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On the Trichoptera of Italy with delineation of incipient sibling species

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Abstract. Lumpers, focussing between gross and molecular morphologies and neglecting fine phenomics, highly underestimate biodiversity. The outdated lumper's attitude fixed in the Distribution Atlas of European Trichoptera (Neu et al. 2018) is revisited and some theoretical background of why and how to delineate phylogenetic-retigenetic incipient species is outlined very briefly. We expose the adverse effect of lumpers in order to improve by fine phenomics the detection of the fine structure of the local genetic resources, the most valuable and most specific living components, the endemics of the particular ecosystems.

In the Italian caddisfly fauna we have recorded, treated or revised the species complex status of *Plectrocnemia geniculata*, *Tinodes dives*, *Diplectrona atra*, *Rhyacophila praemorsa*, *R. pubescens*, *R. vulgaris, Drusus graecus, D. discolor D. muelleri, D. flavipennis, D. mixtus, D. spelaeus, D. alpinus, D. nebulicola, Limnephilus stigma*. Raised the subspecies status to phylogenetic-retigenetic incipient species rank of *Plectrocnemia calabrica* Malicky, 1971 stat. nov., *Tinodes cantabricus* Botosaneanau & Gonzalez, 2001 stat. restit., stat. nov., *Tinodes consiglioi* Botosaneanu, 1980 stat. nov. *Tinodes jeekeli* Botosaneanu, 1980, stat restit., stat. nov., *Ernodes romaniulus* Moretti, Cianficconi, Campadelli & Crudele, 1999 stat. nov. Described 21 new species: *Wormaldia ameliae* sp. nov., *W. dupla* sp. nov., *W. joani* sp. nov., *W. marilouae* sp. nov., *W. reggella* sp. nov., *W. toscanica* sp. nov., *Diplectrona ligurica* sp. nov., *Rhyacophila abruzzica* sp. nov., *R. harmasa* sp. nov., *R. ligurica* sp. nov., *R. pilosa* sp. nov., *Drusus oblos* sp. nov., *D. cerreto* sp. nov., *D. dondenaz* sp. nov., *D. tagolt* sp. nov., *D. hatras* sp. nov., *D. granparadiso* sp. nov., *D. camposilvano* sp. nov., *Limnephilus logos* sp. nov., *Chaetopteryx kimera* sp. nov., *Consorophylax juliae* sp. nov.

Keywords. Italia, caddisflies, fine phenomics, new species complexes, new species.

INTRODUCTION

Working on Italian Trichoptera we have faced again the fully documented fact (Oláh *et al.* 2015, 2017) that several poorly known or so called "*widely distributed and highly varying*" species of lumpers represent actually several closely related sibling species forming together a phylogenetic or rather a retigenetic (Oláh *et al.* 2020b) species complex with various numbers of species. In the present study on the Italian Trichoptera the following species complexes have been listed, partially or completely treated or revised: *Plectrocnemia geniculata*, *Tinodes dives*, *Diplectrona atra*, *Rhyacophila praemorsa*, *R. pubescens*, *R. vulgaris*, *Drusus graecus*, *D. discolor, D. muelleri*, *D. flavipennis*, *D. mixtus*, *D. spelaeus*, *D. alpinus*, *D. nebulicola*, *Limnephilus stigma*.

Unfortunately the lumpers' capacity while navigating between gross and molecular morphologies and embarrasingly focussing on the chimeric reticulation of the taxonomic incongruences (Oláh *et al.* 2019) neglects the rich high-tech and high-throughput arsenal of fine phenomics. Lumpers highly underestimate biodiversity. They are simply unable to recover the fine structure of local genetic resources, the most valuable and most specific living components, the endemics of the

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particular ecosystems. Such an outdated lumper's attitude is practiced and fixed in the Distribution Atlas of European Trichoptera (Neu *et al.* 2018). This limited epistemic capacity of Neu *et al.* (2018) resulted in numerous unjustified taxonomic acts omitting 15 well-documented wonderful local endemics just from the list of Italian Trichoptera as registered recently (Lodovici & Valle, 2020). Moreover, these unjustified taxonomic acts were created without examination of types or any other comparative materials and realised simply in declarations either by considering the validity of incipient phylogenetic species doubtful or estimating morphological characters in the range of variation. Without examining and evaluating the entities themselves this is a typical apophantic (declaratory) treatment of taxa. Additionally, they mix vectorial divergences of adaptive traits and scalar variances of neutral traits (Oláh *et al.* 2019). We consider necessary here to revisit and repeate again very briefly some theoretical background of why it is important and how it is possible to delineate phylogenetic-retigenetic incipient species.

Revisiting the reticulated chimeric incipient species

Slowly we are learning that any entity in the universe is quantified by permanent quantum rearrangement and forms variously related ephemeral complexes. Many, if not most of the living entities, the species of taxonomy, are also composed of several, subtly but stably diverged incipient species. Similarly, Heidegger's human existence of being-in-the world creates and tries to maintain its being with understanding that is with classifying his own momentum in relation to every environing moment.

In the practice of folk taxonomy the putative species principle of "*wide distribution with high variability*" represents a typical epistemic pseudomodel of lumpers, who are compromised with, and stucked into their low-resolution power when trying to determine a species by relating it to the most similar taxon among the known, described and drawn species. They are looking and searching similar character states mostly by gross phenomics instead of looking divergences by fine phenomics. Driven by modern folk-tale, this gross morphology is decorated by virtual molecular taxonomy with incongruent semiotics and semiology, and without real semantic content and with inadequate hermeneutics (Oláh *et al.* 2018b).

The speciation trait was discovered by studying caddisflies in the sky islands of high altitude aquatic habitats along the European mountain ranges in the Carpathians, in the entire Balkans and in the Alps (Oláh *et al.* 2015). The speciation super trait was productive to delineate closely related phylogenetic incipient sibling species in various taxa, particularly in the Hydropsychidae family (Oláh 2018a, 2018b, Oláh & Jan de Vries 2019). The subtle and stable divergences are delicate, look tiny for the human eye of limited capacity or negligible by unsophisticated mental approach. But they are rather robust on the copulatory level of caddisflies to produce selective signals of stimulatory effects for mate recognition in building the reproductive isolation in early stages of reproductive isolation (Oláh 2017). To alleviate our human blindness one has to apply the population thinking and examine more specimens in more populations in order to produce diverged trait matrices of several specimens (Oláh *et al*. 2015). These matrices of speciation traits with many specimens multiply our visual capacity and help our epistemic trials in entity resolutions. The early speciation product is the phylogenetic-retigenetic incipient sibling species. The dubious subspecies and races have been taken out from science, especially by recognising the reticulated nature of divergences and replaced by incipient phylogenetic species (Oláh *et al.* 2018a).

It is shocking for lumpers of gross morphology to learn how complex genetic network of elaborated quantitative trait loci composed of thousands of sequence loci with additive small effects is producing and stabilising minor adaptive shape divergences in the incipient sibling species (McNeill *et al.* 2011). A simple curvature shape divergences of aedeagus almost indiscernible em-

pirically, undetectable reliably by visual experiences, measurable only by geometric morphometrics (Franco *et al.* 2006) involves multitude of quantitative trait loci both in protein coding sequences and in gene expression level (Schafer *et al.* 2011). Among the detected 8000 sequence loci (genes?) 2261 sequence loci were differentially expressed between species (Masly *et al.* 2011). These shape divergences are created by complex organisational network of genetic processes in synergic cooperation of several thousand sequences in numerous quantitative trait loci, superimposed by epistatic and epigenetic interactions, and maintained by complex network of protective mechanisms (Oláh & Oláh 2017). These adaptive shape divergences are quite small for human capacities to recognise them properly, particularly if taxonomy is confined to gross phenomics.

The function of lumpers and splitters is realised on four epistemic levels (Oláh *et al.* 2020a): (1) the lumpers are looking for similarities by gross phenomics and perform the first phase of taxonomy determining taxa on species complex level; (2) the second phase is the splitter's performance in searching divergent character states by fine phenomics in the species complex; (3) the third phase relies on population samples in order to examine the stability or variability ranges of the divergent state of diagnostic characters; (4) the fourth phase is to search the potential speciation super trait having the most diverse and stable shape divergences with high diagnostic value.

Even with careful focus on these epistemic levels, a natural classification by the branching principle of phylogeny is almost an unreal naive believe. Taxonomic incongruences produce almost unlimited number of character trees inside every single species tree. Phylogeny is only the surface. The organisation of living or any entities are reticulated netlike in the deep. Stochastic networking of scalar-dependent *hologeny* on universal scale and vectorial *retigeny* on partial scales are acting behind any speciation processes: Holon (the Whole) and Rete (the Network) dictate the universal reality. Taxonomist's trials to classify this network of reality into distinct hierarchy of taxa are fundamentally and theoretically artificial (Oláh *et al.* 2020b), not phylogenetic and far from being natural.

MATERIAL AND METHODS

This study on the Italian Trichoptera is based on material collected by the second author Gilles Vinçon mostly in 2020 during 4 collecting trips. Some of the related comparative materials have been collected mostly by the first and the third authors. Most of the materials, including types have been deposited in the Oláh Private Collection, Debrecen, Hungary, under national protection by the Hungarian Natural History Museum, Budapest (OPC).

Depositories

Civic Natural Science Museum "E. Caffi", Bergamo, Italy (CNSMB)
National Museum, Prague, Czech Republic (NMPC)
Oláh Private Collection, Debrecen, Hungary, under national protection by the Hungarian Natural History Museum, Budapest (OPC).

TAXONOMY

Annulipalpia

Philopotamoidea superfamily

Philopotamidae

Philopotamus ludificatus McLachlan, 1878

Material examined. **Italy**, Maritime Alps, S.E. Pratolungo, Vallone di Riofreddo, big torrent, 44.2484N, 7.176E, 1500 m, 10.08.2020, leg. Gilles Vinçon (8 males, 7 females; OPC). **Italy**, Graian Alps, Viu Valley, Borgial, big torrent, 45.203N, 7.302E, 1500 m, 26.VI.2020, leg. Gilles Vinçon (4 males, OPC). Italy, Northern Apennines, Toscane, Croce Arcana, spring and brooklet, 44.129N, 10.767 E, 1450 m, 8.VI.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Emilia-Romagna: Passo delle Radici, Nd slope, 1430 m, brook, 44.197N, 10.501E, 4.VI.2020, leg. Gilles Vinçon (2 males, OPC).

***Philopotamus montanus* Donovan, 1813**

Material examined. **Italy**, Basilicata, Lagonegro, Reserva regionale Lago Laudemio, big resurgence, 1300 m, 40.154N, 15.821E, 10.VI.20, leg. Gilles Vinçon (5 males, OPC). Italy, Calabria, Sila grande, many lateral springs, 1580-1650 m, 39.32N, 16.401E, 11.VI.20 leg. Gilles Vinçon (12 males, 4 females; OPC).

***Philopotamus variegatus* Scopoli, 1763**

Material examined. **Italy**, Emilia-Romagna: Passo delle Radici, Nd slope, 1430 m, brook, 44.197N, 10.501E, 4.VI.2020, leg. Gilles Vinçon (8 males, 6 females; OPC).

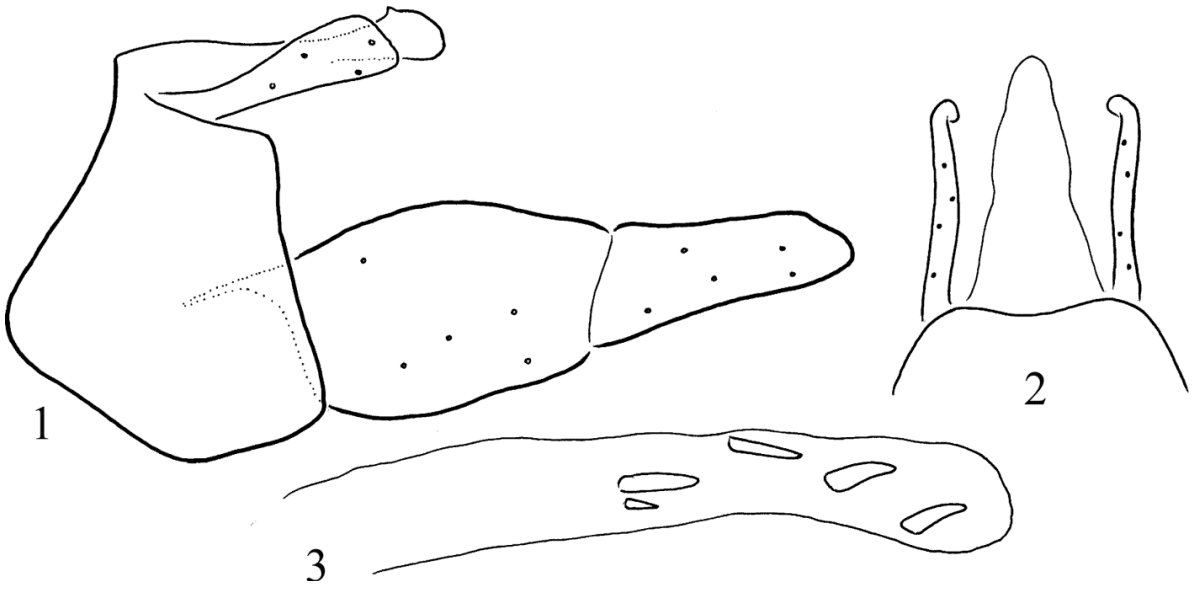
***Wormaldia ameliae* Oláh & Vinçon, sp. nov.**

(Figures 1–3, Map 1, Photo 1)

Material examined. Holotype: **Italy**, Toscana, Val di Luce, brook, 44.123N, 10.628E, 1600–1650 m, 7.VI.2020, leg. Gilles Vinçon (1 male, OPC). Paratypes: same as holotype (2 males, OPC).

Diagnosis. Having character combination of the (1) parallel-sided, not tapering harpago with narrowing harpago head, of the (2) terminal of segment X with capitate "head" and with dorsal subapical pointed process and of the (3) endothecal spine pattern without clusters of small spines and (4) with 3–4 variously shaped and sized spines this new species is a member of the *Wormaldia charalambi* species group; in spite of a small additional spine is present and the endothecal spine pattern is with five spines. *Wormaldia ameliae* sp. nov. is a sibling species of *Wormaldia marilouae* sp. nov., but diverged by the abbreviation of the head of segment X, by the cerci having no pronounced ventroapical narrowing extension and by the endothecal spine pattern of five differently shaped spines.

Description. Male (in alcohol). Medium-sized brown animal. Sclerites medium brown, setal warts both on head and thorax and legs brown.



Figures 1–3. *Wormaldia ameliae* sp. nov. Holotype male: 1 = male genitalia in left lateral view, 2 = mesal excision on tergite VIII and segment X with cerci in dorsal view, 3 = phallic organ with the endothecal spine pattern in left lateral view.

Map 1. Distribution of *Wormaldia* species (full circles represent the type localities).

Maxillary palp formula is I-II-IV-III-V. Forewing length 7 mm. Spur formula is 244.

Male genitalia. Segment X characterized by broader parallel-sided apex in dorsal view, and by a small dorsal slightly anterad directed pointed subapical process visible in lateral view; apex short semicircular in lateral view; the ending is armed with sensory structures of *sensilla basiconica* (pegs) or *sensilla coeloconica* (pitted pegs) both on the very dorsal ending of the narrowing apex as well as on the sublateral broadening. Cerci slender in dorsal view with ventromesad turning apex and its lateral profile is broader without ventroapical narrowing extension. Gonopods very produced, coxopodite and harpago with almost equal length; harpagones parallel-sided with pointed apex in lateral view. Phallic organ with eversible membranous endotheca containing five spines without small spine clusters; four larger spines almost with equal length, and one small spine.

Character combination. (1) Dorso-subapical point of segment X is a small pointed process, visible in lateral profile at the top. (2) Apex of segment X short semicircular. (3) Apex of cerci without ventroapical narrowing extension. (4) Ventromesal projection of cerci present. (5) Harpagones parallel-sided with narrowing apex. (7) Five spines present in endotheca without small spine clusters.

Etymology. We dedicate this unique species, the second Italian member of the *Wormaldia charalambi* species group to Amélia, the elder daughter of the second author.

***Wormaldia botosaneanui* Moretti, 1981**

(Map 1)

Material examined. **Italy**, Liguria, Beigua, brook and spring, 44.427N, 8.543E, 1060 m, 6.VI.2020, leg. Gilles Vinçon (2 males, OPC).

***Wormaldia cianficconiae* Neu, 2017**

(Map 1)

Material examined. **Italy**, Campania, Sabato, spring Sabato tributary, 41.026N, 14.783E, 200 m, 10.VI.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Abruzzi, Prati di Tivo, brooks very steep, 42.514N,13.573E, 1370m, 14.VI.2020, leg. Gilles Vinçon (4 males, OPC). Italy, Abruzzi: Prati di Tivo, spring with mosses below the water captage, 42.514N,13.573E, 1370 m, 9.IX.2020, leg. Gilles Vinçon (2 males, OPC).

***Wormaldia copiosa* McLachlan, 1868**

(Map 1)

Material examined. **Italy**, Maritime Alps, S.E. Pratolungo, Vallone di Riofreddo, big torrent, 44.2484N, 7.176E, 1500 m, 10.08.2020, leg. Gilles Vinçon (2 males, OPC). Italy, Graian Alps, Gran Paradiso Massif, > Dondenaz, spring + cascade, 45.612N, 7.523E, 2400 m, 11.IX.2020, leg. Gilles Vinçon (23 males, 8 females; OPC).

***Wormaldia dupla* Oláh & Vinçon, sp. nov.**

(Figures 4–6, Map 1, Photo 2)

Material examined. Holotype: **Italy**, Emilia – Romagna, Passo delle Radici, South slope, 44.2145N, 10.4875E, 1550m, 30.VI.2020, leg. Gilles Vinçon (1 male, OPC**).** Paratype: same as holotype (1 male, OPC).

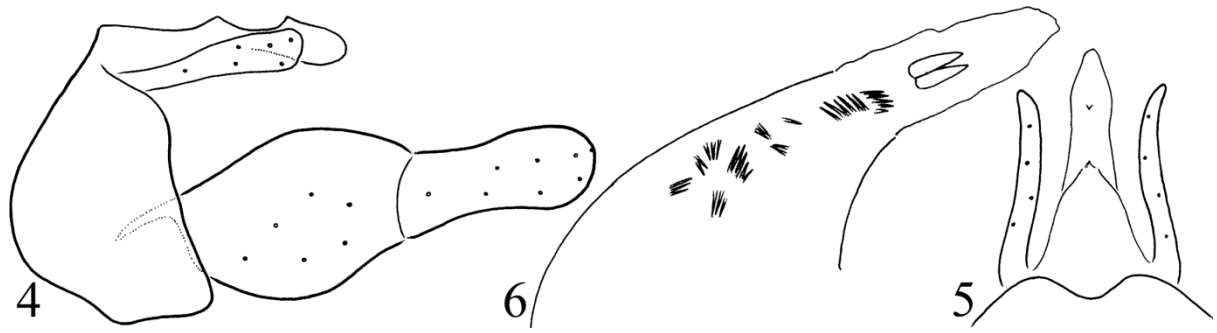
Diagnosis. Having parallel-sided harpago, *W. dupla* sp. nov. belongs to the *Wormaldia occipitalis* species group but, with incomplete endothecal spine system this new species is not a member of the *W. occipitalis* species complex. Most resembles to *W. echinata* Tobias, 1995 described from France, but differs by shorter head of segment X, the doubled subapical pointed process formed by the anterior edge of the subapical concavity. Among the neutral periphallic organs the cerci directed laterad without any mesad turning apex as well as the harpago clearly clavate. The endothecal spine pattern characterized by several groups of small spine clusters and by a pair of similarly shaped and sized stout doubled spines.

Description. Male (in alcohol). Large-sized brown animal. Sclerites medium brown, setal warts both on head and thorax and legs brown. Maxillary palp formula is I-II-IV-III-V. Forewing length 9 mm. Spur formula is 244.

Male genitalia. Segment X characterized by narrowing apex in dorsal view, and by a small dorsal pointed subapical process visible in lateral view; apex elongated semicircular almost ovoid in lateral view; the pointed subapical process is duplicated in the triangular form of the elevated anterior edge of the subapical concavity, the ending is armed with sensory structures of *sensilla basiconica* (pegs) or *sensilla coeloconica* (pitted pegs) both on the very dorsal ending of the rounded apex as well as on the sublateral broadening. Cerci slender with laterad turning apex in dorsal view. Gonopods very produced, coxopodite and harpago with almost equal length; harpagones parallel-sided with strong middle constriction in lateral view producing a clavate apex. Phallic organ with eversible membranous endotheca containing several small spine clusters with various spines and a pair of stout spines similarly shaped and sized.

Character combination. (1) Dorso-subapical point of segment X is a small pointed process, visible in lateral profile as the top formed by the apical right-angle of the dorsal concavity. (2) Apex of segment X elongated semicircular. (3) Apex of cerci rounded. (4) Ventromesal projection of cerci lacking. (5) Harpagones parallel-sided with strong middle constriction. (7) Single slender basal spine lacking. (8) Proximal pair of clusters of small spines disintegrated. (9) Distal pair of clusters present disintegrated. (10) Single pair of similar stout spines present. (11) No arching cluster of small spines developed.

Etymology. *dupla*, coined form “dupla” double in Hungarian, refers to the dorsal subapical pointed process duplicated by the posterior rim of the subapical concavity of segment X as well as to the presence of a pair of stout spines, doubled spines.



Figures 4–6. *Wormaldia dupla* sp. nov. Holotype male: 4 = male genitalia in left lateral view, 5 = mesal excision on tergite VIII and segment X with cerci in dorsal view, 6 = phallic organ with the endothecal spine pattern in left lateral view.

Wormaldia gattolliati Malicky & Graf, 2017

(Map 1)

Material examined. **Italy**, Northern Apennines, Toscane, Croce Arcana, spring and brooklet, 44.129N, 10.767 E, 1450 m, 8.VI.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Emilia-Romagna: Passo delle Radici, Nd slope, 1430 m, brook, 44.197N, 10.501E, 4.VI.2020, leg. Gilles Vinçon (3 males, OPC).

Wormaldia joani Oláh & Vinçon, sp. nov.

(Figures 7–9, Map 1, Photos 3–4)

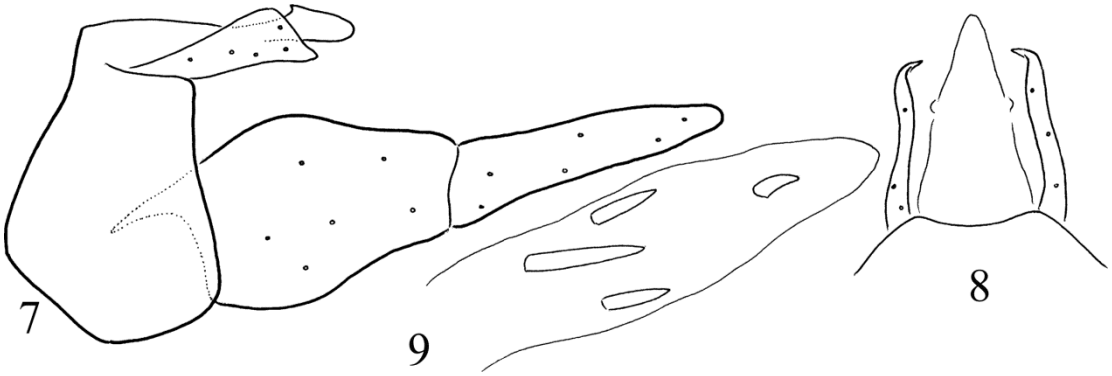
Material examined. Holotype: **Italy**, Liguria, Beigua, brook and spring, 44.427N 8.543E, 1060 m, 6.VI.2020, leg. Gilles Vinçon (1 male, OPC).

Diagnosis. Having character combination of the tapering harpago and of the terminal of segment X with capitate "head" and with dorsal subapical pointed process this new species is a member of the *Wormaldia triangulifera* species group. According to the character combination it is a putative member of the *W. vercorsica* clade of the *W. subnigra* species complex. This clade is rather incongruent, discordant, chimeric and difficult to classify. *Wormaldia joani* sp. nov. is most close to *W. gattolliati* Malicky & Graf, 2017 and to *W. telva* Oláh & Johanson, 2019, but differs by the extremely elongated and tapering harpago, by the pointed ventromesal process of the cerci as well as by the spine pattern of the endotheca.

Description. Male (in alcohol). Medium-sized brown animal. Sclerites medium brown, setal warts both on head and thorax and legs brown. Maxillary palp formula is I-II-IV-III-V. Forewing length 7 mm. Spur formula is 244.

Male genitalia. Segment X characterized by broader apex in dorsal view, and by a small dorsal slightly anterad directed pointed subapical process visible in lateral view; apex elongated semicircular in lateral view; the ending is densely armed with sensory structures of *sensilla basiconica* (pegs) or *sensilla coeloconica* (pitted pegs) both on the very dorsal ending of the narrowing apex as well as on the sublateral broadening. Cerci slender in dorsal view with sharply pointed ventromesad turning apex and its lateral profile is broader and supplied with ventroapical narrowing extension. Gonopods very produced, harpago longer than coxopodite; harpagones extremely elongated, parallel-sided with narrowing apex in lateral view. Phallic organ with eversible membranous endotheca containing four spines without small spine clusters; comprising one larger spine, two medium-sized spines and a single small curved spine.

Character combination. (1) Dorso-subapical point of segment X is a small pointed process, visible in lateral profile at the top. (2) Apex of segment X elongated semicircular. (3) Apex of cerci with ventroapical narrowing extension. (4) Ventromesal projection of cerci present, very pointed. (5) Harpagones elongated, narrowing, slender. (7) Four spines present in endotheca without small spine clusters.



Figures 7– 9. *Wormaldia joani* sp. nov. Holotype male: 7 = male genitalia in left lateral view, 8 = mesal excision on tergite VIII and segment X with cerci in dorsal view, 9=phallic organ with the endothecal spine pattern in left lateral view.

Etymology. We dedicate this unique species to Joan, the son of the second author.

Remark. The Beigua Massif, dominating the Ligurian Appennines, is a famous hot spot of biodiversity housing 3 steno-endemic species: *Wormaldia joani* sp. nov., *Diplectrona ligurica* sp. nov. and *Rhyacophila ligurica* sp. nov.

Wormaldia marilouae Oláh & Vinçon, sp. nov.

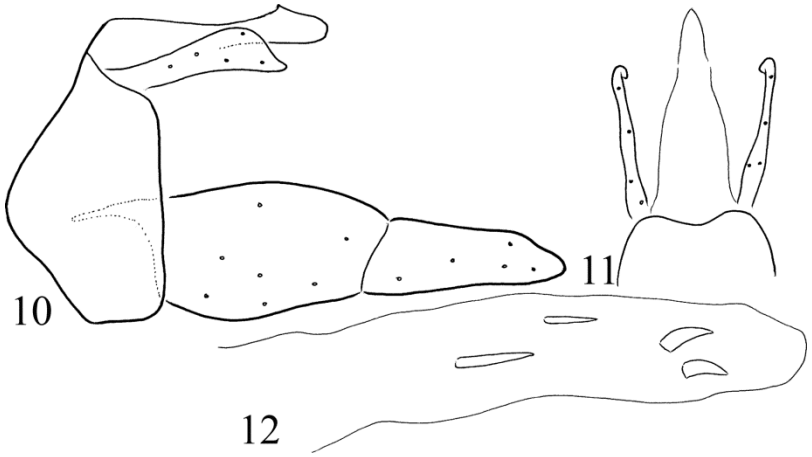
(Figures 10–12, Map 1, Photos 1, 2, 6, 7)

Material examined. Holotype: **Italy,** Emilia – Romagna, Passo delle Radici, Nd slope, 1500 m, spring, 44.194N, 10.502E, 4.VI.2020, leg. Gilles Vinçon (1 male, OPC). Paratypes: same as holotype (5 males, OPC). Italy, Toscana, Val di Luce, brook, 44.123N, 10.628E, 1600-1650 m, 7.VI. 2020, leg. Gilles Vinçon (1 male, OPC). Italy, Toscana, Passo del Cerreto, in direction of La Nuda Glacial Circus, spring and brook, 44.291N, 10.229E, 1400m, 30.VI.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Emilia – Romagna, Passo delle Radici, South slope, 44.2145N, 10.4875E, 1550m, 30.VI.2020, leg. Gilles Vinçon (10 males, 2 females; OPC**).**

Diagnosis. Having character combination of the (1) parallel-sided, not tapering harpago with narrowing harpago head, of the (2) terminal of segment X with capitate "head" and with dorsal subapical pointed process and of the (3) endothecal spine pattern without clusters of small spines and (4) with 3-4 variously shaped and sized spines this new species is a member of the *Wormaldia charalambi* species group. This small species group is comprised of four known species: *W. charalambi* Malicky, 1980 described from Thasos Island, Greece; *W. gardensis* Sipahiler, 1999 described from the surroundings of the Aigoual Mount, west St-André de Valborgne, Massive Central, France; *W. kurta* Oláh, 2019 holotype described from Alibotush Mountain, Bulgaria and paratypes from Greece Rhodope; *W. yavuzi* Sipahiler, 1996 described from Adana, Turkey and *W. ameliae* sp. nov from Toscana, Italy. *Wormaldia marilouae* sp. nov., the second Italian member of the *W. charalambi* species group most resembles to *W. gardensis*, but differs by tergite VIII widely excised apically, not with narrow triangular excision; by cerci with apicoventral pointed extension, not with rounded apex; by the endothecal spine pattern, although Sipahiler (1999) has recorded great spine pattern variation between the holotype and the paratype specimens of *W. gardensis*.

Description. Male (in alcohol). Medium-sized brown animal. Sclerites medium brown, setal warts both on head and thorax and legs brown. Maxillary palp formula is I-II-IV-III-V. Forewing length 7 mm. Spur formula is 244.

Male genitalia. Segment X characterized by narrow parallel-sided apex in dorsal view, and by a small dorsal pointed subapical process visible in lateral view; apex elongated semicircular in lateral view; the ending is armed with sensory structures



Figures 10–12. *Wormaldia marilouae* sp. nov. Holotype male: 10 = male genitalia in left lateral view, 11 = mesal excision on tergite VIII and segment X with cerci in dorsal view, 12 = phallic organ with the endothecal spine pattern in left lateral view.

of *sensilla basiconica* (pegs) or *sensilla coeloconica* (pitted pegs) both on the very dorsal ending of the narrowing apex as well as on the sublateral broadening. Cerci slender in dorsal view with ventromesad turning apex and its lateral profile is broader with ventroapical narrowing extension. Gonopods very produced, coxopodite and harpago with almost equal length; harpagones parallel-sided with pointed apex in lateral view. Phallic organ with eversible membranous endotheca containing four spines without small spine clusters; two spines curved and robust, one longer straight, one shorter straight.

Character combination. (1) Dorso-subapical point of segment X is a small pointed process, visible in lateral profile as the top. (2) Apex of segment X elongated semicircular. (3) Apex of cerci with ventroapical narrowing extension. (4) Ventromesal projection of cerci present. (5) Harpagones parallel-sided with narrowing apex. (7) Four stout spines present in endotheca without small spine clusters.

Etymology. We dedicate this unique species, the second Italian member of the *Wormaldia charalambi* species group to Marilou, the youngest daughter of the second author.

Wormaldia marlieri Moretti, 1981

(Map 1)

Material examined. **Italy**, Liguria, Beigua, brook and spring, 44.418N, 8.531E, 850 m, 6.VI. 2020, leg. Gilles Vinçon (2 males, OPC). Italy, Liguria, Beigua, brook and spring, 44.427N 8.543E, 1060 m, 6.VI.2020, leg. Gilles Vinçon (9 males, OPC).

Wormaldia maclachlani Kimmins, 1953

(Map 1)

Material examined. **Italy**, Graian Alps, Viu Valley, Borgial, big torrent, 45.203N 7.302E, 1500 m, 26.VI.2020, leg. Gilles Vinçon (4 males, OPC). Italy, Piemonte, Pennines Alps, Biella, above Sanctuario di Oropa, below the top of the cable car, 45.634N, 7.949E, 1850m, 4.VII.2020, leg. Gilles Vinçon (8 males, 7 females; OPC). Italy, Graian Alps, Ingria, brooklet and spring, 45.463N, 7.568E, 920m, 8.VIII.2020 leg. Gilles Vinçon (3 males, OPC).

Wormaldia morettii Vigano, 1974

(Map 1)

Material examined. **Italy**, Toscana, > Reggello, spring in sloping ground and brooklets, 43.696N, 11.585E, 800-900m, 8.VI.2020, leg. Gilles Vinçon (2 males, OPC). Italy, Toscana, SE Reggello, < Pratomagno, 1300-1400m, brook and spring, 43.645N, 11.665E, 8. VI.2020, leg. Gilles Vinçon (3 males, OPC). Italy, Campania, Monte Picentini, N. Giffoni Valle Piana, spring + brooklet, 40.781N, 14.924E, 850 m, 10.VI.20, leg.

Gilles Vinçon (1 male, OPC). Italy, Toscana, Val di Luce, spring + brook, 44.124N, 10.635E, 1620 m, 4.IX.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Toscana, SE Reggello, < Pratomagno, brook and spring, 43.65N, 11.655E, 1300 m, 10.IX. 2020, leg. Gilles Vinçon (1 male, OPC).

Wormaldia nielseni Moretti, 1981

(Map 1)

Material examined. **Italy**, Calabria, Mucone River, + lateral spring, 500 m, 39.473N 16.405E, 10.VI.20: leg. Gilles Vinçon (1 male, 1 female; OPC). Italy, Calabria, Aspromonte, above Gambarie, torrent, 38.144N, 15.841E, 1400 m, 8.IX. 2020, leg. Gilles Vinçon (5 males, 2 females in copula; OPC).

Wormaldia occipitalis (Pictet, 1934)

(Map 1)

Material examined. **Italy**, Trentino Alto Adige, Venetian Pre-Alps, Speccheri, low brook below the dam, with a lot of aquatic vegetation, 45.765N, 11.132E, 680 m, 10.IX.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Pennines Alps, Gressoney Valley, near Ronc de Grangia, spring and br., 45.607N, 7.812E, 600 m, 17.X.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Cottian Alps, Fenestre Pass, Chisonne trib., below Fondufaux, nice spring, 45.029N, 7.082E, 1200 m, 19.X. 2020, Gilles Vinçon (7 males, OPC). Italy, Liguria, Beigua, brook and spring, 44.418N, 8.531E, 850 m, 2.IX.2020 Gilles Vinçon (1 male, OPC). Italy, Toscana, Passo del Cerreto, in direction of La Nuda Glacial Circus, 44.286N, 10.228E, 1460m, 3.IX.2020, leg. Gilles Vinçon (1 male, OPC).

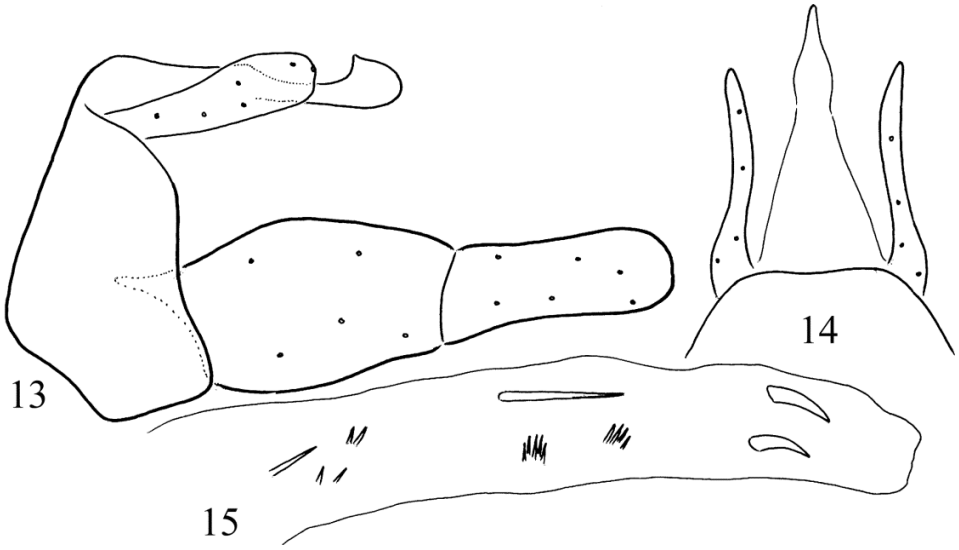
Remarks. The specimens from Liguria and Toscana have endothecal spine pattern slightly different. More specimens would be required to differentiate.

Wormaldia reggella Oláh & Vinçon, sp. nov.

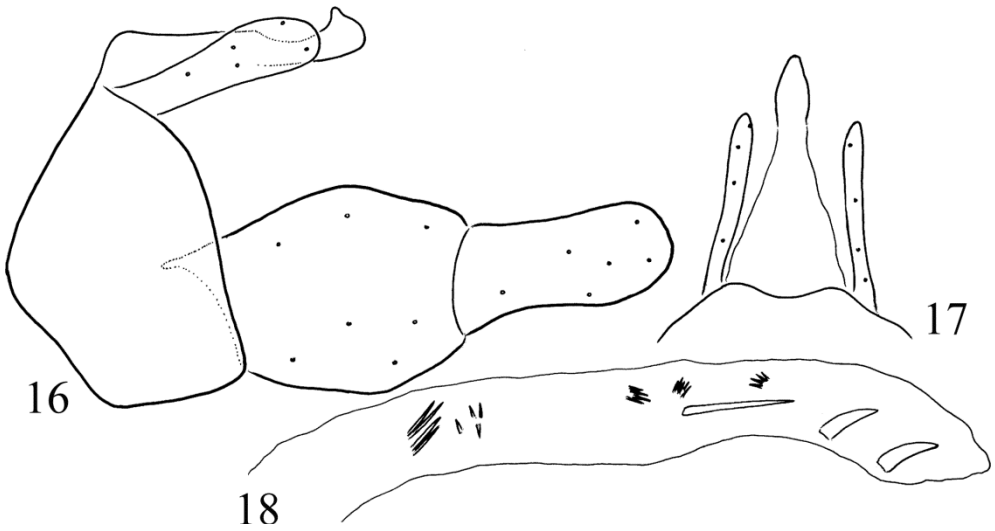
(Figures 13–15, Map 1, Photos 8–9)

Material examined. Holotype: **Italy**, Toscana, > Reggello, spring in sloping ground and brooklets, 43.696N, 11.585E, 800–900m, 8.VI.2020, leg. Gilles Vinçon (1 male, OPC).

Diagnosis. Having parallel-sided harpago, *W. reggella* sp. nov. belongs to the *Wormaldia occipitalis* species group and having complex endothecal spine system this new species is a member of the *W. occipitalis* species complex.



Figures 13–15. *Wormaldia reggella* sp. nov. Holotype male: 13 = male genitalia in left lateral view, 14 = mesal excision on tergite VIII and segment X with cerci in dorsal view, 15 = phallic organ with the endothecal spine pattern in left lateral view.



Figures 16–18. *Wormaldia toscanica* sp. nov. Holotype male: 16 = male genitalia in left lateral view, 17 = mesal excision on tergite VIII and segment X with cerci in dorsal view, 18 = phallic organ with the endothecal spine pattern in left lateral view.

Most resembles to *W. toscanica* sp. nov., but differs by smaller size and the head of segment X, rounded elongated semicircular, almost ovoid, not short and the dorso-subapical point of segment X small, not enforced. The endothecal spine pattern is very similar but with less number of small spine clusters and the basal slender spine cluster is represented by a single spine.

Description. Male (in alcohol). Medium-sized brown animal. Sclerites medium brown, setal warts both on head and thorax and legs brown. Maxillary palp formula is I-II-IV-III-V. Forewing length 7 mm. Spur formula is 244.

Male genitalia. Segment X characterized by narrow parallel-sided apex in dorsal view, and by a small dorsal pointed subapical process visible in lateral view; apex elongated semicircular almost ovoid in lateral view; the ending is armed with sensory structures of *sensilla basiconica* (pegs) or *sensilla coeloconica* (pitted pegs) both on the very dorsal ending of the narrowing apex as well as on the sublateral broadening. Cerci slender with rounded apex. Gonopods very produced, coxopodite and harpago with almost equal length; harpagones parallel-sided with only slight middle constriction in lateral view. Phallic organ with eversible membranous endotheca containing elaborated network of spines as detailed below.

Character combination. (1) Dorso-subapical point of segment X is a small pointed process, visible in lateral profile as the top formed by the apical right-angle of the dorsal concavity. (2) Apex of segment X elongated semicircular. (3) Apex of cerci rounded. (4) Ventromesal projection of cerci lacking. (5) Harpagones parallel-sided with slight middle constriction. (7) Single slender basal spine present. (8) Proximal pair of clusters of small spines disintegrated. (9) Distal pair of clusters present. (10) Two stout curved and one long and stout and straight spines present. (11) No arching cluster of small spines developed.

Etymology. Named after the region of the type locality.

Wormaldia toscanica Oláh & Vinçon, sp. nov.

(Figures 16–18, Map 1, Photos 5–7)

Material examined. Holotype: **Italy**, Toscana, Passo del Cerreto, spring, brook and torrent, 44.291N, 10.229E, 1400m, 6.VI.2020, leg. Gilles Vinçon (1 male, OPC). Paratypes: same as holotype (6 males, OPC). Italy, Toscana, Passo di Cerreto, 1500m sce + ruis., 42.286N, 10.228E, 15. VI.20, leg. Gilles Vinçon (3 males, OPC). Italy, Toscana, Passo del Cerreto, in direction of La Nuda Glacial Circus, spring and brook, 44.291N,

10.229E, 1400m, 30.VI.2020, leg. Gilles Vinçon (3 males, OPC). Italy, Toscana, Passo del Cerreto, spring, brook and torrent, 44.291N, 10.229E, 1400 m, 3.IX.2020, leg. Gilles Vinçon (5 males, OPC). Italy, Toscana, Passo del Cerreto, in direction of La Nuda Glacial Circus, 44.286N, 10.228E, 1460m, 3.IX.2020, leg. Gilles Vinçon (2 males, OPC).

Diagnosis. Having parallel-sided harpago, *W. toscanica* sp. nov. belongs to the *Wormaldia occipitalis* species group and having complex endothecal spine system this new species is a member of the *W. occipitalis* species complex. It is a unique species, easily recognised by its large size and by the well-produced, almost "fat" dorso-subapical point of segment X, and by the abbreviated head of segment X. Most resembles to *W. cianficconiae* Neu, 2017, but differs by short much abbreviated head of segment X, by the enlarged dorso-subapical point of segment X as well as by the endothecal spine pattern.

Description. Male (in alcohol). Large-sized brown animal, the giant of the genus. Sclerites medium brown, setal warts both on head and thorax and legs brown. Maxillary palp formula is I-II-IV-III-V. Forewing length 9 mm. Spur formula is 244.

Male genitalia. Segment X characterized by narrow parallel-sided apex in dorsal view, and by a very produced dorsal pointed subapical process visible in lateral view; apex semicircular and highly abbreviated in lateral view; the ending is armed with sensory structures of *sensilla basiconica* (pegs) or *sensilla coeloconica* (pitted pegs) both on the very dorsal ending of the narrowing apex as well as on the sublateral broadening. Cerci slender with rounded apex. Gonopods very produced, coxopodite and harpago with almost equal length; harpagones parallel-sided with middle constriction in lateral view. Phallic organ with eversible membranous endotheca containing an elaborated network spines as detailed below.

Character combination. (1) Dorso-subapical point of segment X is a well-produced rounded process, visible in lateral profile as the top formed by the apical right-angle of the dorsal concavity. (2) Apex of segment X abbreviated semicircular. (3) Apex of cerci rounded. (4) Ventromesal projection of cerci indistinct. (5) Harpagones parallel-sided with middle constriction. (7) Four slender and long basal spines present. (8) Proximal pair of clusters of small spines present, one is disintegrated at the holotype. (9) Distal pair of clusters present. (10) Two stout curved and one long and stout and straight spines present. (11) No arching cluster of small spines developed.

Etymology. Named after the region of the type locality.

Annulipalpia

Psychomyioidea superfamily

Polycentropodidae

Cyrnus trimaculatus (Curtis, 1834)

Material examined. **Italy**, Toscana, Passo del Cerreto, South slope, near ruined house, low river, 44.296N, 10.208E, 1100m, 30.VI, 2020, leg. Gilles Vinçon (1 male, OPC).

Plectrocnemia calabrica Malicky, 1971 stat. nov.

Plectrocnemia geniculata calabrica Malicky, 1971: 259. „Holotypus ♂: Aspromonte, dint Gambarie 1300 m, 15.-31.VII.1971, leg Hartig; in meiner Sammlungen."

Material examined. **Italy,** Calabria, Aspromonte, 2 nice brooklets separated by about 10 m, with mosses and dripping rocks, 38.25N, 15.853E, 850–900 m, 7.IX.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Lazio, Prati di Mezzo, spring below the second captage, 41.651N, 13.959E, 1700 m, 5.IX.2020, leg. Gilles Vinçon (9 males, 3 females; OPC).

Remarks. *Plectrocnemia calabrica* has shape divergence in the pattern of the apical processes on the paraproct remarkably distinct and stable. It has own distributional area. Based on our adaptive speciation trait concept of reticulated species it is

an independent contemporary born incipient species; here we raise its status to species rank, **stat. nov**. There is a long requested demand to revise the entire *Plectrocnemia geniculata* species complex with so many sibling species.

***Plectrocnemia conspersa* (Curtis, 1934)**

Material examined. **Italy**, Molise, Spring of the Volturno River, (very cold river outfall of the Volturno Lake that is fed by a big pressure pipe coming from the southern Abruzzi mountains), 41.639N, 14.078E, 550m, 2.VII.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Molise, Spring of the Volturno River, 41.639N, 14.078E, 550m, 6.IX.2020 leg. Gilles Vinçon (5 males, OPC).

***Plectrocnemia geniculata* McLachlan, 1871**

Material examined. **Italy**, Piemonte, Pennines Alps, Biella, above Sanctuario di Oropa, below the top of the cable car, 45.634N, 7.949E, 1850m, 4.VII.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Graian Alps, Gran-Paradiso, NW Noasca, spring and brooklet, 45.473N, 7.288E, 2240 m, 7.VIII.2020, leg. Gilles Vinçon (2 males, OPC).

Psychomyiidae Walker, 1852

***Lype phaeopa* (Stephens, 1836)**

Material examined. **Italy**, Liguria, Beigua, brook and spring, 44.418N, 8.531E, 850 m, 6. VI.2020, leg. Gilles Vinçon (2 males, OPC).

