Revision of the colourful genus *Parasetodes* McLachlan, 1880 (Trichoptera, Leptoceridae)

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Abstract. The rare and beautifully colourful old-world *Parasetodes* is a so-called set-aside genus with unsettled taxonomy. For instance, a recent survey (Malicky 2006) has synonymised all the Palaearctic and Oriental species to the type species *Parasetodes respersellus* (Rambur, 1842). The diverse forewing pattern, as a potential diagnostic character state is liable to disappear rapidly in alcohol or denuded and faded even on dry pinned specimens. In this revision we have delineated species by the ventral, surface-perpendicular profile of the dorsal arm of gonopod, the titillating plate, as well as by the lateral profile of the phallic organ and increased the species number of the genus from 12 to 45 describing 33 new species from the Palaearctic, Oriental, and Afrotropical fauna regions. Palaearctic fauna region: *Parasetodes temirlik* Oláh & Salokannel, sp. nov., Oriental fauna region: *P. bali* Oláh, sp. nov., *P. baoloc* Oláh, sp. nov., *P. borneo* Oláh & Mey, sp. nov., *P. dalat* Oláh, sp. nov., *P. gunung* Oláh & Mey, sp. nov., *P. hoang* Oláh, sp. nov., *P. indicus* Oláh, sp. nov., *P. kambait* Oláh & Johanson, sp. nov., *P. lamdong* Oláh, sp. nov., *P. madacus* Oláh & Johanson, sp. nov., *P. maechaem* Oláh & Mey, sp. nov., *P. maehong* Oláh & Mey, sp. nov., *P. namgen* Oláh & Johanson, sp. nov., *P. nokrek* Oláh & Mey, sp. nov., *P. pahang* Oláh, sp. nov., *P. ratnapur* Oláh, sp. nov., *P. sinicus* Oláh, sp. nov., *P. tumbang* Oláh & Me,y sp. nov., *P. umran* Oláh & Mey, sp. nov. Afrotropical fauna region: *P. amboas* Oláh, sp. nov., *P. ambovom* Oláh, sp. nov., *P. barnardi* Oláh, Johanson, Mey & Salokannel, sp. nov., *P. caprivi* Mey & Oláh, sp. nov., *P. ikeleng* Oláh & Johanson, sp. nov., *P. kindam* Oláh, sp. nov., *P. mahajan* Oláh & Johanson, sp. nov., *P. meyan* Oláh, sp. nov., *P. rwandicus* Oláh & Me,y sp. nov., *P. sikasso* Oláh & Johanson, sp. nov., *P. tinko* Oláh & Johanson, sp. nov., *P. weytus* Mey & Oláh, sp. nov., *P. zambicus* Oláh & Johanson, sp. nov. We have reinstated the species status of *P. aquilonius* Yang & Morse, 1997 stat. restit., *P. ussuriensis* Martynov, 1935 stat. restit., *P. bakeri* (Banks, 1913) stat. restit., *P. kiangsinicus* (Ulmer, 1932) stat. restit., *P. maculatus* (Banks, 1911) stat. restit., raised the taxonomic status from subspecies to species rank of *Parasetodes tanganicanus* Marlier, 1956 stat. nov., and transferred *Triaenodes demoulini* Jacquemart, 1966 to *Parasetodes* as *P. demoulini* (Jacquemart, 1966) comb. nov.

Keywords. Caddisflies, *Parasetodes,* revision, Palaearctic, Oriental, Afrotropical, new species.

INTRODUCTION

The present revision of the genus *Parasetodes* was inspired by our comprehensive study running on the Trichoptera of Madagascar that is based on the historical material of Renaud Paulian (1913–2003), presented to the first author and significantly enriched by collections realised by Kjell Arne Johanson and Wolfram Mey, the second and third author of this paper. In the rich historical material, there were detected only two *Parasetodes* specimens representing two species. However, it turned out that their exact identification and description were almost impossible due to the unsettled status of this old-world genus. Malicky (2006) has synonymised all the Palae-

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arctic and Oriental species to the oldest species *Parasetodes respersellus* (Rambur, 1842) and accordingly, most of us have set aside specimens for future study under this name.

Parasetodes are very rare and beautiful species, not easy to collect. Seldom abundant, but distributed widely in the entire old world, but we are unable to identify them! The two genera of the small tribe Nectopsychini in the family Leptoceridae, the Old World genus *Parasetodes* McLachlan, 1880 and the New World genus *Nectopsyche* Müller, 1879, exhibit beautifully colourful forewing patterns of high diagnostic value, a potentially diverse character state to delineate species. This is a great phenomenological challenge for caddisfly workers who are faced with how to differentiate among species by forewing patterns in these colourful creatures.

This dilemma is comparable to the common practice in the taxonomy of micromoths of microlepidopera. Unfortunately, both the forewing colour and the pattern are rapidly lost applying the practical and common practice of most trichopterologists. We are putting and keeping the adults of both genera routinely in alcohol. The same problem may arrive during the long storage of pinned dry specimens.

According to Malm and Johanson (2011) the genus *Parasetodes* forms a monophyletic group, and together with *Achoropsyche* and *Leptocerina* they form a unique branch that originate early in the Leptocerinae. We have elaborated and applied the principles and procedures of fine phenomics to search speciation traits in the reproductive organ of genitalia for differentiating and delineating among the species of the *Nectopsyche* genus stored in alcohol or rubbed during long storage of the pinned dry specimens (Oláh & Oláh 2017). In this revision the same procedure was adapted to the old-world genus *Parasetodes*. We have found the lateral profile of the phallic organ as well as the ventral perpendicular profile of the dorsal arm of the gonopod, the putative titillating plate, as the most diverse and most stable character states in this genus revision in order to delineate and describe new species on the entire distributional area covering Palaearctic, Oriental and Afrotropical fauna regions. Applying the principles, procedures, and practices of our fine phenomics we have described 33 new species and quadrupled the known species number in the *Parasetodes* genus from 11 to 45.

MATERIAL AND METHODS

Speciation traits of the forewing pattern

Similarly to the *Nectopsyche* genus (Oláh & Oláh 2017) the striking metallic or iridescent appearance of the forewing of *Parasetodes* is due partially to hairs and scales with colours of pigment or interference origin as well as the forewing is further diversified by more pigmented membrane pattern usually at pterostigma and arculus as well as along the forks and cross veins, where singular veins meet each other. In many species, there is a hyaline window on the stem of longitudinal vein M present in various, usually circular shape. The intact forewing pattern exhibits diversity and functions probably as a speciation trait in mate choice of premating isolation like the striking variation among bird plumage colour and pattern. Unfortunately, this forewing pattern is gradually lost during storage in alcohol and even on dry pinned specimens. Fortunately, the usually brown membrane patterns on the vein meeting area are lasting longer, but not forever, but are unfortunately less diverse. For instance, in the case of the holotype of *Parasetodes amboas* sp. nov. and *Parasetodes ambovom* sp. nov. from Madagascar collected in 1955 and 1952, stored in alcohol the brown membrane patterns were still well detectable and drawable in 1992, but almost completely disappeared for today, 2023. Nevertheless, the brown membrane pattern of the usually small patches if still detectable can be used as an additional character state to identify species. Here we used membrane patterns to associate the newly collected specimens with old species description patterns or males with putative females. However, the variably and unreliably lasting forewing pattern is not a stable diagnostic character state. Moreover, the drawing style could produce variable patterns from the same specimen.

Speciation traits of the male genitalia

In the genus *Parasetodes* we have found the dorsal arm of the gonopod and the phallic organ as the most diverse character states corresponding to the most important criteria of speciation traits. Diversity is resulted by the speciation of the diverse structures. Examining the limited number of specimens it seems that additionally the dorsal arm and the phallic organ are the most stable, less variable genitalic structures. They are possibly the non-neutral adaptive speciation traits, a result of sexual organisation. However, the diverse and stable therefore, non-neutral adaptive character states must be easily and reliably visible and well discernible to have practical diagnostic value in species delineation. The present revision of the *Parasetodes* genus is based on these two speciation traits. In species delineation we rely mostly on the ventral profile of the dorsal arm of the gonopods and the lateral profile of the phallic organ. Unfortunately the type specimens of the historical species *P. respersellus* (Rambur, 1842), *P. maculatus* (Banks, 1911), *P. kiangsinicus* (Ulmer, 1932) are either lost or unavailable.

Dorsal arm of gonopod

The dorsal arm of the gonopods has a specially modified titillating mesal surface due to the enlarged alveoli along the mesal margin. This rather rough flat structure is produced mesad in a transverse plane perpendicular to both sagittal and coronal planes and may function as a stimulatory organ in cryptic female choice, an isolation barrier resulting in a prezygotic mechanism of isolation. We call this putative speciation trait a titillating plate being a stimulatory structure in cryptic female choice. The shape of this transversal structure is badly discernible in lateral view, highly sensitive to small modifications of the observational angle. This is the reason why drawings in lateral view are variable on different published drawings. At the same time, the ventral view or more precisely the ventral surface-perpendicular view makes the entire surface of the dorsal arm visible. When we speak about the structural properties of the dorsal arm of the gonopods actually we speak about the shape of its highly modified apical flat surface with a specific alveolar fringed margin. Unfortunately there is an obstacle; the less diverse ventral arm of gonopods frequently covers the ventral perpendicular view of the dorsal arm disturbing its clear view for drawing.

Phallic organ

Like in many more caddisfly taxa, the phallic organ of the *Parasetodes* genus also functions as a diverse and stable speciation trait. Here we draw the lateral profile of the phallic organ or at least the stable profile of the phallotheca or phallicata. The exact drawing of the lateral profile is frequently disturbed by lateral and mesal ridges variously developed on the phallotheca. The apical head of the phallic organ in several species is unstable due to varying erection states of the membranous endothecal remnants, phallotremal less sclerotized structures, and membranous lobes of uncertain boundaries. Therefore, the drawn lateral profile of the phallic organ is frequently simplified, but its basal and mesal regions are rather stable with reliable diagnostic value.

Female genital structure

The female genital structures seem rather distinctive and diverse in the described few known species. The following structures have some diagnostic value: lateral profile of segment IX, dorsal posterior margin of tergum IX, papillae processes between posterodorsum of tergum IX and segment X, setose preanal appendages fused with tergum X, lateral and dorsal profile of segment X, setose lamellae and the spermathecal sclerite complex.

Drawings

Here we reproduce the original drawings for all the species without available specimens for direct examination and for new drawings. If possible, we redraw the ventral profile of the dorsal arm of gonopods and the lateral profile of the phallic organ from the old drawings or at least we reproduce the entire original available draw-

ings if these structures are not drawn. If we have specimens or if the original drawings permit, we produce (1) a lateral view of the entire genitalia without a phallic organ, (2) the ventral profile of the dorsal arm of the gonopod, and (3) the lateral profile of the phallic organ. We reproduce all the old drawings with our own drawing style concentrating on diagnostically significant structures and omitting insignificant or obscured details like setae on cerci and gonopods or membranous eversible structures on the head of the phallic organ.

Practical difficulties

Preparing, examining, and drawing these tiny and delicate fragile animals we have faced and experienced several practical and routine difficulties. We had a few dry pinned specimens hard to handle. Especially if we delineate species with the speciation trait of the lateral profile of the phallic organ, and of the ventral profile of the dorsal arm of the gonopod as well as if we need to apply the still detectable brown forewing membrane pattern for taxonomical targets. To cut the last four segments of the abdomen of these dry fragile pinned specimens is very risky and unreliable. Moreover, the wings at least the forewings that remained on the pin after the abdomen cutting, are variously folded, not spread flat, and not denuded that is essential to observe, examine, and draw the brown membrane pattern of the tiny patches on the vein meeting area exactly. If we have a specimen in alcohol we cut the right forewing, spread, and denude it properly with cover glass in order to draw exactly its membrane pattern.

The ventral arms of the gonopods are frequently injured, and variously broken due to premating fighting or copulatory actions. This condition has the advantage of exposing the hidden dorsal arm to discern and draw exactly its ventral perpendicular profile. In intact condition, the ventral arm of the gonopod partially covers the ventral perpendicular profile of the dorsal arm. If we have several specimens, that are very rare, we may cut the ventral arm of the left gonopod of one specimen to expose the entire exact view of the diverse dorsal arm. If we have a single male with an intact ventral arm disturbing the exact view of the dorsal arm the drawing is difficult. A very little change in observation and drawing angles may produce a significant alteration of the drawings.

Depositories. Collections de l'Institut royal des Sciences naturelles de Belgique (CIRSNB). Museum of Comparative Zoology, Cambridge, USA (MCZ). Museum for Natural History of the Humbolt University of Berlin, Germany (ZMB). Museum für Naturkunde, Berlin, Germany (MfN). Oláh Private Collection, Debrecen, Hungary, under national protection by the Hungarian Natural History Museum, Budapest (OPC). Swedish Museum of Natural History, Stockholm, Sweden (SMNH) Zoologisches Museum Hamburg, Hamburg, Germany (ZMH).

Nectopsychini Morse, 1981

Parasetodes McLachlan, 1880

Palaearctic Fauna Region

Parasetodes aquilonius Yang & Morse, 1997 stat. restit.

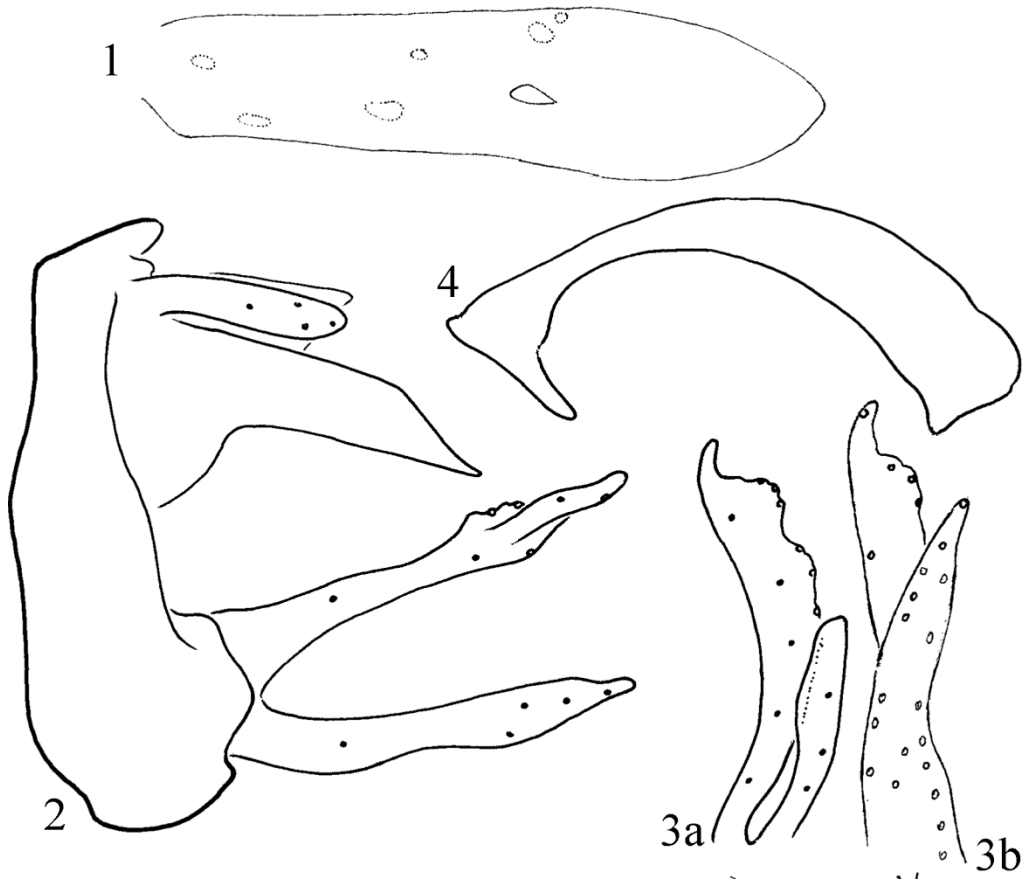
(Figures 1–6, Map 1)

Parasetodes aquilonius Yang & Morse, 1977, in Vshivkova, Morse, & Yang 1997: 177, 179, pl. 114 fig. 1.5, pl. 115 fig 1–3." Holotype male: China Shen-yang Shi (N41.50, E123.26).

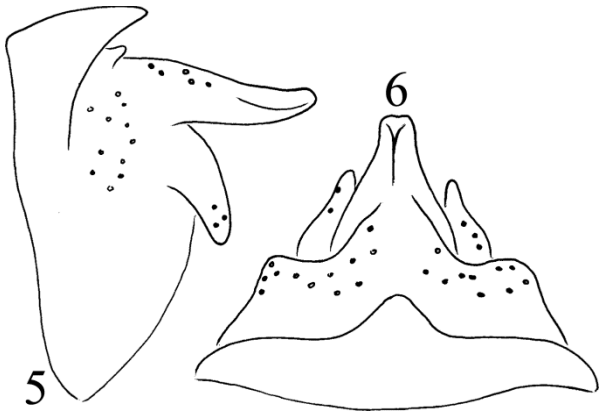
Parasetodes aquilonius Yang & Morse, 1997: Yang & Morse 2000:58–59. Holotype male: China Shen-yang Shi (N41.50, E123.26). "Distribution: known from northern China and south eastern Russia.

Parasetodes respersellus Yang & Morse, 1997 (part.): Malicky 2006: 1514–1515. Examining hundreds of his own *Parasetodes* specimens of the Palaearctic and Oriental Fauna Regions, from Greece to Bali, has synonymised all the described species from both fauna regions, including *Parasetodes aquilonius* Yang & Morse, 1997 with the oldest name *Parasetodes respersellus* (Rambur, 1842).

Remarks. This species has a resemblance to *P. respersellus*, but differs by segment X signifi



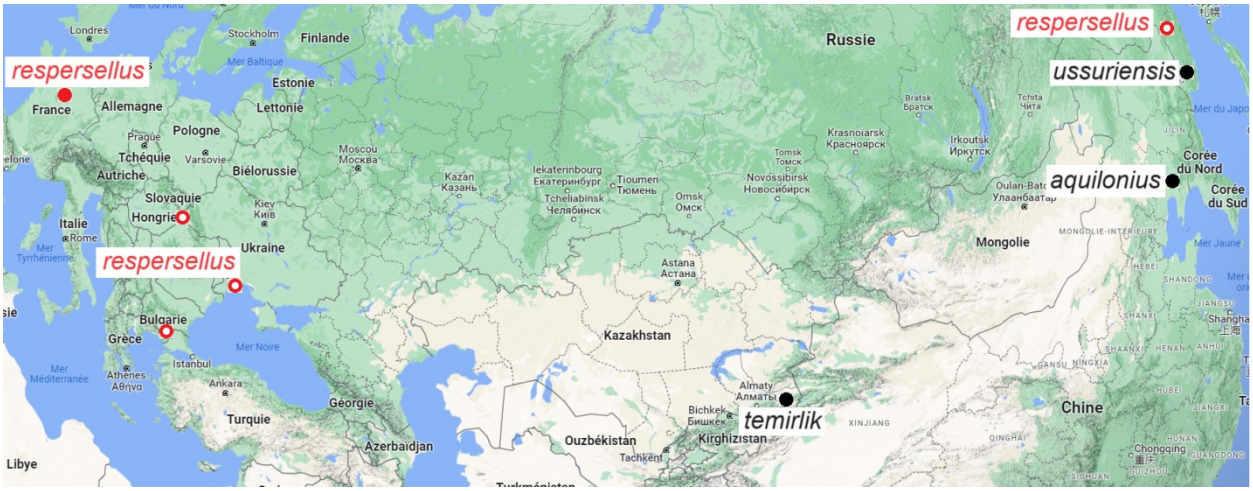
Figures 1–4. *Parasetodes aquilonius* Yang & Morse, 1997. Reproduced from original drawings: 1 = forewing brown membrane pattern, 2 = left lateral view of genitalia, 3a = left gonopod with apicomesal lobe and the cercus in dorsal view, 3b = left gonopod with apicomesal lobe in ventral perpendicular view, partially covered by the ventral arm of gonopod, 4 = phallic organ in lateral view.



