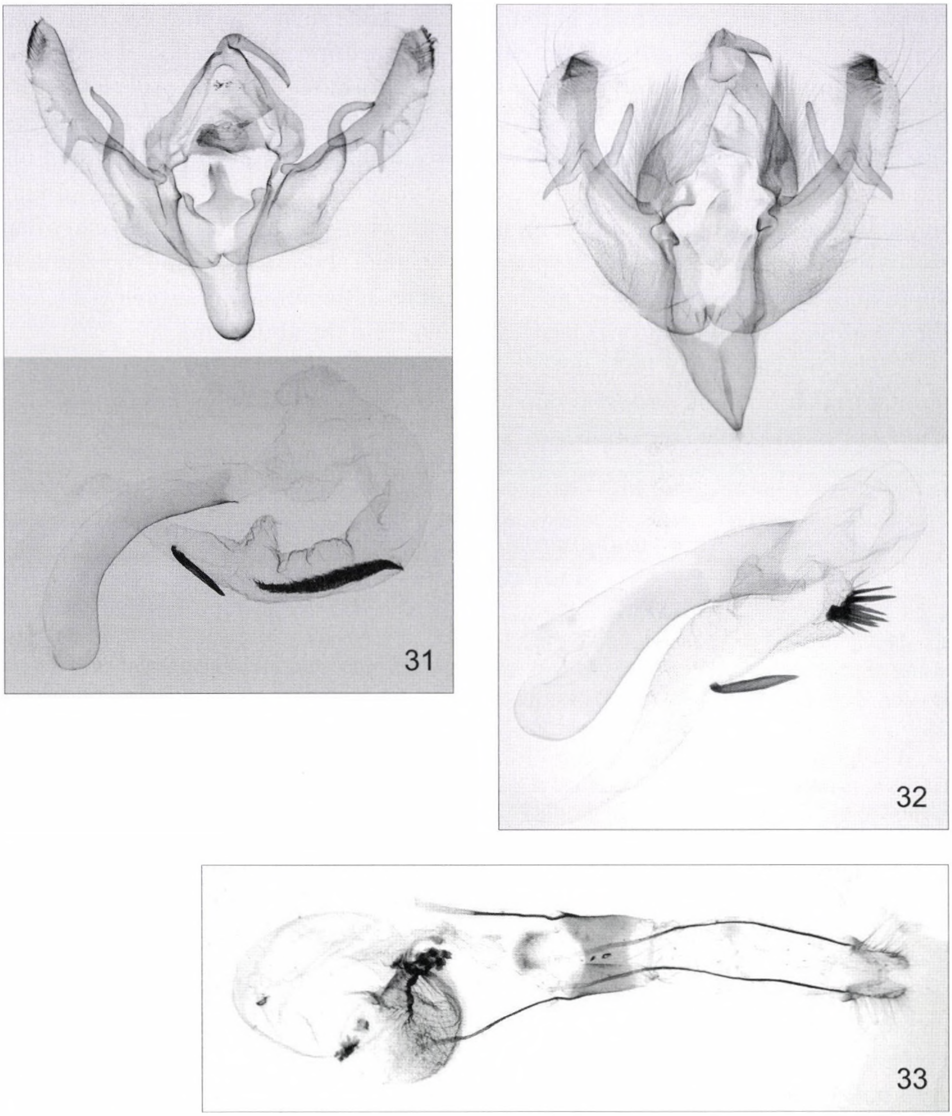
Type material examined: holotype female, Uzbekistan, Alai Mts, 2200 m, Dugobo, 18–20.IX.1984, leg. Z. VARGA, slide No. RL2563 (HNHM, Budapest).

Diagnosis. *A. spectabilis* differs from its sibling species, *A. griseovariegata* by its darker, less variegated ground colour, less continuous crosslines, more prominent stigmata and some features of the female genitalia. The ostium bursae of *A. spectabilis* is shorter but broader than that of *A. griseovariegata*, the ductus bursae is stronger, broader, distally strongly tapering, its posterior part is folded laterally, and the sclerotized part of cervix bursae is significantly longer, larger, situated closer to the fundus bursae.

Description. Wingspan 36 mm, length of forewing 18 mm. Female. Pubescence of body dark olive-grey mixed with ochreous-whitish and blackish grey hairs, sides of palpi darker grey. Antenna filiform. Frons ochreous grey, tip of collar marked with dark grey line, thoracic tufts large. Forewing elongate with acute apex, outer margin finely crenulate. Ground colour dark olive-grey, irrorated strongly with dark fumous grey and a few ochreous scales. Wing pattern rather diffuse, ante- and postmedial lines broad, double, sinuous, dark grey filled with pale ochreous; median fascia indistinct, dark grey shadow. Orbicular and reniform stigmata relatively sharply defined, orbicular rounded, latter elliptical, both encircled with fine ochreous and blackish grey lines. Orbicular filled with whitish-ochreous, filling of reniform darker greyish; claviform obsolescent. Subterminal line fine, whitish-ochreous, sinuous, defined with blackish grey patches and dots at inner side. Terminal line sinuous, dark grey, defined with ochreous-whitish line, cilia as ground colour, variegated with ochreous. Hindwing pale ochreous grey, suffused with brownish grey, veins darker, discal spot absent. Terminal line fine, brownish, cilia whitish with darker medial line. Underside of wings patternless, greyish white, forewing suffused, hindwing strongly irrorated with darker grey.

Female genitalia (Fig. 29): Ovipositor very long, narrow, papillae anales elongate, narrow, weak, gonapophyses very long, fine. Ostium bursae calyculate, relatively broad, ostial plate short, broadly falcate, ductus bursae flattened, sclerotized, proximal part broad, distal half strongly tapering, laterally folded. Bursa copulatrix large, less bilobate, cervix bursae narrow, elongate, with heavily sclerotized, elongate proximo-lateral plate. Corpus bursae large, elliptical-discoidal, partly finely sclerotized and wrinkled; signum rather weak, small.

Bionomics and distribution. The unique known specimen was found at relatively high altitude in the western part of the Tien-Shan mountain system. The bionomics of the species is poorly known, the holotype was collected at light, in the second half of September.



Figs 31–33. 31 = *A. griseovariegata* sp. n., male, paratype; 32–33 = *A. approximata* (HAMPSON, 1906): 32 = male, Pakistan, Kaghan valley, 33 = female, Pakistan, Kaghan valley

Taxonomic novelties of the *Agrochola trapezoides*-group

The *A. trapezoides*-group comprises medium-large species with relatively strong body, elongate-triangular, pointed, forewing and small, more or less rounded hindwing. Eyes small, globular, palpi short, slender, upturned, with long ventral hair-scales; frons broad, smooth, slightly prominent. Antenna of male ciliate with long, fasciculate cilia, that of female filiform with scarce, short cilia. The forewing pattern is very homogeneous within the group, consisting of sharply defined, oblique, usually straight ante- and postmedial crosslines, well-defined orbicular and reniform stigmata and most often interrupted, slightly sinuous subterminal line; the ground colour is ochreous, yellowish, pale brown or greyish, often strongly varying within the same species. The male abdomen is slender, relatively short, abdominal coremata present; the abdomen of the female is stronger, thicker, the tip of the long ovipositor is protruding out from the abdomen.

The ground plan of the genitalia of both sexes of the *A. trapezoides*-group is similar to that of the *A. statira*-group, the differences are discussed in detail in the characterization table (see above).