***Tinodes dives* species complex**

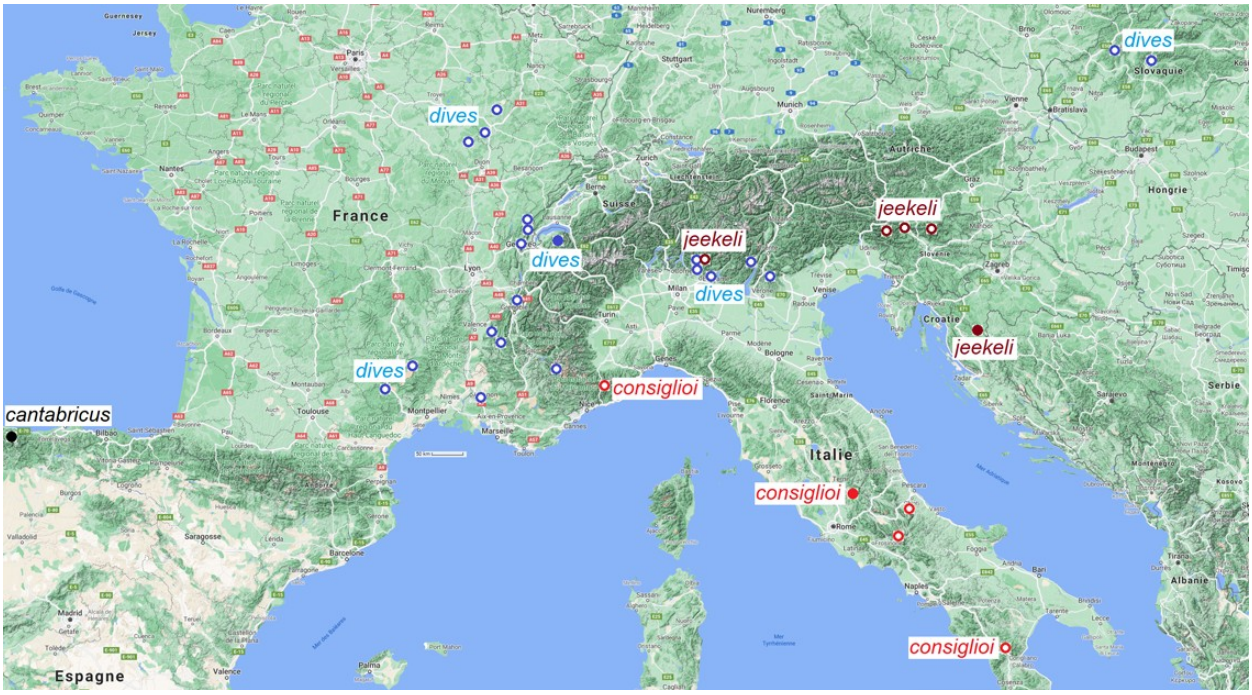
(Map 2)

A unique species with extremely broad cerci, *Tinodes dives* (Pictet, 1834) was described from the Chablais Alps near Geneva. Later Botosaneanu (1980) and Botosaneanu & Gonzalez have described three subspecies: *Tinodes dives consiglioi* Botosaneanu, 1980 from Italy, Lazio; *Tinodes dives jeekeli* Botosaneanu, 1980 from Croatia, Plitvica Lakes; *Tinodes cantabricus* Botosaneanu & Gonzalez, 2001 from Spain, Sierra de Covadonga. Without examination of type specimens and without real justification and explanation the taxa of *Tinodes dives jeekeli* and *Tinodes dives cantabricus* have been synonymised with *Tinodes dives* (Malicky 2005).

Based on the speciation trait principle (Oláh *et al.* 2015), explored by fine phenomics (Oláh *et al.* 2017) as well as applying the phylogenetic species concept (Oláh *et al.* 2018a) here we revise briefly the taxonomic status of the *Tinodes dives* species complex and raise their subspecies to incipient species rank. In this species complex there are four spine-like processes having high diagnostic value on the apical region of the coxopodite of the gonopods. They are frequently badly visible due to the dense setal fringe cover almost as long as the spines themselves. Three spine-like processes, the apicodorsal, the apicoventral and the ventromesal spines belong to the coxopodite and the fourth spine-like process arisen from deep mesad of the coxopodite is an articulated and movable structure representing the vestigial terminal segment of the gonopod that is the harpago.

Our delineation of the incipient species in this complex relies mostly on the lateral profile of apicodorsal spine on the gonopods. It is most accessible to routine examination, easy to recognise and less sensitive to observation angle. Moreover, the apicodorsal spine is the most diverse structural trait covering the basic function of speciation trait. The lateral profile of the apicodorsal spine on the gonopods is highly dependent on the functional state of the gonopods themselves. If the gonopods are closed that is close to or touch each others the apicodorsal spine is turned mesoventrad, its shape is almost indiscernible or looks straight in lateral view. The proper exposition of the spine also changes variously in open or in widely open state of the gonopods. Therefore the real shape of the apicodorsal spine is comparable only in proper perpendicular lateral view.

Besides the lateral profile of the apicodorsal spine there are divergences offering real diag-



Map 2. Distribution of *Tinodes dives* species complex (full circles represent the type localities).

nostic value in the inter-spine shape embraced by the apicodorsal and apicoventral spines, in the lateral shape of the dorsal process on the basal plate of gonopods and in the lateral shape of the paraproct, although the divergences in the paraprocts are not correctly drawn on the holotypes.

Tinodes cantabricus Botosaneanu & Gonzalez, 2001 stat. nov.

(Figure 19, Map 2)

Tinodes (*dives*) *cantabricus* n. prosp. Botosaneanau & Gonzalez, 2001: 224. "Mâle holotype: Espagne, Monte Redemuña, Sierra de Covadonga (Oviedo, Picos de Europa), 1100 m, 1.VIII.1982, leg. M. Gonzalez. Paratypes: 5 mâles, même date et localité."

Remarks. The clearly straight horizontal shape of the lateral profile of the apicodorsal spine on the gonopods as drawn by Botosaneanu & Gonzalez (2001) indicates the independent species status of this taxon. Based upon the principle of the phylogenetic species concept (Oláh *et al.* 2018a) *Tinodes cantabricus* Botosaneanu & Gonzalez 2001 is an incipient species: **stat. nov**. However, there was no specimen available to examine the real nature of the straight horizontal shape of the apicodorsal spine. It could be the result of the adpressed state of the gonopods! Its independent species status has to be confirmed by the examination of type material.

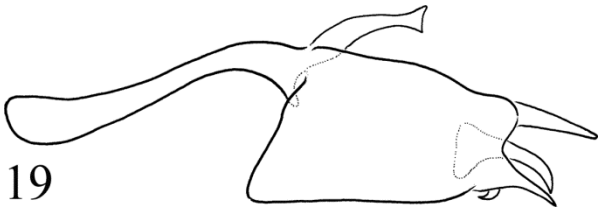


Figure 19. *Tinodes cantabricus* Botosaneanau & Gonzalez, 2001. Holotype: 19=left gonopod with the basal plane in lateral view.

Tinodes consiglioi Botosaneanu, 1980 stat. nov.

(Figures 20–26, Map 2)

Tinodes dives consiglioi Botosaneanu, 1980:76. "Holotype ♂ et 30 Paratypes ♂, d'Italie, Lazio, Paterno: Sorgente Peschiera, 21.V.1957, coll. C. Consiglio."

Material examined. **France**, La Brigue, department Alpes Maritimes, BENS, torrent de piste de, 10.VII.2008, leg. G. Coppa (5 males, 2 females; OPC). **Italy** Basilicate, Pollino, springs and rivulets, 39.916N, 16.177E, 1600–1650 m, 10.VI.2020, leg. Gilles Vinçon (1 male, 2 females; OPC). Italy, Basilicate, Pollino, 39.925N, 16.177E, 1500–1600 m, 10.VI.20, leg. Gilles Vinçon (1 male, OPC). Italy, Abruzzi, Maiella, top of San Spirito Valley, large sliding flagstones, 42.166N, 14.113E, 1530m, 2.VII.2020, leg. Gilles Vinçon (2 males, OPC). Italy, Abruzzi, Val Fondillo, big resurgence, «Sorgente Tornareccia», in beach forest, with mosses and aquatic vegetation, torrent, 41.771,13.856, 1140 m, 5.IX. 2020 leg. Gilles Vinçon (1 male, OPC).

Remarks. The remote position of the apicodorsal and apicoventral spines of the gonopods that is the inter-spine shape embraced by the apicodorsal and apicoventral spines, the laterad and anterad curving pointed tip of the basal plate of gonopods as well as the short head of the paraproct distinguish this species from all the others in the complex. This character combination is stable in all the examined populations in France and Italy. This species was described from central Italy and recorded from all parts of peninsular Italy and also recorded from France, Alpes Maritimes (Botosaneanu & Giudicelli, 2004). Based upon the principle of the phylogenetic species concept (Oláh et al. 2018a) *Tinodes consiglioi* Botosaneanu, 1980 is an incipient species: **stat. nov**.

Tinodes dives (Pictet, 1834)

(Figures 27–34, Map 2)

Hydropsyche dives Pictet, 1834:215–216. "Je n'ai trouvé cette jolie espèce qu'une fois, au mois Juillet, dans la vallée du Biot (Chablais)."

*Material examined***. France,** Western Alps, Saint-Philibert, Grande Chartreuse, 45.370 5.839, 1020 m, 15.VII.2007, leg. M. Bálint (23 males, 3 females, OPC). France, Belledonne, Villard-Saint-Cristopher, 44.976 5.813, 1100m, 16.VII.2007, leg. M. Bálint (2 males, 2 females, HNHM).

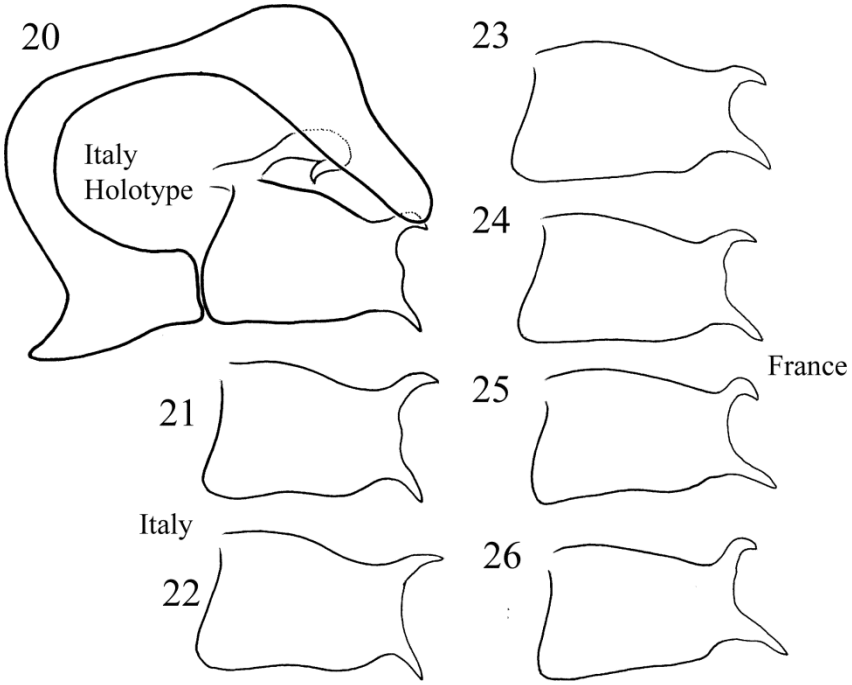


Figure 20–26. *Tinodes consiglioi* Botosaneanu, 1980. Holotype: 20 = left gonopod with the basal plane and paraproct with sternite IX in lateral view, 21–22 = lateral profile of simplified left gonopod from Italian populations, 23–26 = lateral profile of simplified left gonopod from French populations.

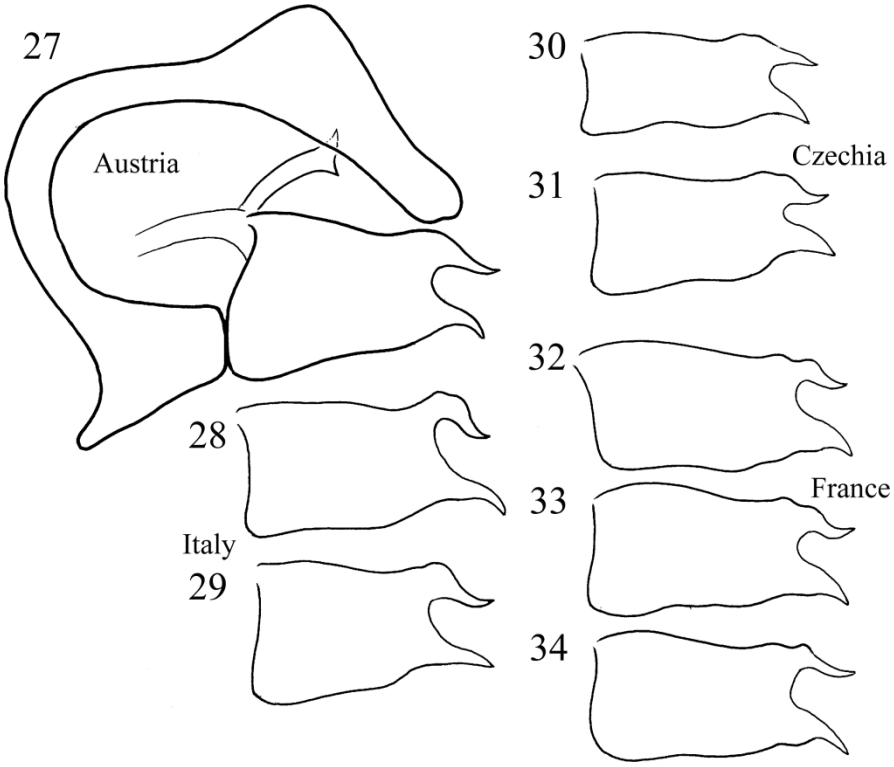


Figure 27–34. *Tinodes dives* (Pictet, 1834). 27 = left gonopod with the basal plane and paraproct with sternite IX in lateral view from Austrian population, 28–29 = lateral profile of simplified left gonopod from Italian populations, 30–31 = lateral profile of simplified left gonopod from Czech populations, 32–34 = lateral profile of simplified left gonopod form French populations.

France, Fontaine-de-Vaucluse, department Vaucluse, la Sorgue, E5°7'49'', N43°55'16'', 79 m, 22.X.2015, leg. G. Coppa (1 male, OPC). France, Ecole, department Savoie, le Nant de la Chapelle, Chapelle de Bellevaux, E 6°12'6'', N 47°35'56'', 1040 m, 12. VII. 2010, leg. G. Coppa (3 males, 2 females; OPC). France, Auberive, department Haute-Marne, source de l'Aube, E5°7'28'', N47° 45'39'', 377 m, 9.VII.2018, leg. G. Coppa (1 male, OPC). France, Mijoux, department Ain, ru Septfontaines, E 5°57'32'', N 46° 19'21'', 968m, 25.VII.2015, leg. G. Coppa (2 males, 1 female; OPC). France, Etalante, department Côte-d'Or, cirque de la Coquille / la Coquille, E4°45'57'', N47°38'42'', 380m, 4.V.2012, leg. G. Coppa (5 males, 3 females; OPC). France, Auberive, department Haute-Marne, Val Clavin, E 5°3'5'', N 47°45'8'', 382 m, 18. VIII. 2018, leg. G. Coppa (2 females; OPC). France, Florac, department Lozère, source du Pêcher, 560 m, 11.VII. 2006, leg. G. Coppa (7 males, 1 female; OPC). France, Omblèze, department Drôme, le Gervanne, cascade de la Pissoire, E 5°11'22'', N 4450°38', 599 m, 4.V.2014, leg. G. Coppa (1 male, 1 female; OPC). France, Die, department Drôme, en aval abbaye de Valcroissant, 17.VII. 2004, leg. G. Coppa (2 males, 1 female; OPC). France, Uvernet-Fours, department Alpes-de-Hautes-Provence, le Bachelard, Bayasse, E 6°44'40'' N 44°18'26'', 1800m, 8.VI.2009, leg. G. Coppa (3 males, 2 females; OPC). France, Les Bondons, department Lozère, ru Malpertuo, Malaval, 969 m, 25.V. 2017, leg. G. Coppa (9 males, 6 females; OPC). France, Ageville, department Haute-Marne, Combe Fontenois, E 5°22'20'', N 48°6'59'', 327 m, 4. V. 2011, leg. G. Coppa (2 males, OPC). France, Chézery-Forens, department Ain, Rocher des Hirondelles, la Valserine, E 5°53'32'', N 46°14' 41'', 677 m, 20.VII.2017, leg. G. Coppa (4 males, 2 females; OPC). France, Foncine-le-Bas, department Jura, ru amont de la Gypserie, E 6°1'48'', N46°37'33'', 752m, 21. VII. 2015, leg. G. Coppa (7 males, 2 females; OPC). France, La Bastide-Pradines, department Aveyron, Le Cernon, 22. VII.2013, leg. G. Coppa (3 males, 4 females; OPC). France, Germaines, department Haute-

Marne, ru de Valverse, E5°0'12'' N47°50'4'', 311 m, 8.VII.2018, leg. G. Coppa (3 males, 2 females; OPC). **Italy,** Lombardia, Monasterolo Del Castello Bergamo, Val Torrezzo Ca'Niverzoli, 500m, 9.VII.2007, leg. M. Bálint, O. Lodovici & M. Valle (9 males, 5 females OPC). Italy, Bergamo Province, Lenna, Sorgente Fregera, 500 m a.s.l. 4.VIII.2010, singled, leg. O. Lodovici & J. Oláh (68 males, 49 females, OPC). Italy, Bergamo Province, S. Giovanni Bianco, Roncaglia, hygropetric habitat, 500 m a.s.l. 4.VIII.2010, singled leg. O. Lodovici & J. Oláh. (4 males, 1 female, OPC). Italy, Trentino Alto Adige, Venetian Pre-Alps, Speccheri, low brook below the dam, with a lot of aquatic vegetation, 45.765N, 11.132E, 680 m, 10.IX.2020, leg. Gilles Vinçon (3 males, OPC). Italy, Trentino, Val di Concei, , many resurgentes with mosses, 45.962N, 10.75E, 1520 m, 11.IX.2020, leg. Gilles Vinçon (1 male, OPC). **Slovakia**, N. Slovakia, Chočské vrchy Mts, source nr. Prosiek, ca 650 m, 14.8.1961, leg. J. Sýkora (1 male,1 female; OPC, 6 males, 8 females; NMPC). Slovakia, W. Slovakia, Strážovské vrchy Mts, Rajčanka stream SE Strážov Mt. (720 m), 27.6.2009, leg. P. Chvojka (4 males, 4 females; OPC, 20 males, 7 females; NMPC).

Remarks. The nearby position of the apicodorsal and apicoventral spines of the gonopods that is the inter-spine shape embraced by the apicodorsal and apicoventral spines, the bifid apex of the basal plate of gonopods as well as the longest head of the paraproct distinguish this species from all the others in the complex. The nominate species of the complex has the longest paraproctal region of megasetae as well as the upward curving tip of the apicodorsal spine.

Tinodes jeekeli Botosaneanu, 1980 stat. nov.

(Figures 35–43, Map 2)

Tinodes dives jeekeli Botosaneanu, 1980:75–76. "Holotype ♂ de Yougoslavie, Croatie: Plitvice Jez., 4.VI.1963, coll. C.A.W. Jeekel; 2 Paratypes ♂, même localité et même date, coll. F.C.J.Fischer."

Tinodes dives (Pictet, 1834): Malicky 2005:555. *Tinodes dives jeekeli* Botosaneanu synonymised with *Tinodes dives* (Pictet).

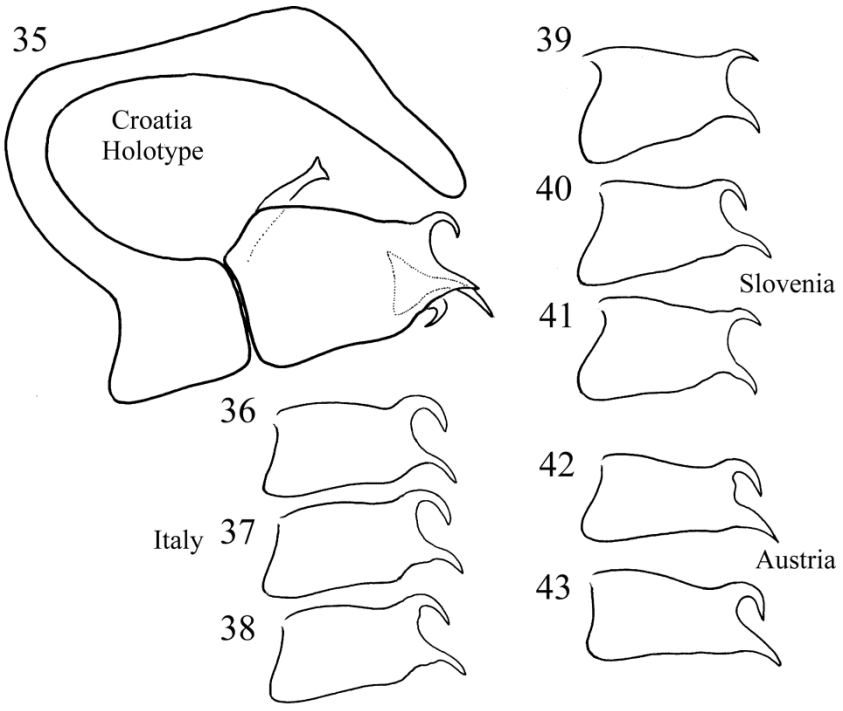


Figure 35–43. *Tinodes jeekeli* Botosaneanu, 1980. Holotype: 35 = left gonopod with the basal plane and paraproct with sternite IX in lateral view, 36–38 = lateral profile of simplified left gonopod from Italian populations, 39–41 = lateral profile of simplified left gonopod from Slovenian populations, 42–43 = lateral profile of simplified left gonopod form Austrian populations.

Material examined. **Austria**, Karawanken mountains, southwards Bad Vellach, Vellach stream, 46.428241°N, 14.550461°E, 25.VII. 1989, leg. J. Oláh (1 male, OPC). **Italy,** Bergamo Province, Mezzoldo, Alpe Ancogno, hygropetric habitat, 1850m, 4.VIII.2010, singled leg. O. Lodovici & J. Oláh. (18 males, 8 females, OPC). **Slovenia**, Julian Alp, Soca Valley, side stream, 23.VI.1988, leg J. Oláh (1 male, OPC). Slovenia, Julian Alp, Radovna stream, 22.VI.1988, leg J. Oláh (6 males, 2 females; OPC). Slovenia, Julian Alp, Radovna stream, side stream, 23.VI.1988, leg J. Oláh (5 males, OPC). Slovenia, Julian Alp, side stream of Slava Bohinja, 24.VI.1988, leg J. Oláh (4 males, OPC). Slovenia, Mojstrana, la Bistrica Triglavska, E 13°55'4'', N 46°26'48'', 705m, 20.VII.2017, leg. J. LeDoaré (2 males, 2 females, both in copula; OPC).

Remarks. The remote position of the apicodorsal and apicoventral spines of the gonopods that is the inter-spine shape embraced by the apicodorsal and apicoventral spines, the bifid apex of the basal plate of gonopods as well as the middle-long head of the paraproct distinguish this species from all the others in the complex. Its speciation trait that is the apicodorsal spine is characterized by downward curving shape. Based upon the principle of the phylogenetic species concept (Oláh et al. 2018a) *Tinodes jeekeli* Botosaneanu 1980 is an incipient species: **stat. nov**.

Tinodes maclachlani Kimmins, 1966

*Material examined***. Italy**, Calabria, SW Cosenza, -> Rizzuto, rochers suintants en bord de route et ruisselet plein d'orties et ronces, 39.25N, 16.163E, 935 m, 12.VI.20, leg. Gilles Vinçon (3 males, 9 females; OPC).

Tinodes sylvia Ris, 1903

Material examined. **Italy**, Toscana, SE Reggello, < Pratomagno, 1300–1400m, brook and spring, 43.645N, 11.665E, 8. VI.2020, leg. Gilles Vinçon (1 male, OPC).

Annulipalpia

Hydropsychoidea superfamily

Hydropsychidae

Diplectrona atra species complex

This complex is comprised of species with abbreviated internal lobes on segment X. Among the European *Diplectrona* species the members of *D. atra* complex have a pair of shorter setose internal lobes on segment X compared to the pair of setaless external lobes. The delineation of related species was based primarily on the comparative dorsal profile of the internal and external processes on segment X. However the relative length and the shape of these processes have been recorded rather variable and the species delineation was more reliably based on the adaptive trait of phallic organ, particularly on the character state of the lateral profile of the phallotheca (Oláh *et al.* 2020).

Diplectrona ligurica Oláh & Vinçon, sp. nov.

(Figures 44–48, Photos 3–4)

Material examined. Holotype: **Italy**, Liguria, Beigua, brook and spring, 44.418N, 8.531E, 850 m, 6.VI.2020, leg. Gilles Vinçon (1 male, OPC). Paratypes: same as holotype (3 males, 5 females; OPC).

Diagnosis. Having the setose internal lobes on segment X shorter than the setaless external lobes that is the paraproct, it belongs to the *Diplectrona atra* species complex. The lateral profile of the curvature of the phallic organ has resemblance to *D. atra*, but the dorsal arch is regular without apical lowering; the phallic apex is broader, especially in ventral view; the middle section of the phallotheca is highly constricted both in lateral and ventral views.

Description. Male (in alcohol). Dark almost black animal. Forewings dark brown. Forewing length is 7 mm, apical fork I present on hindwing. Eyes are setaless not enlarged. Maxillary palp

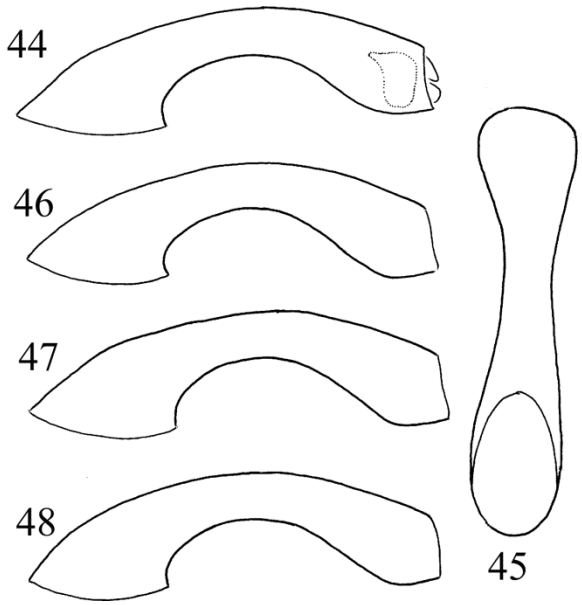


Figure 44–48. *Diplectrona ligurica* sp. nov. Holotype male: 44 = lateral profile of phallic organ, 45 = ventral wiew of phallic organ, 46–48 = lateral profile of phallic organ, paratypes.

formula I-IV-III-II-V. Cephalic setose warts on head dorsum represented by two pairs (1) large egg-shaped compact occipital setose warts, (2) vertexal ocellar compact setose warts, as well as by a single (3) vertexal medioantennal compact setose wart; epicranial suture complete, not abbreviated; curves of lateral vertexal grooves rounded subtriangular; ending posterad far from epicranial groove. Anterodorsal filaments on sternite V 0.7X as long as the sternite, but after a basal first third the apical two thirds is thin; there are two internal reticulated sacs present both in segment VI and VII.

Male genitalia. Segment IX convex anterad, dorsum short and flat with a middle depression line. Segment X fused to the tergum IX. The dorsoapical setose lobes (internal lobes) of segment X well-developed, shorter than setaless external lobe. Cerci setose, high and short in lateral view, semi-circular in dorsal view. Unsetose paraproct (outer lobes or lateral plates of segment X) digitate with laterad turning pointed apices. Gonopods robust straight and its harpago mesad turning. Phallic apparatus with down curving and broadening basal section and with a longer tube-forming horizontal on two thirds apical section; the lateral profile is characterized by regular arching dorsal and ventral apical two thirds; endothecal process movable and variously directed in the examined specimens; phallotremal sclerite large quadrangular in lateral view.

Etymology. *ligurica*, named after the region of holotype locality.

Diplectrona magna Mosely, 1930

Material examined. **Italy**, Calabria, SW Cosenza, -> Rizzuto, rochers suintants en bord de route et ruisselet plein d'orties et ronces, 39.25N, 16.163E, 935 m, 12.VI.20, leg. Gilles Vinçon (4 males, 2 females; OPC).

Hydropsyche doehleri Tobias, 1972

Material examined. **Italy**, Calabria, Aspromonte, spring + brook, 38.189N, 15.846E, 1260 m, 7.IX.2020, leg. Gilles Vinçon (1 male, OPC).

Spicipalpia

Glossosomatidae Wallengren, 1891

Agapetus padanus (Bertuetti, Lodovici & Valle, 2004)

Material examined. **Italy**, above Camposilvano, spring below the water capture, 45.746N, 11.161E, 1320 m, 18.X.2020, leg. Gilles Vinçon (2 males, 2 females; OPC).

Hydroptilidae

Hydroptilinae

Ptilocolepinae

Ptilocolepus granulatus (Pictet, 1834)

Material examined. **Italy**, Graian Alps, Viu Valley, Borgial, big torrent, 45.203N 7.302E, 1500 m, 26.VI.2020, leg. Gilles Vinçon (2 males, 2 females; OPC).

Rhyacophilidae Stephens, 1836

***Rhyacophila appennina* McLachlan, 1898**

Material examined. **Italy**, Toscana: Val di Luce, brook, 44.122N, 10.62, 1700 m, 4.IX.2020, leg. Gilles Vinçon (1 male, 1 female; OPC). Italy, Toscana, Val di Luce, spring + brook, 44.15N, 10.635E, 1400 m, 4.IX.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Toscana, north slope of Passo de Croce Arcana, 44.137N,10.783E, 1550 m, and south slop, 44.129N, 10.781E, 1620 m, 4.IX.2020. leg. Gilles Vinçon (2 males, OPC).

***Rhyacophila bonaparti* Schmid, 1947**

Material examined. **Italy**, Maritime Alps, S.E. Pratolungo, Vallone di Riofreddo, brooklet and spring in open grassland, above the Malinvern and della Paur lakes, 44.219N, 7.207E, 2500 m, 10. VIII.2020, leg. Gilles Vinçon (1 male, OPC).

***Rhyacophila intermedia* McLachlan, 1868**

Material examined. **Italy**, Maritime Alps, S.E. Pratolungo, Vallone di Riofreddo, brooklet and spring in open grassland, above the Malinvern and della Paur lakes, 44.219N, 7.207E, 2500 m, 10.VIII.2020, leg. Gilles Vinçon (1 male, OPC). France, Savoie Forclaz lakes, below the Lac Noir, torrent, 2530 m, 45.658N, 6.699E, 16.VIII.2020, leg. Gilles Vinçon (2 males, OPC). Italy, Madonna di Campiglio, brook above Nero Lake, 46.245E, 10.782N, 2260 m, 11.IX.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Madonna di Campiglio, brook below Serodoli lake and above Serodoli lake, 46.246N, 10.78E, 2350-2380 m, 11.IX.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Pennines Alps, Gressoney Valley, near Ronc de Grangia, spring and br., 45.607N, 7.812E, 600 m, 17.X.2020, leg. Gilles Vinçon (1 male, OPC).

***Rhyacophila kelnerae* Schmid, 1971**

Material examined. **Italy**, Toscana, Passo del Cerreto, in direction of La Nuda Glacial Circus, spring and brook, 44.291N, 10.229E, 1400m, 30.VI.2020, leg. Gilles Vinçon (4 males, 1 female; OPC). Italy, Graian Alps, Gran Paradiso Massif, Champorcher Valley, 45.624N, 7.592E, 1900 m, 11.IX.2020, leg. Gilles Vinçon (2 males, OPC). Italy, Graian Alps, Gran Paradiso Massif, Champorcher Valley, above Champorcher, spring with mosses, after a tunnel, 45.625N, 7.618E, 1480 m, 11.IX.2020, leg. Gilles Vinçon (4 males, OPC).

***Rhyacophila meyeri* McLachlan, 1879**

Material examined. **Italy**, Piemonte, Pennines Alps, Biella, above Sanctuario di Oropa, above the Mucrone Lake, 45.629N, 7.942E, 1930m, 4.VII.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Pennines Alps, Andrate, Viona Valley, torrent and lateral brooklets, 45.547N, 7.889E, 1120 m, 8.VIII.2020 leg. Gilles Vinçon (1 male, OPC). Italy, Pennines Alps, Gressoney Valley, near Ronc de Grangia, spring and br., 45.607N, 7.812E, 600 m, 17.X.2020, leg. Gilles Vinçon (11 male, 8 females; OPC).

***Rhyacophila praemorsa* McLachlan, 1879**

Material examined. **Italy**, Madonna di Campiglio, brook above Nero Lake, 46.245E, 10.782N, 2260 m, 11.IX.2020, leg. Gilles Vinçon (1 male, OPC).

Remarks. It seems *Rhyacophila praemorsa* is a complex of several sibling species. The single specimen has rather diverged genital structure. It is probably represents a new sibling species. Its independent incipient species status has to be examined based on comparative samples from several populations.

***Rhyacophila tristis* species group**

Having complex phallic organ and vertical segment X as well as cerci absent this species group belongs to the *Rhyacophila philopotamoides* species branch. *Rhyacophila tristis* species group has the following state of character combination. Segment IX massive and without

apicodorsal lobe. Segment X has vertical or oblique position and highly diverse, reflecting the function of speciation trait. The anal sclerite that is the epiproct of segment XI is rather large, attached or partially fused to each others and welded to segment X. Apical band that is the U-shaped paraproct of segment XI large with membranous tergal band or strap. Phallotheca large with a dorsal appendage, the aedeagus and the parameres are simple digitiform.

Rhyacophila pubescens species complex

(Map 3)

It seems *Rhyacophila pubescens* is not a single species; it is a species complex in the *Rhyacophila tristis* species group composed possibly of many sibling species. Here we delineate five siblings: *R. abruzzica* sp. nov., *R. harmasa* sp. nov., *R. ligurica* sp. nov., *R. pubescens* Pictet, 1834, *R. tsurakiana* Malicky, 1984.

Similarly to the Caucasian species complexes of the *Rhyacophila tristis* species group, *Rhyacophila spinulata* species complex and *R. abchasica* species complex, the species delineation in the *R. pubescens* complex is also based primarily on the shape divergences in the lateral profile of the structural complex amalgamated by segment X, epiproct and paraproct as well as in the fine structure of the dorsal and lateral profiles of the dorsal appendages of the phallotheca. The phallothecal dorsal appendage of the *pubescens* complex forms a finely pegged, plane with frictional dorsum functioning as an effective stimulatory structure in copulatory processes realising a diversity potential as a speciation trait.

Rhyacophila abruzzica Oláh & Vinçon, sp. nov.

(Figures 49–51, Map 3, Photo 10–12)

Material examined. Holotype: **Italy**, Abruzzi, South Maiella Massif, brook on limestone substratum, 41.882N, 14.25E, 780 m, 13.06.20, leg. Gilles Vinçon (1male, OPC). Paratypes: Italy, Abruzzi: Prati di Tivo, spring with mosses below the water captage, 42.514N, 13.573E, 1370 m, 9.IX.2020, leg. Gilles Vinçon (2 males, OPC). Italy, Abruzzi, Prati di Tivo, spring and brook below the fountain, 42.502N, 13.573E, 1550–1580 m, 9.IX.2020, leg. Gilles Vinçon (1 male, OPC).

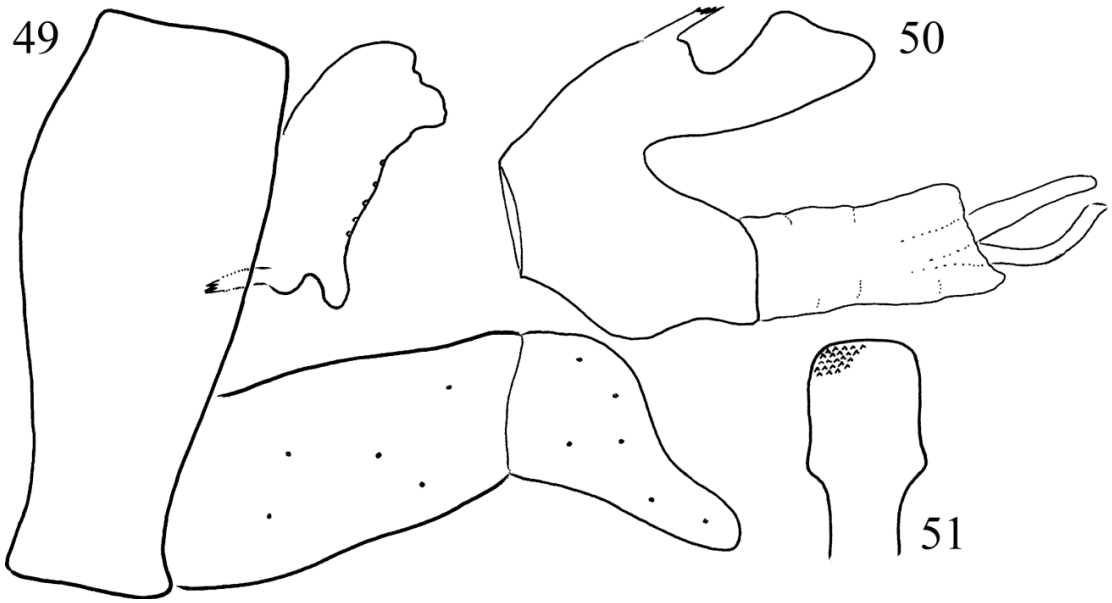
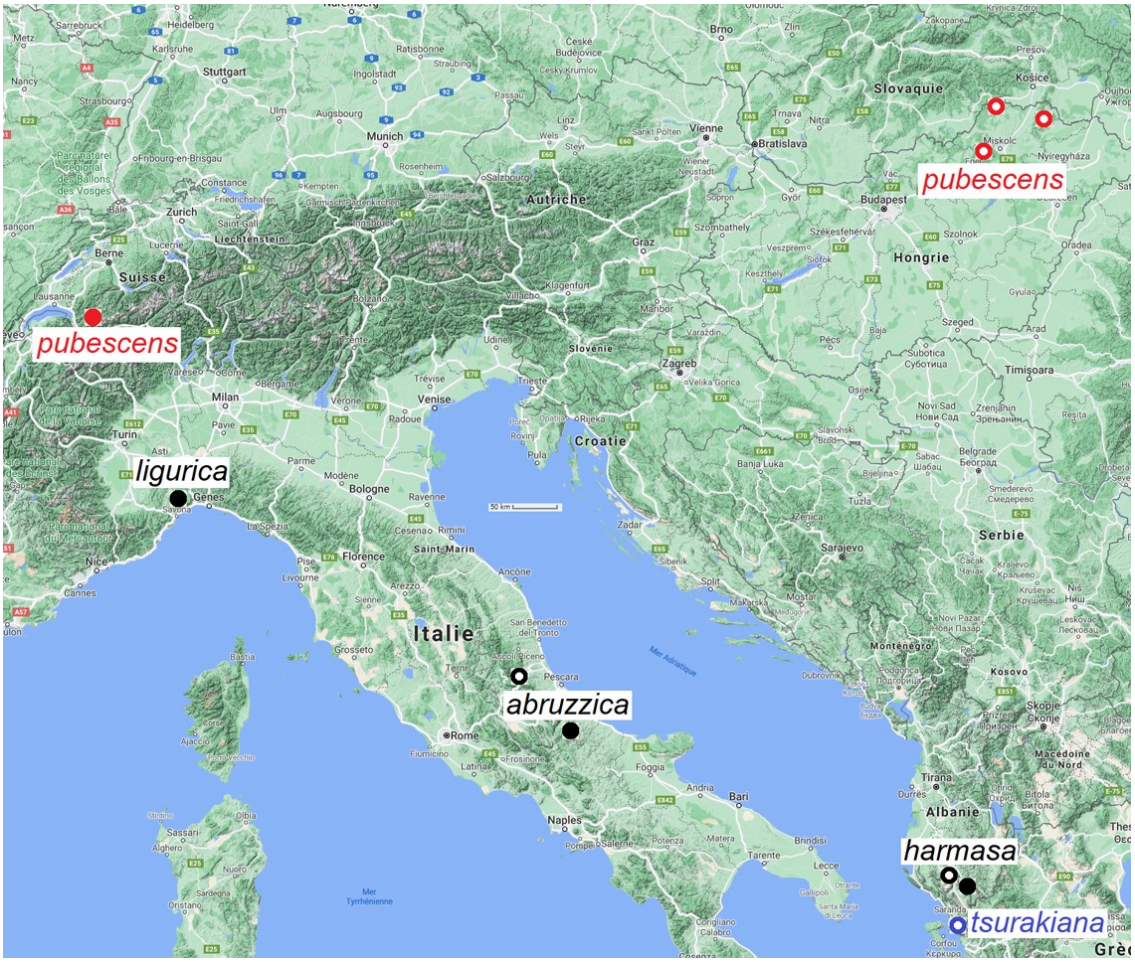


Figure 49–51. *Rhyacophila abruzzica* sp. nov. Holotype male: 49 = Lateral view of the genitalia without phallic organ, 50 = lateral view of the phallic organ, 51 = dorsal view of the dorsal appendages of the phallotheca.



Map 3. Distribution of *Rhyacophila pubescens* species complex (full circles represent the type localities).

Diagnosis. Having oblique vertical directed segment X with fused discernible epiproct and with membranous tergal strap this new species belongs to the *Rhyacophila tristis* species group; this new species with its elongated plate-form dorsal phallothecal appendages with pegged dorsal surface is a member of the *Rhyacophila pubescens* species complex; it is most similar to the nominate species of the complex, *R. pubescens*, but differs by the lateral profile of the segment X-epiproct-paraproct complex as well as by the dorsal phallothecal appendages that are more broad plate-like both in lateral and dorsal view.

Description. Head, antennae, maxillary palps, legs and segmental sclerites dark brown. Forewing brown without any pattern in alcohol, forewing length 9 mm. Segment X rather enlarged subapical process short, somewhat truncated. Lateral shape of the harpago, the second segment of the gonopods with elongated ventral lobe. Phallic organ is particularly organised; it is fixed dorsad to the complex of segment X-epiproct-paraproct by the membranous tergal strap; phallobase together with the phallotheca has a long dorsal appendage with triangular lateral and quadrangular dorsal shape; erectile endotheca clearly mem branous sunken or immersed into phallobase; aedeagus seems a thin rod-like structure, probably the enforced, chitinised ductus ejaculatoricus; a pair of parameres digitiform less pigmented.

Etymology. *abruzzica*, named after the type locality.

***Rhyacophila harmasa* Oláh & Vinçon, sp. nov.**

(Figures 52–54, Map 3)

Material examined. Holotype: **Albania,** Permet county, Nemercke Mts, 1 km S of Leushe, N slope of Mt. Policani 2 km NE of Dhembel Pass, 659 m, N40.220090° E20.356460° 24.V.2006, leg. Z. Barina, T. Pifkó & D. Pifkó (1 male, OPC). Paratype: Albania, Tepelenë district, Dragot, sidebrook of Vjosë River and its plane tree gallery S of the village, N40°17.030' E20°04.100', 145m, 14.X.2013, leg. P.Juhász, T.Kovács, D.Murányi, G.Puskás, (1 male, OPC).

Diagnosis. Having oblique vertical directed segment X with fused discernible epiproct and with membranous tergal strap this new species belongs to the *Rhyacophila tristis* species group; this new species with its elongated plate-form dorsal phallothecal appendages with pegged dorsal surface is a member of the *Rhyacophila pubescens* species complex; it is most similar to the *R. tsurakiana* described from Greece, but differs by the lateral profile of the segment X-epiproct-paraproct complex with longer subapical process and knob-like epiproct as well as by the dorsal phallothecal appendages that is supplied with lateral rims discernible both in lateral and dorsal views. The harpago is with a shorter ventral lobe.

Description. Head, antennae, maxillary palps, legs and segmental sclerites dark brown. Forewing brown without any pattern in alcohol, forewing length 9 mm. Segment X rather enlarged subapical process long, produced. Lateral shape of the harpago, the second segment of the gonopods with abbreviated ventral lobe. Phallic organ is particularly organised; it is fixed dorsad to the complex of segment X-epiproct-paraproct by the membranous tergal strap; phallobase together with the phallotheca has a long dorsal appendage with marginal rims; erectile endotheca clearly membranous sunken or immersed into phallobase; aedeagus seems a thin rod-like structure, probably the enforced, chitinised ductus ejaculatoricus; a pair of parameres digitiform less pigmented.

Etymology. *harmasa*, from "hármas" tripled in Hungarian, refers to the three-lobed dorsoapical region of the segment X-epiproct-paraproct complex.

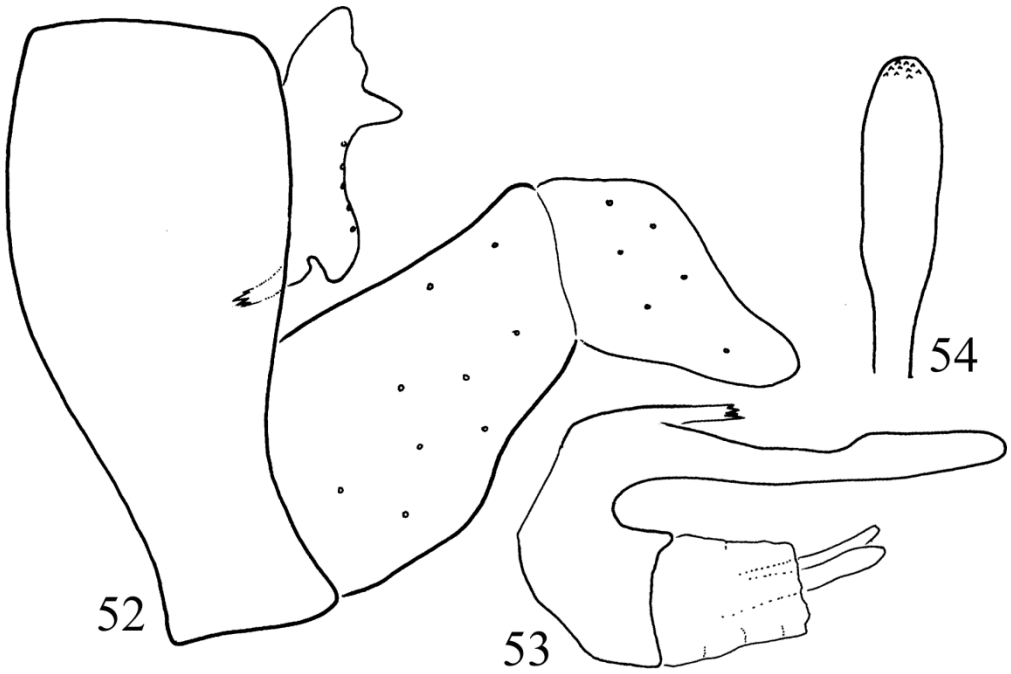


Figure 52–54. *Rhyacophila harmasa* sp. nov. Holotype male: 52=Lateral view of the genitalia without phallic organ, 53=lateral view of the phallic organ, 54=dorsal view of the dorsal appendages of the phallotheca.

