

Changes in sediment and sediment interstitial water characteristics in Lake Fertő/Neusiedler See

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Abstract. Changes in the C, S, N, P concentrations, organic matter content and electron transport system activity (ETS) of the sediment and in the NO_2^- , NO_3^- , PO_4^{3-} , SO_4^{2-} , NH_4^+ concentrations of water and sediment interstitial water were studied in the Hungarian part of Lake Fertő/Neusiedler See during the vegetation period. Sediment samples were collected in healthy and die-back reed stands and in the open water area from the 0-5 cm sediment layers. Organic matter content, C, N, S, P concentrations and ETS-activity were significantly higher in the sediment of the degraded reed stand. Higher electrical conductivity and SO_4^{2-} concentration were found in the second part of the vegetation period, when the water level was lower. The seasonal variation in PO_4^{3-} and NO_3^- concentrations of the surface water showed an antagonistic pattern. Higher PO_4^{3-} and NH_4^+ concentrations were measured in the sediment interstitial water in summer, when the temperature and the decrease in SO_4^{2-} concentration, which indicate the SO_4^{2-} reduction processes were greater. The higher ETS-activity values in September were probably due to the decaying mass of macrophytes.

Wetland ecosystems are among the most productive ecosystems of the biosphere (MANN & WETZEL, 2000), biogeochemical nutrient cycling in these ecosystems is critically influenced by the interaction among water, sediments and macrophytes. Macrophytes have functionally adapted to the anaerobic conditions in the sediments by translocating oxygen into the rhizosphere. Oxygen moving from the rhizosphere into the surrounding sediments changes the redox potential of the sediment (ARMSTRONG & ARMSTRONG, 1988) and favours the chemical oxydation of the reduced chemical components in the interstitial water and the microbial oxydation processes (RODEN & WETZEL, 1996). The concentration of dissolved organic and inorganic nutrients in surface and sediment interstitial water and their spatial and temporal changes provide key data to reveal how these systems function at the biogeochemical level (PAKULSKI et al., 1995). From interstitial water profiles it is, in some cases possible to identify zones of consumption and zones of production of reduced and oxidized form of the elements (GLUD et al., 1998).

Functional evaluation of wetlands in nutrient cycling, requires knowledge of differences in microbial processes between different sampling sites. Community respiration is one of the most commonly measured functional attributes of ecosystems (HILL & GARDNER, 1987; HILL et al., 2000). The activity of electron transport system (ETS), which reflects the metabolic activity of respiring microorganisms (CHRISTIANSEN & PACKARD, 1977; BROBERG, 1985), can be used in sedimentological studies as a measure of the total anaerobic and aerobic respiration (HAKANSON & JANSSON, 1983). The ETS-test developed by PACKARD (1971), KENNER & AHMED (1975), OWENS & KING (1975), and BROBERG (1985) yields the maximum potential respiratory activity.

The aim of this study was to evaluate the differences in the chemical composition of the sediment (C, N, P, S, and organic matter content), sediment interstitial water (NH_4^+ , NO_3^- , NO_2^- , PO_4^{3-} , SO_4^{2-} concentrations) and sediment ETS-activity of degraded and healthy reed stands and a reedless area of Lake Fertő/Neusiedler See during the vegetation period.

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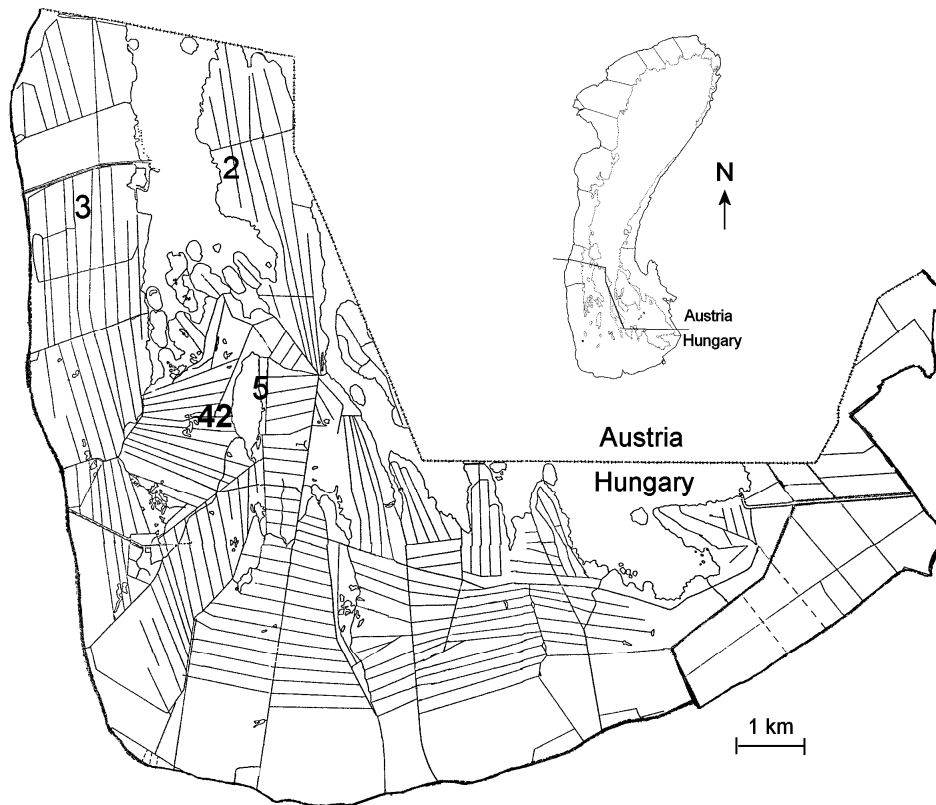


Figure 1. Sampling sites at Lake Fertő/Neusiedler See

Sampling sites

Lake Fertő/Neusiedler See, situated on the Hungarian-Austrian border (47° 42' N, 16° 46' E, Fig. 1), is the westernmost and largest steppe lake in Eurasia, declared as a biosphere reserve by UNESCO in 1977 and 1979. It has a surface area of 309 km² (Hungarian part 75 km²), with a mean depth of 1.1 m and 54 % of the whole lake, 85 % of the Hungarian part is covered by reed (*Phragmites australis* Cav. Trin. ex Steud.). Within the reed belt, there are numerous reedless ponds of variable size. According to the characteristic ionic ratios the water of Lake Fertő/Neusiedler See can be characterised as hydrogencarbonate-sulphate and sodium-magnesian mixed water type, the sediments of the lake are characterised by autochthonously formed minerals, Mg-calcite and protodolomite (MOLNÁR & DINKA, 1997, JUNGWIRTH, 1979).

Sampling sites were selected in the Hungarian part of Lake Fertő/Neusiedler See also taking into consideration the lake configuration and the condition of the reed stands in the process (Fig. 1). Sampling site 42 (S42) is a deep water (60-80 cm) reedless pond within the reed belt, sampling site 2 (S2) is a homogenous healthy reed stand (water depth: 20-40 cm), both sites have a silty-clay sediment. Sampling site 3 (S3) is a degraded stand with clumped distribution of the culms and callus occlusions in their gas space, (ARMSTRONG et al., 1996) (water depth: 30-50 cm), there are several areas of open water. The sediment is a sandy-silty-clayey sapropel rich in organic matter, in which negative redox relationships frequently develop. It is characterised by high S²⁻ concentrations (ARMSTRONG et al., 1996). Sampling site 5 (S5) is a homogeneous, loose healthy reed stand in deep water (80-120 cm), with silty-clay sediment.

In the last two years the water level was lower in early spring than in the same periods of previous years and a further 20-30 cm decrease was observed in the second part of the vegetation period in 2001, as compared to spring values (Fig. 2, data obtained from the Hydro-meteorological Station, Fertőrákos).

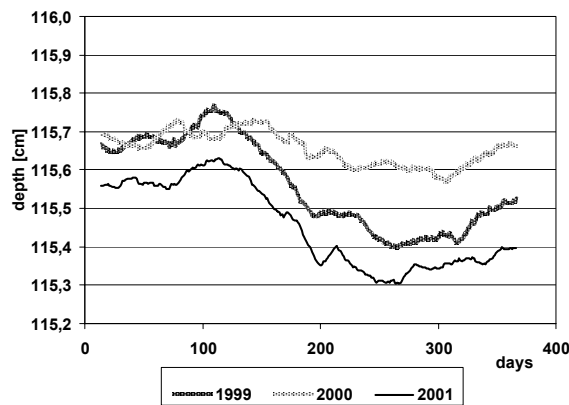


Figure 2. Water level fluctuations at Lake Fertő/Neusiedler See

The samples were collected on April 23th, July 23th, September 5th 2001 at S5 and S42 and on March 26th, April 23rd, June 20th, July 23rd, September 5th 2001 at S3 and S2.

MATERIAL AND METHODS

Sediment sampling and separation

Sediment cores were collected at each sampling site with a 40 cm Gilson sampler diameter of 5 cm, in three replicates. After slicing the sediment in 1 cm thick layers in the laboratory, it was placed in a crucible and dried to constant weight at 105 °C for 24 h for the determination of the moisture content, then combusted at 450 °C (MOLNÁR & DINKA, 1997; JUNGWIRTH, 1979; SUTHERLAND, 1998) for 4 h in a muffle furnace for determination of organic matter content by loss on ignition method (OM_{LOI}).

Total nitrogen (TN), total sulphur (TS) and organic carbon (OC) concentrations of the sediment samples were determined with a Fison

NA-1500 NCS analyser, total phosphorus (TP) concentration by photometry using the molybden-blue complex method, after combustion of the sediment at 450 °C and 12 hours digestion with 1N HCl (ASPILA & AGEMAIN-CHAU, 1976). Sediment ETS-activity was determined by the tetrazolium reduction test introduced by PACKARD (1971) and modified by BROBERG (1985).

Surface and sediment interstitial water analysis

Temperature, electric conductivity (at in situ temperature), pH, of the surface water, the redox potential of the surface and bottom water (3-5 cm above the sediment) were established on the spot with a Hydrolog 2100 field equipment. The interstitial water from the upper sediment layers (0-1, 1-2, 2-3, 3-4 and 4-5 cm) was filtered (Sartorius cellulose acetate filter, pore diameter: 0.4 µm) with the help of a vacuum pump. The NH₄⁺, NO₂⁻, NO₃⁻, PO₄³⁻, SO₄²⁻ concentrations of the interstitial and surface water were measured with a Dionex DX-120-ionchromatograph after filtering (Chromafil filter, pores: 0.2 µm).

Data analysis and statistical methods

An analysis of variance (Statgraf 1.0 for Windows) was used for the statistical evaluation of the individual data (p<0.05).

The relationships between the sampling sites (objects) and the chemical features of the surface water, sediment, sediment interstitial water and the sediment ETS-activity (variables) were determined with standardized Principal Component Analysis (PCA) (PODANI, 1997). The ordinations of sediment and water samples taken in different seasons were compared using the Procrustes analysis, which compares ordinations after rotating the two configurations and rescaling them so that the square total of the distances between the corresponding pairs of points should be minimum (PODANI, 1997).

RESULTS

Surface and sediment interstitial water characteristics

In situ water parameters

The electrical conductivity of surface water ranged from 1.99 to 4.57 mS cm⁻¹, higher values were measured in the second part of the vegetation period. The electrical conductivity in September was twice as high as in spring at S3 and it was 1.5-1.8 times higher than at S42, S2 and S5 (Table 1).

The pH of surface water ranged from 8.2 to 9.6 and at all sampling sites it was one order of magnitude higher in early autumn than in spring (April: 8.2-8.6; September: 9.2-9.6).

The redox potential of surface water ranged between 24-210 mV, the lowest values were measured in summer months (S3: 24 mV). There were no significant differences between the water parameters measured at the surface and above the sediment except of the redox potential values. In summer the redox potential of the bottom water reached -27 and -40 mV values at S3 and S5, respectively.

The temperature of surface water at S3, shallow water, thinning reeds, varied between 11.7 and 20 °C, from March to September, and it was by 2.1-4.6 C° higher than in the shallow water, homogeneous reeds (S2) and by 2.3-4.4 C° higher than at the deep water sampling sites (S42, S5). Differences in surface water temperature of different sampling sites were minimum in July (1.7 C°) and maximum in April and September (4.7 C°).

Table 1. Chemical characteristics of the surface water at Lake Fertő/Neusiedler See in 2001(n.d.=not detected, Eh= redox potential, T=temperature)

Sites	Data 2001	Conductivity mS cm ⁻¹	pH	T °C	Eh mV	PO ₄ ³⁻ mg l ⁻¹	NO ₂ ⁻ mg l ⁻¹	NO ₃ ⁻ mg l ⁻¹	SO ₄ ²⁻ mg l ⁻¹	NH ₄ ⁺ mg l ⁻¹
Site 42	23.04	2.37	8.2	8.6	210	0.16	n.d.	0.09	327.96	n.d.
	23.07	2.64	9.1	17.1	108	0.45	n.d.	0.19	621.44	n.d.
	05.09	3.16	9.2	19.6	205	0.04	n.d.	n.d.	522.74	1.13
Site 2	26.03	1.99	8.6	10.0	206	0.00	n.d.	1.80	331.27	n.d.
	23.04	2.13	8.4	9.7	209	0.38	n.d.	0.26	328.51	n.d.
	23.07	2.53	8.8	17.7	84	0.17	0.48	n.d.	529.60	n.d.
	05.09	2.44	9.4	19.3	205	0.02	n.d.	0.32	491.55	n.d.
Site 3	26.03	2.20	8.5	11.7	206	0.00	n.d.	0.20	219.88	n.d.
	23.04	2.52	8.3	12.9	142	0.38	n.d.	0.49	334.64	n.d.
	23.07	3.55	8.8	19.9	24	0.22	0.74	0.08	791.64	n.d.
	05.09	4.57	9.6	20.0	205	0.00	n.d.	1.13	461.78	n.d.
Site 5	23.04	2.36	8.6	8.4	208	0.16	n.d.	0.19	333.41	n.d.
	23.07	2.74	9.4	17.3	125	0.09	n.d.	0.06	431.80	n.d.
	05.09	3.02	9.4	19.4	195	0.00	n.d.	0.57	520.72	n.d.

Nutrients in surface and interstitial water

Higher SO_4^{2-} concentrations of surface water were measured in the second part of the vegetation period (Table 1). The SO_4^{2-} concentration in the upper 5 cm sediment layer decreased with increasing depth, the highest decrease was observed in the 4-5 cm sediment layer e.g. at S3 the pore water SO_4^{2-} concentration was lower by 57-63 % and at S5 it was lower by 46-62 %, than that of surface water (Fig. 3). Spatial pattern in pore water SO_4^{2-} concentration profiles was evident, a higher decrease was observed at sites S3 and S5 with higher organic matter content. The pore water SO_4^{2-} concentration showed obvious seasonal changes,

at S3 its value was 2.1 times higher in September than in March (Fig. 3), this ratio was 1.6 at S5, 1.2 at S42, and 1.0 at S2 where the water level changes were smallest.

The NO_2^- concentrations in the surface water of most sampling sites were below detection limit, they were detectable only at S2 and S3. NO_2^- was only found in spring and summer in the examined upper 5 cm sediment layer of the sampling sites, its concentration varied from 0.76 to 3.49 mg l^{-1} at S5, from 0.15 to 3.57 mg l^{-1} at S3, from 0.18 to 3.23 mg l^{-1} at S2 and from 3.14 to 3.35 mg l^{-1} at S42 (Table 2). The NO_2^- concentrations did not show any evident spatial pattern.

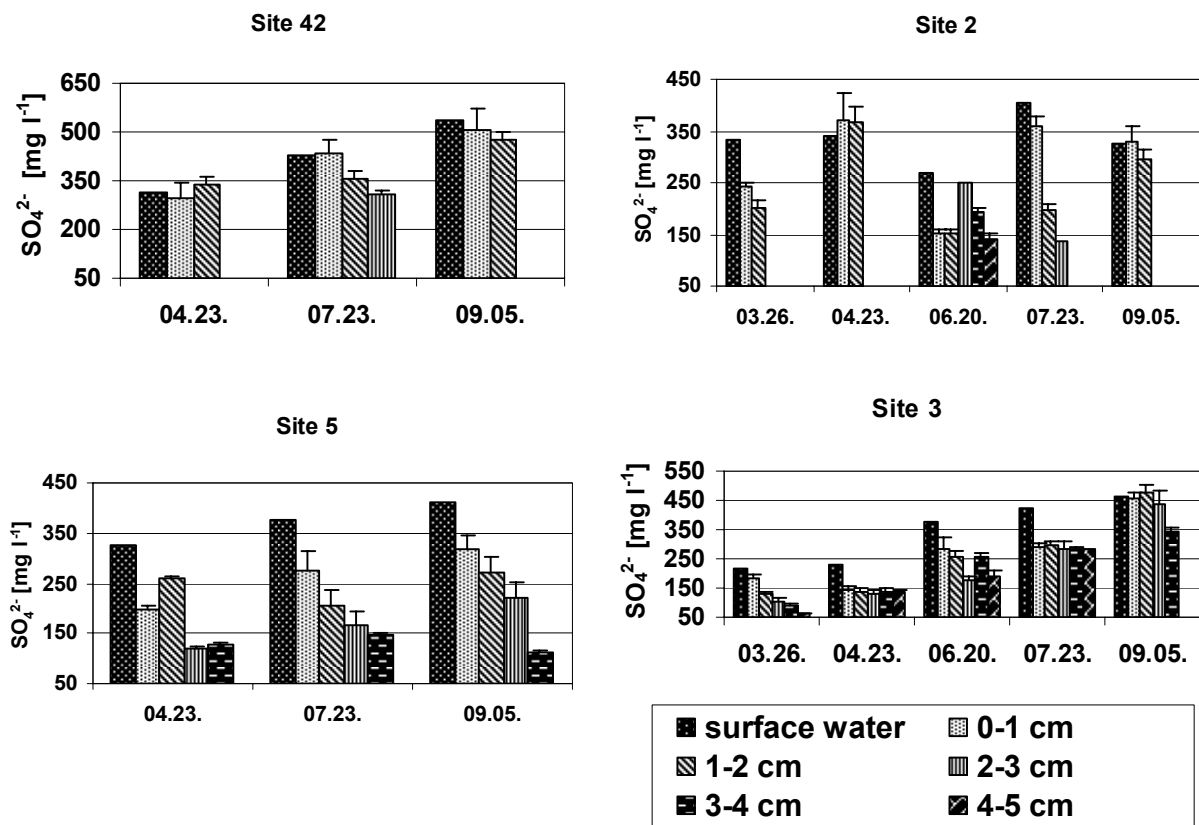


Figure 3. SO_4^{2-} concentration of the surface and sediment interstitial water in Lake Fertő/Neusiedler See in 2001 (means \pm SE, n=3).

Table 2. Changes in NH_4^+ , NO_2^- , NO_3^- , PO_4^{3-} concentrations of the surface (0-5cm) sediment interstitial water at Lake Fertő/Neusiedler See (S.E.=standard error, n.d.=not detected)

		26.03	23.04.	20.06.	23.07.	05.09.	23.04.	23.07.	05.09.	
		Site 2				Site 42				
NH_4^+ [mg l ⁻¹]	Min	n.d.	n.d.	0.87	n.d.	n.d.	n.d.	n.d.	1.13	
	Max	n.d.	n.d.	1.72	n.d.	n.d.	n.d.	n.d.	5.61	
	Mean			1.30					3.37	
	S.E.			0.60					3.17	
NO_2^- [mg l ⁻¹]	Min	n.d.	n.d.	0.18	3.13	n.d.	n.d.	3.14	n.d.	
	Max	n.d.	n.d.	0.53	3.23	n.d.	n.d.	3.35	n.d.	
	Mean			0.33	3.18			3.25		
	S.E.			0.17	0.07			0.11		
NO_3^- [mg l ⁻¹]	Min	0.45	0.15	0.36	n.d.	0.64	0.09	n.d.	0.13	
	Max	0.41	0.38	0.82	n.d.	0.72	1.01	n.d.	0.11	
	Mean	0.43	0.27	0.52		0.68	0.55		0.12	
	SE	0.03	0.17	0.26		0.33	0.65		0.01	
PO_4^{3-} [mg l ⁻¹]	Min	n.d.	n.d.	0.46	0.17	0.01	0.16	0.12	0.04	
	Max	n.d.	n.d.	2.14	1.84	0.02	0.21	0.45	0.17	
	Mean			1.30	1.01	0.02	0.19	0.28	0.11	
	S.E.			1.19	1.18	0.01	0.04	0.23	0.09	
		Site 3				Site 5				
NH_4^+ [mg l ⁻¹]	Min	n.d.	n.d.	0.94	2.99	n.d.	n.d.	0.60	5.65	
	Max	n.d.	n.d.	2.43	3.89	n.d.	n.d.	7.99	8.05	
	Mean			1.72	3.44			3.45	6.85	
	S.E.			0.75	0.45			3.29	1.70	
NO_2^- [mg l ⁻¹]	Min	0.00	n.d.	0.51	3.25	n.d.	0.00	1.56	n.d.	
	Max	0.15	n.d.	0.61	3.57	n.d.	0.76	3.49	n.d.	
	Mean			0.54	3.40			2.96		
	S.E.			0.04	0.12			0.93		
NO_3^- [mg l ⁻¹]	Min	0.11	0.08	n.d.	n.d.	0.10	0.15	n.d.	0.57	
	Max	0.37	0.53	n.d.	n.d.	1.34	0.24	n.d.	0.63	
	Mean	0.10	0.29			0.87	0.26		0.60	
	S.E.	0.38	0.21			0.76	0.12		0.03	
PO_4^{3-} [mg l ⁻¹]	Min	0.14	0.15	0.32	0.22	0.17	0.60	0.33	0.74	
	Max	0.16	0.38	0.89	0.46	0.28	1.99	3.06	4.21	
	Mean	0.15	0.27	0.61	0.34	0.23	0.98	3.61	3.55	
	S.E.	0.01	0.12	0.29	0.12	0.06	0.68	1.65	0.94	

The range of NO_3^- concentrations in the surface water was 0.06-1.80 mg l^{-1} (Table 1) and in the sediment pore water it varied between 0.15 and 0.63 mg l^{-1} at S5, between 0.09 and 1.01 mg l^{-1} at S42, between 0.11 and 1.34 mg l^{-1} at S3 and between 0.15 and 0.82 mg l^{-1} at S2 (Table 2). It changed with the season, with lower values in the first part of the vegetation period, except with S42.

Comparing the sampling sites, the highest pore water NH_4^+ concentrations were measured in summer and early autumn, from 0.60 to 8.05 mg l^{-1} at S5, from 1.13 to 5.61 mg l^{-1} at S42, from 0.94 to 3.89 mg l^{-1} at S3 and from 0.87 to 1.72 mg l^{-1} at S2. The pore water NH_4^+ concentration increased with depth. NH_4^+ was not detectable in the surface water except S42 in September.

Higher PO_4^{3-} concentrations were measured in summer and early autumn (Table 1). The PO_4^{3-} concentration of sediment interstitial water increased in the function of depth, the highest increase was observed at S5, it was by 70-89 % higher than the appropriate sediment surface values (Table 2).

Sediment characteristics

The following discussed characteristics were measured in every sediment layer of the upper 5 cm. Average values are presented in Table 3 with an indication of significant ($p < 5\%$) differences between the sites.

There were significant spatial changes in the organic matter content (OM_{LOI}) of the upper 5 cm sediment layers. S3 had the significantly highest OM_{LOI} from spring to autumn. Summer (OM_{LOI}) samples were highest at all sites, except with S2. Significant differences were observed among the OC values measured in the sediment of different sampling sites. The OC concentration was significantly higher at S3 than at the other sampling sites at each sampling time.

Total nitrogen (TN) value was also significantly higher at S3 than at the other sampling sites. TN concentration differences in the sediment were not significant among the other sampling sites. Significant seasonal and spatial differences in the C:N ratio were recorded between the sampling sites. The greatest changes were measured at S3 (mainly due to N concentration alterations during the vegetation period).

Similarly to other element concentration TP concentration was significantly highest in the sediment of S3. TP concentration of the sediment decreased from April to September at S2 and S3. The significantly lowest average TS concentration was measured at S42 at each sampling time. At S3 the S concentration was significantly (up to 22 times) higher than at the other sites.

Temporal changes of the characteristics in the 1 cm layers at S3 can be seen in Fig. 4. With the exception of the early spring samples no considerable spatial changes were recorded in the organic matter content, OC, TN and TS concentrations of the sediment. TP and TN concentration had a decreasing tendency from cm to cm in the upper part of the sediment, especially in summer months. A similar pattern was detected in the individual characteristics at the other sites.

ETS-activity in sediment

The ETS activity values obtained at each individual sampling site were, however, very different (Fig. 5). In several cases there was a decrease with depth in the upper 5 cm sediment layer. In spring ETS-activity in the sediment was low and did not change considerably from the sediment surface to the 5 cm layer. In summer and especially in autumn ETS activity values often decreased with sediment depth. At S5 and S42 in September only 50 % and 12 % of ETS activity of the upper 1 cm layer, respectively were measured in the 5 cm layer.

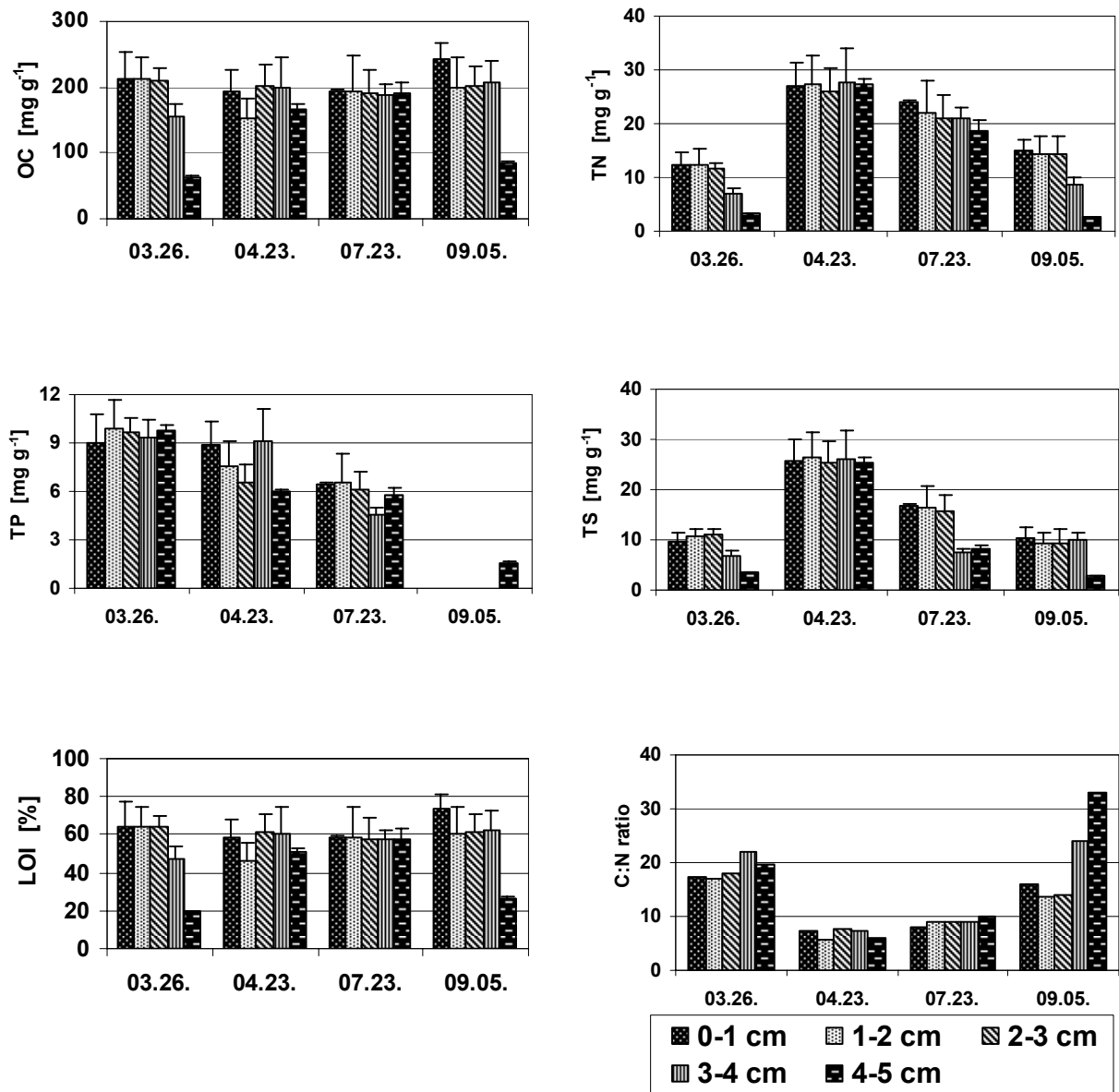


Figure 4. Chemical characteristics of the sediments at Lake Fertő/Neusiedler See, sampling site 3 in 2001 (means±SE, n=3).

The highest ETS-activity values were measured at S3 (0.31-2.2 mg O₂ g_{dw}⁻¹ h⁻¹), this was 5-15 times higher than the ETS activity values measured at other sampling sites. The ETS activity at S3 showed a relatively strong positive correlation ($r^2=0.63$) with OM_{LOI} and a negative

correlation with the C:N ratio of the sediment ($r^2=0.62$), whilst it did not correlate significantly with OM_{LOI} at S42, S2 and S5. The lowest mean values were found at S42 (range 0.01-0.11 mg O₂ g_{dw}⁻¹ h⁻¹, Table 3).

Table 3. Characteristics of the surface sediment layer (0-5 cm) at Lake Fertő/Neusiedler See (values followed by different letters are significantly different at the 0.05 probability level) (mean±SE, n=3).
(LOI=loss of ignition, OC=organic carbon, TN=total nitrogen, TS=total sulphur, TP=total phosphorus)
(a, b, c -significant differences for the columns)

	Dates	site 42	SE	site 2	SE	site 3	SE	site 5	SE
LOI [%]	26.03			13.32 ^a	2.14	51.83 ^b	7.16		
	23.04	6.51 ^a	0.97	13.73 ^b	4.51	55.57 ^c	8.90	9.39 ^{ab}	2.70
	23.07	10.09 ^a	2.05	13.43 ^a	1.24	58.00 ^b	7.64	22.96 ^c	1.63
	05.09	6.49 ^a	0.06	13.28 ^b	1.83	56.70 ^c	8.31	18.70 ^d	4.27
OC [mg g ⁻¹]	26.03			42.76 ^a	10.71	170.76 ^b	23.19		
	23.04	20.12 ^a	4.83	44.11 ^b	22.57	183.18 ^c	29.33	29.70 ^a	13.50
	23.07	32.00 ^a	10.23	43.11 ^b	6.20	191.27 ^d	25.20	74.80 ^c	8.15
	05.09	20.06 ^a	0.31	42.62 ^b	9.17	186.94 ^d	27.40	60.64 ^c	21.35
TN [mg g ⁻¹]	26.03			3.13 ^a	0.30	9.33 ^b	1.49		
	23.04	1.70 ^a	0.22	2.94 ^a	0.34	27.10 ^b	4.28	2.15 ^a	0.66
	23.07	2.60 ^a	0.79	3.14 ^a	0.19	21.40 ^b	2.79	4.60 ^a	0.92
	05.09	2.08 ^a	0.62	2.25 ^a	0.24	11.02 ^c	1.99	6.50 ^b	0.49
TS [mg g ⁻¹]	26.03			3.07 ^a	0.59	8.37 ^b	0.79		
	23.04	1.13 ^a	1.06	2.00 ^a	1.15	25.74 ^b	4.04	0.55 ^a	0.70
	23.07	0.48 ^a	0.38	3.14 ^b	0.22	12.95 ^c	2.21	4.79 ^b	0.48
	05.09	0.20 ^a	0.19	2.71 ^b	0.58	8.30 ^d	1.64	5.28 ^c	1.52
TP [mg g ⁻¹]	26.03			1.48 ^a	0.42	9.66 ^b	1.18		
	23.04	0.82 ^a	0.06	1.41 ^{ab}	0.34	7.63 ^c	1.26	1.86 ^b	0.69
	23.07	0.90 ^a	0.08	1.18 ^{ab}	0.25	5.89 ^c	0.79	1.87 ^b	0.13
	05.09	0.66 ^a	0.09	1.15 ^{ab}	0.11	1.61 ^b	0.44	1.92 ^b	0.13
C:N ratio	26.03			13.67 ^a	0.77	18.30 ^a	26.44		
	23.04	11.86 ^a	8.35	14.99 ^b	1.54	6.76 ^a	0.45	13.80 ^b	19.02
	23.07	12.29 ^b	8.59	13.74 ^a	4.34	8.94 ^a	1.84	16.26 ^b	6.07
	05.09	9.66 ^b	0.06	18.91 ^b	3.35	16.97 ^b	47.84	9.33 ^a	1.48
ETS [mg O ₂ g _{DM} ⁻¹ h ⁻¹]	26.03			0.03 ^a	0.02	0.21 ^b	0.13		
	23.04	0.01 ^a	0.00	0.05 ^a	0.03	0.34 ^b	0.11	0.03 ^a	0.02
	23.07	0.07 ^a	0.04	0.06 ^a	0.03	0.29 ^a	0.15	0.28 ^a	0.09
	05.09	0.11 ^a	0.09	0.17 ^a	0.07	1.07 ^c	1.73	0.76 ^b	0.25

The seasonal variation of the ETS-activity was characteristic and similar at each sampling site, it started with lower values (0.01-0.34 mg O₂ g_{dw}⁻¹ h⁻¹) in spring and increased continuously till autumn (0.11-1.07 mg O₂ g_{dw}⁻¹ h⁻¹).

After conversion of oxygen to carbon (1 mg O₂ = 0.5 mg C, WINBERG 1971), the respiratory energy loss of the sediment from the degraded reed stand (S3) ranged between 1274.26–6605.85 mg C m⁻²h⁻¹, it was 1.64-4.93 times higher than the respiratory energy loss measured in sediment of healthy reed stands (S2 and S5).

PCA comparison of sampling sites

The ordinations of water samples taken in April, July and September were compared using the Procrustes analysis. The square total of the distances between water samples was 0.092 between April and July, 0.562 between April and September, and 0.656 between July and September.

The distribution of the differences between the two random ordinations was examined and compared to the distance square totals. As a result, significant differences were recorded between April and September and also July and September but not between April and July.

Because of the similarity of samples taken in April and July (demonstrated by the Procrustes analysis) only the data from July are presented here (on PCA axes 1 and 2) emphasising differences with the PCA of the autumn (September) samples (Fig. 6). In July the first principal component showed a positive correlation with NO₃⁻, ETS-activity, TN, OC, TP, TS, LOI and a negative correlation with the C:N ratio and NO₂⁻ concentration. SO₄²⁻ showed a positive correlation with the second principal component of the variables, while PO₄³⁻ showed a negative correlation, it could be interpreted as an axis indicating the redox conditions of the sediment. The first principal component showed relationships with more variables than the second principal component. Altogether 75.4 % of the

total variance was accounted for by the first component and 17.6 % by the second component. In September the first principal component showed a positive correlation with ETS-activity, TN, TS, LOI and none of the variables showed negative correlation with this component. The second principal component showed a positive correlation with TP, PO₄³⁻ and a negative one with OC, C:N ratio and SO₄²⁻.

In each case S3 showed a positive correlation with the first principal component. Among the variables NO₃⁻, ETS-activity, TN, OC, TP, TS, LOI played an important part in its separation. In each case the separation of S5 was mainly determined by PO₄³⁻. S42 positively correlated with the second principal component in July and negatively correlated with the first principal component in September, in each case the SO₄²⁻ pointed in its direction. S2 correlated negatively with the second principal component and its separation was mainly determined by the C:N ratio in every sampling time.