Figures 5–6. *Parasetodes aquilonius* Yang & Morse, 1997. Reproduced from original drawings: 5 = female genitalia in lateral view, 6 = female genitalia in dorsal view.

cantly longer than the cerci; the ventral arm of the gonopods shorter than the dorsal arm; the ventroperpendicular profile of the dorsal arm of the gonopods with subapical mesal concavity as well as by the lateral profile of the phallic organ with broader apical half of the phallotheca with characteristic ventroapical pointed corner.

There are distinct divergences in the female genitalia. The setose area at the basement of segment X is flat, not elevated; segment X is almost horizontal, not downward directed, oblique ventrad, lamellae more developed and discernible, and more protruded in dorsal view. Here we reinstate its species status, **stat. restit**.



Map 1. *Parasetodes* species of the Palaearctic Fauna Region

***Parasetodes respersellus* (Rambur, 1842)**

(Figures 7–11, Map 1)

Setodes respersella Rambur, 1842: 515: "Pendant l'été dans les environs de Paris, le long des Rivières."

Parasetodes respersella (Rambur, 1842): McLachlan 1880: 66. "The example before me is an exceedingly pretty insect, and, notwithstanding some slight discrepancies in the description, I am convinced it represents Rambur's species, of which no types exist." It is one of the most striking European species of Leptoceridae."

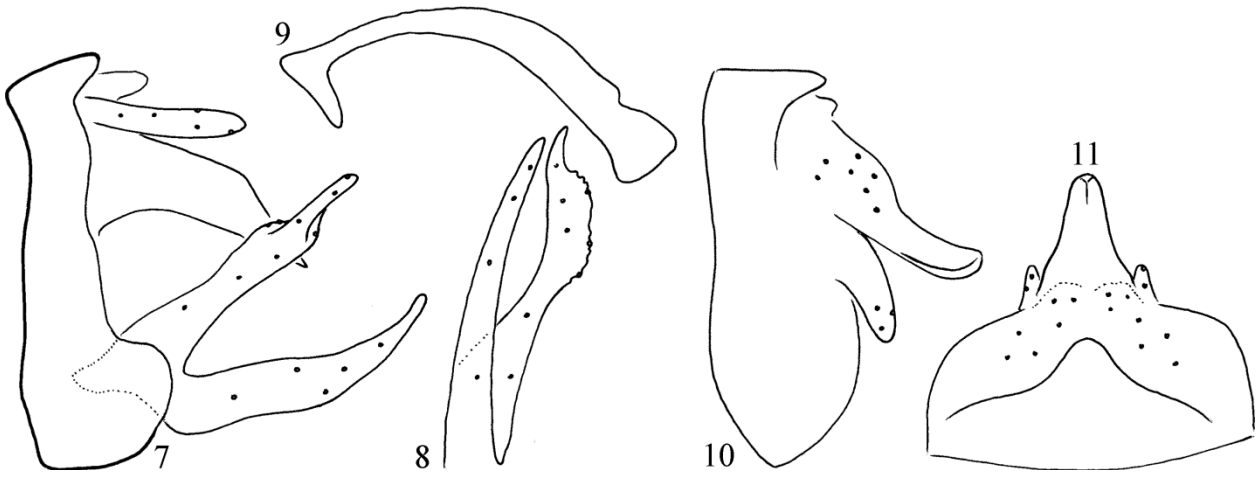
Parasetodes respersella (Rambur, 1842): Ulmer 1907: 48. "1. Exemp., Japan, Coll. Pryer, 47." Das Stück zeigt keine Unterschiede gegen ein französisches Stück, da ich sah (Pariser Museum); die Art muss eine weite Verbreitung haben; ich bemerkte mehrere Stücke auch in der Sammlung des Wiener Museums aus Aegypten! Die Rambur'sche Type fehlt."

Parasetodes respersella (Rambur, 1842): Martynov 1935: 261–262. "*P. respersella* was known from France, Egypt, Turkestan and Japan and here we record it from Russia, Ussuri Region (in Russian)."

Parasetodes respersellus (Rambur, 1842): Yang & Morse 2000: 61–63: "holotype = missing (Mc Lachlan, 1880; Ulmer, 1907); type repository = probably was once the Zoological Collection of the Baron Edmund de Selys Longchamps, National Museum of Natural Science in Brussels, Belgium; type locality = France (Paris)."

Material examined. **Bulgaria**: Eastern Rhodopi, Byala Reka River, Zhultichalskoto dere near Meden Buk Village, Ivaylovgrad District, 121m, 41°22'48"N 26°01'40"E, 25.VII.2012, at light, leg. S. Beshkov & M. Beshkova, (1 male, OPC). Bulgaria, Eastern Rhodopi Mts. near Odrintzi Village, 206 m, 41°26'59"N 26°08'28"E, 16.VIII. 2014, at light, leg. S. Beshkov (4 males, 2 females, NMNHBAS; 4 males, 2 females; OPC). **Hungary**: Hungarian Lowland, Debrecen, Józsa, Tócó stream, 14. VII. 2010, light, leg. J. Oláh (1 female, OPC). Hungary, Hungarian Lowland, Pocsaj, River Ér, 17. VIII. 2010, light leg. J. Oláh (1 female, OPC). **Romania**, Danube Delta, VIII. 2018, leg. C. Ciubuc (1 male, 1 female; OPC). **Russia**, Primorje, Chanka Lake, 4–6.VIII.1994, leg. L. Kühne (3 males, 1 female, MfN; 2 males, 1 female, OPC).

Remarks. *Parasetodes respersellus* resembles *Parasetodes aquilonius* Yang & Morse, 1997, but differs by having segment X significantly weakly longer than cerci; the ventral arm of gonopods is subequal to the dorsal arm; the ventro perpendicular profile of the dorsal arm of gonopods without subapical mesal concavity; in lateral profile the phallic organ has less broad apical half of the phallotheca with characteristic ventroapical blunt corner. There are distinct divergences in the female genitalia. The setose area at the basement of segment X is elevated, not flat; segment X is downward-directed, oblique ventrad, not almost horizontal; and the lamellae are



Figures 7–11. *Parasetodes respersellus* (Rambur, 1842). Bulgarian male: 7 = left lateral view of genitalia, 8 = left gonopod with apicomesal lobe in ventral perpendicular view, 9 = phallic organ in lateral view. Bulgarian female: 10 = female genitalia in lateral view, 11 = female genitalia in dorsal view.

less developed and less protruded in dorsal view. Martynov (1935) has recorded only the female of *Parasetodes respersellus* from Primorje, Russia. We are fortunate to have both the males and the females from Primorje for a detailed comparative study with specimens from Bulgaria, Hungary, and Romania to confirm its identity.

Parasetodes temirlik Oláh & Salokannel, sp. nov.

(Figures 12–17, Map 1)

Material examined. Holotype: **Kazakstan**, Almaty, Uygur district, Temirlik Canyon, Temirlik, 43.358681°N, 79.165506°E, 971 m, 2.VII. 2019, leg. Juha Salokannel (1 male, OPC). Allotype: same as holotype (1 female, OPC).

Diagnosis. This new species is related to *Parasetodes respersellus*, but differs by the reduced number of brown membrane patches on the forewing, by the short ventral arm of the gonopods as well as by the ventral profile of the dorsal arm of gonopods and the lateral profile of the phallic organ. The new species has no even blunt ventroapical corner on the phallotheca.

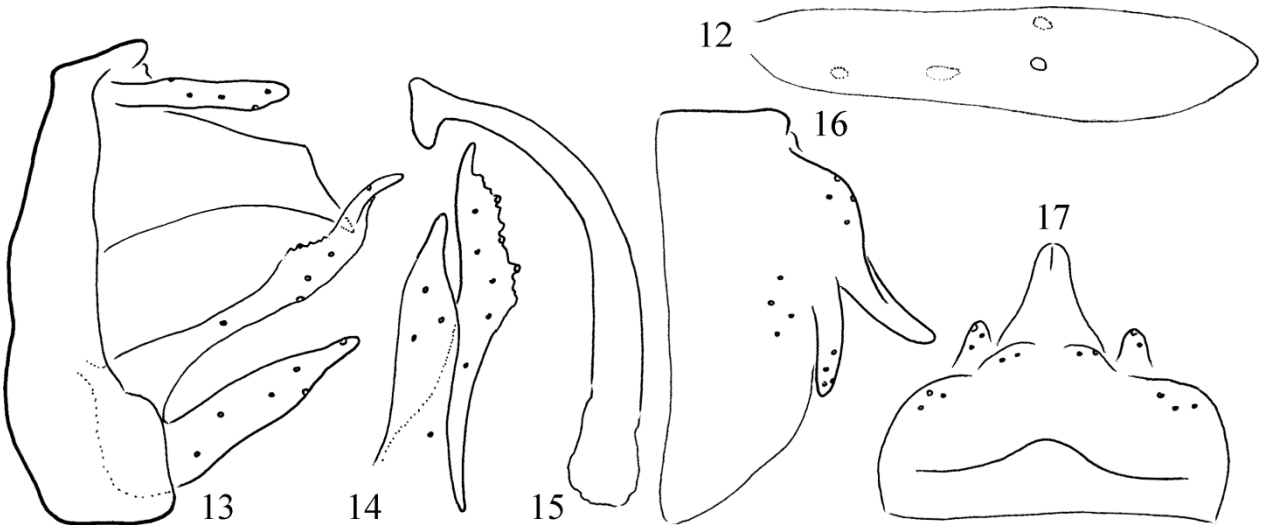
Description. Medium-sized animal. Forewing length 11 mm. Forewing anastomosis not arranged in a nearly straight line, it is arched due to anterad shifted crossvein m-cu. Hyaline window on middle section of M stem present and rounded. Brown membrane pattern characterized by thickened darker vein just on basement of the two apical forks and on anastomosis crossveins as well as by only three real membrane browned patches, one rounded medium-sized before pterostigma, one well-developed and horizontally elongated on M-Cu fork area and one the smallest on the basoanal region where empusal vein meets 1A. Forewing of female allotype has less produced basoanal small brown membrane patch. On male genitalia the lateral profile of segment X trapezoid, its upper part slightly longer than cerci. Ventral arm of gonopods short. Lateral profile of phallic organ gradually broadening apically from basis. On female genitalia segment X and lamellae particularly slender and directed vertically.

Etymology. *temirlik* coined from the name of the holotype's locus typicus, as a noun in apposition.

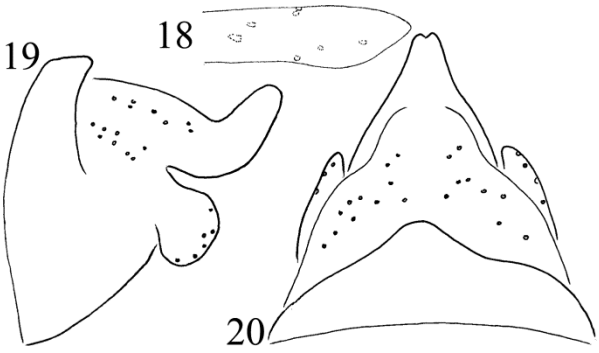
Parasetodes ussuriensis Martynov, 1935 stat. restit.

(Figures 18–20, Map 1)

Parasetodes ussuriensis Martynov, 1935: 263–264. 3♀. Vicinities of the village Jakovlenka, South Ussuri region. [44°25'42"N 133°28'11"E].



Figures 12–17. *Parasetodes temirlik* sp. nov. Holotype: 12 = forewing brown membrane pattern, 13 = left lateral view of genitalia, 14 = left gonopod with apicomesal lobe in ventral perpendicular view, 15 = phallic organ in lateral view. Allotype: 16 = female genitalia in lateral view, 17 = female genitalia in dorsal view.



Figures 18–20. *Parasetodes ussuriensis* Martynov, 1935. Reproduced from original drawings: 18 = forewing brown membrane pattern, 19 = female genitalia in lateral view, 20 = female genitalia in dorsal view.

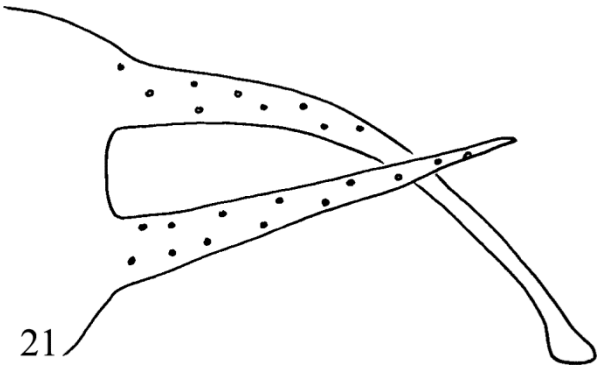


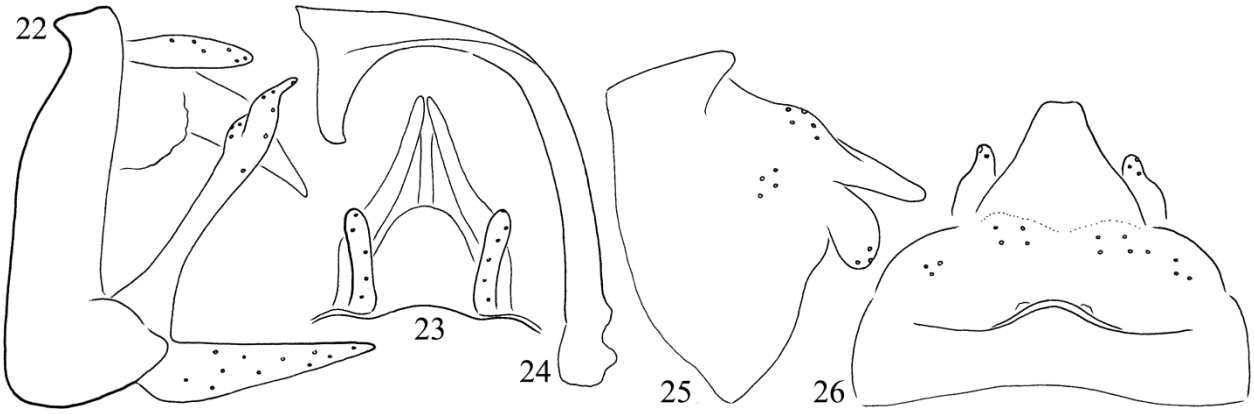
Figure 21. *Parasetodes bakeri* (Banks, 1913). Holotype: 21 = original drawing of Banks.

Parasetodes bakeri (Banks, 1913) (part.): Schmid 1958: 124–125. "Je suis tenté de croire que *P. bakeri* est synonyme de *ussuriensis* Mart., car les genitalia des ♀♀ sont fort semblables."

Parasetodes maculatus (Banks, 1911) (part.): Yang & Morse 2000: 60. "possible synonym of *Parasetodes bakeri* according to Schmid, 1958, p. 124."

Parasetodes respersellus (Rambur, 1842) (part.): Malicky 2006:1514–1515. Examining hundreds of his own *Parasetodes* specimens of the Palaearctic and Oriental Fauna Regions, from Greece to Bali, has synonymised all the described species from both fauna regions, including *Parasetodes ussuriensis* Martynov, 1935 with the oldest name *Parasetodes respersellus* (Rambur, 1842).

Remarks. This species is described from females with very characteristic genital structures significantly differring from all the known *Parasetodes* females of the Palaearctic fauna region. Its genital structure has some resemblance to *Parasetodes ratnapur* sp. nov. described here as a new species from Sri Lanka that was misidentified by Ulmer (1915) and Schmid (1958) as *Parasetodes bakeri* (Banks, 1913) the species known from a single male holotype collected in the Philippines. Here we have collected and described its female and its genital structures are different from the females of *Parasetodes ussuriensis* Martynov, 1935 and *P. ratnapur* sp. nov.



Figures 22–26. *Parasetodes bakeri* (Banks, 1913). Holotype: 22 = left lateral view of genitalia, 23 = genitalia in dorsal view, 24 = phallic organ in lateral view, 25 = female genitalia in lateral view, 26 = female genitalia in dorsal view.

Moreover, there are several distinct *Parasetodes* species on the huge area between the type localities of *Parasetodes ussuriensis* and *P. ratnapur* sp. nov. Here we reinstate its species status, **stat. restit**.

Oriental Fauna Region

Parasetodes bakeri (Banks, 1913) stat. restit.

(Figures 21–26, Map 2, 4)

Leptocella bakeri Banks, 1913: p. 177, pl. 9 fig. 15. "From Los Banos, Philippine Islands (Baker)."

Parasetodes maculata (Banks, 1911) (part.): Kimmins 1963: 288. Synonymised with *Parasetodes maculatus* (Banks, 1911).

Parasetodes maculatus (Banks, 1911) (part.): Yang & Morse 2000: 60. "Holotype sex unknown; type repository unknown, possibly US National Museum of Natural History."

Parasetodes respersellus (Banks, 1913) (part.): Malicky 2006: 1514–1515. Examining hundreds of his own *Parasetodes* specimens of the Palaearctic and Oriental Fauna Regions, from Greece to Bali, (Malicky 2006) has synonymised all the described species from both fauna regions, including *Parasetodes bakeri* (Banks, 1913) with the oldest name *Parasetodes respersellus* (Rambur, 1842).

Material examined. Holotype: **Philippine**, the label data are: "Los Banos, P. I. Baker", "Type MCZ 11733" (1 male, MCZ). Philippine, Luzon, Dinalupihan, Roosevelt National Park, 9.V.1999, light, leg. Mey & Ebert (1 female, ZMB, 1 female, OPC).

Remarks. In the original species description (Banks 1913) the sex of the holotype was not reported, but according to type specimen and also the drawing of figure 15 on plate 9 it is a male. As usual, Banks's drawing is inferior compared to the contemporary level of knowledge on genital structure. It is difficult to understand and interpret properly what exactly the original drawing represents. What we actually knew about this species described from Los Banos, Luzon Island of the Philippine Islands is from a brief description of the pattern of dark brown patches on the forewing and of the wing venation characters as well as the published drawing that represents only part of the genitalia. According to the examination of the holotype, this is a distinct valid species. Here we reinstate its species status, **stat. restit**. The reports from Sri Lanka (Ulmer 1915, 1951, Schmid 1958), as well as from India and Myanmar (Martynov 1936) are misidentifications.

Re-diagnosis of male. The examination of the holotype makes it possible to homologize what represents Banks's original incomplete and partly incorrect drawing. The upper process is the phallic organ erroneously setose on its proximal half and the lower process is the ventral arm of the gonopod crossing each other. As visible on the redrawn holotype this unique phallic organ with very elongated phallotheca is the most important diagnostic character of this species together with the short ventral arm of the gonopods compared to the dorsal arm of the gonopod. Unfortunately, the ventral profile of the dorsal arm is not drawn.

Female. The forewing brown membrane patches of the female are identical to the spotted pattern presented in the original species description. On the genitalia segment X is subtriangular in dorsal view with a clearly truncated apex, straight in lateral view slightly downward directed. Lamellae with broadened lateral basal half in dorsal view, short downward hanging in lateral view.

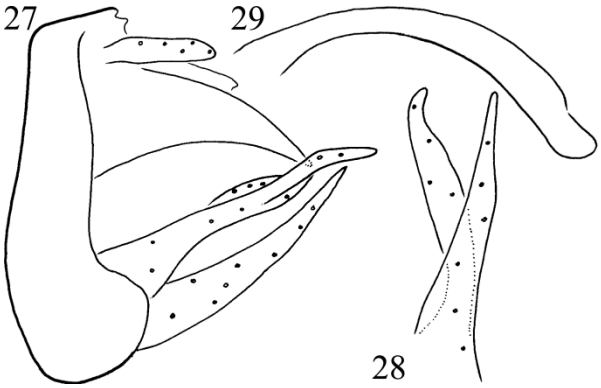
***Parasetodes bali* Oláh, sp. nov.**

(Figures 27–29, Map 2)

Parasetodes respersellus (Rambur, 1842) (part.): Malicky 2006: 1514–1515. "Mir liegen einige hundert Examplare aus Nepal, Myanmar, Sri Lanka, Thailand, Laos, Vietnam, Sumatra und Bali vor. Es ist mir nich gelungen, irgendwelche brauchbaren specifischen Unterschiede zwischen diesen zu finden." "Ich habe aber jetzt Stücke aus Griechenland bekommen, die wohl echte *P. respersellus* sind (die Art ist von Rambur aus Frankreich beschrieben worden) und die ich hier (Tafel 7) abbilde; sie unterscheiden sich nich von asiatischen Stücken. Ich meine also, daβ wir es überall mit *P. respersellus* zu tun haben, die dann also eine sehr weit verbeitete Art (von Westeuropa bis Bali: Taf. 7) wäre, fast so weit verbreitet wie *Oecetis tripunctata*, die von den britischen Inseln bis Bali (Malicky 2005) bekannt ist."