***Rhyacophila ligurica* Oláh & Vinçon, sp. nov.**

(Figures 55–57, Map 3, Photos 3–4)

Material examined. Holotype: **Italy**, Liguria, Beigua, brook and spring, 44.418N,8.531E, 850 m, 2.IX.2020, leg. Gilles Vinçon (1 male, OPC). Paratypes: same as holotype (3 males, OPC).

Diagnosis. Having oblique vertical directed segment X with fused discernible epiproct and with membranous tergal strap this new species belongs to the *Rhyacophila tristis* species group; this new species with its elongated plate-form dorsal phallothecal appendages with pegged dorsal surface is a member of the *Rhyacophila pubescens* species complex; it is most similar to the *R. tsurakiana* described from Greece, but differs by the lateral profile of the segment X-epiproct-paraproct complex with longer subapical process and knob-like epiproct as well as by the dorsal phallothecal appendages that is supplied with lateral rims discernible both in lateral and dorsal views. The harpago is with a shorter ventral lobe.

Description. Head, antennae, maxillary palps, legs and segmental sclerites dark brown. Forewing brown without any pattern in alcohol, forewing length 9 mm. Segment X rather enlarged subapical process long, produced. Lateral shape of the harpago, the second segment of the gonopods with abbreviated ventral lobe. Phallic organ is particularly organised; it is fixed dorsad to the complex of segment X-epiproct-paraproct by the membranous tergal strap; phallobase together with the phallotheca has a long dorsal appendage with marginal rims; erectile endotheca clearly membranous sunken or immersed into phallobase; aedeagus seems a thin rod-like structure, probably the enforced, chitinised ductus ejaculatoricus; a pair of parameres digitiform less pigmented.

Etymology. ligurica, named after the type locality.

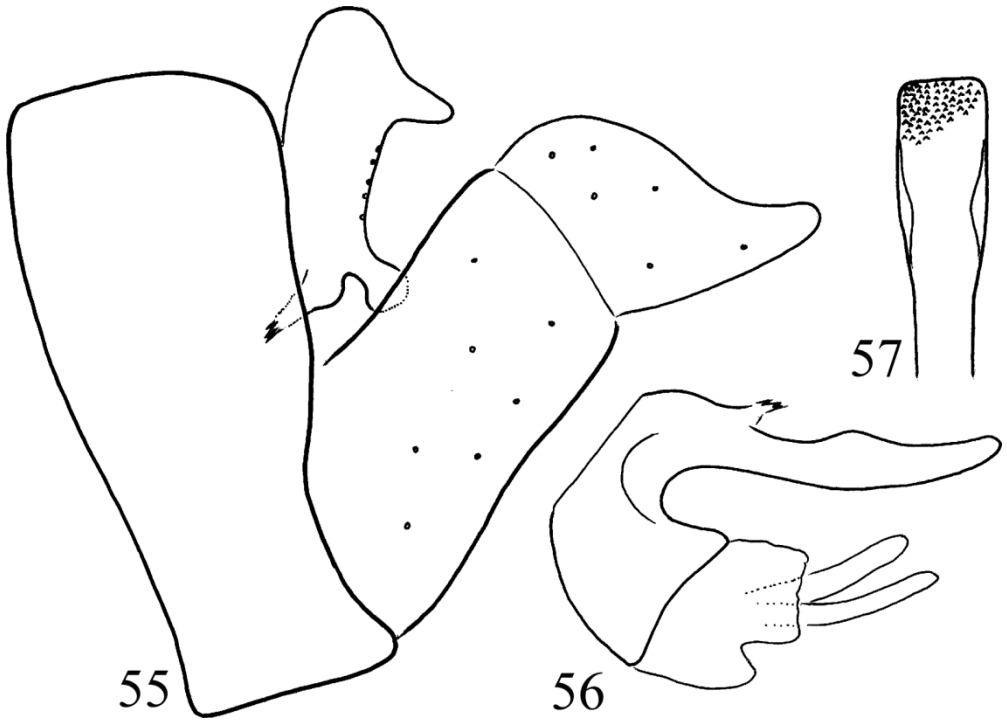


Figure 55–57. *Rhyacophila ligurica* sp. nov. Holotype male: 55=Lateral view of the genitalia without phallic organ, 56=lateral view of the phallic organ, 57=dorsal view of the dorsal appendages of the phallotheca.

***Rhyacophila pubescens* Pictet, 1834**

(Map 3)

Material examined. **Hungary**: Bükk Mts. Sebes Stream, 7. X. 1964, singled leg. J. Oláh (8 males, OPC). Hungary, Zemplén Mts. Komlóska stream, 11. VI. 1964, singled leg. J. Oláh (9 males, OPC). Hungary, Mátra Mts. Ménes stream, Patkós spring, 4–5. VII.1983, singled leg. J.Oláh, (12 males, OPC). Hungary, Bükk Mts, Mályinka, Moldva-völgy, 8.VI.2005 leg. M. Bálint (1 male, OPC).

***Rhyacophila tsurakiana* Malicky, 1984**

(Map 3)

Material examined. **Albania**, Sarandë District, Vrinë, shore of river Lumi i Pavllës, 10m, 39.71786N, 20.02033E, leg. Z. Barina, D. Pifkó & G. Puskás 8.V.2014 (2 males, OPC)

***Rhyacophila tristis* Pictet, 1834**

Material examined. **Italy,** Maritime Alps, S.E. Pratolungo, Vallone di Riofreddo, brooklet and spring in open grassland, above the Malinvern and della Paur lakes, 44.219N, 7.207E, 2500 m, 10. VIII.2020, leg. Gilles Vinçon (1 male, OPC). **Italy**, Graian Alps, Viu Valley, Borgial, big torrent, 45.203N 7.302E, 1500 m, 26.VI.2020, leg. Gilles Vinçon (7 males, 8 females; OPC). Italy, Marches: NW Arquata del Tronto, Camartina, ruisseau, 42.777N, 13.286E, 760 m, 15.VI.2020, leg. Gilles Vinçon (1 male, OPC).

***Rhyacophila rectispina* McLachlan, 1884**

Material examined. **Italy**, Graian Alps, Ingria, brooklet and spring, 45.463N, 7.568E, 920 m, 8.VIII.2020 leg. Gilles Vinçon (2 males, OPC). Italy, Graian Alps, Gran Paradiso Massif, Champorcher Valley, 45.624N, 7.592E, 1900 m, 11.IX. 2020, leg. Gilles Vinçon (2 males, OPC). Italy, Graian Alps, Gran Paradiso Massif, Champorcher Valley, above Champorcher, spring with mosses, after a tunnel, 45.625N, 7.618E, 1480 m, 11.IX.2020, leg. Gilles Vinçon (4 males, OPC). Italy, Pennines Alps, Gressoney Valley, Pillaz, brook and spring, 45.642N, 7.875E, 1340-1380 m, 17.X.2020, leg. Gilles Vinçon (7 males, OPC).

***Rhyacophila rougemonti* McLachlan, 1880**

Material examined. **Italy**, Abruzzi, Val Fondillo, brook and spring, 1300m, 41.749N, 13.865E, 9.VI.20, leg. Gilles Vinçon (4 males, 1 female; OPC). Italy, Basilicata, Lagonegro, Reserva regionale Lago Laudemio, big resurgence, 1300 m, 40.154N, 15.821E, 10.VI.20, leg. Gilles Vinçon (12 males, OPC). Italy, Abruzzi, Prati di Mezzo, > Fontitune, springs near the top, 41.651N, 13.94E and 41.651N, 13.959E, 1650–1700 m, 9. VI.2020, leg. Gilles Vinçon (5 males, 1 female; OPC). Italy, Abruzzi, Val Fondillo, big resurgence, «Sorgente Tornareccia», in beach forest, with mosses and aquatic vegetation, near the springs, 41.771N, 13.858E, 1150 m, 5.IX. 2020, leg. Gilles Vinçon (3 males, 2 females; OPC).

***Rhyacophila stigmatica* (Kolenati, 1859)**

*Material examined***. Italy,** Cottian Alps, Macra valley, spring tributary of the Bedale Intersile, 44.426N, 7.143E, 2300 m, 9.VIII.2020, leg. Gilles Vinçon (8 males, OPC). Italy, Trentino, Val di Concei, brook with mosses, 45.959N, 10.7413E, 1400 m, 11.IX.2020, leg. Gilles Vinçon (1 male, OPC).

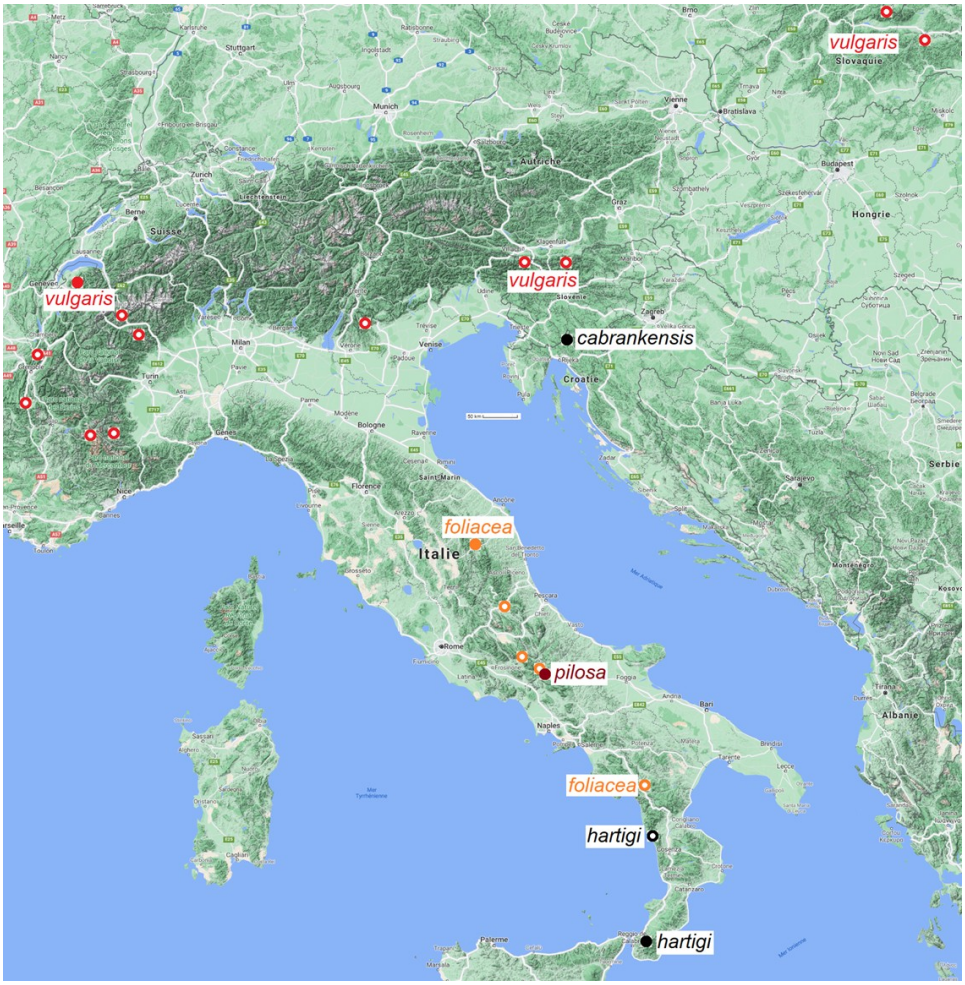
***Rhyacophila torrentium* Pictet, 1834**

Material examined. **Italy**, Cottian Alps, Macra valley, below Canosio, big torrent and lateral brook, Maira tributary, 44.458N, 7.089E, 1200 m, 9.VIII.2020, leg. Gilles Vinçon (2 males, OPC).

***Rhyacophila vulgaris* species complex**

(Map 4)

Rhyacophila vulgaris is a widely distributed European species with rather stable speciation trait of the phallic organ. Three incipient sibling species are known, produced by integrative organisation in the peripheries of its distribution in Italy along the Appenines: *Rhyacophila hartigi*



Map 4. Distribution of *Rhyacophila vulgaris* species complex (full circles represent the type localities).

Malicky, 1971, Calabria; *R. foliacea* Moretti, 1981, Central Appenines as well as in Croatia: *Rhyacophila cabrankensis* Malicky, Previšić & Kučinić, 2007 (Map 4). Here we describe the fourth incipient phylogenetic species of the *Rhyacophila vulgaris* species complex. *Rhyacophila pilosa* sp. nov.

Rhyacophila foliacea Moretti, 1981

(Map 4)

Material examined. **Italy**, Abruzzi, L'Aquila, Spring Fium Vera, 42.370N, 13.458E, 680 m, 9.IX.2020 leg. Gilles Vinçon (1 male, OPC). Italy, Abruzzi, Val Fondillo, big resurgence, «Sorgente Tornareccia», in beach forest, with mosses and aquatic vegetation, torrent, 41.771,13.856, 1140 m, 5.IX.2020 leg. Gilles Vinçon (3 males, OPC). Italy, Molise, Spring of the Volturno River, 41.639N, 14.078E, 550m, 6.IX.2020 leg. Gilles Vinçon (2 males, OPC). Italy, Basilicata, Lagonegro, Reserva regionale Lago Laudemio, big resurgence, 1300 m, 40.154N, 15.821E, 10.VI.20, leg. Gilles Vinçon (1 male, OPC).

Rhyacophila hartigi Malicky, 1971

(Map 4)

Material examined. Italy, Calabria, Acquapessa (CS), F.ra dei Bagni T.L. 150m, 3.XII.1994, leg. Pantini-Valle (1 male, OPC).

***Rhyacophila pilosa* Oláh & Vinçon, sp. nov.**

(Figures 58–59, Map 4)

Material examined. Holotype: Italy, Molise, Colli a Volturno (IS), f. Volturno c/o Ponte Sbiego, 300m, 1.IX.2009, leg. Bertuetti *et al*. identified as *Rhyacophila foliacea* Moretti by M. Valle, 2000 (1 male, OPC).

Diagnosis. Having dorsoapical process on the tergum IX and cerci present this new species belongs to the *Rhyacophila vulgaris* species group. Its particularly structured phallic organ is typical for the *Rhyacophila vulgaris* species complex. According to the lateral shape of the ventral and dorsal arms of the aedeagus as well as the ratio between paramere shaft and terminal spine *Rhyacophila pilosa* sp. nov. is most close to *Rhyacophila hartigi* but differs by the slender, S-forming and bare paramere shaft, by the shape and by the pilosed ventral arm of the aedeagus. The lateral profiles of both the epiproct and the harpago are also significantly diverged.

Description. Head, antennae, maxillary palps, legs and segmental sclerites light brown or yellowish. Forewing brown without any pattern in alcohol, forewing length 11 mm. Segment X rather enlarged with long, narrow and tapering dorsoapical lobe. Lateral shape of the harpago, the second segment of the gonopods with short and high excision. Phallic organ is particularly organised; it is fixed dorsad to the complex of segment X-epiproct-paraproct by the tergal strap; phallobase together with the phallotheca form a slightly narrowing tube, aedeagus with paired dorsal and single ventral arms; ventral arms are particularly pilosed, especially on the dorsum, ductus ejaculatoricus is almost as long as the paired dorsal arm, the dorsal arm with pilosed apex; paramere with long S-forming shaft and short apical spine.

Etymology. *pilosa*, from "pilose" covered with hairs, refers to the dorsal surface of the ventral arm of the aedeagus mostly armed with short spines.

***Rhyacophila vulgaris* Pictet, 1834**

(Map 4)

Material examined. **Austria**, Karawanken Mountains, Vellach stream, 25.VII.1989, leg. J. Oláh (5 males, OPC). **France,** La Condamine, Provence Alps, 44.451 6.741, 1263 m, 11.VII. 2007, leg. M. Bálint (1 male, OPC). Western Alps, Lalley, 44.732N, 5.679E, 1221m, 16.VII. 2007, leg. M. Bálint (4 males OPC). Western Alps, Saint-Philibert, Grande Chartreuse, 45.370 5.839, 1020 m, 15.VII.2007, leg. M. Bálint (1

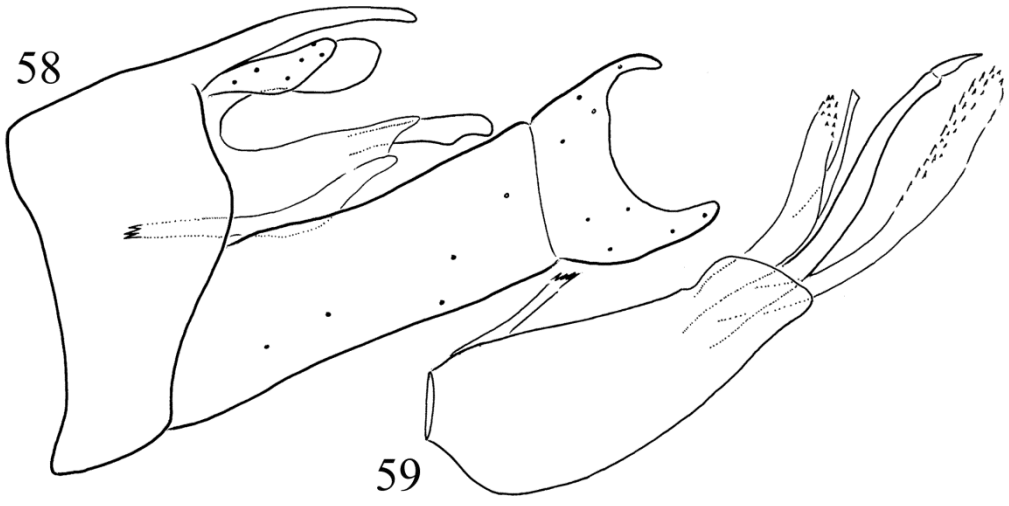


Figure 58–59. *Rhyacophila pilosa* sp. nov. Holotype male: 58=Lateral view of the genitalia without phallic organ, 59=lateral view of the phallic organ.

male, OPC). **Italy**, Piemonte, Grand St Bernard, torrent, spring near the parking, 45.846N, 7.175E, 1780m, 6.VII.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Cottian Alps, Macra valley, below Canosio, big torrent and lateral brook, Maira tributary, 44.458N, 7.089E, 1200 m, 9.VIII.2020, leg. Gilles Vinçon (2 males, OPC). Italy, Graian Alps, Gran Paradiso Massif, > Dondenaz, spring + cascade, 45.612N, 7.523E, 2400 m, 11.IX.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Venetian Pre-Alps, below Campogrosso, spring under a water capture, 45.716N, 11.183E, 1060 m, 18.X.2020, leg. Gilles Vinçon (1 male, OPC). **Poland**, High Tatra, Chocholowska valley, 22. VIII.1986, leg. J. Oláh, (3 males, OPC). **Slovakia**, Slovensky Ray, Hnilec stream valley, small side stream, 27.VII.1964, leg. J. Oláh (1 male, OPC). Slovakia, Slovensky ray, Velky studeny stream, 17.VII.1966, leg. J. Oláh (1 male, 1 female, OPC). Slovakia, Slovensky Ray, Biela Voda stream, 22.VII.1966, leg. J. Oláh (1 male, OPC). Slovakia, Slovensky Ray, Dobsina, Stratena, 10.VII. 1967, leg. H. Steinmann (1 male, OPC). **Slovenia**, Julian Alps, Radovna stream, 21.VI.1988, light leg. J. Oláh (14 male, 2 females; OPC).

Integripalpia

Plenitentoria

Limnephiloidea superfamily

Lepidostomatidae

***Crunoecia irrorata* (Curtis, 1834)**

*Material examined***. Italy**, Toscana, > Reggello, spring in sloping ground and brooklets, 43.696N, 11.585E, 800-900m, 8.VI.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Abruzzi: Prati di Tivo, spring with mosses below the water captage, 42.514N,13.573E, 1370 m, 9.IX.2020, leg. Gilles Vinçon (2 males, OPC).

Brachycentridae

***Micrasema morosum* McLachlan, 1868**

Material examined. **Italy**, Abruzzi, Val Fondillo, brook and spring, 1300m, 41.749N, 13.865E, 9.VI.20, leg. Gilles Vinçon (3 males, OPC). Italy, Abruzzi, L'Aquila, Vera Spring, 42.370N, 13.458E, 680m, 14.VI.20, leg. Gilles Vinçon (4 males, OPC). Italy, Basilicata, Lagonegro, Reserva regionale Lago Laudemio, big resurgence, 1300 m, 40.154N, 15.821E, 10.VI.20, leg. Gilles Vinçon (1 male, OPC). Italy, Abruzzi, Maiella, top of San Spirito Valley, large sliding flagstones, 42.166N, 14.113E, 1530m, 2.VII.2020, leg. Gilles Vinçon (2 males, OPC).

Uenoidae

***Tremma anomalum* Mclachlan, 1876**

Material examined. **Italy**, Toscana, SE Reggello, < Pratomagno,1300–1400m, brook and spring, 43.645N, 11.665E, 8. VI.2020, leg. Gilles Vinçon (1 male, OPC).

Goeridae

***Lithax niger* (Hagen, 1859)**

Material examined. **Italy**, Graian Alps, Viu Valley, Borgial, big torrent, 45.203N 7.302E, 1500 m, 26.VI.2020, leg. Gilles Vinçon (1 male, 3 females; OPC). Italy, Piemonte, > Cogne, Gran Paradiso Massif, Gimillan, spring, 45.643N, 7.413E, 2580–2600m, 5.VII.2020, leg. Gilles Vinçon (2 males, OPC). **Switzerland**, Grand St Bernard, big brook after the Pass, between and above the curves of the road, 2250-2400m, 6.VII.2020, leg. Gilles Vinçon (8 males, 4 females; OPC).

***Silo mediterraneus* McLachlan, 1884**

Material examined. **Italy**, Abruzzi, L'Aquila, Vera Spring, 42.370N, 13.458E, 680m, 14.VI.20, leg. Gilles Vinçon (9 males, 4 females; OPC).

Apataniidae

***Apatania fimbriata* (Pictet, 1834)**

Material examined. **Italy**, Piemonte, Grand St Bernard, torrent, spring near the parking, 45.846N, 7.175E, 1780m, 6.VII.2020, leg. Gilles Vinçon (3 males, OPC).

Limnephilidae

Drusinae

***Drusus annulatus* species group**

***Drusus annulatus* species complex**

***Drusus aprutiensis* Moretti, 1981**

(Map 5)

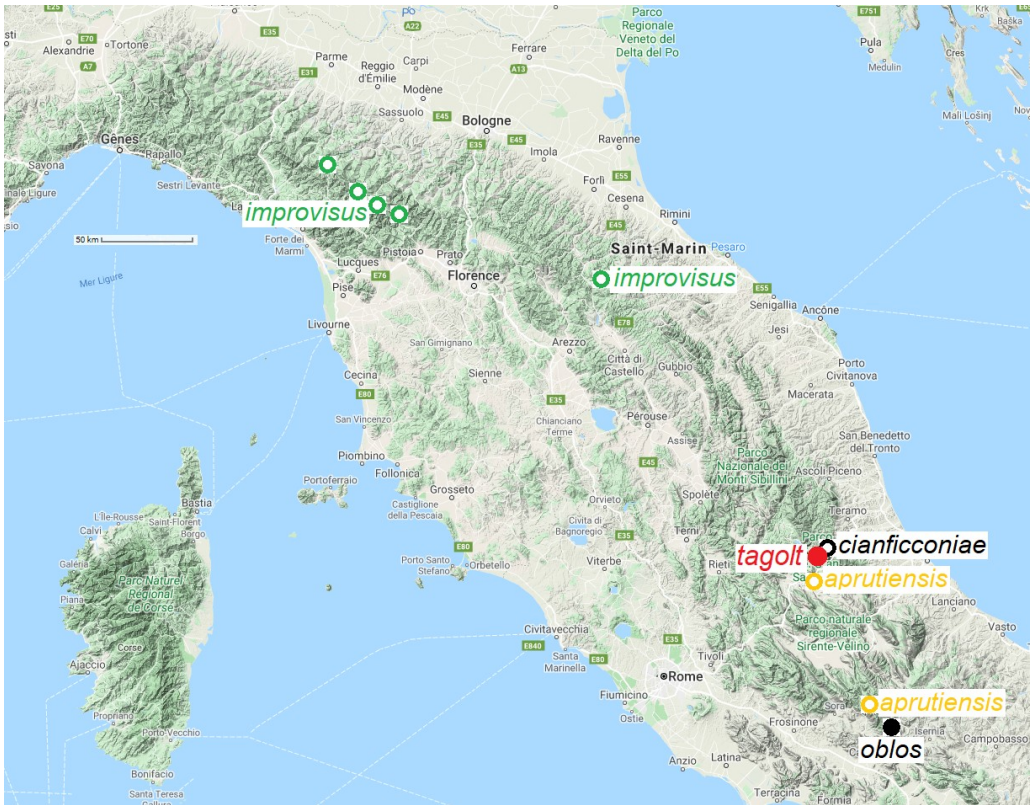
Material examined. **Italy**, Abruzzi, L'Aquila, Vera Spring, 42.370N, 13.458E, 680m, 14.VI.20, leg. Gilles Vinçon (13 males, 1 female; OPC). Italy, Abruzzi, Val Fondillo, two springs, 41.768N, 13.855E, 1100 m, 9.VI.2020, leg. Gilles Vinçon (5 males, 4 females; OPC). Italy, Abruzzi, L'Aquila, Spring Fium Vera, 42.370N, 13.458E, 680 m, 9.IX.2020, leg. Gilles Vinçon (3 males, OPC). Italy, Abruzzi, Val Fondillo, big resurgence, «Sorgente Tornareccia», in beach forest, with mosses and aquatic vegetation, near the springs, 41.771N, 13.858E, 1150 m, 5.IX.2020, leg. Gilles Vinçon (17 males, 6 females; OPC). Italy, Abruzzi, Val Fondillo, brook and spring, 41.749N, 13.865E, 1270 m, 5.IX.2020, leg. Gilles Vinçon (2 males, OPC). Italy, Abruzzi, Val Fondillo, torrent, 41.741N, 13.881E, 1300 m, 5.IX.2020, leg. Gilles Vinçon (2 males, OPC).

***Drusus trifidus* species complex**

***Drusus oblos* Oláh & Vinçon, sp. nov.**

(Figures 60–65, Map 5, Photos 13–14)

*Material examined***.** Holotype: **Italy**, Abruzzi, Prati di Mezzo, spring area, 41.651N, 13.959E, 1700 m, 29.XI.2019, leg. Gilles Vinçon (1 male, OPC). Allotype: same as holotype (1 female, OPC). Paratypes: same as holotype (3 males, 8 females; OPC). Italy, Lazio, Prati di Mezzo, spring below the second captage, 41.651N, 13.959E, 1700 m, 5.IX.2020, leg. Gilles Vinçon (5 males, 2 females; OPC).



Map 5. Distribution of species from *Drusus annulatus* and *Drusus bosnicus* species groups (full circles represent the type localities).

Diagnosis. Having recumbent primary and secondary paramere spines this new species belongs to the *Drusus annulatus* species group. The paraproct is characterized by hook-shaped dorsal branch in lateral view, a character state of the *Drusus trifidus* species complex. Most closed to *Drusus trifidus*, the nominate species of the group, but differs by the lack of trifid spinulose region on tergite VIII; by the cerci rounded, not elongate; the gonopod is more produced, elongated. The lateral profile of the dorsal branch of the paraproct is without dorsobasal ridge. The paramere armed with small recumbent spines. The female of the new species has a very big and wide excision apicad on the fused tergite IX and X visible in dorsal view.

Description. Dark brown animal with forewing length of 6.5 mm. Cephalic and thoracic sclerites are castanean brown, legs and abdomen lighter. Forewing with rather strong erect setae, especially on longitudinal veins.

Female genitalia. Tergite of segment IX and X with deep and wide semicircular apicomesal excision; the lateral setose lobe of sternite IX small rounded triangular. Supragenital plate of segment X (upper vaginal lip) much developed and quadrangular both in lateral and ventral views. Median lobe of the vulvar scale (lower vaginal lip) present slightly shorter than the lateral lobes.

Etymology. *oblos*, from "öblös" similar to sinus or bay in Hungarian, refers to the deep and wide, semicircular apicomesal excision on the fused IX and X tergits of the female.

Drusus bosnicus species group

This species group is characterized by the presence of a single robust erected primary paramere spine accompanied by secondary or tertiary spines anterad. Further lineage divergences have been organised by significant modifications in paraproct shape either through simplification or complexification. The more recent, younger contemporary divergences produced incipient sibling species that are distinguishable by subtle, but stable shape modifications mostly in the fine structures of the paraproct head. The delineation of all the species complexes in the species group is based on paraproct shape divergences (Oláh *et al.* 2017).

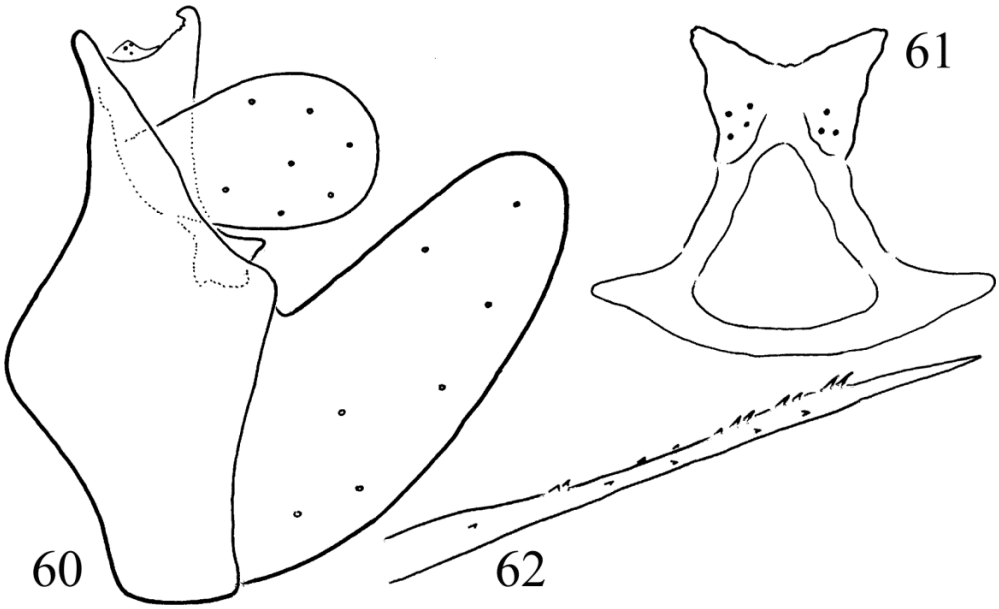


Figure 60–62. *Drusus oblos* sp. nov. Holotype male: 60 = Lateral view of the genitalia without phallic organ, 61 = paraproct in caudal view, 62 = paramere in lateral view.

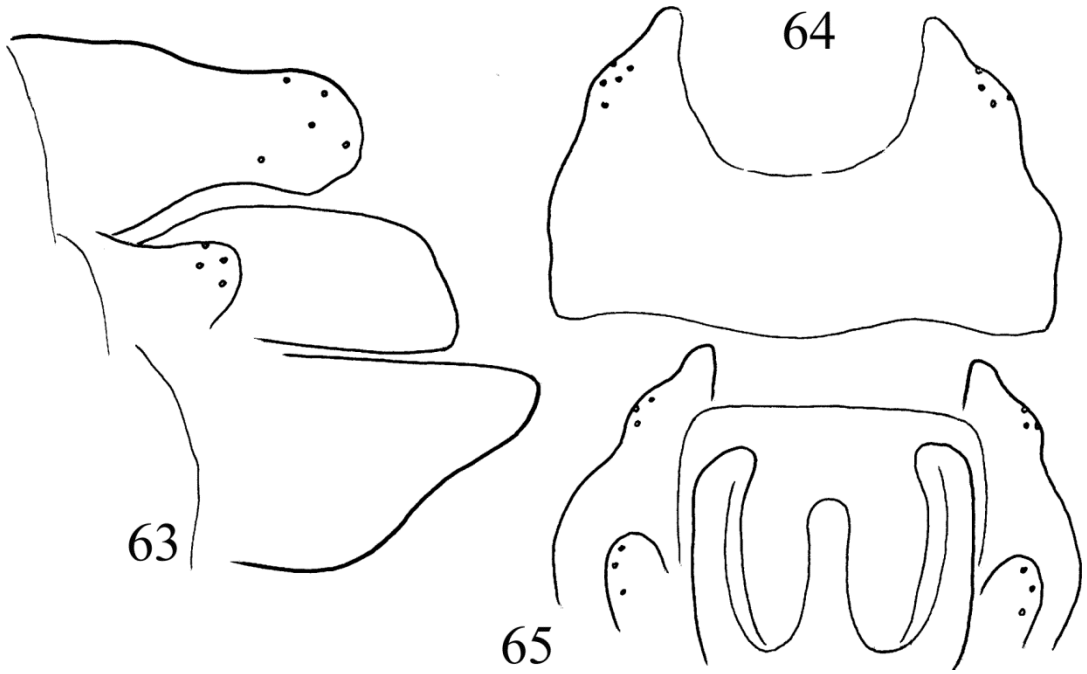


Figure 63–65. *Drusus oblos* sp. nov. Allotype female: 63=Lateral view of the genitalia, 64=dorsal view of the genitalia, 65=ventral view of the genitalia.

Drusus graecus species complex

Drusus graecus species complex has dorsal branches of the paraproct fused forming simple, rounded hump-like, blunt apical arm in lateral view, with laterad slightly enlarged shape in caudal view. The complex has two distinct lineages of sibling species: *Drusus graecus* siblings and *Drusus lepidopterus* siblings.

Drusus lepidopterus siblings

(Map 6)

Monocentra lepidoptera was known as a single species of the monobasic *Monocentra* genus very close to genus *Drusus*, but having scales, a secondary sexual character mostly on the forewing of the male, but in a varying pattern at the different siblings. The genus was synonymised with the genus *Drusus* and the single species *D. lepidopterus* was splitted into six sibling species differenciated by the fine structure of the dorsal surface of the fused dorsal arm of paraproct: *D. apuanensis, D. dudor, D. lepidopterus, D. liguriensis, D. piemontensis, D. savoiensis* (Oláh *et al. 2017*). Here we describe two more new species and we plot on a same map all the 8 *Drusus lepidopterus* siblings.

In caudal view the fused dorsal branches of paraproct of the *lepidopterus* siblings slightly enlarged laterally with basolateral lobes. At higher resolution of compound microscopy we have recognised divergent and very stable dorsal shape profiles at the different sibling species integrated in the isolated mountain ranges. The dorsal shape profile with its surface fine structure seems to function as a sensory-stimulatory copulatory organ. Besides the definite divergences in dorsal shape profiles we have found very diverse surface pattern on these selective shape divergences (Oláh *et al*. 2017). The additional taxonomic tool of setal/surface pattern further enlarges our capacity to delineate closely related incipient sibling species.

***Drusus cerreto* Oláh & Vinçon, sp. nov.**

(Figures 66–68, Map 6, Photos 5–7)

Material examined. Holotype: **Italy,** Toscana, Passo del Cerreto, in direction of La Nuda Glacial Circus, spring and brook, 44.291N, 10.229E, 1400m, 30.VI.2020, leg. Gilles Vinçon (1 male, OPC).

Diagnosis. A new species among the *Drusus lepidopterus* siblings of the *D. greacus* species complex in the *Drusus bosnicus* species group. This species belongs to the northern group of *D. lepidopterus* siblings without pronounced microplate structures in the surface pattern on the dorsal surface of the fused dorsal branches of the paraproct. The new species; *D. cerreto* is most close to *D. apuanensis* Oláh, 2017 but differs by the dorsal profile of the fused dorsal branch of the paraproct that is regular triangular at *D. cerreto* and abbreviated at *D. apuanensis*, as well as by the surface pattern of the fused paraproct without any microplate at the new species and with

Map 6. Distribution of species from the *Drusus lepidopterus* siblings of the *Drusus graecus* species complex in the *Drusus bosnicus* species group (full circles represent the type localities).

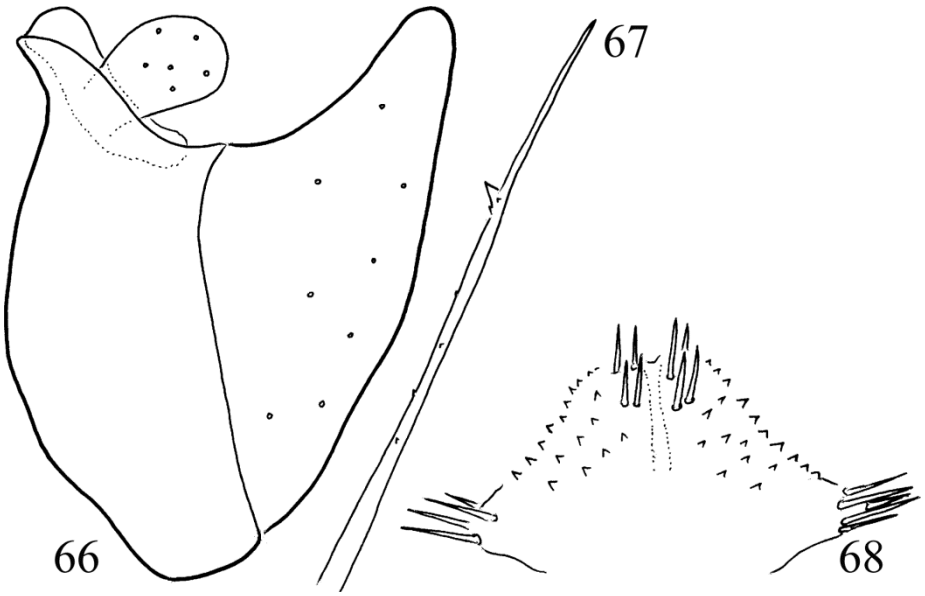


Figure 66–68. *Drusus cerreto* sp. nov. Holotype male: 66 = Lateral view of the genitalia without phallic organ, 67 = paraproct in dorsal view, 68 = paramere in lateral view.

microplate at *D. apuanensis*. Among the peri-phallic organs cercus is shorter and the gonopod is slimmer at the new species. However, a future study needs to examine the trait stabilities at both species represented only by their holotypes.

Description. The architectural shape of the dorsal profile of the fused dorsal arm of the paraproct is characterized by almost a regular triangle. The triangle is the result of the basolateral lobes forming the two angles of triangle. The mesal body of the fused arms of the paraproct has a minute, tiny apicomesal excision, asymmetrical. There is no microplate field discernible, almost fully covered with short microspines. The suture lines running mesad parallel. The paramere setal pattern of the holotype asymmetrical, the erect, short primary spine on the right paramere is even shorter. The erect primary spine is accompanied by a few secondary or tertiary spines located both dorsad; there are several, just discernible small tertiary spines on the entire pre-spine paramere shaft.

Etymology. Named after the region of the type locality as a noun in apposition.

***Drusus dondenaz* Oláh & Vinçon, sp. nov.**

(Figures 69–74, Map 6, Photo 15)

Material examined. Holotype: **Italy**, Graian Alps, Gran Paradiso Massif, Champorcher Valley, above Dondenaz, spring + brook, 45.618N, 7.549E, 2100 m, 11.IX.2020, leg. Gilles Vinçon (1 male, OPC). Allotype: same as holotype (1 female, OPC). Paratypes: same as holotype (9 males, 5 females; OPC).

Diagnosis. A new species among the *Drusus lepidopterus* siblings of the *D. greacus* species complex in the *Drusus bosnicus* species group. The forewing of the male is completely covered with slightly elongated scales, females lacking scales on their forewing. This species belongs to the northern group of *D. lepidopterus* siblings without pronounced microplate structures in the surface pattern on the dorsal surface of the fused dorsal branches of the paraproct. The new species *D. dondenaz* is most close to *D. savoiensis*, but differs by the shape and surface pattern of the fused dorsal branch of the paraproct in dorsal view, according to the fine structure.

Description. The architectural shape of the dorsal profile of the fused dorsal arm of the paraproct is characterized by complex lobe system. Beside the basolateral and apical pair of lobes there is a definite subapical pair of lobes, differentiating this new species from all the other member of the siblings. There is no microplate field discernible; the entire surface is almost fully covered with short microspines. The mesal suture line vestigial, present only apicad. The paramere setal pattern of the holotype slightly asymmetrical, the erect, primary spine is strong; the erect primary spine is accompanied by a few secondary or tertiary spines located both dorsad; there are few, just discernible small tertiary spines on the entire pre-spine paramere shaft.

Female genitalia. Tergite of segment IX and X with deep and wide semicircular apicomesal excision; both in the dorsal and lateral views the lateral lobes bluntly bilobed; the lateral setose lobe of sternite IX elongated triangular, heavily setose. Supragenital plate of segment X (upper vaginal lip) much developed and quadrangular both in lateral and ventral views. Median lobe of the vulvar scale (lower vaginal lip) present half as long as the lateral lobes.

Etymology. Named coined from the name of the type locality as a noun in apposition.

***Drusus piemontensis* Oláh, 2017**

(Map 6)

Material examined. **Italy,** Road to the Lago della Tempesta, spring and brooklet, 44.46N, 7.124E, 1950 m, 9.VIII.2020, leg. Gilles Vinçon (1 male, 1 female; OPC).

***Drusus savoiensis* Coppa & Oláh, 2017**

(Map 6)

Material examined. **Italy**, Graian Alps, Viu Valley, Borgial, big torrent, 45.203N 7.302E,

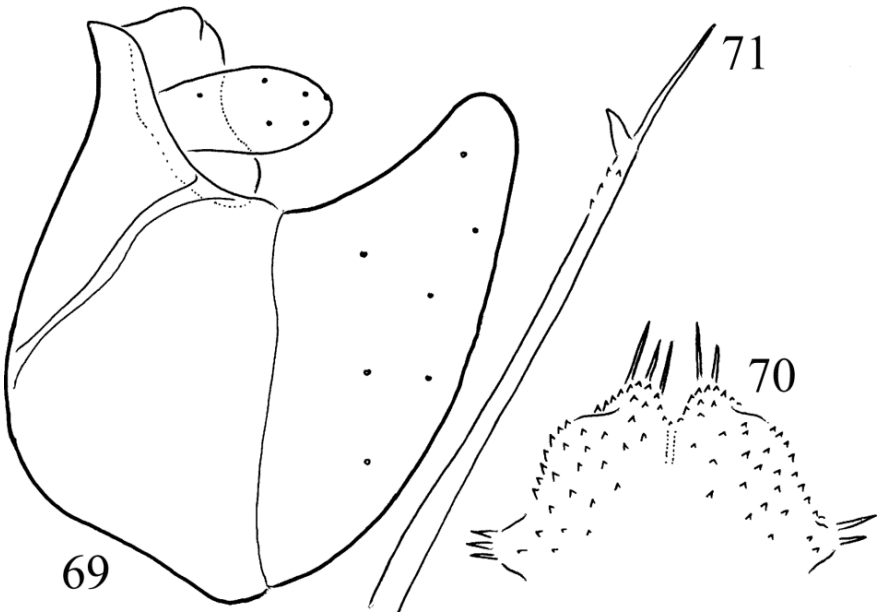


Figure 69–71. *Drusus dondenaz* sp. nov. Holotype male: 69 = Lateral view of the genitalia without phallic organ, 70 = paraproct in dorsal view, 71 = paramere in lateral view.

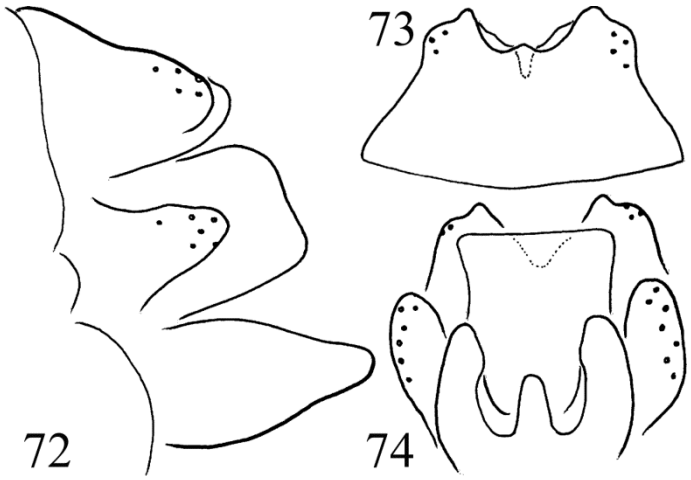


Figure 72–74. *Drusus dondenaz* sp. nov. Allotype female: 72 = Lateral view of the genitalia, 73 = dorsal view of the genitalia, 74 =ventral view of the genitalia.

1500 m, 26.VI.2020, leg. Gilles Vinçon (3 males, 7 females; OPC). Italy, Graian Alps, Gran-Paradiso, NW Noasca, spring and brooklet, 45.473N, 7.288E, 2240 m, 7.VIII.2020, leg. Gilles Vinçon (1 male, OPC).

Remarks. This species represents a new record for Italy.

Drusus tagolt Oláh & Vinçon, sp. nov.

(Figures 75–78, Map 5, Photos 11–12)

Material examined. Holotype: **Italy**, Abruzzi, Prati di Tivo, spring and brook below the fountain, 42.502N, 13.573E, 1550-1580 m, 9.IX.2020, leg. Gilles Vinçon (1 male, OPC).

Diagnosis. This is a highly modified species undergone of great stochastic perturbations resulting in great and unique structural modifications. Segment IX is subdivided almost completely and fused to the ventral branches of the paraproct. Having a single robust erected primary spine on the paramere it is a member of the *Drusus bosnicus* species group. In several members of this species group there are tendencies for subdivision of segment IX indicated by the presence of well-developed articulation sutures. Species complexes of the species group are detectable by the significant structural modifications in the paraproct. The dorsal branch of the paraproct is not enlarged in any extent laterad in caudal view, but enlarged in *D. bosnicus*, *D. discophorus*, *D. muranyorum* and not horizontal digitiform as in *D. improvisus*. Most close to *D. graecus* species complex, but has not as much blunt and fused head of the dorsal branch of the paraproct. The subdivided segment IX differentiates from all the species in the *Drusus* genus.

Description. Medium-sized species with dark, almost castanean brown head and thoracic sclerites; legs and wings are brown; forewing length 11 mm. Segment IX is unique, subdivided into a dorsal and a ventral part; the dorsal part, the tergite is characterized by rather produced dorsal strap. Cerci elongated slightly downward arching. Paraproct with sclerotized dorsal branch and less sclerotized highly inflated ventrum; the head of the dorsal branch subtriangular in lateral view and subdivided by a V-shaped excision in dorsal and caudal views. Gonopods are short. Paramere with a single small, V-shaped erected spine.

Etymology. *tagolt*, from "*tagolt*" partitioned, articulated, divided in Hungarian, refers to the partitioned segment IX subdivided into dorsal (tergal) and ventral (sternal) articles.