DISCUSSION

Surface and sediment interstitial water characteristics

The seasonal variation of electrical conductivity and SO₄²⁻ concentration was largely influenced by water level fluctuations. The seasonal changes in surface and sediment interstitial water characteristics showed similar tendencies but in different values. The changes are mainly due to the shallowness of the lake, hydrometeorological conditions and accelerating eutrophication processes, which is demonstrated well by the PO₄³⁻ concentration of the surface water. The chemical composition of the lake water is characterised by remarkable seasonal and spatial changes (DINKA & BERCZIK, 1992; TAKÁTS et al., 1997).

The chemical characteristics of surface and sediment interstitial water are greatly influenced by the organic matter content of the sediment (THRESH et al., 1944). In our study, the lower

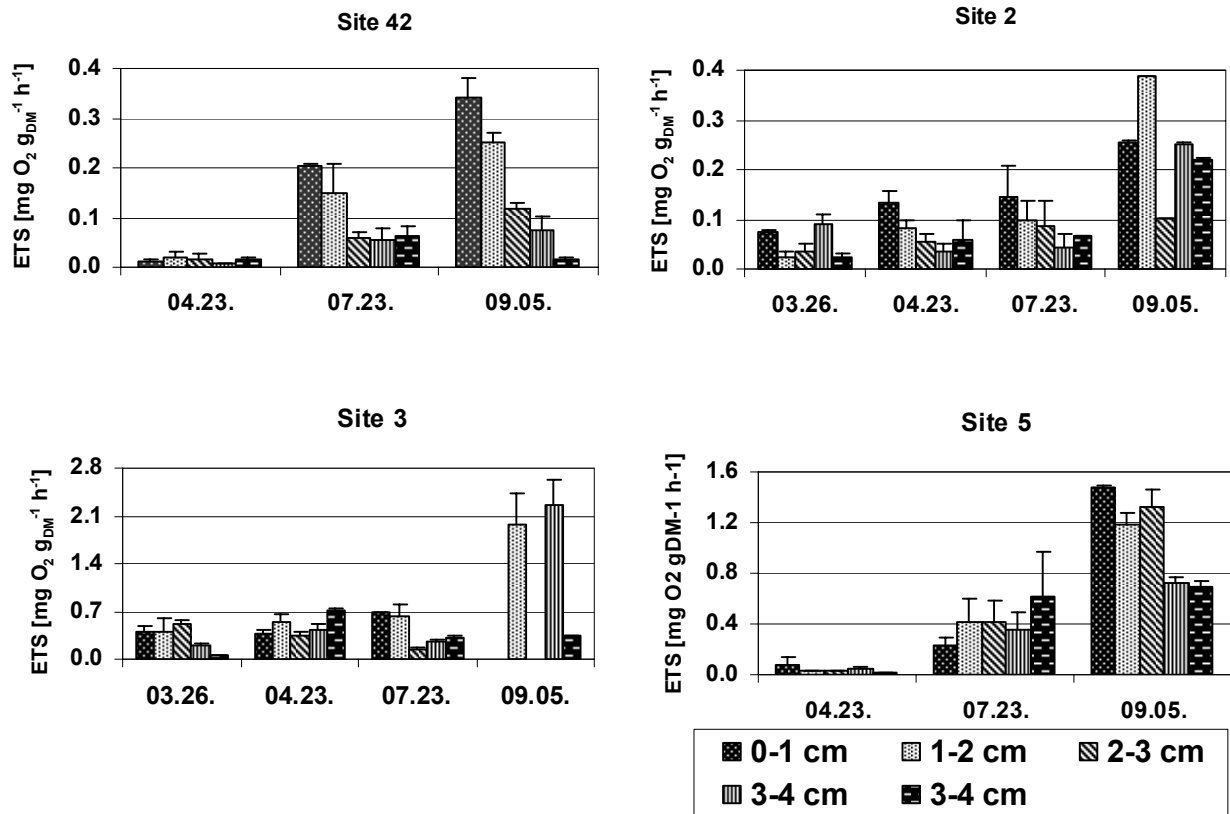


Figure 5. Seasonal changes of the ETS-activity of the sediment in Lake Fertő/Neusiedler See in 2001. (means±SE, n=3).

organic matter content at S2 and S42 resulted in lower concentration of nutrients in the sediment (Table 3) and the interstitial water.

The decrease in SO_4^{2-} concentration with sediment depth can be explained by sulphate reduction, which is one of the most important processes in the decomposition of organic materials (JØRGENSEN, 1977). Spatial patterns in the interstitial water SO_4^{2-} concentration profiles differed according to the sampling sites (Fig. 3). The high SO_4^{2-} concentration decrease at S3 and S5 indicates that there was a substantial sulphate reduction activity in the sediments of these sites, which probably is due to the highly reducing conditions and to the organic rich sediments (51.8-58.0 %, 9.4-23.0 %, respectively). SO_4^{2-} concentration and temperature strongly influences the PO_4^{3-} release from the sediment (CARACO et

al., 1989; NIXON et al., 1980). When sulphate reduction activity is lower, PO_4^{3-} is stored in the sediment. This phenomenon was well illustrated by our results.

NH_4^+ was detectable in higher concentrations in the upper 5 cm interstitial water only in summer months. These high summer NH_4^+ concentrations were probably caused by elevated NH_4^+ generation rate and higher temperature values. In summer, high PO_4^{3-} concentration was often associated with high NH_4^+ concentration, which was also observed by ANDERSEN, 1974; BENGTTSSON, 1975; GOEL et al., 1980. The NH_4^+ concentration of the interstitial water varied spatially, it was always higher than the corresponding values in the overlying water and the NO_3^- concentration in the interstitial water but it was similar with the NO_2^- concentration values

of the interstitial water. The chemical form of the nitrogen deriving from detritus depends on the oxidizing/reducing characteristics of the sediment. NO_2^- was found in the surface water of S3, where the highest NO_3^- and PO_4^{3-} concentrations were

measured. The seasonal variation of PO_4^{3-} and NO_3^- concentrations in the surface water showed opposite tendencies, which has previously been demonstrated by PHILLIPS, (1977) and GOEL et al., (1980).

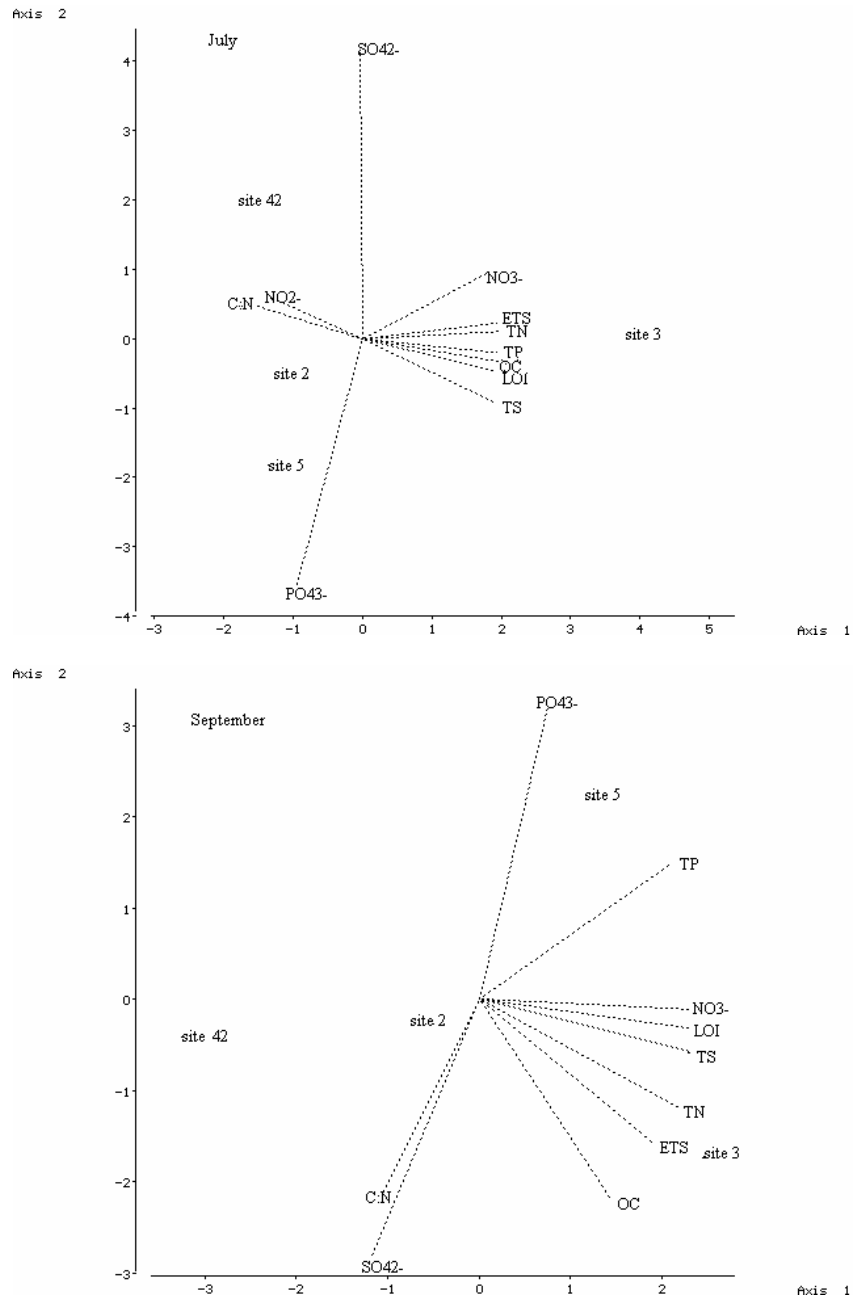


Figure 6. Graphic interpretation of chemical features and principal component analysis of the sampling sites.

In summer negative redox conditions developed in the sediment (unpublished data), which are favourable for anaerobe nitrate reduction (RYSGAARD et al., 1996), therefore the nitrate concentration decreased with depth (DINKA, 2001, SZABÓ, 2001, SZABÓ in press) and PO_4^{3-} increased.

Sediment characteristics

The sediment organic matter, OC, TN, TS and TP content was significantly higher in the degraded (S3) than in the healthy (S2, S5) reed stands or in the inner pond (S42). Increased organic matter accumulation in the upper sediment of degraded reed areas was likely due to the higher annual accumulation rate of wetland plant material and the frequent occurrence of negative redox conditions.

Seasonal changes in the TP concentration of the sediment can be explained by the seasonal pattern of the P release from the sediment. Most P release occurs in summer and is associated with changes in Fe cycling and sulphate reduction (CONLEY, 2000).

ETS-activity in sediment

ETS-activities of the sediment often decreased with depth (Fig. 5), these decreases partly depended on consolidation and stabilization of the sediment and partly on the termination of aerobic metabolism (BROBERG, 1985; SONGSTER-ALPIN & KLOTZ, 1995); benthic algae at the sediment surface, with their photosynthetic ETS, additionally increase measured ETS activity (DEL GIORGIO, 1992). SIMCIC & BRANCELJ (2002) also found decreasing ETS-activities with depth in the sediment of shallow mountain lakes.

Increased bacterial metabolism (increased ETS-activity values) at S3, the degraded reed stand, may be attributed to the increased rates of terminal electron acceptor replenishment (MANN & WETZEL, 2000) due to higher organic matter content than in healthy reed stand areas. In

general heterotrophic bacterial production has a strong positive relationship with the organic matter content of the sediment (SANDER & KALFF, 1993). The higher ETS-activity values in September were probably due to the large decaying mass of macrophytes.

The mean ETS-activity in the uppermost 0-5 cm layer of the Lake Fertő/Neusiedler See sediment (S3: $48.25 \text{ mg O}_2 \text{ g}_{\text{wet wt}}^{-1} \text{ h}^{-1}$ and S2: $37.37 \text{ mg O}_2 \text{ g}_{\text{wet wt}}^{-1} \text{ h}^{-1}$) was similar to or higher than that in Central Swedish lakes (L. ERKEN: $38.7 \text{ mg O}_2 \text{ g}_{\text{wet wt}}^{-1} \text{ h}^{-1}$, L. RAMSJÖN: $21.9 \text{ mg O}_2 \text{ g}_{\text{wet wt}}^{-1} \text{ h}^{-1}$, BROBERG, 1985) and it was higher than in Lake Balaton in Hungary (G. TÓTH et al., 1994). This difference can be explained by the differences in organic matter content, pH, temperature, salinity, and redox conditions in the sediment of the investigated lakes.

CONCLUSIONS

The seasonal variation of electrical conductivity and SO_4^{2-} concentrations was influenced by water level fluctuations. Higher values were measured in the second part of the vegetation period when the water level was lower. The seasonal variation in PO_4^{3-} and NO_3^- concentrations of the surface water showed opposite tendencies. PO_4^{3-} release from the sediment was strongly influenced by the SO_4^{2-} concentration and temperature. Higher PO_4^{3-} and NH_4^+ concentrations were measured in the sediment interstitial water in summer, when the decrease in SO_4^{2-} concentration was higher, which indicated the SO_4^{2-} reduction processes.

The organic matter, OC, TN, TS TP content and the ETS-activity of the sediment were significantly higher in the degraded reed stand area (S3) than in the healthy reed stands (S2, S5) or the inner pond (S42). Increased organic matter accumulation in the upper sediment of degraded reed beds was likely due to the higher annual accumulation rate of wetland plant material and the frequent occurrence of negative redox conditions.

Higher ETS-activity values in September were probably due to the decaying mass of macrophytes. The four examined sampling sites were well discriminated by the chemical composition of the sediment indicating the highest trophic status at S3 (degraded reed stand), an intermediate status at S2 and S5 (healthy reed stands) and a lower status at S42 (inner pond).

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Annotierter Katalog der Benhamiinae Arten in der Sammlung des Zoologischen Instituts und Museums von Hamburg (Oligochaeta: Acanthodrilidae)

Cs. CSUZDI^{1,2}

Abstract. "Annotated catalogue of the Benhamiinae species in the collection of Zoological Institute and Zoological Museum of the University of Hamburg" An annotated catalogue of the Benhamiinae earthworms housed in the Zoological Institute and Zoological Museum of the University of Hamburg is presented. All the entries are arranged by the valid names published (CSUZDI, 1995). An alphabetic list of the original specific epithets with the valid combinations is also tabulated.

Die Oligochaeten Sammlung des Zoologischen Instituts und Museums der Universität Hamburg ist eine der grössten in der Welt. Dies ist dem Begründer der modernen Oligochaeten Systematik, Wilhelm MICHAELSEN zu verdanken, der 50 Jahre hindurch die Sammlung im Museum betreute. Während seiner Tätigkeit sind 1088 megadrili Taxa von ihm beschrieben worden, deren Typenexemplare zum grössten Teil in der Sammlung von Hamburg vorliegen (DZWILLO, 1994).

Von den 360 nominalen Taxa der Unterfamilie Benhamiinae MICHAELSEN, 1897 sind 130 Arten von MICHAELSEN beschrieben worden. Zusammen mit den erworbenen Typen anderer Autoren liegen in der Sammlung zur Zeit 109 Typenexemplare vor, so dass vor der Revision der Unterfamilie Benhamiinae (CSUZDI, 1995b, 1996) zuerst die Sammlung MICHAELSENS überprüft werden müsste.

Da eine ausführliche Bekanntmachung der Vertreter dieser Unterfamilie nie erfolgte, gebe ich die Liste der hier anzutreffenden Arten an, wobei die neuen taxonomischen Kenntnisse berücksichtigt werden. Die Liste enthält in alphabetischer Reihenfolge die im Katalog von

CSUZDI (1995b) angeführten Gattungen, in eckigen Klammern wird die Originalbeschreibung, am Ende jedes Fundortes wird in runder Klammer das Literaturzitat angegeben. Zur leichten Orientierung werden am Ende der Arbeit die Artnamen in alphabetischer Reihenfolge in einer Liste zusammengefasst, wobei in Klammern der ursprüngliche bzw. der jetzt gültige Gattungsname steht.

INVENTAR DER SAMMLUNG, MIT REZENTEN GATTUNGSNAMEN

Gattung: *Benhamia* MICHAELSEN, 1889

Benhamia itoliensis MICHAELSEN, 1892

V300 Typus 1 Ex. Fundort: Ost-Afrika, Victoria Nyanza, Itole. Leg. FR. STUHLMANN, 2. XI. 1890 (MICHAELSEN 1892 p. 3.).

V299 1 Ex. Fundort: Ost-Afrika, Victoria Nyanza, Bukoba. Leg. FR. STUHLMANN, III. 1892 (MICHAELSEN 1896 p. 25.).

V3575 [*Dichogaster itoliensis* f. *Moorei* (BEDDARD, 1901)] 1 Ex. Fundort: Deutsch Ost-Afrika, Ins. Kwidschi. Leg. H. SCHUBOTZ, IX. 1907 (MICHAELSEN 1912 p. 37).

V8859 1 Ex. Fundort: Zentralafrika. Leg. H. SCHUBOTZ. *Unveröffentlicht*.

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- V9386** 1 Ex. Fundort: Deutsch. Ost-Afrika, Zwischenseegebiet. Leg. ZIMMER. *Unveröffentlicht.*
- V12178** [*Dichogaster*] 1 Ex. Fundort: Kaniami am Lomami Fluss. Leg. R. MASSART, 1932 (MICHAELSEN 1935 p. 53.).
- V12303** [*Dichogaster*] 1 Ex. Fundort: Medje, am Fluss Nava. Leg. H. Lang & J.P. Chapin, XI. 1913 (MICHAELSEN 1936c p. 9.).
- V12603** [*Dichogaster itoliensis f. johnstoni-moorei* (BEDDARD, 1901)] 1 Ex. Fundort: Belgisch-Kongo, Park National Albert, Bitashimwa.. Leg. A. TINANT (MICHAELSEN 1937 p. 7).
- Benhamia rosea* MICHAELSEN, 1889
- V287 Typus** 1 Ex., **V288 Typus** 1 Ex. Fundort: West-Afrika, Gabon. Leg. H. SOYLAUX (MICHAELSEN 1889 p. 6.)
- Gattung: *Benhamiona* CSUZDI & ZICSI, 1994**
- Benhamiona baumanni* (MICHAELSEN, 1897)
- V4519** [*Benhamia*] **Typus** 3 Ex. Fundort: Togo, Misahöhe. Leg. E. BAUMANN, 1894 (MICHAELSEN 1897 p. 18.).
- Benhamiona beddardi* (HORST, 1888)
- V9315** [*Acanthodrilus*] 2 Ex. Fundort: Liberia. Leg. J. DEMERY, 2. XI. 1892 (det. MICHAELSEN 1922.). *Unveröffentlicht.*
- Benhamiona biggei* (MICHAELSEN, 1915)
- V7432** [*Dichogaster*] **Typus** 4 Ex. Fundort: Kamerun, Buea. Leg. C. BIGGE (MICHAELSEN 1915 p. 215.).
- Benhamiona budgetti* (BEDDARD, 1900)
- O1 13891** 1 Ex. Senegal, Kolda. Leg. L. DEROUARD, 1994 (CSUZDI 1995 p. 28. don. A. ZICSI AF2958).
- Benhamiona buettikoferii* (HORST, 1884)
- V5099** [*Acanthodrilus büttikoferii*] 2 Ex. Fundort: Liberia. Leg. BÜTTIKOFER, MUS. LEIDEN (HORST 1887 p. 291.).
- Benhamiona hansii* (MICHAELSEN, 1914)
- V7711** [*Dichogaster*] **Typus** 6 Ex. Fundort: West Liberia, Lofa Fluss. Leg. H. SCHOMBURGK, 1912 (MICHAELSEN 1914 p. 101.).
- Benhamiona horsti* (MICHAELSEN, 1898)
- V5083** [*Benhamia*] **Typus** 16 Ex. Fundort: Portugiesisch West-Afrika, Bissao. Leg. H. EHRHARDT (MICHAELSEN 1898 p. 171.).
- Benhamiona hupferi* (MICHAELSEN 1891)
- V304** [*Dichogaster*] **Typus** Fundort: West-Afrika. Leg. HUPFER (MICHAELSEN 1891 p. 66.; OMODEO 1958 p. 43.). *Glas leer.*
- Benhamiona misaensis* (MICHAELSEN, 1897)
- V4518** [*Dichogaster*] **Typus** 1 Ex. Fundort: Togo, Station Misahöhe. Leg. E. BAUMANN, IV. 1893 (MICHAELSEN 1897 p. 28.).
- Benhamiona robertsiana* (MICHAELSEN, 1922)
- V9313** [*Dichogaster*] **Typus** 2 Ex. Fundort: Liberia, Robertsport. Leg. J. DEMERY, 1897 (MICHAELSEN 1922 p. 18.).
- Benhamiona schomburgki* (MICHAELSEN, 1913)
- V7526** [*Dichogaster*] **Typus** Fundort: West Liberia, Mana Gola. Leg. H. SCHOMBURGK, VI. 1911 (MICHAELSEN 1913 p. 156.; OMODEO 1958 p. 43.). *Glas leer.*
- Benhamiona stockhausenii* (MICHAELSEN, 1913)
- V3727** [*Dichogaster*] **Typus** 2 Ex. Fundort: Togo, Atakpame. Leg. STOCKHAUSEN, VI. 1910 (MICHAELSEN 1913 p. 162.).
- Gattung: *Dichogaster (Dichogaster)* BEDDARD, 1888**
- Dichogaster (D.) arcifera* OMODEO, 1958
- O1 14021** [*Dichogaster*] 1 Ex. Fundort: Ghana, Ayeduasi nahe des UST Campus unter faulenden Pflanzenresten. Leg. J. J. NILES, 11. IV. 1968 (CSUZDI 1997 p. 36. don. A. ZICSI AF3447).
- Dichogaster (D.) corticis* (MICHAELSEN, 1899)
- V5200** [*Benhamia*] **Typus** 2 Ex. Fundort: Celebes, Masarang-Kette. Leg. F. SARASIN, IV. 1895 (MICHAELSEN 1899 p. 80.).
- Dichogaster (D.) ehrhardti* (MICHAELSEN, 1898)
- V5082** [*Balanta*] **Typus** viele Ex. Fundort: Portugiesisch West-Afrika, Bissao. Leg. H. EHRHARDT (MICHAELSEN 1898 p. 165.).
- V6363** [*Dichogaster ehrhardti v. linnelli* MICHAELSEN, 1910] **Typus** 3 Ex. Fundort: Kamerun, Debundscha. Leg. G. LINNELL (MICHAELSEN 1910 p. 113.).

Dichogaster (D.) endemica MICHAELSEN, 1914

V8308 [*Dichogaster reincke* v. *endemica* MICHAELSEN, 1914] **Typus** 1 Ex. Fundort: West Liberia, Lofa Fluss. Leg. H. SCHOMBURGK, 1912 (MICHAELSEN 1914 p. 89.). *Innere Organe fehlen.*

Dichogaster (D.) fouoriensis CSUZDI, 1996

O1 13981 Paratypus 1 Ex. Rep. Kongo, Reservat Mt. Fouori an der Grenze von Gabon. Leg. ZICSI & BALOGH, 13. XII. 1963 (CSUZDI 1996 p. 10. don. A. ZICSI AF3323).

Dichogaster (D.) greeffi MICHAELSEN, 1902

V5686 [*Dichogaster*] **Typus** 1+1 Ex. Fundort: St. Thome. Leg. GREEFF (MICHAELSEN 1902 p. 20.).

Dichogaster (D.) lofaensis MICHAELSEN, 1914

V7709 [*Dichogaster*] **Typus** 1 Ex. Fundort: West-Liberia, Lofa Fluss. Leg. H. SCHOMBURGK, 1912 (MICHAELSEN 1914 p. 99.). *Innere Organe fehlen.*

Dichogaster (D.) majoris MICHAELSEN, 1914

V7710 [*Dichogaster*] **Typus** 1 Ex. Fundort: West-Liberia, Lofa Fluss. Leg. H. SCHOMBURGK, 1912 (MICHAELSEN 1914 p. 93.).

Dichogaster (D.) mangeri MICHAELSEN, 1913

V7420 [*Dichogaster*] **Typus** 1+3 juv. Ex. Fundort: Goldküste, Sekundi. Leg. C. MANGER, 1911 (MICHAELSEN 1913 p. 158.).

Dichogaster (D.) reincke (MICHAELSEN, 1898)

V3849 [*Benhamia*] **Typus** 1 Ex. Fundort: Samoa. Leg. REINCKE (MICHAELSEN 1898 p. 175.).

Dichogaster (D.) terricola MICHAELSEN, 1915

V8418 [*Dichogaster*] **Typus** 1 Ex. Fundort: Süd-Kamerun. Leg. A. SCHULZE, 17. VI. 1911 (MICHAELSEN 1915 p. 212.).

Dichogaster (D.) titillata SIMS, 1967

O1 13890 [*Dichogaster*] 1 Ex. Fundort: Senegal, Kolda. Leg. L. DEROUARD, 1994 (CSUZDI 1995 p. 28. don. A. ZICSI AF2956).

Dichogaster (D.) wenke (MICHAELSEN, 1931)

V11279 [*Balanta*] **Typus** 2 Ex. Fundort: Französisch Kongo, südlich von Banja am Sanga. Leg. M. WENKE (MICHAELSEN 1931 p. 539.).

**Gattung: *Dichogaster (Diplothecodrilus)*
CSUZDI, 1996**

Dichogaster (Dt.) adjelana MICHAELSEN, 1915

V8425 [*Dichogaster*] **Typus** 1 Ex. Fundort: Süd-Kamerun Adjela am Djah. Leg. A. SCHULTZE, 20. V. 1911 (MICHAELSEN 1915 p. 200.). *Unbestimmbar zerstört.*

Dichogaster (Dt.) aequatorialis (MICHAELSEN, 1896)

V294 [*Benhamia*] **Typus** 2 Ex. Fundort: Deutsch Ost-Afrika, Ru-nsoro. Leg. FR. STUHLMANN, 12. VI. 1883 (MICHAELSEN 1896 p. 32.).

Dichogaster (Dt.) affinis (MICHAELSEN, 1890)

V303 [*Benhamia*] **Typus** 1 Ex. Fundort: Ost-Afrika, Mosambique. Leg. FR. STUHLMANN (MICHAELSEN 1890 p. 9).

V4511 [*Dichogaster*] 14 Ex. Fundort: Ost-Afrika, Danda am Kingani. Leg. FR. STUHLMANN (MICHAELSEN 1897 p. 13.).

V4541 [*Dichogaster*] 2 Ex. Fundort: Kamerun, Johann-Albrechtshöhe. Leg. L. CONRADT (MICHAELSEN 1897 p. 15.).

V5448 [*Dichogaster*] 1 Ex. Fundort: Kolumbien, Honda, Mine Purnio. Leg. O. Bürger, 28. X. - 29. XI. 1896 (MICHAELSEN 1900 p. 234.).

V7187 [*Dichogaster*] 1 Ex. Fundort: Haiti, Cap Haitien. Leg. REICHARD (MICHAELSEN 1908 p. 15.).

V8039 [*Dichogaster*] 1 Ex. Fundort: Neu-Kaledonien, Ubathe. Leg. F. SARASIN & J. ROUX (MICHAELSEN 1913b p. 274.).

O1 13977 1 Ex. Fundort: Rep. Kongo, Mayombe, Station Dimonika. Leg. I. MBOUKOU, 1994 (CSUZDI 1996 p. 14. don. A. ZICSI AF3004).

Dichogaster (Dt.) aloysiisabaudiae COGNETTI, 1906

V3573 [*Dichogaster bataguensis* MICHAELSEN, 1912] **Typus** 2 Ex. Fundort: Kongo, Ruwenzori, Batagu Tal. Leg. H. SCHUBOTZ, II. 1908. (MICHAELSEN 1912 p. 33.).

Dichogaster (Dt.) anguana MICHAELSEN, 1915

V8444 [*Dichogaster*] **Typus** 6 Ex. Fundort: Belgisch-Kongo, Angu am Uelle. Leg. H.

- SCHUBOTZ, VI. 1911 (MICHAELSEN 1915 p. 209.). *Sehr erweichte juvenile Exemplare.*
- Dichogaster (Dt.) annae* (HORST, 1893)
- V297** [*Benhamia parva* MICHAELSEN, 1896] **Typus** 14 Ex. Fundort: Deutsch Ost-Afrika, Duki Ufer. Leg. FR. STUHLMANN, 8. XI. 1891 (MICHAELSEN 1896 p. 31.).
- V3822** [*Benhamia*] 1 Ex. Fundort: Java. Leg. GRAFF (MICHAELSEN 1896b. p. 235.).
- V6470** 2 Ex. Fundort: Ceylon, Peradeniya. Leg. KRAEPELIN, 15. I. 1904. *Unveröffentlicht.*
- V7693** [*Dichogaster*] 6 Ex. Fundort: D. Südw. Afrika, Waterberg. Leg. M. NASS (MICHAELSEN 1914d p. 168.).
- V7868** [*Dichogaster*] mehrere Ex.. Fundort: D. Südw. Afrika, Okahandja, Forstgarten. Leg. W. MICHAELSEN, 1911 (MICHAELSEN 1914 p. 168.).
- V9152** [*Dichogaster curgensis* MICHAELSEN, 1921] **Typus** 1 Ex. Fundort: Vorderindien, Curg. Leg. NARAYAN RAO, XII. 1918 (MICHAELSEN 1921 p. 54.).
- V9153** [*Dichogaster curgensis* MICHAELSEN, 1921] **Typus** 22 Ex. Fundort: Vorderindien, Curg. Leg. NARAYAN RAO, XII. 1918 (MICHAELSEN 1921 p. 54.).
- V9281** [*Dichogaster*] viele Ex. Fundort: Java, Buitenzorg. Leg. P. BUITENDYK, V. 1920 (MICHAELSEN 1922 p. 18.).
- Ol 13795** [*Dichogaster*] 1 Ex. Fundort: Insel Guadeloupe, la Madelein. Leg. J. M. THIBAUD, 12. XI. 1987 (CSUZDI & ZICSI 1991 p. 190. don. A. ZICSI, AF1182).
- Ol 13796** [*Dichogaster*] 1 Ex. Fundort: Kongo, Loudima. Leg. ZICSI & BALOGH, 11. XII. 1963 (CSUZDI & ZICSI, 1989 p. 135. don. A. ZICSI, AF888).
- Dichogaster (Dt.) austeni* (BEDDARD, 1901)
- V6210** [*Dichogaster*] 30 Ex. Fundort: Wanga, Banja nördlich von Lindi. Leg. EWERBECK, 31. I. 1903 (MICHAELSEN 1905 p. 311). *Sehr erweichte Exemplare.*
- Dichogaster (Dt.) balantina* MICHAELSEN, 1915
- V8441** [*Dichogaster*] **Typus** 3 Ex. Fundort: Belgisch Kongo, Duma am Ubangi. Leg. H. SCHUBOTZ, 27. IX. 1910 (MICHAELSEN 1915 p. 192.). *Im erweichten Zustand.*
- Dichogaster (Dt.) bolau* (MICHAELSEN, 1891)
- V285** [*Benhamia*] **Typus** viele Ex. Fundort: Hamburg, Bergedorf, in warmer Gerberlohe. Leg. W. MICHAELSEN (MICHAELSEN 1891 p. 307.).
- V279** [*Benhamia bolau* v. *palmicola* EISEN, 1896] **Typus** 2 Ex. Fundort: Mexico, Baja California, Miraflores. Leg. G. EISEN (EISEN 1896 p. 132.).
- V3015** [*Dichogaster*] 4 Ex. Fundort: Britisch Nyassaland, Blantyre. Leg. K. FRICKE (MICHAELSEN 1912 p. 28.).
- V3387** [*Dichogaster*] 20 Ex. Fundort: Rhodesia, Bulowago. Leg. D. CHUBB (MICHAELSEN 1912 p. 28.).
- V3652** part. [*Dichogaster papillata* (EISEN, 1896)] 1 Ex. Fundort: Belgisch-Kongo, Mayili. Leg. C. SANDERS (MICHAELSEN 1910 p. 114.). *Im Glas 3 Exemplare, davon 2 Dichogaster (Diplothecondrilus) modiglianii* (ROSA, 1896).
- V4305** [*Benhamia*] 20 Ex. Fundort: St. Thomas. Leg. C. CALWOOD (MICHAELSEN 1898 p. 131.).
- V4392** [*Benhamia*] 4 Ex. Fundort: Westindien, mit Pflanzen nach Hamburg gekommen (MICHAELSEN 1897 p. 12.)
- V4401** [*Benhamia*] viele Ex. Fundort: Westindien, mit Pflanzen nach Hamburg gekommen (MICHAELSEN 1897 p. 12.)
- V4421** [*Benhamia*] 6 Ex. Fundort: Madagaskar, Mojonga. Leg. A. VOELTZKOV (MICHAELSEN 1897b p. 224.).
- V4501** [*Benhamia bolau octonephra* ROSA, 1895] **Typus** 2 Ex Fundort: Paraguay, San Bernardino. Leg. E. MARENZELLER (ROSA 1895 p. 73.).
- V5025** [*Benhamia*] 12 Ex. Fundort: St. Thomas. Leg. C. CALLWOOD (MICHAELSEN 1898 p. 131.).
- V6229** [*Dichogaster*] 7 Ex. Fundort: Dar-es-Salaam. Leg. FR. STUHLMANN (MICHAELSEN 1905 p. 310.).
- V6259** [*Dichogaster*] 2 Ex. Fundort: Gandjule-See am Ufer, ca. 1700 m. Leg. O. NEUMANN, 4. I. 1901 (MICHAELSEN 1903 p. 443.).