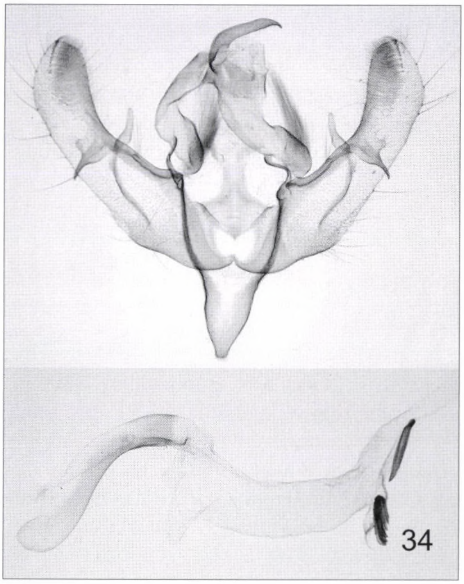
Agrochola approximata (HAMPSON, 1906)
(Figs 10–11, 32–33)

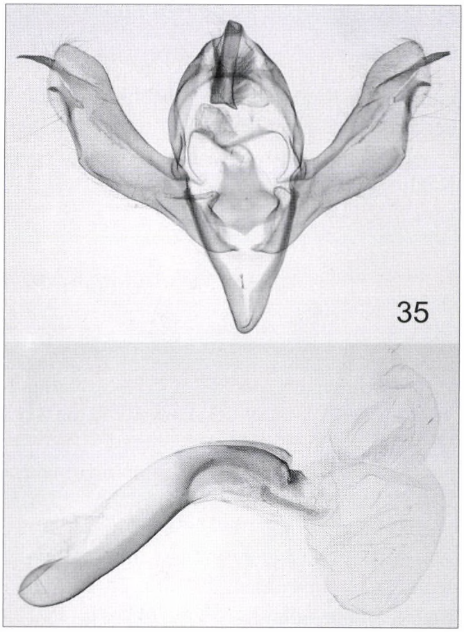
Cosmia approximata HAMPSON, 1906, *Catalogue of the Lepidoptera Phalaenae in the British Museum* VI.: 511, pl. 107, fig. 22.
Agrochola leptographa RONKAY et HACKER, 1990, *Esperiana* **1**: 385, **syn. n.**

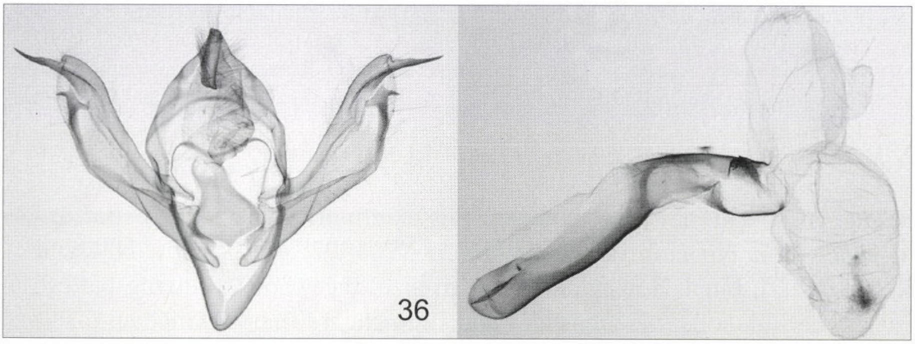
Type material examined: *A. approximata*: lectotype male, Kashmir, Dugi Pass, Slide No. RL3978; paralectotypes (both sexes) from the same locality (coll. BMNH); *A. leptographa*: holotype male, Pakistan, Kaghan valley, Naran, slide No. HH4982, paratype female, Kaghan valley, Saiful Muluk (coll. HACKER).

Additional material examined. Pakistan: 18 males, 29 females, Himalaya Mts, Kaghan valley, Saiful Muluk, 3100 m, 73°42'E, 34°54'N, 24.VIII.1997 and 11.IX.1997, leg. GY. FÁBIÁN and G. RONKAY (coll. HNHM, B. BENEDEK, GY. FÁBIÁN, P. GYULAI, B. HERCZIG, G. RONKAY).

Diagnosis. This species is rather remote from the other taxa of the species-group, due to its characteristic differences in the external and genital features compared with those of the other members of the *A. trapezoides* group. The typical external features of the species are the relatively shorter, broader forewings, the lack of the whitish definition of the ante- and postmedial crosslines and the stigmata and the rather strongly marked, darker brownish subterminal line; the ground colour of the hindwing is also darker ochreous. The distinctive features of the male genitalia (Fig. 32) are the narrowly tubular, reclinate vesica without basal coiling or large subbasal diverticulum, the cornuti of the medial cornuti filed are strong, rather short, more or less straight, sitting on a semiglobular diverticulum; the uncus is short, thick, the apical process of the cucullus is strong, cuneate, the harpe is long, straight. The female genitalia (Fig. 33) is characterized by the long, tubular, membranous ductus bursae and the large, discoidal, slightly helicoid cervix bursae with strong basal crests and finely sclerotized ribs and wrinkles in the apical (distal) half.


34


35


36

Figs 34–36. 34 = *A. deosaiensis* sp. n., male, paratype, 35 = *Owadaglaea reticulata* HREBLAY, PEREGOVITS et RONKAY, 1999, male, Vietnam, Fan-si-pan; 36 = *O. lexuancanhi* sp. n., male, holotype

The studies on the large, newly collected material of the species revealed that the differences recognizable between the types of *A. approximata* and *A. leptographa* are not extending the range of the variation of the large series of *A. approximata*. These two taxa are interpreted here as conspecific, and *A. leptographa* is synonymized here with *A. approximata*. In addition, the Dugi Pass, the type locality of *A. approximata* is one of the higher passes of the upper Kaghan valley (at least, there is a pass named as Dugi Pass), therefore, *A. approximata* can be considered as a species endemic to the Kaghan valley.

Bionomics and distribution. The species appears as a typical member of the mid-autumnal fauna of the Kaghan valley, inhabiting medium high and higher forests, appearing also above the timber zone. The imagines are on wing from the end of August to the beginning of October.

A. approximata has a rather limited distribution, restricted to the central and upper parts of the Kaghan valley.

Agrochola deosaiensis sp. n.
(Figs 12–15, 34, 37)

Holotype: male, "PAKISTAN, Kashmir, Himalaya Mts, Deosai Mts, Bubin valley, 3300 m, 75°02,7'E, 35°13,5'N, 15–17.X.1998, leg. GY.M. LÁSZLÓ and G. Ronkay", slide No. RL6657 (coll. G. RONKAY, in HNHM, Budapest).

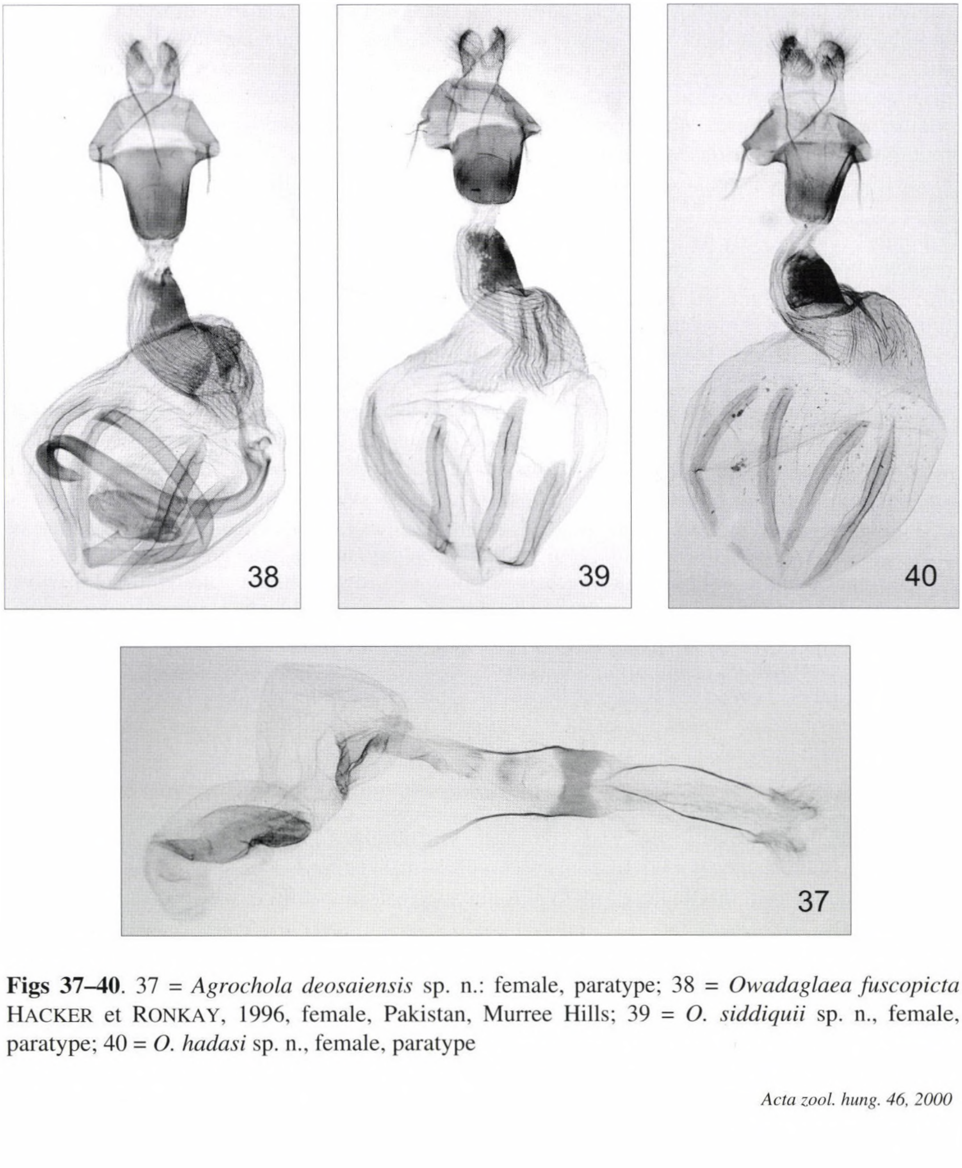
Paratypes: Pakistan. Kashmir, Himalaya Mts, Deosai Mts: 78 males, 97 females, Bubin valley, 3300 m, 75°02,7'E, 35°13,5'N, 15–17.X.1998, leg. GY.M. LÁSZLÓ and G. RONKAY; Bubin valley, 3150 m, 75°02,7'E, 35°13,5'N, 15–19.VIII.1998, leg. G. RONKAY and Z. VARGA; same site, 24–25.IX.1998, leg. P. GYULAI and A. GARAI; same site, 12–16.X.1998, leg. GY.M. LÁSZLÓ and G. RONKAY; Bubin valley, 2910 m, 21–22.IX.1998, leg. P. GYULAI and A. GARAI; 2 males and 4 females, Bubin valley, 3150 m, 74°59'E, 35°12'N, 24.IX.1998, leg. Fida HUSSEIN; 1 female, Deosai NP, 3700 m, 75°12'E, 35°01'N, 4.IX.1997, leg. GY. FÁBIÁN and G. RONKAY; 1 female, Deosai NP, 3 km NW of Chilam Chauki, 22–23.IX.1998, leg. P. GYULAI and A. GARAI; 1 male, Nanga Parbat area, Astor, Rama, 3300 m, 74°48'E, 35°21'N, 4.IX.1997, leg. GY. FÁBIÁN & G. RONKAY (coll. HNHM, BMNH, B. BENEDEK, GY. FÁBIÁN, P. GYULAI, B. HERCZIG and G. RONKAY). Karakoram Mts: 1 female, Naltar valley, 2800 m, 74°12'E, 36°096'N, 11.X.1997, leg GY. M. LÁSZLÓ and G. RONKAY (coll. G. RONKAY).