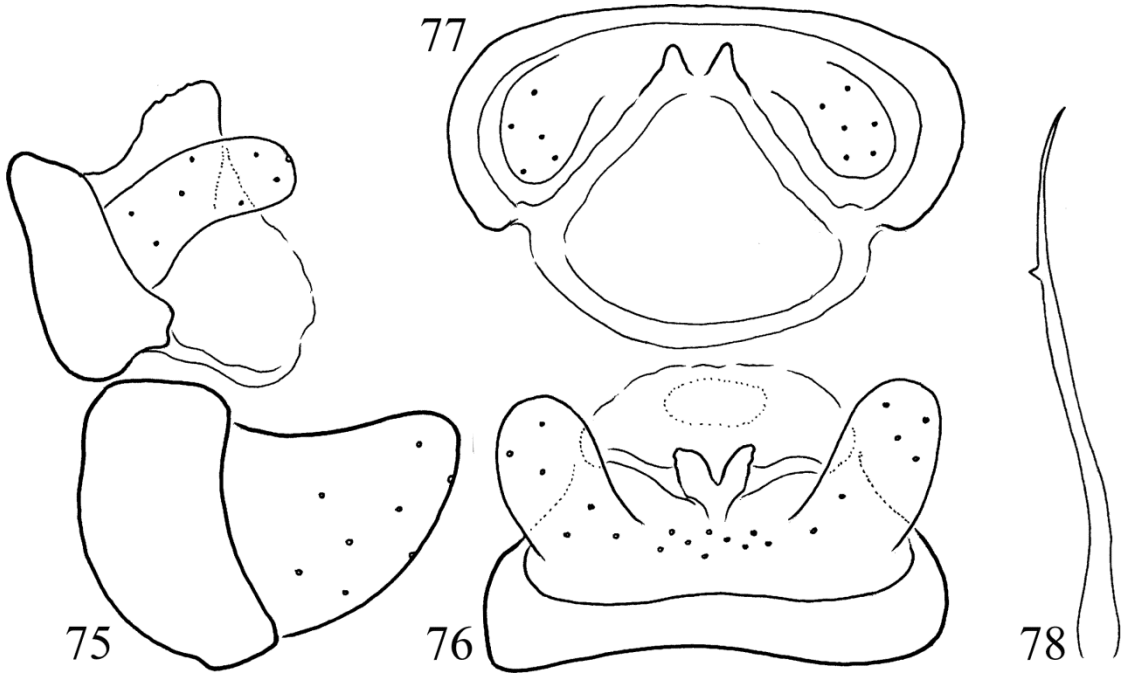


Figure 75–78. *Drusus tagolt* sp. nov. Holotype male: 75 = Lateral view of the genitalia without phallic organ, 76 = genitalia in dorsal view, 77 = tergite IX, cerci and paraproct in caudal view, 78 = paramere in lateral view.

Drusus improvisus species complex

Characterized by dorsal branch of the paraproct with horizontal digitiform fused apical arms with slightly upward directed tip in lateral view; digitiform with variously laterad directed tips in dorsal view. This poorly known species complex is distributed in the Northern and Central Apennine. Further intensive samplings are required in isolated mountain ranges to survey its biodiversity and to understand more comprehensively the diverging pattern of paraproct with variability ranges in various taxa and in the contact populations. To recognise properly the subtle shape divergences we need to apply the higher magnifying capacity of compound microscope with higher resolution also for the paraproct, not only for paramere (Oláh *et al.* 2017). Five species are known in the *Drusus improvisus* species complex: *D. camerinus* Moretti, 1981, *D. improvisus* (McLachlan, 1884), *D. cianficconiae* Oláh, 2017, *D. konok* Oláh, 2017, and a *Drusus* sp.

Drusus cianficconiae Oláh, 2017

(Map 5)

Material examined. **Italy**, Abruzzi, Prati di Tivo, spring and brooklet below the fountain, 42.502N, 13.573E, 1550–1580 m, 14.VI.20, leg. Gilles Vinçon (1 male, 1 female; OPC). Italy, Abruzzi, Prati di Tivo, brooks very steep, 42.514N, 13.573E, 1370m, 14.VI.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Abruzzi: Prati di Tivo, spring with mosses below the water captage, 42.514N, 13.573E, 1370 m, 9.IX.2020, leg. Gilles Vinçon (3 males, OPC).

Drusus improvisus (McLachlan, 1884)

(Map 5)

Material examined. **Italy**, Emilia-Romagna, Passo delle Radici, Nd slope, 1430m, brook, 44.197N, 10.501E, 4.VI.2020, leg. Gilles Vinçon (5 males, 2 females; OPC). Italy, Emilia-Ro

magna: Passo delle Radici, Nd slope, 1500 m, spring, 44.194N, 10.502E, 4.VI.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Toscana-Emilia Romagna: Abetone, Val di Luce, spring + brook, 44.15N, 10.635E, 1320 m, 7.VI.2020, leg. Gilles Vinçon (1 male, 1 female; OPC). Italy, Toscana, Val di Luce, brook, 44.123N, 10.628E, 1600-1650 m, 7.VI.2020, leg. Gilles Vinçon (12 males, 9 females; OPC). Italy, Northern Apennines, Toscana, Croce Arcana, spring and brooklet, 44.129N, 10.767 E, 1450 m, 8.VI.2020, leg. Gilles Vinçon (2 males, 1 female; OPC). Italy, Toscana, Passo di Cerreto, spring and brook, 44.286N, 10.228E, 1500m, 15.VI.20, leg. Gilles Vinçon (5 males, 3 females; OPC). Italy, Toscana, < Abetone, spring and brooklet, 44.139N, 10.673E, 1360m, 1.VII.2020, leg. Gilles Vinçon (2 males, 2 females; OPC). Italy, Emilio-Romagna, Monte Cimone, brook in the forest with cattle, 44.193N, 10.674E, 1400m, 1.VII.2020, leg. Gilles Vinçon (1 male, 1 female; OPC). Italy, Toscana, Passo del Cerreto, in direction of La Nuda Glacial Circus, spring and brook, 44.291N, 10.229E, 1400m, 30.VI.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Emilio-Romagna, Balze, spring of the Tevere River, 1270–1300m, 43.787N, 12.075E, 3. VII.2020, leg. Gilles Vinçon (2 males, OPC). Italy, Toscana, Passo del Cerreto, in direction of La Nuda Glacial Circus, 44.286N, 10.228E, 1460m, 30.VI.2020, leg. Gilles Vinçon (10 males, 6 females; OPC). Italy, Toscana, Passo del Cerreto, in direction of La Nuda Glacial Circus, 44.286N, 10.228E, 1460m, 3.IX.2020, leg. Gilles Vinçon (5 males, 2 females; OPC).

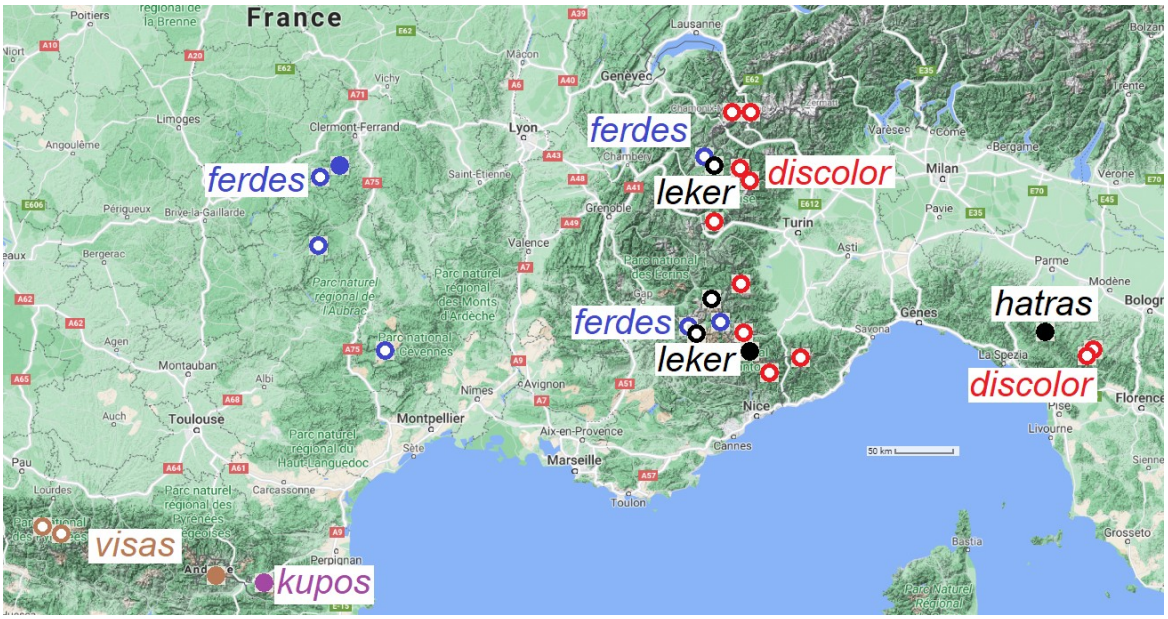
Drusus discolor species group

Drusus discolor species group is integrated through ancestral divergence by the reduction of setal pattern to a single large subapical spine without any secondary or tertiary spines.

Drusus discolor species complex

(Map 7)

According to the architecture of the paraproct this species complex is almost indistinguishable from the *D. romanicus* species complex. The only discernible difference is that members of the *D. discolor* complex have no decisive hump on the apical margin of the paraproct in lateral view.



Map 7. Distribution of species from *Drusus discolor* species complex (full circles represent the type localities).

However, the two complexes are clearly differentiated by the shape of the periphallic organs. *D. discolor* complex has cerci and gonopods short compared to the long cerci and gonopods of *D. romanicus* complex.

High genetic differentiation with haplotype endemism was detected between mountain range populations of *Drusus discolor* especially in the Pyrenees, Massif Central, and Western Alps without any morphological differences by traditional gross morphology (Pauls *et al.* 2006). We have discovered stable paraproctal divergences in the same mountain ranges by applying the speciation trait approach together with fine structure analysis. The taxonomic splits were demonstrated empirically by diverged trait matrices (Oláh *et al.* 2015). Morphological divergences of the speciation trait evolved from the ancestral species *Drusus discolor* in peripatric environment during sexual selection processes by reproductive barriers and reinforced or are under reinforcement in secondary contacts. Subtle and stable divergences resulted in the formation of phylogenetic incipient sibling species: *Drusus ferdes*, *D. kupos*, *D. leker*. *D. visas*. Here in the southern periphery of Tos

cana we have discovered the fifth sibling, *Drusus hatras* sp. nov. of the complex.

Drusus discolor (Rambur, 1842)

(Map 7)

Material examined. **Italy,** Maritime Alps, S.E. Pratolungo, Vallone di Riofreddo, brooklet and spring in open grassland, above the Malinvern and della Paur lakes, 44.219N, 7.207E, 2500 m, 10.VIII.2020, leg. Gilles Vinçon (3 males, 8 females; OPC). Italy, Maritime Alps, S.E. Pratolungo, Vallone di Riofreddo, brooklet and spring in open grassland, 44.213N, 7.187E, 1950 m, 10.VIII.2020, leg. Gilles Vinçon (1 female, OPC). Italy, Graian Alps, Gran-Paradiso, NW Noasca, spring and brooklet, 45.473N, 7.288E, 2240 m, 7.VIII.2020, leg. Gilles Vinçon (1 male, 1 female; OPC). Italy, Piemonte, Grand St Bernard, torrent, spring near the parking, 45.846N, 7.175E, 1780m, 6.VII.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Emilio-Romagna, Monte Cimone, brook in the forest with cattle, 44.193N, 10.674E, 1400m, 1.VII.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Toscana, Val di Luce, spring + brook, 44.15N, 10.635E, 1400 m, 4.IX.2020, leg. Gilles Vinçon (8 males, 2 females; OPC).

Drusus ferdes Oláh & Coppa, 2015

(Map 7)

Material examined. **France**, Savoie Forclaz lakes, below the Lac Noir, torrent, 2530 m, 45.658N, 6.699E, 16.VIII.2020, leg. Gilles Vinçon (2 males, 4 females; OPC).

Drusus hatras Oláh & Vinçon, sp. nov.

(Figures 79–81, Map 7, Photos 5–7)

Material examined. Holotype: **Italy**, Toscana, Passo del Cerreto, spring, brook and torrent, 44.291N, 10.229E, 1400 m, 3.IX.2020, leg. Gilles Vinçon (1 male, OPC). Allotype: same as holotype (1 female, OPC). Italy, Toscana, Passo del Cerreto, in direction of La Nuda Glacial Circus, 44.286N, 10.228E, 1460m, 3.IX.2020, leg. Gilles Vinçon (3 males, OPC).

Diagnosis. A new species in the *Drusus discolour* species complex. Easily distinguished from all the other species of the complex by the backward, posterad directed posterior corner of the serrated dorsal margin of the paraproctal head. The gonopod is rather slender relative to the ancestral species, *Drusus discolor*, but its range of variability is unknown. The spur formation, the actual terminal ending of the paramere is developed into a slightly upward curving and narrowing pointed structure with slight dorsosubapically produced uprising.

Description. Light brown, yellowish species with forewing length of 11 mm. The divergence of this new incipient sibling species is realized in the speciation trait of the modified paraproct. The lateral profile of the paraproctal head is characterized by the posterad directed serrated dorsoa-

pical margin. It seems that the function of this modification on the serrated head of the paraproct works effectively alone or in combination with other premating barriers in mate recognition or in postmating prezygotic barriers of cryptic female choice or in others, like in gametic isolation.

Female genitalia. Tergite of segment IX and X with deep triangular apicomesal excision; both in the dorsal and lateral views the lateral lobes narrowing; the lateral setose lobe of sternite IX rounded triangular, heavily setose. Supragenital plate of segment X (upper vaginal lip) much developed and subquadrangular both in lateral and ventral views. Median lobe of the vulvar scale (lower vaginal lip) present slightly shorter than the lateral lobes.

Etymology. *hatras*, from "*hátra*" posterad in Hungarian, refers to the backward, posterad directed posterior corner of the serrated dorsal margin of the paraproctal head.

Remarks. The three male paratypes represent a contact population with *Drusus discolor*: one male has posterad directed paraproct head similar to the holotype, other two males with broad rounded paraproct head, atypical.

Drusus leker Oláh, 2015

(Map 7)

Material examined. **France**, Savoie Forclaz lakes, below the Lac Noir, torrent, 2530 m, 45.658N, 6.699E, 16.VIII.2020, leg. Gilles Vinçon (2 males, 3 females; OPC).

Drusus muelleri species complex

Drusus muelleri species complex has been distinguished by the following character state combination (Oláh *et al.* 2017): (1) the fused dorsal branches of paraproct rather robust with straith vertical apical margin in lateral view, (2) accompanied by very long cerci and (3) short subapical spine on the paramere. This species complex is comprised of four known species: *arkos* Oláh, 2017, *horgos* Oláh, 2017, *magas* Oláh, 2017, *muelleri* (McLachlan, 1868). Here we describe a new species, *Drusus granparadiso* sp. nov.

Delineation by fine phenomics. To delineate the phylogenetic incipient sibling species in this small species complex with fine phenomics we have to sharpen our eye, focus our mental capacity as well as our microscope of high resolution

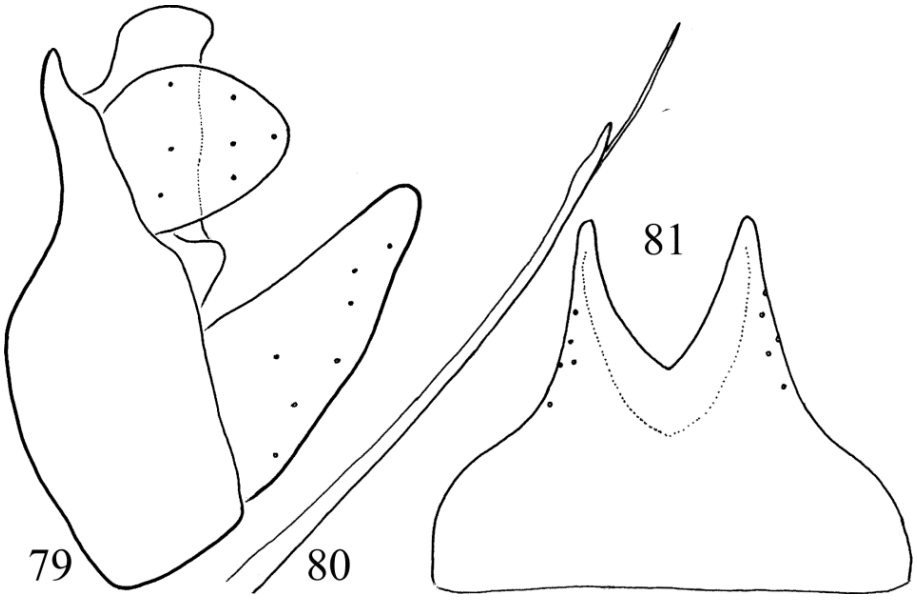


Figure 79–81. *Drusus hatras* sp. nov. Holotype male: 79 = Lateral view of the genitalia without phallic organ, 80 = paramere in lateral view, 81 = allotype female genitalia in dorsal view.

and rely upon the most stable observational view of the speciation trait. In the Drusinae subfamily it is the paraproct being far the most diverse with high shape stability. Examining and drawing the genital substructures we have to take into account their functional dynamism and carefully search and select the most reliable observational view in order to avoid ontological and epistemological artefacts. Especially, when we establish taxonomic entities by fine phenomics we are walking on thin ice. These shape divergences are created by cooperation of several thousand sequences in quantitative trait loci, superimposed by epistatic and epigenetic interactions, and maintained by complex network of protective mechanisms. These adaptive shape divergences are quite small for human capacities to recognise them properly, particularly if taxonomy is confined to gross phenomics.

In the *Drusus chapmani* species complex, that is a close relative of the *Drusus muelleri* species complex a new species, *Drusus katagelastos* Vitecek, 2020 was recently described and separated from *D. letras* Oláh, 2017 by two of such small divergences integrated in the speciation trait of paraproct (Vitecek *et al.* 2020). In the lateral profile *D. letras* has a basal ditch or anterior indentation that is lacking at *D. katagelastos*. However, the basal region of the dorsal branch of paraproct is usually very much obscured; it is usually deeply withdrawn anterad below the black spinulose cover on tergite VIII, therefore the most difficult to discern. It is highly dynamic, movable depending on the erective state of the phallic organ. The second divergence is the presence of a pair of small medial protuberances on the top in the caudal profile of the dorsal arm of the paraproct at *D. letras* that is lacking at *D. katagelastos*. As a rule, the caudal view is the most unreliable observational direction, highly sensitive to even a very small alteration. Please try and examine how these tiny protuberances appear and disappear by slightly modifying the viewing angle. It would be desirable to re-examine these divergences in the speciation trait of these two species to confirm the reality of their divergences. A detailed examination requires population samples, minimum three specimens. Unfortunately both species until now are known only from the holotype male.

Drusus granparadiso Oláh & Vinçon, sp. nov.

(Figures 82–86, Map 8, Photos 16–17)

Material examined. Holotype: **Italy**, Piemonte, > Cogne, Gran Paradiso Massif, Gimillan, spring, 45.643N, 7.413E, 2580–2600m, 5.VII.2020, leg. Gilles Vinçon (1 male, OPC). Allotype: same as holotype (1 female, OPC). Paratypes: same as holotype (4 males, 9 females; OPC).

Diagnosis. Similarly to the species complex this new species has the fused dorsal branches of paraproct rather robust with straight, slightly undulating vertical apical margin in lateral view; the dorsum of the fused dorsal branches of the paraproct is rounded, not straight and not with deep basal ditch like at *D. arkos*; not with posterad turning or directed tip like at *D. horgos*; not ascending high dorsoapicad like at *D. magas*, and not without vertical undulation like at *D. muelleri*. This unique shape of the cerci distinguishes *Drusus granparadiso* sp. nov. from all the known species of the complex.

Description. The speciation trait of the paraproct dorsal branches that is the lateral profile of the posterad directed dorsoapical tip is very stable at all the five males. Cerci are medium long, with very thin shaft with strong middle constriction and extremely broad basement. Gonopods with slender, narrowing apical portion and a small basomesal lobe visible in ventral view. The subapical spine on the paramere is small without small tertiary spines.

Etymology. Named after the region of the type locality as a noun in apposition.

Drusus magas Oláh, 2017

(Map 8)

Material examined. **Italy**, Piemonte, Grand St Bernard, springs, 2450m, 45.872N, 7.158E and 2560m, 45.873N, 7.179E, 6.VII.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Piemonte, Grand St Bernard, torrent, 45.86N, 7.134E, 2370m, 6.VII.2020, leg. Gilles Vinçon (5 males, 1 female; OPC). Italy, Piemonte, > Cogne, Gran Paradiso Massif, Gimillan, spring, 45.649N, 7.415E,

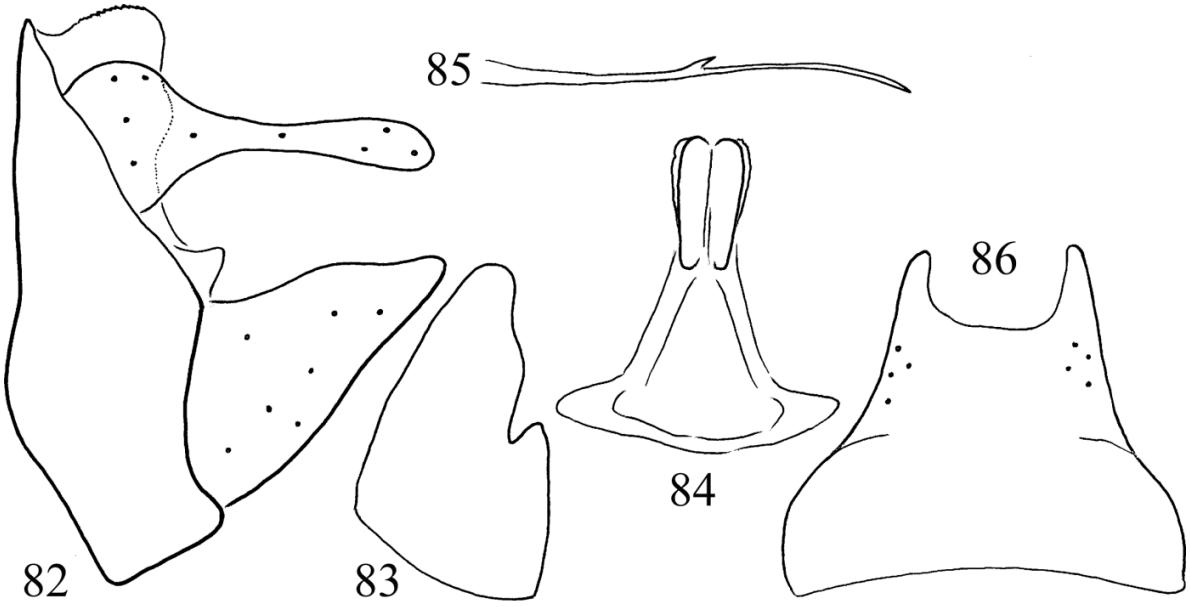


Figure 82–86. *Drusus granparadiso* sp. nov. Holotype male: 82 = Lateral view of the genitalia without phallic organ, 83 = left gonopod in ventral view, 84 = paraproct in caudal view, 85=paramere in lateral view, 86 = allotype female genitalia in dorsal view.

2740m, 5.VII.2020, leg. Gilles Vinçon (6 males, OPC). Italy, Piemonte, Grand St Bernard, torrent, 45.859N, 7.145E, 2230m, 6.VII.2020, leg. Gilles Vinçon (1 male, 2 females; OPC).

Drusus monticola species group

Drusus monticola species complex

Drusus monticola McLachlan, 1876

(Map 8)

Material examined. **Switzerland**, Grand St Bernard, big brook after the Pass, between and above the curves of the road, 45.871N, 7.177E, 2250-2400m, 6.VII.2020, leg. Gilles Vinçon (4 males, 4 females; OPC).

Drusus destitutus species complex

Drusus melanchaetes McLachlan, 1876

(Map 8)

Material examined. **Italy**, Piemonte, Pennines Alps, Biella, above Sanctuario di Oropa, above the Mucrone Lake, 45.629N, 7.942E, 1930m, 4.VII.2020, leg. Gilles Vinçon (4 males, OPC). Italy, Piemonte, Cogne, Gran Paradiso Massif, Gimillan, Lago di Lussert n° 2 (45.656N, 7.4E, 2800m), and n° 3 (Lago 3 almost completely frozen, 45.6583N, 7.396E, 2910m), 5.VII.2020, leg. Gilles Vinçon (2 males, OPC). Italy, Graian Alps, Gran-Paradiso, below Lago superiore di Ciamousseretto, big torrent, 45.49N, 7.266E, 2830 m, 7.VIII.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Graian Alps, Gran-Paradiso, above Lago superiore di Ciamousseretto, 45.49N, 7.262E, 2840 m, 7.VIII.2020, leg. Gilles Vinçon (1 male, OPC)

Drusus mixtus species group

Drusus mixtus species group is integrated through ancestral divergence by subapical spine bunch having at least one larger primary upward arching spine and a stout abbreviated apical shaft. The delineation of the species complexes in the species group is based on paraproct shape divergences (Oláh *et al.* 2017). (1) *Drusus flavi*

pennis species complex has dorsal branch of the paraproct with upward directed digitiform apical arms in lateral view; laterally diverted in caudal view; (2) *Drusus mixtus* species complex has dorsal branch of the paraproct with basal and apical converging lobes in lateral view; diverged apex in caudal view; (3) *Drusus spelaeus* species complex has dorsal branch of paraproct with sharp or blunt hook on apical arms in lateral view; mostly fused in caudal view.

Drusus flavipennis species complex

The complex has dorsal branch of the paraproct with upward directed digitiform apical arms in lateral view; laterally diverted in caudal view. This species complex is comprised of five species: *apados*, *flavipennis*, *malickyi*, *rhaeticus*, *vercorsicus*.

Drusus rhaeticus (Schmid, 1956)

(Map 8)

Material examined. **Italy**, Trentino, Val di Concei, torrent, 45.95N, 10.74 E, 1270m, 11.IX. 2020, leg. Gilles Vinçon (1 male, 2 females; OPC).

Drusus mixtus species complex

This complex has dorsal branch of the paraproct with basal and apical converging lobes in lateral view; the basal and the apical lobes converging and forming, encircling a rounded excision; apical lobes with slightly diverged apex in caudal view. The nominate species complex is comprised of two species: *biguttatus*, *mixtus*.

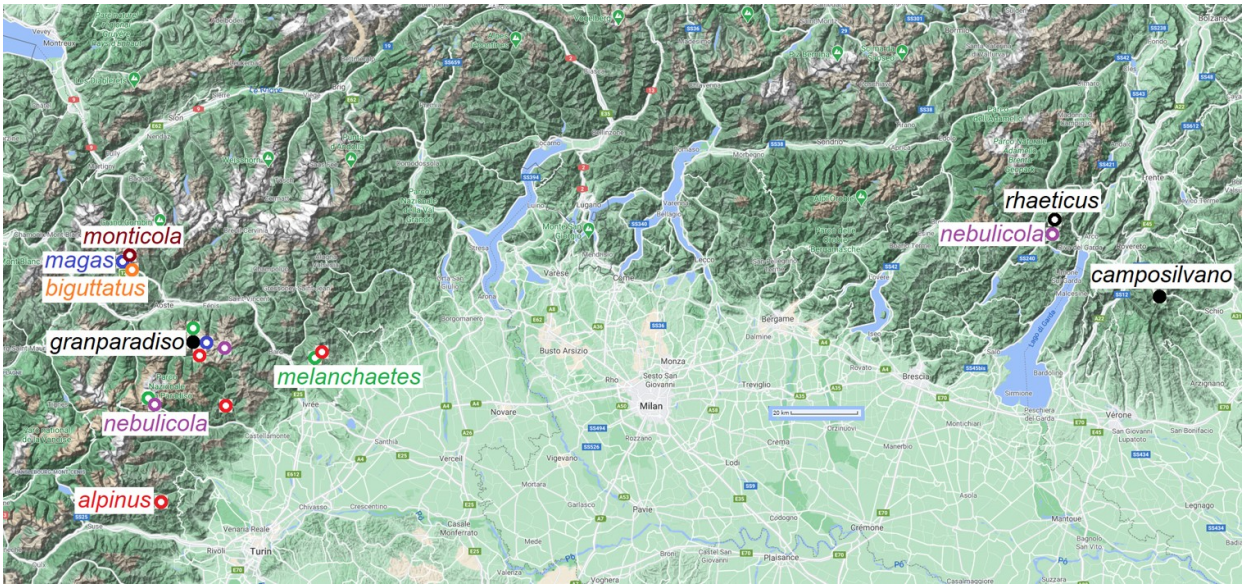
Drusus biguttatus (Pictet, 1834)

(Map 8)

Material examined. **Italy**, Piemonte, Grand St Bernard, torrent, spring near the parking, 45.846N, 7.175E, 1780m, 6.VII.2020, leg. Gilles Vinçon (1 male, OPC).

Drusus spelaeus species complex

In this species complex there is a tendency for disintegration of the subapical spine bunch on the paramere. In the subapical spine bunch the dominating big primary erect spine is less pronounced as well as there are additional spines



Map 8. Distribution of species from *Drusus discolor, Drusus monticola, Drusus mixtus* and *Drusus alpinus* species groups (full circles represent the type localities).

well anterad of the subapical spine bunch. These additional anterad spines are especially dominating on the paramere at *Drusus buscatensis*.

Drusus camposilvano **Oláh & Vinçon, sp. nov.**

(Figures 87–93, Map 8, Photos 18–19)

Material examined. Holotype: **Italy**, Trentino Alto Adige, Venetian Pre-Alps, above Camposilvano, spring, 45.754N, 11.148E, 1010 m, 10. IX.2020, leg. Gilles Vinçon (1 male, OPC). Allotype: same as holotype (1 female, OPC). Paratype (1 female, OPC).

Diagnosis. This new unique species is most close to species in the *Drusus spelaeus* species complex: *Drusus buscatensis*, *D. spelaeus* and *D. valserinensis*, but differs by the modified gonopods as well as by the lateral and caudal profiles of the paraproct.

Description. Drusus camposilvano sp. nov. has two remarkable incongruent character states of the gonopods, unique-in-the-genus *Drusus*. (1) The gonopods are completely fused to segment IX without any discernible vestigial suture; this differentiates the new species from all the known species of the genus. (2) The completely fused gonopods has undergone another architectural modification; its dorsoapical region has produced a secondary or additional lobe-like unite with serrated apex. Such an additional lobe of serrated head is a character state of the gonopods in the *Ecclisopteryx* genus. However the *Ecclisopteryx* genus has lost the sclerotized paraproct entirely, present and well-developed in *Drusus camposilvano* sp. nov.

Female genitalia. Tergite of segment IX and X with deep and wide semicircular apicomesal excision; both in the dorsal and lateral views the lateral lobes bluntly rounded; the lateral setose lobe of sternite IX triangular, heavily setose apically. Supragenital plate of segment X (upper vaginal lip) much developed and quadrangular both in dorsal and ventral views. Median lobe of the vulvar scale (lower vaginal lip) present, shorter than the lateral lobes.

Etymology. Named coined from the name of the type locality as a noun in apposition.

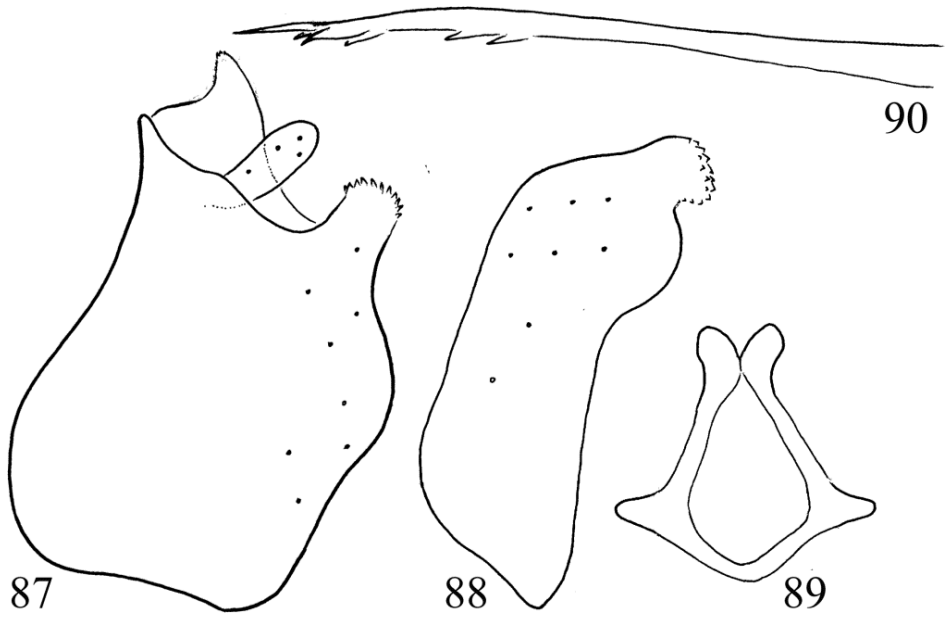


Figure 87–90. *Drusus camposilvano* sp. nov. Holotype male: 87 = Lateral view of the genitalia without phallic organ, 88 = left gonopod in ventral view, 89 = paraproct in caudal view, 90 = paramere in lateral view.

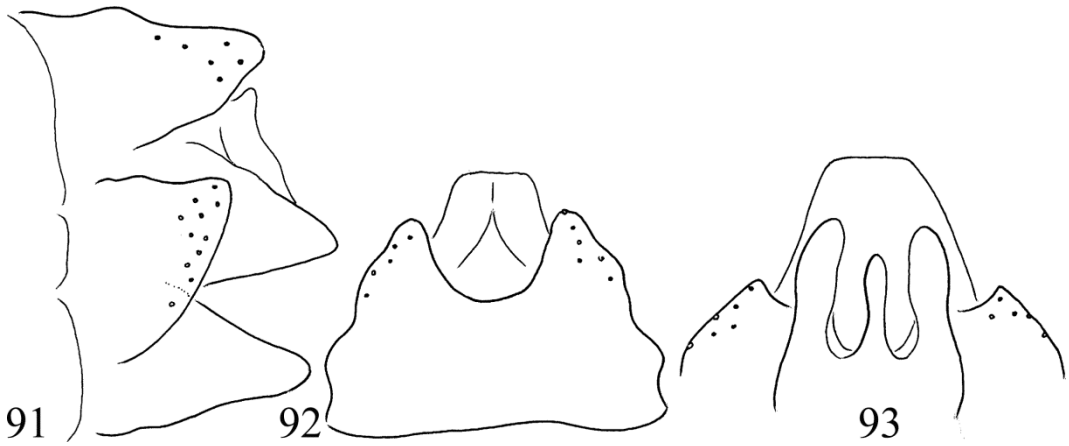


Figure 91–93. *Drusus camposilvano* sp. nov. Allotype female: 91 = Lateral view of the genitalia, 92 = dorsal view of the genitalia, 93 = ventral view of the genitalia.

Drusus alpinus species group

Drusus alpinus species complex

Drusus alpinus Meyer-Dül, 1875

(Map 8)

Material examined. **Italy**, Graian Alps, Viu Valley, Borgial, big torrent, 45.203N 7.302E, 1500 m, 26.VI.2020, leg. Gilles Vinçon (7 males, 17 females; OPC). Italy, Piemonte, > Cogne, Gran Paradiso Massif, Gimillan, spring, 45.643N, 7.413E, 2580–2600m, 5.VII.2020, leg. Gilles Vinçon (1 male, 2 females; OPC). Italy, Piemonte, Pennines Alps, Biella, above Sanctuario di Oropa, above the Mucrone Lake, 45.629N, 7.942E, 1930m, 4.VII.2020, leg. Gilles Vinçon (6 males, OPC). Italy, Piemonte, Pennines Alps, Biella, above Sanctuario di Oropa, spring, 45.6435N, 7.969E, 1800m, 4.VII.2020, leg. Gilles Vinçon (2 males, 2 females; OPC). Italy, Piemonte, > Cogne, Gran Paradiso Massif, Gimillan, spring near the bridge, 45.625N, 7.376E, 1900m, 5.VII.2020, leg. Gilles Vinçon (2 males, OPC). Italy, Piemonte, Pennines Alps, Biella, around the Mucrone Lake, 45.628N, 7.9425E, 1900m, 4.VII. 2020, leg. Gilles Vinçon (3 females, OPC). Italy, Piemonte, Pennines Alps, Biella, above Sanctuario di Oropa, above the Mucrone Lake, 1930m, 45.629N, 7.942E, 4.VII.2020, leg. Gilles Vinçon (6 females, OPC). Italy, Piemonte, > Cogne, Gran Paradiso Massif, Gimillan, brook, 45.637N, 7.405E, 2350m, 5.VII.2020, leg. Gilles Vinçon (2 males, 2 females; OPC). Italy, Graian Alps, Ingria, brooklet and spring, 45.463N, 7.568E, 920m, 8.VIII.2020 leg. Gilles Vinçon (1 male, OPC).

Drusus nebulicola species complex

Drusus nebulicola (McLachlan, 1867)

(Map 8)

Material examined. **Italy,** Graian Alps, Gran-Paradiso, NW Noasca, brook and torrent, 45.4647N, 7.299E, 1860m, 7.VIII.2020, leg. Gilles Vinçon (3 males, 5 females; OPC). Italy, Trentino, Val di Concei, brook with mosses, 45.959N, 10.7413E, 1400 m, 11.IX.2020, leg. Gilles Vinçon (1 male, 1 female; OPC). Italy, Graian Alps, Gran Paradiso Massif, Champorcher Valley, > Dondenaz, spring + brook, 45.618N, 7.549E, 2100 m, 11.IX.2020, leg. Gilles Vinçon (3 males, OPC). Italy, Trentino, Val di Concei, torrent, 45.954N, 10.744E, 1270 m, 11.IX.2020, leg. Gilles Vinçon (13 males, 1 female; OPC).

Ecclisopteryx kunkor Oláh, 2017

Material examined. **Italy**, Abruzzi, Val Fondillo, brook and spring, 1300m, 41.749N, 13.865 E, 9.VI.20, leg. Gilles Vinçon (7 males, 14 females; OPC). Italy, Abruzzi, Prati di Mezzo, Fontitune, spring and brook along the torrent,

1560 m, 41.653N, 13.936E, 9.VI.20, leg. Gilles Vinçon (14 males, 3 females; OPC). Italy, Abruzzi, Val Fondillo, two springs, 41.768N, 13.855 E, 1100 m, 9.VI.2020, leg. Gilles Vinçon (3 males, 3 females; OPC). Italy, Basilicata, SW Pignola, Basento, spring in beech forest, 1250 m, 40.508N, 15.728E, 10.VI.20, leg. Gilles Vinçon (6 males, 2 females; OPC). Italy Basilicate, Pollino, springs and rivulets, 39.916N, 16.177E, 1600–1650 m, 10.VI.2020, leg. Gilles Vinçon (4 males, 1 female; OPC). Italy, Abruzzi, Prati di Mezzo, spring below the water capture, 41.651N, 13.959E, 1700m, 1.VII.2020, leg. Gilles Vinçon (22 males, 42 females; OPC).

Remarks. This brown species is described from Calabria, Basilicata and Emilia Romagna. The present record from Abruzzi suggests its distribution on the entire Apennines representing the *Ecclisopteryx guttulata* species complex.

Ecclisopteryx legeza Oláh & Lodovici, 2017

Material examined. **Italy**, Cottian Alps, Macra valley, below Canosio, big torrent and lateral brook, Maira tributary, 44.458N, 7.089E, 1200 m, 9.VIII.2020, leg. Gilles Vinçon (4 males, 4 females; OPC).

Limnephilinae

Limnephilini

Limnephilus affinis Curtis, 1834

Material examined. **Italy**, Northern Apennines, Toscane, Croce Arcana, spring and brooklet, 44.129N, 10.767 E, 1450 m, 8.VI.2020, leg. Gilles Vinçon (1 male, OPC).

Limnephilus coenosus Pictet, 1834

Material examined. **Italy**, Maritime Alps, S.E. Pratolungo, Vallone di Riofreddo, brooklet and spring in open grassland, above the Malinvern and della Paur lakes, 44.219N, 7.207E, 2500 m, 10. VIII.2020, leg. Gilles Vinçon (2 males, OPC). **Italy**, Pennines Alps, around Lago Mambarone, 45.584N, 7.883E, 1930 m, 8.VIII.2020, leg. Gilles Vinçon (5 males, 8 females; OPC).

Limnephilus hirsutus (Pictet, 1834)

Material examined. **Italy**, Abruzzi, Prati di Mezzo, spring below the water capture, 41.651N, 13.959E, 1700m, 1.VII.2020, leg. Gilles Vinçon (1 male, OPC).

Limnephilus ignavus McLachlan, 1865

Material examined. **Italy**, Basilicata: > Lagonegro, < Reserva regionale Lago Laudemio,brook in beech forest, 40.157N, 15.803E, 1340 m, 6. IX.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Cottian Alps, Fenestre Pass, Chisonne trib., nice spring, 45.0515N, 7.079E, 1780 m, 19.X.2020, leg. Gilles Vinçon (1 male, 1 female; OPC).

Limnephilus italicus McLachlan, 1887

Material examined. **France**, Savoie Forclaz lakes, around and above the Esola lake, brook and lake surrounding, 45.657N, 6.709E, 2330 m, 15. VIII.2020, leg. Gilles Vinçon (6 males, OPC).

Limnephilus lunatus Curtis, 1834

Material examined. **Italy**, Abruzzi, Prati di Tivo, spring and brooklet below the fountain, 42.502N, 13.573E, 1550-1580 m, 14.VI.20, leg. Gilles Vinçon (1 male, OPC).

Limnephilus rhombicus (Linnaeus, 1758)

Material examined. **Italy**, Madonna di Campiglio, brook above Nero Lake, 46.245E, 10.782 N, 2260 m, 11.IX.2020, leg. Gilles Vinçon (1 male, OPC).

Remarks. The single specimen has paramere similar to *Limnephilus rhombicus reseri*. Malicky, 1985. Its independent incipient species status has to be examined based on samples from several populations.

Limnephilus sparsus Curtis, 1834

Material examined. **Italy**, Piemonte, > Cogne, Gran Paradiso Massif, Gimillan, spring, 45.643N, 7.413E, 2580-2600m, 5.VII.2020, leg. Gilles Vin-

çon (1 male, OPC). Italy, Lazio, Prati di Mezzo, spring below the second captage, 41.651N, 13.959E, 1700 m, 5.IX.2020, leg. Gilles Vinçon (1 female, OPC).

Limnephilus stigma species group

Having the duty to describe our new taxa *Limnephilus logos* sp. nov., a new member of the *L. stigma* species group it is necessary to survey briefly the present knowledge of this small group. Due to restrictions imposed by *Coronavirus* disease 2019 (COVID-19) we are unable to examine the types or even all specimens of the seven species in the group. We study their taxonomy by comparing their published drawings. Like to many other taxa the present taxonomic knowledge of the group is limited mostly to original descriptions prepared at the end of the nineteenth century or at the beginning of the twentieth century. According to our ultimate and high valued source of Trichoptera knowledge, promoting and facilitating scientific investigation in Trichoptera (Trichoptera World Checklist Database Search, (Morse 2020)) there are altogether four reports and three listing for the two Nearctic species as well as 47 reports and 12 listing for the five Palaearctic species. There are few studies from the second half of the twentieth century: *Limnephilus politus* and *L. abstrusus* were redrawn by Schmid (1968), *L. stigma* by Malicky (1983), *L. indivisus* and *L. infernalis* by Ruiter (1995), but unfortunately from specimens of unknown origin or from other than types. Moreover, the drawings styles are highly varying insufficient for adequate comparative studies.

Taxonomic history. Schmid (1955) created the *Limnephilus stigma* species group for the following seven species: *L. abstrusus* McLachlan 1872, Siberia; *L. ademiensis* Martynov 1914, East Siberia; *L. politus* McLachlan 1865, Europe, Siberia; *L. infernalis* (Banks 1914), Canada; *L. stigma* Curtis 1934, Palaearctic; *L. indivisus* Walker 1852, Nearctic; *L. flavospinosus* (Stein 1874), Europe. Based on numerous characters *L. infernalis* is removed from the species group (Ruiter, 1986).

Limnephilus politus McLachlan, 1865

Material examined. **Czech Republic**, W Bohemia, Sokolov env., pond SW Nové Sedlo, 490 m, 19.X.1993, leg. P. Chvojka (2 females, OPC; 3 females, NMPC). Czech Republic, W Bohemia, Sokolov env., pond SW Nové Sedlo, 490 m, 8.IX.1994, leg. P. Chvojka (1 male, OPC; 2 males, NMPC). Czech Republic, W Bohemia, Karlovy Vary env., pond W Nová Role, 460 m, 19.IX.1999, leg. P. Chvojka (1 male, OPC; 3 males, NMPC).

Limnephilus stigma species complex

Discovering the new sibling species, *Limnephilus logos* sp. nov. here we establish the *Limnephilus stigma* species complex inside the *Limnephilus stigma* species group as having very short paraproct and particularly bilobed setose apex of the paramere.

Limnephilus logos Oláh & Vinçon, sp. nov.

(Figures 94–100, Photo 20)

Material examined. Holotype: **Italy**, Molise, Spring of the Volturno River, (very cold river outfall of the Volturno Lake that is fed by a big pressure pipe coming from the southern Abruzzi Mountains), 41.639N, 14.078E, 550m, 2.VII. 2020, leg. Gilles Vinçon (1 male, OPC). Allotype: same as holotype (1 female, OPC).

Diagnosis. This new species is a phylogenetic incipient sibling of *Limnephilus stigma*, but differs by having (1) the spinulose zone on tergite VIII reduced to a small apicomesal protuberance with a few elongated small spines, not large; (2) cerci with produced pointed ventroapical region, not rounded; (3) paraproct with downward directed apical half of the gonopod, almost in right angle, not straight; (4) gonopod abbreviated, shorter than high, not long; (5) the dorsal lobe of the paramere very broad, not slender. There are distinct divergences in the structure of the female genitalia, especially in the dorsal and ventral apical margin of the anal tube that are differently formed.

Description. Male (in alcohol). Medium-sized, brown-coloured animal; forewing with heavily pigmented large pterostigma. Spurs: 134. Forewing length 13 mm.

Male genitalia. Tergite VIII with tiny spinulose mesal protuberance. Segment IX long middle, almost subovoid in lateral view with high and short dorsal strap and longer ventrum. Cerci robust, heavily sclerotized, subquadrangular with produced pointed ventroapical corner; basomesal margin fringed with dark pigmented teeth. Paraproct reduced to a pair of downward angled, hook-shaped structure in lateral view. Gonopods abbreviated slightly bilobed. Parameres with bilobed apex, dorsal lobe broad.

Female genitalia. There is almost closed "anal tube" formed by the complex of the fused with suture tergite IX and segment X; its dorsum is deeply cleft and its ventrum with a mesoapical lobe. Tergite and sternite IX fused together, sternite longer and setose. Upper vaginal lip present as a free supragenital plate pointed in lateral and rounded in ventral view. The lower vaginal lip, the vulvar scale with long parallel-sided mesal lobe accompanied by bilobed shorter lateral lobes. Dorsal vaginal sclerite complex and the membranous vaginal chamber is short, reaching only half length of sternite VIII.