- V6660** [*Dichogaster*] viele Ex. Fundort: Deutsch-Ost-Afrika, Amani. Leg. A. BOGERT, VIII. 1904 (MICHAELSEN 1905 p. 310.).
- V6747** 20 Ex. Fundort: Ekuador, Guayaquil. Leg. BUCHWALD. (det. Cs. CSUZDI, 1988). *Unveröffentlicht.*
- V7192** 1 Ex. Fundort: Brasilien, Ouropreto. Leg. F. OHAUS, 12. II. 1905. *Unveröffentlicht.*
- V7609** [*Dichogaster*] 2 Ex. Fundort: N.W. Rhodesia, Broken Hill. Leg. P. TIMM (MICHAELSEN 1913 p. 148.).
- V8035** [*Dichogaster*] 2 Ex. Fundort: Loyalty, Ins. Maré, Netché. Leg. F. SARASIN & J. ROUX (MICHAELSEN 1913b p. 273.).
- V8868** 5 [*Dichogaster*] Ex. Hamburg-Nienstedten, Warmhaus. Leg. C. ANSORGE. *Unveröffentlicht.*
- V11716** [*Dichogaster*] 1 Ex. Fundort: Bonaire, Fontain. Leg. P. HUMMELINCK (MICHAELSEN 1933b p. 350.).
- V8436** [*Dichogaster bolau* var. *decanephra* MICHAELSEN, 1915] **Typus** 3 Ex. Annobon, in morschem Holz. Leg. A. SCHULTZE, 5. XII. 1911 (MICHAELSEN 1915 p. 191.). *Datum am Gläschen stimmt mit der Beschreibung nicht überein (6. X. 1911), Exemplare gehören zweifelsohne zur Typenserie, sie sind ausgetrocknet.*
- V8437** [*Dichogaster bolau* var. *decanephra* MICHAELSEN, 1915] **Typus** 3 Ex. Fundort: Annobon, in epiphytisch. Leg. A. MILDBRAED IX. 1911 (MICHAELSEN 1915 p. 191.). *Ausgetrocknet.*
- O1 13797** 1 Ex. Fundort: Paraguay, Prov. Concepcion Estancia Estrellos. Leg. VAUCHER & MAHNERT, 17. X. 1979 (det. Cs. CSUZDI, don. A. ZICSI, AF252). *Unveröffentlicht.*
- O1 13798** [*Dichogaster*] 2 Ex. Fundort: Kongo, Sibiti. Leg. ZICSI & BALOGH, 25. XI. 1963 (CSUZDI & ZICSI 1989 p. 137. don. A. ZICSI, AF809).
- Dichogaster (Dt.) cagnii* COGNETTI 1906
- V3285** [*Dichogaster*] **Cotypus** 3 Ex. Fundort: Ost-Afrika, Ruwenzori, Toro, Fort-Portal. Leg. L. A. DI SAVOIA. (COGNETTI 1906 p. 2., COGNETTI 1909 p. 12.).
- O1 14023** 1 Ex. Fundort: Zaire, Kivu, River Mululu. Leg. GASANA N'DOLI, 15. VII. 1973 (det. Cs. CSUZDI, don. A. ZICSI, AF3546) *Unveröffentlicht.*
- Dichogaster (Dt.) castanea* (MICHAELSEN, 1896)
- V296** [*Benhamia*] **Typus** 1 Ex. Fundort: Ost-Afrika, Ru-nsoro, Hochmoor. Leg. FR. STUHLMANN, 10. III. 1891. (MICHAELSEN 1896 p. 30.). *Nicht adult.*
- Dichogaster (Dt.) chapini* MICHAELSEN, 1936
- V12309** [*Dichogaster*] **Typus** 4 Ex. + 1 juv. +1 *Gordiodrilus?* Fundort: Belgisch Kongo, Medje am Nava. Leg. H. Lang & J.P. Chapin. (MICHAELSEN 1936c p.4.). *Keine Typenbezeichnung am Glas, mit Sicherheit Typenmaterial.*
- Dichogaster (Dt.) crateris* MICHAELSEN, 1912
- V3572** [*Dichogaster*] **Typus** 6 Ex. Fundort: Deutsch Ost-Afrika, Karissimbi. Leg. H. SCHUBOTZ (MICHAELSEN 1912 p. 29.).
- Dichogaster (Dt.) culminis* (MICHAELSEN, 1896)
- V293** [*Benhamia*] **Typus** 1 Ex. Fundort: Deutsch Ost-Afrika, Ru-nsoro. Leg. FR. STUHLMANN, 12. VI. 1891 (MICHAELSEN 1896 p.32). *Ausgetrocknet.*
- Dichogaster (Dt.) curta* MICHAELSEN, 1896
- V292** [*Benhamia*] **Typus** Fundort: Deutsch Ost-Afrika, Ru-nsoro. Leg. FR. STUHLMANN, 13. VI. 1891 (MICHAELSEN 1896 p. 33.). *Glas leer.*
- Dichogaster (Dt.) daemoniaca* COGNETTI 1907
- O1 13883** [*Dichogaster*] 1 Ex. Fundort: Zaire, Upemba National Park Kabwe rive dr. Muye, Bois de Macousou 1320 m. Leg. G. F. DE WITTE, V. 1948. (CSUZDI & ZICSI 1994 p. 51. don. A. ZICSI, AF2443).
- Dichogaster (Dt.) dorsalis* MICHAELSEN, 1915
- V8357** [*Dichogaster*] **Typus** 1 Ex. Fundort: Belgisch-Kongo, Yambuya. Leg. MAYNE, 29. XI. 1913 (MICHAELSEN 1915 p. 206.). *Innere Organe des Tieres fehlen.*
- Dichogaster (Dt.) dzwilloi* CSUZDI & ZICSI 1989
- O1 13691** [*Dichogaster*] **Paratypus** 2 Ex. Fundort: Rep. Kongo, Reservat Lefinie, Galeriewald beim Nanbouli-Fluß, unter Baumrinde. Leg. ZICSI & BALOGH, 12. I. 1964 (CSUZDI & ZICSI 1989 p. 144. don. A. ZICSI, AF919).

- Dichogaster (Dt.) elgonensis* MICHAELSEN, 1937
V12280 [*Dichogaster*] **Typus** 1 Ex. Fundort: Uganda, Kaburomi, Mt. Elgon. Leg. A. LOVERIDGE, 28. XII. 1933 (MICHAELSEN 1937b p. 437.).
- Dichogaster (Dt.) erlangeri* MICHAELSEN, 1903
V6242 [*Dichogaster*] **Typus** 1 Ex. Fundort: Aethiopien, Abassi-see. Leg. C. VON ERLANGER, XII. 1900. (MICHAELSEN 1903 p. 456.).
V8350 [*Dichogaster kenyae* MICHAELSEN, 1914] **Typus**. Fundort: Britisch Ost-Afrika, Berg Kenya. Leg. CH. ALLAUD UND R. JEANNEL, 22. I. 1912. (MICHAELSEN 1914 p.104.). *Nur Mitteldarm und Muskelmagen Fragmente sind vorhanden.*
- Dichogaster (Dt.) ernesti* (MICHAELSEN, 1897)
V6099 [*Benhamia*] 1 Ex. Fundort: Kamerun. Leg. Y. SJÖSTEDT (MICHAELSEN 1903b p. 160.). *Ausgetrocknet.*
- Dichogaster (Dt.) flandria* MICHAELSEN, 1936
V12329 [*Dichogaster*] **Typus** 1 Ex. Fundort: Equateur (=Kamerun), Flandria. Leg. N. P. HULSTAERT, 15. III. 1932. (MICHAELSEN 1936 p. 213.).
- Dichogaster (Dt.) frickei* MICHAELSEN, 1912
V3016 [*Dichogaster*] **Typus** 3+1 Ex. Fundort: Britisch Nyassaland, Blantyre. Leg. K. FRICKE (MICHAELSEN 1912 p. 35). *Etwas erweichte Exemplare.*
V7642 [*Dichogaster nyassana* MICHAELSEN, 1913] **Typus** 3 Ex. Fundort: Langenburg am Nyassa. Leg. FÜLLEBORN, III. 1899 (MICHAELSEN 1913 p. 154.). *Ausgetrocknet.*
- Dichogaster (Dt.) gabunensis* MICHAELSEN, 1915
V7677 [*Dichogaster*] **Typus** 10 Ex. Fundort: Französisch-Kongo, Gabun. Leg. C. MANGER 1912 (MICHAELSEN 1915 p.198.).
Ol 13978 1 Ex. Fundort: Rep. Kongo, Sibiti, 5 km entfernt von der Stadt in der Umgebung des IRHO und beim Bouenza-Wasserfall und dessen Umgebung. Leg. ZICSI & BALOGH 23. XI. - 3. XII. 1963 (CSUZDI 1996 p. 15. don. A. ZICSI AF1786).
- Dichogaster (Dt.) gatesi* CSUZDI, 1997
Ol 14020 Paratypus 1 Ex. Insel St. Helena, Scotland. Leg. A. LOVERIDGE, 27. VII. 1965 (CSUZDI 1997 p. don. A. ZICSI AF3455).
- Dichogaster (Dt.) gofaensis* MICHAELSEN
V6282 [*Dichogaster*] **Typus** 5 Ex. Fundort: Gofa, Gadat. Leg. O. NEUMANN, 3. I. 1901 (MICHAELSEN 1903 p. 448.).
- Dichogaster (Dt.) golaensis* MICHAELSEN, 1913
V7525 [*Dichogaster*] **Typus** 1 Ex. Fundort: West-Liberia, Mana Gola. Leg. H. SCHOMBOURGK, VI. 1911 (MICHAELSEN 1913 p. 160.).
- Dichogaster (Dt.) gracilis* (MICHAELSEN, 1892)
V3577 [*Benhamia*] 5 Ex. Fundort: Deutsch Ost-Afrika, Kissenji. Leg. H. SCHUBOTZ (MICHAELSEN 1912 p. 32.).
V3730 [*Dichogaster*] 4 Ex. Fundort: Togo, Atakpame. Leg. STOCKHAUSEN (MICHAELSEN 1913 p. 147.).
V4522 [*Benhamia pallida* MICHAELSEN, 1892] 2 Ex. Fundort: Togo, Bismarckburg. Leg. BÜTTNER (det. MICHAELSEN 1897). *Unveröffentlicht.*
V6483 [*Dichogaster*] 20 Ex. Fundort: Deutsch Ost Afrika, Gebiet der Küstenflüsse. Leg. R.P. ZIMMERMANN UND FR. EICHELBAUM. *Unveröffentlicht.*
V6942 3 Ex., V6943 2 Ex. Fundort: Erythraea, Ghindi. Leg. K. ESCHERICH. (MICHAELSEN 1907 p. 13.).
V9312 [*Dichogaster*] viele Ex. Fundort: Liberia, Juring, Suluymah-Fluss. Leg. J. DEMERY, II. 1891. (MICHAELSEN 1922 p. 18.).
V12170 [*Dichogaster*] 2 Ex. Fundort: Belgisch Kongo, Eala. Leg. H. SCHOUTEDEN (MICHAELSEN 1935, p. 54.).
- Dichogaster (Dt.) insularis* (MICHAELSEN, 1895)
V286 [*Benhamia*] **Typus** 1 Ex. Fundort: West-Afrika, Sierra Leone, Insel Scherbro. Leg. H. BRAUNS (MICHAELSEN 1895 p. 31.).
- Dichogaster (Dt.) intermedia* (MICHAELSEN, 1891)
V290 [*Benhamia*] **Typus** Fundort: Togo, Bismarckburg. Leg. BÜTTNER (MICHAELSEN 1891 p. 225.). *Glas leer.*
- Dichogaster (Dt.) kaburomina* MICHAELSEN, 1937
V12289 [*Dichogaster*] **Typus** 5 Ex. Fundort: Uganda, Mt. Elgon, Kaburomi. Leg. A. LOVERIDGE, 28. XII. 1933 (MICHAELSEN 1937b p. 441.). *Die Exemplare sind fragmentiert.*

- Dichogaster (Dt.) kaffaensis* MICHAELSEN, 1903
V6267 [*Dichogaster*] **Typus** 3 Ex. Fundort: Omo Gebiet, West-Kaffa, Tschukka. Leg. O. NEUMANN, 13. IV. 1901 (MICHAELSEN 1903 p. 444.).
- Dichogaster (Dt.) karagoensis* MICHAELSEN, 1912
V3567 [*Dichogaster*] **Typus** 3 Ex. Fundort: N.W. Ruanda, Karago See. Leg. H. SCHUBOTZ, XI. 1907 (MICHAELSEN 1912 p. 23.).
V3568 [*Dichogaster*] **Typus** 6 Ex. Fundort: N.W. Ruanda, Bugoie Wald, O. vom Kivu See. Leg. H. SCHUBOTZ, XI. 1907 (MICHAELSEN 1912 p. 23.).
- Dichogaster (Dt.) karissimbii* MICHAELSEN, 1912
V3570 [*Dichogaster*] **Typus** 1 Ex. Fundort: Deutsch Ost-Afrika, Ruanda, Karissimbi. Leg. H. SCHUBOTZ (MICHAELSEN 1912 p. 18.).
- Dichogaster (Dt.) katangae* MICHAELSEN, 1915
V8358 [*Dichogaster*] **Typus** Fundort: Belgisch Kongo, Katanga (MICHAELSEN 1915 p. 202). *Nur Fragmente, 3 Samentaschen und 2 Prostaten in einem Glas.*
OI 13884 [*Dichogaster*] 1 Ex. Fundort: Zaire, Umpemba National Park, Mabwe, Foret Katanganaise, 585 m. Leg. G. F. DE WITTE, II. 1949 (CSUZDI & ZICSI 1994 p. 51. don. A. ZICSI, AF2445).
- Dichogaster (Dt.) kiwuensis* MICHAELSEN, 1912
V3571 [*Dichogaster*] **Typus** 1 Ex. Fundort: Deutsch Ost-Afrika, Kivu See. Leg. GRANER, XI. 1907 (MICHAELSEN 1912 p. 26.). *Das Exemplar ist nicht geschlechtsreif.*
V9095 [*Dichogaster kiwuensis* MICHAELSEN, 1912 var ?] 1 Ex. Fundort: Deutsch Ost-Afrika, Urundi. Leg. D. VIX, VII.-X. 1912 (MICHAELSEN, 1914 p. 98.).
- Dichogaster (Dt.) kunguluensis* MICHAELSEN, 1915
V8424 [*Dichogaster*] **Typus** 2 Ex. Fundort: Süd-Kamerun, Kungulu Urwald. Leg. A. SCHULTZE, V. 1911. (MICHAELSEN 1915 p. 194.). *In sehr erweichtem Zustand*
- Dichogaster (Dt.) kwidschwiensis* MICHAELSEN, 1912
V3566 [*Dichogaster*] **Typus** 3 Ex. Fundort: Detusch Ost-Afrika, Insel Kwidschi im Kivu-see. Leg. GRAUER, XI. 1907 (MICHAELSEN 1912 p. 25.).
V12617 [*Dichogaster*] 1+1 juv. Ex. Fundort: Belgisch Kongo, Lusambo. Leg. J. GHESQUIÈRE, 12. XII. 1922 (MICHAELSEN 1936b p. 45.).
- Dichogaster (Dt.) lavellei* CSUZDI, 1992
OI 13979 1 Ex. Rep. Kongo, Mayombe, Station Dimonika und Umgebung. Leg. I. MBOUKOU, 1994 (CSUZDI 1996 p. 15. don. A. ZICSI AF2991).
- Dichogaster (Dt.) loboziiana* MICHAELSEN, 1915
V8360 [*Dichogaster*] **Typus** 7 Ex. Fundort: Belgisch-Kongo, Lobozi Fluss. Leg. H. STAPPERS, 21. VI. 1912. (MICHAELSEN 1915 p. 207.). *Gürtellose Exemplare in sehr erweichtem Zustand.*
- Dichogaster (Dt.) lukafuensis* MICHAELSEN, 1935
V12177 [*Dichogaster*] **Typus** 2 Ex. Fundort: Belgisch-Kongo, Landschaft Katanga, Lukafu. Leg. G. F. DE WITTE, 22-31. XII. 1930 (MICHAELSEN 1935 p. 55.).
- Dichogaster (Dt.) medellina* MICHAELSEN, 1914
V7744 [*Dichogaster*] **Typus** 1 Ex. Fundort: Kolumbia, Medellin. Leg. O. FUHRMANN (MICHAELSEN 1914c p.215) *Exemplare zerstört.*
OI 13733 1 Ex. Fundort: Kolumbien, Finca la Sirena, Sendero el Mirador, 2610 m. Leg. ZICSI, CSUZDI & FEIJOO, 17. IV. 1993 (det. CS. CSUZDI, don. A. ZICSI, AF2466). *Unveröffentlicht.*
- Dichogaster (Dt.) meyaensis* CSUZDI & ZICSI 1989
OI 13593 [*Dichogaster*] **Paratypus** 1 Ex. Fundort: Rep. Kongo, Kindamba Meya, Bangu Urwald, in der Laubstreu. Leg. ZICSI & BALOGH, 9. XI. 1963 (CSUZDI & ZICSI 1989 p. 147. don. A. ZICSI, AF781).
- Dichogaster (Dt.) minutissima* CSUZDI, 1996
OI 13976 **Paratypus** 1 Ex. Fundort: Rep. Kongo, Reservat Lefinie, Mbéokala. Leg. ZICSI & BALOGH 10. I. 1964 (CSUZDI 1996 p. 12. don. A. ZICSI AF3324).
- Dichogaster (Dt.) modesta* MICHAELSEN, 1903
V6269 [*Dichogaster*] **Typus** 2 Ex. Fundort: Omo Gebiet Süd-Kaffa, Dereta Berge. Leg. O. NEUMANN, 3. III. 1901.

- V6275** [*Dichogaster*] **Typus** 7 Ex. Fundort: Sagan Gebiet, Gardulla. Leg. O. NEUMANN, 12-13. I. 1901.
- V6284** [*Dichogaster*] **Typus** 4 Ex. Fundort: Omo Gebiet, Kaffa, Anderatscha. Leg. O. NEUMANN, 1. III. 1901 (MICHAELSEN 193 p. 446.).
- Dichogaster (Dt.) modiglianii* (ROSA, 1896)
- V278** [*Benhamia nana* EISEN, 1896] **Typus** 2 Ex. Fundort: Mexico, San Blas. Leg. G. EISEN (EISEN 1896 p. 125.).
- V298** [*Benhamia kafuruënsis* MICHAELSEN, 1896] **Typus** 2 Ex. Fundort: Ost-Afrika, Kafuru. Leg. FR. STUHLMANN. (MICHAELSEN 1896 p. 34.). *In sehr schlechtem Zustand.*
- V3652** part [*Dichogaster papillata* (EISEN, 1896)] 2 Ex. Fundort: Belgisch-Kongo, Mayili. Leg. C. SANDERS (MICHAELSEN 1910 p. 114.). *Nur 3 Ex. im Glas, 1 Ex. Dichogaster (Diplotheocodrilus) bolau* (MICHAELSEN 1891).
- V7701** 3 Ex. Fundort: Mosambique, Buzi-Fluss. Leg. F. F. EIFFE und SCHENNEMANN. (det. CSUZDI, 1988) *Unveröffentlicht.*
- Dichogaster (Dt.) monticola* (MICHAELSEN, 1896)
- V291** [*Benhamia*] **Typus** 1 Ex. Fundort: Deutsch Ost-Afrika, Ru-nsoro. Leg. FR. STUHLMANN, 12. VI. 1891 (MICHAELSEN 1896 p. 27.). *Exemplar sehr erweicht.*
- Dichogaster (Dt.) mulataensis* MICHAELSEN, 1903
- V6252** [*Dichogaster*] **Typus** 5 Ex. Fundort: Wabbi Gebiet, Gara Mulata. Leg. C. VON ERLANGER und O. NEUMANN, 22. III. 1900 (MICHAELSEN 1903 p. 458.).
- Dichogaster (Dt.) mundamensis* (MICHAELSEN, 1897)
- V5838** [*Dichogaster*] 1 Ex. Fundort: Kamerun, Victoria. Leg. P. PREUSS (MICHAELSEN 1902 p. 22.).
- V7433** [*Dichogaster*] 3 Ex.; **V7626** [*Dichogaster*] 5 Ex. Fundort: Kamerun, Buea Leg. C. BIGGE (MICHAELSEN, 1915 p. 193.).
- Dichogaster (Dt.) neumanni* (MICHAELSEN, 1897)
- V4542** [*Benhamia*] **Typus** Fundort: Uganda, Chagre. Leg. O. NEUMANN (MICHAELSEN 1897 p. 10.). *Exemplare verschollen.*
- O1 14018** 1 Ex. Fundort: Uganda, Makerere, Umgebung Kampala, Wald. Leg. W. BLOCK 25. II. 1965 (CSUZDI 1997 p. 40. don. A. ZICSI AF3451).
- Dichogaster (Dt.) papillifera* CSUZDI & ZICSI 1989
- O1 13589** [*Dichogaster modesta papillifera* CSUZDI & ZICSI, 1989] **Paratypus** 1 Ex. Rep. Kongo, Sibiti Urwald, in morschem Holz. Leg. ZICSI & BALOGH 29. XI. 1963 (CSUZDI & ZICSI 1989 p. 139. don. A. ZICSI AF829).
- Dichogaster (Dt.) pauliani* CSUZDI & ZICSI 1989
- O1 13588** [*Dichogaster*] **Paratypus** 2 Ex. Fundort: Rep. Kongo, Kindamba Meya, in der Umgebung der Adam-Höhle, in der Laubstreu, mit Formol-Methode gefangen. Leg. ZICSI & BALOGH, 7. XI. 1963 (CSUZDI & ZICSI 1989 p. 142. don. A. ZICSI AF759).
- Dichogaster (Dt.) proboscideus* MICHAELSEN, 1897
- O1 14019** 1 Ex. Fundort Ghana, Kumasi, UST Campus aus einem unzemementierten Teil eines Kanales. Leg. J. J. NILES, X. 1967 (CSUZDI 1997 p. 41. don. A. ZICSI AF3452)
- Dichogaster (Dt.) rubella* MICHAELSEN, 1935
- V12160** [*Dichogaster*] **Typus** 1 Ex. Fundort: Belgisch Kongo, Tschibinda. Leg. L. BURGEON, XI. 1932 (MICHAELSEN 1935 p. 64.). *Ausgetrocknet.*
- V12615** [*Dichogaster*] 8 Ex. Fundort: Kamatenbe 2100 m. Kongo Mus. *Keine weitere Angaben vielleicht unter MICHAELSEN 1936b p. 46. publiziert.*
- O1 14022** 1 Ex. Zaire, Kivu, Ngungu. Leg. GASANA N'DOLI, 16. VII. 1973 (det. CS. CSUZDI, don. A. ZICSI AF3545). *Unveröffentlicht.*
- Dichogaster (Dt.) saliens* (BEDDARD, 1893)]
- V7662** [*Dichogaster crawi* EISEN, 1900] 8 Ex. Fundort: Natal, Maritzburg, Scottsville. Leg. W. RUMP, XII. 1911 (MICHAELSEN 1913c p. 418.).
- O1 13800** [*Dichogaster*] 3 Ex. Fundort: Bolivien, Prov. Beni, Guayaramerin. Leg. ZICSI, 2. XII. 1966 (ZICSI 1995 p. 603. don. A. ZICSI AF2871)

- Dichogaster (Dt.) savanicola* MICHAELSEN, 1915
V8362 [*Dichogaster*] **Typus** 1 Ex. Belgisch-Kongo, Savanna bei Lukonzolwa am Moreo See. Leg. H. STAPPERS, 23. XI. 1911 (MICHAELSEN 1915 p. 204.).
- Dichogaster (Dt.) schubotzi* MICHAELSEN 1912
V3569 [*Dichogaster*] **Typus** 8 Ex. Fundort: Deutsch Ost-Afrika, N.W. Ruanda, Bugoie Wald. Leg. H. SCHUBOTZ, XI. 1907 (MICHAELSEN 1912 p. 20.).
- Dichogaster (Dt.) silvestris* (MICHAELSEN, 1896)
V295 [*Benhamia*] **Typus** 1 Ex. Fundort: Deutsch Ost-Afrika, Ru-nsoro. Leg. H. SCHUBOTZ, 9. VI. 1891 (MICHAELSEN 1896 p. 28.).
O1 14024 1 Ex. Fundort: Zaire, Kivu, Lwiro. Leg. GASANA N'DOLI, 16. VII. 1973. (det. Cs. CSUZDI, don A. ZICSI AF3567).
Unveröffentlicht.
O1 14025 1 Ex. Fundort: Zaire, Kivu, Ngungu. Leg. GASANA N'DOLI, 16. VII. 1973. (det. Cs. CSUZDI, don A. ZICSI AF3537).
Unveröffentlicht.
- Dichogaster (Dt.) sorosi* CSUZDI & ZICSI 1989
O1 13592 [*Dichogaster*] **Paratypus** 1 Ex. Fundort: Fundort: Rep. Kongo, Reservat Lefinie, am Ufer des Nambouli-Flusses, in der Laubstreu. Leg. ZICSI & BALOGH, 11. I. 1964 (CSUZDI & ZICSI 1989 p. 142. don. A. ZICSI AF916).
- Dichogaster (Dt.) stuhlmanni* (MICHAELSEN, 1890)
V301 [*Benhamia*] **Typus** 40 Ex. Fundort: Mozambique Mopeia. Leg. FR. STUHLMANN, 19. II. 1889 (MICHAELSEN 1890 p. 5.).
V12600 [*Dichogaster sandoa* MICHAELSEN, 1936] **?Typus** 1 Ex. Fundort: Sandoa, Kongo Mus. 1934. (MICHAELSEN 1936b p. 41.).
Keine Typenbezeichnung auf dem Glas, aufgrund des Fundortes und Sammeldatum höchst wahrscheinlich ein Exemplar der Typenexemplare.
O1 13885 [*Dichogaster*] 1 Ex. Zaire, Umpemba National Park, Kabwe, River est du lac Umpemba bord de l'eau, 585 m. Leg. G. F. DE WITTE, 11. XII. 1948 (CSUZDI & ZICSI 1994 p. 52. AF2449).
- Dichogaster (Dt.) taborana* MICHAELSEN, 1913
V7644 [*Dichogaster*] **Typus** 1 Ex. Fundort: Deutsch Ost-Afrika, Tabora. Leg. WINTGENS, 20. IX. 1909 (MICHAELSEN 1913 p. 153
Dichogaster (Dt.) tanganyikae (BEDDARD, 1902)
V3576 [*Benhamia*] 3 Ex. Fundort: Deutsch Ost-Afrika, Kivu See, Kwidschwi Insel. Leg. H. SCHUBOTZ, IX. 1907 (MICHAELSEN 1912 p. 18.).
V12786 [*Dichogaster*] 2 Ex. Fundort: Belgisch-Kongo, Katanga. Leg. VAN SACEGHEM, 14. XI. 1932 (MICHAELSEN 1935 p. 67.).
- Dichogaster (Dt.) tenuiseta* MICHAELSEN 1936
V12328 [*Dichogaster*] **Typus** 1 Ex. Fundort: Mombasa, Lubere. Leg. L. BURGEON, VIII. 1932. (MICHAELSEN 1936 p. 216.).
Ausgetrocknet.
O1 13799 [*Dichogaster*] 1 Ex. Zaire, Park National Umpemba, Kakunda, affl. g. Lupiala et s. affl. dr. Lufira 1300 m. Leg. G. F. DE WITTE, 20. XI. 1947 (CSUZDI & ZICSI 1994 p. 52. don. A. ZICSI AF2453).
O1 13889 [*Dichogaster*] 1 Ex. Zaire, Park National Umpemba, Kakunda, affl. g. Lupiala et s. affl. dr. Lufira, 1300 m. Leg. G. F. DE WITTE, 12. XI. 1947 (CSUZDI & ZICSI 1994 p. 52. don. A. ZICSI AF2451).
- Dichogaster (Dt.) thibaudi* CSUZDI & ZICSI 1989
O1 13590 [*Dichogaster*] **Paratypus** 3 Ex. Fundort: Rep. Kongo, Sibiti, IRHO, in Ölpalmenplantagen. Leg. ZICSI & BALOGH, 26. XI. 1963 (CSUZDI & ZICSI 1989 p. 144. don. A. ZICSI AF812).
- Dichogaster (Dt.) tristani* COGNETTI 1907
V7758 [*Dichogaster pithayana* MICHAELSEN, 1912] **Typus** 4 Ex. Fundort: Costa Rica, Planton, Pithaya. Leg. C. PICADO, IX., XI. 1900 (MICHAELSEN 1912b p. 123.).
Ausgetrocknet.
- Dichogaster (Dt.) ufipana* MICHAELSEN, 1913
V7645 [*Dichogaster*] **Typus** 2 Ex. Fundort: Deutsch Ost-Afrika, Ufipa. Leg. FROMM, XII. 1908 (MICHAELSEN 1913 p. 149.).
- Dichogaster (Dt.) wangaensis* MICHAELSEN, 1905
V6218 [*Dichogaster*] **Typus** 1 Ex. Fundort: Mtschinga in Wanga. Leg. EWERBECK, 25. VII. 1903 (MICHAELSEN 1905 p. 312.).

Gattung: *Eutrigaster (Eutrigaster)* COGNETTI, 1904

Eutrigaster (E.) vialis (MICHAELSEN, 1912)

V3762 [*Dichogaster*] **Typus** 1 Ex. Fundort: Guatemala, Huehuetenango. Leg. G. EISEN, 1902 (MICHAELSEN 1912b p. 121.).

Gattung: *Eutrigaster (Graffia)* CSUZDI & ZICSI, 1991

Eutrigaster (G.) gagzoi (MICHAELSEN, 1908)

V2897 [*Dichogaster*] **Typus** 1 Ex. Fundort: Haiti, St. Marc. Leg. C. GAGZO (MICHAELSEN 1908 p. 17.).

Eutrigaster (G.) godeffroyi (MICHAELSEN, 1890)

V284 [*Benhamia*] **Typus** 2 Ex. Fundort: Haiti Leg. M. G. (MICHAELSEN 1890 p. 5.).

V12310 [*Dichogaster*] 2 Ex. Fundort: Haiti. Leg. SANCHES, 3-6. VI. 1915 (MICHAELSEN 1936c p. 8.).

Eutrigaster (G.) guatemalae (EISEN, 1900)

V7788 [*Benhamia*] 3 Ex. Fundort: Guatemala, Otintepeque. Leg. NOTTEBOHM. Unveröffentlicht.

Eutrigaster (G.) hartmeyeri (MICHAELSEN, 1908)

V7198 [*Dichogaster*] **Typus** 1 Ex. Fundort: Jamaica, Blue Mountains. Leg. HARTMEYER (MICHAELSEN 1908 p. 15.).

Eutrigaster (G.) keiteli (MICHAELSEN, 1898)

V5066 [*Benhamia*] **Typus** 1 Ex. Fundort: Haiti, Port au Prince. Leg. G. KEITEL (MICHAELSEN 1898 p.173). *Exemplar juvenil.*

Eutrigaster (G.) michaelsoniana CSUZDI & ZICSI, 1991

V11884 Holotypus 1 Ex. Fundort: Costa Rica, Farm Hamburg im morschem Holz. Leg. NEVERMANN, 28. I. 1933 (CSUZDI & ZICSI 1991 p. 187.).

Eutrigaster (G.) picadoi (MICHAELSEN, 1912)

V7759 [*Dichogaster*] **Typus** 4 Ex. Fundort: Costa Rica, Plamton. Leg. C. PICADO, V. 1911 (MICHAELSEN 1912b p. 117.).

V7760 [*Dichogaster*] **Typus** 4 Ex. Fundort: Costa Rica, Estrella. Leg. C. PICADO, IX. 1910 und V. 1911 (MICHAELSEN 1912b p. 117.).

Eutrigaster (G.) schporadonephra (COGNETTI, 1905)

V7755 [*Dichogaster*] 4 Ex. Fundort: Costa Rica, Oricuajo. Leg. C. PICADO (MICHAELSEN 1912b p. 117.).

Eutrigaster (G.) viridis (EISEN, 1900)

V5149 [*Benhamia*] **Typus** 1 Ex. Fundort: Mexico. Leg. G. EISEN (EISEN 1900 p. 214.).

V7009 [*Dichogaster paessleri* MICHAELSEN, 1910] **Typus** 2 Ex. Fundort: Mexico, Manzanillo. Leg. R. PAESSLER (MICHAELSEN 1910 p. 154.).

Gattung: *Guineoscolex* CSUZDI & ZICSI, 1994

Guineoscolex inaequalis (MICHAELSEN, 1914)

V270 [*Dichogaster*] **Typus** 1 Ex. Fundort: Sierra Leone. Leg. H. BRAUNS (MICHAELSEN 1914b p. 175.).

Guineoscolex silvestrii (MICHAELSEN, 1914)

V8355 [*Dichogaster*] **Typus** 1 Ex. Fundort: Französisch Guinea, Konakry. Leg. F. SILVESTRI (MICHAELSEN 1914b p. 172.). *Exemplar in schlechtem Zustand, unbestimmbar.*

Gattung: *Millsonia* BEDDARD, 1894

Millsonia guttata (MICHAELSEN, 1913)

V3729 [*Dichogaster*] **Typus** 2 Ex. Fundort: Togo, Atakpame. Leg. STOCKHAUSEN, VI. 1910 (MICHAELSEN 1913 p. 166.).

Millsonia heteronephra (MICHAELSEN, 1897)

V4520 [*Benhamia*] **Typus** 1 Ex. Fundort: Togo, Misahöhe. Leg. E. BAUMANN, 10. XI. 1893 (MICHAELSEN 1897 p. 22.).

Millsonia inermis (MICHAELSEN, 1892)

V7639 [*Benhamia*] 1 Ex. Fundort: Togo, Kete Kratji. Leg. MISCHLICH (MICHAELSEN 1913 p. 166.).

Millsonia nigra BEDDARD 1894

V8354 [*Dichogaster*] 1 Ex. Fundort: Süd Nigeria, Olokemejd. Leg. F. SILVESTRI (MICHAELSEN 1914b p. 182.).

Millsonia schlegeli (HORST, 1884)

V9314 [*Dichogaster*] 3 Ex. Fundort: Liberia, Najam. Leg. J. DEMERY, 1894 (MICHAELSEN 1922 p. 21.).

Millsonia sokodeana (MICHAELSEN, 1913)
V7636 [*Dichogaster*] **Typus** 1 Ex. Fundort: Togo, Sokode. Leg. FR. SCHRÖDER, VIII. 1910 (MICHAELSEN 1913 p. 168). *Sehr erweischtes Exemplar.*

Gattung: *Monogaster* MICHAELSEN, 1915

Monogaster bidjumensis MICHAELSEN, 1915
V8426 Typus 1 Ex. Fundort: Süd-Kamerun, Bidjum bei Lomie. Leg. A. SCHULTZE, V. 1911 (MICHAELSEN 1915 p.188.).

Gattung: *Monothecondrilus* CSUZDI & ZICSI, 1994

Monothecondrilus scherbroensis (MICHAELSEN, 1910)
V408 [*Dichogaster*] **Typus** 1+1 juv. Ex. Fundort: West-Afrika, Scherbro Insel. Leg. H. BRAUNS, VI. 1892 (MICHAELSEN 1910 p. 112.). *Innere Organe fehlen.*

Gattung *Wegeneriella* MICHAELSEN, 1933

Wegeneriella valdiviae (MICHAELSEN, 1903)
V6362 [*Microscolex (Notiodrilus)*] 2 Ex. Fundort: Kamerun, Debundscha. Leg. G. LINNELL, 1903 (MICHAELSEN 1905b p. 23).
V7431 1 Ex. Fundort: Kamerun, Buea. Leg. C. BIGGE. *Etwas ausgetrocknet Unveröffentlichtes Exemplar.*

Gattung *Wegeneriona* ČERNOSVITOV, 1939

Wegeneriona beauforti (MICHAELSEN, 1933)
V11802 [*Wegeneriella*] **Typus**. Fundort: Suriname, Voltzberg. Leg. VAN DER SLEEN, 1932 (MICHAELSEN 1933 p. 125.). *Fragmente, nicht nachbestimmbar.*

Species incertae sedis:

Benhamia tenuis MICHAELSEN, 1891
V289 **Typus** Fundort: Kamerun, Biromba. Leg. P. PREUSS (MICHAELSEN 1891 p. 319.). *Glas leer.*

Dichogaster insularis (MICHAELSEN, 1895) ?
V11816 1 Ex. Fundort: Belgisch-Kongo, Diltolo Gore an der Sudgrenze. Leg. D. F. HAAS, 15-16. XII. 1931. *Unveröffentlicht, nicht identisch mit dem Typusexemplar von D.(Dt.) insularis.*

Dichogaster kamerunensis MICHAELSEN, 1903
V6092 **Typus** 1 Ex. Fundort: Kamerun, Kitta. Leg. Y. SJÖSTEDT, IV. 1891 (MICHAELSEN 1903b p. 158.).