Material examined. Malicky, 2006: 1514–1515, figures on Table 7. Specimen from Bali, deposited in Malicky's private collection.

Description and Diagnosis. According to the drawings *Parasetodes bali* sp. nov. resembles *Parasetodes respersellus* (Rambur, 1842), but is clearly distinguished by the lateral shape of segment X tapering, not trapezoid; by the lateral and ventral profile of the dorsal arm of the gonopods and most clearly by the lateral shape of the phallic organ. *Parasetodes respersellus* has a characteristic head of the phallotheca with dorsal produced lateral profile and with blunt ventroapical corner. While the head of the phallic organ of *Parasetodes bali* sp. nov. is not produced, but reduced subapically and without any ventroapical corners.



Figures 27–29. *Parasetodes bali* sp. nov. Holotype: 27 = left lateral view of genitalia, 28 = left gonopod with apicomesal lobe in ventral perpendicular view, 29 = phallic organ in lateral view.

Etymology. *bali* coined from the name of the holotype's *locus typicus*, as a noun in apposition.

Remarks. The delineation and description of this new species are based on Malicky's drawings. However, in this drawing the ventral pattern of the dorsal arm of the gonopod, this titillating structure seems to be the speciation trait in the *Parasetodes* genus, is not detailed or drawn properly. It would be useful to re-examine and redraw the type specimen in order to confirm the ventral profile of this structure so diverse in genus *Parasetodes*, covering the speciation trait criteria.

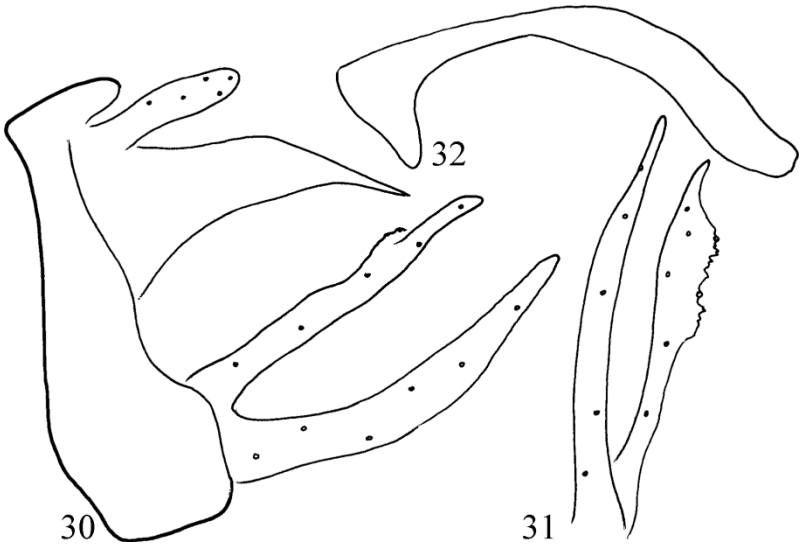
***Parasetodes baoloc* Oláh, sp. nov.**

(Figures 30–32, Map 2, 3)

Material examined. Holotype: **Vietnam**, Lamdong, Baoloc, [Bảo Lộc, Lâm Đồng] Dai Binh River, 22.X.1988, light leg. J. Oláh (1 male, OPC). Paratype: Vietnam, Lamdong, Baoloc, River Da Nga, 21.X.1988, light, leg. J. Oláh (1 male, OPC).

Diagnosis. According to the genital structure *P. baoloc* sp. nov. is close to *Parasetodes madacus* sp. nov. but differs by the less developed brown membrane patch pattern with only four patches compared to over ten patches of *P. madacus*. There are distinct divergences also in the genital structures. In *P. baoloc* sp. nov. the lateral

Map 2. *Parasetodes* species of the Oriental Faunal Region



Figures 30–32. *Parasetodes baoloc* sp. nov. Holotype: 30 = left lateral view of genitalia, 31 = left gonopod with apicomesal lobe in ventral perpendicular view, 32 = phallic organ in lateral view.

profile of segment X is trapezoid, not simply tapering; the ventral profile of the dorsal arm of the gonopod is less broad and without distinct middle excision on its mesal margin; the lateral curvature and the basal region of the phallic organ is diverged.

Description. Small-sized animal. Forewing length 8 mm. Forewing anastomosis arranged not in a nearly straight line, it is arched due to the anterad shifted m-cu crossvein. The hyaline window on middle section of M stem present and rounded. Brown membrane pattern characterized

by thickened darker vein just on the very basement of the two apical forks and on anastomosis crossveins as well as by four real membrane browned patches, two rounded medium sized before pterostigma, one the most developed and horizontally elongated on the M-Cu fork area and one the smallest on the basoanal region where the empusal vein meets 1A. On male genitalia the lateral profile of segment X trapezoid, its upper part is slightly longer than cerci. Ventral arm of gonopod is slightly longer than the dorsal arm. Lateral profile of the phallic organ with very slim smaller basal half and slightly broader larger apical half.

Etymology. *baoloc* coined from the name of the holotype's *locus typicus*, as a noun in apposition.

***Parasetodes borneo* Oláh & Mey, sp. nov.**

(Figures 33–35, Map 2)

Material examined: Holotype: **Indonesia**, Borneo, Kalimantan, Kewah, Tumbang Korik, 28. I.1996, leg. A. Kallies (1 male, MfN). Paratype: same as holotype (1 male, OPC).

Diagnosis. This species resembles *P. tumbang* sp. nov., collected and described here from the same habitat, but differs by the abbreviated apical finger and straight without constricted titillating plate on the dorsal arm of the gonopod; by the longer and more slender ventral arm of the gonopod as well as by the lateral profile of the phallic organ with rounded ventroapical corner of the head of the phallotheca.

Description. Medium-sized. Forewing length 8 mm. Forewing anastomosis not arranged in a straight line, but arched due to anterad shifted m-cu crossvein; hyaline window on middle section of M stem and brown membrane pattern indistinct. In male genitalia lateral profile of segment X tapering and abruptly narrowing before the pointed apex, double long than cerci, slightly curving downward. Cerci short. Ventral profile of dorsal arm of gonopods with short, even tiny apical finger, the titillating plate with straight dentate mesal stimulating surface without constriction on middle; ventral arm of gonopods as long as dorsal arm, slightly upward curving. Lateral profile of phallic organ arching and broadening from middle, apex monolobed, ventroapical corner rounded; dorsal and ventral margin undulating on the apical third of the phallotheca.

Etymology. *borneo* coined from the name of the holotype's *locus typicus*, as a noun in apposition.

***Parasetodes dalat* Oláh, sp. nov.**

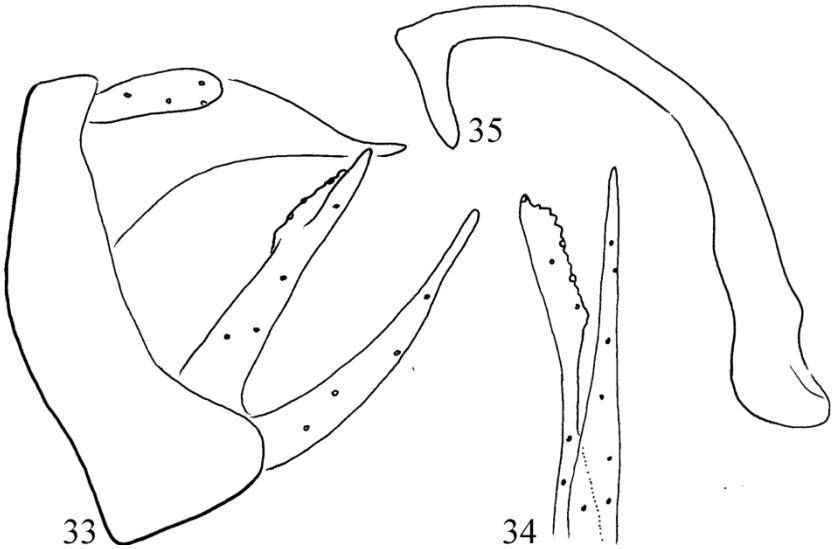
(Figure 36–38, Map 2, 3)

Material examined. Holotype: **Vietnam**, Lamdong, Dalat, [Đà Lạt, Lâm Đồng], Monastery balcony, 19.X.1988, light, leg. J. Oláh (1 male, OPC).

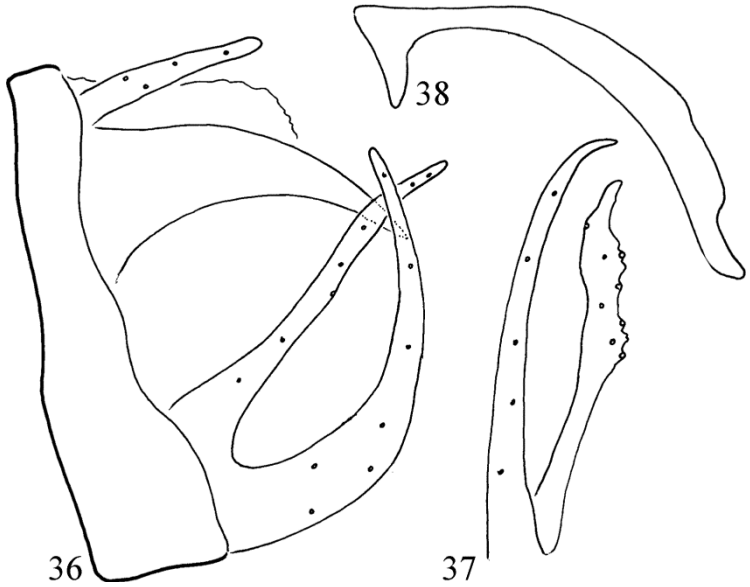
Diagnosis. According to the genital structure *Parasetodes dalat* sp. nov. is close to *P. madacus* sp. nov. but differs by the less developed brown membrane patch pattern with only about 9 patches compared to 15 patches of *P. madacus* sp. nov. There are distinct divergences also in the genital structures. *Parasetodes dalat* sp. nov. have slender cerci, not broad; the ventral profile of the dorsal arm of the gonopod narrow and with elongateed, shallow middle excision on its mesal margin; the lateral curvature and the basal region of the phallic organ are also diverged; the head of the phallic organ half as high.

Description. Medium sized animal. Forewing length 9 mm. Forewing anastomosis not arranged in a nearly straight line, it is arched due to the anterad shifted m-cu crossvein. The hyaline window on middle section of M stem present and rounded. Brown membrane pattern is present with about 9 patches, but indistinct. On male genitalia the lateral profile of segment X tapering, about double longer than cerci. Cerci slender. Ventral arm of gonopod is almost equal with the dorsal arm, but curving upward, almost semicircular. Lateral profile of the phallic organ gradually broadening apically from middle to apicad, excised dorsoapicad.

Etymology. *dalat* coined from the name of the holotype's *locus typicus*, as a noun in apposition.



Figures 33–35. *Parasetodes borneo* sp. nov. Holotype: 33 = left lateral view of genitalia, 34 = left gonopod with apicomesal lobe in ventral perpendicular view, 35 = phallic organ in lateral view.



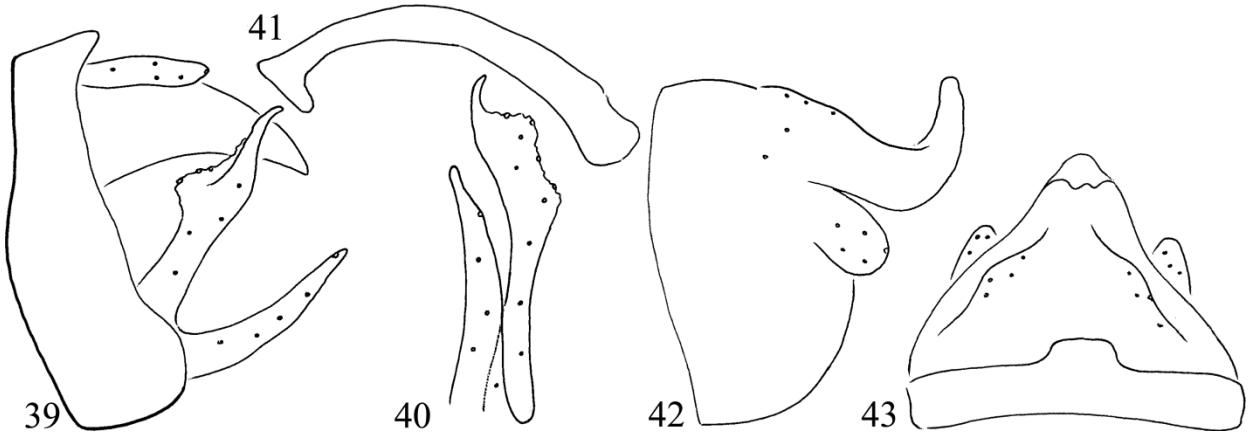
Figures 36–38. *Parasetodes dalat* sp. nov. Holotype: 36 = left lateral view of genitalia, 37 = left gonopod with apicomesal lobe in ventral perpendicular view, 38 = phallic organ in lateral view.

***Parasetodes gunung* Oláh & Mey, sp. nov.**

(Figures 39–43, Map 2)

Material examined: Holotype: Indonesia, Sumatra, Ketambe, 200 m, 30k m NNW Kutacane, Gunung Leuser National Park, 22-24.1.1995, leg. A. Kallies (1 male, MfN). Allotype: same as holotype (1 female, MfN). Paratype: same as holotype (1 female, OPC).

Diagnosis. This species has some resemblance to *P. pahang* sp. nov., collected and described from Malaysia, but differs by the more slender and mesad curving apical finger and more produced broader titillating plate on the dorsal arm of



Figures 39–43. *Parasetodes gunung* sp. nov. Holotype: 39 = left lateral view of genitalia, 40 = left gonopod with apicomesal lobe in ventral perpendicular view, 41 = phallic organ in lateral view. Allotype: 42 = female genitalia in lateral view 43 = female genitalia in dorsal view.

the gonopod; by the shorter ventral arm of the gonopod as well as by the lateral profile of the phallic organ without produced ventroapical corner on the head of the phallotheca.

Description. Medium-sized species; forewing length 8 mm. Forewing anastomosis not arranged in a straight line, but arched due to anterad shifted m-cu crossvein; hyaline window on middle section of M stem and brown membrane pattern indistinct. In male genitalia lateral profile of segment X tapering with less pointed apex, double long than cerci, slightly curving downward. Cerci short. Ventral profile of dorsal arm of gonopods with long, mesad curving apical finger, the titillating plate rather enlarged with slightly middle constricted mesal stimulating surface; ventral arm of gonopods shorter than dorsal arm, stout and slightly upward curving. Lateral profile of phallic organ arching and gradually broadening; apex monolobed, ventroapical corner rounded; slight dorsoapical excision present.

On the female genitalia segment X is subtriangular in dorsal view with a small apical excision, upward curving in lateral view. Lamellae short and rounded broad, obliquely downward hanging in lateral view.

Etymology. *gunung* coined from the name of the holotype's *locus typicus*, as a noun in apposition.

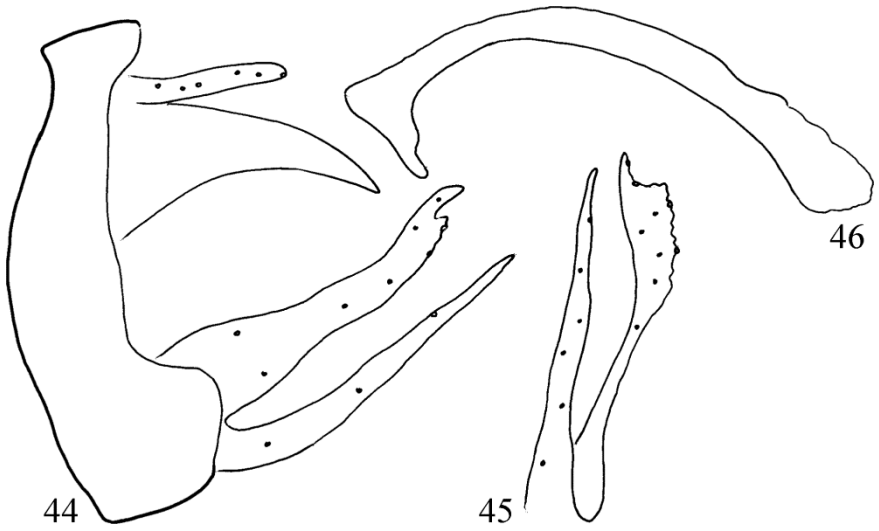
***Parasetodes hoang* Oláh, sp. nov.**

(Figures 44–46, Map 2, 3)

Material examined. Holotype: **Vietnam**, Ho Chi Minh (Saigon), Than Loc [Thạnh Lộc] fishpond, 12.X.1988, light, leg. J. Oláh (1 male, OPC).

Diagnosis. According to the genital structure *P. hoang* sp. nov. is close to *P. madacus* sp. nov. but differs by the less developed brown membrane patch pattern with only about 9 patches compared to 15 patches of *P. madacus* sp. nov.; moreover the patch pattern is confluent with the more extensive lighter brown basic pattern. There are distinct divergences also in the genital structures. In *P. hoang* sp. nov. the cerci are slender, not broad; the ventral profile of the dorsal arm of the gonopod with a right-angled apicomesal corner, and without any middle excision on its mesal margin; the lateral curvature and the basal region of the phallic organ have also diverged; the head of the phallic organ is clavate.

Description. Medium sized animal. Forewing length 9 mm. Forewing anastomosis not arranged in a nearly straight line, it is arranged in step-wise due to the significantly anterad shifted m-cu crossvein. The hyaline window on middle section of M stem present and rounded. Brown membrane



Figures 44–46. *Parasetodes hoang* sp. nov. Holotype: 44 = left lateral view of genitalia, 45 = left gonopod with apicomesal lobe in ventral perpendicular view, 46 = phallic organ in lateral view.

pattern is present with about 6 patches, but indistinct and confluent with the more extensive less pigmented brown pattern. On male genitalia the lateral profile of segment X tapering, half longer than cerci. Cerci slender. Ventral profile of the dorsal arm of the gonopod broad, with right-angled apicomesal corner and without middle excision mesad; ventral arm of gonopod is equal to the dorsal arm, almost straight. Lateral profile of the phallic organ gradually broadening from basad to apicad, with clavate head.

Etymology. *hoang*, "*trang hoang*" means colourful, decorate in Vietnamese language referring to the collector's striking primary experience when first recognised the splendid, colourful intact *Parasetodes* specimen sitting on the brightly illuminated white sheet. Unfortunately the important character state of the forewing colour pattern was immediately lost in alcohol.