Etymology. *logos* from "*lógós*" downward directed in Hungarian, refers to the lateral profile of paraproct that is curving or arching in right angle verticad, compared to the straight or slightly curved paraproct of its ancestral sibling species *Limnephilus stigma*. The given name "*logos*" refers also to its original meaning in ancient Greek philosophy "*reasoned discourse*", as one of the three modes of persuasion alongside *ethos* and *pathos* according to Aristotle. The second item of etymology in describing of this unique sibling species remind us to the frequent missing of Aristotle's triplet, *logos*, *ethos*, and *pathos* in the contemporary scientific discourse on sibling species.

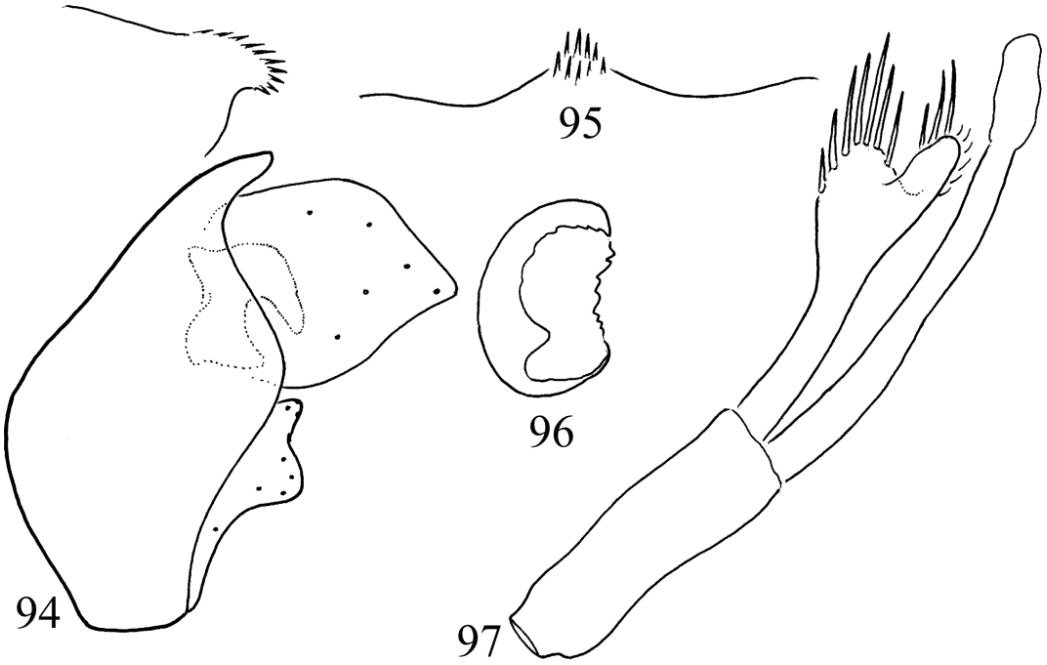


Figure 94–97. *Limnephilus logos* sp. nov. Holotype male: 94 = Lateral view of the genitalia without phallic organ 95 = spinose area on tergite VIII, 96 = cerci in caudal view, 97 = phallic organ in lateral view.

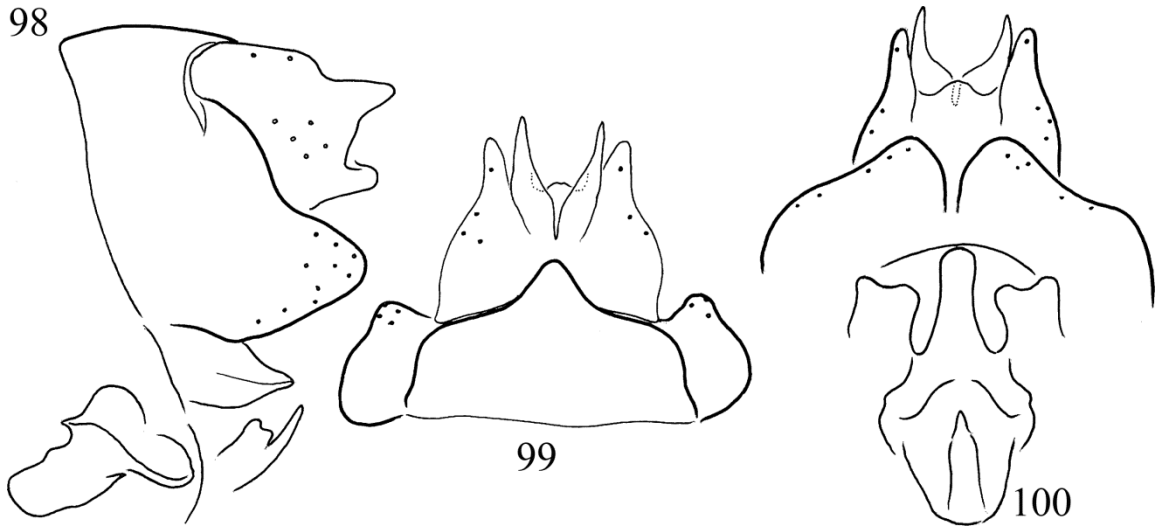


Figure 98–100. *Limnephilus logos* sp. nov. Allotype female: 98 = Lateral view of the genitalia with the vaginal sclerite complex, 99 = dorsal view of the genitalia, 100 = ventral view of the genitalia with the vaginal sclerite complex.

Limnephilus stigma Curtis, 1834

Comparative material examined. **Czech Republic**, W Bohemia, Sokolov env., wetlands S Lomnice, 420 m, Malaise trap, V.–X.2014, leg. P. Chvojka (2 males, 1 female, OPC; 1 male, 5 females; NMPC). Czech Republic, W Bohemia, Sokolov env., wetlands N Sokolov, 440 m, Malaise trap, VII.–IX.2001, leg. P. Chvojka (2 males, 2 females, OPC; 4 males, 2 females, NMPC). **France**, Entraunes, department Alpes-Maritimes, marais près d'Estrop, E6°47'48" N44°13'14", 2390m 25. VIII. 2017, leg. G. Coppa (2 males, 2 females; OPC). **Hungary,** Aggtelek National Park, Jósvafő, VII. 1981, light leg. J. Oláh (1 male, OPC). Hungary, Bockerek, VII. 1982, light trap (3 males, OPC). Hungary, Duna-Dráva national Park, Gyékényes, Lankóci Forest Swamp, 8.VI.2010, light leg. J. Oláh & Á. Uherkovics (25 males, 23 females; OPC). Hungary, Duna-Dráva national Park, Gyékényes, Lankóci Forest, Alnus swamp, Grófi road, N46°13’51” E17°03’01”, 19.V.2011, light leg. J. Oláh (1 male, OPC). **Russia**, Central Altai, 20km S of Ongoday, 3. VIII.993, light leg. Z. Varga (1 male, OPC). **Serbia,** W Serbia, Prijepole Region, Zvijezda, Savina Voda near Jabuka, N43°22'03" E019° 33'07", 1117m, 16.VII.2014, leg. S. Beshkov (1 male, OPC).

Chaetopterygini

Chaetopteryx eugenea Moretti & Malicky, 1986

Material examined. **Italy**, Venetian Pre-Alps, below Campogrosso, spring under a water capture, 45.716N, 11.183E, 1060 m, 18.X.2020, leg. Gilles Vinçon (1 male, OPC).

Chaetopteryx gessneri McLachlan, 1857

Material examined. **Italy**, Pennines Alps, Gressoney Valley, near Ronc de Grangia, spring and br., 45.607N, 7.812E, 600 m, 17.X.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Cottian Alps, Fenestre Pass, Chisonne trib., nice spring, 45.0515N, 7.079E, 1780 m, 19.X.2020, leg. Gilles Vinçon (14 males, 9 females; OPC). Italy, Cottian Alps, Fenestre Pass, Chisonne trib., nice spring, 45.053N, 7.079E, 1820–1950 m, 19.X.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Toscana, Passo di Cerreto, 1500m sce + ruis., 42.286N, 10.228E, 2.XII.2019, leg. Gilles Vinçon (3 males, 1 female; OPC). Italy, Toscana, Cerreto Pass, spring, brook and torrent, 44.291N, 10.229E, 1400 m, 18.X.2020, leg. Gilles Vinçon (4 males, 1 female; OPC).). Italy, Toscana, Cerreto Pass, 44.286N, 10.228E, 1460 m, 18.X.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Marche, Visso, 17.

X.1987, leg. H. Malicky (1 male, 1 female; OPC). Italy, Abruzzi, Prati di Mezzo, > Fontitune, springs near the top, 41.651N, 13.94E and 41.651N, 13.959E, 29.XI.2019, 1650–1700 m, leg. Gilles Vinçon (1 male, 4 females; OPC). Italy, Molise-Bojano (CB), Torr Calderone aff. Biferno, 41.482N 14.659E, 24.X.1995, leg. M. Baccaro (1 male, OPC).

Chaetopteryx kimera Oláh & Vinçon, sp. nov.

(Figures 101–106)

Material examined. Holotype: **Italy**, Piemonte, > Cogne, Gran Paradiso Massif, Gimillan, Lago di Lussert n° 2 (45.656N, 7.4E, 2800m) and n° 3 (Lago 3 almost completely frozen, 45.6583N, 7.396E, 2910m), 5.VII.2020, leg. Gilles Vinçon (1 male, OPC). Allotype: same as holotype (1 female, OPC). Paratypes: same as holotype (20 males, OPC).

Diagnosis. This new *Chaetopteryx*, collected in high elevation, is a rather unique chimeric species having several character states of different origin. (1) All European chaetopterygini species fly only in autumn, *C. kimera* sp. nov. is getting active in early summer, a general functional character state of most caddisflies, including its sister tribe Stenophylacini. (2) It is a derived member of the *Chaetopteryx*, the genus with erected spines present both on the veins and membranes of the forewing, but *C. kimera* sp. nov. has erected spines only on the veins of the forewing, a character state of the *Psilopteryx* genus. (3) Having spine-like spiniform apomorphic character state of paramere, a general character state of the Stenophylacini tribe. (4) According to the general structure of the cerci, paraproct and gonopod *C. kimera* sp. nov. is almost identical with *Micropterna lateralis*, *Leptotaulius gracilis* and *Parachiona picicornis*, especially in caudal view. (5) The habitus, the reduced body size, the brachypterous wings and the enlarged female abdomen are similar to the members of the *Chaetopteryx rugulosa* species group. Having simplified spiniform parameres without terminal setae *C. kimera* sp. nov. has resemblance with the member of *Chaetopteryx major* species group, but differs from all species of the group by the above listed combination of chimeric character states.

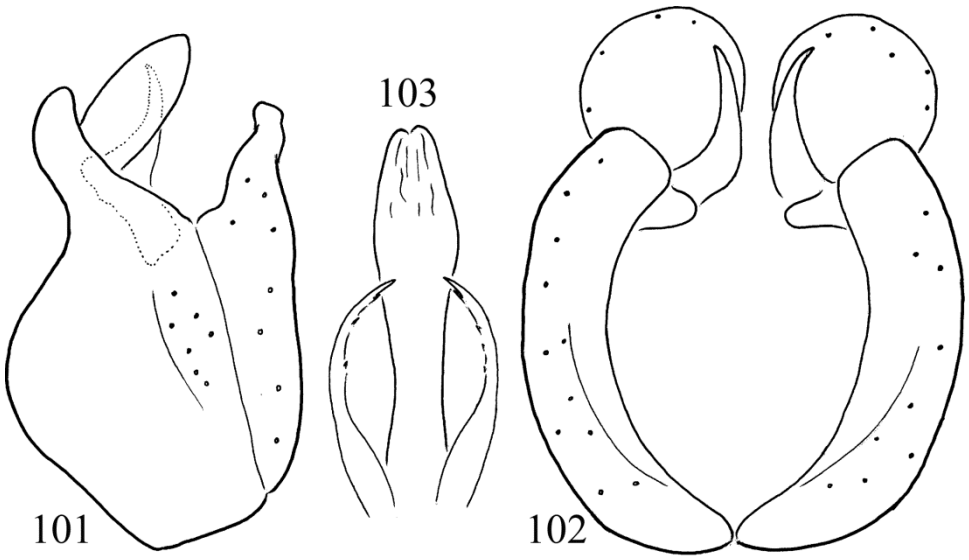


Figure 101–103. *Chaetopteryx kimera* sp. nov. Holotype male: 101 = lateral view of the genitalia without phallic organ, 102 = genitalia in caudal view, 103 = phallic organ in dorsal view.

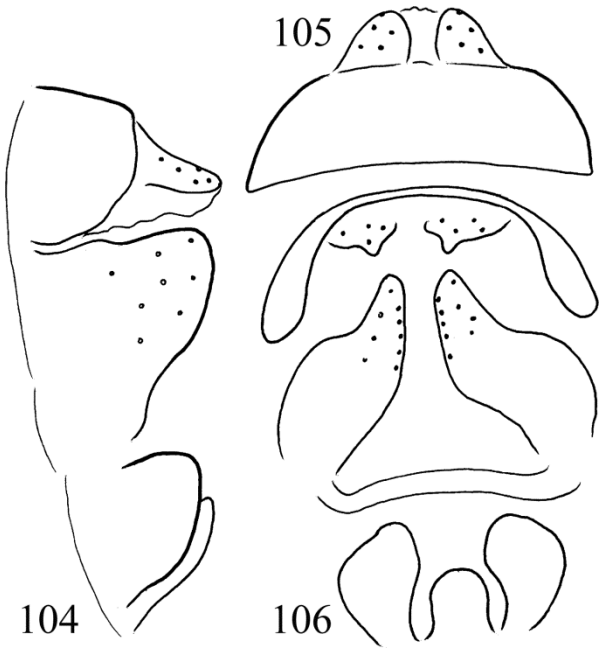


Figure 104–106. *Chaetopteryx kimera* sp. nov. Allotype female: 104 = lateral view of the genitalia, 105 = dorsal view of the genitalia, 106 = ventral view of the genitalia.

Description. Male and female (in alcohol). Very dark, highly pigmented animal with fuscous castanean brown cephalic and thoracic sclerites and appendages. Forewing with rounded apex and with tendency to brachyptery; very long erect spine-like setae present only on the veins; membrane between veins scattered with tiny recumbent setae. Tibial spur number 034. Forewing length of holotype 10 mm, that of allotype 14 mm. Forewing shorter than the enlarged abdomen, probably unable to fly. However legs are extremely enlarged and strong due probably to the crawling habits. Both male and female characterized by distinct circular light spots on forewings, a unique character state in the entire Chaetopterygini tribe.

Male genitalia. Posterodorsal spinate area of vestitural noncellular microtrichia less pigmented on tergite VIII and scattered with tiny peg-like structures. Segment IX long ventrally, very short strap or bridle-like dorsally; its lateral length elongated by rounded convexity anterad, its posterior margin straight vertical with pronounced submarginal setal region middle. Segment X partly fused to tergite IX forming together the short dorsal bridle and partly present as less sclerotized membranous vestigium connecting mesad the invaginated basal part of the circular cup-like cerci. Cerci are extremely large and regular circular in caudal view. Paraproct slender, tapering and slightly curving anterad and laterad. Gonopods almost parallel-sided in apical view. Phallic organ composed of the entirely membranous aedeagus and of the short parameres; apex of aedeagus without any sclerotized structure; paramere mesad curving spine-like with some tiny spinules mesad.

Female genitalia. There is a short "anal tube" formed by the complex of the partially fused tergite IX and segment X. Tergite IX compact, delineated from tergite X that is composed of setose lateral lobes connected by less sclerotized mesal region. Sternite IX very much produced and setose connected by glabrous large convex mesal plate, this glabrous ventral surface of sternite IX and X functions like the upper vaginal lip of a supragenital plate. The lower vaginal lip, the vulvar scale is visible somewhat separated from sternite VIII by its more sclerotized structure; its lateral lobes large rounded triangular, its mesal lobe smaller. Vaginal chamber is short, reaching only half length of sternite VIII.

Etymology. *kimera*, coined from from *chimaros* male goat *and chimaira* female goat in Greek. Chimera is a Greek mythical creature with body parts taken from various animals. A symbol of creature composed of different origins. It refers to genital structures integrated from various sources, a vivid phenomenon of retigeny, the reticulation nature of integrative organisation opposed to the phylogeny of evolution.

Stenophylacini

***Allogamus ausoniae* Moretti, 1991**

Material examined. **Italy**, Lazio, Prati di Mezzo, spring below the second captage, 41.651N, 13.959E, 1700 m, 5.IX.2020 leg. Gilles Vinçon (1 male, 4 females; OPC). Italy, Lazio, Prati di Mezzo, spring below the second captage, 41.651N,

13.959E, 1700 m, 5.IX.2020, leg. Gilles Vinçon (9 males, 3 females; OPC).

Allogamus botosaneanui Moretti, 1991

Material examined. **Italy**, Toscana: Val di Luce, brook, 44.122N, 10.62, 1700 m, 4.IX.2020, leg. Gilles Vinçon (1 male, 1 female; OPC). Italy, Toscana, Val di Luce, spring + brook, 44.124N, 10.635E, 1620 m, 4.IX.2020, leg. Gilles Vinçon (2 males, OPC).

Allogamus hilaris (McLachlan, 1876)

*Material examined***. Italy**, Cottian Alps, Fenestre Pass, Chisonne trib., nice spring, 45.053N, 7.079E, 1820–1950 m, 19.X.2020, leg. Gilles Vinçon (1 male, 4 females; OPC).

Allogamus mendax (Mclachlan, 1876)

Material examined. **Italy**, Cottian Alps, Fenestre Pass, Chisonne trib., nice spring, 45.0515N, 7.079E, 1780 m, 19.X.2020, leg. Gilles Vinçon (2 males, OPC). Italy, Cottian Alps, Fenestre Pass, Chisonne trib., nice spring, 45.053N, 7.079E, 1820-1950 m, 19.X.2020, leg. Gilles Vinçon (3 males, 5 females; OPC). Italy, Pennines Alps, Gressoney Valley, Pillaz, brook and spring, 45.65N, 7.911E, 1720 m, 17.X.2020, leg. Gilles Vinçon (1 male, 4 females; OPC).

Allogamus silanus Moretti, 1991

Material examined. **Italy**, Calabria, Sila grande, spring, 39.32N, 16.401E, 1650–1700 m, 7.IX. 2020, leg. Gilles Vinçon (1 male, OPC).

Allogamus uncatus (Brauer,1857)

Material examined. **Italy**, Madonna di Campiglio, brook above Nero lake, 46.245E, 10.782N, 2260 m, 11.IX.2020, leg. Gilles Vinçon (6 males, OPC). **Italy,** Cogne, Gran Paradiso Massif, Gimillan, above Corona lake, spring, 45.649N, 7.415E, 2740 m, 12.09.2020, leg. Gilles Vinçon (10 males, 3 females; OPC). Italy, Madonna di Campiglio, brook below Serodoli lake and above Serodoli lake, 46.246N, 10.78E, 2350–2380 m, 11.IX.2020, leg. Gilles Vinçon (2 males, 2 females; OPC). Italy, above Camposilvano, spring below the water capture, 45.746N, 11.161E, 1320 m, 18.X.2020, leg. Gilles Vinçon (1 male, OPC).

Anisogamus difformis (McLachlan, 1867)

Material examined. **Italy**, Maritime Alps, S.E. Pratolungo, Vallone di Riofreddo, big torrent, 44.2484N, 7.176E, 1500 m, 10.VIII.2020, leg. Gilles Vinçon (1 male, 2 females; OPC). Italy, Maritime Alps, S.E. Pratolungo, Vallone di Riofreddo, brooklet and spring in open grassland, above the Malinvern and della Paur lakes, 44.219N, 7.207E, 2500 m, 10.VIII.2020, leg. Gilles Vinçon (8 females; OPC). Italy, Maritime Alps, S.E. Pratolungo, Vallone di Riofreddo, brooklet and spring in open grassland, 44.213N, 7.187E, 1950 m, 10.VIII.2020, leg. Gilles Vinçon (2 males, 2 females; OPC). **Italy**, Toscana, Passo del Cerreto, spring, brook and torrent, 44.291N, 10.229E, 1400m, 6.VI.2020, leg. Gilles Vinçon (4 males, OPC). Italy, Toscana, Passo di Cerreto, 1500m spring + brook, 44.286N, 10.228E, 15. VI.20, leg. Gilles Vinçon (4 males, 2 females; OPC). Italy, Toscana, West passo di Cerreto, spring tributary of the Secchia River, 44.327N, 10.198E, 1650m, 30.VI.2020, leg. Gilles Vinçon (1 male, 1 female; OPC). Italy, Toscana, Passo del Cerreto, in direction of La Nuda Glacial Circus, spring and brook, 44.291N, 10.229E, 1400m, 30.VI.2020, leg. Gilles Vinçon (4 males, 1 female; OPC). Italy, Toscana, Passo del Cerreto, La Nuda Glacial Circus, spring of the Rosario River, 44.284N, 10.232E, 1630m, 30.VI.2020, leg. Gilles Vinçon (7 males, 2 females; OPC). Italy, Toscana, Passo del Cerreto, in direction of La Nuda Glacial Circus, 44.286N, 10.228E, 1460m, 30. VI.2020, leg. Gilles Vinçon (10 males, 6 females; OPC). Italy, Cottian Alps, Macra valley, spring tributary of the Bedale Intersile, 44.426N, 7.143E, 2300 m, 9.VIII.2020, leg. Gilles Vinçon (4 males, 4 females; OPC). Italy, Graian Alps, Gran-Paradiso, NW Noasca, spring and brooklet, 45.473N, 7.288E, 2240 m, 7.VIII.2020, leg. Gilles Vinçon (7 males, OPC). Italy**,** Road to the Lago della Tempesta, spring and brooklet, 44.46N,

7.124E, 1950 m, 9.VIII.2020, leg. Gilles Vinçon (7 males, 11 females; OPC). Italy, Graian Alps, Gran Paradiso Massif, Champorcher Valley, > Dondenaz, spring + brook, 45.618N, 7.549E, 2100 m, 11.IX.2020, leg. Gilles Vinçon (1 female, OPC).

Consorophylax consors (McLachlan, 1880)

(Map 9)

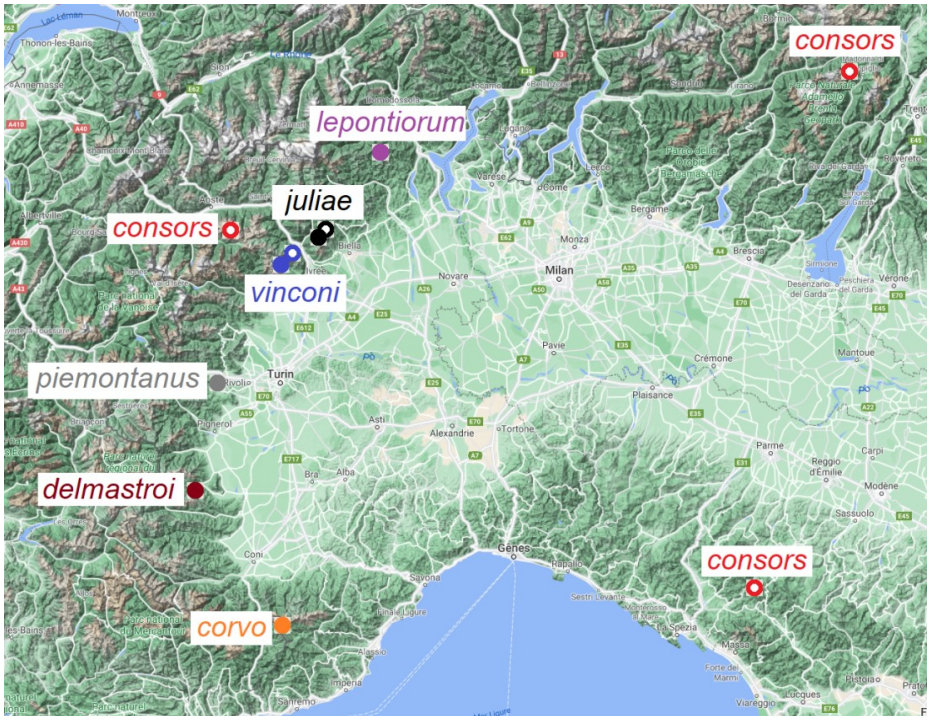
Material examined. **Italy**, Cogne, Gran Paradiso Massif, Gimillan, below upper Lussert Lake, 45.6583N, 7.396E, 2900m, 12.IX.2020 leg. Gilles Vinçon (2 males, OPC). Italy, Madonna di Campiglio, brook below Serodoli lake and above Serodoli lake, 46.246N, 10.78E, 2350-2380 m, 11.IX.2020, leg. Gilles Vinçon (2 males, OPC). Italy, Toscana, Cerreto Pass, La Nuda glacial circus, 44.286N, 10.228E, 1460 m, 18.X.2020, leg. Gilles Vinçon (2 males, OPC).

Remarks. For the first time the Alpin genus *Consorophylax* was found outside the Alps (Graf & Vitecek 2016). *C. consors* extends far in the northern Appennines up to the Glacial circus of la Nuda, close to the Cerreto Pass. In this hot spot of biodiversity also occur four new species: *Wormaldia marilouae* sp. nov., *W. toscanica* sp. nov., *Drusus cerreto* sp. nov., *D. hatras* sp. nov. Moreover three glacial relicts stoneflies occur in the same locality (*Dictyogenus fontium, Perlodes intricatus* and *Capnia vidua*) (Vinçon & Ravizza, in preparation)

Consorophylax juliae Oláh & Vinçon, sp. nov.

(Figures 107–113, Map 9, Photos 24–27)

Material examined. Holotype: **Italy**, Pennines Alps, Gressoney Valley, Pillaz, brook and spring, 45.642N, 7.875E, 1340–1380 m, 17.X.2020, leg. Gilles Vinçon (1 male, OPC). Allotype: same as holotype (1 female, OPC). Paratypes: same as holotype (1 male, 5 females; OPC). Italy, Pennines Alps, Gressoney Valley, Pillaz, brook and spring, 45.65N, 7.911E, 1720 m, 17.X.2020, leg. Gilles Vinçon (1 male, 4 females; OPC). Italy, Pennines Alps, Gressoney Valley, Pillaz, spring, 45.642N, 7.875E, 1400m, 17.X.2020, leg. Gilles Vinçon (7 females; OPC).



Map 9. *Consorophylax* species occurring in the Italian Alps and Apennines (full circles represent the type localities).

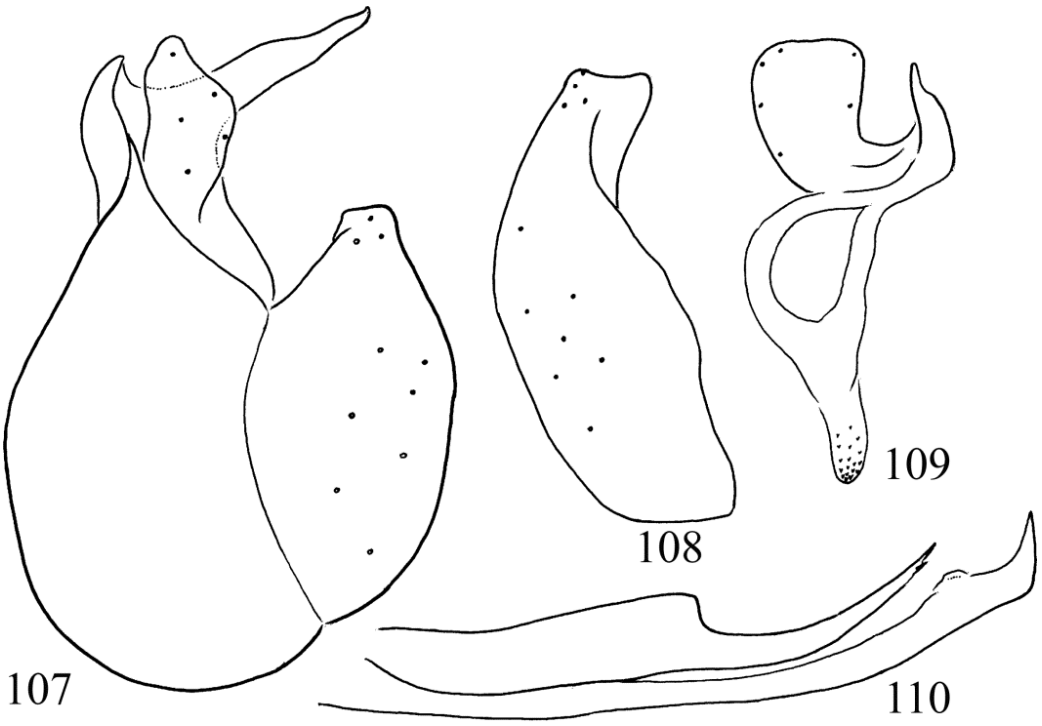


Figure 107–110. *Consorophylax juliae* sp. nov. Holotype male: 107 = lateral view of the genitalia without phallic organ, 108 = gonopod in caudal view, 109 = left cercus and paraproct in caudal view, 110 = phallic organ in lateral view.

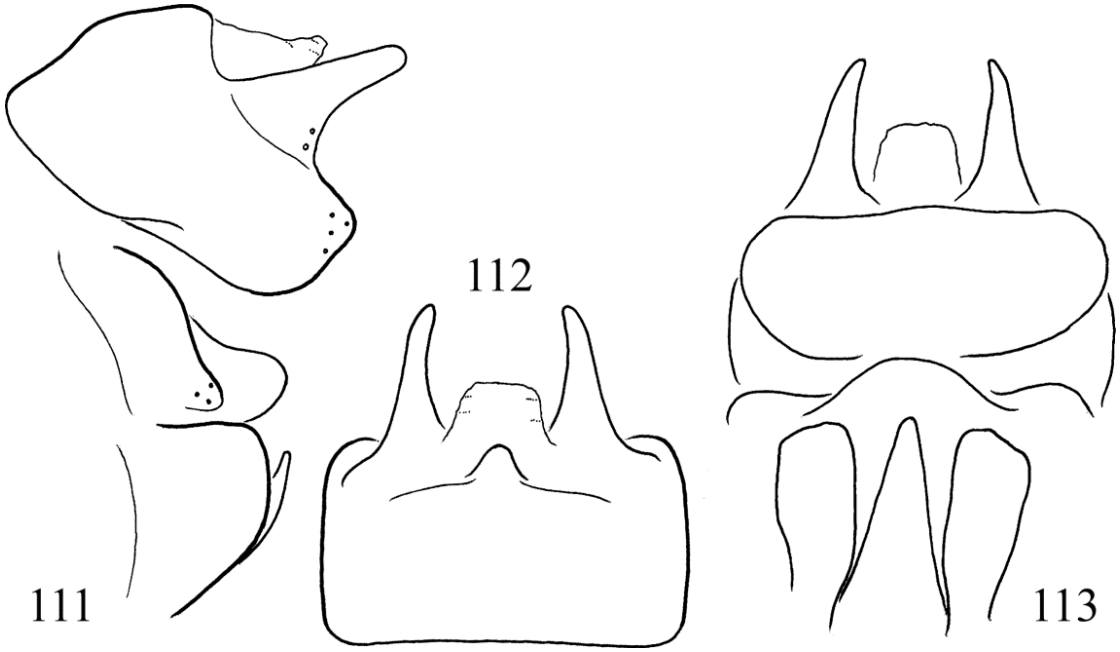


Figure 111–113. *Consorophylax juliae* sp. nov. Allotype female: 111 = lateral view of the genitalia, 112 = dorsal view of the genitalia, 113 = ventral view of the genitalia.

Diagnosis. This new *Consorophylax* species is a close relative of *C. vinconi* described from nearby habitats, but differs by several character states. Body sclerites are dark, almost castanean,and not light brown or cream coloured. Male has spur number 134, not 234. Male genitalia have the truncate apex of the gonopods in caudal view, not mesad pointed as well as the fine structure of the dorsal and ventral branches of the paraproct and the lateral profile of the paramere different. Female genitalia have quadrangular dorsal profile of the anal tube, not rounded, the mesal lobe of the vulvar sclerite long and pointed, not short and blunt.

Description. Male and female (in alcohol). This is a very dark, highly pigmented animal with fuscous castanean brown cephalic and thoracic sclerites with variously lighter appendages. Forewing has rounded apex and tendency to brachyptery in female, with long erect spine-like setae present on the longitudinal veins, especially on anal and cubital veins; membrane between veins scattered with tiny recumbent setae; female forewing length 11 mm. Male forewing length 14 mm, without brachyptery and without pronounced erect setae on the longitudinal veins. Tibial spur number 134 both at male and female.

Male genitalia. Posterodorsal spinate area of vestitural noncellular microtrichia less pronounced on tergite VIII, scattered only with tiny peg-like structures. Segment IX long ventrally, very short strap or bridle-like dorsally; its lateral length elongated by rounded convexity anterad, its posterior margin slightly concave. Segment X partly fused to tergite IX forming together the short dorsal bridle and partly present as less sclerotized membranous vestigium connecting mesad the invaginated basal part of the circular cup-like cerci. Cerci are large and subquadrangular in caudal view fused partially to the dorsal branch of the paraproct. Dorsal branch of paraproct slender, tapering straight and directed posterad; well-produced ventral branch forming a closed suptriangular strap with small ventral pegged lobe. Gonopods truncate in apical view. Phallic organ composed of the slender aedeagus and of the two partite parameres; basal half is stout, apical half spine-like with two subterminal seta; apex of aedeagus upward directed with fine pointed less sclerotized lobe.

Female genitalia. Anal tube oblique in lateral and quadrangular in dorsal view supplied with a pair of digitiform processes and with a mesal membranous irregular quadrangular lobe. Supragenital plate less pronounced rounded both in lateral and ventral views. Vulvar sclerites well-produced, mesal lobe tapering.

Etymology. *juliae*, dedicated to my wife to remember that hard times we cared together in quarantine isolation of Covid 19, while working on Trichoptera.

Enoicyla reichenbachi **(Kolenati, 1848)**

Material examined. **Italy**, Abruzzi, Prati di Tivo, spring and brook below the fountain, 42.502N, 13.573E, 1550–1580 m, 9.09.2020, leg. Gilles Vinçon (3 males, OPC).

Halesus rubricollis **(Pictet, 1834)**

Material examined. **Italy**, Maritime Alps, S.E. Pratolungo, Vallone di Riofreddo, brooklet and spring in open grassland, above the Malinvern and della Paur lakes, 44.219N, 7.207E, 2500 m, 10. VIII.2020, leg. Gilles Vinçon (1 male, 1 female; OPC). Italy, Graian Alps, Gran Paradiso Massif, > Dondenaz, spring + cascade, 45.612N, 7.523E, 2400 m, 11.IX.2020, leg. Gilles Vinçon (1 male, 5 females; OPC).

Parachiona picicornis **(Pictet, 1834)**

Material examined. **Italy**, Piemonte, Grand St Bernard, torrent, spring near the parking, 45.846N, 7.175E, 1780m, 6.VII.2020, leg. Gilles Vinçon (4 males, OPC).

Potamophylax alpinus **Tobias, 1994**

Material examined. **France**, Savoie Forclaz lakes, around and above the Esola lake, brook and lake surrounding, 45.657N, 6.709E, 2330 m, 15. VIII.2020, leg. Gilles Vinçon (1 male, OPC). **Italy**, Piemonte, Pennines Alps, Biella, above

Sanctuario di Oropa, spring, 45.6435N, 7.969E, 1800m, 4.VII.2020, leg. Gilles Vinçon (1 male, OPC).

***Potamophylax gambaricus* Malicky, 1971**

Material examined. **Italy**, Abruzzi, Prati di Mezzo, spring below the water capture, 41.651N, 13.959E, 1700m, 1.VII.2020, leg. Gilles Vinçon (1 male, 1 female; OPC). Italy, Lazio, Prati di Mezzo, spring below the second captage, 41.651N, 13.959E, 1700 m, 5.IX.2020, leg. Gilles Vinçon (2 males, 1 female; OPC). Italy, Calabria, Aspromonte, 2 nice brooklets separated by about 10 m, with mosses and dripping rocks, 38.25N, 15.853E, 850–900 m, 7.IX.2020, leg. Gilles Vinçon (1 male, OPC).

***Potamophylax inermis* Moretti & Cianficconi, 1994**

Material examined. **Italy**, Abruzzi, L'Aquila, Vera Spring, 42.370N, 13.458E, 680m, 14.VI.20, leg. Gilles Vinçon (1 male, OPC). Italy, Abruzzi, Prati di Mezzo, Fontitune, spring and brook along the torrent, 1560 m, 41.653N, 13.936E, 9.VI.20, leg. Gilles Vinçon (1 male, OPC). Italy, Abruzzi, Val Fondillo, two springs, 41.768N, 13.855E, 1100 m, 9.VI.2020, leg. Gilles Vinçon (4 males, 3 females; OPC). Italy, Abruzzi, L'Aquila, Spring Fium Vera, 42.370N, 13.458E, 680 m, 9.IX.2020, leg. Gilles Vinçon (6 males, 3 females; OPC).

***Potamophylax spinulifer* Moretti, 1994**

Material examined. Italy, Abruzzi, Val Fondillo, River, 41.768N, 13.855E, 1100 m, 5.IX. 2020, leg. Gilles Vinçon (1 male, OPC).

***Stenophylax mitis* McLachlan, 1875**

Material examined. **Italy**, Toscana, Passo del Cerreto, spring, brook and torrent, 44.291N, 10.229E, 1400m, 6.VI.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Emilia-Romagna, Monte Cimone, spring and brook, 44.191N, 10.683E 1550–1600m, 1.VII.2020, leg. Gilles Vinçon (1 female, OPC).

***Stenophylax sequax* McLachlan, 1875**

Material examined. **Italy**, Pennines Alps, around Lago Mambarone, 1930m, 45.584N, 7.883E, 8.VIII.2020, leg. Gilles Vinçon (1 male, OPC).

***Stenophylax wageneri* (Malicky, 1971)**

Material examined. **Italy**, Toscana, Reggello, spring in sloping ground and brooklets, 43.696N, 11.585E, 800–900m, 8.VI.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Toscana, > Reggello, Source en terrain pentu et ruisseaux plus loin, 43.696N, 11.585E, 800–900m, 8.VI.2020, leg. Gilles Vinçon (2 males, 1 female; OPC). Italy, Liguria, Beigua, brook and spring, 44.427N 8.543E, 1060 m, 6.VI.2020, leg. Gilles Vinçon (1 female, OPC). Italy, Emilia-Romagna, Monte Cimone, spring and brook, 44.191N, 10.683E 1550-1600m, 1.VII.2020, leg. Gilles Vinçon (1 male, 1 female, OPC).

Integripalpia

Brevitentoria

Leptoceroidea superfamily

Odontoceridae

***Odontocerum albicorne* Scopoli, 1763**

Material examined. **Italy**, Maritime Alps, S.E. Pratolungo, Vallone di Riofreddo, big torrent, 44.2484N, 7.176E, 1500 m, 10.08.2020, leg. Gilles Vinçon (3 males, 2 females; OPC).

Integripalpia

Brevitentoria

Sericostomatoidea superfamily

Beraeidae

***Beraea maura* (Curtis, 1834)**

Material examined. **Italy**, Abruzzi, Val Fondillo, two springs, 41.768N, 13.855E, 1100 m, 9.VI.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Campania, Monte Picentini, N. Giffoni

Valle Piana, spring + brooklet, 40.781N, 14.924E, 850 m, 10.VI.20, leg. Gilles Vinçon (5 males, 1 female, OPC).

Beraeamyia gudrunae Malicky, 2002

Material examined. **Italy**, Maritime Alps, S.E. Pratolungo, Vallone di Riofreddo, big brook in the forest, 44.2434N, 7.1744E, 1560 m, 10.VIII.2020, leg. Gilles Vinçon (male, OPC).

Ernodes romaniulus Moretti, Cianficconi, Campadelli & Crudele, 1999 stat. nov.

Ernodes nigroauratus romaniulus ssp. Moretti *et al*. 1999:55–57, 65. "Fosso dell'Abetio o La Stretta, FO, 1273 m. Letto pianeggiante con grosse pietre rivestite di briofite, interessato da risorgive. Ipocrenal ed epirhitral. 15.VII.1992: 1♀." "Cullace, FO, 1045 m. Torrentesu substrato sassoso, con massi emergent dall'acqua e ripetute cascatelle. Sponde coperte di rovi, sambuchi, aceri campestri e delimitate da abetine. Epirhitral. 8. VII. 1990: 2♀; 23.VI.1990: 1♂, 1♀."

*Material examined***. Italy**, Toscana, > Reggello, spring in sloping ground and brooklets, 43.696N, 11.585E, 800–900m, 8.VI.2020, leg. Gilles Vinçon (3 males, OPC).

Remarks. The shape of dorsal pair of processes on segment X as well as the huge spines of aedeagus both are diverged rather significantly from the Corsican species *Ernodes nigroaurata* Mosely, 1930. The divergences in both genital structures are stable. *Ernodes romaniulus* is an incipient sibling species of the *Ernodes nigroaurata* species complex. The third member of this species complex is *Ernodes siculus* Malicky, 1981. **Stat. nov.**

Helicopsychidae

Helicopsyche sperata McLachlan, 1876

*Material examined***. Italy**, Calabria, SW Cosenza, -> Rizzuto, rochers suintants en bord de route et ruisselet plein d'orties et ronces, 39.25N, 16.163E, 935 m, 12.VI.20, leg. Gilles Vinçon (3 males, 5 females; OPC). Italy, Calabria, Sila grande, spring, 39.32N, 16.401E, 1650-1700 m, 7.IX.2020, leg. Gilles Vinçon (26 males, 5 females; OPC).

Sericostomatidae

Sericostoma cianficconiae Moretti, 1978

Material examined. **Italy**, Calabria, Aspromonte, 2 nice brooklets separated by about 10 m, with mosses and dripping rocks, 38.25N, 15.853 E, 850–900 m, 7.IX.2020, leg. Gilles Vinçon (2 males, OPC).

Sericostoma italicum Moretti, 1978

Material examined. **Italy**, Abruzzi, Prati di Mezzo, spring below the water capture, 41.651N, 13.959E, 1700m, 1.VII.2020, leg. Gilles Vinçon (22 males, 4 females; OPC).

Sericostoma pedemontanum McLachlan, 1876

Material examined. **Italy**, Piemonte, Pennines Alps, Biella, above Sanctuario di Oropa, spring, 45.6435N, 7.969E, 1800m, 4.VII.2020, leg. Gilles Vinçon (1 male, OPC). Italy, Graian Alps, Ingria, torrent, Rio del Mulinet, 45.463N, 7.5676E, 900 m, 8.VIII.2020, leg. Gilles Vinçon (1 male, OPC).

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Appendix 1. Habitat photos of the collection localities

Photo 1. Italy, Toscana, Val di Luce, brook, 44.123N, 10.628 E, 1650 m (G. Vinçon) (*Wormaldia ameliae* Oláh & Vinçon, sp. nov., *W. marilouae* Oláh & Vinçon, sp. nov.).

Photo 2. Italy, Emilia – Romagna, Passo delle Radici, South slope, 44.2145N, 10.4875E, 1550 m, (G. Vinçon) (*Wormaldia dupla* Oláh & Vinçon sp. nov., *W. marilouae* Oláh & Vinçon, sp. nov.).

Photo 3. Italy, Liguria, Beigua, brook, 950 - 1000 m (G. Vinçon) (*Wormaldia joani* Oláh & Vinçon, sp. nov., *Diplectrona ligurica* Oláh & Vinçon, sp. nov., *Rhyacophila ligurica* Oláh & Vinçon, sp. nov.).

Photo 4. Italy, Liguria, Beigua, spring, 44.427N 8.543E, 1060 m (G. Vinçon) (*Wormaldia joani* Oláh & Vinçon, sp. nov., *Diplectrona ligurica* Oláh & Vinçon, sp. nov., *Rhyacophila ligurica* Oláh & Vinçon, sp. nov.).Vinçon, sp. nov.).

Photo 5. Italy, Toscana, Passo del Cerreto, La Nuda Glacial Circus (G. Vinçon).

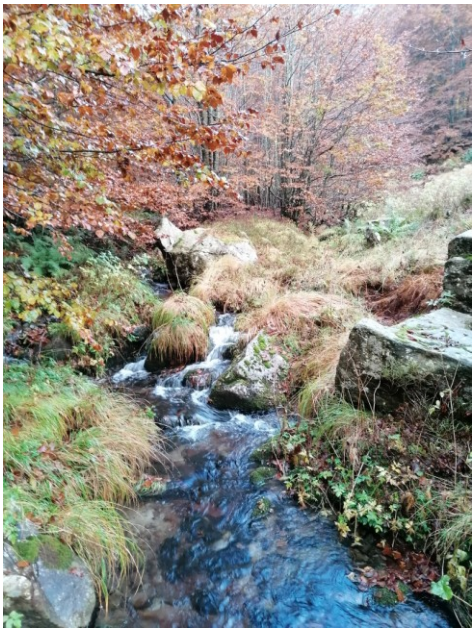

Photo 6. Italy, Toscana, Passo del Cerreto, La Nuda Glacial Circus, torrent, 44.289N, 10.227E, 1400m (G. Vinçon) (*Wormaldia marilouae* Oláh & Vinçon, sp. nov., *W. toscanica* Oláh & Vinçon, sp. nov., *Drusus cerreto*Oláh & Vinçon, sp. nov., *D. hatras* Oláh & Vinçon, sp. nov.).

Photo 7. Italy, Toscana, Passo del Cerreto, La Nuda Glacial Circus, spring and brook, 44.289N, 10.227E, 1400 m (G. Vinçon) (*Wormaldia marilouae* Oláh & Vinçon, sp. nov., *W. toscanica* Oláh & Vinçon, sp. nov.,*Drusus cerreto* Oláh & Vinçon, sp. nov., *D. hatras* Oláh & Vinçon, sp. nov.).

Photo 8. Italy, Toscana,Reggello, spring in sloping ground and brooklets, 43.696N, 11.585E, 800-900m (G. Vinçon) (*Wormaldia reggella* Oláh & Vinçon, sp. nov.).

Photo 9. Italy, Toscana,Reggello, spring in sloping ground and brooklets, 43.696N, 11.585 E, 900m (G. Vinçon) (*Wormaldia reggella* Oláh & Vinçon, sp. nov.).

Photo 10. Italy, Abruzzi, South Maiella Massif, brook on limestone substratum, 41.882N, 14.25E, 780 m (G. Vinçon) (*Rhyacophila abruzzica* Oláh & Vinçon, sp. nov.).

Photo 11. Italy, Abruzzi Prati di Tivo, Gran Sasso Massi (G. Vinçon).

Photo 12. Italy, Abruzzi Prati di Tivo, spring and grook, below the fountain, 42.502N, 13.573E, 1550-1580 m (G. Vinçon) (*Rhyacophila abruzzica* Oláh & Vinçon, sp. nov., *Drusus tagolt* Oláh & Vinçon, sp. nov.).

Photo 13. Italy, Abruzzi, Prati di Mezzo, 1650 m (G. Vinçon)

Photo 14. Italy, Abruzzi, Prati di Mezzo, spring area, 41.651N, 13.959E, 1700 m (G. Vinçon) (*Drusus oblos* Oláh & Vinçon, sp. nov.).