Slide Nos RL6600, RL6722 (males), RL6656, RL6721 (females).

Diagnosis. The new species resembles externally to its related species (*A. trapezoides*, *A. pamiricola* HACKER et RONKAY, 1992; *A. nekrasovi* HACKER et RONKAY, 1992), but is somewhat larger in size, the whole forewing pattern is paler, less conspicuous, the crosslines and stigmata are fine, the median fascia is more diffuse, without stronger patch between orbicular and reniform stigmata.

The genitalia of both sexes of *A. deosaiensis* differ conspicuously from all the other species of the species-group. The unique feature of the male genitalia is the very long vesica, being conspicuously longer than those of the other members of the *A. trapezoides*-group, without basal coiling or recurved distal half, but with two rather large basal diverticula. The medial, membranous part of the tube of vesica is very long, the cornuti field is situated far more distally than in the other species, the cornuti of this field are the largest within the species-group.

The female genitalia of the new species have strongly bilobate bursa with the apical part of the cervix bursae with ductus seminalis extending over the fundus bursae proximally, this long cervix has large, elongate sclerotized plate. The cervix



Figs 37–40. 37 = *Agrochola deosaiensis* sp. n.: female, paratype; 38 = *Owadaglaea fuscopicta* HACKER et RONKAY, 1996, female, Pakistan, Murree Hills; 39 = *O. siddiquii* sp. n., female, paratype; 40 = *O. hadasi* sp. n., female, paratype

bursae of *A. pamiricola*, the other species of the group having rather bilobate bursa, is much shorter, rounded-discoidal, without stronger sclerotized lamina and the ostium and ductus bursae are weaker, finer, less sclerotized than those of *A. deosaiensis*.

Description. Wingspan 35–40 mm, length of forewing 16–19 mm. Sexes similar, antenna of male ciliate with long, fasciculate cilia, that of female filiform. Pubescence of head and thorax more or less unicolorous, variably dark ochreous-brown, orange- or reddish brown, mixed with a few darker brown hairs; abdomen somewhat more brownish. Forewing rather broad, with apex acute, outer margin finely concave below apex. Ground colour pale ochreous- or orange-brown, basal area with weaker, marginal field with stronger dark ochreous-brown or reddish brown suffusion. Wing pattern well-discernible, but not very prominent, ante- and postmedial crosslines more or less straight, double, consisting of whitish and darker brownish lines. Antemedial line strongly oblique, straight, postmedial often defined with dark brown scales, its upper third usually finely arcuate; median fascia regularly broad, diffuse, dark ochreous- or reddish-brown. Subterminal line obsolescent, whitish, often interrupted, sometimes marked with dark brown spots between veins. Terminal line fine, sinuous, brown, cilia as ground colour, variegated with whitish. Costal and marginal areas of hindwing ochreous, inner area variably strongly suffused with brown, discal spot and transverse line absent or very pale; cilia whitish-ochreous. Underside of wings ochreous with weak orange-brownish irroration, veins slightly darker, discal spots and traces of transverse lines present but diffuse, often obsolete.

Male genitalia (Fig. 34): Uncus medium-long, relatively strong, hooked, tegumen weak, broad, with narrow penicular lobes, fultura inferior subdeltoidal, with rather small, rounded apical lobe; vinculum slender, V-shaped. Valva narrow, elongate, medially slightly constricted, cucullus broadened, apex finely rounded, without apical process on dorsal side; corona long, weak, situated at middle of cucullus. Costa sclerotized, with long, acute medial extension, clavus reduced to small, rounded, setose surface, harpe medium-long, slender, straight. Aedeagus large, cylindrical, arcuate, vesica very long, broadly tubular, its walls membranous with fine scobination. Basal part of vesica curved, with two long, conical-tubular subbasal diverticula. Medial part very long, membranous, cornuti field situated at terminal end, close to terminal cornutus, consisting of long, apically curved spines, sitting on small diverticulum; terminal cornutus long, almost straight, finely ribbed.

Female genitalia (Fig. 37): Ovipositor very long, narrow, papillae anales elongate, narrow, pointed, gonapophyses very long, fine. Ostium bursae narrow, calyculate, finely, granulously sclerotized, ductus bursae medium-long, tubular, membranous with fine wrinkles, stronger proximo-lateral scobination and with sclerotized posterior end. Bursa copulatrix large, elongate-sacculiform, twisted at middle, cervical part situated proximo-laterally. Corpus bursae with long, sclerotized crests running from ductus bursae to twisted medial part, cervix bursae elongate, with large, heavily sclerotized, partly folded patch.

Bionomics and distribution. An autumnal species, the second part of the flight period is overlapping with the last aspects of the year. The species was observed as rather frequent in the higher regions of the Bubin valley, it was found only occasionally in other parts of the Deosai Mts, and a single datum is known from the Naltar valley (SW Karakoram Mts, about fifty kms northwards from the Deosai Mts).

Etymology. The new species is named after its homeland, the Deosai Mts, from where the overwhelming majority of the specimens and localities are known.

NEW TAXA OF THE GENUS OWADAGLAEA HACKER ET RONKAY, 1996

The *Owadaglaea lucida*-group

This species-group contains, by our recent knowledge, four species. These four species represents two allopatric lineages, the *O. lucida* HREBLAY et RONKAY, 1998 – *O. reticulata* HREBLAY, PEREGOVITS et RONKAY, 1999 and *O. nigricomma* HREBLAY et RONKAY, 1998 – *O. lexuancanhi* sp. n. species-pairs. The members of the two sibling groups occur parallelly sympatrically: *O. lucida* with *O. nigricomma* in E Nepal, *O. reticulata* with *O. lexuancanhi* in N Vietnam.

The wing pattern of the species is rather constant within the whole group, the colouration is more variable, pale ochreous, slate-grey, paler or darker chocolate-brown. The characteristic elements of the forewing pattern are the three black spots along upper half of antemedial line (costal, praecellular and claviform), all are rounded or quadratic, never triangular; the small blackish dots in the reniform stigma and the rather deep angle of the postmedial line below cell; in addition, the black streak of the collar is the strongest within this species-group. The abdominal coremata are completely reduced.

The configuration of the genitalia also shows relatively small variation, the typical features of the male genitalia are as follows: genital capsula symmetrical, valvae elongated, medially slightly dilated with rounded ventro-medial margins, cucullus rounded, corona reduced, sacculus long, narrow, saccular extension absent, clavi symmetrical, situated basally, harpe-ampulla complex very small, symmetrical, costal extension very long, thorn-like, fultura inferior lyriform, vesica without cornutus. The specific differences can be found in the shape and size of the uncus, the costal extension, the valva and the cucullus, and the sclerotization of the dorso-lateral plate of the carina (see HREBLAY & RONKAY 1998).