LISTE DER ARTEN IN ALPHABETISCHER REIHENFOLGE DER ARTENNAMEN

adjelana [*Dichogaster*] *Dichogaster* (*Diplothecondrilus*) MICHAELSEN, 1915 **Typus**
aequatorialis [*Benhamia*] *Dichogaster* (*Diplothecondrilus*) (MICHAELSEN, 1896) **Typus**
affinis [*Benhamia*] *Dichogaster* (*Diplothecondrilus*) (MICHAELSEN, 1890) **Typus**
anguana [*Dichogaster*] *Dichogaster* (*Diplothecondrilus*) MICHAELSEN, 1915 **Typus**
arcifera [*Dichogaster*] *Dichogaster* (*Dichogaster*) OMODEO, 1958
austeni [*Benhamia*] *Dichogaster* (*Diplothecondrilus*) (BEDDARD, 1901)
balantina [*Dichogaster*] *Dichogaster* (*Diplothecondrilus*) MICHAELSEN, 1915 **Typus**
bataguensis [*Dichogaster*] MICHAELSEN, 1912] **Typus** = *D. (Dt.) aloisiisabaudiae* COGNETTI, 1906
baumanni [*Benhamia*] *Benhamiona* (MICHAELSEN, 1897) **Typus**
beauforti [*Wegeneriella*] *Wegeneriona* (MICHAELSEN, 1933) **Typus**
beddardi [*Acanthodrilus*] *Benhamiona* (HORST, 1888)
bidjumensis *Monogaster* MICHAELSEN, 1915 **Typus**
biggei [*Dichogaster*] *Benhamiona* (MICHAELSEN, 1915) **Typus**
bolaii [*Benhamia*] *Dichogaster* (*Diplothecondrilus*) (MICHAELSEN, 1891) **Typus**
[*bolaii octonephra* *Benhamia* ROSA, 1895] **Typus** = *D. (Dt.) bolaii* (MICHAELSEN, 1891)
[*bolaii v. palmicola* *Benhamia* EISEN, 1896] **Typus** = *D. (Dt.) bolaii* (MICHAELSEN, 1891)
[*bolaii var. decanephra* *Dichogaster* MICHAELSEN, 1915] **Typus** = *D. (Dt.) bolaii* (MICHAELSEN, 1891)
budgetti [*Benhamia*] *Benhamiona* (BEDDARD, 1900)
buettikoferii [*Acanthodrilus büttikoferii*] *Benhamiona* (HORST, 1884)
cagnii [*Dichogaster*] *Dichogaster* (*Diplothecondrilus*) COGNETTI 1906 **Cotypus**
castanea [*Benhamia*] *Dichogaster* (*Diplothecondrilus*) (MICHAELSEN, 1896) **Typus**

- chapini* [*Dichogaster*] *Dichogaster* (*Diplothecodrilus*)
MICHAELSEN, 1936 **Typus**
- corticis* [*Benhamia*] *Dichogaster* (*Dichogaster*)
(MICHAELSEN, 1899) **Typus**
- crateris* [*Dichogaster*] *Dichogaster* (*Diplothecodrilus*)
MICHAELSEN, 1912 **Typus**
- culminis* [*Benhamia*] *Dichogaster* (*Diplothecodrilus*)
(MICHAELSEN, 1896) **Typus**
- [*curgensis* *Dichogaster* MICHAELSEN, 1921] **Typus** = *D.*
(*Dt.*) *annae* (HORST, 1893)
- curta* [*Benhamia*] *Dichogaster* (*Diplothecodrilus*)
MICHAELSEN, 1896 **Typus**
- daemoniaca* [*Dichogaster*] *Dichogaster* (*Diplothecodrilus*)
COGNETTI 1907
- dorsalis* [*Dichogaster*] *Dichogaster* (*Diplothecodrilus*)
MICHAELSEN, 1915 **Typus**
- dzwilloi* [*Dichogaster*] *Dichogaster* (*Diplothecodrilus*)
CSUZDI & ZICSI 1989 **Paratypus**
- ehrharti* [*Balanta*] *Dichogaster* (*Dichogaster*)
(MICHAELSEN, 1898) **Typus**
- [*ehrharti* v. *linnelli* *Dichogaster* MICHAELSEN, 1910] **Typus**
= *D.*(*D.*) *ehrharti* (MICHAELSEN, 1898)
- elgonensis* [*Dichogaster*] *Dichogaster* (*Diplothecodrilus*)
MICHAELSEN, 1937 **Typus**
- erlangeri* [*Dichogaster*] *Dichogaster* (*Diplothecodrilus*)
MICHAELSEN, 1903 **Typus**
- ernesti* [*Benhamia*] *Dichogaster* (*Diplothecodrilus*)
(MICHAELSEN, 1897)
- flandria* [*Dichogaster*] *Dichogaster* (*Diplothecodrilus*)
MICHAELSEN, 1936 **Typus**
- fouoriensis* *Dichogaster* (*Dichogaster*) CSUZDI, 1996
Paratypus
- frickei* [*Dichogaster*] *Dichogaster* (*Diplothecodrilus*)
MICHAELSEN, 1912 **Typus**
- gabunensis* [*Dichogaster*] *Dichogaster* (*Diplothecodrilus*)
MICHAELSEN, 1915 **Typus**
- gagzoi* [*Dichogaster*] *Eutrigaster* (*Graffia*) (MICHAELSEN,
1908) **Typus**
- gatesi* *Dichogaster* (*Diplothecodrilus*) CSUZDI, 1997
Paratypus
- godeffroyi* [*Benhamia*] *Eutrigaster* (*Graffia*) (MICHAELSEN,
1890) **Typus**
- gofaensis* [*Dichogaster*] *Dichogaster* (*Diplothecodrilus*)
MICHAELSEN **Typus**
- golaensis* [*Dichogaster*] *Dichogaster* (*Diplothecodrilus*)
MICHAELSEN, 1913 **Typus**
- gracilis* [*Benhamia*] *Dichogaster* (*Diplothecodrilus*)
(MICHAELSEN, 1892)
- greeffi* [*Dichogaster*] *Dichogaster* (*Dichogaster*)
MICHAELSEN, 1902 **Typus**
- guatemalae* [*Benhamia*] *Eutrigaster* (*Graffia*) (EISEN, 1900)
- guttata* [*Dichogaster inermis* v. *guttata*] *Millsonia*
(MICHAELSEN, 1913) **Typus**
- hansi* [*Dichogaster*] *Benhamiona* (MICHAELSEN, 1914)
Typus
- hartmeyeri* [*Dichogaster*] *Eutrigaster* (*Graffia*)
(MICHAELSEN, 1908) **Typus**
- heteronephra* [*Benhamia*] *Millsonia* (MICHAELSEN, 1897)
Typus
- horsti* [*Benhamia*] *Benhamiona* (MICHAELSEN, 1898) **Typus**
- hupferi* [*Dichogaster*] *Benhamiona* (MICHAELSEN 1891)
Typus
- inaequalis* [*Dichogaster*] *Guineoscolex* (MICHAELSEN, 1914)
Typus
- inermis* [*Benhamia*] *Millsonia* (MICHAELSEN, 1892)
- insularis* [*Benhamia*] *Dichogaster* (*Diplothecodrilus*)
(MICHAELSEN, 1895) **Typus**
- intermedia* [*Benhamia*] *Dichogaster* (*Diplothecodrilus*)
(MICHAELSEN, 1891) **Typus**
- itoliensis* *Benhamia* MICHAELSEN, 1892 **Typus**
- kaburomina* [*Dichogaster*] *Dichogaster* (*Diplothecodrilus*)
MICHAELSEN, 1937 **Typus**
- kaffaensis* [*Dichogaster*] *Dichogaster* (*Diplothecodrilus*)
MICHAELSEN, 1903 **Typus**
- [*kafuruënsis* *Benhamia* MICHAELSEN, 1896] **Typus** = *D.*
(*Dt.*) *modiglianii* (ROSA, 1896)
- kamerunensis* *Dichogaster* MICHAELSEN, 1903 **Typus** = spec.
inc. sed.
- karagoensis* [*Dichogaster*] *Dichogaster* (*Diplothecodrilus*)
MICHAELSEN, 1912 **Typus**
- karissimbii* [*Dichogaster*] *Dichogaster* (*Diplothecodrilus*)
MICHAELSEN, 1912 **Typus**
- katangae* [*Dichogaster*] *Dichogaster* (*Diplothecodrilus*)
MICHAELSEN, 1915 **Typus**
- keiteli* [*Benhamia*] *Eutrigaster* (*Graffia*) (MICHAELSEN, 1898)
Typus
- [*kenyae* *Dichogaster* MICHAELSEN, 1914] **Typus** = *D.* (*Dt.*)
erlangeri MICHAELSEN, 1903
- kiwuensis* [*Dichogaster*] *Dichogaster* (*Diplothecodrilus*)
MICHAELSEN, 1912 **Typus**
- kunguluensis* [*Dichogaster*] *Dichogaster* (*Diplothecodrilus*)
MICHAELSEN, 1915 **Typus**
- kwidschwiensis* [*Dichogaster*] *Dichogaster*
(*Diplothecodrilus*) MICHAELSEN, 1912 **Typus**
- lavellei* *Dichogaster* (*Diplothecodrilus*) CSUZDI, 1992
- loboziana* [*Dichogaster*] *Dichogaster* (*Diplothecodrilus*)
MICHAELSEN, 1915 **Typus**
- lofaensis* [*Dichogaster*] *Dichogaster* (*Dichogaster*)
MICHAELSEN, 1914 **Typus**
- lukafuensis* [*Dichogaster*] *Dichogaster* (*Diplothecodrilus*)
MICHAELSEN, 1935 **Typus**
- majoris* [*Dichogaster*] *Dichogaster* (*Dichogaster*)
MICHAELSEN, 1914 **Typus**
- mangeri* [*Dichogaster*] *Dichogaster* (*Dichogaster*)
MICHAELSEN, 1913 **Typus**
- medellina* [*Dichogaster*] *Dichogaster* (*Diplothecodrilus*)
MICHAELSEN, 1914 **Typus**
- meyaensis* [*Dichogaster*] *Dichogaster* (*Diplothecodrilus*)
CSUZDI & ZICSI 1989 **Paratypus**
- michaelseniana* *Eutrigaster* (*Graffia*) CSUZDI & ZICSI, 1991
Holotypus

- minutissima* *Dichogaster* (*Diplotheocodrilus*) CSUZDI, 1996
Paratypus
- misaensis* [*Dichogaster*] *Benhamiona* (MICHAELSEN, 1897)
Typus
- modesta* [*Dichogaster*] *Dichogaster* (*Diplotheocodrilus*)
MICHAELSEN, 1903 **Typus**
- modesta papillifera* [*Dichogaster*] **Paratypus** = *D. (Dt.) papillifera* CSUZDI & ZICSI, 1989
- monticola* [*Benhamia*] *Dichogaster* (*Diplotheocodrilus*)
(MICHAELSEN, 1896) **Typus**
- mulataensis* [*Dichogaster*] *Dichogaster* (*Diplotheocodrilus*)
MICHAELSEN, 1903 **Typus**
- mundamensis* [*Dichogaster*] *Dichogaster* (*Diplotheocodrilus*)
(MICHAELSEN, 1897)
- [*nana* *Benhamia* EISEN, 1896] **Typus** = *D. (Dt.) modiglianii*
(ROSA, 1896)
- neumanni* [*Benhamia*] *Dichogaster* (*Diplotheocodrilus*)
(MICHAELSEN, 1897) **Typus**
- nigra* *Millsonia* Beddard 1894
- [*nyassana* *Dichogaster* MICHAELSEN, 1913] **Typus** = *D. (Dt.) frickei* MICHAELSEN, 1912
- [*paessleri* *Dichogaster* MICHAELSEN, 1910] **Typus** = *E. (G.) viridis* (EISEN, 1900)
- [*parva* *Benhamia* MICHAELSEN, 1896] **Typus** = *D. (Dt.) annae* (HORST, 1893)
- pauliani* [*Dichogaster*] *Dichogaster* (*Diplotheocodrilus*)
CSUZDI & ZICSI 1989 **Paratypus**
- picadoi* [*Dichogaster*] *Eutrigaster* (*Graffia*) (MICHAELSEN, 1912) **Typus**
- [*pithayana* *Dichogaster* MICHAELSEN, 1912] **Typus** = *D. (Dt.) tristani* COGNETTI, 1907
- proboscideus* [*Dichogaster*] *Dichogaster* (*Diplotheocodrilus*)
MICHAELSEN, 1897
- reinckei* [*Benhamia*] *Dichogaster* (*Dichogaster*)
(MICHAELSEN, 1898) **Typus**
- reinckei v. endemica* [*Dichogaster*] **Typus** = *D. (D.) endemica* MICHAELSEN, 1914
- robertsiana* [*Dichogaster*] *Benhamiona* (MICHAELSEN, 1922)
Typus
- rosea* *Benhamia* MICHAELSEN, 1889 **Typus**
- rubella* [*Dichogaster*] *Dichogaster* (*Diplotheocodrilus*)
MICHAELSEN, 1935 **Typus**
- saliens* [*Microdrilus*] *Dichogaster* (*Diplotheocodrilus*)
(BEDDARD, 1893)
- [*sandoa* *Dichogaster* MICHAELSEN, 1936] **Typus** = *D. (Dt.) stuhlmanni* (MICHAELSEN, 1890)
- savanicola* [*Dichogaster*] *Dichogaster* (*Diplotheocodrilus*)
MICHAELSEN, 1915 **Typus**
- scherbroensis* [*Dichogaster*] *Monotheocodrilus* (MICHAELSEN, 1910) **Typus**
- schlegeli* [*Acanthodrilus*] *Millsonia* (HORST, 1884)
- schomburgki* [*Dichogaster*] *Benhamiona* (MICHAELSEN, 1913) **Typus**
- schporadonephra* [*Dichogaster*] *Eutrigaster* (*Graffia*)
(COGNETTI, 1905)
- schubotzi* [*Dichogaster*] *Dichogaster* (*Diplotheocodrilus*)
MICHAELSEN 1912 **Typus**
- silvestrii* [*Dichogaster*] *Guineoscolex* (MICHAELSEN, 1914)
Typus
- silvestris* [*Benhamia*] *Dichogaster* (*Diplotheocodrilus*)
(MICHAELSEN, 1896) **Typus**
- sokodeana* [*Dichogaster*] *Millsonia* (MICHAELSEN, 1913)
Typus
- sorosi* [*Dichogaster*] *Dichogaster* (*Diplotheocodrilus*) CSUZDI
& ZICSI 1989 **Paratypus**
- stockhauseni* [*Dichogaster*] *Benhamiona* (MICHAELSEN, 1913)
Typus
- stuhlmanni* [*Benhamia*] *Dichogaster* (*Diplotheocodrilus*)
(MICHAELSEN, 1890) **Typus**
- tabarana* [*Dichogaster*] *Dichogaster* (*Diplotheocodrilus*)
MICHAELSEN, 1913 **Typus**
- tanganyikae* [*Benhamia*] *Dichogaster* (*Diplotheocodrilus*)
(BEDDARD, 1902)
- tenuis* *Benhamia* MICHAELSEN, 1891 **Typus** = spec. inc. sed.
- tenuiseta* [*Dichogaster*] *Dichogaster* (*Diplotheocodrilus*)
MICHAELSEN 1936 **Typus**
- terricola* [*Dichogaster*] *Dichogaster* (*Dichogaster*)
MICHAELSEN, 1915 **Typus**
- thibaudi* [*Dichogaster*] *Dichogaster* (*Diplotheocodrilus*)
CSUZDI & ZICSI 1989 **Paratypus**
- titillata* [*Dichogaster*] *Dichogaster* (*Dichogaster*) SIMS, 1967
- ufipana* [*Dichogaster*] *Dichogaster* (*Diplotheocodrilus*)
MICHAELSEN, 1913 **Typus**
- valdiviae* [*Notiodrilus?*] *Wegeneriella* (MICHAELSEN, 1903)
- vialis* [*Dichogaster*] *Eutrigaster* (*Eutrigaster*) (MICHAELSEN, 1912) **Typus**
- viridis* [*Benhamia*] *Eutrigaster* (*Graffia*) (EISEN, 1900)
Typus
- wangaensis* [*Dichogaster*] *Dichogaster* (*Diplotheocodrilus*)
MICHAELSEN, 1905 **Typus**
- wenkei* [*Balanta*] *Dichogaster* (*Dichogaster*) (MICHAELSEN, 1931) **Typus**

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Über Calciphilie bei *Lithobius nodulipes* LATZEL, 1880 (Chilopoda, Lithobiomorpha) sowie die Beurteilung von *L. nodulipes scarabanciae* LOKSA, 1947 in Ungarn

L. DÁNYI¹

Abstract. Previously, there were just two known occurrences of *Lithobius nodulipes* LATZEL, 1880 in Hungary, but in the last couple of years we could show its presence in several new areas of the country. The recent findings disprove the presumed calciphily of the species (MATIC, 1966) and raise taxonomical questions in connection with the subspecies *Lithobius nodulipes scarabanciae* LOKSA, 1947, which was first found and described in an area of Hungary. We give a list of the newly discovered occurrences and describe the characteristics which are needed for the determination of the species. A drawing of the hind legs of a male and a map showing the occurrences are provided as well.

Über das Vorkommen des Hundertfüßers *L. nodulipes* LATZEL, 1880 waren in Ungarn früher nur zwei Aufzeichnungen bekannt. Die ersten Exemplare wurden aus der nordöstlichen Ecke des Landes, dem zum Balfer Hügelland gehörendem Tómalom-Gebiet gesammelt (LOKSA, 1947; LOKSA, 1955). Das Material dieser Sammlung diente zugleich als Grundlage zur Beschreibung einer neuen Unterart, *L. nodulipes scarabanciae* LOKSA, 1947. Danach wurde die Art aus Ungarn nur noch von ILOSVAY (1983) in Bakony-Gebirge gemeldet. Außerhalb Ungarns ist diese Art aus großen Teilen Mittel- und Osteuropas bekannt, wo sie überall als selten betrachtet wird (LATZEL, 1880; MATIC, 1966; KACZMAREK, 1979; MINELLI & IOVANE, 1987).

Die Lebensräume der Art zeigen in südlicheren Gebieten ein montan-subalpines Vorkommen, während sie sich im Norden in niedrigere Lagen zurückzieht (KACZMAREK, 1979).

MATIC fand in einigen Kalksteingebirgen Rumäniens ein inselartiges Vorkommen von *L. nodulipes* und nimmt deswegen an, dass sie calciphil sein könnte (MATIC, 1966). Diese Theorie wird auch von KOREN (KOREN, 1992), erwähnt, aber im wesentlichen nicht bewiesen. Andere Autoren geben bei der Beschreibung keine diesbezüglichen Angaben an.

UNTERSUCHUNG DES CALCIPHILEN CHARAKTERS

Anhand der Fundorte der vergangenen Jahre konnte festgestellt werden, dass die Verbreitung von *L. nodulipes* tatsächlich viel größer ist als bisher bekannt war. Zahlreiche weitere Exemplare konnten, nunmehr nicht nur aus dem Balfer Hügelland, (welches durch auf Leitha-Kalkstein entstandenen Rendzina-Böden gekennzeichnet ist, MAKÁDI, 2002), sondern auch aus dem Soproner Gebirge, dem Mecsek-Gebirge, wie auch dem Gebiet des Örség und Zselic nachgewiesen werden.

Diese neuen Fundorte wären (vergleiche Abb. 1): **Balfer Hügelland:** Fertőboz, Fertő-Wiese (SzSD); Sopron, Pinty-Spitze) (SzSD); **Soproner Gebirge:** Sopron, Vörös-bérc (SK); **Örség:** Kercaszomor (SzCs); **Zselic:** Ibafa, Ratkóca (KR); **Ostmecsek:** Komló, Egregyer Tal (DL); Mánfa, Dóczy-Mühle (KZ); Óbánya, Farkas-árok, Seitenarm am Hideg-oldal (DL); Óbánya, Hideg-oldal (DL); Óbánya, Nagy-árok (DL); Óbánya, Försterhaus bei Váralja (DL); Vékény, Csöpögő-Quelle (DL); **Westmecsek:** Abaliget, neben der Höhle (KR); Abaliget (DL); Melegmányer Tal (DL); Orfű (KR); Namensabkürzungen der Sammler: **SzSD:** G. SZÖVÉNYI, K. SCHÖLL & L. DÁNYI; **SzCs:** Cs. SZINETÁR; **SK:** K. SCHÖLL; **KR:** Z. KORSÓS & H. READ; **KZ:** Z. KORSÓS; **DL:** L. DÁNYI

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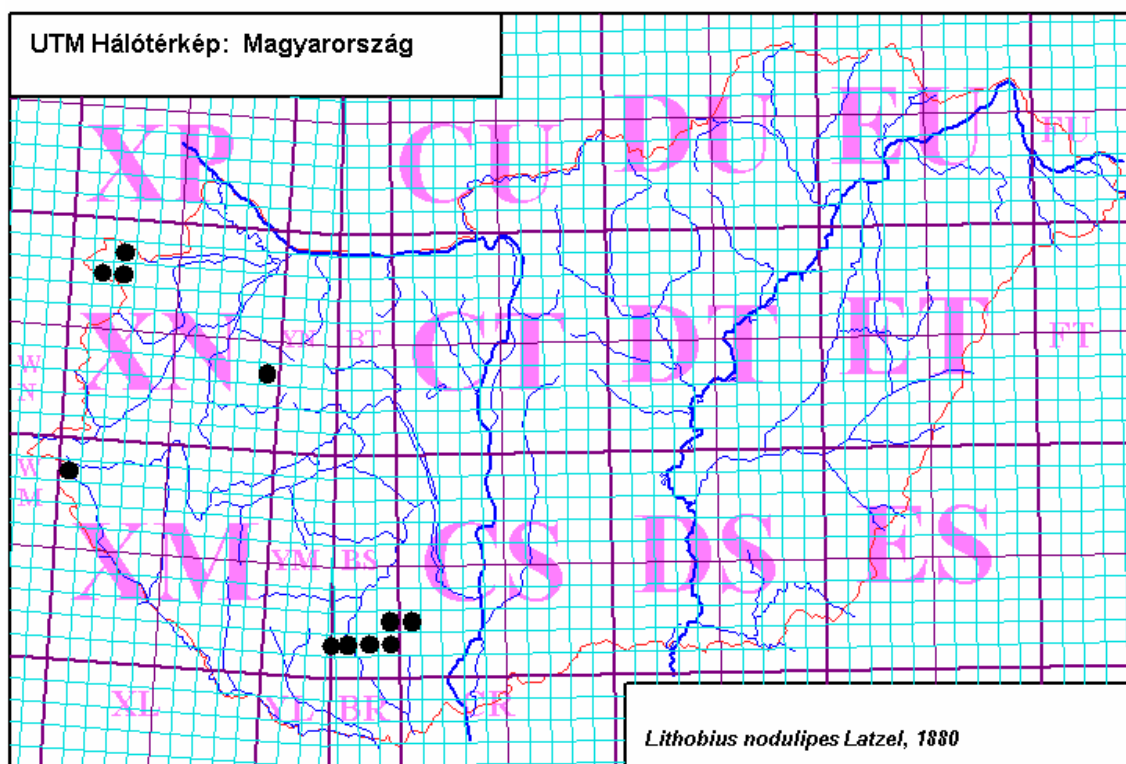


Abbildung 1. Die Fundorte von *L. nodulipes* in Ungarn.

Bei der Untersuchung der nun bekannten geologischen bzw. bodenkundlichen Charakteristika der Lebensräume wurden einige nicht auf kalkhaltigem Gestein liegende Gebiete angetroffen. Da sich die Kalkhaltigkeit des Grundgesteins auf die Zusammensetzung des Bodens auswirkt, folglich einige der untersuchten Gebiete eher saure Böden besitzen, sind bezüglich der Calciphilie der Art Zweifel aufgekommen. Dies wären folgende untersuchte Gebiete Soproner Gebirge: Vörös-bérc (kristallines Grundgestein, deutlich saure Waldböden), Gebiet des Órség: Kercaszomor (Pseudogley-Böden) (STEFANOVITS, 1981; JUHÁSZ, 1983), Zselic (am nördlichen Fuß des Mecsek-Gebirges): Ibafa (braune Waldböden mit eingeschwemmtem Ton), Mecsek: Csöpögő-Quelle (silikathaltiges Vulkanit, braune Waldböden mit eingeschwemmtem Ton) (STEFANOVITS, 1981; HETÉNYI et al., 1982). In einigen wenigen Fällen

ist es nicht gelungen, genauere Daten über das Grundgestein der Fundorte bzw. der Kalkhaltigkeit der dortigen Böden nachzuweisen (z.B. Mánfa: Dóczy- Mühle, wo der Kalkgehalt des miozänen Konglomerats bzw. des sich darauf gebildetem Bodens je nach Art und den jeweiligen Verhältnissen der verschiedenen, angeschwemmten Gesteinsstücke sehr variabel gestaltet ist (HETÉNYI et al., 1982).

Im Falle der Csöpögő-Quelle nahe des Dorfes Vékény kann der sehr abwechslungsreiche geologische Aufbau, so die nicht weit entfernt (1-2 km) auftauchenden kalkhaltigen Mergeldecken (eine größere Fläche mit möglicherweise mehreren kleineren, noch näher liegenden Ausläufern, HETÉNYI et al., 1982) die Interpretation der Daten unsicher machen. Doch beweist das großflächige Vorkommen auf Gebieten mit sauren Böden, wie das Soproner

Gebirge, das Gebiet des Órség, sowie das des Mecsekalja, dass die Kalkhaltigkeit des Grundgesteins keine Voraussetzung für ein Vorkommen der Art sein muss. Hoffentlich kann die Position des inselartigen Vorkommens durch künftige Sammlungen verfeinert werden, wobei bei der Suche nach Ursachen auch Verbindungen mit klimatologischen und mikroklimatologischen Parametern, vielleicht auch biogeographische Erklärungen in Betracht gezogen werden können.

Übereinstimmend mit den Erfahrungen anderer Autoren, kann aufgrund des Vorkommens in Ungarn die Art, da sie an feuchtere Wälder gebunden zu sein scheint, als Wald bewohnend bezeichnet werden. In den trockeneren Jahreszeiten wurde sie in Gräben und Bachfurchen von Hainbuchen-Eichenwäldern und Buchenwäldern erfolgreich gesammelt.

Ein weiteres Vorkommen dieser Art ist noch aus zahlreichen anderen Gebieten Ungarns zu erwarten, wie z.B. aus dem Kőszeger Gebirge, aus dem Gebiet des Hetés, sowie aus Gőcsej.

***Lithobius nodulipes* LATZEL, 1880**

Es haben sich bereits verschiedene Autoren mit *L. nodulipes* in Europa befasst. (MATIC, 1966; KACZMAREK, 1979; KOREN, 1992). Die Bestimmungsmerkmale stimmen z.T. überein, weichen aber teilweise voneinander ab. Unsere Erfahrungen mit diesen vergleichend, lässt sich folgende Liste der Bestimmungsmerkmale von *L. nodulipes* anführen:

Länge der auffallend glänzenden Tiere 10-15 mm. Rücken hell-rostbraun, Kopf und Antennen etwas dunkler. Antennen aus 35-46 Gliedern bestehend, die sich zum Ende hin aufhellen. Hinterrand der Tergite oft etwas dunkler. An den Ecken des 9., 11. und 13. Tergits sind posteriolateral große und spitze, dreieckige Fortsätze. An den restlichen Tergiten fehlen diese, hintere Ecken dieser abgerundet oder eckig. Basalglied der Kieferfüße (Coxosternum) mit je zwei kleinen, weit voneinander stehenden Zahnhöckern besetzt.

Dem 15. Beinpaar fehlt der laterale Dorn des Coxalgliedes, neben der Krallen an der Fußspitze befindet sich keine weitere Seitenkrallen. Dornenformel der letzten zwei Beinpaare lautet: 14.: 00311/01331; 15.: 00200/01310

An den Gonopoden der Weibchen 2+2 Sporne kurz. Bei den Individuen im Mecsek gefundenen ist das Verhältnis der auf mindestens einer Seite auch einen dritten Sporn (2+3, 3+3) tragenden Tiere auffallend hoch (dies wurde schon von KOREN (KOREN, 1992) in Verbindung mit Tieren aus Kärnten erwähnt. Krallen am Ende der Gonopoden breit, läuft in drei stumpfen Spitzen aus.

An den 14. Tibien der Männchen bilden kurze, gerade Borsten einen dichten Fleck auf der dorsalen Seite, während auf den 15. Tibien, ebenfalls dorsal, ein tropfenförmiger Auswuchs am distalen Ende zu sehen ist (Abb. 2). Auswuchs fein beborstet, Glied als Ganzes nicht verdickt.

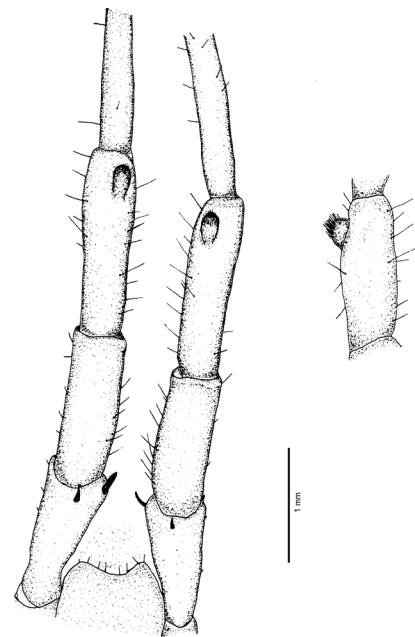


Abbildung 2. 15. Beinpaar des Männchens von *L. nodulipes* mit charakteristischen Artmerkmalen

DIE TAXONOMISCHE FRAGE DER UNTERART

Nachstehend muss die Stichhaltigkeit der Unterart *L. nodulipes scarabanciae* LOKSA, 1947 geklärt werden. Mit der Stichhaltigkeit dieser Unterart hat sich die spätere Literatur bis jetzt nicht befasst, es wurde auch kein anderer Fundort gemeldet. Da die Original Exemplare nicht auffindbar sind, müssen die in den letzten Jahren vom relativ kleinflächigen Balfer Hügelland gesammelten Individuen als besonders wertvoll

betrachtet werden. Im Falle dieser und etwas entfernter gelegener Fundorte konnte beobachtet werden, dass mit den von LOKSA erwähnten abgrenzenden Merkmalen der Unterart (die Bedornung der 1., 2., 3., 4., Beine) keine Übereinstimmungen bestehen, dagegen zwischen Individuen eines Fundortes eine so große Variabilität bezüglich der Bedornung der ersten vier Beinpaare vorkommt (Tabelle 1), dass diese als Trennungsmerkmale zur Bestimmung in Frage gestellt werden müssen.

Tabelle 1. Vergleich der Dornenformeln von *L. nodulipes scarabanciae* mit denen neuerer Funde. (Die Angaben beziehen sich am gegebenem Bein auf: Prefemur-Femur-Tibia dorsal/ Prefemur-Femur-Tibia ventral)

	1. Beinpaar	2. Beinpaar	3. Beinpaar	4. Beinpaar
<i>L. n. scarabanciae</i>	011/002	111/101	121/111	121/111
Fertőboz, Fertő-Wiese	111/001	121/011	121/111	121/11(2)1
Mánfa, Dóczy-Mühle	111/000	121/011	122/011	122/021
Abaliget	001/000	121/011	121/01(2)1	121/121
Sopron, Vörösbérc	011/000	111/011	---	121/011
Sopron, Vörösbérc	---	121/011	121/011	121/111
Ostmecsek, Egregyer Tal	111/000	---	121/021	121/021
Ostmecsek, Egregyer Tal	001/000	011/001	---	121/011
Vékény, Csöpögő Quelle	111/001	121/011	121/011	121/011
Óbánya, Farkasárók	111/000	121/001	121/011	122/111
Órség, Kercaszomor	100/001	121/001	121/011	121/011

Die von LOKSA beschriebenen Abweichungen der Unterart können aus heutiger taxonomischer Sicht auch als individuelle Variabilität betrachtet werden. (Die genaue Anzahl der von ihm beschriebenen Individuen ist nicht bekannt, es

wird nur ♂♂="mehr als ein Männchen" erwähnt (LOKSA, 1947).) Die Unterart wird hiermit eliminiert. Trotzdem sei erwähnt, dass eine korrekte Meinungsbildung nur aufgrund der fehlenden Original Exemplare erfolgen kann.

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The effects of *Najas marina* on the zooplankton species composition and water chemistry in a small, shallow lake (Fehér-tó, Fertő-Hanság National Park, Hungary)

A. KISS¹

Abstract. Horizontal distribution and diurnal migration of zooplankton as well as a few water chemistry parameters were investigated in the clear-water and the turbid state of the extremely shallow Lake Fehér (Hungary) between 1998-2001. Significant horizontal and diel differences were recorded in the density and composition of zooplankton assemblages as well as a few water chemical parameters between the turbid and clear-water state of lake. In the turbid state copepods dominated zooplankton assemblages developed with low density and species richness and the cladoceran zooplankton consisted of mainly pelagic species with low abundance values. During the presence of *Najas marina* the zooplankton community was dominated by cladocerans and the ratio of the macrophyta-associated species was high. In case of few cladoceran species significant diel density differences developed between the macrophyte bed and the above macrophyte-free water column however macrophyta-associated species did not show diel vertical migration. Based on the result of diurnal monitoring the importance of DHM (diel horizontal migration) was irrelevant in the uniform and dense *Najas* beds and zooplankton appear to migrate vertically rather than horizontally.

Submerged macrophytes have a major impact on the biological structure and water quality of shallow lakes (SCHEFFER & JEPPESEN, 1998). Macrophytes enhance water clarity through enhanced grazing on phytoplankton, shading, reduction of nutrient and light availability, excretion of allelopathic substances, increase of sedimentation and reduction of resuspension. The role of macrophytes as stabilizing and structuring components in lakes of differing trophic levels have been emphasized in the stable state theory by SCHEFFER et al. (1993) based on that over a range of nutrient concentrations, shallow lakes can have two alternative equilibria: a clear-water state dominated by aquatic vegetation, and a turbid state characterized by high algal biomass. The biomass and seasonality of zooplankton is connected to lake trophic level, in turn reflecting the vegetation density. In eutrophic lakes with high macrophyte density, the zooplankton peak follows plant biomass, coinciding in late summer. On the contrary shallow lakes with scanty vegetation the zooplankton biomass takes place in the beginning of summer or autumn (JEPPESEN et

al., 1998). Dense macrophyte beds can act as a refuge for large zooplankton species, which in turn control the phytoplankton (TIMMS & MOSS, 1984), but the refuge effect being diminished at increasing predator density (JEPPESEN et al., 1998). In shallow lakes opposite to deep-lakes, the predator-avoidance strategy of diel vertical migration (DVM) is less advantageous, in these systems the importance of diel horizontal migration (DHM) increases. During the DHM the pelagic zooplankton move into macrophyte beds during daytime, using it as spatial refuge against fish predators, but migrate into open water at night to feed on phytoplankton.

The Fertő-Hanság area is one of the most important wetlands in Central Europe. Limnological research has a long tradition in the Seewinkel and Lake Fertő but only limited information is available on the neighbouring shallow lakes in the Hanság region. In 1998, a four-year project was started to study the faunistics, temporal and spatial distribution of several Crustacean taxa and composition of the

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zooplankton assemblages of the Lake Fehér (KISS, 2002). Besides zooplankton the main water chemical parameters were also recorded because only little information has the diel and horizontal changes of the main water chemical parameters (temperature, pH, conductivity, dissolved oxygen concentration) in extremely shallow lakes. In this paper the turbid and the clear-water state of the lake is compared and the diel variation in horizontal and vertical distribution of the several species is discovered in the vegetation period.

GENERAL DESCRIPTION OF THE STUDY AREA

Lake Fehér (Fehér-tó) (47° 41' N, 17° 21' E) is situated in the area of the Fertő-Hanság National Park, in the northwestern part of Hungary. It is strictly protected and not influenced by human activities. The lake is small and very shallow (area: 2.69 km², open water: 0.25 km², mean depth: 50 cm, maximum depth: 110 cm). The hydrology of the lake depends on the interplay of precipitation and evaporation and there is an accidental water supply from the River Rába through a little channel. The littoral zone of the lake is characterised by beds of emergent macrophytes (*Phragmites australis* and *Typha angustifolia*). Since 1994, the lake was devoid of open water macrophytes, whereas in 1999 and 2000 the open water was covered by dense vegetation of *Najas marina* (95 % Plant Volume Infested).

Until 1983 Lake Fehér was a fish pond. Since 1983, when the area became protected, the fish stock has been considerably increased. The fish assemblage is dominated by cyprinids. The most abundant species are *Carassius auratus*, *Rutilus rutilus* and *Perca fluviatilis* (G. GUTI, personal communications).