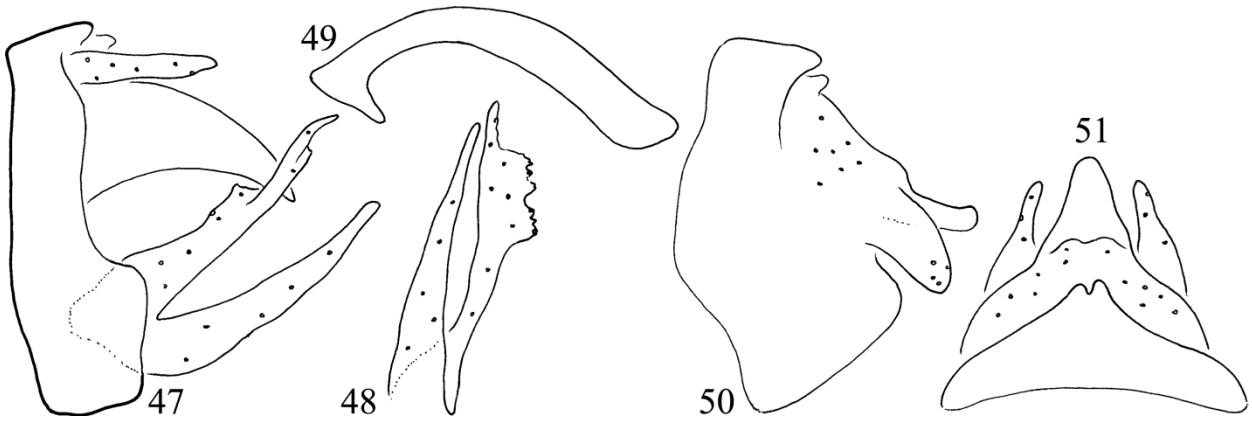
***Parasetodes indicus* Oláh, sp. nov.**

(Figures 47–51, Map 2)

*Material examined***.** Holotype: **India**, Gujarat, Ghandinagar, River Sabarmati, 22.IV.1992, light, leg. J. Oláh (1 male, OPC). Allotype: same as holotype (1 female, OPC). Paratypes: same as holotype (5 males, OPC). India, Orissa State [Odisha State], Bhubaneswar, Daya River, 20. II.1985, light, leg. J. Oláh (1 male, 1 female; OPC). India, Orissa State, Bhubaneswar, Daya River, 21.II.1985, light, leg. J. Oláh (1 male, 2 females; OPC).

Diagnosis. According to the genital structure *P. indicus* sp. nov. resembles *P. respersellus* (Rambur, 1842) but differs by the less developed (or disappeared) brown membrane patch pattern. There are distinct divergences in the genital structures as well. In *P. indicus* sp. nov. the lateral profile of segment X downward curving and tapering, not trapezoid; the ventral profile of the dorsal arm of the gonopod is broader with right-angled apicomesal corner, and with some middle excision on its mesal margin. The lateral curvature and the basal region of the phallic organ have also diverged; the head of the phallic organ is without a blunt ventroapical corner. The female genital structure differs from all the known *Parasetodes* females with its less developed segment X and more developed lamellae in lateral view.

Description. Medium sized animal. Forewing length 9 mm. Forewing anastomosis arranged not in a nearly straight line, arranged step-wise due to the significantly anterad shifted m-cu crossvein. Hyaline window on middle section of M stem



Figures 47–51. *Parasetodes indicus* sp. nov. Holotype: 47 = left lateral view of genitalia, 48 = left gonopod with apicomesal lobe in ventral perpendicular view, 49 = phallic organ in lateral view. Allotype: 50 = female genitalia in lateral view, 51 = female genitalia in dorsal view.

present and rounded. Brown membrane pattern indistinct. In male genitalia lateral profile of segment X tapering, double longer than cerci. Cerci slender. Ventral profile of dorsal arm of the gonopod extremely broad, almost quadrangular with right angled apicomesal corner and with small indistinct middle excision mesad; ventral arm of gonopod equal with dorsal arm, almost straight. Lateral profile of the phallic organ gradually broadening from basad to apicad, with obliquely cut head. Female genital structure characterized by bilobed apicodorsal mesal apex in dorsal view; by less developed segment X and more developed lamellae.

Etymology. *indicus* coined from the country name of the holotype's *locus typicus*.

Parasetodes kambait Oláh & Johanson, sp. nov.

(Figures 52–54, Map 2)

Material examined. Holotype: **Myanmar**, N.E Myanmar, Kambaiti [Kan Paik Ti], 2000 m, 21.V.1934, leg. R. Malaise (1 male, SMNH).

Diagnosis. The genital structure, particularly the straight segment X and straight phallic organ distinguishes this species from all the other species of the genus.

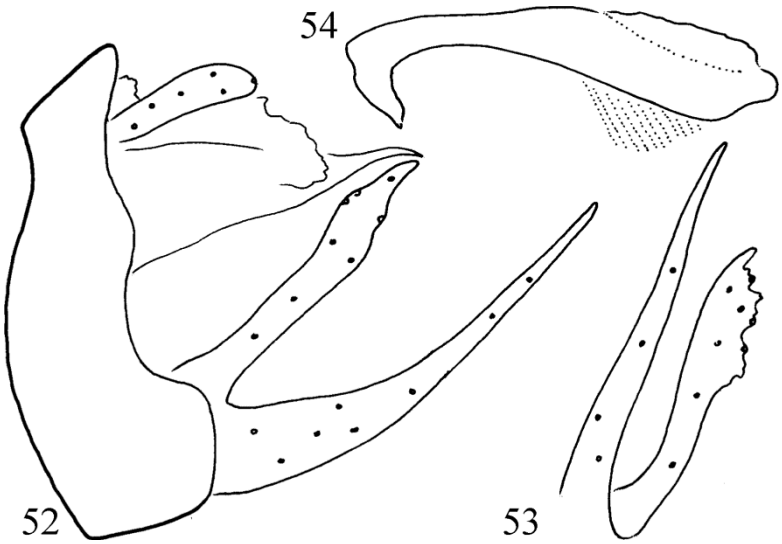
Description. Medium-sized animal. Forewing length 9 mm. Forewing anastomosis not arranged in straight line, but arranged step-wise due to anterad-shifted m-cu crossvein. Hyaline window on middle section of M stem and brown membrane pattern indistinct. Male genitalia in lateral profile of segment X tapers with pointed apex; double as long as cerci, straight, not curving downward. Cerci broad. Ventral profile of dorsal arm of the gonopod broad, without right angled apicomesal corner and with small indistinct middle excision mesad; ventral arm of gonopods longer than dorsal arm, slightly arching upward. Phallic organ particularly organised; almost straight, not curving with broad apical half and narrow head, a particularly developed erected row of long fragile filament, attached together, is present ventrad.

Etymology. *kambait* coined from the name of the holotype's *locus typicus*, as a noun in apposition.

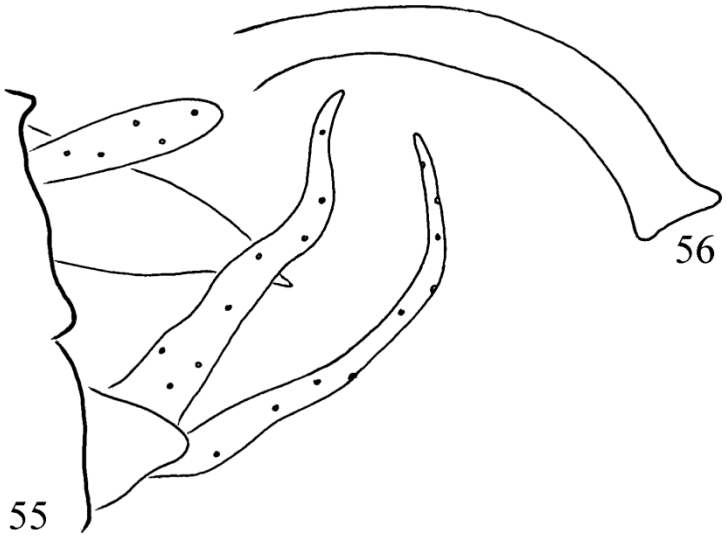
Parasetodes kiangsinicus (Ulmer, 1932) stat. restit.

(Figures 55–56, Map 2)

*Leptocella kiangsinic*a Ulmer, 1932: 59–60: **China**: "Material: 1 ♂, C 28, Kiangsi [Jiangxi], C. F. Wu



Figures 52–54. *Parasetodes kambait* sp. nov. Holotype: 52 = left lateral view of genitalia, 53 = left gonopod with apicomesal lobe in ventral perpendicular view, 54 = phallic organ in lateral view.



Figures 55–56. *Parasetodes kiangsinicus* (Ulmer, 1932). Original drawings: 55 = left lateral view of genitalia, 56 = phallic organ in lateral view.

leg., im Museum der Yenching University." "Das einzige ♂, in Spiritus konserviert, sieht infolge der mit dunklen Aderpunkten gezierten Vorderflügel der *Leptocella bakeri* Bks. u. a. ähnlich."

Parasetodes kiangsinicus (Ulmer, 1932): Yang & Morse, 2000: 59–60. "holotype=male; type repository=Museum of Yen-ching (now Beijing University); type locality=Jiang-xi Province." "The existence of the holotype of this species is in doubt. We did not find this species in our collecting."

Parasetodes respersellus (Ulmer, 1932) (part.): Malicky 2006: 1514–1515. Examining hundreds of his own *Parasetodes* specimens of the Palaearctic and Oriental Fauna Regions, from Greece to Bali, Malicky (2006) has synonymised all the described species from both fauna regions, including *Parasetodes kiangsinicus* (Ulmer, 1932) with the oldest name *Parasetodes respersellus* (Rambur, 1842).

Remark. Our knowledge on this species is limited to the original description and drawings. The type probably is lost. However, the original Ulmer's drawing characterizes this species, particularly by the lateral profile of the dorsal and ventral arms of the gonopods, as well as the lateral profile of the phallic organ. The drawings are complete enough to identify newly collected male specimens.

Parasetodes lamdong Oláh, sp. nov.

(Figures 57–59, Map 2, 3)

Material examined. Holotype: **Vietnam**, Lamdong, Baoloc [Bảo Lộc, Lâm Đồng], River Da Nga, 21.X.1988, light, leg. J. Oláh (1 male, OPC).

Diagnosis. The S-shaped head of the phallic organ distinguishes this species from all the other species of the genus.

Description. Medium-sized animal. Forewing length 9 mm. Forewing anastomosis not arranged in straight line, but arranged step-wise due to anterad shifted m-cu crossvein. Hyaline window on middle section of M-stem and brown membrane pattern indistinct. In male genitalia the lateral profile of segment X tapers, with pointed apex; almost double as long as cerci and curving downward. Cerci slender. Ventral profile of dorsal arm of gonopods narrow, without right angled apicomesal corner and with shallow middle constriction mesally; ventral arm of gonopods slightly longer than dorsal arm, arching downward. Phallic organ with characteristic S-shaped head.

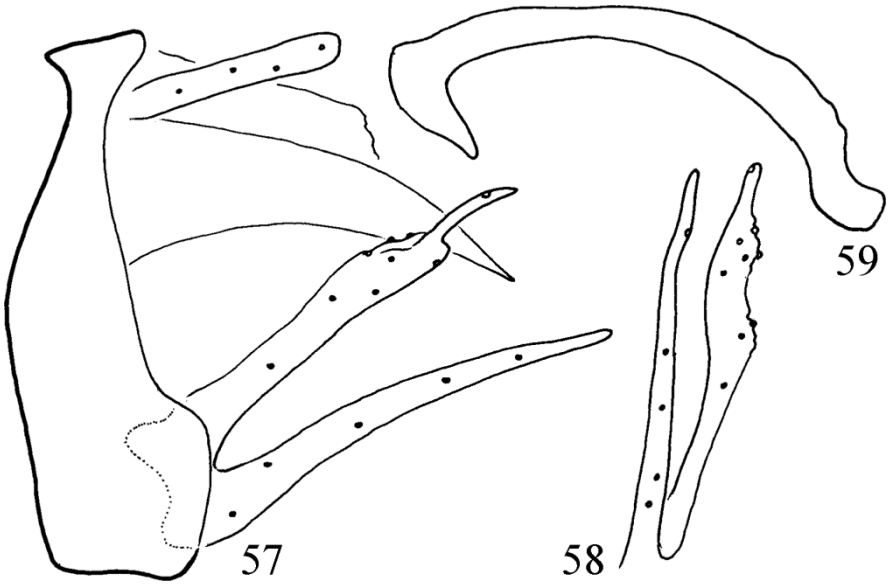
Etymology. *lamdong* coined from the name of the *locus typicus*, as a noun in apposition.

Parasetodes maculatus (Banks, 1911) stat. restit.

(Figures 60, Map 2)

Leptocella maculata Banks, 1911: 104, pl. 6 fig. 6: "From Pusa [25.9837, 85.6752], Bengal, July 30, on rice leaves."

non *Parasetodes maculata* (Banks): Kimmins 1963: 288. Recorded from India, Ceylon, and Burma. Misidentification.



Figures 57–59. *Parasetodes lamdong* sp. nov. Holotype: 57 = left lateral view of genitalia, 58 = left gonopod with apicomesal lobe in ventral perpendicular view, 59 = phallic organ in lateral view.

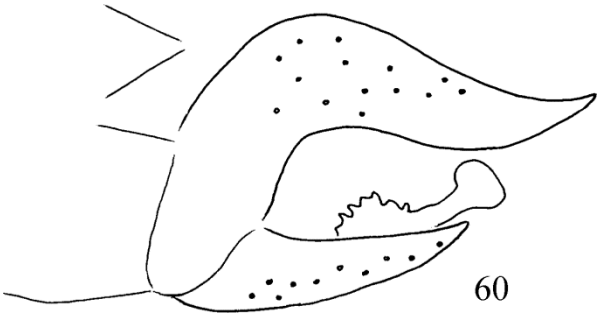


Figure 60. *Parasetodes maculatus* (Banks, 1913). Holotype, original drawing of Banks.

Parasetodes maculatus (Banks, 1911): Yang & Morse 2000:60. "holotype = male; type repository = possibly USNM (United States Museum of Natural History); type locality = "Pusa, Bengal (India)."

Parasetodes respersellus (Rambur, 1842) (part.): Malicky 2006: 1514–1515. Examining hundreds of his own Parasetodes specimens of the Palaearctic and Oriental Fauna Regions, from Greece to Bali, Malicky (2006) has synonymised all the described species from both fauna regions, including *Parasetodes maculatus* (Banks, 1911) with the oldest name *Parasetodes respersellus* (Rambur, 1842).

Remarks. The type is not available. Our knowledge is limited to the very poor description and the very incomplete original drawings. However, in *P. maculatus* (Banks, 1911) apparent forks 1 and 3 on forewing are of equal length while in *P. respersellus* (Rambur, 1842) apparent fork 3 is longer; the dorsal arm of gonopod is robust S-shaped, not slender straight and the apex of phallic organ circular, not truncate.

Parasetodes madacus Oláh & Johanson, sp. nov.

(Figures 61–66, Map 2, 3)

Material examined. Holotype: **Vietnam**, Dong Nai Province, Vinh Cuu District, Vinh Cuu Nature Reserve, Ma Da stream, 11°22'38.2"N, 107°03'36.7"E, 78 m, loc#VN016, 16.IV.2011, light trap, leg. K. A. Johanson & T. T. Du (1 male, SMNH). Allotype: Vietnam, Dong Nai Province, Vinh Cuu District, Vinh Cuu Nature Reserve, Ma Da stream, 11°23'05.3"N, 107°03'38.7"E, 59m, loc#VN019, 19.IV.2011, light trap, leg. K. A. Johanson & T. T. Du (1 female, SMNH). Paratypes: same as allotype (1 female, SMNH; 2 females, OPC)

Diagnosis. According to the genital structure *P. madacus* sp. nov. is close to *P. baoloc* sp. nov. but differs by the more developed brown membrane patch pattern with 15 patches compared to four patches of *P. baoloc* sp. nov. There are distinct divergences also in the genital structures. In *P. madacus* sp. nov. the lateral profile of segment X is simply tapering, not trapezoid; the ventral profile of the dorsal arm of the gonopod is broad and with distinct middle excision on its mesal margin; the lateral curvature and the basal region of the phallic organ have also diverged.

Description. Small sized animal with forewing length 8 mm. Forewing anastomosis not arranged straight line, but arched due to anterad shifted m-cu crossvein. Hyaline window on middle section of M stem present and rounded. Brown membrane pattern as presented in the forewing drawing. Male genitalia segment X tapering in lateral profile, longer than cerci. Ventral arm of gonopods slightly longer than dorsal arm. Lateral profile of phallic organ gradually broadening apically from basis. In female genitalia segment X deeply excised apically in dorsal view and upward curving almost semicircular in lateral view; lamellae very small.

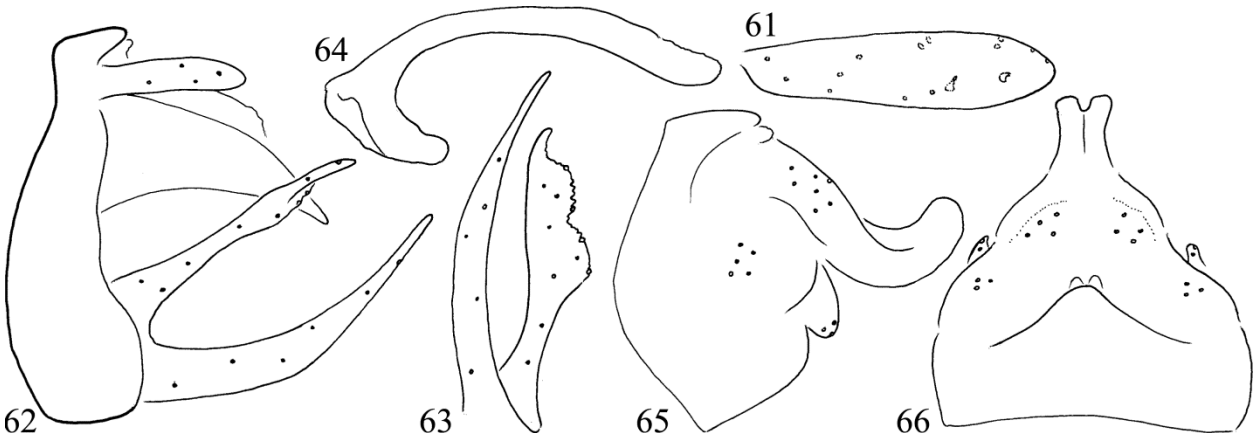
Etymology. *madacus* coined from the name of the *locus typicus*.

Parasetodes maechaem Oláh & Mey, sp. nov.

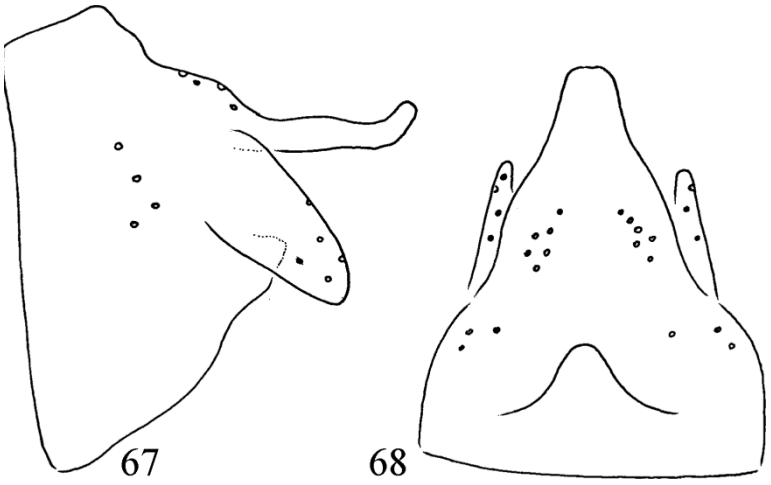
(Figures 67–68, Map 2)

Material examined. Holotype: **Thailand**, Mae Hong Son Province, Mae Chaem River, Hot Resort, 18°12'07N, 98°36'33"E, 268 m, loc #Tr08, 17.IV.2003, leg. D. Braasch (1 female, MfN).

Diagnosis. According to the female genital structure this species differs very significantly from its cohabitant *P. maehong* sp. nov. and from all the known *Parasetodes* females. The uniquely



Figures 61–66. *Parasetodes madacus* sp. nov. Holotype: 61 = forewing brown membrane pattern, 62 = left lateral view of genitalia, 63 = left gonopod with apicomesal lobe in ventral perpendicular view, 64 = phallic organ in lateral view. Allotype: 65 = female genitalia in lateral view, 66 = female genitalia in dorsal view.