In the female genitalia the ovipositor is short, weak, the ostium bursae is heavily sclerotized, large, trapezoidal with fine incision at the proximal edge, the caudal margin is usually convex. Posterior half of ductus bursae is as long as ostium, flattened, broad, caudally tapering. Anterior half is fused with cervical part of bursa copulatrix, dilated, partly sclerotized and ribbed, ductus seminalis originating from small, conical, ventro-lateral "diverticulum". Corpus bursae elongate-elliptical, with four long signum-stripes. The species of the group differ in the shape and size of the ostium bursae and the portions of the ductus bursae.

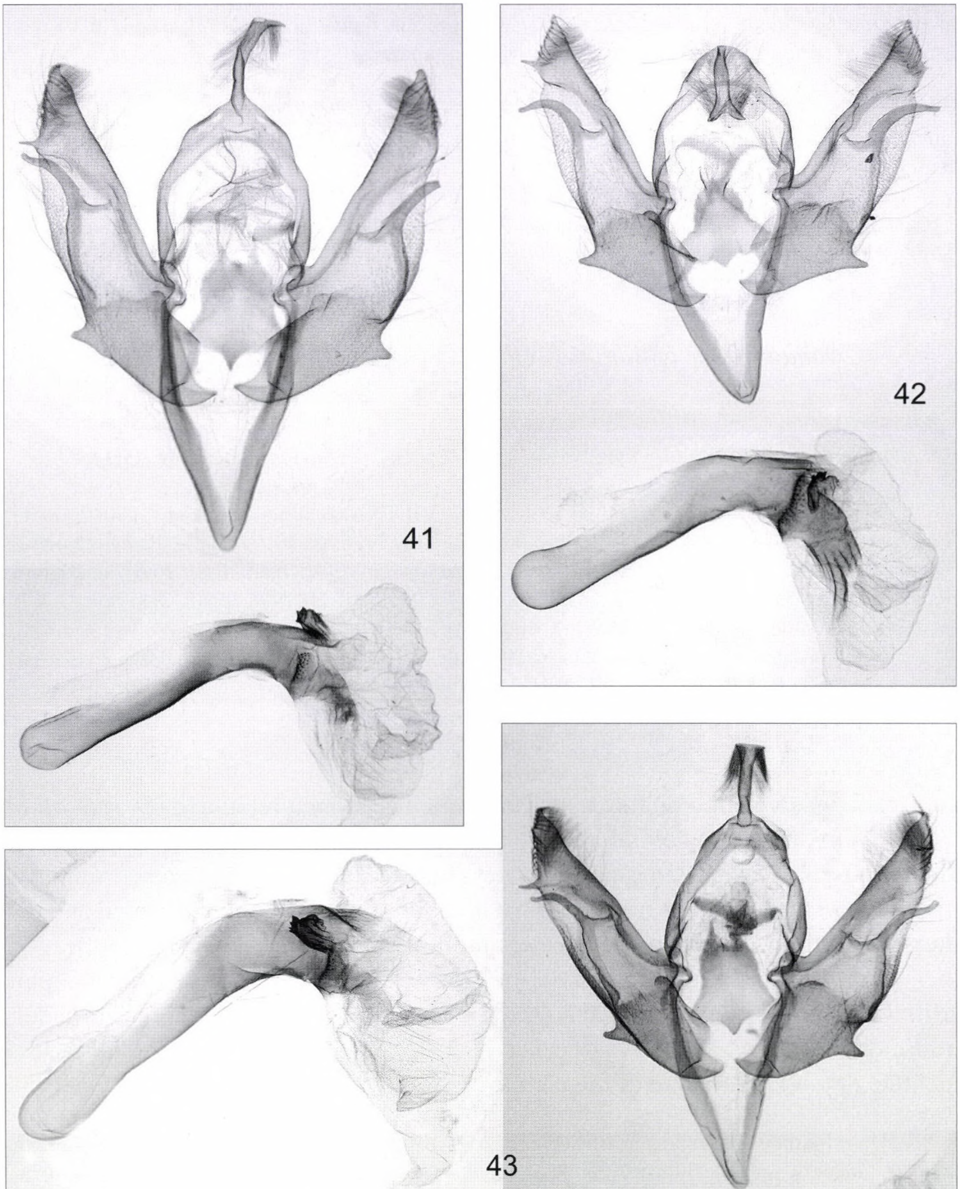
Owadaglaea lexuancanhi sp. n.
(Figs 17, 36)

Holotype: male, "VIETNAM, Prov. Lao Cai, Fan-si-pan Mts, 2650 m, 103°48'E, 22°18'N, 1.II.1999, leg. L. Peregovits and G. Ronkay", slide No. RL6608 (coll. G. Ronkay, in HNHM, Budapest).

Diagnosis. The new species is the allopatric sibling of *O. nigricomma*. The external appearance of the two species is very similar, but the new species is darker, the orbicular and reniform stigmata are less distinct. The male genitalia of *O. lexuancanhi* differ from those of *O. nigricomma* by their narrower uncus with almost parallel margins, much longer, more acute costal extension, somewhat stronger, longer harpe-ampulla complex and clavi and larger, stronger dorso-lateral plate of the carina with stronger dentition; from those of *O. lucida* and *O. reticulata* by the narrower uncus and valva, much longer, stronger costal extension and dorso-lateral plate of the carina.

Description. Wingspan 33 mm, length of forewing 14 mm. Male. Pubescence of head and thorax dark brown, collar and tegulae mixed with paler ochreous brown hair-scales. Lateral sides of palpi dark borwn, third joint short, its tip brownish. Antenna finely ciliate with fasciculate cilia, collar with strong blackish brown apical stripe, tegulae and metathorax marked with a few blackish hairs. Forewing elongate, rather broad, with apex pointed, outer margin finely crenulate. Ground colour shining dark chocolate-brown with fine bronze-ochreous sheen, irrorated with ochreous and a few blackish scales. Scaling finely reticulate; veins covered with ochreous. Costal area striolate with blackish, basal area unicolorous, subbasal line short, double, blackish. Ante- and postmedial crosslines double, dark brown, filled with ochreous, antemedial arcuate, postmedial less sinuous, finely S-shaped; median fascia diffuse, dark fumous grey. Costal patch less darkened, praeorbicular and claviform strong, black, praeorbicular trapezoidal, claviform larger, rounded, both encircled with fine ochreous lines. Orbicular stigma large, rounded, reniform quadrangular, both encircled incompletely with blackish spots and fine ochreous lines, filled with ground colour, reniform marked also with blackish spots. Subterminal indistinct, interrupted, pale ochreous shadow, costal triangle slightly stronger, dark brown; terminal line fine, whitish-ochreous, marked by a row of dark dots; cilia as ground colour, with fine whitish-ochreous medial line. Hindwing almost unicolorous blackish brown, darker than forewing, inner area slightly paler, discal spot poorly visible; cilia dark brown. Underside of wings covered with dark chocolate-brown scales, inner area of hindwing paler, mixed with a few ochreous scales, discal spots present on both wings, stronger on hindwing, transverse line of hindwing diffuse, but well-discernible.

Male genitalia (Fig. 36): Uncus relatively short, distally only slightly dilated and spatulate, apically only slightly incised. Tegumen narrow, moderately high, fultura inferior large, pyriform, with pointed lateral arms apically; vinculum moderately long, V-shaped. Valvae symmetrical, elongate, medial third slightly dilated ventrally, cucullus slightly broadened, rounded, corona reduced. Costa sclerotized, costal extension long, acute, horn-like, harpe-ampulla-complex forming small, flattened, double-peaked bar. Sacculus elongate, narrow, left clavus relatively large, rounded triangular, right clavus smaller, narrower. Aedeagus cylindrical, curved at apical third; carina with two long, narrow sclerotized bars, dorso-lateral bar with elongate, dentate plate terminally. Vesica broad,



Figs 41–43. 41 = *Owadaglaea siddiquii* sp. n., male, holotype; 42 = *O. hadasi* sp. n., male, holotype; 43 = *O. fuscopicta* HACKER et RONKAY, 1996, male, Pakistan, Murree Hills

membranous, without cornutus, basal part with large, subconical diverticulum, medial third with smaller diverticulum projecting forward, distal third tapering.

Bionomics and distribution. The species is a member of the winter aspect of the Fan-si-pan area, the unique specimen was collected at light at the border of the high montane primary forest-elphin forest belts, above 2600 m a.s.l.

Etymology. The new species is dedicated to Dr LE XUAN CANH, Director of the Zoological Institute of the IEBR, Hanoi.