Photo 15. Italy, Graian Alps, Gran Paradiso Massif, Champorcher Valley, above Dondenaz, spring and brook, 45.618N, 7.549E, 2100 m (G. Vinçon) (*Drusus dondenaz* Oláh & Vinçon, sp. nov.).

Photo 16. Italy, Piemonte, above Cogne, Gran Paradiso Massif, Gimillan, 2580-2600 m.

Photo 17. Italy, Piemonte, above Cogne, Gran Paradiso Massif, Gimillan, spring, 45.643N, 7.413 E, 2600 m (G. Vinçon) (*Drusus granparadiso* Oláh & Vinçon, sp. nov.).

Photo 18. Italy, Trentino Alto Adige, Venetian Pre-Alps, above Camposilvano, brook, 45.754N, 11.148E, 1000 m (G. Vinçon) (*Drusus camposilvano* Oláh & Vinçon, sp. nov.)

Photo 19. Italy, Trentino Alto Adige, Venetian Pre-Alps, above Camposilvano, spring, 45.754N, 11.148E, 1010 m (G. Vinçon) (*Drusus camposilvano* Oláh & Vinçon, sp. nov.).

Photo 20. Italy, Molise, Spring of the Volturno River, 41.639N, 14.078E, 550 m (G. Vinçon) (*Limnephilus logos* Oláh & Vinçon, sp. nov.).

Photo 21. Italy, Piemonte, above Cogne, Gran Paradiso Massif, Gimillan, upper Lago di Lussert, 45.6583N, 7.396E, 2910 m (G. Vinçon) (*Chaetopteryx kimera* Oláh & Vinçon, sp. nov.).

Photo 22. Italy, Piemonte, above Cogne, Gran Paradiso Massif, Gimillan, upper Lago di Lussert, 45.6583N, 7.396E, 2910 m (G. Vinçon) (*Chaetopteryx kimera* Oláh & Vinçon, sp. nov.).

Photo 23. *Chaetopteryx kimera* Oláh & Vinçon, sp. nov. Italy, Piemonte, above Cogne, Gran Paradiso Massif, Gimillan, upper Lago di Lussert, 45.6583N, 7.396E, 2910 m (G. Vinçon).

Photo 24. Italy, Pennines Alps, Gressoney Valley, Pillaz, brook, 45.642N, 7.875E, 1340–1380 m (G. Vinçon) (*Consorophylax juliae* Oláh & Vinçon, sp. nov.).

Photo 25. Italy, Pennines Alps, Gressoney Valley, Pillaz, spring, 45.642N, 7.875E, 1400 m (G. Vinçon) (*Consorophylax juliae* Oláh & Vinçon, sp. nov.).

Photo 26. Italy, Pennines Alps, Gressoney Valley, Pillaz, above Vargno Lake,1650 m (G. Vinçon).

Photo 27. Italy, Pennines Alps, Gressoney Valley, Pillaz, above Vargno Lake, spring, 45.65N, 7.911E, 1720 m (G. Vinçon) (*Consorophylax juliae* Oláh & Vinçon, sp. nov.).

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Biodiversity of Indian Rotifers (Rotifera) with remarks on biogeography and richness in diverse ecosystems

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Abstract. We assess biodiversity status of Rotifera known from India to-date based on our studies from various regions of this country and evaluation of other viable records, and highlight notable features of biogeography and richness. The Indian fauna reveals 434 valid species belonging to 68 genera and 25 families and thus indicates the most biodiverse Rotifera vis-à-vis south and Southeast Asia, and records ~25% and ~41% species of global and regional biogeographic interest. It depicts the littoral-periphytic nature, broadly tropical character, the limited reports of cold-water species from the sub-Himalayan and Himalayan latitudes, paucity of the endemics and Bdelloids, and cryptic diversity awaits analyses. The richest diversity and distinct biogeographic identity of Rotifera of Northeast India (NEI) is attributed to location of this region in the 'Himalayan and Indo-Burmese' biodiversity hot-spots, 'Assam gateway' – the biogeographic corridor, and the 'Rotiferologist effect'. Regional disparity and spatial heterogeneity of biodiversity elsewhere from India are attributed to the limited sampling, inadequate collections from diverse ecosystems, unidentified species, and paucity of attention on smaller species. The biodiverse rotifer assemblages of the floodplain lakes including Deepor Beel and Loktak Lake, the two Ramsar sites and globally megadiverse ecosystems, are hypothesized to habitat diversity of these ecotones, while 'Rotifera paradox' depict speciose constellations per sample. The species-rich small floodplain and urban wetlands focus interest on rotifer diversity in small water bodies. We estimate more diverse Indian Rotifera following analyses of collections from underexplored and unexplored regions and ecosystems, and the bdelloid and sessile rotifers using integrative taxonomic approaches.

Key words. Biodiverse rotifers, diverse environs, regional disparity, richness, Rotifera paradox

INTRODUCTION

Rotifera or 'wheel animalcules' colonize diverse aquatic and semi-aquatic environs with endless profusion of body forms well adapted to their living habits and habitats. These features along with the latitudinal variations *vs*. 'tropic' and 'temperate' centered origin of various taxa (Pejler 1977, Dumont 1983, Segers 1996, 2001, 2008) characterize these metazoans as useful models for assessing patterns in global and regional biodiversity as well as biogeography analyses. The studies on the Indian Rotifera were initiated in West Bengal (Anderson 1889) and indicated useful earlier faunal surveys of Murray (1906), Edmondson & Hutchinson (1934), Nayar (1968) and Wulfert (1966). Sharma & Michael (1980) provided an overview of taxonomic studies until 1980's, while the state-of-art reports (Sharma 1991, 1996, 1998a) and useful but unvalidated compilation by Dhanapathi (2000) traced the subsequent faunal diversity progress which lacked a definite focus on biodiversity and biogeography until the end of the 20th century. The period from beginning of the 21st century to-date indicated notable Rotifera biodiversity works from the states of Arunachal Pradesh (Sharma & Sharma 2019a), Jammu & Kashmir (Sharma & Sharma 2018a), Mizoram (Sharma & Sharma 2015a), Nagaland (Sharma *et al.* 2017), and Tamil Nadu (Sharma & Sharma 2009). Meta-diversity updates on NEI Rotifera (Sharma & Sharma 2005, 2014a, 2019b), and the reviews on the Indian species of Lecanidae (Sharma & Sharma 2014b), Brachionidae (Sharma & Sharma 2014c), Lepadellidae (Sharma & Sharma 2015b) and *Testudinella* (Sharma & Sharma 2018b) notably added to our understanding of the rotifer diversity of India. This

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period also indicated certain important biodiversity studies from the floodplains of Assam (Sharma 2005, 2014; Sharma & Sharma 2008, 2014d, 2019c, 2019d, Sharma *et al*. 2017, 2018) and Manipur (Sharma 2009a) states of NEI, and the river Yamuna floodplains (Arora & Mehra 2003). Besides, our studies provided useful database for meta-analysis of Rotifera diversity of Deepor beel (Sharma & Sharma 2011, 2012, 2013, 2015c) and Loktak Lake (Sharma 2009b; Sharma & Sharma 2018c; Sharma *et al.* 2016) – the two intensively sampled Ramsar sites of India.

This study aims to present a critical appraisal of the current biodiversity status of the Indian Rotifera based on our contributions from various regions of India *vis-a-vis* intensive sampling from NEI; the semi-intensive collections from Jammu & Kashmir (western Himalayas) and West Bengal (east India) and Tamil Nadu (south India); the studies (BKS, unpublished) from central, east and south India; and evaluation of other viable reports published over the last nearly 130 years. A detailed systematic list of 434 valid Rotifera species known to-date from India is presented. Comments are made on biodiversity and biogeography of the Indian Rotifera with reference to nature and composition, species of global and regional distribution significance, spatial heterogeneity and regional disparity of the biodiversity, and species richness of the rotifer assemblages in various aquatic ecosystems. In addition, we highlight existing lacunae and suggest areas needing attention for the future biodiversity studies on the taxon.

MATERIALS AND METHODS

This biodiversity assessment is primarily based on analyses of our plankton and semi-planktonic samples collected from the diverse lentic environs of various regions of India over the last three decades. In addition, we undertook validation of the viable taxa vide the published reports. All our collections were obtained by towing nylobolt plankton net (# 40µm) and were preserved in 5% formalin. Voucher collections are deposited in the national holdings of Zoological Survey of India, Kolkata. We examined the collections from the following regions / states of India (Fig. 1):

1. Northeast India – Arunachal Pradesh, Assam, Manipur, Mizoram, Meghalaya, Nagaland and Tripura (Fig. 2).
2. Eastern India – West Bengal, Odisha (Orissa), Bihar and Jharkhand.
3. North India – Jammu & Kashmir, Panjab, Haryana.
4. Central India – Madhya Pradesh, Maharashtra and Goa.
5. South India – Andhra Pradesh, Telangana, Tamil Nadu, Karnataka and Kerala.
6. Insular freshwaters off the south Andamans Islands.

Microphotographs were taken by a Leica (DM 1000) stereoscopic phase contrast microscope fitted with an image analyzer and the figures were drawn with a drawing tube attachment. Rotifera species were identified following Koste (1978), Koste & Shiel (1987, 1989, 1990), Shiel & Koste (1992), Segers (1995, 1996), Sharma (1983, 1987a, 1987b, 1998b), Sharma & Sharma (1987, 1999, 2000, 2008, 2013, 2014b, 2014c, 2015a, 2019b) and Jersabek and Leitner (2013). Segers (2002, 2007) and Jersabek & Leitner (2013) were followed for classification, nomenclature, and biogeography of the taxon. Unless indicated otherwise, the figures and the micro-photographs are based on our collections from different parts of India.

RESULTS

A total of 434 Rotifera species belonging to 25 families and 68 genera are considered as validly known from India based on our present biodiversity assessment. A detailed systematic list of the documented taxa is presented hereunder:

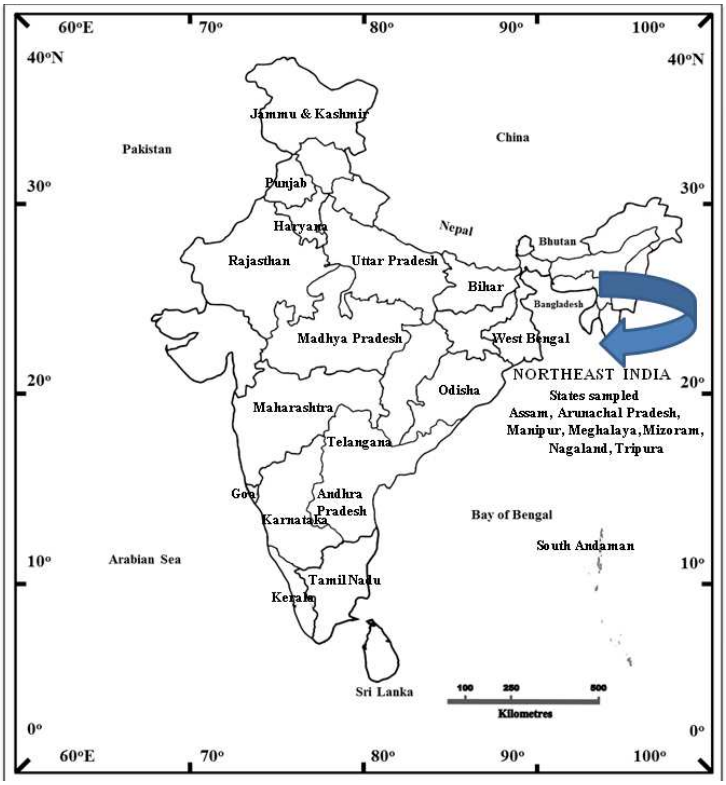

Figure 1. Map of India showing the sampled states

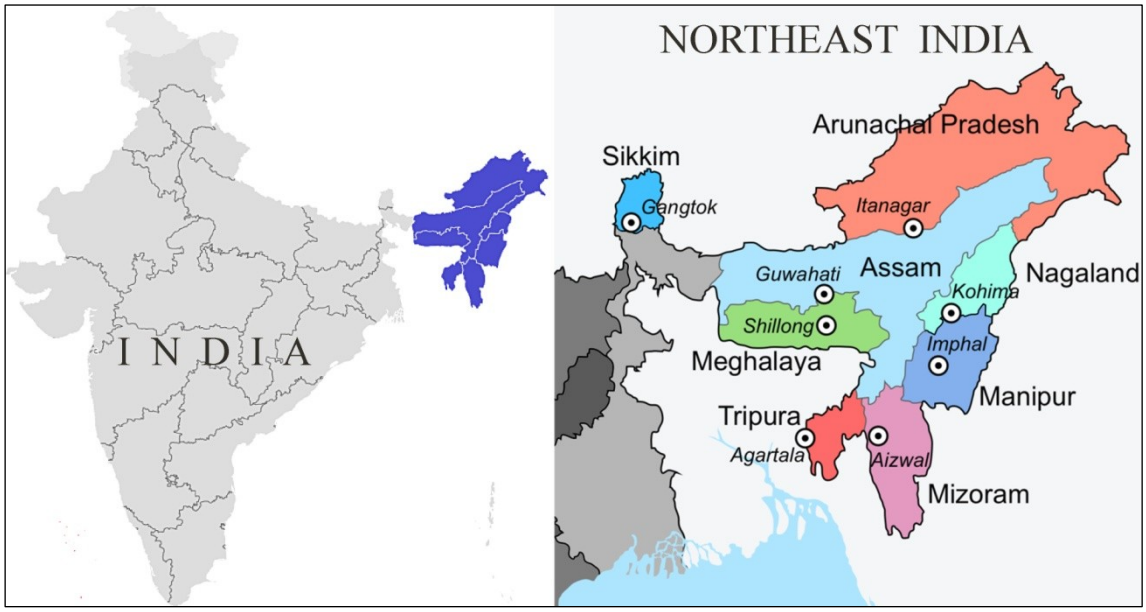

Figure 2. A = Map of India showing northeast India (blue color), B = map of NEI indicating the sampled states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura (After Sharma & Sharma 2019b)

Systematic list of Rotifera recorded from India

Phylum: Rotifera
Class: Eurotatoria
Subclass: Monogononta

Order: Ploima

Family: **Brachionidae**

1. *Anuraeopsis coelata* De Beauchamp, 1932 *
2. *A. fissa* (Gosse, 1851) *
3. *A. navicula* Rousselet, 1911*
4. *Brachionus ahlstromi* Lindeman, 1939*
5. *B. angularis* Gosse, 1851 *s. lato* *
   B. angularis bidens Plate, 1886 *
6. *B. bennini* Leissling, 1924 *
7. *B. bidentatus* Anderson, 1889 *s. lato* *
8. *B. budapestinensis* Daday, 1885 *
9. *B. calyciflorus* Pallas, 1766 *s. lato* *
10. *B. caudatus* Barrois & Daday, 1894 *s. lato* *
11. *B. dichotomus reductus* Koste & Shiel, 1980 *
12. *B. dimidiatus* Bryce, 1931 *
13. *B. diversicornis* (Daday, 1883) *s. lato* *
14. *B. donneri* Brehm, 1951 *
15. *B. dorcas* Gosse, 1851*
16. *B. durgae* Dhanapathi, 1974 *
17. *B. falcatus* Zacharias, 1898 *s. lato* *
    B. falcatus reductus Koste & Shiel, 1987 *
18. *B. forficula* Wierzejski, 1891 *s. lato* *
19. *B. kostei* Shiel, 1983 *
20. *B. leydigii* Cohn, 1862 *
21. *B. lyratus* Shephard, 1911*
22. *B. mirabilis* Daday, 1897 *
23. *B. murphyi* Sudzuki, 1989 *
24. *B. nilsoni* Ahlstrom, 1940 *
25. *B. plicatilis* O.F. Muller, 1786 *s. lato* *
26. *B. pterodinoides* Rousselet, 1913 *
27. *B. quadridentatus* Hermann, 1783 *s. lato* *
28. *B. rotundiformis* Tschugunoff, 1921*
29. *B. rubens* Ehrenberg, 1838 *
30. *B. sessilis* Varga, 1951 *
31. *B. srisumonae* Segers, Kotethip & Sanoamuang, 2004 *
32. *B. urceolaris* O. F. Muller, 1773 *
33. *Kellicottia longispina* (Kellicott, 1879) *
34. *Keratella cochlearis* (Gosse, 1851) *s. lato* *
35. *K. edmondsoni* Ahlstrom, 1943 *
36. *K. javana* Hauer, 1937 *
37. *K. hiemalis* Carlin, 1943 *
38. *K. lenzi* Hauer, 1953 *
39. *K. procurva* (Thorpe, 1891) *
40. *K. quadrata* (O.F. Muller, 1786) *
41. *K. serrulata* (Ehrenberg, 1838) *
42. *K. tecta* (Gosse, 1851) *
43. *K. ticinensis* (Callerio, 1921) *
44. *K. tropica* (Apstein, 1907) *s. lato* *
45. *Notholca acuminata* (Ehrenberg, 1832) *
46. *N. labis* Gosse, 1887
47. *N. squamula* (O.F. Muller, 1786) *
48. *N. striata* (Müller, 1786) *
49. *Plationus patulus* (O.F. Muller, 1786) *s. lato* *
50. *Platyias leloupi* (Gillard, 1967) *
51. *P. quadricornis* (Ehrenberg, 1832) *
    P. quadricornis andhraensis Dhanapathi, 1974 *

Family: **Epiphanidae**

52. *Cyrtonia tuba* (Ehrenberg, 1834)
53. *Epiphanes brachionus* (Ehrenberg, 1837) *s. lato* *
    E. brachionus spinosa (Rousselet, 1901) *
54. *E. clavatula* (Ehrenberg, 1831) *
55. *E. macroura* (Barrois & Daday, 1894) *
56. *E. senta* (O.F. Muller, 1773) *
57. *Mikrocodides chlaena* (Gosse, 1886)
58. *Proalides subtilis* Rodewald, 1940

Family: **Euchlanidae**

59. *Beauchampiella eudactylota* (Gosse, 1886) *
60. *Dipleuchlanis ornata* Segers, 1993 *
61. *D. propatula* (Gosse, 1886) *
62. *Euchlanis alata* Voronkov, 1912
63. *E. deflexa* Gosse, 1851
64. *E. dilatata* Ehrenberg, 1832 *s. lato* *
65. *E. incisa* Carlin, 1939 *
66. *E. meneta* Myers, 1930 *
67. *E. oropha* Gosse, 1887 *
68. *E. semicarinata* Segers, 1993 *
69. *E. triquetra* Ehrenberg, 1838 *
70. *Pseudoeuchlanis longipedes* Dhanapathi, 1978 *
71. *Tripleuchlanis plicata* (Levander, 1894) *

Family: **Mytilinidae**

72. *Lophocharis naias* Wulfert, 1942
73. *L. oxysternon* (Gosse, 1851) *
74. *L. salpina* (Ehrenberg, 1834) *
75. *Mytilina acanthophora* Hauer, 1938 *
76. *M. bisulcata* (Lucks, 1912) *
77. *M. brevispina* (Ehrenberg, 1830) *
78. *M. lobata* Pourriot, 1996 *
79. *M. michelangellii* Reid & Turner, 1988 *
80. *M. mucronata* (O.F. Muller, 1773) *
81. *M. ventralis* (Ehrenberg, 1830) *s. lato* *

Family: **Trichotriidae**

82. *Macrochaetus collinsi* (Gosse, 1867) *
83. *M. danneelae* Koste & Shiel, 1983 *
84. *M. longipes* Myers, 1934 *
85. *M. sericus* (Thorpe, 1893) *

86. *M. subquadratus* Perty, 1850 *
87. *Trichotria pocillum* (O.F. Muller, 1776) *
88. *T. tetractis* (Ehrenberg, 1830) *s. lato* *
89. *Wolga spinifera* (Western, 1894) *

Family: **Lepadellidae**

90. Co*lurella adriatica* Ehrenberg, 1831*
91. *C. colurus* (Ehrenberg, 1830) *s. lato* *
92. *C. obtusa* (Gosse, 1886) *s. lato* *
93. *C. oxycauda* Carlin, 1939
94. *C. sanoamuangae* Chittapun, Pholpunthin & Segers, 1999*
95. *C. sulcata* (Stenroos, 1898) *
96. *C. tesselata* (Glascott, 1893) *
97. *C. uncinata* (O.F. Muller, 1773) *s. lato* *
98. *Lepadella acuminata* (Ehrenberg, 1834) *s. lato* *
99. *L. apsicora* Myers, 1934 *
100. *L. apsida* Harring, 1916 *
101. *L benjamini* Harring, 1916 *
102. *L. bicornis* Vasisht & Battish, 1971 *
103. *L. biloba* Hauer, 1958 *
104. *L. costatoides* Segers, 1992 *s. lato* *
105. *L. cristata* (Rousselet, 1893) *
106. *L. dactyliseta* (Stenroos, 1898) *
107. *L. desmeti* Segers & Chittapun, 2001*
108. *L. discoidea* Segers, 1993 *
109. *L. ehrenbergi* (Perty, 1850) *
110. *L. elongata* Koste, 1992 *
111. *L. eurysterna* Myers, 1942 *
112. *L. cf. favorita* Klement, 1962 *
113. *L. heterodactyla* Fadeew, 1925 *
114. *L. heterostyla* (Murray, 1913) *
115. *L. imbricata* Harring, 1914 *
116. *L. kostei* Wulfert, 1966
117. *L. latusinus* (Hilgendorf, 1889) *
118. *L. lindaui* Koste, 1981*
119. *L. longiseta* Myers, 1934*
120. *L. minoruoides* Koste & Robertson, 1983 *
121. *L. minuta* (Weber & Montet, 1918) *
122. *L. nartiangensis* Sharma & Sharma, 1987 *
123. *L. neglecta* Segers & Dumont, 1995 *
124. *L. ovalis* (O.F. Muller, 1786) *s. lato* *
125. *L. patella patella* (O.F. Muller, 1773) *s. lato* *
    L. patella oblonga (Ehrenberg, 1834) *
    L. patella persimilis De Ridder, 1961
126. *L. quadricarinata* (Stenroos, 1898) *
127. *L. quinquecostata* (Lucks, 1912) *
128. *L. rhomboides* (Gosse, 1886) *s. lato* *
129. *L. rhomboidula* (Bryce, 1890) *
130. *L. triba* Myers, 1934 *
131. *L. triptera* Ehrenberg, 1832 *s. lato* *
132. *L. vandenbrandei* Gillard, 1952 *
133. *Squatinella bifurca* (Bolton, 1884) *
134. *S. lamellaris* (O. F. Müller, 1786) *

Family: **Lecanidae**

135. *Lecane acanthinula* (Hauer, 1938) *
136. *L. aculeata* (Jakubski, 1912) *
137. *L. arcuata* (Bryce, 1891) *
138. *L. arcula* Harring, 1914 *
139. *L. aeganea* Harring, 1914 *
140. *L. aspasia* Myers, 1917 *
141. *L. batillifer* (Murray, 1913) *
142. *L. bifastigata* Hauer, 1938 *
143. *L. bifurca* (Bryce, 1892) *
144. *L. blachei* Berzins, 1973 *
145. *L. braumi* Koste, 1988 *
146. *L. bulla bulla* (Gosse, 1851) *s. lato* *
    L. bulla diabolica (Hauer, 1936) *
147. *L. calcaria* Harring & Myers, 1926*
148. *L. clara* (Bryce, 1892) *
149. *L. closterocerca* (Schmarda, 1859) *s. lato* *
150. *L. cornuta* (Müller, 1786) *s. lato* *
151. *L. crenata* (Harring, 1913) *
152. *L. crepida* Harring, 1914 *
153. *L. curvicornis* (Murray, 1913) *s. lato* *
154. *L. decipiens* (Murray, 1913) *
155. *L. depressa* (Bryce, 1891)
156. *L. dorysimilis* Trinh Dang, Segers & Sanoamuang, 2015*
157. *L. doryssa* Harring, 1914 *
158. *L. elasma* Harring & Myers, 1926
159. *L. elegans* Harring, 1914 *
160. *L. elongata* Harring & Myers, 1926 *
161. *L. eswari* Dhanapathi, 1976 *
162. *L. flexilis* (Gosse, 1886) *s. lato* *
163. *L. furcata* (Murray, 1913) *s. lato* *
164. *L. galeata* (Bryce, 1892)
165. *L. glypta* Harring & Myers, 1926 *
166. *L. haliclysta* Harring & Myers, 1926 *
167. *L. hamata* (Stokes, 1896) *s. lato* *
168. *L. hastata* (Murray, 1913) *
169. *L. hornemanni* (Ehrenberg, 1834) *
170. *L. inermis* (Bryce, 1892) *
171. *L. inopinata* Harring & Myers, 1926 *
172. *L. isanensis* Sanoamuang & Savatenalinton, 2001 *
173. *L. jaintiaensis* Sharma, 1987 *
174. *L. lateralis* Sharma, 1978 *
175. *L. latissima* Yamamoto, 1951 *
176. *L. leontina* (Turner, 1892) *s. lato* *
177. *L. levistyla* (Olofsson, 1917) *
178. *L. ligona* (Dunlop, 1901) *
179. *L. ludwigii* (Eckstein, 1883) *s. lato* *
180. *L. luna* (Müller, 1776) *s. lato* *
181. *L. lunaris* (Ehrenberg, 1832) *s. lato* *
182. *L. marchantaria* Koste & Robertson, 1983 *
183. *L. monostyla* (Daday, 1897) *s. lato* *
184. *L. nana* (Murray, 1913) *
185. *L. nitida* (Murray, 1913) *
186. *L. niwati* Segers, Kothetip & Sanoamuang, 2004*

187. *L. obtusa* (Murray, 1913) *s. lato* *
188. *L. ohioensis* (Herrick, 1885) *
189. *L. papuana* (Murray, 1913) *s. lato* *
190. *L. pawlowskii* Wulfert, 1966 *
191. *L. paxiana* Hauer, 1940 *
192. *L. perplexa* (Ahlstrom, 1938)
193. *L. pertica* Harring & Myers, 1926 *
194. *L. ploenensis* (Voigt, 1902) *
195. *L. punctata* (Murray, 1913)
196. *L. pusilla* Harring, 1914 *
197. *L. pyriformis* (Daday, 1905) *
198. *L. quadridentata* (Ehrenberg,1830) *s. lato* *
199. *L. rhenana* Hauer, 1929 *
200. *L. rhytida* Harring & Myers, 1926 *
201. *L. rugosa* (Harring, 1914) *
202. *L. ruttneri* Hauer, 1938 *
203. *L. schraederi* Wulfert, 1966 *
204. *L. scutata* (Harring & Myers, 1926) *
205. *L. shieli* Segers & Sanoamuang, 1994 *
206. *L. signifera* (Jennings, 1896) *s. lato* *
207. *L. simonneae* Segers, 1993 *
208. *L. sinuata* (Hauer, 1938) *
209. *L. sola* Hauer, 1936 *
210. *L. solfatara* (Hauer, 1938) *
211. *L. stichaea* Harring, 1913 *
212. *L. stichoclysta* Segers, 1993 *
213. *L. stenroosi* (Meissner, 1908) *
214. *L. stokesii* (Pell, 1890) *
215. *L. styrax* (Harring & Myers, 1926) *
216. *L. superaculeata* Sanoamuang & Segers, 1997 *
217. *L. sympoda* Hauer, 1929 *
218. *L. syngenes* (Hauer, 1938) *
219. *L. tenuiseta* Harring, 1914 *
220. *L. thalera* (Harring & Myers, 1926)
221. *L. thienemanni* (Hauer, 1938) *
222. *L. tryphema* Harring & Myers, 1926
223. *L. undulata* Hauer, 1938 *
224. *L unguitata* (Fadeev, 1925) *s. lato* *
225. *L. ungulata* (Gosse, 1887) *s. lato* *
226. *L. vasishti* Sharma, 1980 *
227. *L. verecunda* Harring & Myers, 1926 *

Family: **Proalidae**

228. *Proales decipiens* (Ehrenberg, 1832)
229. *P. fallaciosa* Wulfert, 1937
230. *P. indirae* Wulfert, 1966

Family: Notommatidae

231. *Cephalodella auriculata* (O.F. Müller, 1773) *
232. *C. catellina* (O.F. Müller, 1786) *
233. *C. exigua* (Gosse, 1886) *
234. *C. forficata* (Ehrenberg, 1832) *
235. *C. forficula* (Ehrenberg, 1838) *
236. *C. gibba* (Ehrenberg, 1830) *
237. *C. gigantea* Remane, 1933
238. *C. hiulca* Myers, 1924
239. *C. intuta* Myers, 1924*
240. *C. megalocephala* (Glascott, 1893)
241. *C. misgurnus* Wulfert, 1937
242. *C. mucronata* Myers, 1924 *
243. *C. panarista* Myers, 1924 *
244. *C. trigona* (Rousselet, 1895) *
245. *C. ventripes* (Dixon-Nuttall, 1901) *
246. *Eosphora anthadis* Harring & Myers, 1922
247. *E. najas* Ehrenberg, 1830
248. *Itura aurita* (Ehrenberg, 1830)
249. *Monommata actices* Myers, 1930
250. *M. grandis* Tessin, 1890 *
251. *M. longiseta* (O.F. Müller, 1786) *
252. *M. maculata* Harring & Myers, 1930 *
253. *Notommata aurita* (Müller, 1786)
254. *N.copeus* Ehrenberg, 1834 *
255. *N. glyphura* Wulfert, 1935 *
256. *N. pachyura* (Gosse, 1886) *
257. *N. pseudocerberus* De Beauchamp, 1908
258. *N. saccigera* Ehrenberg, 1830 *
259. *N. spinata* Koste & Shiel, 1991*
260. *N. tripus* Ehrenberg, 1838 *
261. *Taphrocampa annulosa* Gosse, 1851 *
262. *T. selenura* Gosse, 1887 *

Family: Scaridiidae

263. *Scaridium longicaudum* (O.F. Müller, 1786) *

Family: **Gastropodidae**

264. *Ascomorpha. ecaudis* Perty, 1850 *
265. *A. saltans* Bartsch, 1870 *
A. saltans indica Wulfert, 1966
266. *A. ovalis* (Bergendal, 1892) *
267. *Gastropus hyptopus* (Ehrenberg, 1838) *
268. *G. minor* (Rousselet, 1892) *
269. *G. stylifer* Imhof, 1891*

Family: Trichocercidae

270. *Ascomorphella volvocicola* (Plate, 1886)
271. *Trichocerca abilioi* Segers & Sarma, 1993 *
272. *T. bicristata* (Gosse, 1887) *
273. *T. bidens* (Lucks, 1912) *
274. *T. brachyura* (Gosse, 1851)
275. *T. braziliensis* (Murray, 1913) *
276. *T. capucina* (Wierzejski & Zacharias, 1893) *
277. *T. cavia* (Gosse, 1886)
278. *T. chattoni* (De Beauchamp, 1907)
279. *T. cylindrica* (Imhof, 1891) *
280. *T. edmondsoni* (Myers, 1936) *
281. *T. elongata* (Gosse, 1886) *
282. *T. flagellata* Hauer, 1937 *
283. *T. hollaerti* De Smet, 1990 *

284. *T. iernis* (Gosse, 1887) *
285. *T insignis* (Herrick, 1885) *
286. *T. insulana* (Hauer, 1937) *
287. *T. kostei* Segers, 1993 *
288. *T. longiseta* (Schrank, 1802 *
289. *T. maior* (Hauer, 1935)*
290. *T. mus* Hauer, 1938 *
291. *T. myersi* (Hauer, 1931)
292. *T. porcellus* (Gosse, 1881) *
293. *T. pusilla* (Jennings, 1903) *
294. *T. rattus* (O.F. Müller, 1776) *s. lato* *
295. *T. ruttneri* Donner, 1953 *
296. *T. scipio* (Gosse, 1886) *
297. *T. siamensis* Segers & Pholpunthin, 1997 *
298. *T. similis* (Wierzejski, 1893) *s. lato* *
299. *T. stylata* (Gosse, 1851) *
300. *T. sulcata* (Jennings, 1894) *
301. *T. taurocephala* (Hauer, 1931) *
302. *T. tenuior* (Gosse, 1886) *
303. *T. tigris* (O.F. Müller, 1786)
304. *T. uncinata* (Voigt, 1902) *
305. *T. voluta* (Murray, 1913) *
306. *T. weberi* (Jennings, 1903) *

Family: Asplanchnidae

307. *Asplanchna brightwelli* Gosse, 1850 *
308. *A. herricki* de Guerne, 1888
309. *A. intermedia* Hudson, 1886 *
310. *A. priodonta* Gosse, 1850 *
311. *A. sieboldii* (Leydig, 1854) *
312. *Asplanchnopus bhimavaramensis* Dhanapathi, 1975 *
313. *A. hyalinus* Harring, 1913 *
314. *A. multiceps* (Schrank, 1793)

Family: Synchaetidae

315. *Ploesoma hudsoni* (Imhof, 1891) *
316. *P. lenticulare* Herrick, 1885 *
317. *Polyarthra euryptera* Wierzejski, 1891*
318. *P.* cf. *dolichoptera* Idelson, 1925 *
319. *P. indica* Segers & Babu, 1999
320. *P. vulgaris* Carlin, 1943 *s. lato* *
321. *Synchaeta oblonga* Ehrenberg, 1832 *
322. *S. longipes* Gosse, 1887 *
323. *S. pectinata* Ehrenberg, 1832 *
324. *S. stylata* Wierzejski, 1893 *
325. *S. tremula* (O.F. Müller, 1786) *

Family: Dicranophoridae

326. *Dicranophoroides caudatus* (Ehrenberg, 1834) *
327. *Dicranophorus dolerus* Harring & Myers, 1928 *
328. *D. epicharis* Harring & Myers, 1928 *
329. *D. forcipatus* (O.F. Müller, 1786) *
330. *D. luetkeni* (Bergendal, 1892) *
331. *D. myriophylli* (Harring, 1913)
332. *D. tegillus* Harring & Myers, 1928
333. *Encentrum longipes* Wulfert, 1936

Order: **Floscullariaceae**

Family: Floscularidae

334. *Beauchampia crucigera* (Dutrochet, 1812)
335. *Floscularia conifera* (Hudson, 1886) *
336. *F. ringens* (Linnaeus, 1758) *s. lato* *
337. *Lacinularia flosculosa* (O.F. Müller, 1773) *
338. *L. racemovata* Thorpe, 1893 *
339. *Limnias ceratophylli* Schrank, 1803 *s. lato* *
340. *L. melicerta* Weisse, 1848
341. *Ptygura barbata* (Edmondson, 1939)
342. *P. furcillata* (Kellicott, 1889)
343. *P. kostei* José De Paggi, 1996
344. *P. melicerta* Ehrenberg, 1832 *
345. *P. pedunculata* Edmondson, 1939
346. *P. stephanion* (Anderson, 1889)
347. *P. tacita* Edmondson, 1940 *
348. *Sinantherina procera* (Thorpe, 1893)
349. *S. semibullata* (Thorpe, 1893) *
350. *S. socialis* (Linne, 1758) *
351. *S. spinosa* (Thorpe, 1893) *
352. *Stephanoceros fimbriatus* (Goldfusz, 1820) *

Family: Conochilidae

353. *Conochilus dossuarius* Hudson, 1885 *
354. *C. natans* Seligo 1901*
355. *C. hippocrepis* (Schrank, 1803)
356. *C. unicornis* Rousselet, 1892*

Family: Hexarthridae

357. *Hexarthra bulgarica* (Wiszniewski, 1933)
358. *H. intermedia* (Wiszniewski, 1929) *
359. *H. mira* (Hudson, 1871) *
360. *H. oxyuris* (Zernov, 1903)

Family: Testudinellidae

361. *Pompholyx complanata* Gosse, 1851*
362. *P. sulcata* Hudson,1885 *
363. *Testudinella amphora* Hauer, 1938 *s. lato* *
364. *T. brevicaudata* Yamamoto, 1951 *
365. *T. dendradena* de Beauchamp, 1955 *
366. *T. emarginula* (Stenroos, 1898) *s. lato* *
367. *T. greeni* Koste, 1981 *
368. *T. incisa* (Ternetz, 1892)
369. *T. insinuata* Hauer, 1938 *
370. *T. mucronata* (Gosse, 1886) *
371. *T. parva parva* (Ternetz, 1892) *
T. parva bidentata (Ternetz, 1892) *
T. parva semiparva Hauer, 1938 *
372. *T. patina* (Hermann, 1783) *s. lato* *
373. *T. tridentata* Smirnov, 1931 *s. lato* *
374. *T. walkeri* Koste & Shiel, 1980 *

375. *T.* sp. Sharma & Sharma 2018b *
376. *T.* sp.1 Sharma & Sharma 2018b *

Family: Trochosphaeridae

377. *Filinia brachiata* (Rousselet, 1901) *
378. *F. camasecla* Myers, 1938 *
379. *F. cornuta* (Weisse, 1848) *
380. *F. longiseta* (Ehrenberg, 1834) *s. lato* *
381. *F. opoliensis* (Zacharias, 1898) *
382. *F. pejleri* Hutchinson, 1964 *
383. *F. saltator* (Gosse, 1886) *
384. *F. terminalis* (Plate, 1886) *s. lato* *
385. *Horaella brehmi* Donner, 1949 *
386. *Trochosphaera aequatorialis* Semper, 1872 *
387. *T. solstitialis* Thorpe, 1893 *

Order: **Collothecaceae**

Family: Atrochidae

388. *Cupelopagis vorax* (Leidy, 1857) *

Family: Collothecidae

389. *Collotheca ambigua* (Hudson, 1883)
390. *C. campanulata* (Dobie, 1849) *
391. *C. hexalobata* Banik, 2000
392. *C. mutabilis* (Hudson, 1885)
393. C. *ornata* (Ehrenberg, 1832) *
394. C. *tetralobata* Banik, 2000
395. C. *tenuilobata* (Anderson, 1889)
396. C. *trilobata* (Collins, 1872)

Subclass: Bdelloidea

Family: Adinetidae

397. *Adineta vaga major* Bryce, 1893 *
A. vaga minor Bryce, 1893
398. *A. longicornis* Murray, 1906

Family: Habrotrochidae

399. *Habrotrocha angusticollis* (Murray, 1905) *
H. angusticollis attenuata (Murray, 1906) *
400. *H. aspera* (Bryce, 1892)
401. *H. bidens* (Gosse, 1851)
402. *H. lata* (Bryce, 1892)
403. *H. leitgebii* (Zelinka, 1886)
404. *H. microcephala* (Murray, 1906)
405. *H. nodosa* (Murray, 1906)
406. *H. perforata* (Murray, 1906)

Family: Philodinidae

407. *Dissotrocha aculeata* (Ehrenberg, 1832) *
408. *Embata laticeps* (Murray, 1905)
409. *Macrotrachela bullata* (Murray, 1906)
410. *M. formosa* (Murray, 1906)
411. *M. habita* (Bryce, 1894)
412. *M. multispinosa* Thompson, 1892 *
413. *M. musculosa* (Milne, 1886)
414. *M. papillosa* Thompson, 1892
415. *M. plicata* (Bryce, 1892)
416. *M. quadricornifera rigida* Milne, 1916
417. *Philodina brevipes* Murray, 1902
418. *P. citrina* Ehrenberg, 1832*
419. *P. flaviceps* Bryce, 1906
420. *P. indica* Murray, 1906
421. *P. megalotrocha* Ehrenberg, 1832
422. *P. roseola* Ehrenberg, 1832
423. *P. squamosa* Murray, 1906
424. *P. vorax* (Janson, 1893)
425. *Rotaria citrina* (Ehrenberg, 1838) *
426. *R. macroceros* (Gosse, 1851) *
427. *R. mento* (Anderson, 1889) *
428. *R. neptunia* (Ehrenberg, 1830) *
429. *R. neptunoida* Harring, 1913*
430. *R. ovata* (Anderson, 1889)
431. *R. rotatoria* (Pallas, 1766) *
432. *R. sordida sordida* (Western, 1893)
R. sordida fimbriata (Murray, 1906)
433. *R. tardigrada* (Ehrenberg, 1830)
434. *R. tridens* (Montet, 1915)

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*Recorded in our collections from different regions of India

Of the listed Indian Rotifera, 359 species belonging to 25 families and 67 genera (Table 1) are observed in our plankton and semi-plankton collections from the different regions / states of India (Fig. 3), while 303 species (Fig. 4) belonging to 53 genera and 24 families are observed from seven states of NEI. The monogonont rotifers include 396 belonging to 22 families and 61 genera, and 339 belonging to 21 families and 53 genera from India and in our collections, respectively (Table 1). The bdelloid rotifers (Table 1) are represented by 38 species belonging to 3 families and 7 genera, while our samples reveal 11 species and four genera of bdelloids. Rotifera of NEI reveals 287 species of Monogononta and 16 species of Bdelloidea.

Lecanidae (93 species) > Brachionidae (51 species) > Lepadellidae (45 species) > Trichocercidae (37 species) > Notommatidae (32 species) and Philodinidae (27) are notable, families, while Floscularidae (19 species), Testudinellidae

(16 species), Euchlanidae (13 species), Synchaetidae (11 species), Trochosphaeridae (11 species) and Mytilinidae (10 species) are noteworthy. *Lecane* (93 species) is most speciose genus; *Trichocerca* (36 species) ≥ *Lepadella* (35 species) > *Brachionus* (30 species) are notable, while *Cephalodella* (15 species) ≥ *Testudinella* (14 species) > *Keratella* (11 species) ≥ *Rotaria* (10 species) are other important genera; *Euchlanis, Colurella, Notommata, Filinia, Collotheca, Habrotrocha, Macrotrachela* and *Philodina* include eight species each and *Mytilina* includes seven species.

The family-wise breakup of the rotifer taxa known from India and in our collections are indicated in Table 1. The species observed in our collections from the different states of India are indicated in Fig. 3. Our intensive samples from seven states of NEI (Fig. 4) indicate the rotifer richness ranging between 181±39 species with 244, 200, 176, 172, 162, 161 and 150 species observed from Assam, Manipur, Tripura, Arunachal Pradesh, Mizoram, Meghalaya and Nagaland, respectively.