Figures 67–68. *Parasetodes maechaem* sp. nov. Holotype: 67 = female genitalia in lateral view, 68 = female genitalia in dorsal view.

slender and digitiform lateral shape of segment X has some resemblance to *P. tumbang* sp. nov., but it is truncated, not narrowing rounded in dorsal view and straight with upward turning apex, not curving upward along its entire length; moreover lamellae are giant in *P. maechaem* sp. nov. and very tiny in *P. tumbang* sp. nov.

Description. Genitalia with mesal dorsoapical lobe rather narrowing in dorsal view; dorsal profile of segment X elongated triangular with truncated apex; in lateral view uniquely slender digitiform and very apex turning upward; lamellae very produced, in lateral view obliquely directed downward.

Remarks. This species was collected form the same habitat as the *P. maehong* sp. nov., but without any male specimen. Nevertheless, the female genital structures exhibit significant character state differences. Here we describe *Parasetodes maechaem* sp. nov. as a distinct, independent species in the hope that its male will be collected within short.

Etymology. *maechaem*, coined from the name of the holotype's *locus typicus*, as a noun in apposition.

Parasetodes maehong Oláh & Mey, sp. nov.

(Figures 69–73, Map 2)

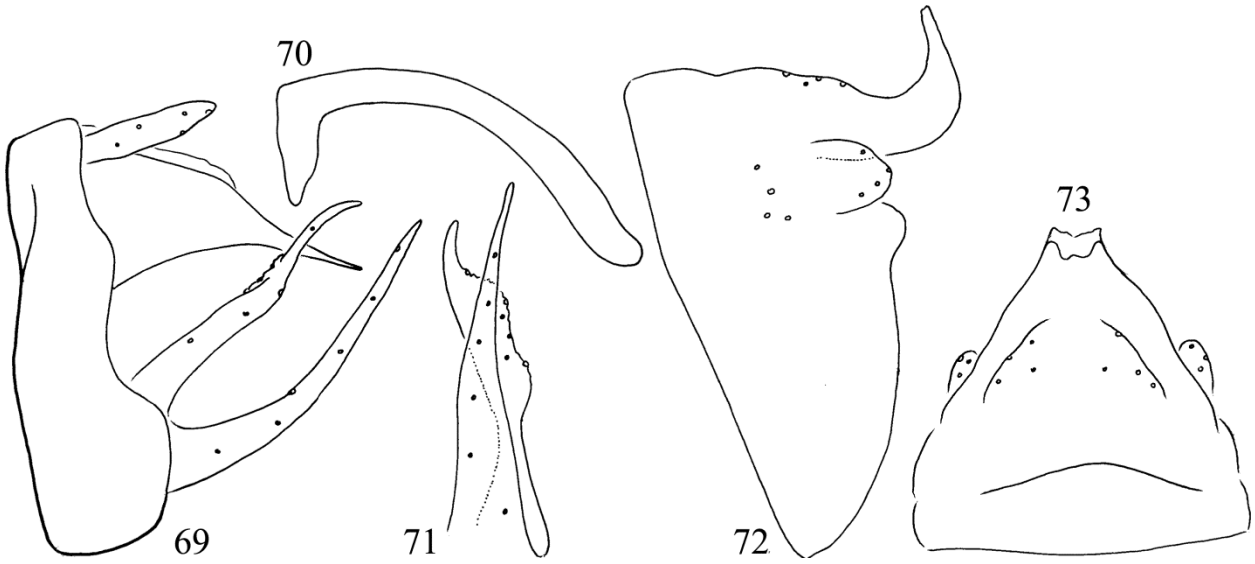
Material examined. Holotype: **Thailand**, Mae Hong Son Province, Mae Chaem river, Hot Resort, 18°12'07N, 98°36'33"E, 268 m, loc #Tr08, 17.IV.2003, leg. D. Braasch (1 male, MfN). Allotype: same as holotype (1 female, MfN). Paratypes: same as holotype (2 females, OPC).

Diagnosis. According to the genital structure *P. maehong* sp. nov. has resemblance to *P. baoloc* sp. nov. and *P. madacus* sp. nov., but differs from both by the filiform apical half of segment X, by the very slender lateral shape of the dorsal arm of gonopod as well as by the particular lateral shape of the phallic organ. The female genitalia is completely different from the known female genitalia of *P. madacus* sp. nov., but has some resemblance to the female genitalia of *P. gunung* sp. nov., however the lateral profile of segment X is more tapering, lamellae short and broad.

Description. Small-sized animal. Forewing length 7 mm. Forewing anastomosis not arranged in straight line, but arched due to anterad shifted m-cu crossvein. Hyaline window on middle section of M stem indiscernible. On male genitalia the lateral profile of segment X tapering, almost filiform from midway and double long than cerci. Titillating plate of the dorsal arm of gonopod with long digitiform ending, broad and slightly constricted middle. Ventral arm of gonopods is slightly longer than dorsal arm. Lateral profile of phallic organ forms an almost regular tube regularly curving from basad to apicad.

On the female genitalia segment X is subtriangular in dorsal view with a small apical excision, upward curving and significantly tapering in lateral view. Lamellae very short and rounded broad, obliquely downward hanging in lateral view.

Etymology. *maehong* coined from the name of the holotype's *locus typicus*, as a noun in apposition.



Figures 69–73. *Parasetodes maehong* sp. nov. Holotype: 69 = left lateral view of genitalia, 70 = left gonopod with apicomesal lobe in ventral perpendicular view, 71 = phallic organ in lateral view. Allotype: 72 = female genitalia in lateral view, 73 = female genitalia in dorsal view.

***Parasetodes namgen* Oláh & Johanson, sp. nov.**

(Figures 74–76, Map 2)

Material examined. Holotype: **Laos** PDR, Luang Namtha Prov. Nam Ha NBCA, Nam Gnang [Nam Ngang] stream, 300 m upstr. Namgnen Village, 558mao, UTM 47Q 0746256, UTM 2321311, Malaise trap, loc#24, 29.IV.-1.V.2005, leg. N. Jönsson, T. Malm and B. Viklund (1 male, SMNH).

Diagnosis. The very broad lateral and the particular ventral profile of the dorsal arm of the gonopods as well as the short and broad ventral arm of the gonopods distinguish this species from all other known members of *Parasetodes*.

Description. Medium-sized animal. Forewing length 9 mm. Forewing anastomosis arranged in step-wise due to anterad shifted m-cu crossvein. Male genitalia in lateral profile with segment X with blunt downward directed apex; half as long as cerci and curving downward. Cerci broad. Lateral profile of dorsal arm of gonopod, uniquely very broad with terminal digitate process; in ventral profile dorsal arm of gonopod subquadrangular, without produced apicomesal corner, excision or mesal constriction; ventral arm of gonopods is broad and short, much than the dorsal arm, straight with slightly upward directed narrowing apex. Phallic organ with truncate head.

Etymology. *namgen* coined from the name of the *locus typicus*, as a noun in apposition.

***Parasetodes nokrek* Oláh & Mey, sp. nov.**

(Figures 77–79, Map 2)

Material examined. Holotype: **India**, Meghalaya, Garo Hills, Nokrek National Park, 25°27N, 90°26E, 2-13.VII.1997, leg. Afonin & V. Siniaev (1 male, MfN).

Diagnosis. According to the genital structure *P. nokrek* sp. nov. has resemblance to *P. umran* sp. nov. and *P. indicus* sp. nov., but differs from both by the blunt head of segment X, not pointed, by the less broad titillating plate as well as by the lateral profile of the phallic organ curving along its entire length and the phallic apex with pronounced ventroapical rounded angle.

Description. Medium sized animal. Forewing length 9 mm. Forewing anastomosis arranged in arche due to anterad shifted m-cu crossvein. Hyaline window on middle section of M stem indiscernible. Male genitalia in lateral profile with segment X tapering, with blunt apex. Titillating plate of the dorsal arm of gonopod with long digitiform ending, medium broad and slightly constricted middle. Ventral arm of gonopods almost as long as dorsal arm. Lateral profile of phallic organ forms almost regular tube regularly curving from basis to apex with ventroapical produced rounded corner.

Etymology. *nokrek* coined from the name of the *locus typicus*, as a noun in apposition.

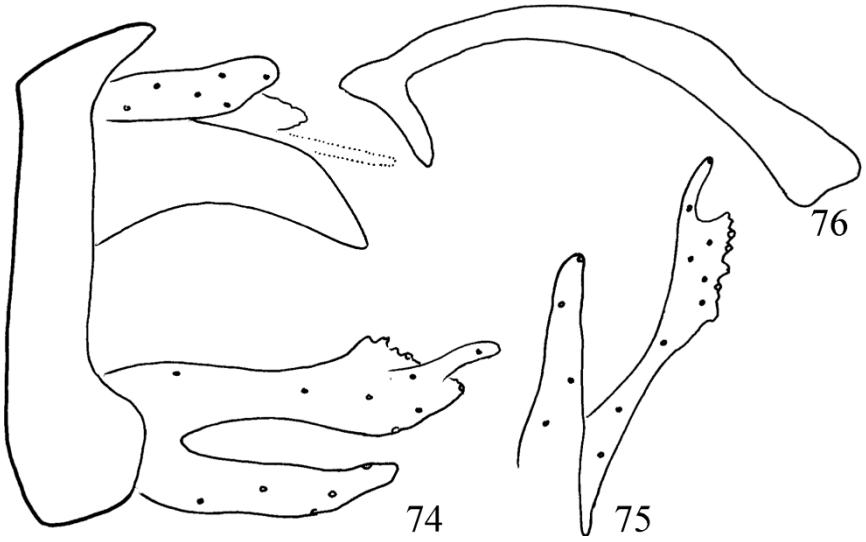
***Parasetodes pahang* Oláh, sp. nov.**

(Figures 80–82, Map 2)

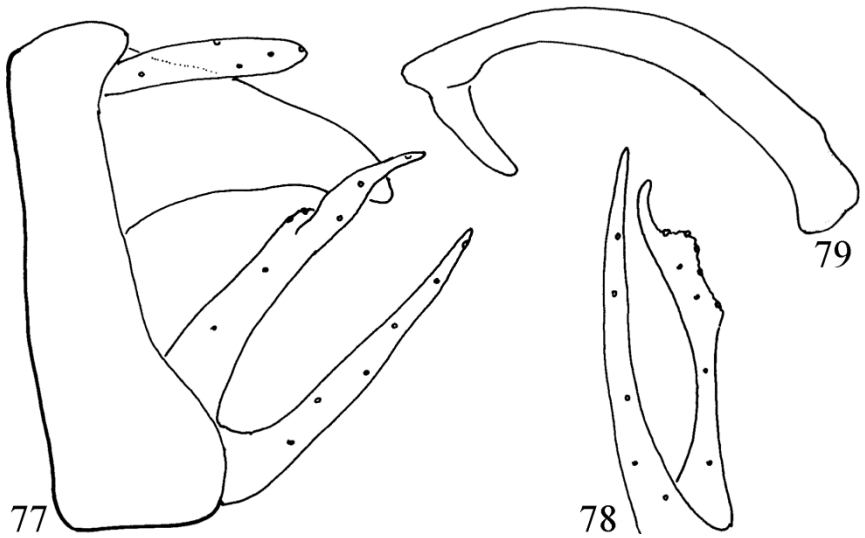
Material examined. Holotype: **Malaysia**, W. Pahang, Genting Tea Estate, 2000 ft, 22–31.X. 1981, light, leg. K. R. Tuck (1 male, OPC).

Diagnosis. This small species has a resemblance to *P. respersellus* (Rambur, 1842), but differs by the tapering, not trapezoid, lateral profile of segment X; by the longer and narrower titillating region of the dorsal arm as well as by the different curvature of the lateral profile of the phallic organ.

Description. Small-sized animal. Forewing length 7 mm. Forewing anastomosis not arranged in straight line, but step-wise due to anterad shifted m-cu crossvein. Hyaline window on middle section of M stem and brown membrane pattern indistinct. On male genitalia the lateral profile of segment X tapering with blunt apex; half longer than cerci and slightly curving downward. Cerci slender. Ventral profile of the dorsal arm of gonopods narrow, without right angled



Figures 74–76. *Parasetodes namgen* sp. nov. Holotype: 74 = left lateral view of genitalia, 75 = left gonopod with apicomesal lobe in ventral perpendicular view, 76 = phallic organ in lateral view.



Figures 77–79. *Parasetodes nokrek* sp. nov. Holotype: 77 = left lateral view of genitalia, 78 = left gonopod with apicomesal lobe in ventral perpendicular view, 79 = phallic organ in lateral view.

apicomesal corner and without middle constriction mesad; ventral arm of gonopods shorter than dorsal arm, straight. Phallic organ arching and gradually broadening from middle; head broader than rest of phallic organ.

Etymology. *pahang* coined from the name of the holotype's *locus typicus*, as a noun in apposition.

***Parasetodes ratnapur* Oláh, sp. nov.**

(Figures 83–85, Map 2)

Leptocella bakeri Banks, 1913: Ulmer 1915: 56–57. "Material: 3 ♂, 1♀ (dies mit schmalem Hinterflügel), Peradeniya, Ceylon, Februar, März, Juni 1911, J. E. Fryer leg., Museum Camridge. Ferner 1 ♀, Peradeniya, Ceylon, 15. Nov. 1911, Dr. Uzel leg., im Museum Wien." Misidentification.

Leptocella bakeri Banks 1913: Ulmer 1951: 415–416. "Kein neues Material; Ich beschreibe hier nach Material aus Ceylon (Coll. Hugh Scott), 1 ♂ der letzteren in meiner Sammlung." Misidentification.

Parasetodes bakeri (Banks, 1913): Schmid 1958: 124–125. "Ceylon, Ratnapura 3–II, 1♂ 2♀♀; Aranayaka 26–I, 3♂♂; Maha Oya 12–III, 1♀, de meme que les wewas: Rukam wewa 14–III, 1♂; Akuressa 6–II, 1♂ 1♀." Misidentification.

Material examined. Holotype: **Ceylon**, Ratnapura 3–II, 1954, leg. F. Schmid (1 male, CNC). Allotype: same as holotype (1 female, CNC).

Diagnosis. Re-examination and redrawing of the holotype as well as the recent collection, examination and drawing of the putative female of the genuine *P. bakeri* (Banks, 1913) confirm that *P. ratnapur* sp. nov. from Sri Lanka is not *P. bakeri* (Banks, 1913) from the Philippines. *Parasetodes ratnapur* sp. nov. has the dorsal arm of the gonopods digitiform on its apical half, not broadened clavate; the ventral arm of the gonopod slender, upward curving and longer than the dorsal arm, not broad, straight and not shorter than the dorsal arm. Moreover the phallic organ is short, less curving, not extremely elongated and curving like at *P. bakeri* (Banks, 1913).

There are even more pronounced divergences in the structure of the female genitalia. The lateral profile of segment X forms a much produced upward directed hook. Such hook formation is present only at *Parasetodes ussuriensis* Martynov, 1935, *Parasetodes sinicus* sp. nov., *Parasetodes madacus* sp. nov. *Parasetodes bakeri* (Banks, 1913) female has not got any hook formation at the terminal of segment X. Its segment X forms the usual slightly downward directed structure.

Rremarks. Ulmer (1915, 1951) and Schmid (1958) described this species from Sri Lanka, both the male and female in details, as *P. bakeri* (Banks, 1913) known from Philippines.

Etymology. *ratnapur* coined from the name of the *locus typicus*, as a noun in apposition.

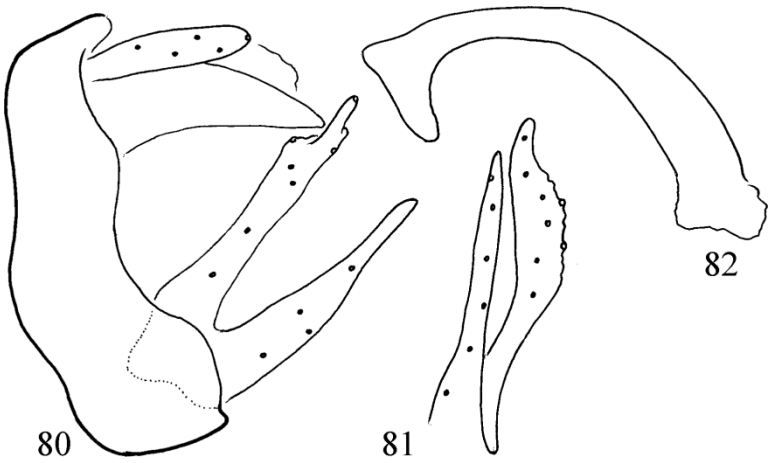
Parasetodes sinicus Oláh, sp. nov.

(Figures 86–91, Map 2)

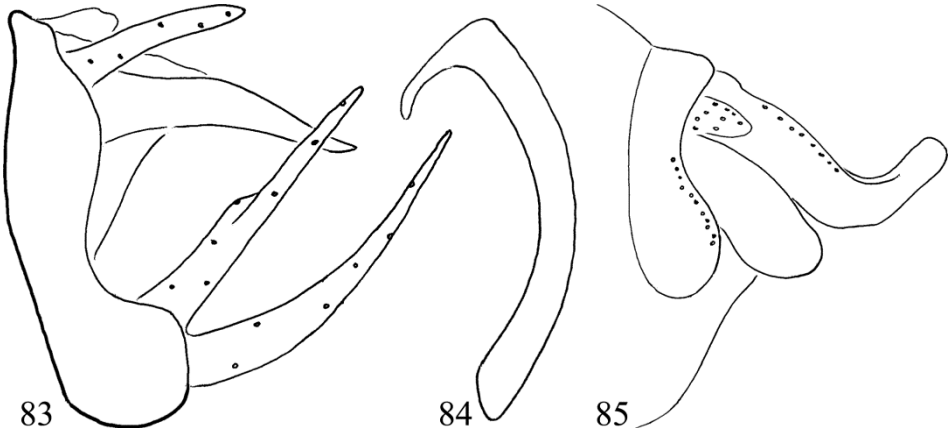
Parasetodes maculatus (Banks, 1911): Yang & Morse 2000: 60–61. 1 male, China, An-hui Province, Wu-hu-Shi (31.23°N, 118.25°E), 4-9.VIII.1987, leg. Li You-wen; 28 females, China, Fu-jian Province, Jiu-qu-xi, 700 m elevation, 30.V.1990, leg. Qi & Yang Liang-fang; 2 males, 1 female, China, Hu-bei Province, Wu-han Shi (30.90°N, 113.55°E), Dong-hu, 11.VII.1990, leg. John Morse & Yang Lian-fang; 3 females, China, An-hui Province, Jin Xian (30.70°N, 118.35°E), Song-cun, Ding-xi-he, 33 kmE of Jin Xian, 120 m elevation, 8.VI.1990, leg. John Morse & Sun Chang-hai; 1 female, China, Fu-jian Province, Shao-wu Shi (27.21°N, 117.27°E), Nan-ban-qiao-cun, Jiao-xi, 40km S.W. of Shao-wu, 420m elevation, 2.VI.1990, leg. John Morse, Yang Lian-fang, and Sun Chang-hai; 6 females, China, Jiang-xi Province, Gui-xi-Xian (28.30°N, 117.20° E), Xi-qi-he, 10km S. of Gui-xi, 30m elevation, 4.VI.1990, leg. John Morse, Yang Lian-fang, and Sun Chang-hai; 4 males, 6 females; China, Gui-zhou Province, Li-bo Xian (25.4°N, 107.8°E), Xiao-qi-kong, 12-13.VII.1994, leg. Du Yu-zhou; 1 male, 2 females, China, Gui-zhou Province, Li-bo Xian (25.4°N, 107.8°E), Da-qi-kong-chu, 6.VII. 1994, leg. Du Yu-zhou. Misidentification.