Owadaglaea reticulata HREBLAY, PEREGOVITS et RONKAY, 1999
(Figs 16, 35)

Owadaglaea reticulata HREBLAY, PEREGOVITS et RONKAY, 1999, *Acta zool. hung.* **45**(1): 53.

Type material examined: holotype female: "VIETNAM, Prov. Lao Cai, 1900–2000 m, Fan-si-pan Mts, 14 km NW Sa Pa, 103°46,06'E, 22°20,9'N, 8.XII.1997, leg. L. Peregovits & L. Ronkay", slide No. RL6048 (HNHM Budapest); paratype female, Vietnam, Prov. Lao Cai, 2050 m, Fan-si-pan Mts, 5 km W Cat Cat, 22°18,337'N, 103°49, 291'E, 15.III.1998, leg. L. PEREGOVITS & T. VÁSÁRHELYI, slide No. RL6175 (HNHM, Budapest).

Additional material examined: 2 males, 1 female, Vietnam, Prov. Lao Cai, 2100 m, Fan-si-pan Mts, 6 km W Sa Pa, 103°48'5E, 22°17,9'N, 3.II.1999, leg. L. PEREGOVITS & G. RONKAY (coll. P. GYULAI, G. RONKAY and HNHM).

Slide No. RL6607 (male).

Diagnosis (based on the male genitalia). The closest relative of *O. reticulata* is *O. lucida*, the male genitalia of the two species differ in the following details: The uncus of *O. reticulata* is narrower, less dilated distally, less furcate terminally, the valva and the cucullus are somewhat broader, the latter is more rounded and the large ventral diverticulum of the vesica is shorter, broader.

Comparing the male genitalia of the *O. reticulata–O. lucida* species-pair with those of *O. nigricomma* and *O. lexuancanhi*, the former group has broader, more dilated uncus and valva, weaker, shorter costal extension and smaller, less dentate dorso-lateral plate of the carina.

Description of the male genitalia (Fig. 35): Uncus relatively short, distally dilated, spatulate, apically incised, subapical arms pointed. Tegumen narrow, fultura inferior large, pyriform, dorso-lateral arms long, pointed; vinculum moderately long, V-shaped. Valvae symmetrical, elongated, slightly dilated medially, cucullus rounded, corona reduced. Costa sclerotized, costal extension long, slender, acute, harpe-ampulla-complex small, flattened, sclerotized, both arms peaked. Sacculus elongate, narrow, left clavus larger, rounded triangular with broad base, right clavus smaller, narrower. Aedeagus cylindrical, curved at apical third; carina with two long, narrow sclerotized bars, dorso-lateral bar with small, rounded dentate terminal plate. Vesica broad, membranous, without cornutus, basal part with large, apically rounded subconical diverticulum, medial part with conical, smaller diverticulum.

The *Owadaglaea chloromixta*-group

This species-group contains, by our recent knowledge, nine species belonging to four lineages, the *chloromixta*-, the *fuscopicta*-, the *moorei*- and the *triangulifera*-lines, respectively. The wing pattern of the species is rather constant within the whole group while the colouration is rather variable from pale green to dark chocolate-brown. The abdominal coremata are well-developed.

The configuration of the genitalia also shows relatively small variation, the male genitalia are characterizable by the slightly asymmetrical, acute triangular valvae with most often symmetrical, triangular saccular extensions, the slightly asymmetrical harpe-ampulla complex, the asymmetrical costal extensions and the characteristic subbasal, mace-like, bulbed cornutus of the vesica. The specific differences can regularly be found in these features and in the shape and size of the uncus, the configuration of which is typical of the whole genus (see HACKER & RONKAY 1996, HREBLAY & RONKAY 1998). In the female genitalia the ovipositor is short, weak, the ostium bursae is large, flattened, heavily sclerotized, more or less quadrangular, lyriform or funnel-like, the ductus bursae is relatively broad, ribbed, medial part often with large, sclerotized lateral plate, the distal part is narrow, neck-like.

The taxa of the group are distributed from eastern Afghanistan (*O. nigriclava*) to eastern Nepal and Sikkim, no species of the *O. chloromixta*-group is known from Indochina.

The species of the species-group are listed below, the illustrations of the species and their genitalia can be found, besides this paper (Figs 38–43), in HACKER (1992), YOSHIMOTO (1995), HACKER and RONKAY (1996), and HREBLAY and RONKAY (1998, 1999).

Owadaglaea chloromixta-group

O. chloromixta HACKER et RONKAY, 1996
O. hackeri HREBLAY et RONKAY, 1998
O. hadasi sp. n.
O. nigriclava (BOURSIN, 1957)
O. fuscopicta HACKER et RONKAY, 1996
O. siddiquii sp. n.

O. moorei (HACKER, 1992)
O. elongata HREBLAY et RONKAY, 1998
O. triangulifera HREBLAY et RONKAY, 1998

DESCRIPTIONS OF THE NEW TAXA

Owadaglaea siddiquii sp. n.

(Figs 19–20, 39, 41)

Holotype: male, "PAKISTAN, Kashmir, Himalaya Mts, Deosai Mts, Bubin valley, 3150 m, 75°02,7'E, 35°13,5'N, 12–16.X.1998, leg. GY.M. LÁSZLÓ and G. Ronkay", slide No. RL6601 (coll. G. RONKAY, in HNHM Budapest).

Paratypes: 5 females, with the same data as the holotype, leg. GY. M. LÁSZLÓ and G. RONKAY (coll. HNHM, G. RONKAY and P. GYULAI).

Slide No. RL6676 (female).

Diagnosis. The new species belongs to the *O. chloromixta* species-group. This species group contains four parallel lineages the species of which may occur sympatrically, the species of the same lineage are regularly allopatric. The closest relative of *O. siddiquii* is *O. fuscopicta*, distributed from W Nepal westwards to the Murree Hills, although the colouration of the two taxa are rather dissimilar. The ground colour of the new species is dark ochreous grey irrorated with mossy green and brownish scales, that of *O. fuscopicta* dark chocolate-brown with variably strong, usually weak ochreous irroration. The elements of the wing pattern are more or less similar in the two sister-species, but the crosslines and the orbicular and reniform stigmata of *O. siddiquii* are more conspicuous, more sharply defined, the reniform is smaller, not dilated apically, the area between the reniform stigma and the postmedial line is not darkened, the hindwing is paler, greyish brown while that of *O. fuscopicta* is dark chocolate-brown. The colouration of the third related Pakistani species, *O. hadasi* sp. n., described below, is even paler, the ground colour is ashy grey with intense bluish-greenish suffusion, the reniform stigma is larger with broader apical part, its filling is conspicuously paler than ground colour, the area between reniform stigma and postmedial line is conspicuously dark, the claviform stigma is regularly longer and the hindwing is ochreous-greyish with darker brownish grey irroration. The fourth related taxon of the region, *O. nigriclava* has more brownish forewings with darkened medial area, the reniform is narrower, with darker grey-brownish filling, the claviform stigma is rather short triangular, the postmedial is sharply defined, slightly sinuous and the hindwing is suffused with greyish brown. This species has the north-westernmost distribution within the whole genus, it is known from NE Afghanistan.

The male genitalia of *O. siddiquii* are similar in type to those of the members of the species-group, differing from those of *O. fuscopicta* by their terminally broader, more furcate uncus, stronger corona, weaker, smaller left costal extension, broader apical (dorsal) part of fultura inferior with shorter, weaker apical processi, less developed right clavus, somewhat stronger right lateral plate of carina and with narrower, more elongate cornutus of vesica; from those of *O. hadasi* by their terminally narrower, less furcate uncus, longer, more acute triangular cuculli, broader apical part of fultura inferior, somewhat longer left clavus, much smaller, weaker right lateral plate of carina, more elongated cornutus and by the broader vesica, having somewhat larger diverticula.

The female genitalia of *O. siddiquii* differ from those of *O. fuscopicta* by their broader, shorter, more quadratic ostium bursae, from those of *O. hadasi* by their broader, more quadratic ostium bursae, larger, but less strongly sclerotized dorsal patch of ductus bursae having diffuse margins, more strongly ribbed cervix bursae and by the larger, laterally more angular sac of corpus bursae.