Table 1: Family-wise composition of Rotifera

Families↓ Taxa→	**Species**		**Genera**	
	India	**Our collections**	**India**	**Our collections**
Subclass : Monogononta				
Order : Ploima				
Family: Brachionidae	51	50	7	7
Family: Epiphanidae	07	04	4	1
Family: Euchlanidae	13	11	5	5
Family: Mytilinidae	10	09	2	2
Family: Trichotriidae	08	08	3	3
Family: Lepadellidae	45	43	3	3
Family: Lecanidae	93	88	1	1
Family: Proalidae	03	0	1	0
Family: Notommatidae	32	22	6	4
Family: Scaridiidae	01	01	1	1
Family: Gastropodidae	06	06	2	2
Family: Trichocercidae	37	32	2	2
Family: Asplanchnidae	08	06	2	2
Family: Synchaetidae	11	09	3	3
Family: Dicranophoridae	08	05	3	2
Order: Flosculariaceae				
Family: Flosculariidae	19	11	7	6
Family: Conochilidae	04	03	1	1
Family: Hexarthridae	04	02	1	1
Family: Testudinellidae	16	15	2	2
Family: Trochosphaeridae	11	11	3	3
Order: Collothecaceae				
Family: Atrochidae	01	01	1	1
Family: Collothecidae	08	02	1	1
Sub-class: Bdelloidea				
Family: Adinetidae	02	01	1	1
Family: Habrotrochidae	08	01	1	1
Family: Philodinidae	28	09	5	4
Total Rotifer taxa	**434**	**350**	**68**	**59**

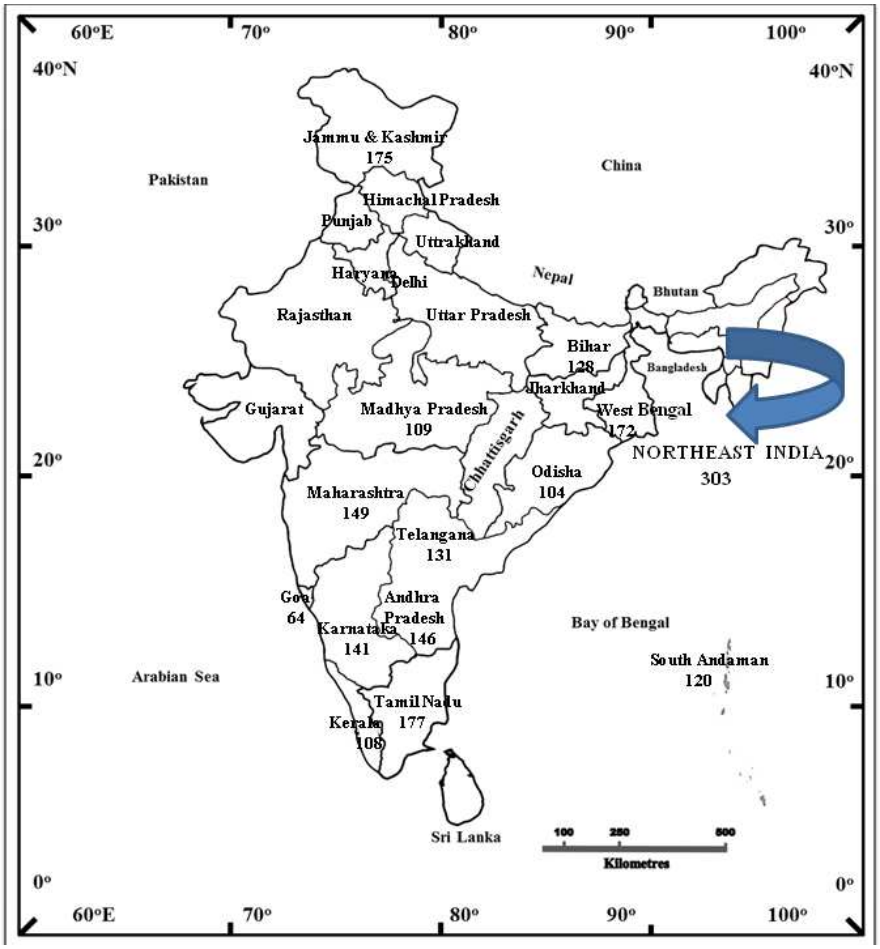

Figure 3. Species richness of Rotifera in various states of India

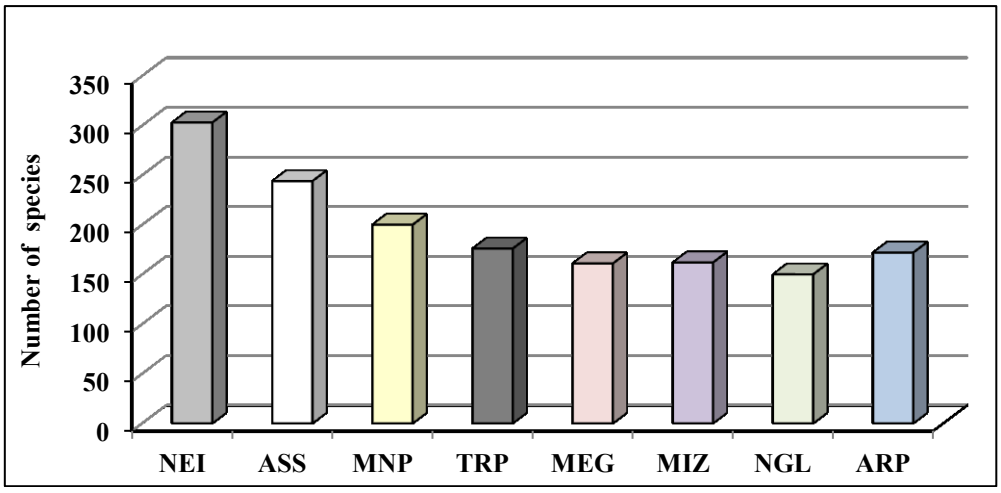

Figure 4. Rotifera species known from Northeast India
(NEI- northeast India; ASS-Assam; MNP-Manipur; TRP- Tripura; MEG-Meghalaya; MIZ-Mizoram, NGL-Nagaland; ARP-Arunachal Pradesh)

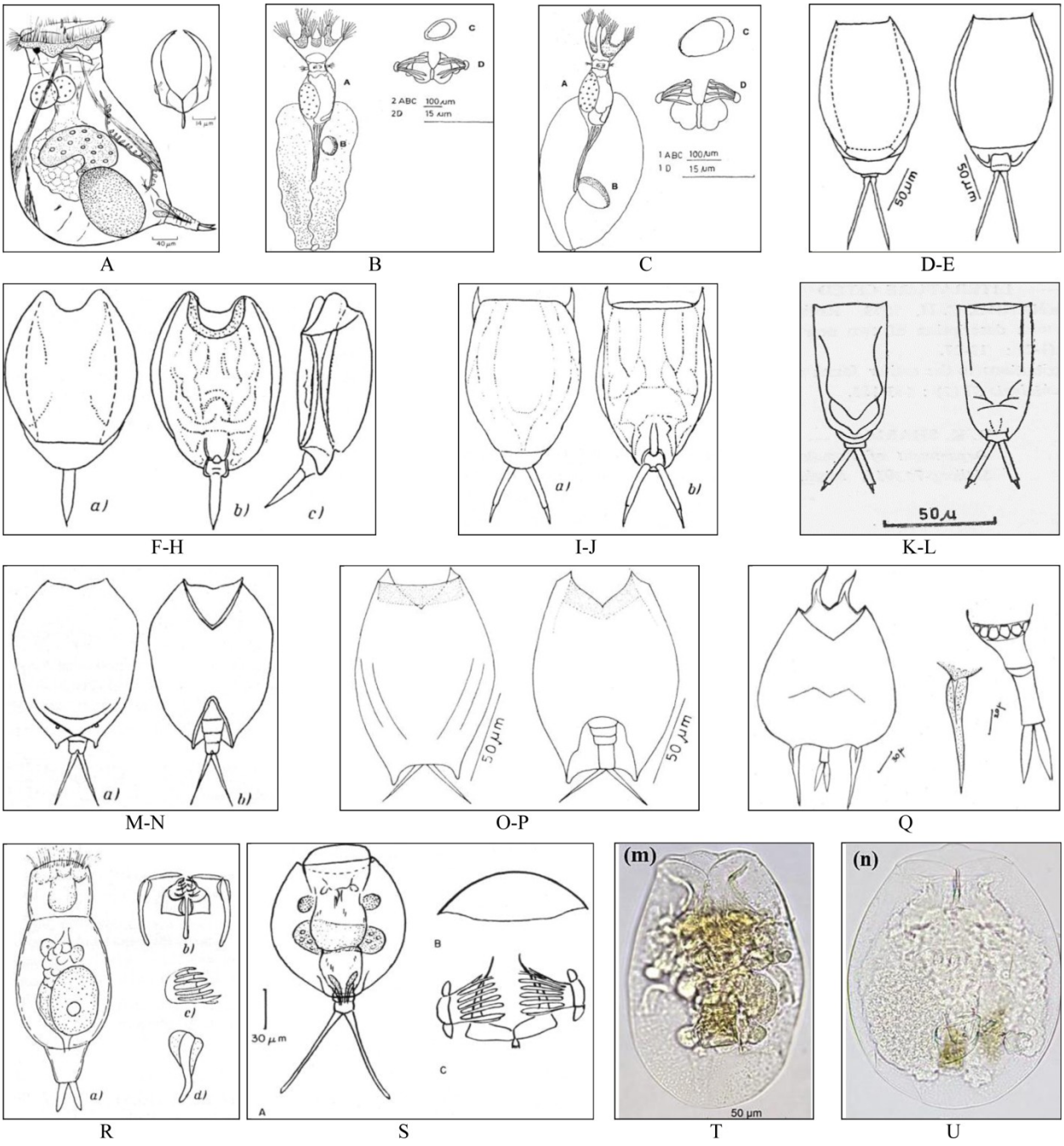

Figure 5. Indian endemics. **A** = *Asplanchnopus bhimavaramensis* Dhanapathi (lateral view and trophi, after Dhanapathi, 1975); **B** = *Collotheca hexalobata* Banik (lateral view, trophi and amictic egg, after Banik 2000); **C** = *Collotheca tetralobata* Banik (lateral view, trophi and amictic egg, after Banik 2000); **D-E** = *Lecane jaintiaensis* Sharma (dorsal and ventral view views, after Sharma 1987b); **F-H** = *Lecane schraederi* Wulfert (dorsal, ventral and lateral views); **I-J** = *Lecane pawlowski* Wulfert (dorsal and ventral views, after Wulfert, 1966); **K-L** = *Lecane vasishti* Sharma (dorsal and ventral view); **M-N** = *Lepadella kostei* Wulfert (dorsal and ventral views, after Wulfert 1966); **O-P** = *Lecane nartiangensis* Sharma & Sharma (dorsal and ventral views, after Sharma & Sharma 1987); **Q** = *Platyias quadricornis andhraensis* Dhanapathi (ventral view, after Dhanapathi, 1974); **R** = *Proales indirae* Wulfert (dorsal view, trophi, unci and ramu, after Wulfert 1966); **S** = *Pseudoeuchlanis longipedes* Dhanapathi (dorsal view, cross-section and trophi, after Dhanapathi 1978); **T** = *Testudinella* sp. (ventral view, after Sharma and Sharma 2018b); **U** = *Testudinella* sp.1 (ventral view, after Sharma & Sharma 2018b).

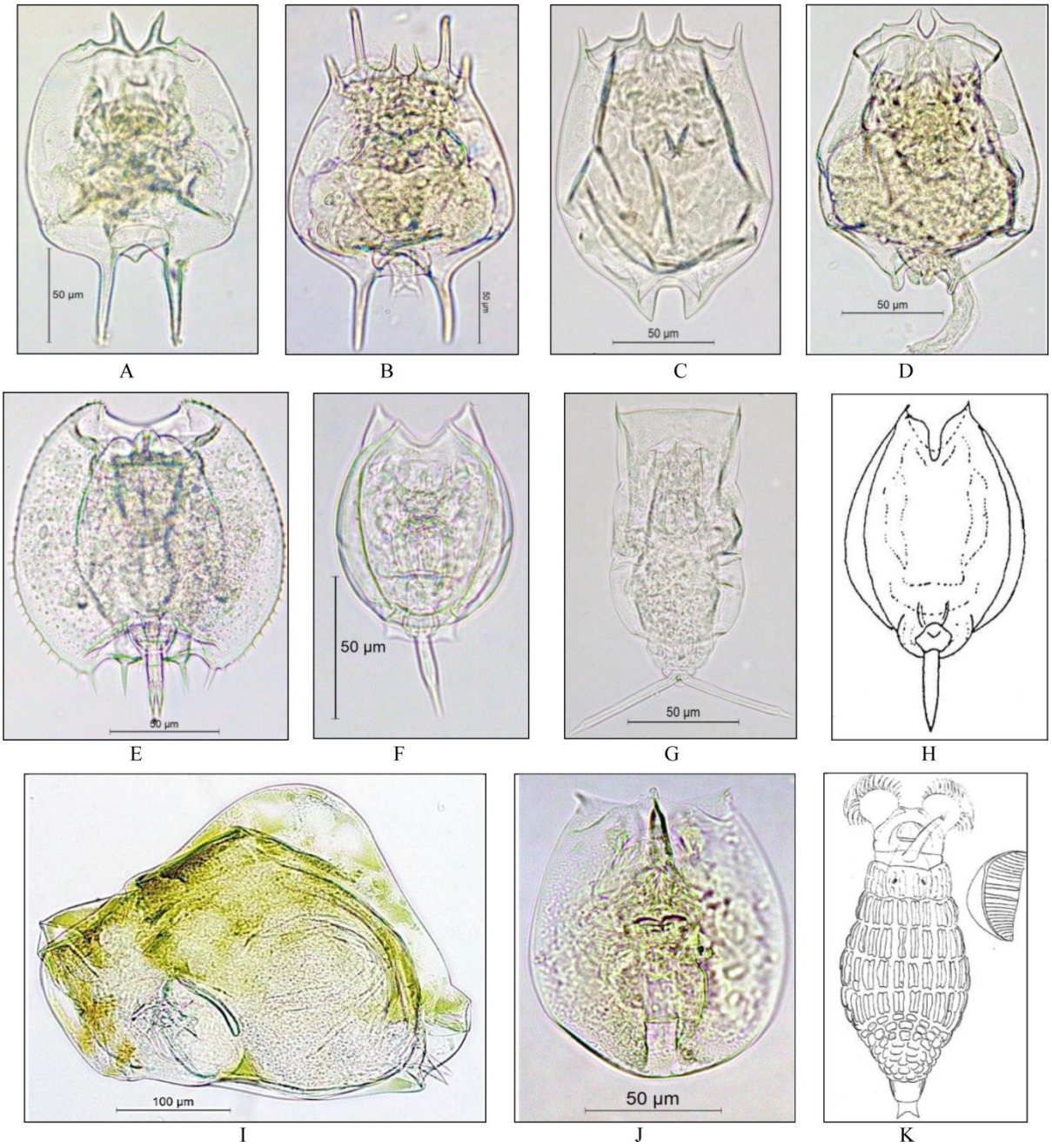

Figure 6. Australasian Rotifera. **A =** *Brachionus dichotomus reductus* Koste & Shiel (ventral view); **B** = *Brachionus falcatus reductus* Koste & Shiel (dorsal view, after Sharma & Sharma 2019b); **C** = *Brachionus kostei* Shiel (dorsal view); **D** = *Brachionus lyratus* Shephard (ventral view, after Sharma & Sharma 2019b); **E** = *Macrochaetus danneelae* Koste & Shiel (dorsal view, after Sharma & Sharma, 2019b); **F** = *Lecane batillifer* (Murray) (dorsal view); **G** = *Lecane shieli* Segers & Sanoamuang (dorsal view, after Sharma & Sharma 2019b); **H** = *Lecane sinuata* (Hauer) (ventral view, after Sharma & Sharma 2014b); **I** = *Notommata spinata* Koste & Shiel (parially compressed, lateral view); **J** = *Testudinella walkeri* Koste & Shiel (ventral view, after Sharma & Sharma 2015b); **K** = *Philodina squamosa* Murray (dorsal view and trophi, after Murray 1906).

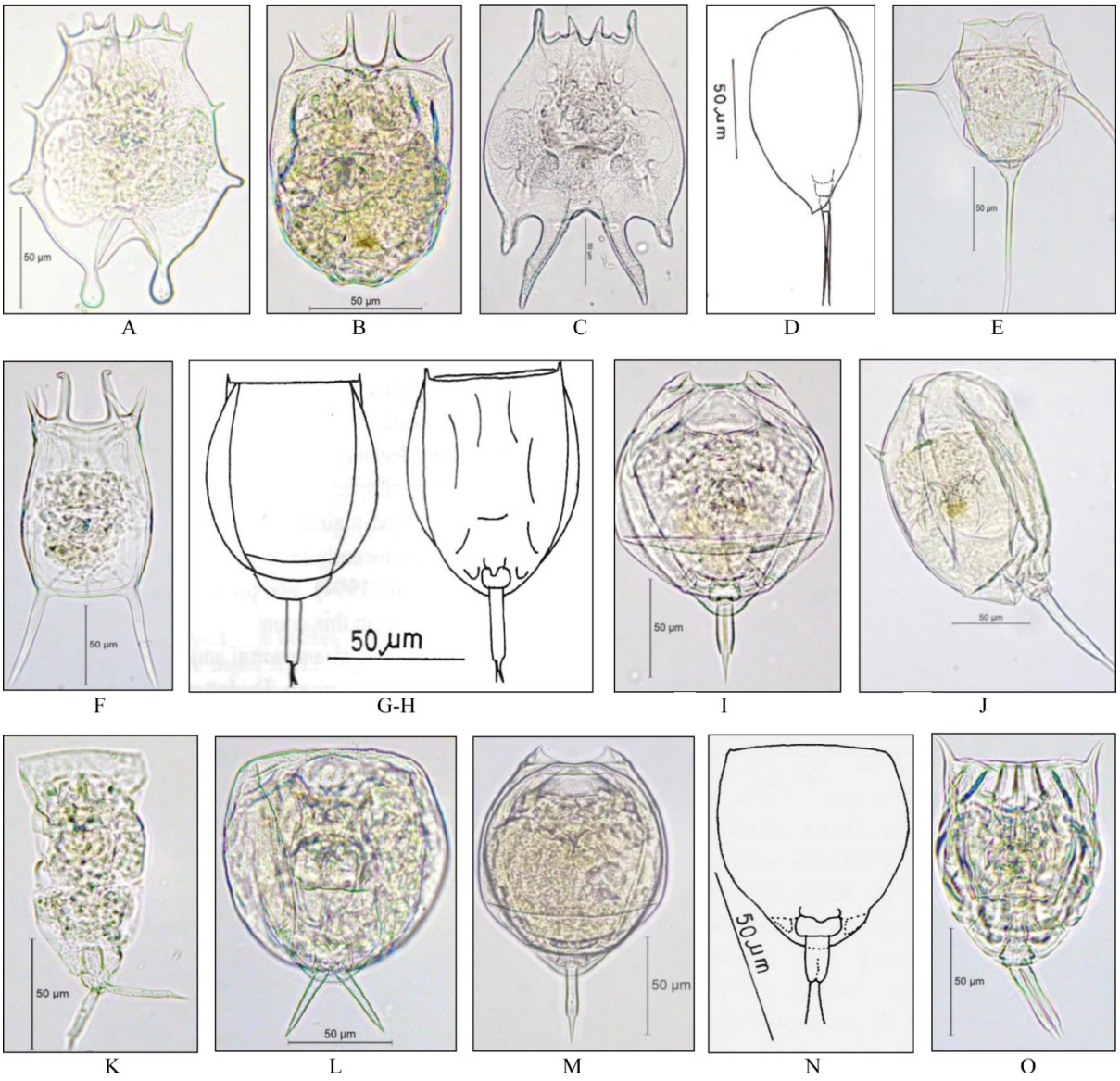

Figure 7. Oriental Rotifera. **A** = *Brachionus donneri* Brehm (ventral view); **B** = *Brachionus murphyi* Sudzuki (ventral view, after Sharma & Sharma 2019b); **C** = *Brachionus srisumonae* Segers, Kothetip & Sanoamuang (venral view, after Sharma & Sharma 2019b); **D** = *Colurella sanoamuangae* Chittapun, Pholpunthin & Segers (lateral view, after Sharma & Sharma 2015a); **E** = *Filinia camasecla* Myers (ventral view); **E** = *Keratella edmondsoni* Ahlstrom (dorsal view); **G-H** = *Lecane acanthinula* (Hauer) (dorsal and ventral views, after Sharma & Sharma 2014b); **I** = *Lecane blachei* Berzins (ventral view); **J** = *Lecane bulla diabolica* (Hauer), lateral view; **K** = *Lecane isanensis* Sanoamuang & Savatenalinton (ventral view, after Sharma & Sharma 2019b); **L** = *Lecane latissima* Yamamoto (dorsal view); **M** = *Lecane niwati* Segers, Kothetip & Sanoamuang (ventral view); **N** = *Lecane solfatara* (Hauer) (ventral view, after Sharma 2005); **O** = *Lecane superaculeata* Sanoamuang & Segers (ventral view).

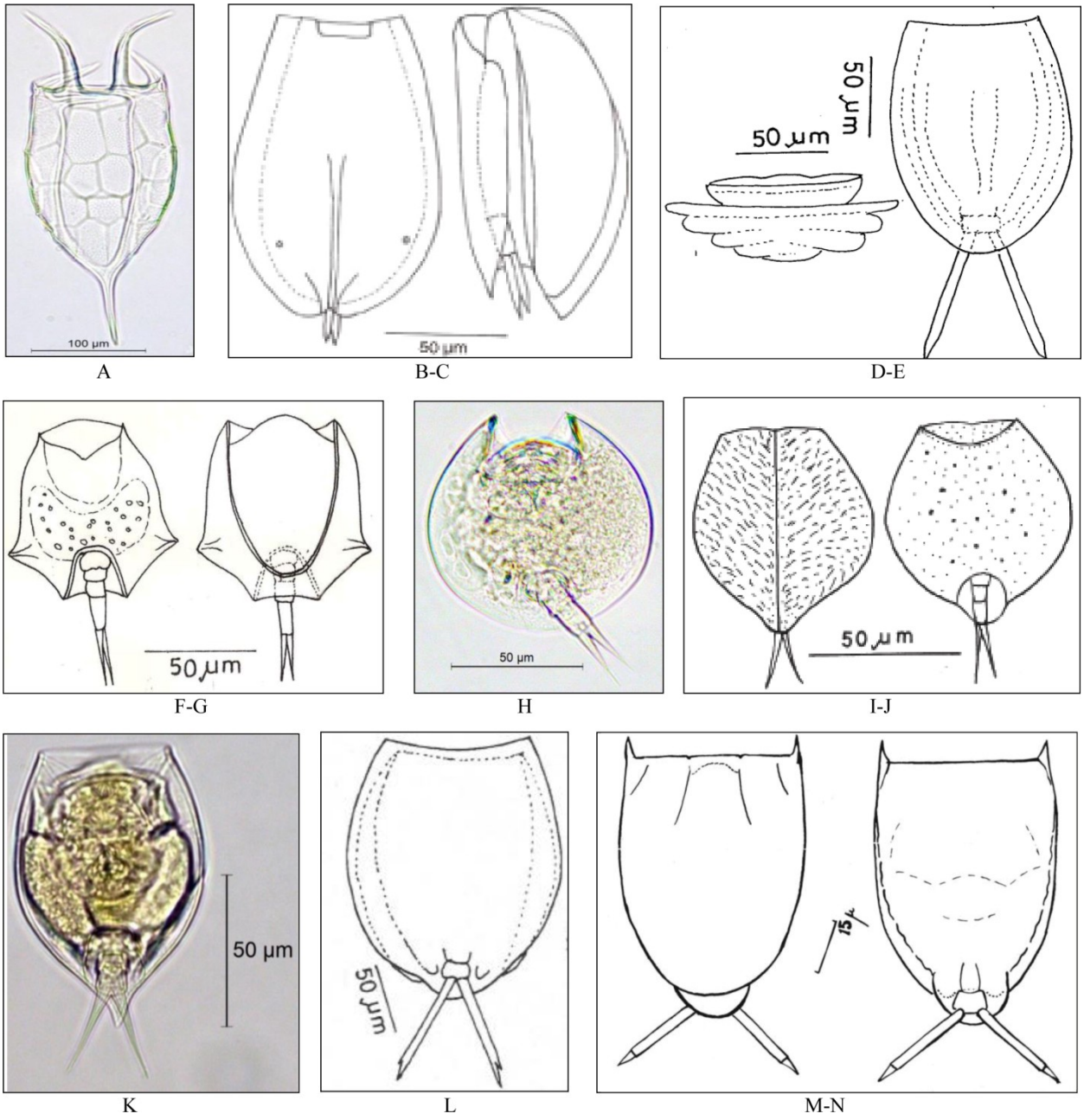

Figure 8. Paleotropical Rotifera. **A** = *Keratella javana* Hauer (ventral view); **B-C** = *Euchlanis semicarinata* Segers(dorsal and lateral views, after Sharma 2005); **D-E =** *Dipleuchlanis ornata* Segers (ventral view and cross-section, after Sharma 2005); **F-G** = *Lecane bicornis* Vasisht & Battish (ventral and dorsal views); **H** = *Lepadella discoidea* Segers (ventral view); **I-J** = *Lepadella minoruoides* Koste & Robertson (dorsal and ventral view, after Sharma 2004); **K** = *Lepadella vandenbrandei* Gillard (ventral view); **L** = *Lecane braumi,* Koste (ventral view, after Sharma & Sharma 1987); **M–N** = *Lecane eswari* Dhanapathi (dorsal and ventral views, after Dhanapathi 1976)

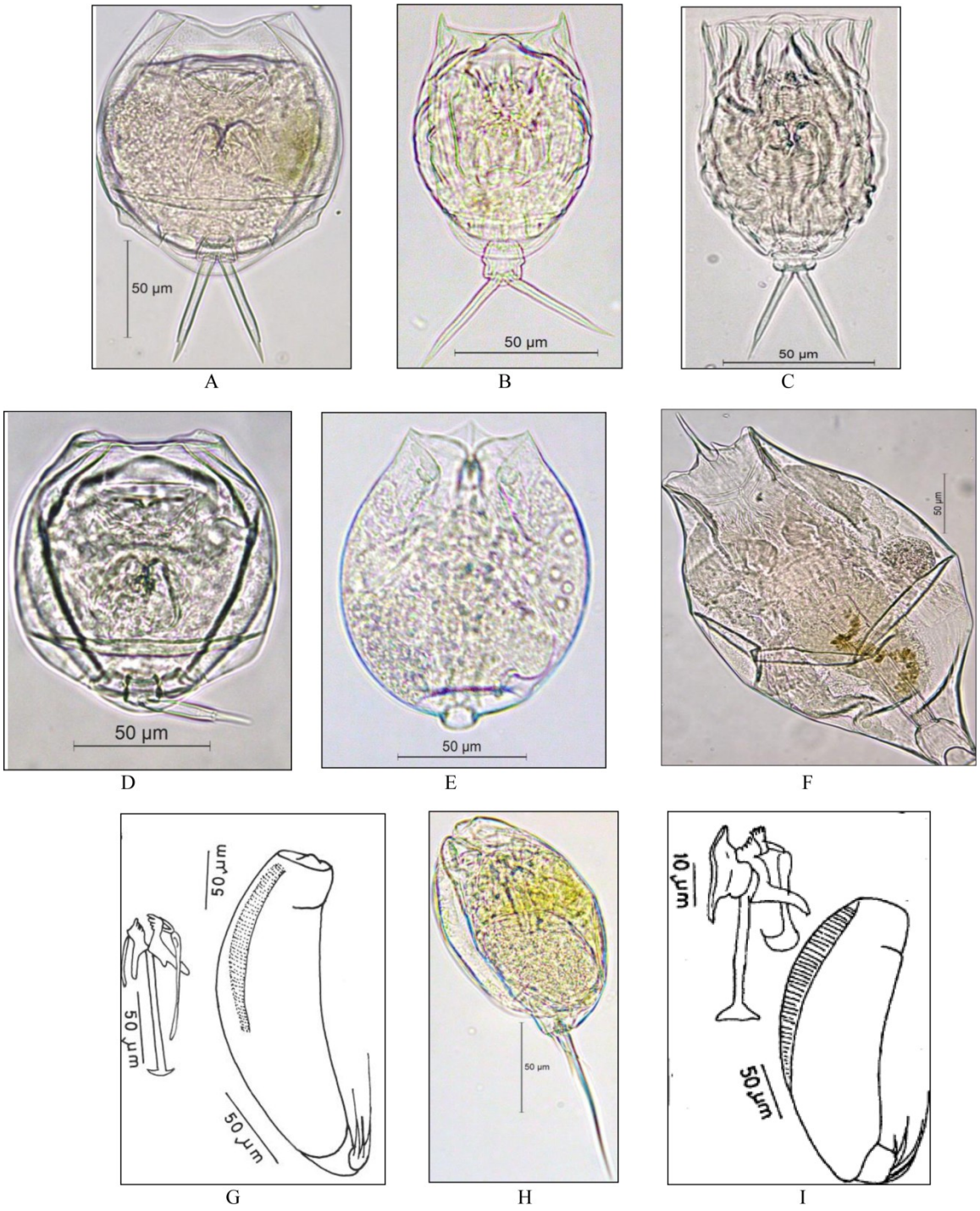

Figure 9. Paleotropical Rotifera. **A** = *Lecane lateralis* Sharma, (ventral view); **B** = *Lecane simonneae* Segers (dorsal view); **C** = *Lecane stichoclysta* Segers (dorsal view, Sharma & Sharma 2019c); **D** = *Lecane unguitata* (Fadeev) (ventral view); **E** = *Testudinella brevicaudata* Yamamoto, ventral view; **F** = *Testudinella greeni* Koste (dorsal view); **G** = *Trichocerca abilioi* Segers & Sarma (lateral view and trophi, Sharma & Sharma 2008); **H** = *Trichocerca hollaerti* De Smet (lateral view); **I** = *Trichocerca kostei* Segers (lateral view and trophi, Sharma & Sharma, 2008).

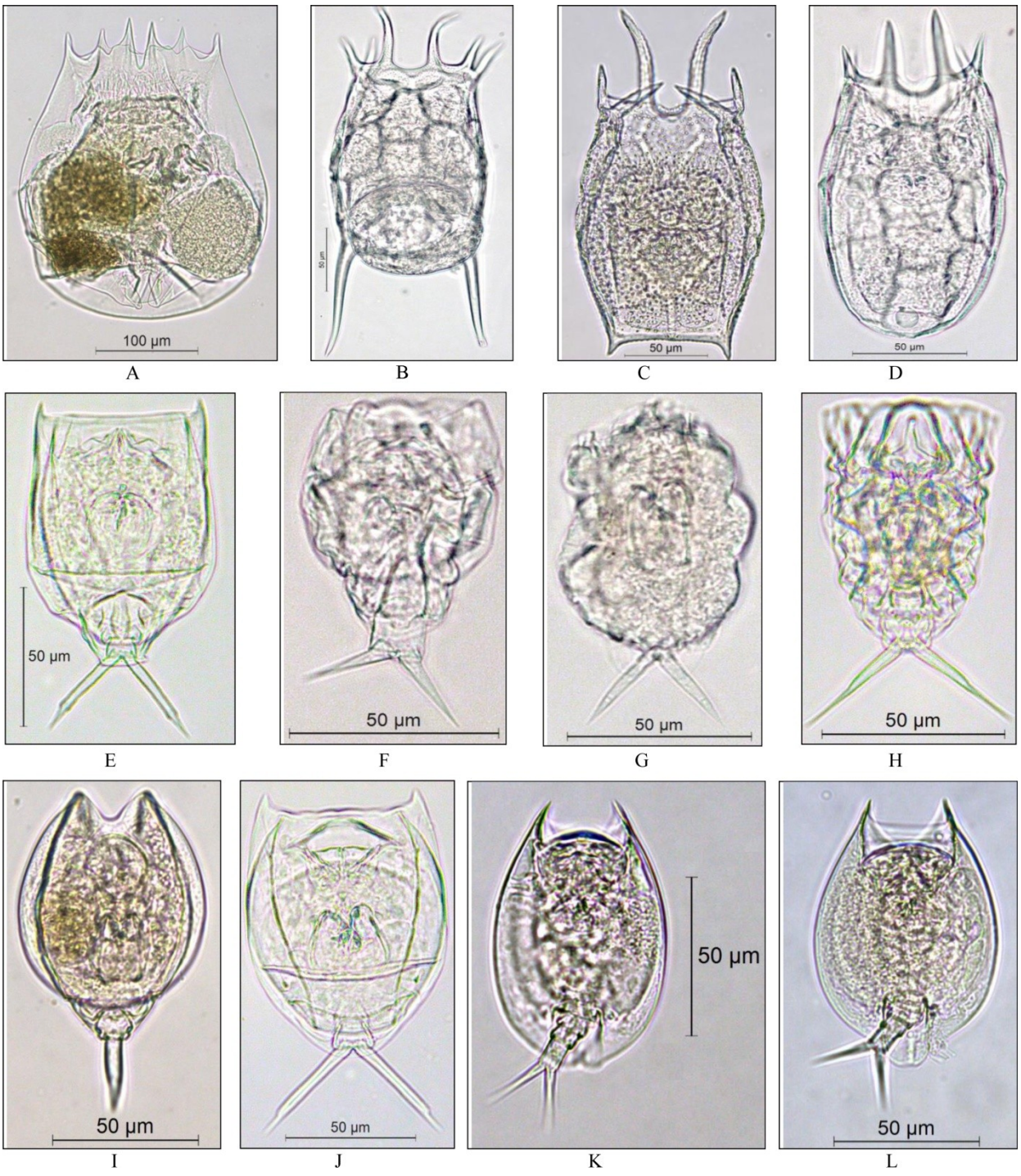

Figure 10. Interesting species. **A** = *Brachionus durgae* Dhanapathi (dorsal view); **B** = *Keratella hiemalis* Carlin (ventral view, Sharma & Sharma 2018a); **C** = *Keratella serrulata* (Ehrenberg) (dorsal view, Sharma & Sharma 2018a); **D** = *Keratella ticinensis* (Callerio) (ventral view, Sharma and Sharma 2018a); **E** = *Lecane bifastigata* Hauer, (ventral view); **F** = *Lecane calcaria* Harring & Myers (ventral view); **G** = *Lecane clara* (Bryce) (dorsal view); **H** = *Lecane dorysimilis* Trinh Dang, Segers & Sanoamuang (ventral view); **I** = *Lecane marchantaria* Koste & Robertson (dorsal view, Sharma & Sharma 2019a); **J** = *Lecane rhenana* Hauer (ventral view); **K** = *Lepadella desmeti* Segers & Chittapun (ventral view, Sharma & Sharma 2015a); **L** = *Lepadella neglecta* Segers & Dumont (ventral view, Sharma & Sharma 2018c).

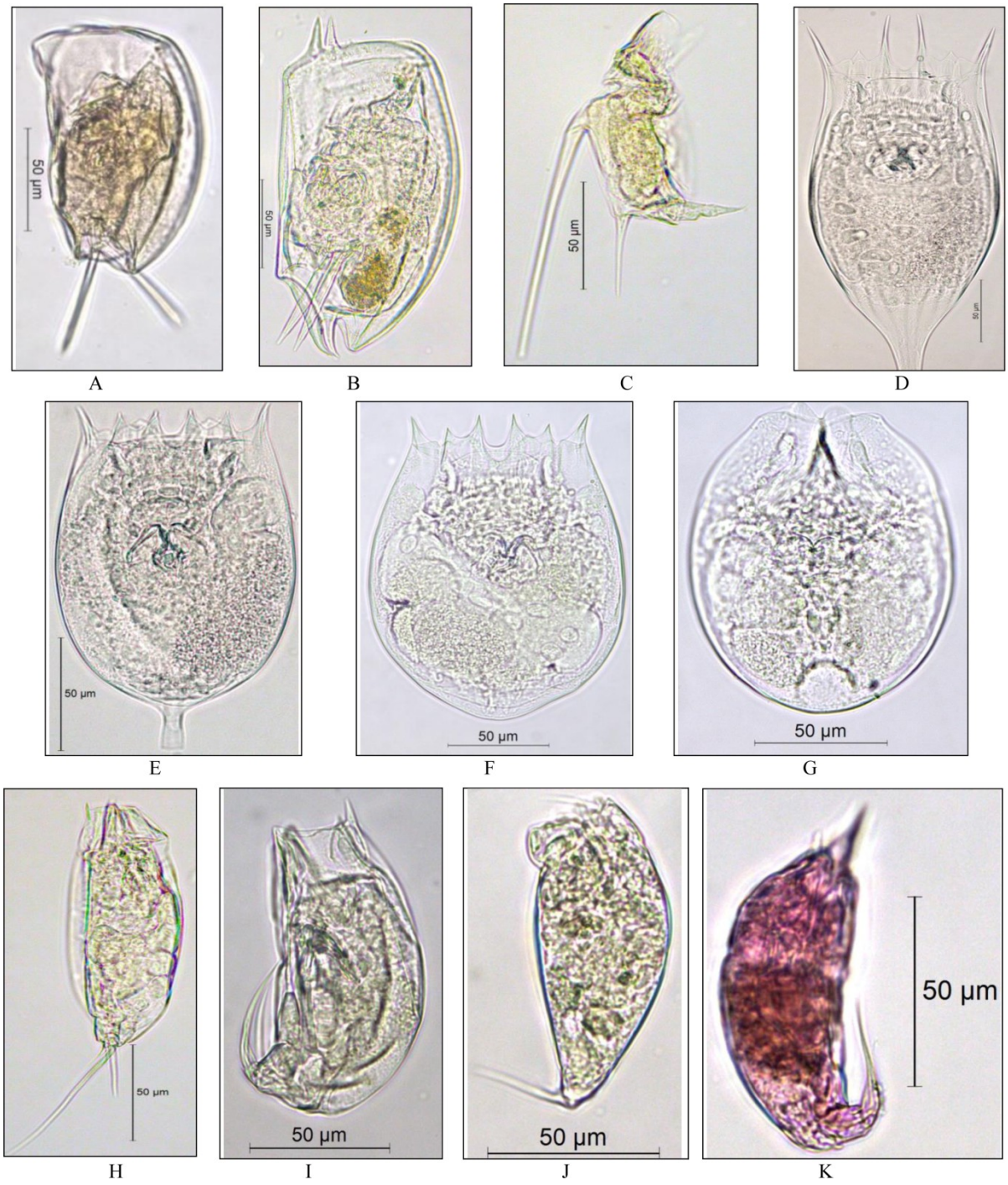

Figure 11. Interesting Rotifera. **A** = *Mytilina lobata* Pourriot (lateral view, Sharma & Sharma 2019b); **B** = *Mytilina michelangellii* Reid & Turner (lateral view); **C** = *Squatinella bifurca* (Bolton) (lateral view, Sharma et al. 2017); **D** = *Notholca acuminata* (Ehrenberg) (ventral view, Sharma & Sharma 2018c); **E** = *Notholca labis* Gosse (ventral view, Sharma & Sharma 2018c); **F** = *Notholca squamula* (Muller) (ventral view); **G** = *Testudinella insinuata* Hauer (ventral view, Sharma and Sharma, 2018b); **H** = *Trichocerca edmondsoni* (Myers) (lateral view); **I** = *Trichocerca maior* Hauer (lateral view); **J** = *Trichocerca siamensis* Segers & Pholpunthin (lateral view, Sharma & Sharma, 2015a); **K** = *Trichocerca taurocephala* (Hauer) (lateral view, after Sharma & Sharma 2015a).

Indian Rotifera includes 11 Australasian, 15 Oriental, 20 Paleotropical, 15 Indian endemics, 10 Holarctic and four Palearctic species, one species each of the Indo-Chinese and Cosmo (sub) tropical categories, eight cold-water species and 16 other interesting species (Figs. 5–11). A total of 176 species depict regional distribution interest in India; of these, 70 species are known for their distribution restricted to NEI India. The rotifer diversity in Ramsar sites, floodplain lakes of Assam (*beels*) and Manipur (*pats*) and small floodplain wetlands (*dobas* or *dubies*) and small lentic biotopes of NEI; the floodplain wetlands of Kashmir and West Bengal; and small lentil environs of the Gangetic and north Bengal regions of West Bengal are included in Table 2.

Table 2: Rotifera richness in various aquatic ecosystems (Modified after Sharma & Sharma 2019b)

Study sites↓ Taxa →	**Species**	**Genera**	**Families**
NORTHEAST INDIA			
Ramsar sites			
Loktak Lake, Manipur (93° 46'– 93° 55'E, 24° 25'–24° 42'N)	203	48	23
Deepor Beel, Assam (91° 35'–91° 43'E, 26° 05'–26°11'N)	183	36	20
Floodplain lakes (*beels*) of Brahmaputra Basin, Assam	244	46	21
Barpeta (6 *beels*) (90° 52′–91° 42'E, 26° 17'–26° 40'N)	176	35	19
Majuli River Island (10 *beels*) (93°–95° E, 25°–27° N)	174	34	18
Dibru-Saikhowa Biosphere Reserve (5 *beels*) (95°22'–95°24'E, 27°34'–27°55'N)	162	32	18
Tinsukia (5 *beels*) (95°22'–96°35'E, 27°14'–28°40'N)	169	33	19
Dibrugarh (6 *beels*) (93°22'–95°35'E, 26°19'–27°30'N)	179	35	19
Floodplain lakes (*pats*) of Manipur			
Manipur valley (15 *pats*) (93°45'–94°00'E, 24°25'–24°45'N)	218	48	23
Small floodplain wetlands (*dobas* or *dubies*) of Assam			
Brahmaputra valley (90°–93°E; 26°–27^0 N)	167	34	18
Lower Assam	154	34	18
Central Assam	150	31	19
Upper Assam	135	30	17
Barak valley (92°45'–92.75°E, 24°48'–24.80°N)	159	35	19
NEI: small lentic ecosystems			
Arunachal Pradesh (91°20'–97°30'E, 26°28v–29°30'N)	165	37	19
Nagaland (93°3'–93°5' E, 25°4'–27°0' N)	150	37	19
Mizoram (92°15'–93°29'E, 21°58'–24°35'N)	162	35	19
Meghalaya (90°05'–92°40'E, 25°10'–26°15'N)	161	40	20
Tripura (92°10'–92°20'E, 22°56'–24°32'N)	163	35	19
Manipur (93°50'–94°00'E, 24°10'-24°55'N)	169	44	22
Meghalaya: small urban wetland	90	29	15
OTHERS PARTS OF INDIA			
Floodplain wetlands of Kashmir valley	140	43	22
Floodplain wetlands of West Bengal	152	40	19
Small lentic ecosystems of Gangetic West Bengal	142	38	18
Small lentic ecosystems of north Bengal	130	40	18

DISCUSSION

We record a total of 434 valid species belonging to 68 genera and 25 families; these comprise ~82% and ~24% of the species of the phylum known from the Oriental region and globally (*vide* Segers 2008), respectively, and thus reveal the rich and diverse Rotifera assemblage of India. The Indian fauna is more speciose than the faunas of Thailand (Sa-Ardrit *et al.* 2013), Cambodia (Sor *et al.* 2015), Vietnam (Trinh *et al.* 2019), and Malaysia (Segers 2004, Fontaneto & Ricci 2004) from SE Asia, and is distinctly diverse than the fauna of Sri Lanka (Fernando 1980) – the sole reasonably studied country of south Asia. The comparisons characterize the Indian Rotifera to be most biodiverse *vis-a-vis* south and SE Asia faunas. Besides, a total of 359 species belonging to 25 families and 67 genera observed in our plankton and semi-planktonic collections from various regions comprise ~81%, ~88% and 96% of species, genera and families, respectively known from this country and thus reiterate important contributions of our studies to the rotifer fauna of India. In general, the Indian faunal surveys lacked focus on biodiversity till the end of the 20th century, while it received attention in limited subsequent works to-date. Nevertheless, the significant increase in the tally of rotifers species known from India, than the earlier reports (Sharma & Michael 1980, Sharma 1991, 1996, 1998a, Sharma & Sharma 2005), is attributed notably to our studies from NEI (Sharma 2004, 2005, 2014, Sharma & Sharma 2012, 2014a, 2014b, 2014c, 2015a, 2015b, 2015c, 2018a, 2018b, 2019a, 2019b, 2019c, 2019d, Sharma *et al*. 2016, 2017) and Jammu & Kashmir (Sharma & Sharma 2018a), and elsewhere from Madhya Pradesh (Sharma & Naik 1996), Tamil Nadu (Sharma & Sharma 2009) and West Bengal (Sharma 1998b).

Lecanidae (21.5, 27.9%) > Brachionidae (11.8, 15.4%) > Lepadellidae (10.4, 13.5%) contribute notably to the rotifer and monogonont species known to-date from India, respectively; the three families collectively comprise an important fraction (~44%) of the Indian Rotifera. In addition, Trichocercidae > Notommatidae > Philodinidae include ~22% species, while Flosculariidae > Testudinellidae > Euchlanidae > Synchaetidae = Trochosphaeridae indicate limited importance (~14%). The significance of the stated families imparts the 'littoral-periphytic' character to the Indian Rotifera broadly concurrent with the reports from Thailand (Sa-Ardrit *et al.* 2013), Cambodia (Sor *et al.* 2015) and Vietnam (Trinh *et al.* 2019). This generalization is further supported by inadequate documentation of the bdelloid and sessile rotifers from India till-date. The latitudinal variations of Rotifera *vs*. biogeographic role of the 'tropic' or 'temperate' centered taxa had been discussed by Green (1972), Pejler (1977), De Ridder (1981), Dumont (1983) and Segers (1996, 2001). We extend these remarks to the Indian rotifers *vides* the diverse nature of Lecanidae, Brachionidae and Lepadellidae, the speciose nature of the 'tropic-centered' *Lecane, Lepadella* and *Brachionus* (Sharma & Sharma 2017, 2019b) and also to certain extent that of 'Laurasian' centered *Trichocerca*. These features along with the predominance of cosmopolitan species and the reports of several pantropical and cosmotropical species impart a broadly 'tropical character' to the Indian Rotifera in agreement with the reports of Fernando (1980), Dussart *et al. (*1984), Segers (1996, 2001, 2008) and Green (2003). On the contrary, the localized valid reports of cold-water species of 'temperate' centered' *Kellicottia, Keratella*, *Synchaeta* and *Notholca* from the sub-Himalayan and Himalayan latitudes of India are diagnostic of specific ecological regimes. We caution on emphasis of 'cosmopolitan species' importance as 'cosmopolitanism' concept is debated in certain freshwater zooplankton groups *vides* the integrative taxonomical approaches.

Rotifera of India is characterized by a notable fraction (~25%) of species of the global biogeography interest; these are assigned to the following categories:

Australasian: *Brachionus dichotomus reductus*, *B. falcatus reductus*, *B. kostei*, *B. lyratus*, *Macrochaetus danneelae*, *Lecane batillifer*, *L. shieli*, *L. sinuata*, *Notommata spinata, Testudinella walkeri,* and *Philodina squamosa*;

Oriental: *Brachionus donneri, B. murphyi*, *B. srisumonae, Colurella sanoamuangae*, *Filinia camasecla*, *Keratella edmondsoni*, *Lecane acanthinula*, *L. blachei*, *L. bulla diabolica*, *L. isanensis*, *L. latissima*, *L. niwati*, *L. solfatara*, *L. superaculeata,* and *Ptygura stephanion*;

Paleotropical: *Keratella javana*, *Dipleuchlanis ornata*, *Euchlanis semicarinata*, *Lepadella bicornis*, *L. discoidea*, *L. minoruoides*, *L. vandenbrandei*, *Lecane braumi*, *L. eswari*, *L. lateralis*, *L. simonneae*, *L. stichoclysta*, *L. unguitata*, *Polyarthra indica*, *Testudinella brevicaudata*, *T. greeni*, *Trichocerca abilioi*, *T. brazieliensis*, *T. hollaerti,* and *T. kostei*;

Indian endemics: *Asplanchnopus bhimavaramensis*, *Collotheca hexalobata*, *C. tetralobata*, *Lecane jaintiaensis*, *L. schraederi*, *L. pawlowski*, *L. vasishti*, *Lepadella kostei L. nartiangensis*, *Platyias quadricornis andhraensis*, *Proales indirae*, *Pseudoeuchlanis longipedes*, *Rotaria ovata*, *Testudinella* sp., and *T.* sp. 1 (undetermined *vide* Sharma & Sharma 2018b);

Holarctic: *Lecane depressa*, *L. elasma*, *L. elongata*, *L. galeata*, *L. levistyla*, *L. stokesii*), *L. styrax*, *L. tryphema*, *Trichocerca taurcephala*, and *T. uncinata*;

Palaearctic: *Encentrum longipes*, *Cephalodella trigona*, *Lecane bifastigata,* and *Squatinella bifurca*;

Indo-Chinese: *Lecane dorysimilis*;

Cosmo (sub) tropical: *Brachionus durgae*;

Cold-water: *Hexarthra bulgarica, Keratella hiemalis, K. serrulata, Kellicottia longispina, Notholca acuminata, N. labis, N. squamula,* and *N. striata,*

Others: *Lecane calcaria, L. ligona, L. marchantaria*, *L. rhenana, L. ruttneri, L rugosa, L. sola, Lepadella desmeti, L. patella oblonga*,, *L. neglecta*, *Mytilina lobata*, *M. michelangellii*, *Ptygura tacita, Testudinella amphora, Trichocerca edmondsoni,* and *T. siamensis*.

The reports of the Australasian rotifers, known exclusively from south and SE Asia and Australia, highlight affinity of the Indian Rotifera with Southeast Asian and Australian faunas. The Oriental rotifers reiterate affinity with south and Southeast Asia faunas, and the richness of Paleotropical species is noteworthy. Interestingly, the reports of ~91%, ~93% and ~90% species of the three categories from NEI (Sharma & Sharma 2019b) in particular reveal a closer faunal affinity of the rotifer assemblages of this region with the SE Asian and Australian faunas, and thus assign a distinctive biogeographic identity to NEI Rotifera in contrast with the rest of India. This salient feature is hypothesized as an incursion of various SE Asian and Australian rotifers through 'the Assam gateway' – a unique biogeographic corridor of India (Sharma & Sharma 2019b). Besides, Indian Rotifera reveals ~41% species of regional biogeography interest. Of these, *Adineta vaga major, A. longicornis, Cephalodella intuta, C. ventripes, Colurella tesselata, Habrotrocha angusticollis, H. angusticollis attenuata, H. lata, H. leitgebii, H. microcephala, Keratella javana, Lecane aeganea, L. clara, L. glypta, L. rhytida, L. stichaea, Lepadella heterodactyla. L. latusinus, L. patella oblonga, Monommata grandis, M. maculata, Stephanoceros fimbriatus, Taphrocampa annulosa, Testudinella dendradena, T. tridentata, Trichocerca bidens, T. insignis, T. insulana, T. mus, T. scipio,* and *T. sulcata* are known to-date for their distribution restricted to NEI (Sharma & Sharma 2019b). *Cephalodella panarista, Dicranophorus myriophylli, Floscularia conifera, Hexarthra bulgarica, Itura aurita, Kellicottia longispina, Keratella hiemalis, Lecane elasma, Notholca striata, Notommata aurita, N. copeus, N. tripus, Synchaeta stylata, S. tremula, Testudinella insinuata. T. mucronata, Trichocerca cavia, Trichotria pocillum,* and *Trochosphaera solstitialis* are known exclusively from Jammu & Kashmir (Sharma & Sharma 2018a), while *Colurella colurus, Euchlanis meneta, Keratella serrulata, K. ticinensis, Mytilina michelangellii, Notholca acuminata, N. labis,* and *N. squamula* indicate validated reports restricted to both the Kashmir Himalayas and NEI (Sharma & Sharma 2018a, 2019b). In addition, *Ascomorpha saltans indica, Cephalodella megalocephala, C. misgurnus, Lophocharis naias, Lepadella kostei, Lecane galeata, L. pawlowskii, L. perplexa, L. schraederi, Notommata pseudocerberus, Proales indirae* and *Ptygura furcillata* are reported only from the state of Gujarat (Wulfert 1966). Our

remarks thus highlight both the global and regional biogeographic interest of the Indian Rotifera eventhough more interesting species of the two categories are likely to be added pending analyses of extensive collections from hitherto unexplored regions of India and the 'Himalayan, Indo-Burmese and Western Ghats biodiversity hot-spots' in particular.