Material examined. Holotype: **China**, An-hui Province, Wu-hu-Shi (31.23°N, 118.25°E), 4–9.VIII.1987, leg. Li You-wen. Types are deposited in the collections of the Department of Plant Protection, Nan-jing Agricultural University (NAU), Nan-jing, Jiang-su Province, People's Republic of China.

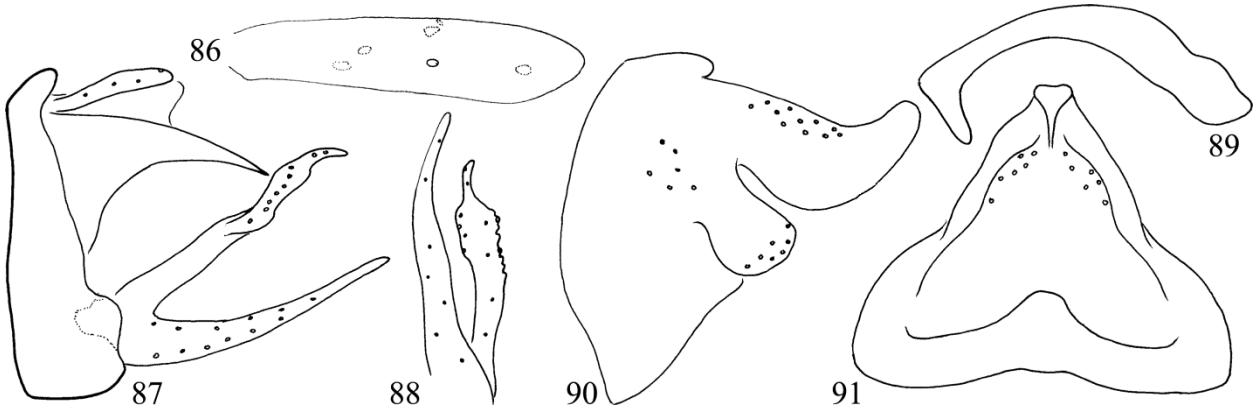
Diagnosis. This new species differs from all the known species by unique character state combination of the tapering and pointed lateral profile of segment X; the slender cerci; the particularly shaped lateral and ventral profile of the dorsal arm of the gonopod; the uniquely patterned phallic organ as well as the special female genital structure with specifically hooked lateral profile of segment X.



Figures 80–82. *Parasetodes pahang* sp. nov. Holotype: 80 = left lateral view of genitalia, 81 = left gonopod with apicomesal lobe in ventral perpendicular view, 82 = phallic organ in lateral view.



Figures 83–84. *Parasetodes ratnapur* sp. nov. Holotype: 83 = left lateral view of genitalia, 84 = phallic organ in lateral view. Figures 85. *Parasetodes ratnapur* sp. nov. Allotype: 85 = left lateral view of female genitalia,



Figures 86–91. *Parasetodes sinicus* sp. nov. Holotype: 86 = forewing brown membrane pattern, 87 = left lateral view of genitalia, 88 = left gonopod with apicomesal lobe in ventral perpendicular view, 89 = phallic organ in lateral view. Allotype: 90 = female genitalia in lateral view, 91 = female genitalia in dorsal view.

Remarks. Specimens from China were described and drawn by Yang and Morse (2000) in details as *P. maculatus* (Banks, 1911), a poorly known species described from India (Bengal). However, in *P. maculatus* (Banks, 1911) apparent forks 1 and 3 on forewing are of equal length while in *P. sinicus* sp. nov. apparent fork 3 is longer; the dorsal arm or the gonopod is robust S-shaped, not slender straight and much longer than the ventral arm as well as apex of phallic organ circular, not oblique ventrad.

Etymology. *sinicus* coined from the country name of the holotype's *locus typicus*.

Parasetodes tumbang Oláh & Mey, sp. nov.

(Figures 92–96, Map 2)

Material examined: Holotype: **Indonesia**, Kalimantan, Kewah, Tumbang Korik, 28.1.1996, leg. A. Kallies (1 male, MfN). Allotype: same as holotype (1 female, MfN).

Diagnosis. This species resembles *P. borneo* sp. nov., collected and described here from the same habitat, but differs by the long apical finger and middle constricted titillating plate on the dorsal arm of the gonopod, the shorter and little stouter ventral arm of the gonopod as well as by the lateral profile of the phallic organ with right-angled ventroapical corner of the head of the phallotheca. The female associated to male by forewing membrane pattern and venation has a rather unique genital structure with particularly elongate, slender upward curving segment X not detected yet at any other known females in the *Parasetodes* genus.

Description. Medium-sized. Forewing length 8 mm. Forewing anastomosis not arranged in straight line, but arched due to anterad shifted m-cu crossvein; hyaline window on middle section of M stem and brown membrane pattern indistinct. In male genitalia the lateral profile of segment X tapering with less pointed apex, longer than cerci, slightly curving downward. Cerci long. Ventral profile of dorsal arm of gonopods with rather long apical finger the titillating plate slightly constricted on middle; ventral arm of gonopods little shorter than dorsal arm, slightly upward curving. Lateral profile of phallic organ arching and broadening on dorsoapical two-thirds, apex monolobed, ventroapical corner right-angled.

The female genitalia have mesal dorsoapical lobe well discernible, short and rounded; dorsal profile of segment X highly elongated triangular, lateral shape slender digitiform, directed and curved upward; lamellae small, directed downward, lateral shape slightly elongated.

Etymology. *tumbang* coined from the name of the holotype's *locus typicus*, as a noun in apposition.

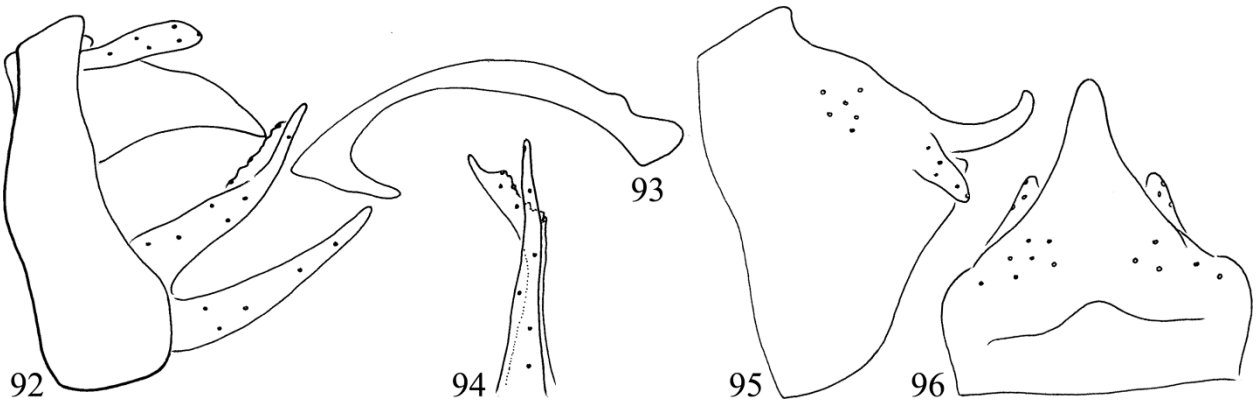
Parasetodes umran Oláh & Mey, sp. nov.

(Figures 97–101, Map 2)

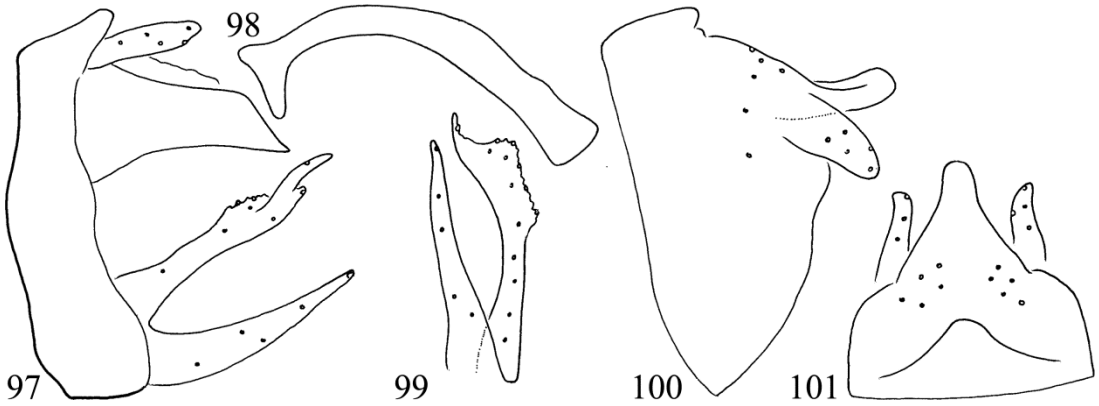
Material examined. Holotype: **India**, Meghalaya, Umran, 33 km N Shillong, 800 m, 25.77N, 91.87E, 14–-23.VII.19997, leg. Afonin & V. Siniaev (1 male, MfN). Allotype: same as holotype (1 female, MfN). Paratypes: same as holotype (6 male, MfN; 4 males, OPC).

Diagnosis. According to the genital structure *P. umran* sp. nov. has resemblance to *P. nokrek* sp. nov. and *P. indicus* sp. nov., but differs from both by the trapezoid head of segment X, by the less broad basad narrowing titillating plate as well as by the lateral profile of the phallic organ with truncated head.

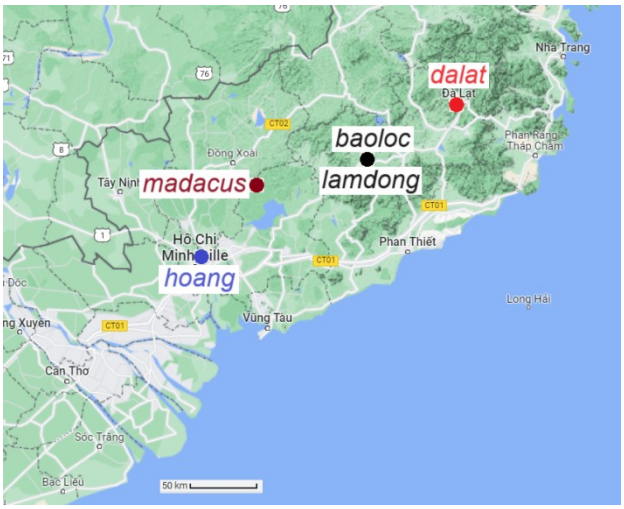
Description. Medium sized animal. Forewing length 8 mm. Forewing anastomosis arranged in arch due to the anteriorly shifted m-cu crossvein. Hyaline window on middle section of M stem indiscernible. In male genitalia the lateral profile of segment X tapering, with trapezoid pointed head, longer than cerci. Titillating plate of dorsal arm of gonopod with long digitiform ending, broad and slightly narrowing basad. Ventral arm of gonopods slightly shorter than the dorsal arm. Lateral profile of phallic organ forms an almost regular tube curving from basad to middle and straight after; phallic head slightly broadening and truncated.



Figures 92–96. *Parasetodes tumbang* sp. nov. Holotype: 92 = left lateral view of genitalia, 93 = left gonopod with apicomesal lobe in ventral perpendicular view, 94 = phallic organ in lateral view. Allotype: 95 = female genitalia in lateral view, 96 = female genitalia in dorsal view.



Figures 97–101. *Parasetodes umran* sp. nov. Holotype: 97 = left lateral view of genitalia, 98 = left gonopod with apicomesal lobe in ventral perpendicular view, 99 = phallic organ in lateral view. Allotype: 100 = female genitalia in lateral view, 101 = female genitalia in dorsal view.



Map 3. *Parasetodes* species in Vietnam

Map 4. *Parasetodes bakeri* localities surrounding Manille, in the Luzon Island of the Philippine Islands.

The female genitalia have mesal dorsoapical lobe well discernible, short and rounded; dorsal profile of segment X highly elongated triangular, lateral shape short digitiform, slightly upward directed; lamellae elongated, as long as segment X, directed downward.

Etymology. *umran* coined from the name of the holotype's *locus typicus*, as a noun in apposition.

Afrotropical Fauna Region

Parasetodes amboas Oláh, sp. nov.

(Figures 102–105, Map 5)

Material examined. Holotype: **Madagascar**, Amboasary (Bac) [25.04°S, 46.379°E], Route Fort Dauphin, III. 1955, leg. Paulian (1 male, OPC).

Diagnosis. This species resembles the other Malagasy species *P. ambovom* sp. nov., but differs by the different, highly reduced pattern of brown membrane patches, as well as by the pointed, not broad and blunt cerci, the different curvature of the phallic organ, and the bilobed apex of the phallic organ with blunt, not pointed apical lobe.

Description. Medium-sized animal. Forewing length 11 mm. Forewing anastomosis arranged in a nearly straight line; the hyaline window on middle section of M stem indistinct; pattern of the brown membrane patches reduced to distinct patches before pterostigma, fork of discoidal cell, fork of sector radius and along anal vein. On male genitalia the lateral profile of segment X tapering with pointed apex; double longer than cerci and slightly curving downward. Cerci pointed. Ventral profile of dorsal arm of gonopods tapering from broad base to apex; ventral arm of gonopods is slightly longer than dorsal arm, straight. In lateral profile, the phallic organ arching and gradually broadening apically, apex bilobed.

Etymology. *amboas*, coined from the name of the *locus typicus*, as a noun in apposition.

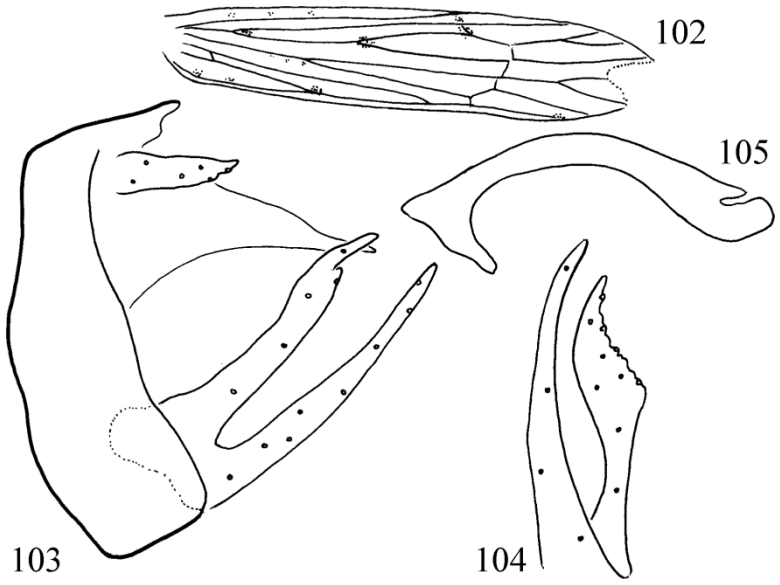
Parasetodes ambovom Oláh, sp. nov.

(Figures 106–109, Map 5)

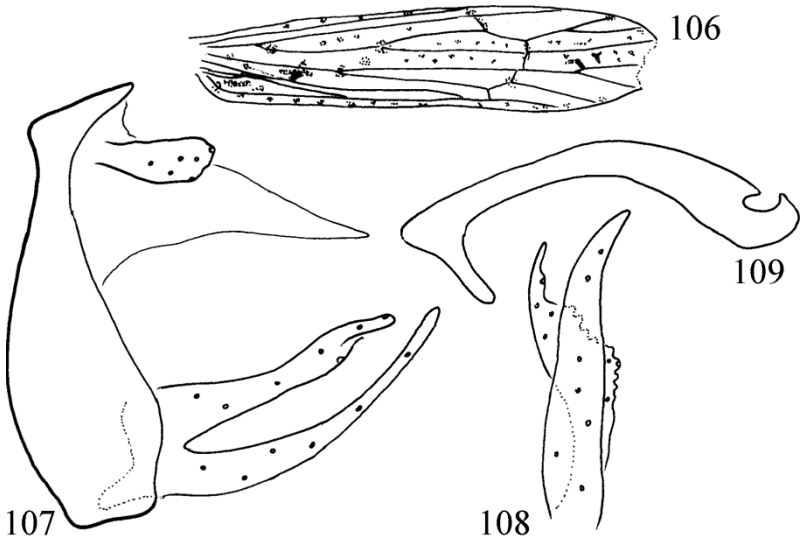
Material examined. Holotype: **Madagascar**, Ambovombe, Tulear Province [25.165°S, 46.09° E], VII. 1952, leg. Paulian (1 male, OPC).

Diagnosis. This species resembles the other Malagasy species *P. amboas* sp. nov., but differs by the different, highly elaborated rich pattern of brown membrane patches, as well as by the short, broad and blunt not pointed cerci, the different curvature of the phallic organ, the bilobed apex of the phallic organ with pointed, not blunt apical lobe.

Description. Medium sized animal. Forewing length 11 mm. Forewing anastomosis arranged in nearly straight line; hyaline window on middle section of M stem indistinct; pattern of brown membrane patches elaborated forming dense patches and spots both on veins and on membrane. On male genitalia the lateral profile of segment X tapering with pointed apex; almost triple longer than cerci and slightly curving downward. Cerci short, broad with rounded apex.



Figures 102–105. *Parasetodes amboas* sp. nov. Holotype: 102 = forewing brown membrane pattern, 103 = left lateral view of genitalia, 104 = left gonopod with apicomesal lobe in ventral perpendicular view, 105 = phallic organ in lateral view.



Figures 106–109. *Parasetodes ambovom* sp. nov. Holotype: 106 = forewing brown membrane pattern, 107 = left lateral view of genitalia, 108 = left gonopod with apicomesal lobe in ventral perpendicular view, 109 = phallic organ in lateral view.

Ventral profile of dorsal arm of gonopods tapers from broad base to apex; ventral arm of gonopods slightly longer than dorsal arm, straight. Lateral profile of phallic organ arching and gradually broadening apically, apex bilobed.

Etymology. *ambovom*, coined from the name of the *locus typicus*, as a noun in apposition.

Parasetodes barnardi Oláh, Johanson, Mey & Salokannel, sp. nov.

(Figures 110–114, Map 5)

Parasetodes sp. Barnard 1934: 331. „Locality. Otjimbombe [near Ruacaná: 17.387°S, 14.21°E], Kunene River, South West Africa [Angola-Namibie border] (K. H. B., March 1923, 1 specimen). Antennae,

> fore-legs, and abdomen missing. Ulmer did not figur the wing of the Sudan species, but there seems to be considerable similarity between his species and the Kunene specimen. Without knowing the genitalia of the latter, it would be unwise to pronounce them either distinct or the same. No specific name is therefore attached."

Material examined. Holotype: **Namibia**, Kunene, Kunene River, 17°21'16.6"S 13°52'54.0" E, 760 m, 24.XI.2019 light leg. Risto Haverinen (1 male, OPC). Allotype: same as holotype (1 female, OPC). Paratypes: Namibia, Popa Falls, Okawango River, 3.IX.1993, leg. F. Koch (2 males, 1 female; ZMB). **South Africa**, KwaZulu Natal. S. Graytown, Umvoti River crossing road at Kinloch Farm, 29.1483°S 30.644°E, 935 m, 20.X.2011, light trap, leg. M. Espeland (1 male, 3 females; SMNH; 1 female, OPC).

Diagnosis. This species has resemblance to *P. maguirus* (Mosely, 1948), but differs by the lateral shape of segment X, just pointed, not with terminal filament, the dorsal arm of the gonopod with distinct and characteristic terminal digitate process, as well as by the lateral profile of the phallic organ simple clavate, not upward curving capitate.

Description. Small-sized animal. Forewing length 8 mm. Forewing anastomosis arranged in a nearly straight line; the hyaline window on middle section of M stem indistinct; pattern of brown membrane patches very elaborated on veins. In male genitalia lateral profile of segment X tapering with pointed apex; almost double longer than cerci and slightly curving downward. Cerci short, broad with tapering apex. Ventral profile of dorsal arm of gonopods with apically narrowing plate terminated in digitate process; ventral arm of gonopods longer than dorsal arm, slightly curving upward. The lateral profile of phallic organ almost straight, gradually broadening apically, apex partially membranous.