Description. Wingspan 35–36 mm, length of forewing 16–17.5 mm. Sexes similar. Pubescence of head and thorax pale ochreous grey, mixed with blackish and greenish hairs. Lateral sides of palpi dark fumous grey, tip of last segment ochreous, frons dark grey, upper part somewhat paler, mixed with ochreous hairs. Antenna of male finely ciliate with short, fasciculate cilia, that of female filiform, dark brown. Collar small, medial and apical lines blackish. Tegulae broad, more or less unicolorous, prothoracic tuft and mesothoracic crest large, somewhat darker than tegulae; metathoracic tuft darker grey-brown, mixed with blackish hairs. Abdominal coremata present. Forewing elongate, with apex pointed, outer margin finely crenulate. Ground colour pale, shining ochreous grey, basal and marginal areas suffused with fine mossy-greenish and ochreous brown scales, median area usually darkened, covered with blackish grey; scaling finely reticulate. Inner margin pale ochreous-greenish, lower third of basal area irrorated with dark grey-brown. Ante- and postmedial lines fine, double, dark grey or blackish, filled with ochreous. Antemedial evenly arcuate, postmedial slightly sinuous, median fascia diffuse, shadow-like, darker grey, except stronger, oblique, blackish costal streak. Orbicular and reniform stigmata rather sharply defined, encircled with fine blackish and ochreous lines, filled with ground colour. Orbicular rounded, reniform larger, bean-shaped, its outer half with a few greenish-ochreous scales. Costal, praeorbicular and claviform spots sharply defined, black, claviform triangular, medium-long. Subterminal line ochreous, its costal patch strong, triangular, blackish, other parts obsolescent, sinuous. Terminal line fine, ochreous, sinuous, cilia as ground colour, with very fine, ochreous medial line. Hindwing suffused with dark greyish brown, discal spot and transverse line diffuse, somewhat darker; cilia as ground colour. Underside of wings shining, pale whitish-ochreous with olive shine, most parts of forewing covered with brownish grey scales; traces of reniform, postmedial and subterminal lines well-discernible. Hindwing irrorated with brown, discal spot large, diffuse, transverse line and marginal area darker grey.

Male genitalia (Fig. 41): Uncus relatively short, distally slightly dilated, spatulate, apically finely furcate with pointed subapical extremities. Tegumen weak, narrow, penicular lobes narrow, elongate. Fultura inferior large, shield-like, broad at base, slightly constricted at middle, apex with fine lateral arms; vinculum long, strong, V-shaped. Valvae elongate, slightly asymmetrical, right valva somewhat broader. Cucullus relatively long, triangular, with apex acute, corona medium-long. Costa heavily sclerotized, pollex-like extension of left valva short, spine-like, that of right valva fully reduced. Sacculus short, right clavus represented by setose, small lobe situated rather distally, left clavus somewhat stronger, larger, more rounded. Ventral margin of sacculus with strong but short triangular extension. Harpe-ampulla complex slightly asymmetrical, outer arms long, slender, pointed, horn-like, inner arms much finer, slender. Aedeagus long, cylindrical, curved at apical third; carina with basally dentate ventro-lateral plate on right side, extending into basal part of vesica. Vesica broadly tubular, inflated, membranous with dense scobination, basal part with strong, elongate, bulbed, mace-like cornutus. Medial part spacious, saccate, with two subconical diverticula, distal third tapering, with subconical terminal diverticulum.

Female genitalia (Fig. 39): Ovipositor short, weak, papillae anales rounded, setose, posterior apophyses slender, short. Ostium bursae large, flattened, heavily sclerotized, more or less quadratic with folded lateral edges, caudal margin finely convex. Ductus bursae medium-long, proximal part broad, spacious, ribbed, medial part with large, sclerotized, triangular ventro-lateral plate, distal part much narrower, tubular, wrinkled. Cervix bursae small, conical, situated at middle of corpus bursae. Apical part of corpus bursae rounded, strongly ribbed, partly finely, smoothly sclerotized, main part of corpus bursae discoidal-quadratic, membranous with weak scobination and with four long, broad, ribbon-like signa.

Bionomics and distribution. *O. siddiquii* is known only from the Deosai Mts (Bubin valley) of the NW Himalaya, the specimens were collected at light at the middle of October.

Etymology. The new species is dedicated to Dr ABDUL HALEEM SIDDIQUI, senior researcher of the Deosai National Park, Himalayan Wildlife Project, Islamabad.

Owadaglaea hadasi sp. n.
(Figs 21–22, 40, 42)

Holotype: male, Pakistan, Karakoram Mts, Naltar valley, 2800 m, 74°12'E, 36°096'N, 18.X.1997, leg GY. M. LÁSZLÓ and G. RONKAY; slide No. RL6602 (coll. G. RONKAY, in HNHM Budapest).

Paratypes: 3 females, with the same data as the holotype, leg GY. M. LÁSZLÓ and G. RONKAY; 2 males, from the same locality, end of November, 1998, leg. F. HUSSEIN (coll. HNHM, G. RONKAY and P. GYULAI).

Slide No. RL6675 (female).

Diagnosis. The comparison of the external features of the Pakistani species of the *O. chloromixta*-group is given in the diagnosis of *O. siddiquii*. The configuration of the male genitalia of *O. hadasi* shows an intermediate stage between those of the *O. chloromixta* – *O. hackeri* and the *O. fuscopicta* – *O. siddiqui* pairs of species. The male genitalia of *O. hadasi* differ from those of *O. chloromixta* and *O. hackeri* by the terminally much broader, much more furcate uncus, narrower valvae with more acute cucullus and longer corona, larger, stronger costal extensions, weaker ampullar part of harpe-ampulla complex, narrower apical part of fultura inferior, smaller clavi, longer saccular extensions and by the stronger, broader cornutus; from those of *O. fuscopicta* and *O. siddiqui* by the terminally significantly broader, much more furcate uncus, shorter, somewhat broader cuculli with shorter, weaker corona, smaller left costal extension, situated rather far from harpe, basally broader, apically narrower plate of fultura inferior, somewhat smaller left clavus, much stronger, larger right lateral plate of carina, shorter, but broad basal cornutus and by their narrower main tube of vesica having somewhat smaller diverticula.

Description. Wingspan 35–36 mm, length of forewing 16–17.5 mm. Sexes similar. Head small, palpi short, porrect, third joint relatively long. Pubescence of head and thorax smooth, pale bluish ashy grey with greenish-turquise shade. Lateral sides of palpi dark fumous grey, tip of last segment ochreous. Lower half of frons dark grey, upper part much paler, mixed with ochreous hairs. Antenna of male finely ciliate with short, fasciculate cilia, that of female filiform, dark brown with fine ochreous rings. Collar small, medial and apical lines sharp, blackish. Tegulae broad, unicolorous, prothoracic tuft and mesothoracic crest large, their tips somewhat paler than tegulae; metathoracic tuft darker grey, mixed with brown hairs. Abdominal coremata present. Forewing elongate, rather broad triangular, with apex pointed, outer margin finely crenulate. Ground colour pale, bluish ashy grey with fine greenish-turquise shade and ochreous shining, scaling finely reticulate. Basal and marginal areas unicolorous, with a few darker scales only, median area somewhat darker, with stronger grey-brown irroration. Inner margin pale ochreous, lower third of basal area suffused with dark grey. Basal area broad, ante- and postmedial lines fine, double, dark grey or blackish with whitish inner line. Antemedial evenly arcuate, postmedial more indistinct, less sinuous, defined with ochreous scales. Median fascia diffuse, shadow-like, darker grey. Orbicular and reniform stigmata clearly visible, encircled with fine blackish and whitish lines. Orbicular rounded, filled with ground colour, reniform large, ovoid with broader upper part, its outer half filled with ochreous; dark patch between reniform and postmedial line large, dark brownish grey. Costal, praeorbicular and claviform spots sharply defined, black, claviform acute triangular, long, sometimes very long. Subterminal line obsolete, its costal patch strong, triangular, blackish, other parts obsolete or completely missing. Terminal line fine, ochreous, sinuous, cilia as ground colour, with fine ochreous medial line. Hindwing ochreous, suffused with rather pale brownish grey, discal spot and transverse line diffuse, somewhat darker, marginal area relatively narrow; cilia whitish-ochreous with diffuse, brownish medial line. Underside of wings shining, pale whitish olive-grey, forewing suffused strongly with brownish grey, traces of reniform and postmedial line recognizable. Hindwing with scarce brown irroration, discal spot large, rounded, diffuse, transverse line and lower half of marginal stripe darker grey, diffuse, partly interrupted.