We consider the current paucity of the Indian endemics to be secondary as: (a) 10 rotifer species *i.e. Brachionus srisumonae, Colurella sanoamuangae*, *Lecane dorysimilis, L. isanensis, L. latissima, L. niwati, L. shieli, L. superaculeata, Lepadella desmeti* and *Trichocerca siamensis* added as new records from India (Sharma & Sharma 2019b) are originally described as new species from SE Asia; (b) a number of newer taxa observed in our collections from NEI yet await descriptions; (c) the paucity of endemics elsewhere from India is attributed to inadequate sampling particularly of diverse aquatic and semi-aquatic environs; and (d) the future collections from the 'Himalayan and Western Ghats biodiversity hot-spots' along with other unexplored / under-explored regions of India are likely to improve the status of the Indian endemics. The reports of the tropical-latitude populations of the Holarctic and Palaearctic species and other cold-water elements from the Himalayas are likely to represent glacial relicts as hypothesized by Segers (1996), while the reports of certain species in our sub-tropical collections are attributed to extension of the Himalayan mountain ranges as hypothesized by Sharma & Sharma (2014c).

Sharma (1991, 1996, 1998a) focussed attention on state-wise / regional biodiversity disparities. This lacuna still holds valid (Sharma & Sharma 2017) as highlighted by the fact that amongst 29 states of India, the rotifer assemblages of only 10 states are reasonably well examined, while the regional diversity studies evade attention except for NEI. Referring to NEI, it reveals a total of 303 species (Sharma & Sharma 2019b), while its seven states namely Assam > Manipur > Tripura, Arunachal Pradesh > Mizoram ≥ Meghalaya > Nagaland record 244, 200, 176, 172, 162, 161 and 150 species, respectively. NEI fauna as thus far characterized categorizes it as the most Rotifera biodiverse region of India and also interestingly as one of the most biodiverse in comparison with the countries of south and SE Asia. These salient features are hypothesized to habitat heterogeneity of water bodies located under diverse geo-ecological regimes of NEI, location of this region under the 'Himalayan' and the 'Indo-Burmese' biodiversity hotspots, 'the Assam gateway' – an interesting biogeographic corridor of India and the sampling intensity (Sharma & Sharma 2019b), and overall the 'Rotiferologist effect' (Fontaneto *et al.* 2012). In light of our earlier meta-diversity updates on NEI (Sharma & Sharma 2005, 2014a, 2019b), we expect more diverse rotifer assemblage of this region pending analyses of the extensive collections from practically unexplored eastern Himalayan state of Sikkim (except for the report of Murray 1906) as well as under-explored eastern Himalayan state of Arunachal Pradesh (Sharma and Sharma 2019a). We also extend our remarks on regional / state wise biodiversity disparities to the states of western India; of these, Jammu & Kashmir Rotifera records 173 species (Sharma and Sharma 2018a) and offers scope of the future update, and Uttarakhand Rotifera (Sharma 2021) is poorly documented, while Himachal Pradesh and Ladakh yet lack biodiversity surveys on the taxon (BKS, unpublished). Further, we report 177 and 168 species from the states of Tamil Nadu (Sharma & Sharma 2009) and West Bengal (Sharma 1998b) of east and south India respectively. Our recent studies (BKS unpublished) recording 104 species from Bihar (eastern India); 149, 109 and 64 species from Maharashtra, Madhya Pradesh and Goa, respectively from central India; and 146, 131, 108 and 141 species from Andhra Pradesh. Telengana, Kerala and Karanataka, respectively of south India attempt to augment the regional diversity status but yet suffer from the sampling intensity. Regional disparities of Rotifera biodiversity are influenced by spatial heterogeneity of the speciose monogonont families namely Lecanidae (Sharma & Sharma 2014b), Brachionidae (Sharma & Sharma 2014c), Lepadellidae (Sharma & Sharma 2015b) and Trichocercidae (BKS unpublished). However, we

focus special attention on paucity of Bdelloidea which are documented to-date *vide* the limited surveys by Anderson (1889), Murray (1906) and Edmondson & Hutchinson (1934) and thus deserve specific investigations in the future Rotifera studies from India.

Various Rotifera species examined from India are reported to exhibit morphological variations (Sharma 1983, Sharma and Sharma 2014b, 2014c, 2015a, 2015b, 2018a, 2018c, 2019a). The variations observed in *Brachionus angularis, B. bidentatus, B. caudatus, B. calyciflorus, B. diversicornis, B. falcatus, B. forficula, B. plicatilis, B. quadridentatus, Colurella colurus, C. obtusa, C. uncinata, Epiphanes brachionus, Euchlanis dilatata, Filinia longiseta, F. terminalis, Floscularia ringens, Keratella cochlearis, K. tropica, Lecane bulla, L. closterocerca, L. cornuta, L. curvicornis, L. hamata, L. inermis, L. leontina, L. luna, L. lunaris, L. ludwigii, L. monostyla, L. obtusa, L. quadridentata, L. signifera, L. stenroosi, L. ungulata, L. unguitata, Lepadella acuminata, L. costatoides, L. ovalis, L. patella, L. rhomboides, L. triptera, Limnias ceratophylli, Plationus patulus, Testudinella amphora, T. emarginula, T. patina, T. tridentata, Trichocerca rattus* and *T. similis* thus await cryptic diversity analyses following some interesting studies (Suatoni *et al*. 2006; Schröder & Walsh 2010, Montero-Pau *et al*. 2011, Mills *et al*. 2017, Michaloudi *et al*. 2018) and using 'integrative taxonomic approaches' including 'reverse taxonomy' (Michaloudi *et al*. 2018). The specific focus on the likely cryptic species complexes is expected to enhance the faunal diversity status of Indian Rotifera.

The rotifer faunal diversity works from India are largely biased to the assemblages from the inland waters of the Indian mainland. In contrast, our exclusive report of 120 species from freshwater rotifers from the south Andaman (Sharma 2017, Sharma *et al.* 2017) highlights scope of extending such studies to insular freshwaters off other islands of the Andaman and Nicobar group of Islands and the Lakshadweep Islands. The rotifer diversity of the riverine systems is yet poorly known in spite of our highest report of 72 species, belonging to 30 genera and 17 families from an intensively sampled 600 km long stretch of the river Narmada in Madhya Pradesh, Central India (Sharma & Naik 1996). We also focus attention on inadequately explored rotifer assemblages of the brackish water environs in light of the limited preliminary reports of Rama Rao & Chandra Mohan (1984), Anitha & George (2006), Varghese & Krishnan (2008), George *et al.* (2011), Varghese (2011), and Cleetus *et al.* (2015, 2016). The biodiversity literature, however, lacks the reports of marine rotifers from India.

Rotifera received attention of majority of 'amateurs' and fewer Indian 'specialists' to-date; the former invariably listed planktonic species from certain ponds, lakes and reservoirs. This trend has hampered holistic analyses of the rotifer assemblages, and the sessile, colonial and bdelloid species in particular, while the littoral-periphytic species are reported in selected studies (Sharma & Sharma 2017). Further, the Indian literature is loaded with works 'poor illustrations' or 'micro-photographs' which fail to enable an objective opinion on actual status of various recorded taxa and thus render them 'unverifiable' (Sharma & Sharma 2017), while lack of 'voucher specimens' categorize many other reports as 'invalidated and unverifiable'. 'Dubious reports' of species of temperate-centered *Keratella, Kellicottia, Notholca* and *Synchaeta*, 'unrealistic' and 'fuzzy' reports of *Brachionus havanaensis* and *Keratella valga*, and 'incomplete species lists' due to 'overlooking of identification of small species' adversely influence the rotifer biodiversity studies. The 'sloppy and uncritical' descriptions of new taxa, another notable impediment, is highlighted by synonymized 15 new species and subspecies (Sharma & Sharma 2017), while nine new species are designated as 'species inquirenda' (Segers 2007), *Pseudoembata acutipoda* Wycliffe & Michael is treated as 'Genus & species inquirendus' (Segers 2007, Jersabek & Leitner 2013) and four species are categorized as 'nomen nudum' (Sharma & Sharma 2017). Above all, the majority of 'classical taxonomy' based faunal works highlight need to shift to 'integrative taxonomic approaches' for the effective biodiversity updates on Indian Rotifera.

Analyses of the rotifer diversity from diverse aquatic environs of India remained neglected until certain noteworthy inputs from the floodplains lakes (*beels* and *pats*) of NEI (Sharma & Sharma 2001, 2008, 2014a, 2014d, 2019b, Sharma 2005, 2009a, 2009b, 2014, unpublished) resulting in the reports of 244 species belonging to 46 genera and 21 families from the *beels* of Assam, and 210 species belonging to 48 genera and 23 families from *pats* of Manipur. We, hypothesize these biodiverse Rotifera assemblages to habitat diversity and environmental heterogeneity of the floodplain lakes of NEI located in the 'Indo-Burmese biodiversity hot-spot'. Further, Assam *beels* record more speciose rotifers and those of Manipur *pats* are marginally diverse than the reports of 207 (Segers *et al.* 1993) and 218 (Bonecker *et al.* 1998) species from the floodplains of Africa and South America, respectively. Our results endorse hypothesis of Segers *et al.* (1993) on the floodplain lakes as the globally important rotifer habitats. Besides, our collections affirm the fairly speciose Rotifera of the Kashmir valley (140 species: Sharma & Sharma 2018a) and West Bengal (152 species: BKS, unpublished) floodplains, while the floodplain lakes elsewhere from India are yet to adequately surveyed for Rotifera biodiversity.

Loktak Lake (Sharma & Sharma 2018c, 2019a, BKS unpublished) and Deepor Beel (Sharma & Sharma 2011, 2012, 2013, 2015c, BKS unpublished), only two intensively sampled Ramsar sites of India record 203 and 191 species respectively, and are thus categorized as the globally megadiverse Rotifera ecosystems. These important floodplain lakes of NEI depict biodiverse Rotifera than the Rio Pilcomayo National Park (114 species, Jose de Paggi 2001) and Thale-Noi Lake (106 species, Segers & Pholpunthin 1997) – the Ramsar sites of Argentina and Thailand, respectively as well as the well sampled Upper Paraná floodplain of Brazil (184 species; Bonecker *et al.* 2005). Our reports from Loktak Lake and Deepor Beel assume distinct national importance in contrast to the poor state-of-art status of the rotifer biodiversity of rest of 40 Ramsar sites of India (Chandra *et al.* 2021). The comparisons highlight importance of extension of studies on Rotifera assemblages from other Ramsar sites of this country *vis-à-vis* potential to augment the biodiversity status of Indian fauna. Interestingly, our reports of 85 species each in December 2016 and January 2017 samples from Deepor beel and 86 and 89 species in November and December 2017 collections from Loktak Lake (Sharma & Sharma 2019b), and 84 and 81 species (during May and June, 2017) from a floodplain lake (*beel*) of upper Assam highlight speciose rotifer constellations per sample. We designate the speciose constellations of 80+ species per sample as the 'Rotifera paradox' as these depict examples of intriguing possibility of the co-existence of a number of species due to high amount of niche overlaps as hypothesized (MacArthur 1965).

The small water bodies (ponds and wetlands) are considered as keystone systems for analyses of biodiversity (Vad *et al.* 2017; Oertli 2018). Our collections from small floodplain wetlands (*dobas* or *dubies*) of the Brahmaputra and the Barak river basins of Assam state of NEI report 167 and 156 species, respectively and thus highlight the speciose rotifers. Besides, our reports of 165, 150, 162 and 161 species highlight species-rich rotifer assemblages of small lentic biotopes (wetlands) predominant in the hill states of Arunachal Pradesh, Nagaland, Mizoram and Meghalaya states of NEI, respectively (Sharma & Sharma 2019b), while 163 and 168 species known from small wetlands of Tripura and Manipur states of NEI, respectively also endorse our results. Hill *et al*. (2017) hypothesized the importance of small urban wetlands for maintaining regional biodiversity in highly modified urban environments. This hypothesis is affirmed by 90 species reported from a small urban wetland of Meghalaya state (Sharma & Sharma 2021). In general, the biodiversity importance of *dobas* or *dubies*, and other small and urban wetlands of NEI are attributed to habitat heterogeneity of these unstructured environs and the sampling intensity. Our collections from *dobas* or *dubies* of the Majuli River Island and those of upper Assam highlight 'Rotifera paradox' with the speciose assemblages of up to 50 species per sample (Sharma & Sharma

2019b, 2019c, 2019d). Besides, our report of 46 species per sample from small urban wetland of Meghalaya (Sharma & Sharma 2021) is categorized as 'Rotifera paradox' analogous to the reports (Sharma & Sharma, 2019b, 2019c, 2019b) from unstructured *dobas* or *dubies*.

To sum up, the rich and diverse Indian Rotifera highlights its biodiversity interest and notable fractions of species of the global and regional distribution interest impart biogeography importance. The rotifer fauna of India as thus far characterized reflects the littoral-periphytic nature and broadly tropical character though certain cold-water species are observed from the sub-Himalayan and Himalayan latitudes. We highlight the disparity of the state wise / regional biodiversity studies, inadequate analyses of bdelloid rotifers, and spatial heterogeneity of the richness. NEI is notable for the richest regional Rotifera diversity; Loktak Lake and Deepor beel deserve global attention as the rotifer megadiverse environs; and the floodplain lakes (*beels* and *pats*), the small floodplain wetlands (*dobas* or *dubies*) and small lentic environs depict the speciose assemblages with interesting instances of 'Rotifera paradox'. The biodiversity status of Indian Rotifera yet needs to be augmented based on the intensive sampling of unexplored or under-explored states / regions / ecosystems, the 'Himalayan and Western Ghats biodiversity hotspots', and various 'Ramsar' sites of India. Analyses of cryptic diversity as well as adequate focus on the sessile, colonial, benthic and littoral-periphytic assemblages, and identification of smaller species deserve attention. As per conservative estimate, we expect the Indian Rotifera tally of 550+ species pending attention to various lacunae.

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Checklist of rotifer species from Albania (phylum Rotifera)

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Abstract. The checklist of Rotifera species recorded for Albanian inland waters and its neighboring regions is provided. A total of 140 species of bdelloids and monogononts, with representatives of 38 genera are listed. The history of rotifer surveys as a component of zooplankton in Albania started at the end of 19th century. Mostly they were taxonomic and descriptive ones, while later on after the mid 20th century appeared the systematic approaches emphasizing the particularities and richness of zooplankton in specific karstic Mediterranean ecosystems. In this article 140 taxa of bdelloids and monogononts representing 39 genera are reported.

Keywords. Rotifera, Albania, checklist, inland water, distribution records

INTRODUCTION

Albania is a small country (Fig. 1) however, it is rich in water resources including lakes, rivers and springs. There are more than 152 streams and small rivers flow into the seven large rivers, Buna, Drini, Mati, Erzeni, Shkumbini, Semani, and Vjosa, which run southeast to north west towards the Adriatic coast (Cullaj *et al*. 2005). About 247 natural lakes are dispersed throughout the country, most of karstic or glacial origin and they are often very small (less than 1 ha). Albania shares with neighboring countries three of the largest Balkanic Lakes (Ohrid, Prespa and Shkodra). They represent distinct environments among all aquatic habitats of the Balkan in the view of origin, hydrology, and biodiversity (Shumka *et al.* 2018). Around 134 glacial lakes are situated mainly in the northeastern part of the country at altitudes between 1500 – 1800 m a.s.l. Generally, they are small, formed mainly over magmatic (mainly of ultrabasics) and terrene formations (Cullaj *et al*. 2005).

Following Segers (2007) the Phylum Rotifera comprises about 2030 known species worldwide and classified in three main groups, the marine Seisonida (4 species), the Monogononta (1570 species) and the unique, exclusively parthenogenetic Bdelloidea with 461 clonal species. Although the morphology of different species varies widely, all of them possess a specialized masticatory organ containing a set of densely sclerotized trophi (Fontaneto *et al*. 2008). Rotifers, as a component of zooplankton organisms, comprise crucial elements of the structure and function of freshwater ecosystems, not only as consumers of algae, bacteria, protozoans and other invertebrates (Russell *et al.* 2010), but also as food items for juvenile stages of several fish species (Shumka *et al.* 2018). Moreover, their pivotal role in freshwater ecosystems food web, as well as its sensitivity to both man-made and natural changes, makes zooplankton quite suitable for assessing alterations in the trophic dynamics and the ecological state of aquatic ecosystems related to changes in nutrient loading and climate (Hoffmann 1977, Ferrara *et al.* 2002, Preston & Rusak 2010).

Similarly to other large Balkanic lakes like Ohrid and Prespa, the history of zooplankton surveys in Albania starts from the end of 19th century. Basically they were taxonomic and descriptive ones, while later, after the mid 20th century appeared the systematic approach emphasizing

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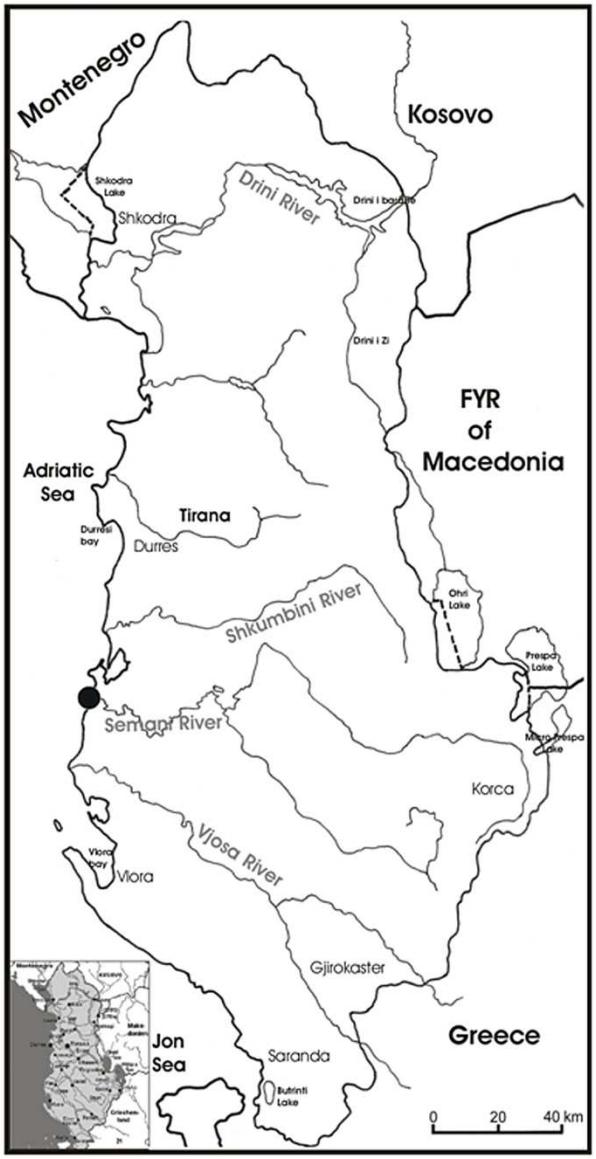

Figure 1. Map of Albania

the particularities and richness of zooplankton in specific karstic Mediterranean ecosystem. Amongst them can be mention Richard (1897) with his work dedicated to *Cladocera*, Steur (1900) with paper published on *Copepoda*, Vereščagin (1912) and Parenzan (193) on *Cladocera*, Nedeljković (1959) on *Rotifera*, Petkovski (1961) with fundamental work on *Cladocera* and *Copeoda*, separately *Harpacticoida* and *Ostracoda*, Živković (1965) and Milovanović & Živković (1965) on Rotifera, Protozoa and Cladocera.

MATERIALS AND METHODS

There are a large number of references, including identification keys with abundant information on ecological and systematical aspects of rotifers from different regions of the world. From this, the following papers were consulted: Segers (2002) and Wallace *et al.* (2006); higher-level classification. For taxonomy and distribution of the different families the following sources were used: De Ridder (1986, 1991, 1993), De Ridder & Segers (1997), Donner (1965), De Smet (2006), De Smet & Pourriot (1997), Jersabek (2003), Koste (1978), Koste & Shiel (1987, 1989a, b), Nogrady *et al.,* (1995), Nogrady & Segers (2002), Segers (1995a, b, 2003), Segers & Wallace (2001), Sørensen *et al.* (2005).

The following articles were used to compile the list of rotifers of Albanian inland waters: Brusina (1898), Byron (1981), Gannon & Stemberger (1981), Guseska (2012), Guseska *et al.* (2008, 2012, 2014), Gushevska *et al.* (1996), Kiefer (1937), Kostoski (1998), Kostoski *et al.* (2004, 2005), Michaloudi (2005), Michaloudi *et al.* (1997), Milovanovic & Živkovic (1965), Nedeljkovic (1959), Parenzan (1931), Petković (1973, 1975, 1978, 1981), Popovska-Stankovič *et al.* (1988, 2003), Richard (1897), Serafimova-Hadzisce (1954, 1958, 1975), Shumka (1994, 1997a, b, 2000, 2001, 2014), Shumka & Miho (2006), Shumka & Nikleka (2018), Shumka & Špoljar (2018), Shumka *et al.* (1998, 2018), Steuer (1900), Tasevska (2002), Tasevska *et al.* (2006, 2008, 2012a, b, 2017, 2018), Veršcagin (1912), Živkovic (1974, 1975),

RESULTS AND DISCUSSION

All species names appeared in the literature listed above were checked and corrected based on Segers *et al*. 2007 and Jersabek & Leitner 2013, and the following changes were made: *Brachionus calyciflorus f. amphiceros* (Ehrenberg, 1838) (synonym, considered an infrasubspecific variant of *B. calyiflorus*); *Brachionus q.* f. *brevispinus* Ehrenberg, 1832 (synonym, considered an infra

subspecific variant of *B. quadridentatus*); *Brachinus q.* f. *cluniorbicularis* Skorikov, 1894 (synonym considered an infrasubspecific variant of *B. quadridentatus*); *Brachionus quadridentatus* f. *rhenanus* Lauterborn, 1893, (synonym considered an infrasubspecific variant of *B. quadridentatus*); *Lophocharis salpina* (Ehrenberg, 1834) synonym of *Lepadella salpina* Ehrenberg, 1834; *Testudinella patina trilobata* (Anderson et Shepard, 1892), synonym of *T. patina* (Hermann 1783); *Testudinella pseudoelliptica* Bartoš, 1951 synonym of *T. patina* (Hermann 1783); *Trichocerca similis similis* (Wierzejski, 1893) synonymous with *Rattulus bicornis* (Western, 1893).

Reviewing the studies dedicated to the Albanian inland water Rotifera fauna is resulted in a list of 140 taxa of bdelloids and monogononts (Table 1). Among the rotifers, the most frequently reported genera are *Lecane* with 16 species, *Trichocerca* with 15 species, *Brachionus* (15 species), *Keratella* (7 species), *Polyarthra* (7 species) and *Lepadella* (6 species). At regional scale it is worth mentioning that from the neighboring Montenegro Petković (1973, 1978) recorded 205 rotifer taxa just for the Lake Scadar/Shkodra, while from North Macedonia for the lakes Ohrid, Prespa and Dojran altogether 60 rotifer taxa were reported (Tasevska *et al.* 2006). However, the high number of species reported for the Lake Scadar/Shkodra by Petković (1973, 1978) does not reflect the latest taxonomic results of Segers *et al*., (2007) and Jersabek & Leitner (2013) listing numerous synonym names and corrections.

The biogeography of Rotifera is highly controversial and prior to the work of Dumont (1983) it was generally accepted that all taxa were cosmopolitan. In the present list of the Albanian rotifers most of the species show a typical Palearctic distribution (Segers 2007) however, to clear the biogeography of several widely distributed species further studies with molecular approaches are needed.

Based on the data presented in the Table 1 almost 90% of the species are found in the Drini Basin (including Lakes of Lesser and Macro Prespa, Ohrid and Scadar/Shkodra), while the transitional water bodies belonging to Ionian and Adriatic Coastal areas are populated only by 9 different species. This disproportional distribution of species calls for further studies.

Table 1. List of Bdelloidea and Monogononta rotifers recorded from continental fresh- and transitional water habitats in Albania (genus and species)

Taxon	**Locality** (water basins)	**References**
***Adineta* Hudson & Gosse, 1886**		
A. steineri Bartos, 1951	**A5** (A)	14, 15, 30, 31, 32, 38, 40, 41,42
***Anuraeopsis* Lauterborn, 1900**		
A. fissa Gosse, 1851	**A1, A2, A5** (A)	12, 13, 15, 17
A. coelata de Beauchamp, 1932	**A5** (A)	12, 13, 15, 17, 30, 31, 32
***Ascomorpha* Perty, 1850**		
A. ecaudis Perty, 1850	**A5, B1, B2** (A, B)	12, 13, 15, 17, 30, 31, 32
A. ovalis Carlin, 1943	**A2, A5, B1** (A, B)	
A. saltans Bartsch, 1870	**A5** (A)	12, 13, 14, 15, 30, 31, 32, 38, 40, 41, 42
***Asplanchna* Gosse, 1850**		
*A. girodi*de Guerne, 1888	**A5** (A)	14, 15, 30, 31, 32, 38, 40, 41, 42
A. priodonta Gosse, 1850	**A1, A2, A3, A4, A5, A6, B1, B2, C1**	
A. sieboldii Leydig, 1854	**A5** (A)	12, 13, 14, 15, 30, 31, 32, 38, 40, 41, 42
***Brachionus* Pallas, 1766**		
B. angularis Gosse, 1851	**A1, A2, A3, A5, B1, B2, C1, C2, C2, C4, C5, D1** (A, B, C, D)	3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 30, 31, 32, 38, 40, 41, 42
B. bidentatus Anderson, 1889	**A5** (A)	13, 14, 15, 30, 31, 32, 38, 40, 41, 42
B. calyciflorus Pallas, 1776	**A5, B2** (A, B)	12, 13, 14, 15, 28, 29, 31, 32, 38, 40
B. dimidiatus Bryce, 1931	**A5** (A)	12, 13, 14, 15, 17, 30, 31, 32, 38, 40, 41, 42

B. diversicornis Daday, 1883	**A1, A2, A5** (A)	2, 3, 10, 11, 18, 19, 20, 21, 22, 23, 24, 25
B. falcatus Zacharias, 1898	**A5** (A)	12, 13, 31, 32, 42
B. forficula Wierzejski, 1891	**A1, A2, A5** (A)	13, 14, 15, 31, 32, 38, 42
B. havanaensis Rousselet, 1911	**A5** (A)	13, 14, 15, 31, 32, 38, 42
B. leydigii Cohn, 1862	**A5** (A)	13, 14, 15, 31, 32, 38, 42
B. plicatilis O.F. Müller ,1786	**A5, B1** (A, B)	12, 13, 14, 15, 28, 29, 31, 32, 38, 40
B. rhenanus Lauterborn, 1893.	**A5, B1** (A, B)	12, 13, 14, 15, 28, 29, 31
B. quadridentatus Hermann, 1783	**A1, A3, A4, A5, B2**. (A, B)	12, 13, 14, 15, 28, 29, 31, 32, 38, 40
B. brevispinus Ehrenberg, 1832	**A5** (A)	13, 14, 15, 31, 32, 38, 42
B. quadridentatus melhemi Barrios et Daday, 1894	**A5** (A)	13, 14, 15, 31, 32, 38, 42
B. urceolaris O.F. Müller, 1773	**A2, A5** (A)	13, 14, 15, 31, 32, 38, 42
***Cephalodella* Bory de St. Vincent, 1826**		
C. catellina O.F.Müller, 1786	**A2**, A5 (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
C. forficula Ehrenberg, 1831	**A2, A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
C. gibba Ehrenberg, 1832	**A2, A3, A5** (A)	10, 11, 18, 19, 20, 21, 22
C. misgurnus Wulfert, 1937	**A5**. (A)	13, 14, 15, 31, 32, 38, 42
C. ventripes Dixon-Nuttall, 1901	**A5, C1** (A, C)	13, 14, 15, 29, 31, 32, 38, 42
***Collotheca* Harring, 1913**		
C. mutabilis Hudson, 1885	**A5** (A)	13, 14, 15, 31, 32, 38, 42
C. pelagic Rousselet, 1893	**A5** (A)	13, 14, 15, 31, 32, 38, 42
***Colurella* Bory de St. Vincent, 1824**		
C. adriatica Ehrenberg, 1831	**A3, A5, A6, D1, E1, E2, E3, E4** (A, D, E)	3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 30, 31, 32, 38, 40, 41, 42
C. colurus Ehrenberg, 1830	**A2, A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
C. obtuse Gosse, 1886	**A2, A5, A6** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
C. uncinato bicuspidato Ehrenberg, 1830	**A2, A3** (A)	10, 11, 18, 19, 20, 21, 22, 23, 33
C. uncinata O. F. Müller, 1773	**A5** (A)	13, 14, 15, 31, 32, 38, 42
***Conochilus* Ehrenberg, 1834**		
C. exiguous Ahlstrom, 1938	**A5** (A)	13, 14, 15, 31, 32, 38, 42
C. hippocrepis Schrank, 1830	**A1, A2, A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
C. unicornis Rousselet, 1892	**A5** (A)	13, 14, 15, 31, 32, 42
***Dicranophorus* Nitsch, 1827**		
D. forcipatus O.F. Müller, 1786	**A2, E1** (A, E)	10, 11, 31
D. grandis Ehrenberg, 1832	**A5** (A)	14, 15, 30, 31, 32, 38, 40, 41, 42
D. rostratus Dixon Nuttal et Freeman, 1902	**A2, A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
***Dipleuchlanis* de Beauchamp, 1910**		
D . propatula Gosse, 1886	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
***Dissotrocha* Bryce, 1910**		
D. aculeata Ehrenberg, 1832	**A3, A5, A6** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
***Epiphanes* Ehrenberg, 1832**		
E. macrourus Barrois &Daday, 1894	**A5, B1** (A, B)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
E. senta O.F. Müller, 1773	**A5, B1** (A, B)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
***Euchlanis* Ehrenberg, 1832**		
E. dilatata Ehrenberg, 1832	**A2,A3, A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
E. incise Carlin, 1939	**A3, A5** (A)	13, 14, 15, 31, 32, 38, 39, 41, 42
E. meneta Myers, 1930	A5 (A)	39, 41
***Filinia* Bory de St. Vincent, 1824**		
F. longiseta Ehrenberg, 1834	**A1, A2, A3, A4, A5, B1, B2, C4, C5, D1** (A, B, C, D)	2, 3, 4, 6, 7, 8, 9, 10, 12, 13, 14, 15, 19, 20, 31, 32, 38, 39, 40, 41, 42
F.opoliensis Zacharias, 1898	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
F.terminalis Plate, 1886	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42

***Gastropus* Imhof, 1898**		
G. hyptopus Ehrenberg, 1838	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
G.stylifer Imhof, 1891	**A1, A2, A4, A5, B1, D1, E1** (A, B, D, E)	3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 30, 31, 32, 38, 40, 41, 42
***Hexarthra* Schmarda, 1854**		
H. mira Hudson, 1871	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
***Kellicottia* Ahlstrom, 1938**		
K. longispina Kellicott, 1879	**A1, A2, A3, A4, A5, B1, B2, C1, C2, C3, C4, D1, E1** (A, B, C, D, E)	2, 3, 4, 6, 7, 8, 9, 10, 12, 13, 14, 15, 28, 19, 20, 21, 22, 23, 24, 25, 27, 28, 29, 30, 31, 32, 38, 39, 40, 41, 42
***Keratella* Bory de St. Vincent, 1822**		
K. cochlearis Gosse, 1851	**A1, A2, A3, A4, A5, B1, B2, C1, C2, C3, C4, C5, D1, E2** (A, B, C, D, E)	2, 3, 4, 6, 7, 8, 9, 10, 12, 13, 14, 15, 19, 20, 21, 22, 23, 24, 25, 27, 28, 29, 30, 31, 32, 38, 39, 40, 41, 42
K. cochlearis v. hispida Lauterborn, 1898	**A2** (A)	2, 25, 26, 36
K. hiemalis Carlin, 1943,	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
K. quadrata O.F. Müller, 1786,	**A1, A2, A5, D1, E2** (A, D, E)	2, 3, 4, 6, 7, 8, 9, 10, 12, 13, 14, 15
K. tecta Gosse, 1851	**A2, A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
K. ticinensis Callerio, 1921	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
K. valga Ehrenberg, 1832	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
***Lecane* Nitzsch, 1827**		
L. bulla Gosse, 1851	**A2, A3, A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
L. closterocerca Schmarda, 1859	**A2, A3, A5, B1** (A, B)	2, 13, 14, 15, 32, 38, 39, 41, 42
L. copeis Harring et Myers, 1926	**A2, A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
L.curvirostris Yamamoto, 1941	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
L.elasma Harring& Myers, 1926	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
L.elsa Nitzsch, 1827	**A5, A6** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
L.flexilis Gosse, 1886	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
L. hamata Stokes, 1896	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
L. ivli Wiszniewski, l935	**A2, A5** (A)	2, 13, 14, 15, 31, 32, 38, 39, 40, 41, 42
L. lamellate Daday, 1893	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
L.luna O.F. Müller, 1776	**A1, A2, A3, B1** (A, B)	13, 14, 15, 30, 32, 38, 39, 40, 41, 42
L. lunaris Ehrenberg, 1832	**A3** (A)	3, 9, 23, 24, 25, 29
L.nana Murray, 1913	**A5, B2** (A, B)	13, 14, 15, 39, 30, 32, 38, 39, 40, 41, 42
L.quadridentata Ehrenberg, 1832	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
L.obtusa Hauer, 1889	**A5** (A)	2, 13, 14, 15, 31, 32, 38, 39, 40, 41, 42
L. stenroosi Meissner, 1908	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
***Lepadella* Bory de St. Vincent, 1826**		
L. acuminate Ehrenberg, 1834	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
L.ehrenbergii Perty, 1850	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
L.ovalis O.F. Müller, 1786	**A2, A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
L.patella O.F. Müller, 1773	**A2, A3, A5** (A)	13, 14, 15, 39, 30, 32, 38, 39, 40, 41, 42
L.rhomboides Gosse, 1886	**A5** (A)	1,2, 13, 14, 15, 31, 32, 38, 39, 40, 41, 42
L.triptera Erenberg, 1830	**A2, A3, A5** (A)	13, 14, 15, 39, 30, 32, 38, 39, 40, 41, 42
***Lophocharis* Ehrenberg, 1838**		
L.oxysternon Gosse, 1851	**A3, A5** (A)	13, 14, 15, 39, 30, 32, 38, 39, 40, 41, 42
L. salpina Ehrenberg, 1834	**A5, A6** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
***Monommata* Bartsch, 1870**		
M. aequalis Ehrenberg, 1832	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
***Mytilina* Bory de St. Vincent, 1826**		
M. crassipes Luchs, 1912	**A5** (A)	1, 2, 13, 14, 15, 31, 32, 38, 39, 40, 41, 42
M. mucronata Ehrenberg, 1832	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
M. ventralis brevispina Ehrenberg, 1832	**A2, A3** (A)	13, 14, 15, 39, 30, 32, 38, 39

M. ventralis ventralis Ehrenberg, 1832	**A2, A3** (A)	13, 14, 15, 39, 30, 32, 38, 39
***Notholca* Gosse, 1886**		
N. acuminatae Ehrenberg, 1832	**A2, A3** (A)	13, 14, 15, 39, 30, 32, 38, 39
N. foliacea Ehrenberg, 1838	**A5** (A)	1,2, 13, 14, 15, 31, 32, 38, 39, 40, 41, 42
N. squamula O.F. Müller , 1786	**A2** (A)	13, 14, 15, 30, 32, 38
***Notommata* Ehrenberg, 1830**		
N. copeus Ehrenberg, 1834	**A2, A3, A5** (A)	13, 14, 15, 39, 30, 32, 38, 39, 40, 41, 42
***Philodina* Ehrenberg, 1830**		
P. megalotrocha Ehrenberg, 1832	**A3** (A)	36, 37
***Plationus* Segers, Murugan& Dumont, 1993**		
P.patulus O.F. Müller, 1786	**A2, A5** (A)	13, 14, 15, 39, 30, 32, 38, 39, 41, 42
***Platyias* Harring, 1913**		
P. quadricornis Ehrenberg, 1832	**A3, A5** (A)	13, 14, 15, 39, 30, 32, 38, 39, 41, 42
***Ploesoma* Herrick, 1885**		
P.hudsoni Imhof, 1891	**A5** (A)	13, 14, 15, 39, 38, 39, 40, 41, 42
P.truncatum Levander, 1894)	**A3, A4, A5, B1** (A, B)	13, 14, 15, 39, 30, 32, 38, 39, 41, 42
***Polyarthra* Ehrenberg,1834**		
P.dolichoptera Delson, 1925	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 41, 42
P. euryptera Wierzejski, 1891	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 41, 42
P.major Bueckhardt, 1900	**A5, A5, B1, B2** (A, B)	13, 14, 15, 39, 30, 32, 38, 39, 41, 42
P.minor Voigt, 1904	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
P.remata Skorikov, 1896	**A5, B1, B2, E1** (A, B, E)	2, 13, 14, 15, 39, 30, 32, 38, 39,
P.trygla Ehrenberg, 1834	**A1, A2, A3, A5, B1** (A, B)	13, 14, 15, 39, 30, 32, 38, 39, 41, 42
P.vulgaris Carlin, 1943	**A1, A2, A3, A5, B1** (A, B)	13, 14, 15, 39, 30, 32, 38, 39, 41, 42
***Pompholyx* Gosse, 1851**		
P.complanata Gosse, 1851	**A5, A6** (A)	2, 13, 14, 15, 39, 30, 32, 38, 39
P.sulcata Hudson, 1885	**B1, B2, D, E1, E2** (B, D, E)	26, 27, 28, 29, 30, 31, 32
P. triloba Pejler, 1957	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 41, 42
***Rotaria* Scopoli, 1777**		
R. citrine Ehrenberg, 1838	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 41, 42
R. rotatoria Pallas, 1766	**A3, A5** (A)	13, 14, 15, 30, 32, 38, 39, 41, 42
R. socialis Kellicot, 1888	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 41, 42
***Scaridium* Ehrenberg, 1830**		
S. longicaudum O.F. Müller, 1786	**A3** (A)	7, 8, 35, 36, 37
***Squatinella* Bory de St. Vincent, 1826**		
S. lamellaris O.F. Müller, 1786	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
***Synchaeta* Ehrenberg, 1832**		
S. littoralis Rousselet, 1902	**A5, A6, E1** (A, E)	13, 14, 15, 29, 30, 32, 38, 39, 40, 41, 42
S. pectinata Ehrenberg, 1832	**A1, A2, A5, A6, B1, B2, C1, C5**. (A, B, C)	2, 3, 4, 6, 7, 8, 9, 10, 12, 13, 14, 15, 28, 19, 20, 21, 22, 23, 24, 25, 27, 28, 29, 30, 31, 32, 38, 39, 41, 42
S. stylata Wierzejski, 1893	**B1, B2, C1, C2, C3, C4, C5** (B, C)	27, 28, 29, 30, 31, 32
***Testudinella* Bory de St. Vincent, 1826**		
T. mucronata Gosse, 1886	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 41, 42
T. patina Hermann, 1783	**A2, A3** (A, B)	13, 14, 15, 30, 32, 38, 39, 41, 42
T.truncata Gosse, 1886	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 41, 42
***Trichocerca* Lamarck, 1801**		
T.bicristata Gosse, 1887	**A3** (A)	5, 6, 7, 8, 35, 36
T.capucina Wie&Zach,1893	**A1, A2, A3, A4, A5, A6, B1, B2, D, C3, C4, C5** (A, B, C)	2, 3, 4, 6, 7, 8, 9, 10,12, 13, 14, 15, 28, 19, 20, 21, 22, 23, 24, 25, 27, 28, 29, 30, 31, 32, 38, 39, 41, 42
T.cylindrica Imhof, 1891	**A1, A2, A5** (A)	2, 28, 19, 20, 21, 22, 23, 24, 25, 27, 28, 29, 30, 31, 32, 38, 39, 40, 41, 42

T. elongate Gosse, 1886	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 41, 42
T.iernis Gosse, 1887	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 40, 41, 42
T.longiseta Schrank, 1802	**A1, A2, A3** (A)	13, 14, 15, 30, 32, 38, 39, 40, 41, 42
T.myersi Hauer ,1931	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 41, 42
T.porcellus Gosse, 1886	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 41, 42
T.pusilla Lauterborn, 1898	**A2, E3, E4** (A, E)	3, 4, 6, 7, 8, 9, 10, 12, 13, 14
T.rattus O.F. Müller, 1776	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 41, 42
T.rousseleti Voigt, 1902)	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 41, 42
T.similis Wierzejski, 1893)	**A1, A2, A5** (A)	2, 28, 19, 20, 21, 22, 23, 24, 25, 27, 28, 29, 30, 31, 32, 38, 39, 40, 41, 42
T.stylata Gosse, 1851	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 41, 42
T. tenuior Gosse, 1886	**A2** (A)	13, 14, 15, 30, 32, 38
T.weberi Jennings, 1903	**A2, A3** (A)	2, 28, 19, 20, 21, 22, 23, 24, 25, 27, 28, 29, 30, 31, 32, 38
***Trichotria* Bory de St. Vincent, 1827**		
T. curta Skorikov, 1914	**A5** (A)	13, 14, 15, 31, 32, 38, 39, 41, 42
T. pocillum O.F. Müller, 1776	**A3, A5** (A)	2, 13, 14, 15, 39, 30, 32, 38, 39, 41, 42
T. tetractis Ehrenberg, 1830	**A3, A5** (A)	2, 13, 14, 15, 39, 30, 32, 38, 39, 41, 42

Legends for letter symbols and nearest central point in brackets

A1 - Lake Micro Prespa (N:40.691447; E:21.028600),
A2 - Lake Macro Prespa (N:40.794431; E:20.946263),
A3 - Lake Ohrid (N:40.974442; E:20.676057),
A4 - Lake Fierza (N:42.090651; E:20.395832),
A5 - Lake Scadar/Shkodra (N:42.150502; E:19.395438),
A6 - River Buna (N:42.005522; E:19.456769),
B1 - Reservoir Bovilla (N:41.444056; E:19.893058),
B2 - Lake Tirana (N:41.310917; E:19.816143),
C1 - Lake Belshi (N:40.978345; E:19.891313),
C2 - Lake Merhoe (N:40.952991; E:19.899225),
C3 - Lake Seferani (N:40.940781; E:19.920761),
C4 - Reservoir Thana (N:40.862995; E:19.840817),
C5 - Reservoir Murrizi (N:40.727543; E:19.728467),
D1 - Lake Butrinti (N:39.784623; E:20.032498),
E1 - Lagoon of Patok (N:41.631068; E:19.601154),
E2 - Lagoon of Karavasta (N:40.918227; E:19.475840),
E3 - Lagoon of Narta (N:40.538250; E:19.424175),
E4 - Lagoon of Orikum (N:40.317013; E:19.441460),

Albanian water basin symbols in brackets from Dill (1993)

A (Drini Basin); **B** (Ishmi/Erzeni Basin); **C** (Semani Basin); **D** (Coastal Ionian Sea); **E** (Coastal Adriatic Sea).

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1. Byron 1981, **2.** Gannon *et al.* 1981, **3.** Guseska *et al.* 2012, **4.** Gusheska 2003, **5.** Guseska *et al.* 2008, **6.** Guseska *et al.* 2014, **7.** Kostoski 1998, **8.** Kostoski *et al.* 2004, **9.** Kostoski *et al.* 2005, **10.** Michaloudi *et al.* 1997, **11.** Michaloudi 2005, **12.** Milovanovic *et al.* 1965, **13.** Nedeljkovic 1959, **14.** Petković 1973, **15.** Petković 1975, **16.** Petković 1978, **17.** Petković 1981, **18.** Popovska-Stankovič 1988, **19.** Popovska-Stankovič 2003, **20.** Serafimova-Hadžišče 1954, **21.** Serafimova-Hadžišče 1958, **22.** Serafimova-Hadžišče 1978, **23.** Shumka 1994, **24.** Shumka 1998a, **25.** Shumka 1998b, **26.** Shumka *et al.* 1998, **27.** Shumka 2000, **28.** Shumka 2001, **29.** Shumka *et al.* 2006, **30.** Shumka 2014, **31.** Shumka *et al.* 2018a, **32.** Shumka *et al.* 2018b, **33.** Tasevska 2005, **34.** Tasevska *et al.* 2006, **35.** Tasevska *et al.* 2008, **36.** Tasevska *et al.* 2012a, **37.** Tasevska *et al.* 2012b, **38.** Tasevska *et al.* 2017, **39.** Taseska *et al.* 2018, **40.** Verščagin 1912, **41.** Živkovic 1974, **42.** Živkovic 1975.

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In Memoriam Prof. Dr. İbrahim Mete Mısırlıoğlu

(1972–2021)

İbrahim Mete Mısırlıoğlu was a world renown earthworm taxonomist, and a valuable scientist both in Turkey and internationally. He passed away unexpectedly in 02. May 2021 at age of 49. He will be remembered as a leading soil zoologist in Turkey and the Middle East due to his outstanding contributions to oligochaete taxonomy, faunistics and biogeography and as a good person because of his charming personality and helpfulness.

İbrahim Mete Mısırlıoğlu was born in 05. September 1972. He started his studies at the biology department of Anadolu University in 1989 and graduated from there in 1993. After graduating from the department of biology, he started his master's degree in the biology department of the Eskişehir Osmangazi University and graduated in 1995. He earned his Doctor of Philosophy (PhD) degree at the same university in 2001 and ever since he was working there, first as a research assistant at the Department of Biology, Science and Literature Faculty of Eskişehir Osman Gazi University. In 2013 he was appointed as an Associate Professor and in 2018 received the title of Full Professor.

He was working as a farabi coordinator between 2009–2021, and between 2013–2021 as the head of the biology department. The rapid rise in his academic career shows how talented a scientist he was.

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During his academic career, Prof. Mısırlıoğlu has written 10 books, 1 chapter and some 90 articles, making great contributions to the knowledge on earthworms, especially in Turkey and the East Mediterranean. Besides his scientific activity he was a prolific popular science writer as well writing some 50 popular science articles on diverse topics like the Anatolian leopard or loss of Anatolian biodiversity.

He was full of plans, especially writing a book on earthworms for children and also a review paper on the world distribution of earthworm families and genera. Unfortunately, these plans remain to be accomplished by his students and colleagues around the world.

Certainly, Prof. Dr. İbrahim Mete Mısırlıoğlu will sadly be missed by us, his students, and also his colleagues and friends both in Turkey and abroad.

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Complete list of publications of Prof. Dr. İbrahim Mete Mısırlıoğlu

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