Female genitalia is characterized by rounded apical margin of segment X in dorsal view; by reduced narrowing segment X in lateral view; lamellae rather produced and narrowing in dorsal view and downward directed almost vertical in lateral view.

Etymology. Relying on the excellent published wing drawings of K. H. Barnard with exact forewing membrane pattern and compared them to our male and female specimens collected along the Kunene River and from other localities recently we are sure that the Barnard specimen and our specimens represent the same species. Here we dedicate this beautiful new species to the name of the first collector.

Remarks. This new species was already partially described by Barnard (1934) as *Parasetodes* sp. from an injured specimen without an abdomen, but with a very distinct drawing of the forewing pattern. We have recollected this species both from Namibia and South Africa and associated it with the elaborated identical forewing pattern.

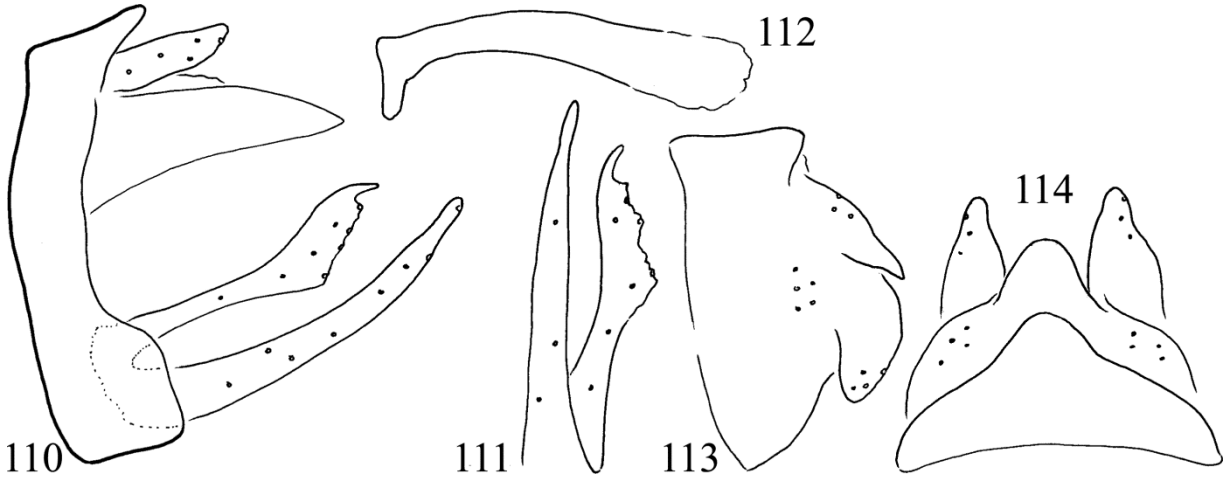
***Parasetodes caprivi* Mey & Oláh, sp. nov.**

(Figures 115–117, Map 5)

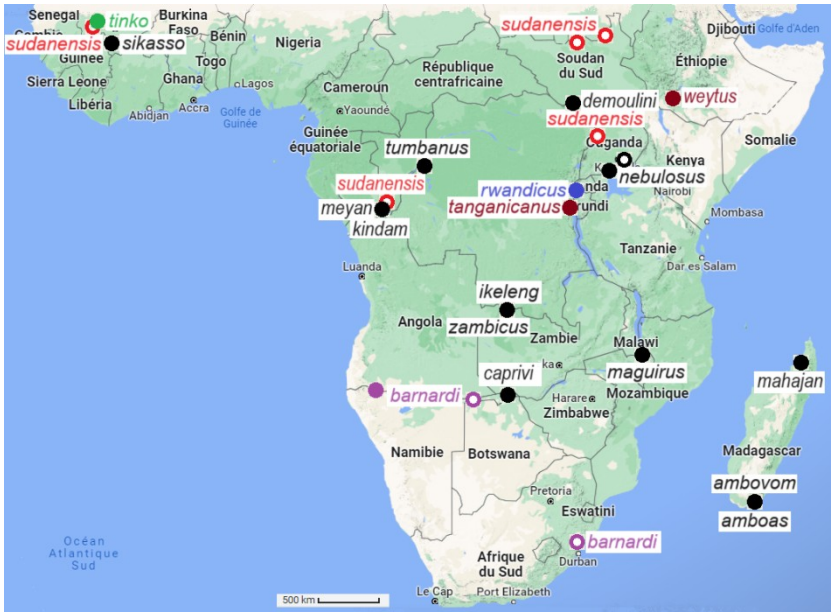
Material examined. Holotype: **Namibia,** E. Caprivi Distr., 15 km NW Ngoma, 17°46'S 24° 35'E, 26.II.2006, leg. H. Hacker & H-P. Schreier (1 male, holotype male genitalia slide, Mey39/23; MfN). Paratypes: same as holotype (1 male in alcohol, 1 male pinned; MfN).

Diagnosis. This species resembles *P. nebulosus* Kimmins, 1956, but differs by the lateral shape of segment X, less pointed, lateral profile of dorsal arm of the gonopods less S-shaped curved, ventral arm of the gonopods longer than the dorsal arm, not equal, ventral arm of the gonopods almost straight, not curving upward, phallic organ longer with differently patterned bilobed apex.

Description. Small sized animal with forewing *ca.* 7 mm. In male genitalia the lateral profile of segment X tapering particularly along terminal region; double longer than cerci. Cerci short, broad with rounded apex. Ventral profile of dorsal arm of gonopods slightly S-shaped and gradually



Figures 110–114. *Parasetodes barnardi* sp. nov. Holotype: 110 = left lateral view of genitalia, 111 = left gonopod with apicomesal lobe in ventral perpendicular view, 112 = phallic organ in lateral view. Allotype: 113 = female genitalia in lateral view, 114 = female genitalia in dorsal view.



Map 5. *Parasetodes* species of the Afrotropical Faunal Region

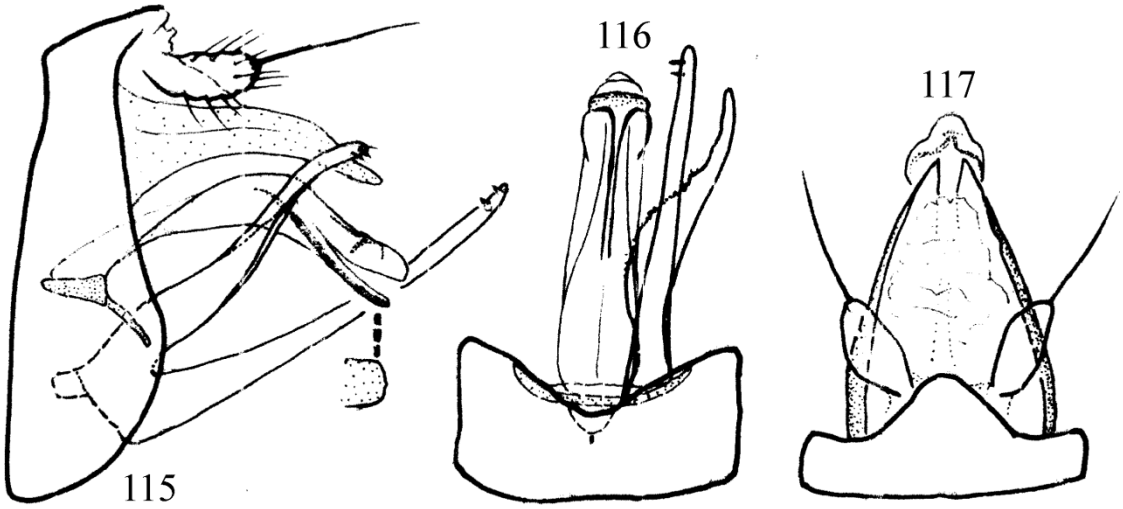
tapering from the middle to apex; ventral arm of gonopods longer than dorsal arm, almost straight. The lateral profile of phallic organ arching, gradually broadening from basal to middle, ending in a bilobed apex.

Etymology. *caprivi* coined from the name of the *locus typicus*, a noun in apposition.

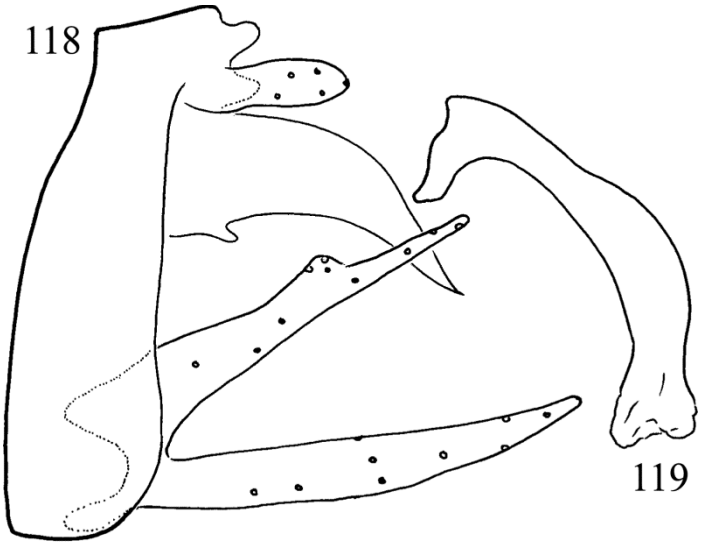
***Parasetodes demoulini* (Jacquemart, 1966) comb. nov.**

(Figures 118–11, Map 5)

Triaenodes demoulini Jacquemart, 1966: 41. "Holotype ♂, 10. XI. 1949 (De Saeger), camp de Bagbele, lisière de galerie forestière humide." Garamba National Park, Democratic Republic of the Congo.



Figures 115–117. *Parasetodes caprivi* sp. nov. Holotype: 115 = left lateral view of genitalia, 116 = genitalia in ventral view, 117 = genitalia in dorsal view.



Figures 118–119. *Parasetodes demoulini* (Jacquemart, 1966). Male: 118 = left lateral view of genitalia, 119 = phallic organ in lateral view.

Remarks. This species was very briefly described by Jacquemart (1966) as a new *Triaenodes* taxon. However, it was supplied with a rather detailed lateral view of the male genitalia and its structure clearly demonstrates that it is a genuine *Parasetodes* species. Here we transfer it to *Parasetodes*, *P. demoulini* (Jacquemart, 1966) **comb**. **nov**. According to the lateral profile of the gonopods, particularly the lateral shape of the dorsal arm of the gonopod this species has resemblance to the Afrotropical species of *P. meyan* sp. nov., *P. nebulosus* Kimmins, 1956 and *P. sikasso* sp. nov., but differs from all the three species by the lateral profile of the phallic organ. More reliable identity will be confirmed by the knowledge of the unknown ventral profile of the dorsal arm of gonopod.

***Parasetodes ikeleng* Oláh & Johanson, sp. nov.**

(Figures 120–122, Map 5)

Material examined. Holotype: **Zambia**, North-Western Province, Ikelenge District, Hillwood Farm, 1395 m, 11.2669°S, 24.3166°E, loc#Tr08, stream at campsite, in riverine forest, light trap, 11.XII.2011, leg. M. Espeland & R. Vila (1 female, SMNH, NHRS-HISI, 000001207). Paratypes: same as holotype (1 female, SMNH; 1 female, OPC).

Diagnosis. According to both the brown membrane pattern and the female genital structure this species differs from its cohabitant *P. zambicus* sp. nov. and from all the known *Parasetodes* females. The unique, almost regular semicircular lateral profile of the lamellae combined with the subtriangular dorsal profile of segment X makes the delineation of *P. ikeleng* female easy.

Description. Small species with forewing 7 mm. The genitalia with mesal dorsoapical lobe rather narrowing; dorsal profile of segment X almost triangular, lateral shape is digitiform; lamellae short, lateral shape simple semicircular.

Remarks. This species was collected form the same habitat as the *Parasetodes zambicus* sp. nov., but without any male specimen. Nevertheless, the female genitalia exhibit significant character state differences. Here we describe *Parasetodes ikeleng* sp. nov. as a distinct, independent species in the hope that its male will be collected sometimes in a more science respectful period. We have distinguished 12 brown patches on the forewing.

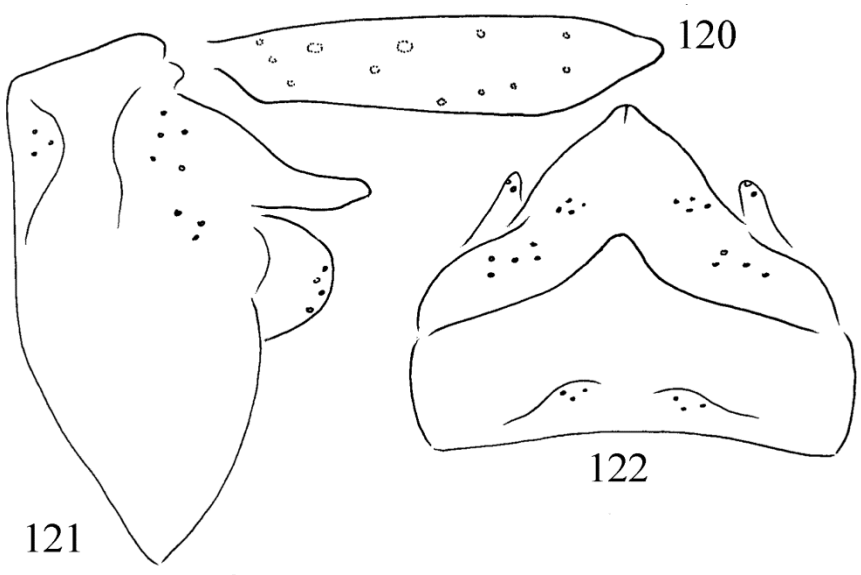
Etymology. *ikeleng* coined from the name of the s *locus typicus*, as a noun in apposition.

***Parasetodes kindam* Oláh, sp. nov.**

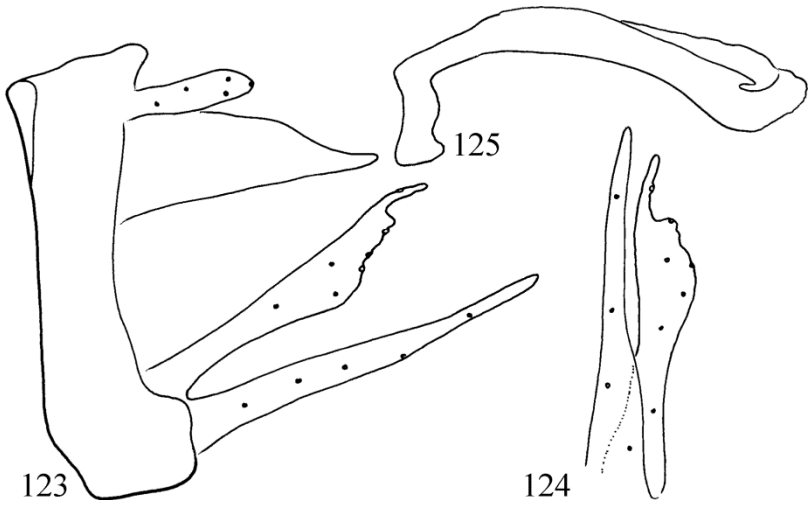
(Figures 123–125, Map 5)

Material examined. Holotype: **Republic of Congo** (Congo-Brazzaville), Kindamba [3.743°S, 14.525°E], Meya, Lovolo River, 12.XI.1963, light leg. Balogh & Zicsi (1 male, OPC). Paratype: same as holotype (1 male, OPC). Republic of Congo (Congo-Brazzaville), Brazzaville, 21.XII. 1963, light leg. Endrődy (1 male, OPC).

Diagnosis. This species resembles *P. barnardi* sp. nov., but differs by the mesal pattern of the dorsal arm of gonopod in ventral view and by the phallic organ with bilobed apex.



Figures 120–122. *Parasetodes ikeleng* sp. nov. Holotype female: 120 = forewing brown membrane pattern, 121 = female genitalia in lateral view, 122 = female genitalia in dorsal view.



Figures 123–125. *Parasetodes kindam* sp. nov. Holotype: 123 = left lateral view of genitalia, 124 = left gonopod with apicomesal lobe in ventral perpendicular view, 125 = phallic organ in lateral view.

Description. Small-sized animal. Forewing length 8 mm. Forewing anastomosis not arranged in straight line, but arched due to anterad shifted m-cu crossvein; hyaline window on middle section of M stem and brown membrane pattern indistinct. Male genitalia in lateral profile of segment X tapering with pointed apex; double as long as cerci. Cerci short. Ventral profile of dorsal arm of gonopods exhibits downward broadening mesal lobe with single small mesal constriction and long digitiform apical process; ventral arm of gonopods slightly longer than dorsal arm, straight. Lateral profile of phallic organ arching and significantly broadening on dorsoapical half, apex bilobed.

Etymology. *kindam* coined from the name of the holotype's *locus typicus*, as a noun in apposition.

Parasetodes maguirus (Mosely, 1948)

(Figures 126–128, Map 5)

Leptocerus maguirus Mosely, 1948: 32–34. Lake Nyasa, Fort Maguire [southern part of Lake Malawi]: 30.VI.–1.VII.1946. Insect collected in spirit and almost completely bleached white.

Remark. Based upon the almost straight, not curving stem of phallotheca, with an upward directed phallic head, and ventral profile of the truncated dorsal arm head, this is a distinct species of Lake Nyasa.

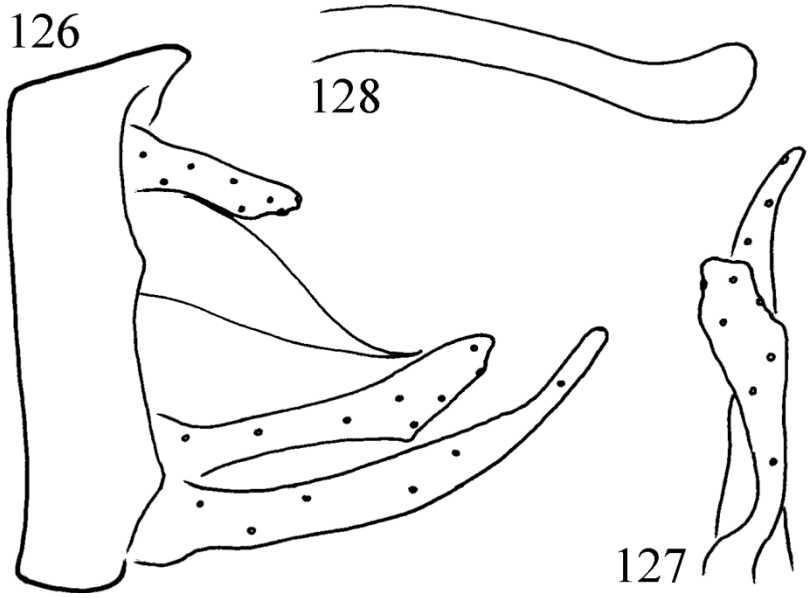
Parasetodes mahajan Oláh & Johanson, sp. nov.