Male genitalia (Fig. 42): Uncus relatively short, slender at base, distally spatulate, dilated, strongly furcate with acute subapical extremities. Tegumen weak, narrow, moderately high, penicular lobes narrow, elongate. Fultura inferior large, shield-like, broad at base, tapering at middle, apex with fine medial lobe; vinculum long, strong, V-shaped. Valvae elongate, slightly asymmetrical, right valva somewhat broader. Cucullus short, triangular with apex acute, corona short, weak. Costa heavily sclerotized, with pollex-like, asymmetrical extensions, left one spine-like, right one forming small triangle. Sacculus short, strong, right clavus reduced to setose surface, left clavus small, sclerotized, rounded lobe. Ventral margin of sacculus with strong, triangular extension distally. Pulvillus regularly long, bar-like, densely setose. Harpe-ampulla complex slightly asymmetrical, outer arm of left harpe more curved, inner arms much finer, slender, stick-like. Aedeagus long, cylindrical, curved at apical third; carina sclerotized, with dentate ventro-lateral plate on right side, its sclerotization extending far into basal part of vesica. Vesica broadly tubular, inflated, scobinate, with strong but rather short, bulbed, mace-like cornutus. Medial part spacious, saccate, with two broad, membranous diverticula, distal third tapering, with broad terminal diverticulum.

Female genitalia (Fig. 40): Ovipositor short, weak, papillae anales rounded quadrangular, setose, posterior apophyses slender, fine. Ostium bursae huge, heavily sclerotized, more or less quadratic with folded lateral edges, tapering proximally. Ductus bursae medium-long, proximal part broader, spacious, wrinkled, medial part with large, heavily sclerotized ventro-lateral plate, distal part narrow, tubular, wrinkled. Cervix bursae small, conical, situated at middle of corpus bursae. Apical part of corpus bursae rounded conical, ribbed, finely, smoothly sclerotized, main part of corpus bursae discoidal, finely scobinate, with four long, broad, ribbon-like signa.

Bionomics and distribution. *O. hadasi* is known only from the Karakoram Mts (Naltar valley), the flight period of the adults is October–November.

Etymology. The new species is dedicated to Mr LÁSZLÓ HADAS, former Counsellor of the Embassy of the Republic of Hungary in Islamabad who has supported our scientific work in Pakistan.

Owadaglaea fuscopicta HACKER et RONKAY, 1996
(Figs 23–24, 38, 43)

Owadaglaea fuscopicta HACKER et RONKAY, 1996, *Esperiana* **4**: 351.

Material examined: 7 males, 11 females, Pakistan, Kashmir, Himalaya Mts, 30 km NW Murree, near Nathia Ghali, Ayubia village, 2600 m, 22–25.X.98, leg. GY. M. LÁSZLÓ and G. RONKAY (coll. P. GYULAI, G. RONKAY and HNHM).

Slide Nos RL6677 (male), RL6696 (female).

Diagnosis. *O. fuscopicta* differs from its close relatives by its darker, most often unicolorous dark chocolate-brown forewings, weaker, less distinctly marked orbicular and reniform stigmata, and the usually shorter, less acute claviform stigma. Comparing the female genitalia of *O. fuscopicta* with those of *O. siddiquii* and *O. hadasi*, the ostium bursae is the longest in *O. fuscopicta*, it is lyriform, tapering rather strongly towards proximal end, the sclerotized ventro-lateral plate of the ductus bursae is narrower, longer, weaker than that of *O. hadasi*.

Description of the female genitalia (Fig. 38): Ovipositor short, weak, gonapophyses slender, fine. Ostium bursae huge, heavily sclerotized, rather long lyrifom, tapering proximally, lateral edges slightly folded. Ductus bursae flattened, medium-long, proximal part strongly wrinkled, medial part with triangular, heavily sclerotized ventro-lateral plate, distal part narrow, tubular, wrinkled. Cervix bursae small, conical, situated at middle of corpus bursae. Apical part of corpus bursae broad, rounded, strongly ribbed, main part of corpus bursae discoidal, finely scobinate, with four long, broad signum-stripes.

Bionomics and distribution: A western Himalayan species, its range extends from W Nepal throughout the northern regions of India (type locality: Himachal Pradesh) towards the southern chains of the Himalaya in Pakistan (Murree Hills). The main habitats are mixed and shrubby deciduous and coniferous forests at medium high altitudes (2000–3000 m a.s.l.). The imagines are on wing in the late autumn and throughout the winter period (from October to January).

*

Acknowledgements – The authors would like to express their gratitude to Mr M. R. HONEY (London), Dr C. NAUMANN and Dr D. STÜNING (Bonn), Dr W. MEY (Berlin), Dr A. HAUSMANN (Munich), Mr H. HACKER (Staffelstein), Mr A. V. NEKRASOV (Moscow), Dr Z. VARGA (Debrecen), Dr P. GYULAI (Miskolc), Dr B. HERCZIG (Tata) for the opportunity to study the material of their institutions and private collections. We are indebted to Dr V. ZAKARIA and Dr A. H. SIDDIQUI (Islamabad), Mr F. HUSSEIN and Mr RAJA ALI ANWAR KHAN (Gilgit), Dr LE XUAN CANH and Dr VU QUANG CON (IEBR Hanoi), Mr R. SOBEY, Mr J. TORDOFF, Mr S. SWAN and Mr M. GRINDLEY (Frontier-Vietnam, Hanoi), Mr HUNG (Sa Pa), Mr L. PEREGOVITS (Budapest) and Mr GY. M. LÁSZLÓ (Csákvár) for their kind help and assistence in the field collectings. We are highly appreciate for Mr. L. HADAS, Mr. Á. SZŐKE and Mr. L. FODOR (Embassy of the Republic of Hungary in Islamabad), and Mr J. FÖLDESY (Ministry of Foreign Affairs, Budapest) for their kind support of our expeditions in Pakistan. Our sincere thanks to Mr A. KUN for the preparation of the illustrations.

The research was supported by the Hungarian Scientific Research Fund (OTKA, grant No. 32247).

REFERENCES

BOURSIN, CH. (1957) Nouvelles "trifinae" d'Afghanistan de l'expedition Klapperich (Lep. Noct.) (Diagnoses preliminaires). (Contributions a l'étude des "Noctuidae-trifinae", 94). *Bull. mens. Soc. linn. Lyon* **26**: 242–250.

BOURSIN, CH. (1960) Nouvelles "trifinae" d'Afghanistan de l' expedition Klapperich (3me note). (Lep. Noctuidae) (Diagnoses preliminaires). (Contributions a l'étude des "Noctuidae-trifinae", 103). *Bull. mens. Soc. linn. Lyon* **29**: 136–152.

HACKER, H. (1990) Systematik und Faunistik der Noctuidae (Lepidoptera) des himalayanischen Raumes. Beitrag I. *Esperiana* **1**: 219–236.

HACKER, H. (1992) Systematik und Faunistik der Noctuidae (Lepidoptera) des himalayanischen Raumes. Beitrag II. *Esperiana* **3**: 67–214.

HACKER, H. (1990) Systematik und Faunistik der Noctuidae (Lepidoptera) des himalayanischen Raumes. Beitrag III. *Esperiana* **4**: 331–335.

HACKER, H. & RONKAY, L. (1990) Systematik und Faunistik der Noctuidae (Lepidoptera) des himalayanischen Raumes. 5. Liste der Cucullia Schrank, 1802, Agrochola Hübner, [1821] und Autophila Hübner [1823]-Arten mit Beschreibung neuer Taxa. *Esperiana* **1**: 377–392.

HACKER, H. & RONKAY, L. (1992) Beschreibungen neuer Taxa der Spätherbst-Noctuidae – Fauna Zentralasiens und des Himalayaraumes (Cuculliinae sensu Hampson) (Lepidoptera, Noctuidae). *Esperiana* **3**: 193–221.

HACKER, H. & RONKAY, L. (1996) Three new genera, six new species and a general view on the late autumnal noctuid fauna of the Himachal Pradesh region of India (Lepidoptera, Noctuidae: Cuculliinae sensu Hampson). *Esperiana* **4**: 337–359.

HREBLAY, M., PEREGOVITS, L. & RONKAY, L. (1999) New genera and species of Noctuidae from Vietnam, Thailand and Nepal (Lepidoptera). *Acta zool. hung.* **45**(1): 1–96.

HREBLAY, M. & RONKAY, L. (1998) Noctuidae from Nepal. *In* HARUTA, T. (ed.): Moths of Nepal, Vol. 5. *Tinea* **15** (Suppl. 1): 117–310.

HREBLAY, M. & RONKAY, L. (1999) Neue trifide Noctuidae aus dem himalayanischen Raum und der südostasiatischen Region (Lepidoptera: Noctuidae). *Esperiana* **7**: 485–620.

YOSHIMOTO, H. (1995) Noctuidae. *In* HARUTA, T. (ed.): Moths of Nepal, Part. IV, *Tinea* **14** (Suppl. 2): 49–88.