MATERIALS AND METHODS

Sampling was carried out from June to September at monthly intervals in 1998 and 2001 and biweekly in 1999 and 2000. The temperature,

pH, conductivity and dissolved oxygen were measured in the field by using MULTILINE-P4 portable meter as well as the laboratory analyses were carried out with DX-120 ion chromatograph. The quantity of the zooplankton sample usually was 50 litre, but from the *Najas* beds only 5 litre sample was collected because of the high crustacean density. As zooplankton distribution is characterized by a high degree of horizontal patchiness we attempted to reduce this problem by collecting and pooling five subsamples on each occasion and each sampling. Samples were filtered through a 70 µm mesh net then preserved in 5 % formaldehyde solution. The diel changes of the zooplankton assemblages and the in situ measured water chemical parameters were followed in August of 1998, 1999, 2000 and 2001 in every two hours between 2 a.m. and 11 p.m. from three vertical zones of the lake: 1. water surface, 2. middle of the water column, 3. sediment surface. To test the horizontal distribution of the crustacean species, the monthly, biweekly and diurnal zooplankton samples were collected from three sampling points along the 100 m long transect: 1. mid-lake (approximately 100 m from the shore, 2. between 1. and 3., approximately 20 m from the emergent macrophyta zone, 3. outer side of the *Typha angustifolia* stand. When *Najas marina* occurred using the same methods zooplankton were also sampled in a *Najas*-free patches close to the *Typha* zone (4. sampling site).

Microcrustaceans were enumerated by using inverted microscopy and identified to species level. Very dense samples were subsampled.

RESULT AND DISCUSSION

Environmental parameters

Turbid state (1998, 2001)

In the turbid state the open water was devoid of macrophytes. In 1998 and 2001 hypertrophic conditions were recorded, dense blooms of blue-green algae developed in the lake. The most frequent species were *Anabaena spiroides* and

Microcystis reinboldii (K. T. KISS, personal comments).

In the vegetation period the turbidity (140 FTU) and the suspended solid content (84 mg l^{-1}) was high especially in August. In summer because of the high pH values there was no bicarbonate (HCO_3^-) in the water and the CO_3^{2-} -concentration (mean: 23.2 mg l^{-1}) increased. The temperature ranged from $15.2\text{--}31.3^\circ\text{C}$. The mean temperature was $1\text{--}3^\circ\text{C}$ lower on the outer side of the *Typha* zone than the open water. There was no significant vertical temperature difference in the water column, the average deviation was only $0.4\text{--}0.5^\circ\text{C}$. The pH ranged from $9.10\text{--}10.73$, the maximum was in August of 2001. The pH values decreased inshore and except August there was no vertical pH difference in the water column. The conductivity ranged from $333\text{--}521 \mu\text{S/cm}^{-1}$ and there were no significant vertical and horizontal conductivity differences in the lake. The dissolved oxygen concentration ranged from $8.75\text{--}20.7 \text{ mg l}^{-1}$ and decreased inshore an average 2.9 mg l^{-1} in 1998 and 7.6 mg l^{-1} in 2001. The mean vertical oxygen difference in the water column was 0.52 mg l^{-1} in 1998 and 3.51 mg l^{-1} in 2001. The vertical differences increased inshore both years.

In August of 1998 and 2001 the lake was extremely shallow (34 and 31 cm) and considerable cyanophyta blooms were developed. During the diurnal monitoring the horizontal differences between the water surface temperature in the mid-lake (mean: 26.76°C in 1998 and 27.49°C in 2001) and the outer side of the *Typha* zone (mean: 26.32°C in 1998 and 26.52 in 2001) were insignificant. The temperature decreased inshore both years. Significant diurnal temperature fluctuations were detected both in the mid-lake (9.0°C in 1998 and 8.6°C in 2001) and the *Typha* zone (8.6°C in 1998 and 6.3°C in 2001). The maximum was at 3 p.m. (30.9°C in 1998 and 31.2°C in 2001) and the minimum was at 2 a.m. (21.9°C in 1998 and 22.6°C in 2001). The vertical temperature differences in the water column were

inconsiderable (mean: 0.39°C in 1998 and 0.9°C in 2001) at all sampling sites of the transect. The horizontal differences between the water surface pH in the mid-lake (mean: 8.93 in 1998 and 10.14 in 2001) and the outer side of the *Typha* zone (mean: 9.11 in 1998 and 9.8 in 2001) were insignificant (mean difference: 0.18 in 1998 and 0.39 in 2001). The mean diurnal pH difference was 1.02 in 1998 and 1.15 in 2001. The maximum was at 3 p.m. (9.64 in 1998 and 10.73 in 2001) and the minimum was at 5 a.m. (8.48 in 1998 and 9.47 in 2001). The mean vertical pH differences in the water column were inconsiderable (0.128 in 1998 and 0.184 in 2001) at all sampling points of the transect. The conductivity increased inshore in 1998 and 2001 too, and the mean horizontal differences between the mid-lake (mean: $359 \mu\text{S cm}^{-1}$ in 1998 and $463.6 \mu\text{S cm}^{-1}$ in 2001) and the outer side of the *Typha* zone (mean: $368 \mu\text{S cm}^{-1}$ in 1998 and $472 \mu\text{S cm}^{-1}$ in 2001) were $8.67 \mu\text{S cm}^{-1}$ in 1998 and $7.6 \mu\text{S cm}^{-1}$ in 2001. Significant interannual differences were recorded in the mean diurnal conductivity fluctuation - in 1998 the diurnal difference was $11.7 \mu\text{S cm}^{-1}$, but $107 \mu\text{S cm}^{-1}$ in 2001. The conductivity maximum was in daytime and the minimum was at night. The mean vertical conductivity differences in the water column were low ($1.66 \mu\text{S cm}^{-1}$ in 1998 and $4.45 \mu\text{S cm}^{-1}$ in 2001).

The dissolved oxygen concentration decreased inshore and the mean horizontal differences between the mid-lake and the outer side of the *Typha* zone was 1.91 mg l^{-1} in 1998 and 5.59 mg l^{-1} in 2001. The mean oxygen concentration as well as the maximum values (14.73 mg l^{-1} in 1998 and 26.2 mg l^{-1} in 2001) was notably higher in 2001 because of the photosynthetic activity of the notably higher blue-green algae biomass. The mean diurnal concentration fluctuation was 8.81 mg l^{-1} in 1998 and 11.91 mg l^{-1} in 2001. The concentration maximum was between 5-7 p.m. and the minimum was at 5 a.m. The mean vertical differences in the water column were low, 2.19 mg l^{-1} in 1998 and 2.29 mg l^{-1} in 2001.

Clear-water state (1999, 2000)

In the clear-water state of the lake the open water was covered by the homogeneous stand of *Najas marina*. In 1999 the *Najas* appeared at the end of June. In July the *Najas* entirely covered the open water (95 % Plant Volume Infested) and above the macrophyte beds there was a 20-25 cm deep *Najas*-free water column (mean water depth: 69 cm). It was particular that in the *Najas* beds the phytoplankton was very diverse (60-80 species) and the phytoplankton biovolume was high. The dominant species were *Microcystis aeruginosa* and *Meriosmopedia tenuissima* (5000-30000 ind ml⁻¹) (K. T. KEVE, personal comment). From July to August in the macrophyte beds the density of *Notonecta glauca* and the juvenile fish were high. In 2000 *Najas marina* appeared at the end of June and opposite to 1999 in front of the *Typha* zone, there was a 2-3 m wide zone which was devoid of *Najas*. The mean water depth (53 cm) was lower than the previous year therefore the *Najas*-free water column was only 10-15 cm deep. In August, rich periphyton assemblages developed on the *Najas* which in August in the open water entirely colonized the macrophyte beds and that by shading reduces the *Najas* photosynthesis (SAND-JENSEN 1977). In the macrophyte beds the phytoplankton biovolume was low. The density of the YOY fish was high like in 1999, but *Notonecta glauca* was not present.

In the clear-water state the water turbidity (mean: 12.66 FTU) and the suspended solid content were low (mean: 0.012 mg l⁻¹ in 1999 and 10.8 mg l⁻¹ in 2000). From June to September the water surface temperature ranged from 18.1–26.1°C. The horizontal differences were insignificant (mean: 1.72°C) however the vertical temperature differences, opposite to turbid state, notably increased (mean: 2.81°C, maximum: 6.4°C). The pH ranged from 7.63–10.08. The mean horizontal pH difference was low (0.70) and the values fluctuated horizontally. The vertical pH differences in the water column increased with the expansion of the *Najas* and the maximum was in August 2000 (1.2). The

conductivity ranged from 233-619 µs cm⁻¹, increased inshore and the conductivity differences increased horizontally with the expansion of the *Najas*. The dissolved oxygen concentration ranged from 1.14-21.34 mg l⁻¹ and as compared with the turbid state the mean vertical oxygen difference in the water column significantly increased (mean: 3.57 mg l⁻¹, max: 10.82 mg l⁻¹). In the end of September, when *Najas* was disintegrated, the pH and the dissolved oxygen content decreased (mean: 5.66 mg l⁻¹, min: 1.14 mg l⁻¹), as well as the turbidity and conductivity increased because of the intensive *Najas* degradation.

During of the diurnal monitoring the water depth was 67 cm in 1999 and 40 cm in 2000. The horizontal temperature differences between the mid-lake and the outer side of the emergent macrophyta zone were insignificant (mean: 0.83°C). The diurnal temperature changes decreased with water depth (mean water surface: 8.1°C, mean sediment surface: 2.9°C) and the vertical temperature differences in the water column were considerably increased compared with the turbid state (mean turbid state: 0.4°C, mean clear-water state: 2.85°C, max: 7.0°C). In case of pH there were no significant horizontal differences in the lake (mean: 0.47 in 1999 and 0.86 in 2000). The pH decreased with the water depth in accordance with several observations - that plant beds frequently have high pH in the surface layers, but lower values in the darker, deeper layers (FRODGE et al 1990). The mean diurnal pH difference also decreased with water depth (mean water surface: 1.9, mean sediment surface: 0.92). The minimum values (7.35-9.61) were at night (between 11 p.m and 2 a.m.) and the maximum values (8.86-10.47) were between 3 and 9 p.m. The conductivity increased inshore and significant horizontal differences were detected between the mid-lake (mean: 250 µs cm⁻¹ in 1999 and 293 µs cm⁻¹ in 2000) and the outer side of the *Typha* zone (mean: 272 µs cm⁻¹ in 1999 and 463 µs cm⁻¹ in 2000). The mean vertical conductivity differences in the water column increased comparing to the turbid state (mean turbid state: 3.05 µs cm⁻¹, mean clear-water state: 12.69 µs

cm⁻¹) and the maximum vertical differences (40–22 $\mu\text{s cm}^{-1}$) were in daytime. Significant diurnal and vertical dissolved oxygen concentration differences were recorded both years of the clear-water state (Fig. 1). The diurnal differences decreased with water depth (mean water surface: 12.38 mg l⁻¹, mean sediment surface: 5.63 mg l⁻¹) and the mean vertical difference was 9.04 mg l⁻¹ in 1999 and 5.57 mg l⁻¹ in 2000. The horizontal differences were higher in the water surface (mean: 4.38 mg l⁻¹) than in the *Najas* bed (mean: 1.57 mg l⁻¹).

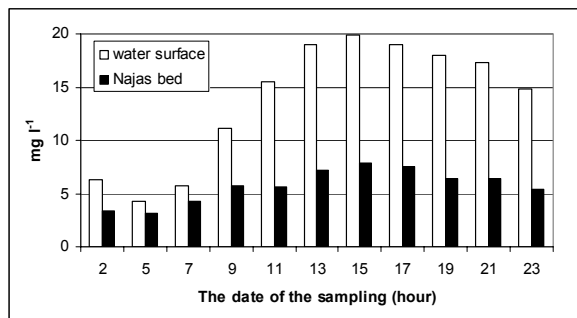


Figure 1. The diurnal variation of the mean diel dissolved oxygen concentration (mg l⁻¹) differences between the water surface and the *Najas* bed (n = 66, average values of the diurnal experiments in August 1999 and 2000)

Crustacean assemblages

Turbid state (1998, 2001)

Like most shallow lakes in the turbid state due to the low refuge availability, the highest zooplankton biomass occurred in the beginning of the growing season. In summer in Lake Fehér the zooplankton density, especially the large-bodied cladocerans were extremely low as well as cyclopoid copepods dominated in the Crustacean assemblages. The mean density of copepods (3.76 ind l⁻¹ in 1998 and 2.06 ind l⁻¹ in 2001) was higher than the mean density of cladocerans (0.85 ind l⁻¹ in 1998 and 1.24 ind l⁻¹ in 2001) both years. The mean Crustacean density was 4.6 ind l⁻¹ in 1998 and 3.32 ind l⁻¹ in 2001. In 1998 the cladoceran zooplankton consisted of mainly pelagic species with low abundance values and out of the recorded 7 Cladocera species *Moina brachiata* (39.67% of the total Crustacean density) was completely dominant from June to

September. The copepods community consisted of 6 species, *Diacyclops bicuspidatus* and *Mesocyclops leuckarti* appeared with extremely low abundance values and *Megacyclops viridis* (mean: 0.53 ind 50 l⁻¹) existed only close to the *Typha* zone. The dominant species were *Acanthocyclops vernalis* (42.65% of the total density), *Cyclops vicinus* (33.21%) and *Eucyclops serrulatus* (5.24%). In 2001 16 species were identified and the dominant species were *Moina brachiata* (13.18%), *Eucyclops serrulatus* (27.78%), *Cyclops vicinus* (18.74%) and *Acanthocyclops vernalis* (8.37%). Horizontal differences were detected in the distribution of several species, the mean density of *Diaphanosoma brachyurum*, *Moina brachiata* and *Acanthocyclops vernalis* decreased inshore as well as *Simocephalus vetulus*, *Chydorus sphaericus*, *Alona intermedia* and *Megacyclops viridis* increased inshore.

During the diurnal monitoring there was a significant difference in the species richness in 1998 (9) and 2001 (18) indicating that the clear-water state in 2000 could promote the colonization of several species in the open water (Table 1). The species richness (mid-lake: 3 (1998), 11 (2001), *Typha* edge: 8 (1998), 18 (2001) increased inshore both years, but in respect to the mean density there were interannual differences. In 1998 the mean density (mid-lake: 0.93 ind l⁻¹, *Typha* edge: 1.12 ind l⁻¹) increased inshore. The zooplankton consisted of only 3 pelagic species (*Moina brachiata*, *Cyclops vicinus* and *Acanthocyclops vernalis*) in the mid-lake with low and fluctuating density values and the total zooplankton abundance was below 2 ind l⁻¹ all day. The mean density was higher at night (1.33 ind l⁻¹) than in daytime (0.9 ind l⁻¹) and the differences between the night and daytime density increased inshore because of the higher night appearance of the littoral zone species (*Megacyclops viridis*, *Mesocyclops leuckarti*, *Eucyclops serrulatus*) (Fig. 2). The mean density of the pelagic *Moina brachiata* and *Acanthocyclops vernalis* decreased inshore while the density of *Chydorus sphaericus* increased inshore and the edge of the *Typha* stand a few individual of *Pleuroxus aduncus*, *Eucyclops serrulatus* and *Megacyclops viridis* were presented.

Table 1. The composition of Crustacean assemblages as well as the mean diel density of the species during the diurnal monitoring (n= 33 in each monitoring years)

	1998	1999	2000	2001
<i>Alona intermedia</i>	-	201.86	160.4	31.72
<i>Alonella excisa</i>	-	0.52	25.2	-
<i>Bosmina longirostris</i>	-	0.66	27.65	5.72
<i>Ceriodaphnia quadrangula</i>	-	14.95	420.9	1.78
<i>Ceriodaphnia reticulata</i>	-	1.09	525.6	3.14
<i>Chydorus sphaericus</i>	11.97	2458.4	138.8	-
<i>Diaphanosoma brachyurum</i>	0.315	151.9	286.4	18.72
<i>Disparalona rostrata</i>	-	-	9,8	5,75
<i>Graptoleberis testudinaria</i>	-	4.7	836.7	-
<i>Leydigia acanthocercoides</i>	-	-	-	2.25
<i>Moina brachiata</i>	11.48	0.79	-	155.9
<i>Pleuroxus aduncus</i>	0.27	226.3	358.3	-
<i>Polyphemus pediculus</i>	-	-	6.41	-
<i>Pseudochydorus globosus</i>	-	2.46	-	-
<i>Scapholeberis mucronata</i>	-	2.7	163	10.18
<i>Simocephalus serrulatus</i>	-	-	0.9	-
<i>Simocephalus vetulus</i>	-	1185.5	5434.4	5.84
<i>Cyclocypris ovum</i>	-	0.4	4.66	-
<i>Physocypris kraepelini</i>	-	2.02	3.74	1.87
<i>Pseudocandona compressa</i>	-	0.9	3.19	1.51
<i>Acanthocyclops vernalis</i>	20.45	650.9	860.1	34.57
<i>Canthocamptus staphylinus</i>	-	-	-	0.66
<i>Cyclops vicinus</i>	2.55	0.8	5.15	-
<i>Ectocyclops phaleratus</i>	-	0.13	5.06	-
<i>Eucyclops serrulatus</i>	3.09	21.16	455	104.3
<i>Macrocyclus albidus</i>	-	3.63	184.3	0.85
<i>Megacyclops viridis</i>	1	16.66	90.5	2.75
<i>Mesocyclops leuckarti</i>	2.91	624.4	1622.2	54.91
SUM /50L	54.035	5572.83	11628.36	441.57
ind l ⁻¹	1.08	111.45	232.56	8.83

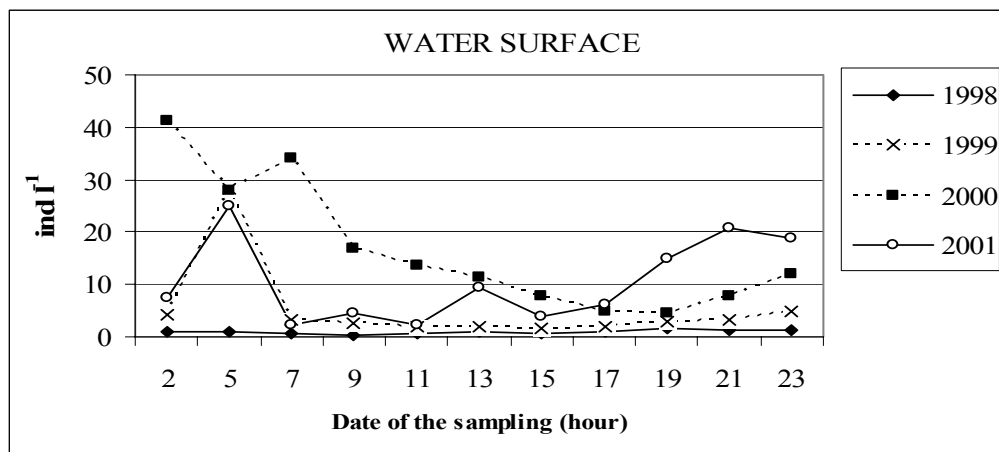


Figure 2. Diel density differences of the Crustacean assemblages in the mid-lake during the diurnal monitoring

Opposite to 1998 in 2001 the mean density decreased inshore (mid-lake: 10.55 ind Γ^{-1} , macrophyta zone: 0.53 ind Γ^{-1}) because of the inshore density decrease of the pelagic *Moina brachiata* (mid-lake: 6.32 ind Γ^{-1} , *Typha* zone: 0.52 ind Γ^{-1}). Like in 1998 the mean density was higher at night (13.3 ind Γ^{-1}) than daytime 7.18 ind Γ^{-1}) because the mean density of *Moina brachiata*, *Alona intermedia* and *Mesocyclops leuckarti* were notably higher at night. At the edge of *Typha* zone the representative species of the reed-belt appeared (*Simocephalus vetulus*, *Ceriodaphnia reticulata*, *Pseudocandona compressa*, *Macrocyclus albidus* and *Megacyclus viridis*).

Besides the low refuge availability the direct and indirect effects of high pH are also important in controlling the density of filter-feeding zooplankton (JEPPESEN et al., 1990). The enhanced pH in the turbid state caused by high photosynthetic activity of the blooming phytoplankton probably affected cladoceran density because cladocerans are generally more sensitive to elevated pH than cyclopoid copepods. The summer presence of *Cyclops vicinus* and *Acanthocyclops vernalis* also supported the finding that some cyclopoid copepods are tolerant to high pH (HANSEN et al., 1991). In 1998 and 2001 because of the unfavourable environmental conditions (cyanophyta bloom, high temperature and pH values) the open water were unsuitable for fish, but cladoceran density was low also because of the decreased phytoplankton edibility and the high concentration of suspended sediment which are known to decrease fecundity and survivorship of cladocerans via reduced ingestion rates of phytoplankton cells (ARRUDA et al., 1983).

Clear-water state (1999, 2000)

During the presence of *Najas marina* the composition of the zooplankton assemblages remarkably changed, the density and the species richness both increased. Especially the density of

plant-associated cladoceran species were high because the homogeneous macrophyte beds with low edge:area ratio would favour the non-migrating macrophyta-associated cladoceran species (PATERSON, 1993). Opposite to the turbid state the mean density of Cladocera assemblages (48.5 ind Γ^{-1} in 1999 and 146.4 ind Γ^{-1} in 2000) was significantly higher than Copepoda assemblages (25.68 ind Γ^{-1} in 1999 and 37.4 ind Γ^{-1} in 2000). Considerable density differences were formed between the *Najas*-free water surface (mean: 3.5 ind Γ^{-1} in 1999 and 17.7 ind Γ^{-1} in 2000) and the *Najas* beds (mean: 181.7 ind Γ^{-1} in 1999 and 408.61 ind Γ^{-1} in 2000) and these differences increased with the expansion of the *Najas*. From June to September there was no interannual difference in the species richness (26 species in 1999, 27 species in 2000) but the density of several species differed.

In 1999 high abundance cladoceran community with macrophyte-associated species (*Simocephalus vetulus*, *Alona intermedia*, *Pleuroxus aduncus*) formed in the *Najas marina* beds, as well as a few individuals of *Moina brachiata*, *Ceriodaphnia quadrangula*, *Bosmina longirostris*, *Alona guttata* and the necrophagous *Pseudochydorus globosus* were also identified. The dominant species were *Simocephalus vetulus* (28.9%), *Chydorus sphaericus* (28.2%), *Acanthocyclops vernalis* (17.72%) and *Mesocyclops leuckarti* (16.22%). The mean density decreased inshore (mid-lake: 102.8 ind Γ^{-1} , *Typha* edge: 53.23 ind Γ^{-1}) especially because of the density decrease of *Diaphanosoma brachyurum* and *Acanthocyclops vernalis*. The lower inshore densities could explain the lower refuge availability of the less dense *Najas* beds where small fish usually aggregated during the day, preferably outside the dense emergent vegetation.

In 2000 the dominant species were *Simocephalus vetulus* (51.36%), *Graptoleberis testudinaria* (14.87%) and *Mesocyclops leuckarti* (16.45%) and opposite to previous year the abundance of *Chydorus sphaericus* (1.88%) and *Acanthocyclops vernalis* (0.95%) significantly

decreased. In 2000, among the new species in the *Najas* bed, *Ceriodaphnia reticulata*, *Alonella excisa*, *Scapholeberis mucronata*, *Graptoleberis testudinaria* and *Polyphemus pediculus* appeared

that previously had been detected from the reed-belt. From the *Najas* beds a small population of *Simocephalus serrulatus* was detected for the first time in the lake in August of 2000.

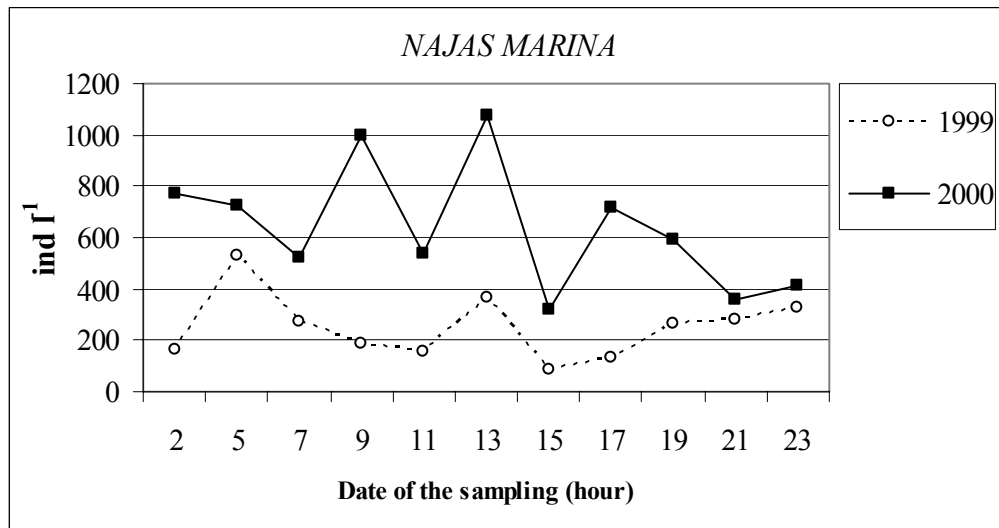


Figure 3. Diel density differences of the Crustacean assemblages in the *Najas* beds of the mid-lake during the diurnal monitoring in August 1999 and 2000

The abundance of the Crustacean assemblages was significantly higher in 2000 (mean: 184 ind l⁻¹, max: 1291 ind l⁻¹) than in 1999 (mean: 74.24 ind l⁻¹, max: 365 ind l⁻¹) as well as the mean density notably decreased inshore (mid-lake: 2477.6 ind l⁻¹, *Typha* zone: 617.5 ind l⁻¹) in 2000 especially the massive occurrence of *Simocephalus vetulus* in the mid-lake. These interannual differences and the lower density values in 1999 could be explained by the increased predation pressure of the invertebrate predator, *Notonecta glauca* and small fish in the *Najas* beds. The massive presence of *Notonecta glauca* usually produced a top-down effect in small lakes which was similar to that reported in case of planktivorous fish (ARNÉR et al., 1998). In 2000 the absence of invertebrate predators and the rich periphyton assemblages on *Najas marina* contributed to the increased Crustacean density. In 2000 the abundance of small fish also decreased in the macrophyte beds (personal observation) because the expansion as well as the structural complexity of the *Najas* bed

increased and zooplanktivorous fish tend to avoid dense macrophyte beds (ENGEL, 1987). It was particular that the ostracods did not found in high density in the *Najas* beds (mean: 3.51 ind 50 l⁻¹ in 1999 and 6.95 ind 50 l⁻¹ in 2000) and a significant part of the individuals were juvenile. The density and species number of ostracods increased inshore both years.

During the diurnal monitoring 23 species were recorded in 1999 and 24 in 2000. (Table 1) The density of Crustacean assemblages, especially of the macrophyte-associated species (*Simocephalus vetulus*, *Graptoleberis testudinaria*, *Alona intermedia*, *Pleuroxus aduncus* and *Chydorus sphaericus*) was significantly higher in the *Najas* bed than the *Najas*-free open water and there were notably interannual differences in the density of these species (Fig. 2, 3). The mean density of *Simocephalus vetulus*, *Ceriodaphnia quadrangula*, *C. reticulata*, *Scapholeberis mucronata*, *Graptoleberis testudinaria*, *Pleuroxus*

aduncus, *Eucyclops serrulatus*, *Macrocyclus albidus* and *Mesocyclops leuckarti* was significantly higher in 2000 in the mid-lake and *Typha* edge alike however the density of *Chydorus sphaericus* remarkably decreased. The typical littoral predator, *Polyphemus pediculus* was recorded only 2000 and its density was increased inshore. The dominant copepod species were *Acanthocyclops vernalis* in 1999, and *Acanthocyclops vernalis*, *Eucyclops serrulatus* and *Mesocyclops leuckarti* in 2000. The predators, *Macrocyclus albidus* and *Megacyclus viridis* were presented only inside the *Najas* beds. The mean density of copepods considerably higher in the *Najas* beds (mean: 59.53 ind l⁻¹ in 1999 and 135 ind l⁻¹ in 2000), than in the open areas (mean: 1.38 ind l⁻¹ in 1999 and 8.95 ind l⁻¹ in 2000) but except *Acanthocyclops vernalis* no diel changes in density were observed. The density of copepods was notably higher than the turbid state and opposite to the observation of several authors (JEPPESEN et al., 1990) that the appearance of submerged macrophytes was the cause of the decline in cyclopoid abundance

The mean total density of the Crustacean assemblages in the water column were considerably higher in the mid-lake (mean: 11.68 ind l⁻¹ in 1999, 15.3 ind l⁻¹ in 2000) than in front of the *Typha* zone (mean: 6.2 ind l⁻¹ in 1999 and 8.76 ind l⁻¹ in 2000). These horizontal differences could explain that cyprinid fish usually aggregate close to the emergent macrophyte zone hence the predation pressure on zooplankton is higher (HALL, 1979).

In case of few species diel migration pattern were detected. The mean density of *Alona intermedia*, *Bosmina longirostris* *Ceriodaphnia* spp., *Chydorus sphaericus* *Diaphanosoma brachyurum* and *Scapholeberis mucronata* increased at night close to the water surface and parallel to this decreased in the *Najas* beds so these species show diel vertical migration between the *Najas* beds and the above *Najas*-free water column (Fig. 4). Like other results (LAURIDSEN & BUENK, 1996) macrophyte-associated species did not show diel vertical migration between the

macrophyte bed and the *Najas*-free water surface layer, however, density values fluctuated all day in the *Najas* beds at all sampling sites of the transect. (Fig. 5) In 2000 the density of plant-associated species was considerably decreased inshore (mean mid-lake: 435 ind l⁻¹, mean *Typha* zone: 204.4 ind l⁻¹) especially because of the decreased density of *Najas* close to the *Typha* zone.

In the *Najas*-free sampling site the zooplankton density was low and the mean day-night density of *Ceriodaphnia* spp. (day: 0.95 ind 50 l⁻¹, night: 34.83 ind 50 l⁻¹), *Scapholeberis mucronata* (day: 7.63 ind 50 l⁻¹, night: 48.67 ind 50 l⁻¹) and *Acanthocyclops vernalis* (day: 190.5 ind 50 l⁻¹, night: 1302 ind 50 l⁻¹) differed, but in case of the other species the day-night abundance did not change significantly indicating that the importance of DHM is little in Lake Fehér because the PVI is nearly 100 %. Like other observations (CERBIN et al., 2003) this result indicates that in lakes with extensive and uniform macrophyte vegetation, zooplankton appear to migrate vertically rather than horizontally.

CONCLUSION

Significant horizontal and diel differences were recorded in the density and composition of zooplankton assemblages as well as a few water chemical parameters between the turbid and clear-water state of Lake Fehér. In the turbid state in case of the examined water chemical parameters there were no vertical differences in the water column however in case of temperature, dissolved oxygen concentration and conductivity horizontal differences were detected between the mid-lake and the emergent macrophyte vegetation. In the clear-water state the horizontal water chemical differences in the lake except conductivity were insignificant because of the relative homogeneous environmental conditions in the *Najas* beds. Opposite to the turbid state the vertical water chemical differences significantly increased in the water column because of the photosynthetic activity and shading of *Najas marina*.

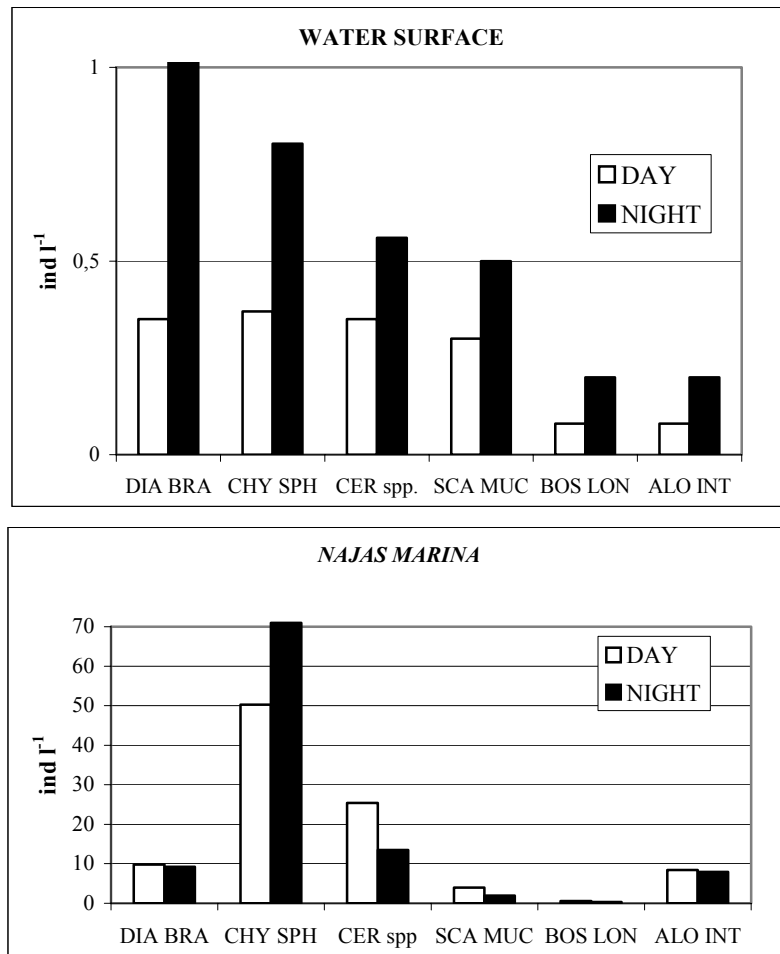


Figure 4. Mean day-night differences of the vertically migrating species (*Diaphanosoma brachyurum*, *Chydorus sphaericus*, *Ceriodaphnia* spp., *Scapholeberis mucronata*, *Bosmina longirostris* and *Alona intermedia*) in the *Najas*-free water surface and the *Najas* bed (n = 66, average values of the diurnal experiments in August 1999 and 2000)

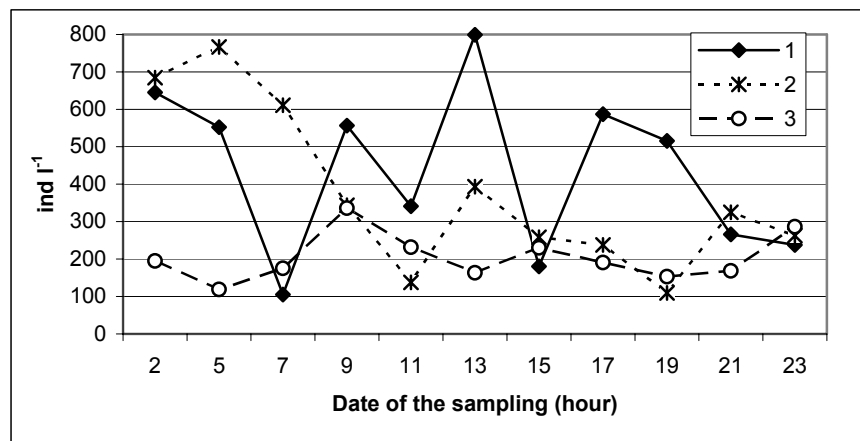


Figure 5. Mean diel and horizontal density differences of the plant-associated species in the mid-lake (1), in the near-shore (2) and close to the emergent macrophyte vegetation (3)

In the turbid state copepods dominated zooplankton assemblages developed with low density and species richness and the cladoceran zooplankton consisted of mainly pelagic species with low abundance values. In case of *Diaphanosoma brachyurum*, *Moina brachiata*, *Acanthocyclops vernalis*, *Simocephalus vetulus*, *Chydorus sphaericus*, *Alona intermedia* and *Megacyclops viridis* horizontal density differences were formed.

During the presence of *Najas marina* the zooplankton community was dominated by cladocerans and the ratio of the macrophyta-associated species was high. In case of few cladoceran species significant diel density differences developed between the *Najas* bed and the above *Najas*-free water column however macrophyta-associated species did not show diel vertical migration. Based on the result of diurnal monitoring the importance of DHM was irrelevant in the uniform and dense *Najas* beds and zooplankton appear to migrate vertically rather than horizontally.

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Uropodina mites of East-Africa (Acari: Mesostigmata) I.

J. KONTSCHÁN¹

Abstract. Five new Uropodina species (*Afrotrachytes longicaudatus* sp. n., *Polyaspis africanus* sp. n., *Trigonouropoda gerei* sp. n., *Trigonouropoda takacsi* sp. n., *Macrodirinychus alveolaris* sp. n.) are described from East-Africa (Tanzania and Kenya). They belong to four genera (*Afrotrachytes* KONTSCHÁN, 2006, *Polyaspis* BERLESE, 1881, *Trigonouropoda* TRÄGARDH, 1952 and *Macrodirinychus* BERLESE, 1917), short description of genera are given. With 33 figures.

The Uropodina fauna of East-Africa are poorly-investigated. However Tanzania from this point of view is must better known than the other African countries. Up till now 38 species have been recorded in Tanzania, (WISNIEWSKI 1993) belonging to seven genera. Two of the genera show tropical distribution (*Rotundabaloghia* HIRSCHMANN, 1975 and *Trigonouropoda* TRÄGARDH, 1952), and the other five are distributed across the tropical countries and the Holarctic.

The Uropodina mites of the other investigated East-African countries (for example Kenya) are absolutely unknown, up till now there are not any record published (Wisniewski 1993).

The Pedozoological Collection of the Hungarian Natural History Museum contains a lot of soil samples from different part of East-Africa; all the materials presented are from this collection.

In the present paper five new species are described from following genera: *Afrotrachytes* KONTSCHÁN, 2006, *Polyaspis* BERLESE, 1881, *Trigonouropoda* TRÄGARDH, 1952 and *Macrodirinychus* BERLESE, 1917. The species of these genera occur throughout in the tropical countries, but there are only a few data from the Afro-tropical region (Fig. 1).

The specimens identified are preserved in alcohol and deposited in the Pedozoological Collections of the Hungarian Natural History Museum. The system and the names of the species are according to WISNIEWSKI (1993).

genus *Afrotrachytes* KONTSCHÁN, 2006

Diagnosis. Idiosoma: Shape oval, posterior margin rounded. First and second legs with characteristic processes. Dorsal shield with trapezoid postdorsal shield. Caudal region bear some very long setiform setae.

Gnathosoma: h1, long and setiform, h2 with some branches, h3 long and setiform, h4 short and distally serrated.

Type species. *Afrotrachytes seticaudatus* KONTSCHÁN, 2006.

Type locality. Angola.

Afrotrachytes longicaudatus sp.n. (Figs. 2-9)

Material examined. Holotype: female, Tanzania, Matombo Morogoro region, 45 km South from Morogoro, from litter and soil, 04. 02. 1987, leg. S. MAHUNKA, T. PÓCS & A. ZICSI. Paratypes: two female, Tanzania, Matombo Morogoro region, 45 km South from Morogoro, from litter and soil, 04. 02. 1987, leg. S. MAHUNKA, T. PÓCS & A. ZICSI.

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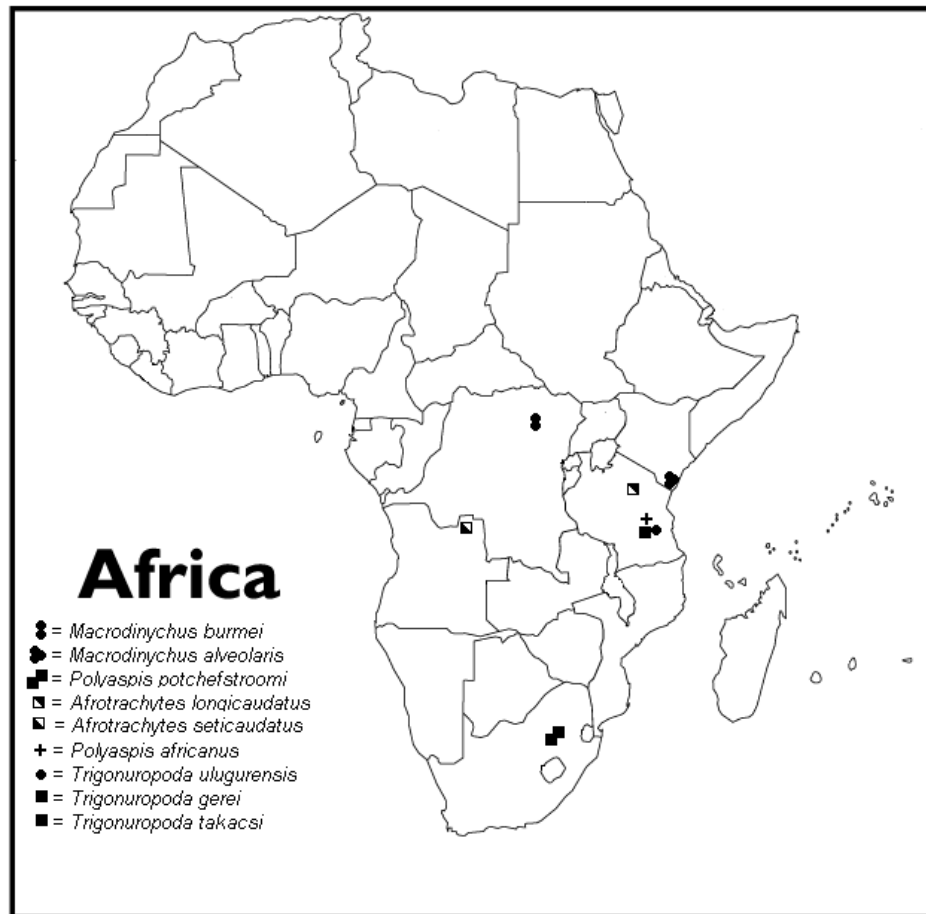


Figure 1. Occurrence of *Afrotrachytes*, *Polyaspis*, *Trigonuropoda* and *Macrodinychus* species in Africa

Diagnosis. Dorsal, postdorsal, ventral and marginal shield with alveolar ornamentation. Caudal region with three pairs long, spiniform setae. Marginal setae serrated. Genital shield of females with characteristic ornamentation.

Description. Female. Length of idiosoma 700-710 µm, width (in middle of idiosoma) 470-480 µm. Shape oval, posterior margin rounded.

Male, deuteronymph, protonymph and larva unknown.

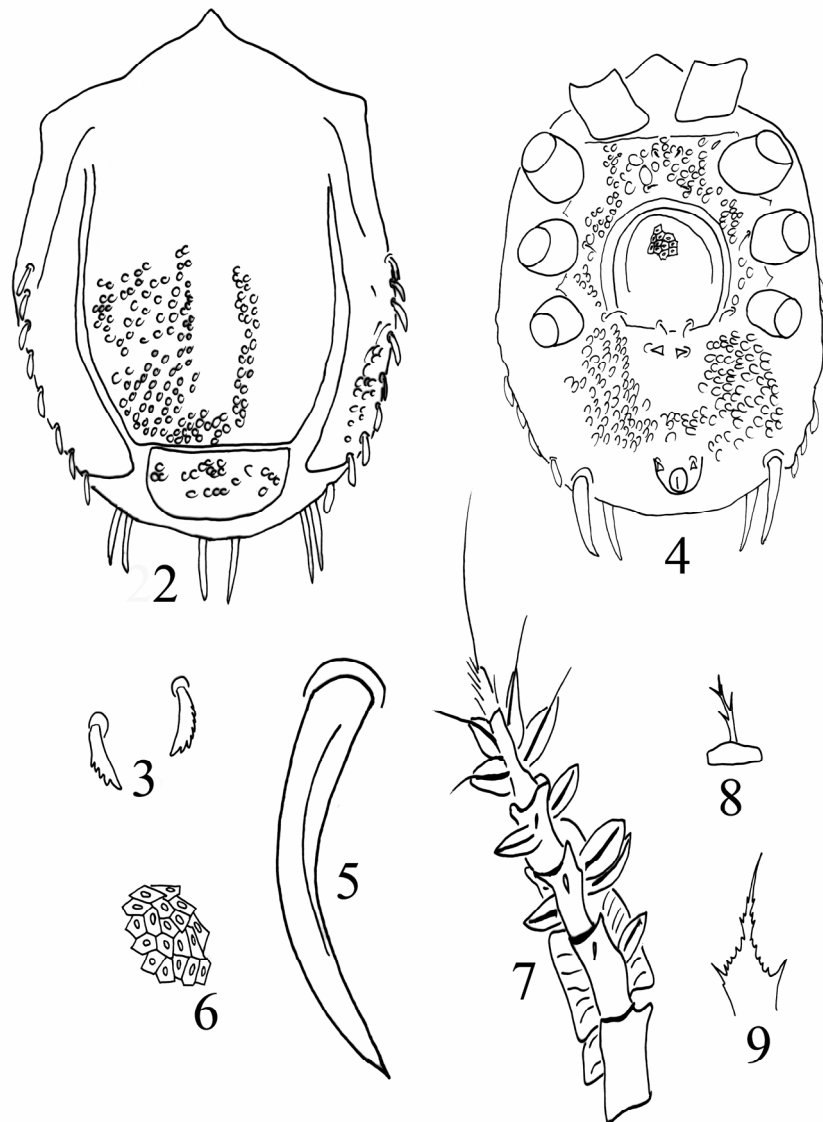
Dorsal side (Fig. 2). Dorsal setae not clearly visible. Dorsal shield with alveolar ornamentation. Postdorsal shield with alveolar ornamentation, setae lacking. Marginal shield with alveolar ornamentation and serrated setae (Fig. 3). Interscutellar membrane between present dorsal and marginal shield and in the caudal region.

Ventral side (Fig. 4). Steranal shield with alveolar ornamentation. Three (St3, St4, St5) of the sternal setae short, smooth and filiform, but St1 stronger and shorter than St3, St4 and St5. St2 triangular. Ventral shield with alveolar ornamentation. Ventral and ventroanal setae are not clearly visible. Visible setae are triangular inform. Caudal part of ventral shield with three pairs long, strong, smooth and setiform setae (Fig. 5).

Genital shield large, rounded and with characteristic ornamentation and without process (Fig. 6). Genital shield between coxae 2 and 4.

First legs with characteristic processes and phylliform setae (Fig. 7).

Gnathosoma. Corniculae short, horn-like, laciniae short. Ventral side of gnathosoma with 4 pairs of hypostomal setae: h1 long, smooth and



Figures 2-9. *Afrotrachytes longicaudatus* sp.n. 2: dorsal aspect; 3: serrated marginal setae; 4: ventral aspect; 5: caudal seta; 6: ornamentation of genital shield of female; 7: first leg; 8: tritosternum; 9: epistoma

setiform, h2 short with four branches, h3 not clearly visible, h4 shorter, distally serrated. Base of tritosternum wide, laciniae with four branches (Fig. 8). Base of epistoma wider with serrated lateral margins and apical part (Fig. 9). Chelicera not clearly visible.

Etymology. This species is named after its long caudal setae.

Remarks. The new species is similar to the species *Afrotrachytes seticaudatus* Kontschán, 2006. The most important differences are the followings: the postdorsal shield of the known species is narrower than the new species, the known species has reticulate ornamentation on dorsal and sternal shield, but the dorsal, ventral and sternal shield of the new species bear alveolate pattern.

genus *Polyaspis* BERLESE, 1881

The species of this genus occur in the Holarctis and New Guinea. One species (*Polyaspis potchefstroomi* RYKE, 1956) was found in South Africa (RYKE 1956).

The main characteristics of the genus are the followings: *Idiosoma*. Shape oval, posterior margin rounded. First and second legs with characteristic processes. Dorsal and ventral side with large interscutellar region. Dorsal shield with postdorsal shield.

Gnathosoma. h1, h2 setiform, h3 longer and setiform distally serrated, h4 short and distally serrated, laciniae and corniculi long.

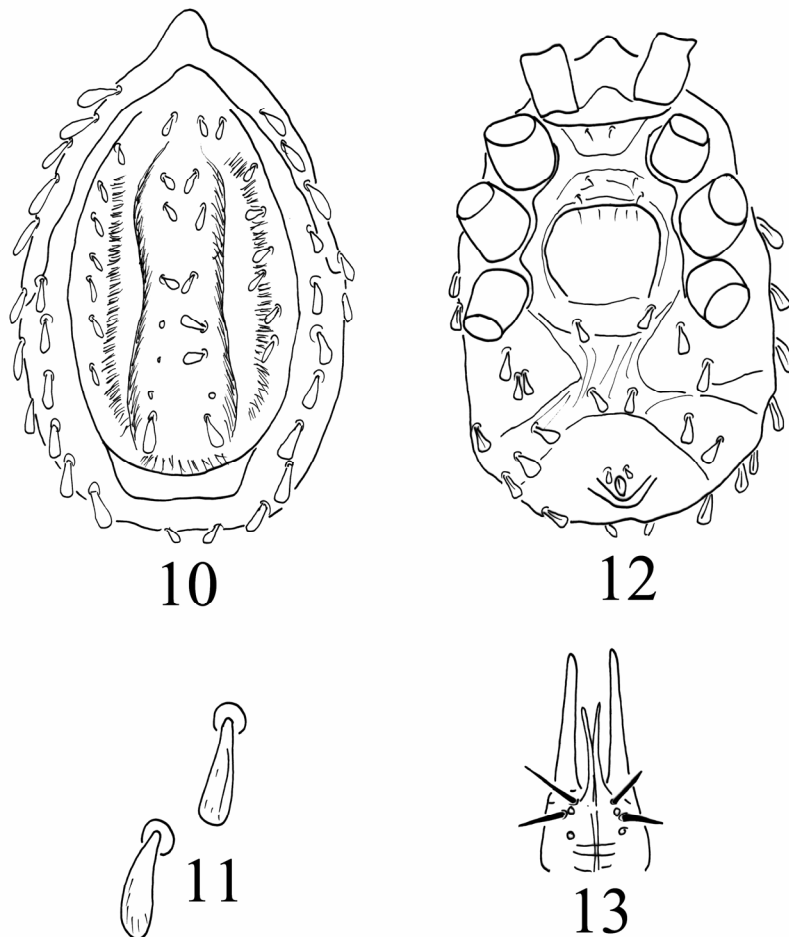
Polyaspis africanus sp.n.

(Figs. 10-13)

Material examined. Holotype: female, Tanzania, Mbulu Highland, Evergreen Mountain forest, 1900 m a.s.l., 01. 05. 1990, leg. T. PÓCS.

Diagnosis. Dorsal, postdorsal, ventral and marginal shield without ornamentation. Marginal, dorsal and ventral setae spatuliform. Genital shield of female large. Postdorsal shield trapezoid-shape.

Description. Female. Length of idiosoma 620 μ m, width (in middle of idiosoma) 410 μ m. Shape oval, posterior margin rounded.



Figures 10-13. *Polyaspis (Polyaspis) africanus* sp.n. 10: dorsal aspect; 11: spatuliform setae; 12: ventral aspect; 13: gnathosoma

Male, deuteronymph, protonymph and larva unknown.

Dorsal side (Fig. 10). Dorsal shield without ornamentation. Central region of dorsal shield with eight, lateral part with seven pairs of spatuliform setae (Fig. 11). Postdorsal shield trapezoid, ornamentation and setae lacking. Marginal shield short with spatuliform setae. Interscutellar membrane between marginal and dorsal shields and on caudal region. Several spatuliform setae on interscutellar membrane.

Ventral side (Fig. 12). Sternal shield poorly sclerotised. Sternal setae not clearly visible, the visible setae (St1 and St3) short, smooth and filiform. Ventral shield subdivided to metapodal and anal shields. Interscutellar membrane present between metapodal, sternal and anal shields. All setae of metapodal and anal shield and on interscutellar membrane are spatuliform.

Genital shield between coxae 3 and 4. It is large, rounded and without ornamentation.

Gnathosoma (Fig. 13). Corniculae very long, laciniae long and smooth. Hypostomal setae are the follows: h1 and h3 long, smooth and setiform, h2 and h4 not clearly visible. Tritosternum, epistoma and chelicera not clearly visible.

Etymology. This species is named after its locality.

Remarks. The new species is similar to *Polyaspis potchefstroomi* Ryke, 1956. The most important difference between the two species are the following: adanal setae of the known species are setiform, but these setae are spatuliform in the new species.

genus *Trigonuropoda* TRÄGARDH, 1952

The species of this genus occur in South and Central-America, Indo-Malay Region and New Guinea. Only one species (*Trigonuropoda ulugurensis* HIRAMATSU, 1981) was known from Africa (HIRAMATSU 1981).

The main characteristics of the genus are the followings:

Idiosoma. Shape oval, posterior margin rounded. Dorsal and ventral side with phylliform

setae. Ornamentation of genital shield coriaceous or reticulate.

Gnathosoma. h1 long, setiform, calyciform or biretiform, h2 short setiform, h3 long and setiform, h4 short and distally serrated. Laciniae long, corniculi horn-like.

***Trigonuropoda gerei* sp.n.**

(Figs. 14-20)

Material examined. Holotype: female, Tanzania, Mikumi National Park, E boundary of the park, Morogoro region, 01. 02. 1987, leg. S. MAHUNKA, T. PÓCS & A. ZICSI. Paratype: female, Tanzania, Mikumi National Park, E boundary of the park, Morogoro region, 01. 02. 1987, leg. S. MAHUNKA, T. PÓCS & A. ZICSI.

Diagnosis. All dorsal, ventral and marginal setae phylliform. Ventroanal setae longer than other ventral and dorsal setae. Dorsal, marginal and ventral shield without ornamentation. The genital shield of females reticulated.

Description. Female. Length of idiosoma 530-540 µm, width (in middle of idiosoma) 330-340 µm. Shape oval, posterior margin rounded.

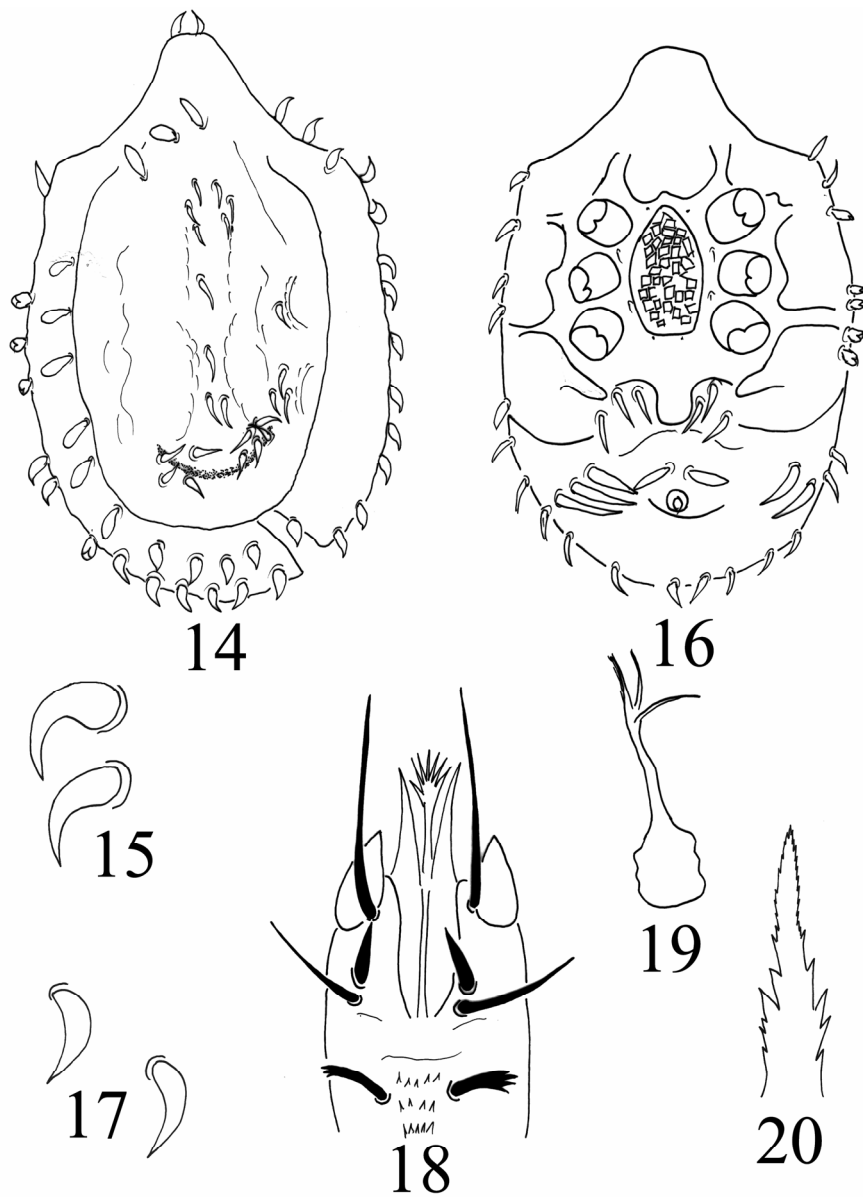
Male, deuteronymph, protonymph and larva unknown.

Dorsal side (Fig. 14). Dorsal shield without ornamentation, central part of dorsal shield with several thinner (Fig. 15) caudal part with thicker phylliform setae. Postdorsal shield lacking. Marginal shield not ornamented and with very thick phylliform setae.

Ventral side (Fig. 16). Sternal shield smooth. Sternal setae not clearly visible, some setae (St3, St4) short, smooth and filiform. Ventral shield without ornamentation. Three pairs of ventral setae thin and phylliform, ventroanal setae phylliform, longer and thicker than the ventral setae. All marginal setae phylliform (Fig. 17)

Genital shield narrow, tongue-like and with reticulate ornamentation. Genital shield between coxae 2 and 4.

Gnathosoma (Fig. 18). Corniculae short, horn-like, laciniae long and smooth. Ventral side of gnathosoma with 4 pairs of coxal setae. h1 long,



Figures 14-20. *Trigonuropoda gerei* sp.n. 14: dorsal aspect; 15: dorsal setae; 16: ventral aspect; 17: marginal setae; 18: gnathosoma; 19: tritosternum; 20 epistoma

smooth and setiform, h2 shorter and setiform, h3 long, smooth and setiform, h4 shorter, distally serrated. Base of tritosternum narrow, laciniae with four branches (Fig. 19). Base of epistoma wider and lateral margins serrated (Fig. 20). Chelicera not clearly visible.

Etymology. This species is named after PROF. DR. GÉZA GERE, with whom I traveled to Africa.

Remarks. The shape of the idiosoma and the types of the dorsal and marginal setae are not similar to the other known Afrotropical species.

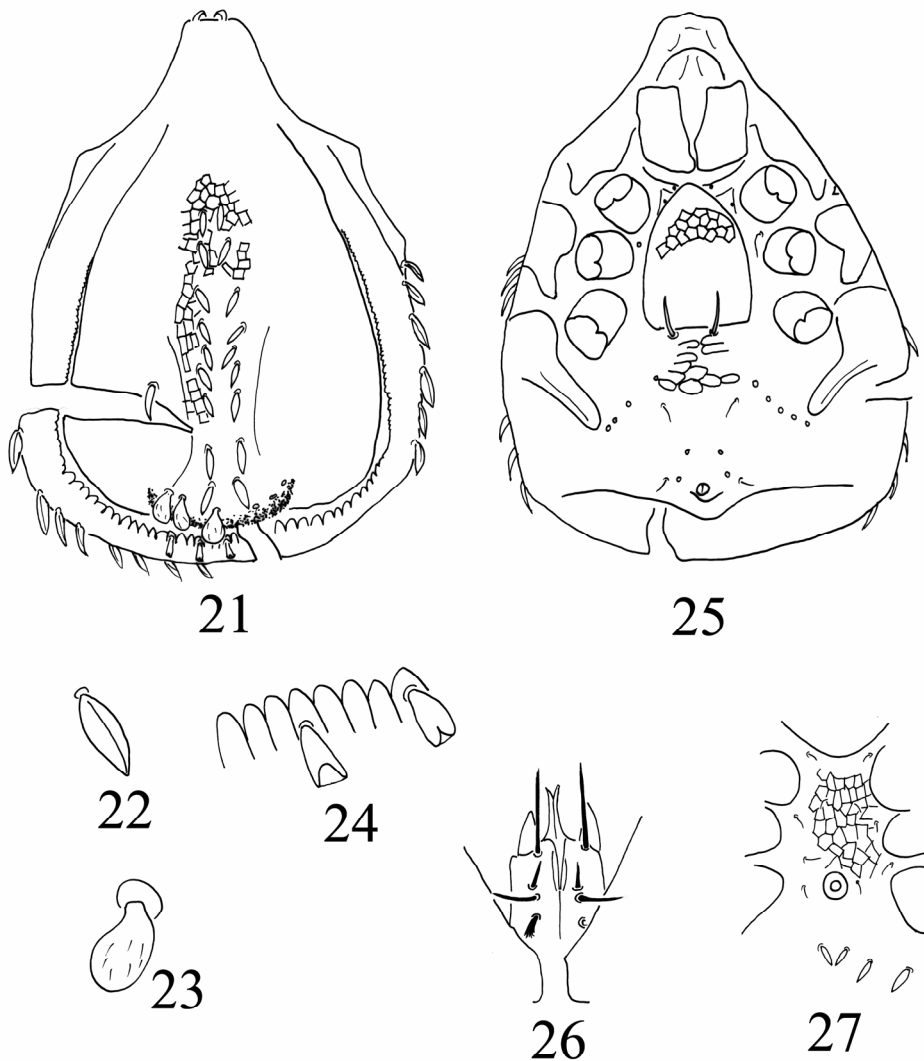
***Trigonuropoda takacsi* sp.n.**
(Figs. 21-27)

Material examined. Holotype: female, Tanzania, Mikumi National Park, E boundary of the park, Morogoro region, 01. 02. 1987, leg. S. MAHUNKA, T. PÓCS & A. ZICSI. Paratype: male Tanzania, Mikumi National Park, E boundary of the park, Morogoro region, 01. 02. 1987, leg. S. MAHUNKA, T. PÓCS & A. ZICSI.

Diagnosis. Dorsal, ventral and marginal setae phylliform, caudal part of dorsal shield with three pairs of fungiform setae. Dorsal shield with coriaceous ornamentation. St5 long and setiform. Genital shield of females coriaceous.

Description. Female. Length of idiosoma 400 μ m, width (in middle of idiosoma) 310 μ m. Shape triangular, posterior margin rounded.

Deuteronymph, protonymph and larva unknown.



Figures 21-27. *Trigonuropoda takacsi* sp.n. 21: dorsal aspect; 22: dorsal seta; 23: fungiform seta; 24: marginal seta; 25: ventral aspect; 26: gnathosoma; 27: sternal shield of male

Dorsal side (Fig. 21). Dorsal shield with coriaceous ornamentation, central part of dorsal shield with nine pairs phylliform (Fig. 22), caudal part of dorsal shield with three pairs of fungiform setae (Fig. 23). Postdorsal shield absent. Marginal shield without ornamentation and provided with phylliform setae (Fig. 24). Marginal shield with scalloping margin.

Ventral side (Fig. 25). Steranal shield without ornamentation. Sternal setae not clearly visible. S3 short, smooth and filiform, S5 setae longer and setiform. Ventral shield without ornamentation, three pairs of ventral setae phylliform and one pair ventroanal setae short and filiform.

Genital shield between coxae 2 and 4, shield-shape with coriaceous ornamentation.

Gnathosoma (Fig. 26). Corniculae short, horn-like, laciniae long and smooth. Hypostomal setae are the follows: h1 long, smooth and setiform, h2 shorter and setiform, h3 long, smooth and setiform, h4 shorter, distally serrated. Tritosternum, epistoma and chelicera not clearly visible.

Male: Length of idiosoma 400 µm, width 300 µm. Ventral and dorsal side similar to female, sternal shield coriaceous, all sternal setae filiform and smooth. Genital shield rounded, between coxae 4 (Fig. 27). Ventral setae phylliform.

Etymology. This species is named after MR. KÁROLY TAKÁCS, ex-director of Vért Rt., who supported my travel to Africa.

Remarks. The new species is similar to *Trigonuopoda ulugurensis* HIRAMATSU, 1981, but the St5 of this species is short, while that of the new species is long. Furthermore, the central part of the dorsal shield possesses Phylliform setae in the new species, while there are setiform setae on this region in the known species.

genus *Macrodinychus* BERLESE, 1917

The species of this genus are distributed in the Palearctis, South and Central-America, Indo-Malay Region and New Guinea. Only one species

(*Macrodinychus durmei* HIRSCHMANN, 1983) is described from Africa (HIRSCHMANN 1983).

The main characteristics of the genus are the followings:

Idiosoma. Very large mites. Shape oval, posterior margin rounded. Dorsal side with dorsal and postdorsal shields. Genital shield small, and between coxae 2 and 3.

Gnathosoma. All hypostomal setae (h1, h2, h3 and h4) distally serrated, laciniae short and serrated, corniculi horn-like.

***Macrodinychus alveolaris* sp.n.**

(Figs. 28-33)

Material examined. Holotype: female, Kenya, Shimba Hills, from litter and epiphytes plants, 10. 03. 2001, leg. S. MAHUNKA & L. MAHUNKA-PAPP. Paratype: female, Kenya, Shimba Hills, from litter and epiphytes plants, 10. 03. 2001, leg. S. MAHUNKA & L. MAHUNKA-PAPP.

Diagnosis. Dorsal and ventral setae very short and filiform. Dorsal, ventral and marginal shield with alveolar ornamentation. Genital shield of female small, smooth and between coxae 2 and 3. Postdorsal shield without sculpture.

Description. Female. Length of idiosoma 1350-1360 µm, width (in middle of idiosoma) 850-860 µm. Shape oblong, posterior margin rounded.

Male, deuteronymph, protonymph and larva unknown.

Dorsal side (Fig. 28). Dorsal and marginal shield with alveolar ornamentation and with very short filiform setae (Fig. 29). Postdorsal shield smooth.

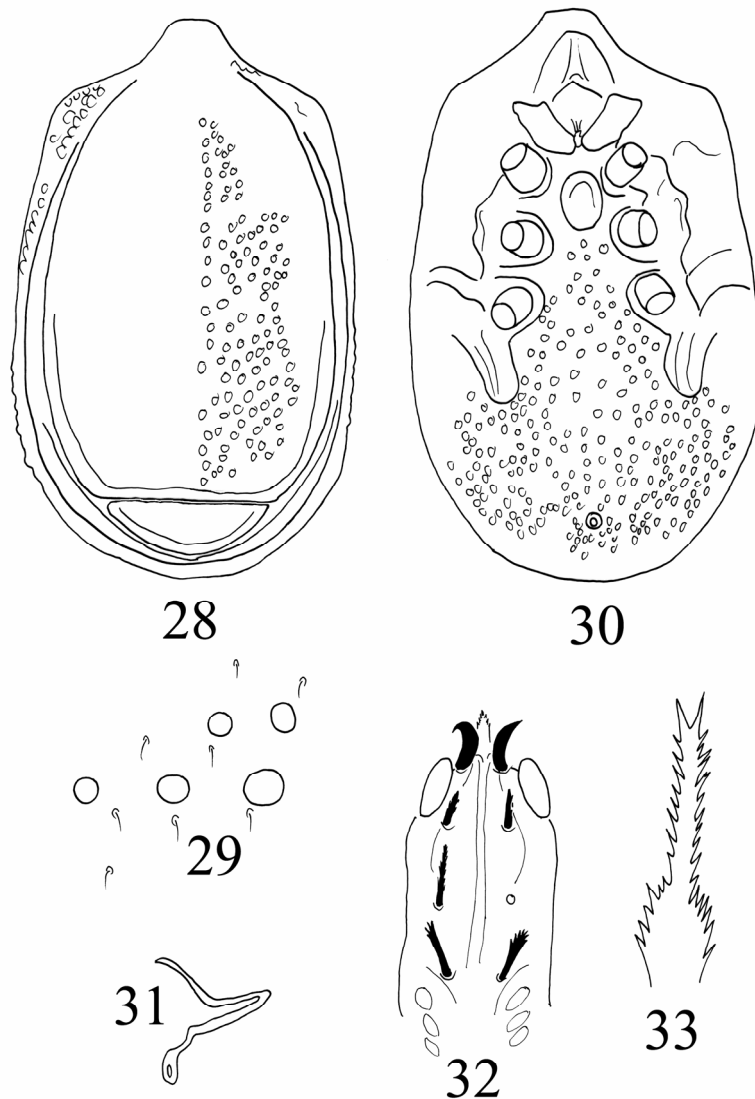
Ventral side (Fig. 30). Steranal shield smooth. All sternal setae not clearly visible. Ventral shield with alveolate and with very short filiform setae. Peritreme V-form (Fig. 31).

Genital shield very small and oval-form, without ornamentation. Genital shield between coxae 2 and 3.

Gnathosoma (Fig. 32). Corniculae short, oval, laciniae short and serrated. Ventral side of gnathosoma with four pairs of hypostomal setae: h1 short, smooth, thick and setiform, h2 short, setiform and distally serrated, h3 and h4 long, setiform and distally serrated. Epistoma with serrated margin (Fig. 33) Tritosternum and chelicera not clearly visible.

Etymology. This species is named after its characteristic ornamentation.

Remarks. The ornamentation of the new species is unique in the genus *Macrodinychus*, there are not any known *Macrodinychus* species with such alveolar pattern.



Figures 28-33. *Macrodinychus alveolaris* sp.n. 28: dorsal aspect; 29: setae and ornamentation on dorsal shield; 30: ventral aspect; 31: peritrema; 32: gnathosoma; 33: epistoma

Acknowledgements. I am grateful to PROF. DR. SÁNDOR MAHUNKA and DR. CSABA CSUZDI for their valuable comments on the manuscript.

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Oribatids from the Carpathian Basin with zoogeographical and taxonomical notes (Acari: Oribatida)

S. MAHUNKA¹

Abstract. A list of oribatids collected at several sites in the Carpathian Basin includes 32 species. The researches yielded some species new for the area examined and two (*Dissorhina longispina* and *Conchogneta vasiliorum* spp. n.) new to science. Some taxonomical notes on rare or little known species (e.g. in family Autognetidae) and notes on zoogeographical distribution of some species are presented. With 20 figures.

The main goal of our research was to explore the origin of the oribatid fauna of Hungary, and in other side to publish of data of rare and little known species in the studied territory. Our researches were, on the one hand, partly supported by the OTKA (T-45889), and on the other, by the National R&D project (No. 3B023-04) titled: The zoological values and the focal area of the fauna of the Carpathian Basin.

These researches have been carried out for many years. We successfully proved (MAHUNKA & MAHUNKA-PAPP 2004) that the oribatid fauna living in the present-day Hungary i.e. the central part of the Carpathian Basin (the faunistical and taxonomical results are present in different series of publications)*, and living in other parts of this region (today Slovakia, Romania, Croatia) (e.g. MAHUNKA 2006). In every respect of the fauna of the whole Carpathian Basin especially interesting and significant are the taxa living in Transylvania. Therefore we concentrated our studies to the Transylvanian region.

Several oppiids and autognetid taxa of the Transylvanian species are especially important and interesting for the relationships in the group. Therefore in connection of one *Dissorhina* HULL, 1918 and one *Conchogneta* GRANDJEAN, 1963 species I studied some specimens of this group

also from different European localities. Some taxonomical notes of them are given hereunder.

I examined also some species from zoogeographical point of view. It was remarkable to note the high number of the endemic species and the similarity the Transylvanian (Carpathian) and the alpine (South-Switzerland: Wallis) fauna.