Received 18th August, 1999, accepted 20th December, 2000, published 15th May 2001

ACTA ZOOLOGICA ACADEMIAE SCIENTIARUM HUNGARICAE

AN INTERNATIONAL JOURNAL OF ANIMAL TAXONOMY AND ECOLOGY

CUMULATIVE INDEX FOR VOLUME 46, 2000

ACTA ZOOLOGICA
ACADEMIAE SCIENTIARUM HUNGARICAE
An international journal of animal taxonomy and ecology

Instruction to authors

Submission of a paper implies that it has not been published previously, that is not under consideration for publication elsewhere, and that if accepted for the Acta Zoologica Hungarica, the authors will transfer copyright to the Hungarian Academy of Sciences/the Hungarian Natural History Museum as is customary. Articles and illustrations become the property of the HAS/HNHM.

Papers must be in English with British spelling, and be original contributions in the field of animal taxonomy, systematics, zoogeography and ecology. All manuscripts must be submitted to one of the editors (editor, assistant editor).

Entire manuscripts must be submitted on IBM compatible floppy disk and in duplicate printed copies and the author should retain a copy. In the case of multiple authors, the corresponding author should be indicated. Series of numbered papers will not be considered.

Manuscripts must be printed with double spacing (including the reference list), and with wide margins (30–35 mm) on the left side of the paper only. Authors are requested to keep their communications as concise as possible. Footnotes should be avoided or minimized, and italics should not be used for emphasis. A running head of not more than 30 letters should be supplied.

The manuscript should contain the following information:

Title should be followed by the name and full address of the author(s). Where possible, the fax and/or e-mail number of the corresponding author should be supplied with the manuscript, for use by the publisher.

Abstract should be a brief summary of the contents and conclusions of the paper, and should not be longer than 200 words and should not contain references.

Key words should not be more than five (exceptionally 6) key word entries.

Introduction should contain a brief survey of the relevant literature and the reasons for doing the work.

Materials and Methods supply sufficient information to permit repetition of the experimental or field work. The technical description of methods should be given only when such methods are new.

Results should be presented concisely. Only in exceptional cases will it be permissible to present the same set of results in both table and a figure. The results section should not be used for discussion.

Discussion should be separate from the results section and should deal with the significance of the results and their relationship to the object of the work (and, this is the place of the identification key in taxonomic revisions).

Acknowledgements (at most in 10 lines).

References. In principle the Harvard system is to be followed. References should be detailed in the following order: authors' names and initials, date of publication (in parentheses), the title of the article, the name of the journal as abbreviated in the World List of Scientific Periodicals (4th edn 1963), the volume, and the first and last pages of the article, e.g.

NORRBOM, A. L. & KIM, K. C. (1985) Taxonomy and phylogenetic relationships of Copromyza Fallén (s. s.) (Diptera: Sphaeroceridae). *Ann. Entomol. Soc. Am.* **78**: 331–347.

For books the author's names, date of publication, title, edition, page reference, publisher's name and the place of publication should be given, e.g.

HINTON, H. E. (1981) *Biology of insect eggs, vol. 2.* Pergamon Press, New York, 234 pp.

or

PRICE, P. W. (1984) Alternative paradigms in community ecology. Pp. 353–383. *In* PRICE, P. W., SLOBODCHIKOFF, C. N. & W. S. GAUD (eds): *A new ecology: Novel approaches to interactive systems.* Wiley, New York.

In the text references should be given as MARSHALL (1992) or (MARSHALL 1992). When a citation includes more than two authors, e.g. GREY, BLACK and WHITE, the paper should be referred to in the text as GREY *et al.*, provided that this not ambiguous. If papers by the same author(s) in the same year are cited, they should be distinguished by the letters, *a*, *b*, *c*, etc., e.g. MARSHALL (1992*a*).

References to papers "in press" must mean that the article has been accepted for publication. References to "personal communications" and unpublished work are permitted in the text only: references to papers in preparation or submitted are not permissible.

All necessary **illustrations** should accompany the manuscript, but should not be inserted in the text. All photographs, graphs and diagrams should be numbered consecutively in Arabic numerals in the order in which they are referred to in the text. Glossy photographs or positive prints should be sent unmounted wherever possible and should be kept to a minimum. Figures should be of good quality. Explanation of lettering and symbols should be given in the figure caption and only exceptionally in the figures. Lettering and symbols to appear on the illustration should be of sufficient size to allow for considerable reduction where necessary (usually proper for a 50% reduction in size). Scales must be indicated on micrographs, not by magnifications in the legends. Figure size must not exceed 24×30 cm. On the back of each illustration should be indicated the author's name, the figure number (in Arabic numerals), and the top of the illustration, where this is not clear. Half-tones should be included only when they are essential. Details and quotation of publication of colour plates should be made to the editors. The following symbols should be used on line drawing: ● ■ ○ ☐ ◆ ▲ etc.

Legends to figures should be typed on a separate sheet. They should give sufficient data to make the illustration comprehensible without reference to the text.

Tables and appendices should be constructed so as to be intelligible without reference to the text, numbered in Arabic numerals and typed on separate sheets. Every table should be provided with an explanatory caption and each column should carry an appropriate heading. Units of measure should always be indicated clearly (metric units are preferred). All tables and figures must be referred to in the text.

Only standard **abbreviations** should be used. Arbitrary abbreviations and jargon will not be accepted.

The Latin names should be given for all species used in the investigation, although taxonomic affiliation and authority need not be provided in the title.

Page proofs will be sent to the author (or the first-mentioned author in a paper of multiple authorship) for checking. Corrections to the proofs must be restricted to printers' errors. Any substantial alterations other than these may be charged to the author. Authors are particularly requested to return their corrected proofs as quickly as possible in order to facilitate rapid publication. Please note that authors are urged to check their proofs carefully before return, since late corrections cannot be guaranteed for inclusion in the printed journal.

Fifty reprints free of charge will be sent to the first author; extra copies of the issue (at a specially reduced rate) can be ordered on the form which will accompany the proofs. These should be returned to: The Editorial Office of the Acta Zoologica, Hungarian Natural History Museum, Budapest, Baross u. 13, H-1088, Hungary

The **page charge** required from authors outside Hungary is USD 15 per printed page. In exceptional cases, the page charge may be waived. Please contact the editor in before submitting a paper if you ask for a waiver. Authors of papers exceeding 16 printed pages are asked to pay USD 40 (or HUF equivalent) for each such page, i.e. all costs of publication (irrespective of their nationality).

FOR FURTHER INFORMATION PLEASE CONTACT US
The Editorial Office of the Acta Zoologica
H-1088 Budapest, Baross u. 13, Hungary
Fax: (36–1) 3171669
http://actazool.nhmus.hu/
E-mail: perego@zoo.zoo.nhmus.hu

Catalogue of Palaearctic Diptera

edited by Á. SOÓS, L. PAPP and P. OOSTERBROEK

Volume 1
Trichoceridae – Nymphomyiidae

The Catalogue contains the basic taxonomic, nomenclatorial and distribution data of all species occurring in the Palaearctic Region with the fundamental morphological features for the majority of the fly groups.

Contents: Introduction to Volumes 1–13 (Á. SOÓS and L. PAPP). History of the Catalogue of Palaearctic Diptera. Structure. Genera and their type-species. Species names, type-localities. Distribution. Literature data, references. Dates of publication. Readers. Acknowledgements and closing remarks. List of contributors (Vols 1–13). Type-species designations in Volume 1. New names proposed in Volume 1. Families: Trichoceridae (C. DAHL). Tanyderidae (R. WAGNER). Blephariceridae (P. ZWICK). Deuterophlebiidae (L. JEDLIČKA). Tipulidae (P. OOSTERBROEK and BR. THEOWALD). Cylindrotomidae (Á. SOÓS and P. OOSTERBROEK). Limoniidae (E. N. SAVCHENKO, P. OOSTERBROEK and J. STARY). Ptychopteridae (R. ROZKOŠNÝ). Nymphomyiidae (L. JEDLIČKA). Bibliography. Index.

April 30, 1992. 520 pages
US$ 80.00 plus US$ 8.00 for package and postage
(and an extra US$ 5.00 if you want it air mail)
ISBN 963 7093 10 9
Hungarian Natural History Museum, Budapest

Order should be sent
to the Hungarian Natural History Museum, Library
Baross u. 13., Budapest, H-1088 Hungary
Fax: (36–1) 3171669

SUBSCRIPTION INFORMATION

Orders should be addressed to

Editorial Office of the Acta Zoologica
Hungarian Natural History Museum
H–1088 Budapest, Baross u. 13, Hungary
Fax: (36–1) 3171669
E-mail: perego@zoo.zoo.nhmus.hu

Typeset: Pars Ltd., Budapest.
Printed by Mondat Ltd., Hungary

CONTENTS

HU ISSN 1217–8837