The field work was made and organised by CS. CSUZDI, J. KONTSCHÁN, D. MURÁNYI, A. OROSZ and T. PÓCS and/or their co-workers. So far three samplings have been performed, whose materials are extracted in Budapest. The elaboration of the extracted species is continuous. The voucher specimens are deposited in the Pedozoological Collection of the Hungarian Natural History Museum and some in the Collection of Musée d'Histoire naturelle, Gèneve.

Our research proved the presence of 32 species, of which 2 species are new to science, and 8 are rare or little known in the examined area. In discussing 7 species I surveyed their distribution or completed some descriptions.

In this paper I usually follow the system of MARSHALL et al. (1987), with some modifications introduced by WOAS (2002), SUBÍAS (2004) and WEIGMANN (2006). In the description the morphological terminology of WOAS (2002) was used with some modifications of the studied groups (e.g. NORTON & al. 1997, MAHUNKA & MAHUNKA-PAPP 2001).

*Contributions to the knowledge of the Hungarian Oribatida fauna (Acari).

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LIST OF LOCALITIES

SLOVAKIA

- E-1061 Dolno Lehota, Vajkorska dolina, Nizke Tatry, soil and litter in pine forest, 22.04.1983, leg. F. MÉSZÁROS
E-1295 Stos-Kupele, litter, 16-18.06.1987, leg. S. MAHUNKA
E-1390 Dedinky, Belij voda, wet litter and moss from rocky wall, 02.07.1991, leg. S. MAHUNKA
E-1613 Zadiel, Szádelő valley, moss from rocky wall, 08.10.2003, leg. E. HORVÁTH

ROMANIA

- E-1576 Transylvania, Retyezát Mts., Cabana Buta, 1500 m, wet moss from stones, 07.09.2002, leg. A. OROSZ
E-1677 Transylvania, Retyezát Mts., Lapusnyik valley, cca. 1200 m, spruce-wood, 02.07.2005., leg. Cs. CSUZDI
E-1678 Transylvania, Gutin pass, 900 m, beech-wood, 03.07.2005., leg. Cs. CSUZDI
E-1679 Transylvania, Vlegyásza Mt., below the hospice, 1300 m, spruce-wood, 01.07.2005. leg. Cs. CSUZDI
E-2045 Bihor county, Padiş Mts, Staþiunea Boga, Bazarul Someşului, 900 m, beech litter, 17.07.2006., leg. D. MURÁNYI
E-2046 Bihor county, Padiş Mts, Staþiunea Boga, Bazarul Someşului, 900 m, litter, 17.07.2006., leg. D. MURÁNYI
E-2048 Bihor county, Padiş Mts, Staþiunea Boga, Aragyásza Cave, 1300 m, *Sphagnum* and other moss near the entrance of cave, 18.07.2006., leg. D. MURÁNYI
E-2049 Bihor county, Padiş Mts, Staþiunea Boga, 1350 m, pine litter and forest soil, 17.07.2006., leg. D. MURÁNYI

LIST OF THE NEWLY IDENTIFIED SPECIES

BRACHYCHTHONIIDAE THOR, 1934

- Eobrachychthonius borealis* FORSSLUND, 1942
Locality: Slovakia, E-1295.
Liochthonius horridus (SELLNICK, 1928)
Locality: Romania, E-1677.
Liochthonius leptaleus MORITZ, 1976
Locality: Romania, E-2048.
Sellnickochthonius hungaricus BALOGH, 1943
Locality: Romania, E-2048; Slovakia, E-1295.

ORIBOTRITIIDAE GRANDJEAN, 1954

- Protoribotritia oligotricha* MÄRKEL, 1963
Locality: Romania, E-2045.

MALACONOTHRIDAE BERLESE, 1916

- Malacothrus monodactylus* (MICHAEL, 1888)
Locality: Romania, E-1576.
Trimalaconothrus angulatus WILLMANN, 1931
Locality: Romania, E-1576.

LICNODAMAEIDAE GRANDJEAN, 1954

- Licnodamaeus undulatus* (PAOLI, 1908)
Locality: Slovakia, E-1613.

CARABODIDAE C. L. KOCH, 1837

- Carabodes tenuis* FORSSLUND, 1953
Locality: Romania, E-1678; Slovakia, E-1061.

AUTOGNETIDAE GRANDJEAN, 1960

- Autogneta parva* FORSSLUND, 1947
Locality: Romania, E-2048.
Conchogneta traegardhi (FORSSLUND, 1947)
Locality: Romania, E-2045.
Conchogneta vasiliorum sp. n.
Locality: Romania, E-2045
Conchogneta willmanni (DYRDOWSKA, 1929)
Locality: Romania, E-2045.

OPPIIDAE SELLNICK, 1937

- Dissorhina longispina* sp. n.
Locality: Romania, E-2048
Dissorhina ornata (OUDEMANS, 1900)
Locality: Romania, E-2045.
Multioppia (Multilanceoppia) carpatica (SCHALK, 1966)
Locality: Romania, E-2049.
Oppiella acuminata (STRENZKE, 1951)
Locality: Romania, E-2048.
Oppiella (Rhinoppia) getica (VASILIU & CALUGAR, 1981)
Localities: Romania, E-2046, E-2047.

MACHUELLIDAE BALOGH, 1983

- Machuella bilineata* WEIGMANN, 1976
Locality: Slovakia, E-1613.

SUCTOBELBIDAE JACOT, 1938

- Rhynchobelba ornithorhyncha* (WILLMANN, 1953)
Locality: Romania, E-2045.
Suctobelba altvateri MORITZ, 1976
Locality: Romania, E-1677.

Suctobelba reticulata MORITZ, 1976

Locality: Slovakia, E-1390.

Suctobelbata prelli MÄRKEL & MEYER, 1958

Locality: Romania, E-2048.

Suctobelbella forsslundi (STRENZKE, 1950)

Locality: Romania, E-1678.

Suctobelbella moritzi MAHUNKA, 1987

Locality: Slovakia, E-1390.

Suctobelbella similis (FORSSLUND, 1941)

Locality: Romania, E-1677.

Suctobelbella subcornigera (FORSSLUND, 1941)

Locality: Romania, E-1677.

LIMNOZETIDAE THOR, 1937

Limnozetes ciliatus (SCHRANK, 1803)

Locality: Romania, E-1576.

ORIBATELLIDAE JACOT, 1925

Ophidiotrichus tectus (MICHAEL, 1884)

Locality: Romania, E-1678.

Oribatella dudichi WILLMANN, 1938

Locality: Romania, E-2049; Slovakia, 1295.

Oribatella eutricha BERLESE, 1908

Locality: Romania, E-1576.

GALUMNIDAE JACOT, 1925

Pilogalumna tenuiclava WILLMANN, 1938

Locality: Romania, E-1576.

DESCRIPTIONS OF NEW AND NOTES ON
RARE SPECIES

Protoribotritia oligotricha MÄRKEL, 1963

This is a boreo-alpine species from the Holarctic region occurring rarely and in all cases in small individual number. Only recently was it proved to exist in the Nearctic region (NIEDBALA 2002). In the Palearctic it had been shown from Sweden, and not yet in the area just under study. Most likely it is a glacial relict species here.

The presently studied single specimen displays small morphological differences diverging from the type (MÄRKEL 1963) and also from NIEDBALA's description and published figures. In

other words, the earlier descriptions make on reference as to the position and the number of notogastral pori, whereas in the present specimen five pairs of pori clearly discernible, *ip* especially robust (Fig. 1). The sensillus of our specimen is much bigger specifically the breadth its head is much more striking than in the earlier figures (Fig. 2), furthermore, the sculpture of the aspis is comprised exclusively fine lines. The fine sculpture is also clearly seen on the notogaster. The numbers of genital setae are 7 and 8, respectively (Fig. 3).

Locality: Romania, Transylvania (E-2045).

Dissorhina longispina sp. n.

Material examined. Holotype (HNHM¹ 11723-HO-2007): Romania, Bihor county, Padiş Mts, Staþiunea Boga, Aragyásza Cave, 1300 m, *Sphagnum* and other moss near the entrance of cave, 18. 07. 2006., leg. D. MURÁNYI (E-2048). Paratypes (HNHM 1723-PO-2007) 1 ex., (MHNG) 1 ex., locality same as that of the Holotype.

Diagnosis: Rostral apex separated by two incisions, sharply pointed, Prodorsal surface with complicated costulae. Sensillus very long, lanceolate, smooth. Lamellar setae very short, interlamellar setae much longer. Ten pairs of notogastral setae. Apodemes weakly developed, no connection between *ap. 2* and *ap. sej.* Aggenital and adanal setae very short.

Measurements. Length of body: 290-301 µm, width of body: 140-147 µm.

Prodorsum. Rostral apex narrow, triangular (Fig. 6) bearing the bent rostral setae, they arise very near to each other, well pilose. A pair of deep and comparatively deep, large incisions present along it. Prodorsal structure (Fig. 4) well developed, characteristic for the genus *Dissorhina* Hull, 1918. Lamellar setae arising separately from

¹ HNHM: deposited in the Hungarian Natural History Museum, Budapest, with identification number of the specimens in the Collection of Arachnids. MHNG: deposited in the Muséum d'histoire naturelle, Genève.

the costulae, being much shorter than the interlamellar ones. Sensillus very long, its head lanceolate, sharply pointed, without cilia (Fig. 7).

Notogaster. Dorsosejugal suture strongly narrowed anteriorly, straight medially. Ten pairs of comparatively short notogastral setae present, setae c_2 shorter than the others.

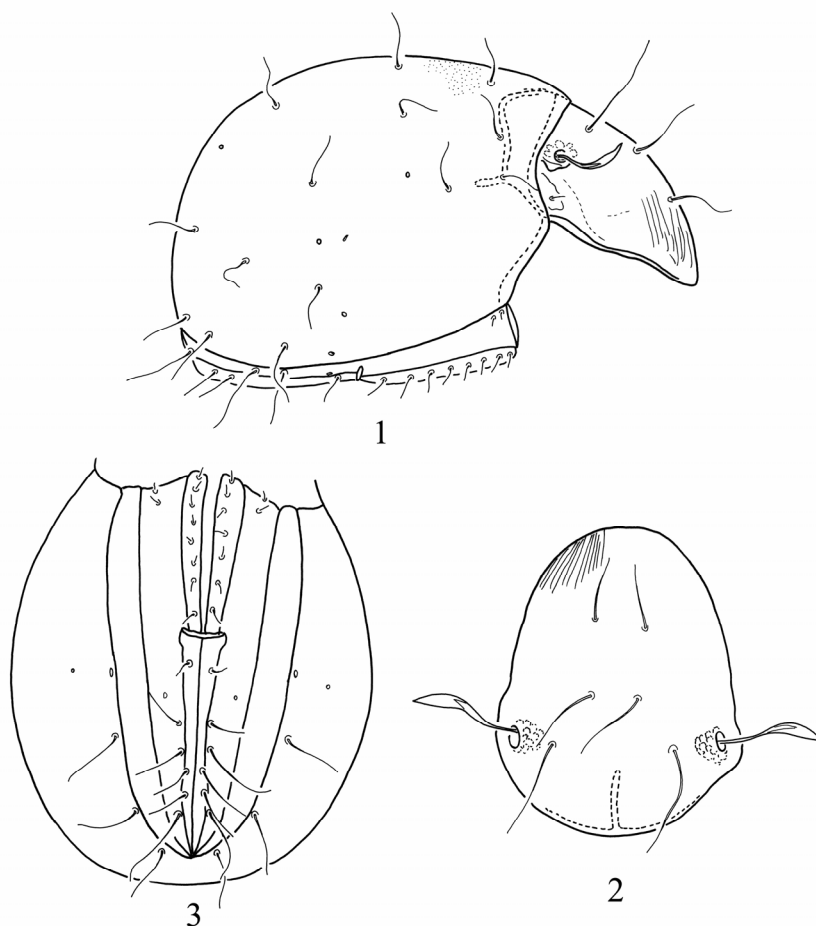
Lateral part of podosoma: As shown in Fig. 7.

Ventral regions (Fig. 5). Apodemes and epimeral borders weakly developed. Sternal apodema partly reduced, partly absent or not observable anteriorly and between *ap. 2.* and *ap. sej.* A pair of peculiarly oval field present in the sejugal region, on *bo. sej.* All epimeral setae short, no essential difference among them. Genito-anal setal formula: 5 – 1 – 2 – 3. Anterior

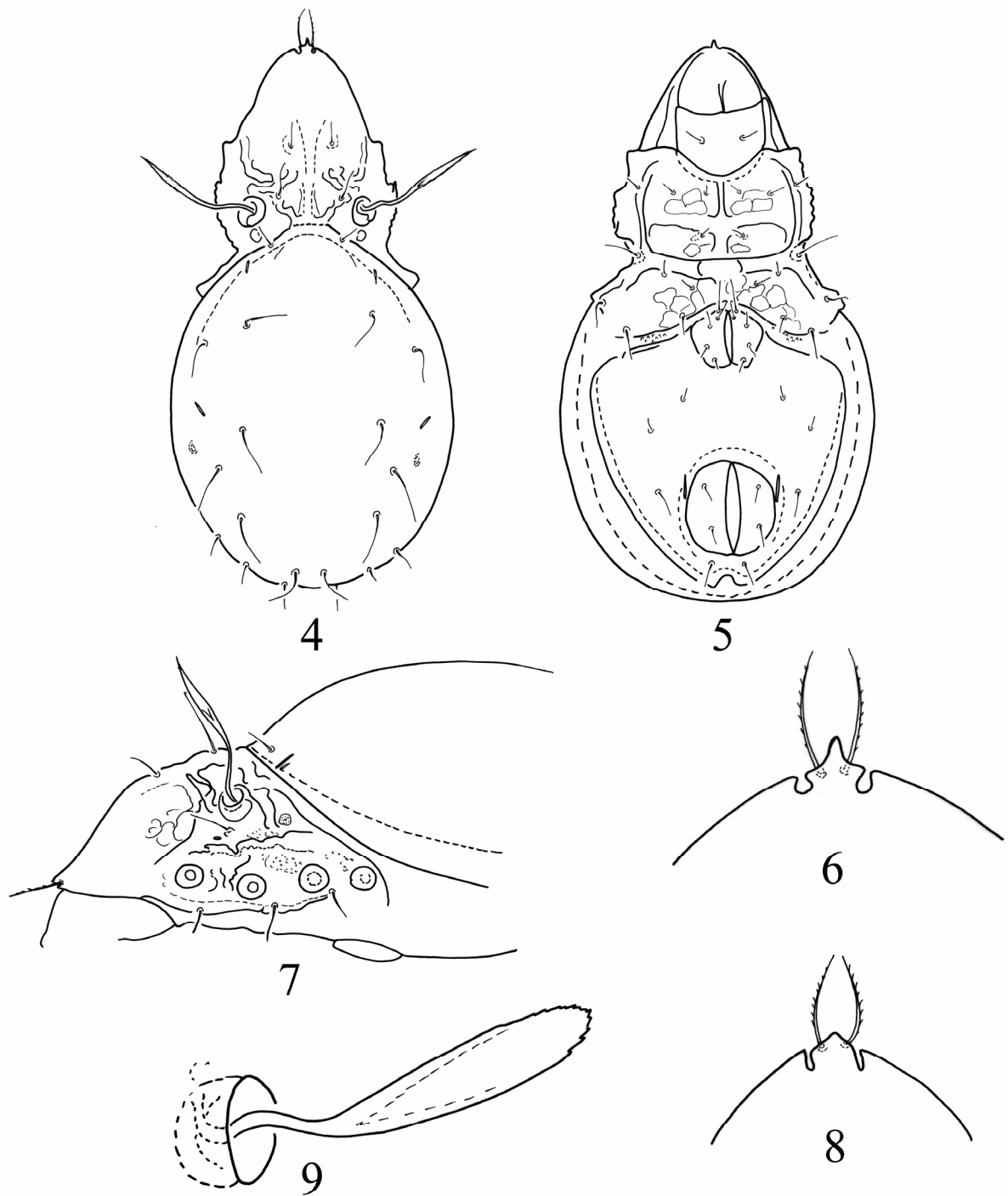
pair of genital setae long, much longer than the others. Aggenital, anal and adanal setae nearly equal in length, all short. Ventral plate with an unpaired depression in posteromarginal position.

Remarks. The new species is well characterised by the narrow, elongated rostral apex and the smooth and peculiarly long, lanceolate sensillus. This combination of characters is unknown in the heretofore described species, e.g. *Dissorhina ornata* OUDEMANS, 1900 (Figs. 8-9).

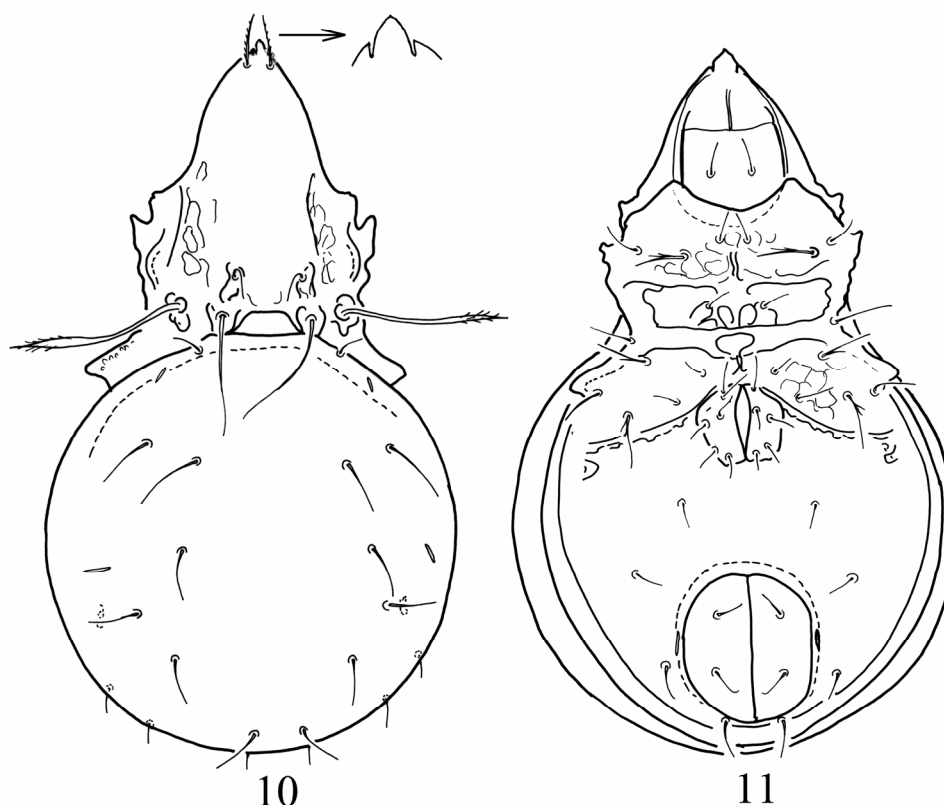
Etymology. The new species is named after the form of the sensillus.



Figures 1-3. *Protoribotritia oligotricha* MÄRKEL, 1963. 1: body in lateral view, 2: aspis in dorsal view, 3: anogenital region



Figures 4-7. *Dissorhina longispina* sp. n. 4: body in dorsal view, 5: body in ventral view, 6: rostrum, 7: prodorsum in lateral view. **Figures 8-9.** *Dissorhina ornata* (OUDEMANS, 1900). 8: rostrum, 9: sensillus



Figures 10-11. *Oppiella (Rhinoppia) getica* (VASILIU & CALUGAR, 1981). 10: body in dorsal view, 11: body in ventral view

***Oppiella (Rhinoppia) getica* (VASILIU & CALUGAR, 1981) comb. n.**

The newly collected and identified specimens without doubts are identical with the described specimens by VASILIU and CALUGAR (1981). I give drawings (Figs. 10-11) from the studied specimens.

I agree with MIKO (in WEIGMANN 2006), who – on contrary to SUBÍAS (2004) – placed this species in relationships to the *Oppiella (Rhinoppia)* BALOGH 1983. It is supported by the form of the rostrum, the shape of the prodorsal costulae, the position of the notogastral setae and by the apodemes, the borders of the epimeral costulae and the peculiar, branching epimeral setae.

**Notes on the family Autognetidae
GRANDJEAN, 1960**

***Autogneta parva* FORSSLUND, 1947**

It is a Palearctic species, everywhere common in forests.

***Conchogneta traegardhi* (FORSSLUND, 1947)**

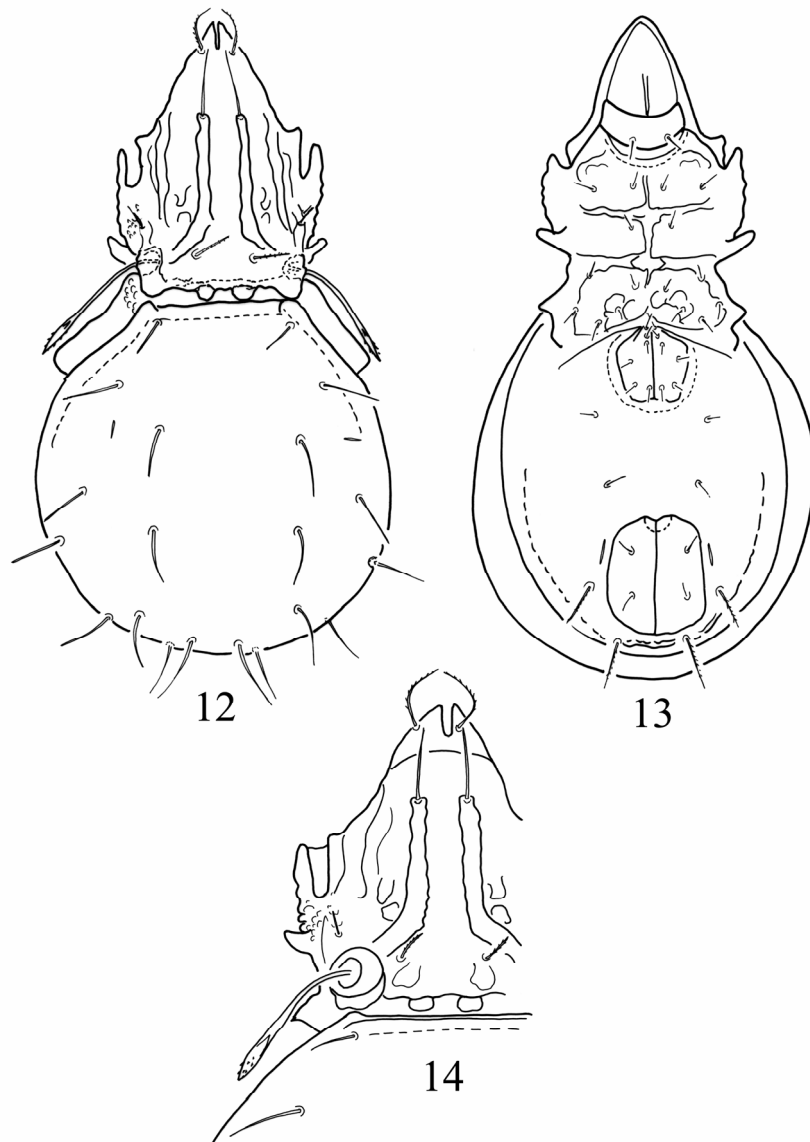
This sylvicolous species is well distributed in the Holarctic Region, but nowhere common. On the basis of the keys and figures published by WEIGMANN (2006) easily identifiable.

The studied specimens from Finland and from Romania unambiguously belong also this species. The most important characters are:

Prodorsal costulae narrow, they run over a long part parallelly, near to each other (Fig. 14). Lateral part of prodorsum with a pair of strong tubercles, placed in opposite position. A pair of basal tubercles is also present, connected by a fine, narrow lath. Rostral setae directed strongly inwards, well ciliate (Fig. 12). Lamellar setae straight, reaching to the insertions of the preceding ones. Interlamellar setae bacilliform.

Sensillus very long, with lanceolate head, bearing 3-5 short cilia. Notogastral setae comparatively strong, setae c_2 shorter and thinner than the others. Apodemes and epimeral borders weakly developed, sternal ones hardly observable (Fig. 13). Aggenital and setae ad_3 much shorter than setae ad_1 and ad_2 .

Measurements. length of body: 356-363 μm , width of body: 207-211 μm .

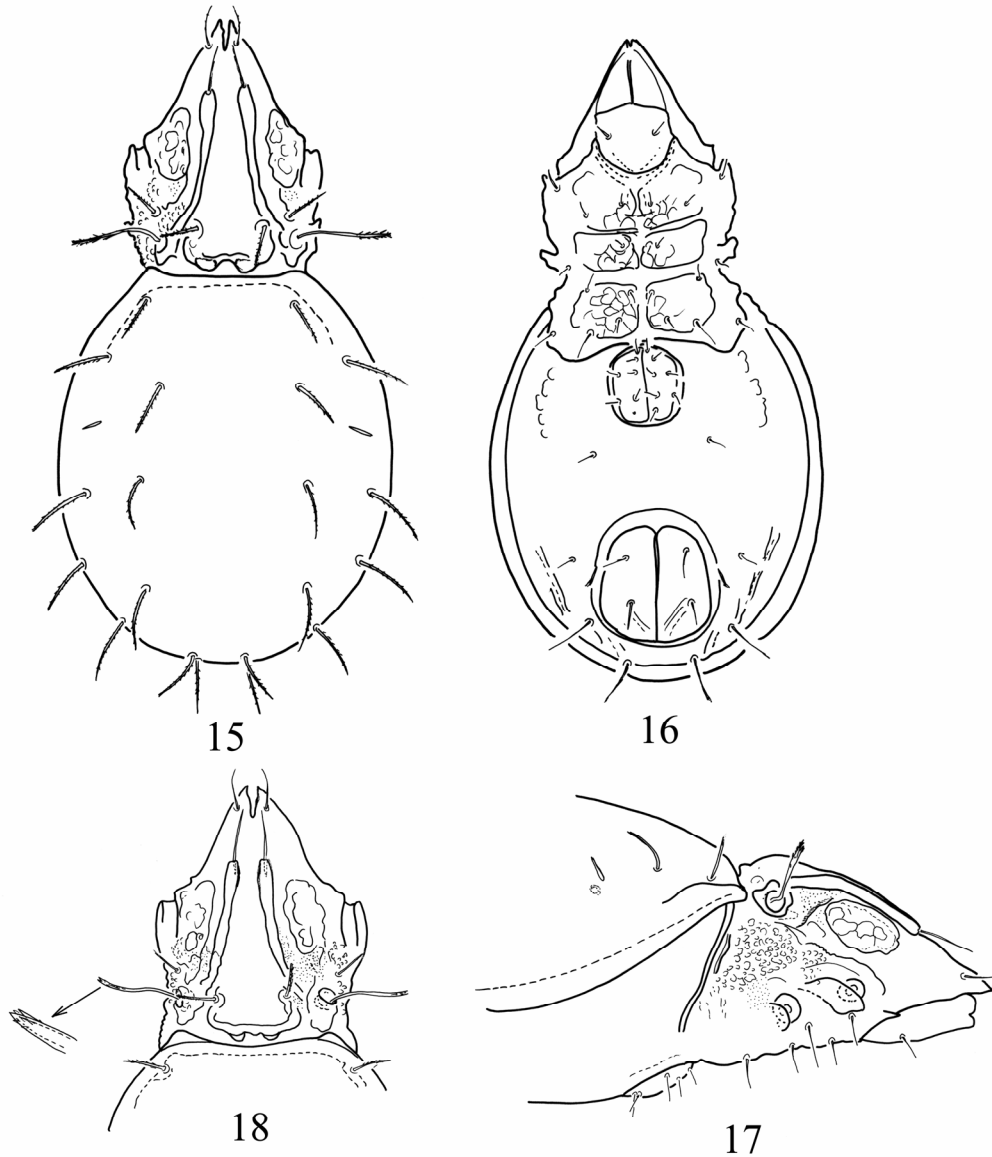


Figures 12-14. *Conchogneta traegardhi* (FORSSLUND, 1947). 12: body in dorsal view, 13: body in ventral view, 14: prodorsum in dorsal view

***Conchogneta vasiliorum* sp.n.**

Material examined. Holotype (HNHM 1724-HO-2007): Romania, Bihor county, Padiş Mts, Staþiunea Boga, Bazarul Someşului, 900 m, beech litter, 17. 07. 2006., leg. D. MURÁNYI (E-2045. Paratypes: (HNHM 1724-PO-2007) 1 ex., (MHNG) 1 ex., locality same as that of the Holotype.

Diagnosis. Rostral apex with deep incision. Lamellae run partly parallel, near to each other, peculiarly dilated anteriorly. Sensillus long, bacilliform, distally covered by short spines, sometime bifurcate. Interlamellar setae bacilliform, roughened, exobothridial ones shorter, setiform. Ten pairs stout, roughened, mostly bacilliform, notogastral setae. Epimeral surface ornamented by polygonal pattern, epimeres and borders – excepting sternal ones – well developed.



Figures 15-18. *Conchogneta vasiliorum* sp. n. 15: body in dorsal view, 16: body in ventral view, 17: prodorsum in lateral view, 18: prodorsum in dorsal view

Ventral plate with some fine rugae in posteromarginal position and on the anal plates. All legs monodactylous.

Measurements. Length of body: 500-527 μm , width of body: 263-271 μm .

Prodorsum. Rostral incisure narrowing basally, V-shaped. Rostral teeth sharply pointed. Distal part of lamellae running partly parallel, their distal end characteristically dilated (Fig. 15). There is a pair of lateral field, ornamented by polygonal pattern (Fig. 18). The lateral tubercles absent. A well developed transcostula present in the interbothridial region, bearing one pair of roundish tubercles. Rostral and lamellar setae setiform, thin, rostral ones only slightly bent inwards. Interlamellar setae bacilliform, blunt at tip. Bothridium with guttiform protuberances posteriorly. Sensillus thin, bacilliform, hardly dilated distally, distal part covered by spines, sometimes bi-, or trifurcate, slightly roughened.

Notogaster. Humeral part of notogaster with a pair of triangular protuberances. Ten pairs of bacilliform notogastral setae present, without larger variation in length, only setae c_2 shorter, than the others.

Lateral part of podosoma. Along the lamellae a well framed oval field present, ornamented by polygonal pattern (Fig. 17). Exobothridial region covered by characteristic, comparatively large pustules. Anterior part of this field granulate.

Ventral regions (Fig. 16): Apodemes and epimeral borders well developed, composing a thick network. Epimeral surface distinctly polygonate. All epimeral setae short, simple, setae $1c$ originating laterally, near to pedotecta 1. In the anterolateral part of the ventral plate some sigilla arranged in two longitudinal rows. In this posteromarginal part some weak rugae present, one pair on the surface of anal plates. Genitoanal setal formula: 6 – 1 – 2 – 3. All setae – excepting adanal ones – in posteromarginal position (ad_1 and ad_2) much shorter than the others.

Legs. All legs monodactylous. Anterodorsal process of leg I conspicuously long, also very long is the solenidium ϕ_1 of leg I.

Remarks. In the connection of this new species I have studied some *Conchogneta* GRANDJEAN,

1963 species from different localities of Europe, e.g. *Conchogneta traegardhi* (FORSSLUND, 1947) from Finland and Hungary and *Conchogneta dalecarlica* (FORSSLUND, 1947) from Hungary and *C. willmanni* (DYRDOWSKA, 1929) from Slovakia. The new species stands nearest to *C. traegardhi*, however the new species is distinguished from it by the measurements of body (the maximum length 440 μ in *traegardhi*), by the form of the sensillus and by the absence of the lateral tubercles in the prodorsum.

Etymology. The new species is dedicated to Drs. NICOLE VASILIU and MIHAI VASILIU, the renowned oribatidologists in Romania.

Conchogneta willmanni (DYRDOWSKA, 1929)

I was able study Hungarian and Transylvanian specimens. In my opinion it is not synonymous with *C. dalecarlica* (FORSSLUND, 1947), but the two species stand very near to each other. They are distinguishable by the length and form of the sensillus (much longer in *willmanni*, Fig. 19) and by the distal end of sensillar head (clearly bifurcate in *willmanni* Fig. 19, distinctly pilose, nearly pectinate in *dalecarlica*, Fig. 20).

Identification key to the *Conchogneta* species

1 (4) Prodorsal costulae run far from each other, converging anteriorly.

2 (3) Sensillus very long, its head bifurcate
willmanni (DYRDOWSKA, 1929)

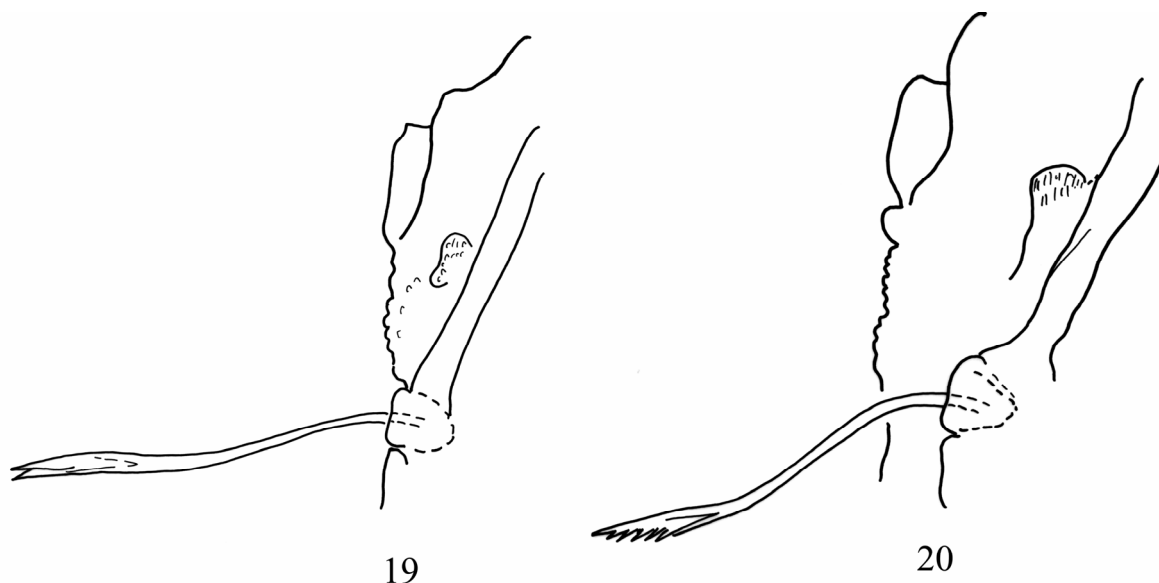
3 (2) Sensillus shorter, its head pectinate or well pilose
dalecarlica (FORSSLUND, 1947)

4 (1) Prodorsal costulae run near to each other, over a long part parallelly.

5 (6) Prodorsal costulae narrow, without dilated distal part. A pair of tubercles on lateral part of prodorsum, along the costulae
traegardhi (FORSSLUND, 1947)

6 (5) Prodorsal costulae wide, with dilated distal part. A pair of polygonate field on lateral part of prodorsum, along the costulae

vasiliorum sp. n.



Figures 19-20. 19: *Conchogneta willmanni* (DYRDOWSKA, 1929): sensillus, 20: *Conchogneta dalecarlica* (FORSSLUND, 1947): sensillus

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Comparison of *Leuctra kisi* STEINMANN, 1968 with *Leuctra quadrimaculata* KIS, 1963 (Plecoptera: Leuctridae), and the first record of *L. quadrimaculata* from Ukraine

D. MURÁNYI¹

Abstract. Female of *Leuctra kisi* STEINMANN, 1968, is compared with *Leuctra quadrimaculata* KIS, 1963. The similarity of their characters is stated, and the distinguishing characters of the original descriptions of *L. kisi* is rejected. The first record of *L. quadrimaculata* from Ukraine is given.

Leuctra kisi STEINMANN, 1968 was described in the identification book of the Hungarian stoneflies (STEINMANN, 1968) on the basis of a single female. More detailed description of the species, or any other mention on its further occurrence was never published, despite of the large Plecoptera material in the Hungarian Natural History Museum (HNHM) from its type locality. Later the species was considered as species inquirenda (TÓTH, 1990).

During the revision of the Plecoptera collection of HNHM, we found a female specimen, identified by H. STEINMANN as *L. kisi*. The specimen was not labeled as holotype, but its locality is the same as mentioned in the description. Moreover, the posture of the abdomen agrees with the drawing of STEINMANN (Figs. 1-2), and no other *L. kisi* specimen was present in our collection. As the *L. kisi* specimen seems identical with *L. quadrimaculata*, we also report the *L. quadrimaculata* material of HNHM, identified by B. KIS, and the first data of the species from the Ukrainian Carpathians.

MATERIAL EXAMINED

***Leuctra kisi* STEINMANN, 1968:** Hungary, Visegrádi-mts., Visegrád, Apátkuti valley, PLH 355., 14.07.1965, 1♀, leg. et det. H. STEINMANN

***Leuctra quadrimaculata* KIS, 1963:** Ukraine: Mts. Kraszna, River Tereblja (Talabor), between

Kolocsava (Alsókalocsa) and Meresor (Rókarét), PLP 907., 23. 05. 2002, 1♀, leg. K. BALOGH, B. CSER & D. MURÁNYI, det. D. MURÁNYI; Romania: Borşa (Borsa), PLP 546., 24. 07. 1963, 1♂6♀ leg. et det. B. KIS; Bálványos spring, PLP 552., 20. 06. 1971, 6♂7♀, leg. et det. B. KIS; Mts. Vîlcan (Vulkán), Balea, Sokodol, Balami, PLP 564., 06. 07. 1962 - 08. 08. 1963, 2♂13♀, I. Székely, det. B. KIS; Bologo, PLP 600., 20. 06. 1967, 2♂4♀, leg. et det. B. KIS; Mts. Vîlcan (Vulkán), PLP 821., 10. 07. 1962, 3♂3♀, leg. et det. B. KIS; Borşa (Borsafüred), PLP 1010., 24. 07. 1963, 1♂, leg. et det. B. KIS.

RESULTS

Examination of the *Leuctra kisi* specimen

On the basis of the shape of the subgenital plate (Figs. 2-4), the specimen labeled as *L. kisi* belongs to the *Leuctra inermis* species group sensu AUBERT, 1946. Although some members of this group could probably form a species complex (ZWICK & SIVÉC, pers. com.). Despite the great variability of *L. quadrimaculata* females the characters of this specimen agree with the description of *L. quadrimaculata*.

Comparing the specimen with our *L. quadrimaculata* material identified by KIS, real distinguishing characters were not found. Unfortunately, the spermathecal ring is unstudyable because of the poor condition of the

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specimen, but this structure is generally of little interest in separating closely related species since the armatures are often very similar even within a species group (RAVIZZA & VINÇON, 1998).

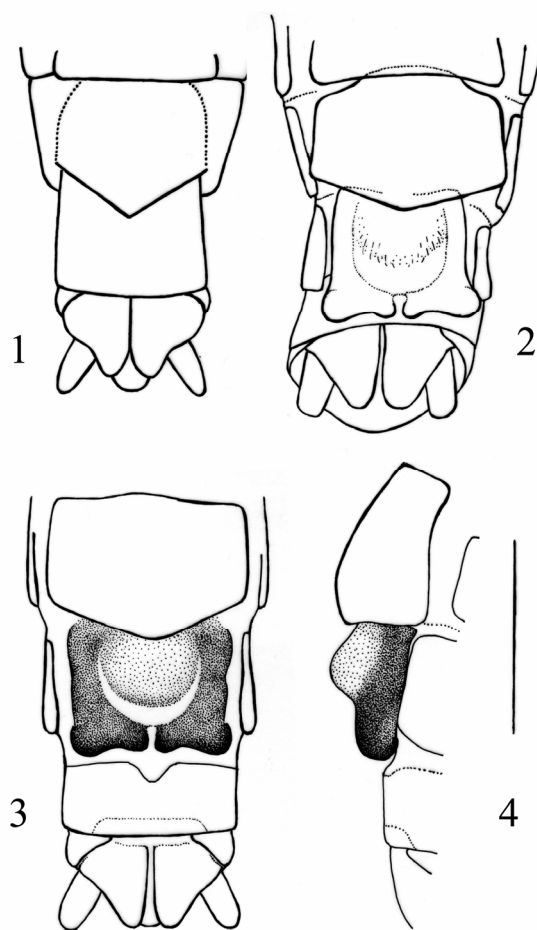
STEINMANN described three characters distinguishing *L. kisi*, these are the shape of the subgenital plate, the length of the 9th abdominal segment and the length of the epiproct. Comparing the specimen with his drawing, the sclerite, which was regarded as subgenital plate, obviously refers to the sternum 7. The drawing of the 9th abdominal segment includes the contracted 8th and 9th segments, and the real subgenital plate is therefore not described. The long epiproct probably refers to the contracted posture of the abdomen.

The identity of *L. kisi* with *L. quadrimaculata* is highly probable, but the synonymy is definitively not stated, because of the great variability of the females in the *inermis*-group, and the unstudyable spermathecal ring of the specimen. To reach a solution of this problem, examination of additional specimens from the type locality, or even the revision of the *inermis*-group in the Carpathian Basin would be necessary.

New record of *Leuctra quadrimaculata* in Ukraine

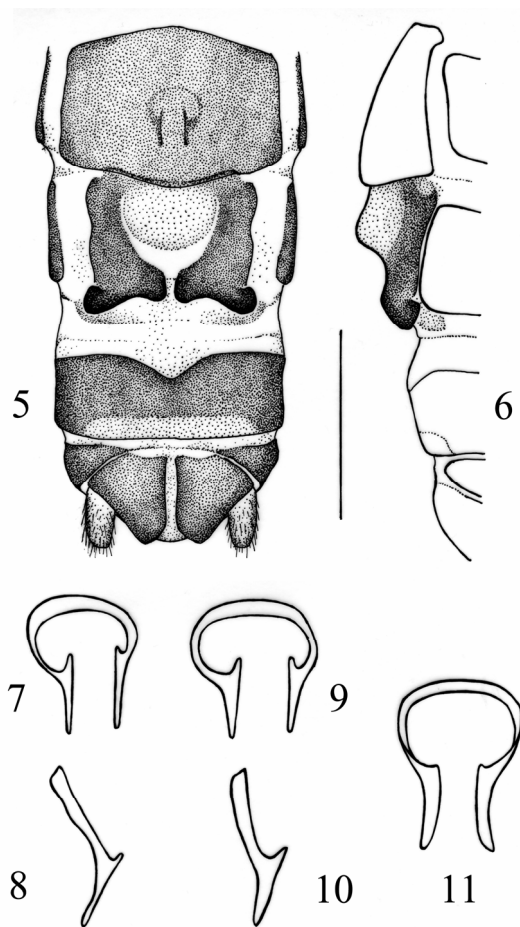
In the Plecoptera material collected in the Mts. Kraszna, Ukrainian Carpathians during May of 2002, we have found a female specimen of *L. quadrimaculata* from the River Tereblja. This is the first data of the species from Ukraine. It is worth to mention that the spermathecal rings of both Ukrainian specimen (Figs. 7-8) and the Transylvanian ones, identified by B. KIS (Figs. 9-10), are differing in ventral aspect from the figures of the original description (KIS, 1963), but in flattened position (Fig. 11) it agrees with the figures of the work on the Romanian fauna (KIS, 1974). Moreover, every other characters of the specimen agree with *L. quadrimaculata*, so its identity is sure.

In the Carpathian Basin, the *inermis*-group is represented by the European *L. inermis* KEMPNY,



Figures 1-4. *Leuctra kisi* STEINMANN, 1968. 1: end of female abdomen, ventral (after STEINMANN 1968); 2: end of female abdomen, ventral, original position of the conserved animal; 3: end of female abdomen, ventral, after KOH boiling; 4: end of female abdomen, lateral, after KOH boiling; scale 0.5 mm.

1899, the Alpine *L. teriolensis* KEMPNY, 1900, the Central European *L. rauscheri* AUBERT, 1957, the Central and South European *L. handlirschi* KEMPNY, 1898 (that needs confirmation according to KIS, 1974) and the Balkano-Carpathian *L. quadrimaculata* (KIS, 1974, RAUŠER, 1980, SIVEC, 1980). In Ukraine, the presence of *L. inermis*, *L. rauscheri* and *L. handlirschi* was hitherto confirmed (ZHILTZOVA, 1997), and *L. quadrimaculata* is the fourth member of the group. In Hungary, only *L. inermis* was reported from Mts. Bükk (ÚJHELYI, 1969), apart from the uncertain *L. kisi* that is assigned here to *L. quadrimaculata*.



Figures 5-11. *Leuctra quadrimaculata* KIS, 1963. 5: end of female abdomen, ventral (Ukraine); 6: end of female abdomen, lateral (Ukraine); 7: spermathecal ring, ventral (Ukraine); 8: spermathecal ring, lateral (Ukraine); 9: spermathecal ring, ventral (Romania); 10: spermathecal ring, lateral (Romania); 11: spermathecal ring, ventrally flattened (Ukraine) scale 0.5 mm.

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Changes in rotifer communities regarding to the water-level fluctuations in the floodplain Gemenc, Danube (Hungary)

K. SCHÖLL¹

Abstract. The planktonic rotifer communities in three hydrodynamically different river-arms at the floodplain of the Danube river at Gemenc have been studied. In the numerous arms the current has different speeds depending on the water level, therefore the physical and chemical parameters (temperature, conductivity, transparency, dissolved oxygen content) are different. We have found forty-six rotifer taxa in the area, but the species-composition changes seasonally. There are therefore big differences in the qualitative and quantitative data between the main arm and the other branches. At high water levels (flood), the rotifer communities of the area are uniformized but, at low water levels the area becomes divided into a series of different water bodies, some near to the lake-state. This phenomenon develops a few days after the flood. The species composition and the abundance relations of the planktonic rotifer communities reflect this effect.

Gemenc, a part of the Duna-Dráva National Park lies between the 1500th and 1470th river kilometers of the River Danube and is about 5-10 km wide and 30 km long. This type of area, which covers 18000 hectares is unique in Central Europe. Various characteristic river-arms and backwaters are there in different states, which are lying completely on the floodplain. In this reach of the Danube the mean discharge is about 2260 m³/sec, with the minimum discharge at 470 m³/s, and floods at 8700 m³/s. The stream gradient is 5 cm/km, the mean velocity is 0.5-1.2 m/s. The difference is near 800 cm between the extreme values of the water-level fluctuation. Depending on the water-level extreme hydrodynamical processes occur in this area, owing to the numerous other river arms, backwaters and lakes.

PREVIOUS RESEARCH IN THE AREA, AND PURPOSE OF THE PRESENT STUDY

BARTSCH was the first, who reported data about Rotifers from this area in 1877 (BARTSCH, 1877). In 1951 VARGA worked on Gemenc's Rotifer-fauna. His examinations covered other river arms too, which were not examined by us.

He found forty-three euplanctonic and fifty-five tychoplantonic species. (KOL & VARGA, 1960). In 1991 GULYÁS listed fifty-nine species from the Rezéti-Holt-Duna, the Vén-Duna and the main arm (GULYÁS et al., 1991).

We started our study in 2001. Our purpose is to find, besides the faunistical data, the spatio-temporal pattern, the connection to the stream-flow regime and to the chemical-physical parameters, if these connections exist. Our goal is to unravel the above data during several years of examination.

MATERIAL AND METHODS

The study area

Our study area in Gemenc's floodplain contains three river-arms, in downstream succession: Grébeci-Holt-Duna (GDU) (~7 km), Rezéti-Holt-Duna (RDU) (~15 km), and Vén-Duna (VDU) (~5 km) (Fig. 1). Grébeci-Holt-Duna is classified as plesiopotamon (ROUX, 1982). The upstream end is usually closed, and connected again to the main arm in periods of higher water-levels. At low water conditions the

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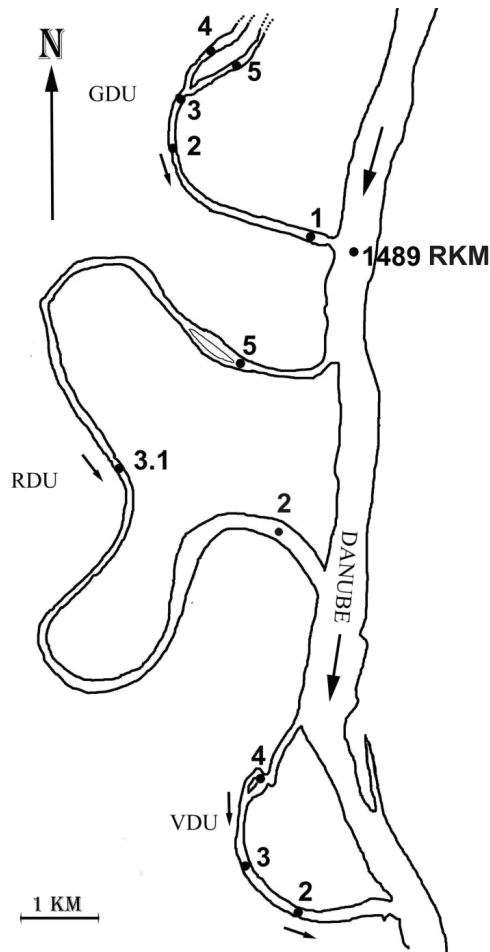


Figure 1. The study area with the sampling sites

conductivity is higher than in the main arm. Thermal stratification can be observed. The depth at mean water-level is about 100-300 cm. Rezéti-Holt-Duna is fully connected at all times, it is a parapotamon-type river-arm with 25-40 m width and 150-400 cm depth at mean water-level. The relatively long extension of this arm and its shallowness are such that the water entering from the main arm changes gradually so to finally possess differing physical and chemical characteristics when compared to the main channel. Vén-Duna finally is a much shorter, parapotamon-type river-arm with running water all over the year. The width is 25-30 m, the depth is about 10-12 m at mean water-level.

Samples were taken between August 2001 and November 2002 at monthly intervals, as far as it was possible. We selected five sampling sites along GDU, three along RDU, three along VDU 3 and one in the main arm (river km 1489) (Fig. 1). We measured, on each occasion the temperature, the pH, the conductivity, the oxygen-content and the oxygen saturation with a WTW Multi 340i instrument. Two 20 litre samples were collected, one was taken to the laboratory without preserving for identification (BANCSI, 1986), (DUMONT, 1995), the other was instantly preserved in 4 % formaldehyde solution.

Data analysis

After the identification of the Rotifer taxa, the preserved animals were counted in a Sedgewick-Rafter chamber. The SYN-TAX 5.1 Multivariate Statistical Program Package (PODANI, 1993) was used to analyse our data. Several analyses were run and evaluated with SYN-TAX on the database. The temporal and spatial comparisons between samples were based both of presence absence and quantitative data. A distance matrix was created using Euclidean distances and chord distances. Qualitative data were analysed with their standard deviation (\log_2). Ordination was carried out using non-metric multi-dimensional scaling (NMDS). Hierarchical classification was carried out using the unweighted pair group method (UPGMA) within distance optimisation.

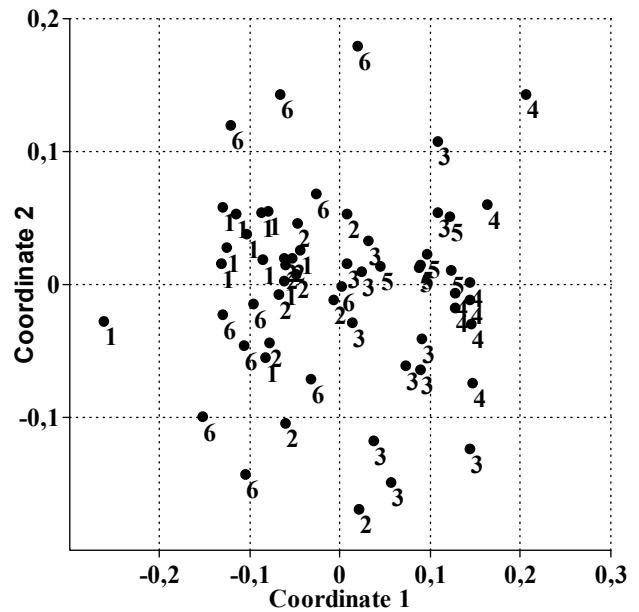
RESULTS

During the first year of the study 46 taxa of Rotifers were found (Table 1) Several taxa listed in the table 1. occurred for the first time in this area. *Brachionus angularis f. aestivus* SKORIKOV is a new addition to the Hungarian fauna.

The multivariate data-analysis shows, that the Rotifer-fauna of the study area undergoes seasonal changes. The sampling sites form 3 characteristic groups (Fig. 2).

Table 1. List of Rotifera found at Gemenc

1. *Asplanchna girodi* DE GUERNE 1888
2. *A. priodonta* GOSSE 1850
3. *A. sieboldi* LEYDIG 1854
4. *Brachionus angularis f. aestivus* SKORIKOV 1914
5. *B. angularis f. angularis* GOSSE 1851
6. *B. angularis f. bidens* PLATE 1886
7. *B. budapestiensis f. budapestiensis* DADAY 1885
8. *B. budapestiensis f. punctatus* HEMPEL 1896
9. *B. calyciflorus f. amficeros* EHRENBERG 1838
10. *B. calyciflorus f. anuraeiformis* BREHM 1909
11. *B. calyciflorus f. calyciflorus* PALLAS 1766
12. *B. calyciflorus f. dorcas* GOSSE 1851
13. *B. calyciflorus f. spinosus* WIERZEJSKI 1891
14. *B. diversicornis* DADAY 1883
15. *B. falcatus* ZACHARIAS 1898
16. *B. leydigi f. leydigi* COHN 1862
17. *B. quadridentatus var. cluniorbicularis* SKORIKOV 1894
18. *B. quadridentatus var. brevispinus* EHRENBERG 1832
19. *Chromogaster ovalis* BERGENDAL 1892
20. *Conochilus dossuarius var. dossuarius* HUDSON 1875
21. *Euchlanis dilatata* EHRENBERG 1832
22. *Filinia longiseta* EHRENBERG 1834
23. *F. terminalis* PLATE 1886
24. *Hexarthra mira* HUDSON 1871
25. *Kellicottia longispina* KELLICOTT 1879
26. *Keratella cochlearis var. cochlearis* GOSSE 1851
27. *K. cochlearis var. macracantha* LAUTERBORN 1900
28. *K. cochlearis var. robusta* LAUTERBORN 1900
29. *K. cochlearis var. tecta* GOSSE 1886
30. *K. irregularis f. connectens* LAUTERBORN 1900
31. *K. quadrata var. quadrata* O. F. MÜLLER 1786
32. *K. quadrata var. frenzeli* ECKSTEIN 1895
33. *K. tropica f. tropica* APSTEIN 1907
34. *Lepadella patella* O. F. MÜLLER 1826
35. *Notholca labis f. labis* GOSSE 1887
36. *Polyarthra longiremis* CARLIN 1943
37. *P. major* BRUCKHARDT 1900
38. *P. minor* VOIGT 1904
39. *P. vulgaris* CARLIN 1943
40. *Synchaeta longipes* GOSSE 1887
41. *S. pectinata* EHRENBERG 1832
42. *S. stylata* WIERZEJSKI 1893
43. *S. tremula* O. F. MÜLLER 1786
44. *Trichocerca rattus* O. F. MÜLLER 1776
45. *T. pusilla* LAUTERBORN 1898
46. *Trichotria tetractis var. tetractis* EHRENBERG 1830

**Figure 2.** Ordination plot of NMDS analysis. The numbers denote the samples, which were collected at the same date

Comparing the quantitative data the species list can be divided into 3 groups, which contain species and forms in similar constancy and abundance:

1. Rare species and forms with low abundance (*Asplanchna girodi*, *Brachionus falcatus*, *Kellicottia longispina*, *Brachionus angularis f. aestivus*).
2. Rare species and forms with high abundance (*Filinia longiseta*, *Keratella tropica*, *Brachionus budapestiensis f. budapestiensis*).
3. Frequent species and forms with high abundance (*Brachionus angularis bidens*, *Keratella cochlearis tecta*, *Keratella cochlearis cochlearis*).

The physical and chemical parameters measured at the same time as the sampling indicate the difference between the river-arms (Table 2).

Table 2. The physical and chemical parameters measured at the same time as the sampling

04.08.2002.	VDU2	VDU3	VDU4	RDU2	RDU3.1	RDU5	GDU1	GDU2	GDU3	GDU4	GDU5	1489
Temperature (°C)	9,4	11,1	9,3	10	9,6	9,4		10,4		10,2	9,4	9,7
pH	8,4	8,1	8,4	8,4	8,4	8,4		8,4		8,4	7,5	8,4
Conductivity (µs/cm)	454	463	446	452	450	449		386		373	561	447
Oxygen content (mg/l)	11,1	10,7	10,1	11,5	11,5	11,8		12,8		13,1	12,1	12,1
Oxygen saturation (%)	97	96	88	101	100	103		114		116	105	106
05.02.2002.	VDU2	VDU3	VDU4	RDU2	RDU3.1	RDU5	GDU1	GDU2	GDU3	GDU4	GDU5	1489
Temperature (°C)	16,7	15,7	15,5	16,9	16,4	15,8	20,7	21,9	22,2	24,8	22,6	15,7
pH (µs/cm)	7,99	7,89	8,61	8,48	8,51	8,56	8,63	8,42	8,46	8,25	7,96	8,63
Conductivity	416	421	418	427	420	415	498	534	564	510	821	498
Oxygen content (mg/l)	14,51	14,89	14,58	15,39	17,35	15,68	18,32	18,37	16,73	11,39	13,52	12,13
Oxygen saturation (%)	148,3	150,9	147,6	163,3	177,2	158,1	207	219	195,4	139	158,6	122,8
06.13.2002.	VDU2	VDU3	VDU4	RDU2	RDU3.1	RDU5	GDU1	GDU2	GDU3	GDU4	GDU5	1489
Temperature (°C)	20,2	19,1	19,1	21,7	20,1	19,5	22,1	24,7	24,2	26,8	25,1	19,3
pH	8,54	8,6	8,63	8,88	8,78	8,65	8,99	8,54	8,69	8,65	8,82	8,77
Conductivity (µs/cm)	361	365	363	364	363	364	319	351	41	463	518	362
Oxygen content (mg/l)	11,85	14,28	13,08	14,13	13,09	15,7	22,2	17,14	23,3	17,93	26,2	14,28
Oxygen saturation (%)	131,6	157,4	142,4	162,4	142,1	168,8	261	210	275	224	295	155,5
07.03.2002.	VDU2	VDU3	VDU4	RDU2	RDU3.1	RDU5	GDU1	GDU2	GDU3	GDU4	GDU5	1489
Temperature (°C)	23,8	23,4	23,3	26,7	25,3	25,3	31,2					23
pH	9,2	9,1	9,1	8,5	9,2	9,2	8,2					9,1
Conductivity (µs/cm)	317	322	323	326	307	312	509					318
Oxygen content (mg/l)	13	11,5	11,7	13	17,8	16,1	15,8					13
Oxygen saturation (%)	155	137	139	165	220	199	216					153
11.12.2002.	VDU2	VDU3	VDU4	RDU2	RDU3.1	RDU5	GDU1	GDU2	GDU3	GDU4	GDU5	1489
Temperature (°C)	7,8	7,8	7,8	8	8	7,8	8	7,8	7,6	8	7,8	8
pH	8,31	8,2	8,28	8,3	8,37	8,33	8,08	8,16	8,13	8,22	8,24	8,32
Conductivity (µs/cm)	422	422	423	417	425	428	444	437	432	452	420	425
Oxygen content (mg/l)	5,49	5,42	5,76	5,84	5,84	6,43	5,21	5,13	5,11	6,16	5,78	6,35
Oxygen saturation (%)	46,3	45,7	48,8	49,8	49,8	54,4	44,2	43	43	52,7	48,9	55,2

DISCUSSION

We analyzed the relations between our samples (12 sampling sites, about 130 sample) by multivariate methods and we found, that the examined river-arms form 3 functional groups:

1. "Eupotamon" type, which has flowing water whatever the water-level, and has the same physical-chemical parameters as the main arm. The quantitative and qualitative properties of the planktonic rotifer assemblages are similar to the main arm (the upper reach of the Rezéti-Holt-Duna (RDU) and the Vén-Duna (VDU), and of course the main arm).
2. "Parapotamon" type where streaming water is also flowing, but where are differences in the physical, chemical and hydrodynamical parameters when compared to the eupotamal reaches (at the lower reach of the RDU and the VDU).
3. "Plesiopotamon" type, where contact exist with the main arm only at the downstream end at mean or low water-level. Grébeci-Holt-Duna (GDU) belongs to this group. There are marked differences in the

physical-chemical parameters at the sampling sites, which are reflected in the qualitative-quantitative properties of the planktonic rotifers too. For example on the 2nd of May, 2002 the conductivity at GDU4 was 510 $\mu\text{S}/\text{cm}$ and at GDU5, (only 50-60 meters farther upstream GDU4) it was 821 $\mu\text{S}/\text{cm}$.

In the first year of our study, the species-composition and the quantitative relations of the samples could be characterized generally by the seasonal changes. The local fundamentals contributed to this main factor, but this effect was not so intense, as we expected. The species composition of rotifer assemblages depended rather on sampling date than sampling site (SCHÖLL, 2002). We could not find any significant relationship between water-level and Euclidean distance among samples, but it does not mean, that the period directly before the sampling time did not influence the hydrochemical relations and the planktonic rotifer assemblages. An improved understanding of the relations between the hydrological regime and planctonic rotifer assemblages requires more data possibly another yearly set.

In conclusion, we can say that comparing the rotifer fauna of the main arm to the other river-arms, the species-composition is similar, but the abundances in the branches are higher, this depending on the water retention.

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First record of Racer Goby *Neogobius gymnotrachelus* (PALLAS, 1811) in the Hungarian section of the Danube

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Abstract. Two specimens of *Neogobius gymnotrachelus* were found in the sidearm system of the Szigetköz floodplain of the Danube (rkm 1837-1836) in September 2004. It was the first detection of this Ponto-Caspian goby in Hungary.

Number of recorded fish species in the Hungarian section of the Danube gained in a Ponto-Caspian species in September 16th, 2004, when two specimens of Racer Goby *Neogobius gymnotrachelus* (PALLAS, 1811) were collected in the Cikola branch-system of the Szigetköz floodplain. Racer Goby was originally distributed in brackish estuaries and fresh waters of the Black and Azov Seas, as well in the central and southern areas of the Caspian basin. It was known earlier from coastal lagoons of Romania, and in lakes and tributaries of the lower Danube, downstream from Ruse. Recently, this species has spread along the middle Danube. It was discovered in the Yugoslav section of the river (rkm 884) in 1991 (HEGEDIŠ et al., 1991) and it appeared in the Austrian section, downstream from Vienna in 1999 (ZWEIMÜLLER et al., 2000, AHNELT et al., 2001) and in the Slovak stretch, upstream from Bratislava (KAUTMAN, 2001). Its occurrence was expected in the Hungarian Danube (HARKA & SALLAI, 2004).

The first two specimens were collected using an electroshocker during a regular ichthyological survey in a large eopotamon like side arm (Danube rkm 1837-1836) of the Cikola branch-

system. Their standard length was 73 and 80 mm, and morphology corresponded to the description of the species (MILLER, 1986, PINCHUK et al., 2003). Their habitat was a shallow, slow-flowing stretch in the sidearm, where shoreline has silted up and a 200 m long and 5-10 m wide strip of aquatic vegetation has developed since the second half of the 1990s. The racer goby was found in an assemblage of the following species: *Rutilus rutilus*, *Leuciscus cephalus*, *Leuciscus idus*, *Alburnus alburnus*, *Abramis brama*, *Abramis bjoerkna*, *Vimba vimba*, *Rhodeus sericeus*, *Carassius auratus*, *Sabanejewia aurata*, *Esox lucius*, *Gasterosteus aculeatus*, *Proterorhinus marmoratus*, *Neogobius kessleri*, *N. melanostomus*.

Distribution and spread of race goby along the Middle Danube is not well-known actually. It was not caught during two extensive survey on 43 stretches (500 m long) of the Hungarian Danube in 2004 (ERŐS et al., 2005) nor in the Slovak Danube during the same year (JURAJDA et al., 2005). At the same time it has established population in Austria (WEISNER, 2005) and it may be expected in the next years to become widespread in the Hungarian Danube too.

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Figure 1. *Neogobius gymnotrachelus*, collected in the Szigetköz floodplain of the Danube

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A new record of an interesting parasitic rotifer *Balatro calvus* CLAPARÉDE, 1867 in Hungary

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Abstract. Although widely distributed the parasitic rotifer *Balatro calvus* CLAPARÉDE, 1867 has only been sporadically observed. Here we document the presence of this species in enchytraeid (Annelida) specimens from different regions of Hungary.

Members of phylum Rotifera are microscopic aquatic invertebrates. Because of their adaptability, these opportunistic organisms are widely distributed in freshwater, marine, and limno-terrestrial habitats (WALLACE et al. 2006). Most of the approximately 1800 species are consumers of algae, bacteria and organic materials; some of them are predators, but only a few species are parasitic. Among this rare trophic type are members of the genera *Albertia*, *Balatro* and *Claria*, which are endoparasites of annelids. Here we describe the presence of *Balatro calvus* in annelid specimens from three regions in Hungary.

Balatro calvus CLAPARÉDE, 1867 is an endoparasitic rotifer that attaches to the intestinal epithelium of members of two annelid families (Fig. 1). In Lumbriculidae it has been found in *Trichodrilus* sp. However, in Enchytraeidae it has been found in five species: *Henlea ventriculosa* (D'UDEKEM, 1854), *H. perpusilla* FRIEND, 1911, *Fridericia bulbosa* (ROSA, 1887), *Buchholzia appendiculata* (BUCHHOLZ, 1862), *Enchytraeus buchholzi* (VEJDOVSKY, 1879). The type locality is in the Seime rivulet, canton of Geneva, Switzerland (CLAPARÉDE, 1867). In central Europe it has been found only in Slovakia (KOSEL 1973). It also has been observed sporadically in

South America and Australia (DE SMET & POURRIOT 1997).

Balatro calvus has a small head characterized by an annulated proboscis with a suction ring (Fig. 3-4). The posterior end of the foot has three lobes (Fig. 6). At the distal end of trunk is a fishtail shaped dorsal appendage (Fig. 5). This species has three salivary glands, and a very large vitellarium that contains eight nuclei. Its total length is 170–253 μm , and the appendage width is 45–80 μm . The dimensions of the trophi are as follows: 16–18 μm , with a 7 μm ramus, fulcrum of 5–6 μm , uncus of 3–5 μm , and manubrium of 14–17 μm (DE SMET & POURRIOT 1997).

METHODS

The photos were taken pending a process of Enchytraeidae samples, of a prepared, living specimen. Enchytraeids were extracted from the soil with the O'Connor's wet funnel method (O'CONNOR 1962) and identified by light microscope. For the investigation of microscopic internal characters, the living worms were put on a slide in a few drops of water and covered with cover slip. The rotifers were dissected out of the worms alive (Fig. 2). The morphology and size of the animals fit the type description (DE SMET & POURRIOT 1997).

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Figure 1. *Balatro calvus* in intestine of *Buchholzia appendiculata* juvenil.

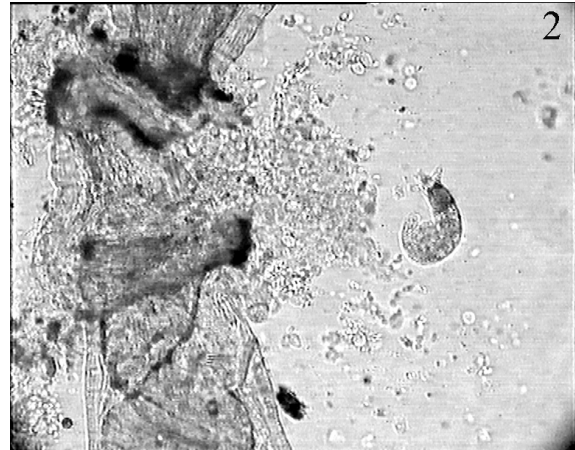


Figure 2. *Balatro calvus* dissecting out from the encythyraeids

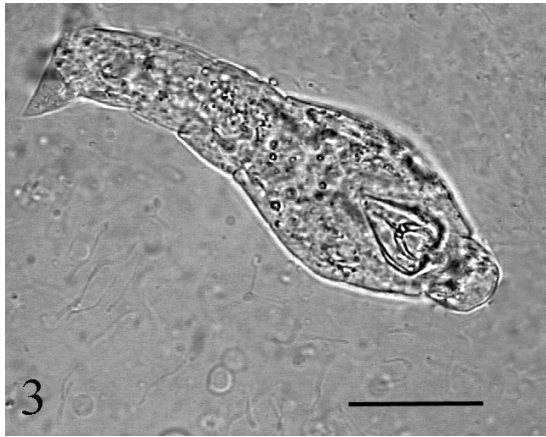


Figure 3-4. Micrograph of *Balatro calvus* (dorsal view). The figure 3 is sized with a black line, representing 40µm length.

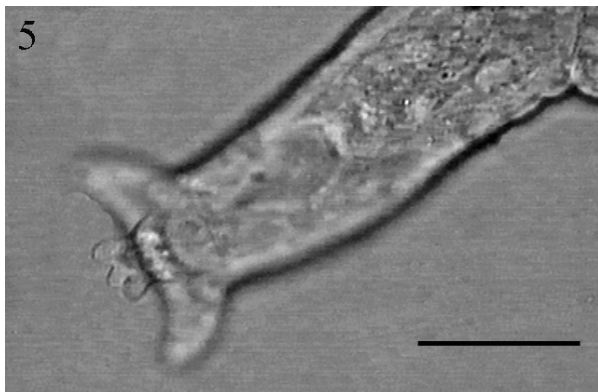


Figure 5. Micrograph of posterior end of *Balatro calvus* (dorsal view), by K. DÓZSA-FARKAS. The figure is sized with a black line, representing 40µm length.

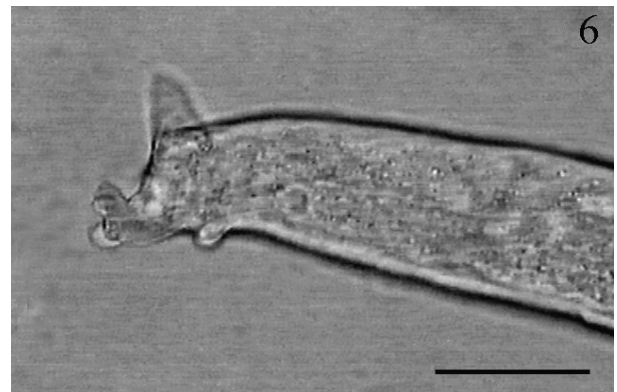


Figure 6. Micrograph of posterior end of *Balatro calvus* (lateral view), by K. DÓZSA-FARKAS. The figure is sized with a black line, representing 40µm length.

RESULTS

Balatro calvus is new to the Hungarian fauna. It was found at the three sites listed below.

(1) Balatonberény, 16.12.1997; host, *Buchholzia appendiculata* juvenile; number of individuals = 1.

(2) Kis-Balaton, Island between Feketesziget and Nagyrada, 11.12.1997; host, *Buchholzia appendiculata* juvenile; number of individuals = 6;

(3) Mátra, N 47° 50' 45" E 20° 03' 32", 03.11.2004; rotten wood in the oak forest next to Markaz village, 378 m; host, *Buchholzia appendiculata*; number of individuals = 1.

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