(Figures 129–132, Map 5)

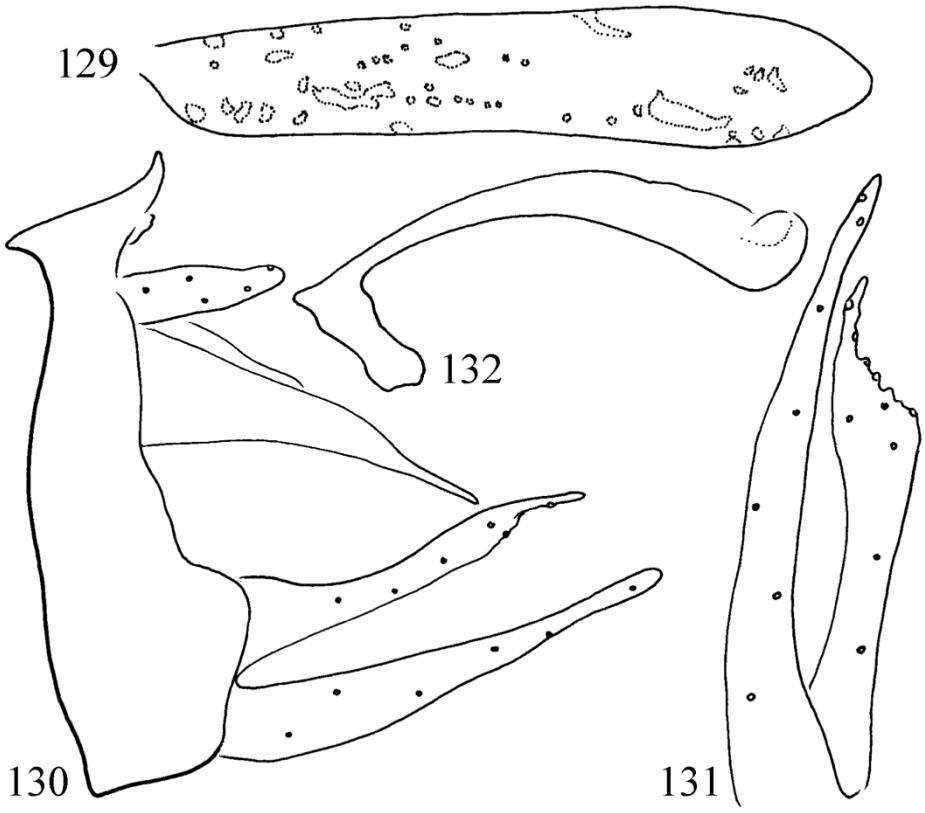
Material examined. Holotype: **Madagascar**, Mahajanga, Manongarivo NP, Beraty, river Antsambarahy on bridge, 21.XI.2012, 22W black light trap, 14.03715°S, 48.22945°E, leg. J. Bergsten, R. Bukontaite, T. Ranarilalatiana & J. H. Randriamihaja (1 male, SMNH).

Diagnosis. According to the genital structure this new species resembles the other Malagasy species *P. amboas* sp. nov. and *P. ambovom* sp. nov., but differs by the different and most elaborated pattern of brown membrane patches, as well as by the capitate apex of the phallic organ. Unfortunately, the fine structures of the phallic head are not discernible clearly in all the three Madagascar species.

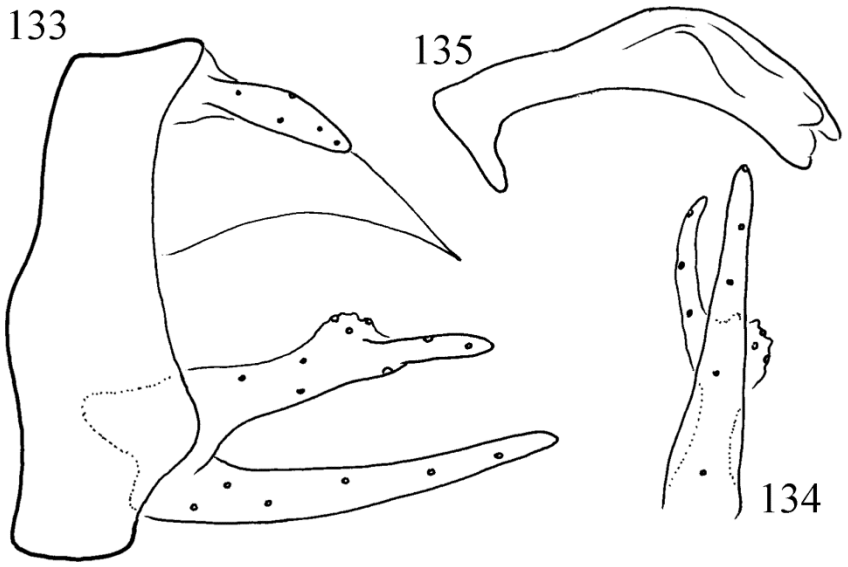
Description. Medium-sized animal. Forewing length 10 mm. Forewing anastomosis arranged in nearly straight line; hyaline window on middle section of M stem indistinct; pattern of the brown



Figures 126–128. *Parasetodes maguirus* (Mosely,1948). Reproduced from original drawings: 126 = left lateral view of genitalia, 127 = left gonopod with apicomesal lobe in dorsal perpendicular view, 128 = phallic organ in lateral view.



Figures 129–132. *Parasetodes mahajan* sp. nov. Holotype: 1129 = forewing brown membrane pattern, 130 = left lateral view of genitalia, 131 = left gonopod with apicomesal lobe in ventral perpendicular view, 132 = phallic organ in lateral view.



Figures 133–135. *Parasetodes meyan* sp. nov. Holotype: 133 = left lateral view of genitalia, 134 = left gonopod with apicomesal lobe in ventral perpendicular view, 135 = phallic organ in lateral view.

membrane patches is much elaborated. In lateral profile male genitalia of segment X tapering with filiform and pointed apical region; more than double the length of cerci and slightly curving downward. Cerci narrowing apicad. Ventral profile of dorsal arm of the gonopods tapering from broad base to apex; mesal dentate margin concave; ventral arm of gonopods slightly longer than dorsal arm, straight. In lateral profile phallic organ arching and gradually broadening apically, apex clavate.

Etymology. *mahajan* coined from the name of the *locus typicus*, as a noun in apposition.

***Parasetodes meyan* Oláh, sp. nov.**

(Figures 133–135, Map 5)

Material examined. Holotype: **Republic of Congo** (Congo-Brazzaville), Kindamba [3.743°S, 14.525°E], Meya, 10.XI.1963, light leg. Balogh & Zicsi (1 male, OPC).

Diagnosis. This species resembles *P. zambicus* sp. nov., but differs by the less produced tergite IX, the segment X with needle-pointed apex, the rounded mesal lobe on the dorsal arm of gonopod and by the phallic organ with trilobed apex.

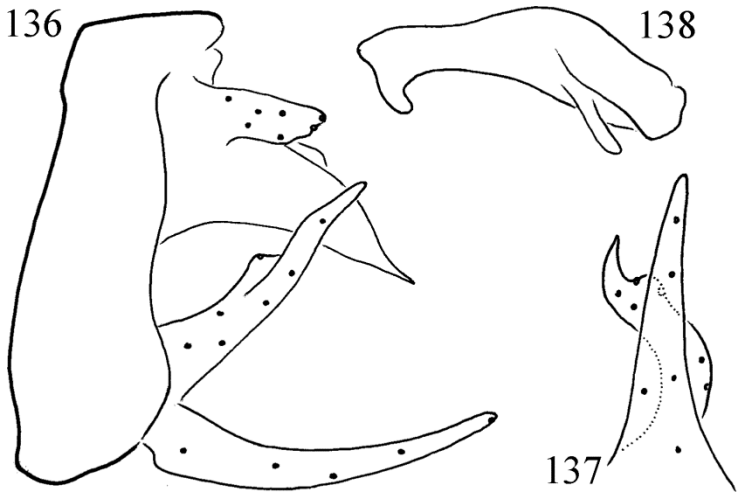
Description. Small-sized animal. Forewing length 8 mm. Forewing anastomosis not arranged in a straight line, but arched due to anterad shifted m-cu crossvein; hyaline window on middle section of M stem and brown membrane pattern indistinct. Male genitalia in lateral profile of segment X tapering with pointed apex; double as long as cerci, slightly curving downward. Cerci short. Ventral profile of dorsal arm of gonopods with rounded mesal lobe and long digitiform apical process; ventral arm of gonopods slightly longer than dorsal arm, straight. Lateral profile of phallic organ arching and significantly broadening on dorsoapical half, apex trilobed.

Etymology. *meyan* coined from the name of the *locus typicus*, as a noun in apposition.

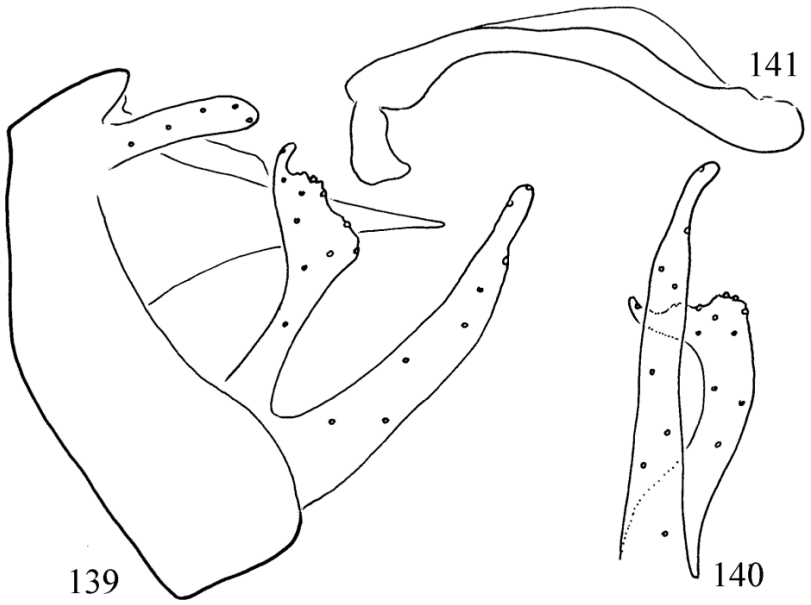
***Parasetodes nebulosus* Kimmins, 1956**

(Figures 136–138, Map 5)

Parasetosus nebulosa Kimmins, 1956: 123–124. „Uganda: L. Viktoria, Kagera Bay [0.944°S, 31.778°E], 12. V. 1954, 1 ♂ (N. E. Hickin); Jinja [0.437°N, 33.192°E], VI. 1954, 1 ♂, 2♀ (P. S. Corbet). ♂ Holotype (Kagera Bay, pinned, with abdomen mounted as microscope preparation in Canada balsam) in Brit. Mus. (Nat. Hist.), para



Figures 136–138. *Parasetodes nebulosus* Kimmins, 1956. Reproduced from original drawings: 136 = left lateral view of the genitalia, 137 = left gonopod with apicomesal lobe in ventral perpendicular view, 138 = phallic organ in lateral view.



Figures 139–141. *Parasetodes rwandicus* sp. nov. Holotype: 139 = left lateral view of the genitalia, 140 = left gonopod with apicomesal lobe in ventral perpendicular view, 141 = phallic organ in lateral view.

types (in fluid) int he E.A.F.R.O. collection, Jinja and in Brit. Mus. (Nat. Hist.).” „This species is closely related to the two other described African species, *P. sudanensis* Ulmer and *P. maguira* (Mosely), the latter being here transferred from its original genus *Leptocerus*, in which it was clearly misplaced, having regard to the venation of the hind wing and the structure of the genitalia. It may be distinguished from both by the form of the upper branch of the clasper, which in *sudanensis* is stouter, suddenly constricted near the apex in side view. In *maguira* the upper branch is dilated and truncate at the apex in dorsal view, and in side view expanded on its ventral surface.”

Remarks. This species resembles *P. meyan* sp. nov., but differs by the broader cerci; the ventral profile of the dorsal arm of gonopods being S-shaped with reduced rounded mesal lobe; its phallic organ with a unique ventral rod-like process.

Parasetodes rwandicus Oláh & Mey, sp. nov.

(Figures 139–141, Map 5)

Material examined. Holotype: **Rwanda**, Butare, University Guesthouse, 2.35°S, 29.44°E, 11.IX.2002, light leg. L. Kühne (1 male, ZMB). Paratypes: same as holotype (3 males, ZMB; 2 males, OPC).

Diagnosis. This species is unique and characteristic by the straight, narrowing and needle-like pointed segment X and by the ventral profile of the dorsal arm of gonopods with its almost right-angled terminal process

Description. Medium-sized. Forewing length 9 mm. Forewing anastomosis not arranged in straight line, but arched due to anterad shifted m-cu crossvein; hyaline window on middle section of M stem lacking, brown membrane pattern indistinct. In male genitalia the lateral profile of segment X tapering with pointed apex; double as long as cerci, straight, not curving downward. Cerci broad. Ventral profile of dorsal arm of gonopods with short mesal lobe and right-angled terminal process; ventral arm of gonopods slightly longer than dorsal arm, straight. Lateral profile of phallic organ arching and significantly broadening on dorsoapical half, with mesal ridge.

Etymology. *rwandicus* named after the *locus typicus*.

Parasetodes sikasso Oláh & Johanson, sp. nov.

(Figures 142–146, Map 5)

Material examined. Holotype: **République du Mali.** Sikasso Region, Lac du Barrage de Sélingue, 11°34’33”N, 8°10’26”W, 21–22.VIII. 1980, light, leg. W. Tobias (1 male, SMNH). Allotype: (1 female, SMNH). Paratypes: same as holotype (22 males, 17 females; SMNH, 10 males, 10 females; OPC). République du Mali: Barrage de Manantali [13.203°N, 10.455°W], 1000 m en aval du barrage. Cité de trois cases, 4-6.X.1993, leg. W. Tobias (1 male, SMNH; 1 male, OPC). République du Mali: Bafing at Tinko [13.4984°N, 10.7555°W], 9.X.1992, 18:50–20:50h, leg. W. Tobias (1 male, SMNH).

Diagnosis. This species resembles *P. zambicus* sp. nov., but differs by the less produced tergite IX; by the downward narrowing mesal lobe on the dorsal arm of the gonopods, and by the more slender phallic organ.

Description. Medium-sized. Forewing length 9 mm. Forewing anastomosis not arranged in a straight line, but arched due to anterad shifted m-cu crossvein; hyaline window on middle section of M stem and brown membrane pattern indistinct. In male genitalia lateral profile of segment X tapering with less pointed apex; double as long as cerci, slightly curving downward. Cerci long. Ventral profile of dorsal arm of gonopods with gradually downward narrowing mesal lobe and medium long digitiform apical process; ventral arm of gonopods shorter than dorsal arm, upward curving. Lateral profile of phallic organ arching and slightly broadening on dorsoapical two-thirds, apex monolobed.

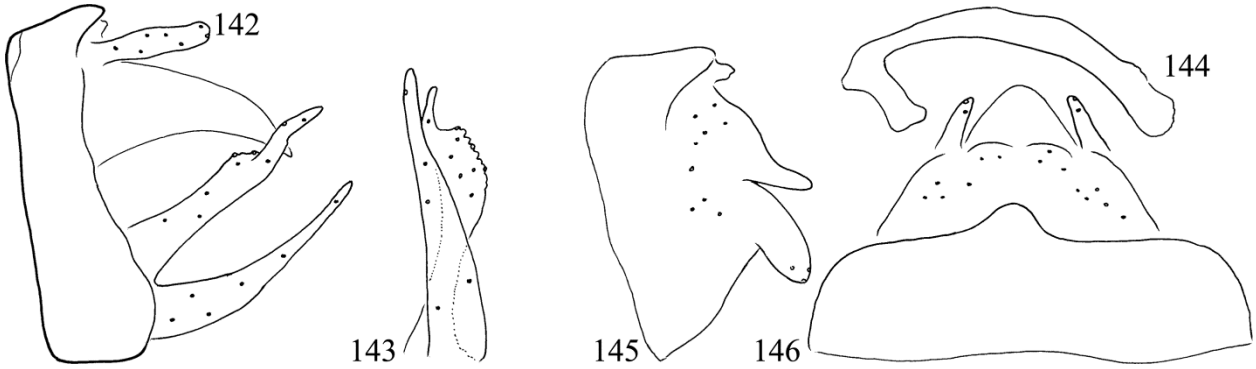
The female genitalia have mesal dorsoapical lobe short and rounded; dorsal profile of segment X rounded triangular, lateral shape digitiform and directed downward; lamellae directed downward, lateral shape slightly elongated.

Etymology. *sikasso* coined from the name of the holotype’s *locus typicus*, as a noun in apposition.

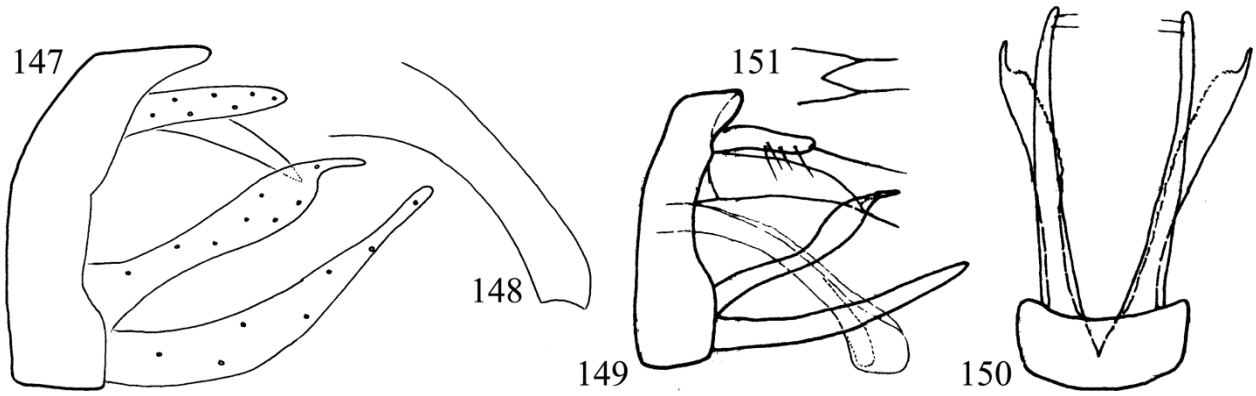
Parasetodes sudanensis Ulmer, 1922

(Figures 147–153, Map 5)

Parasetodes sudanensis Ulmer, 1922: 47. “An Material für die folgenden Mitteilungen über Sudan-Trichopteren stand mir zur Verfügung: 1. Eine Sammlung von Spiritusexemplaren, die auf einer Jagdexpedition zum Weiβen Nil mittels eines Dahlschen Lichtfangapparates durch Herren Hesselberger im Februar 1912 gefangen wurden; dies Material gehört der Zoologischen Sammlung des Bayerischen Staates in München. 2. Ein reiche Sammlung ebenfalls von Spiritus-exemplaren, gesammelt auf der „Expedition von Prof. Dr. A Koenig in den anglo-ägyptischen Sudan, Frühjahr



Figures 142–146. *Parasetodes sikasso* sp. nov. Holotype: 142 = left lateral view of genitalia, 143 = left gonopod with apicomesal lobe in ventral perpendicular view, 144 = phallic organ in lateral view. Allotype: 145 = female genitalia in lateral view, 146 = female genitalia in dorsal view.



Figures 147–150. *Parasetodes sudanensis* Ulmer,1922. Reproduced from original drawings: 147 = left lateral view of the genitalia, 148 = phallic organ in lateral view. Lectotype: 149 = left lateral view of genitalia, 150 = gonopods with apicomesal lobe of dorsal arm in ventral perpendicular view 151 = dorsal view of the head of segment X.

Figures 152–153. *Parasetodes sudanensis* Ulmer, 1922. Female from the syntype series: 152 = left lateral view of genitalia, 153 = dorsal view of the apex of segment X.

1913" durch die Herren H. Freiherr Geyr von Schweppenburg und Dr. O.le Roi; diese Sammlung ist Eigentum des Museums Koenig in Bonn a. Rh. und wird mir weiter unten immer als Coll. Roi bezeichnet. 3. Eine Sammlung trockener Exemplare im Besitze des Zoologischen Museums Wien; dieses Material wurde von Herrn Prof. R. Ebner im Februar, März und April 1914 zusammengebracht." 57–59: „Material: 1.(first) Coll. le Roi: 1♂ Meschra Zeraf (B.el Ab.) 23.II.1913; 2♂ 1♀ Bahr el Ghazal [9.3266°N, 29.86°E], 5.III.; 1♂ Lul [9.765°N, 31.95°E] (B el Ab.) 18.III.; 1♂ Gebel Achmed Aga (B. el Ab.) 22.III. 2.(second) Coll. Ebner: 1♂ bei Tonga, am Dampler, 17.IV.1914."

Leptocerus maguirus Mosely, 1948: Jacquemart 1959: 113–114. "Matériel recueilli par M. J. Verbeke au lac Albert, Parcs Nationaux du Congo Belge: Kase

nyi [1.388°N, 30.438°E], 21.VI.1953, 23.VI. 1953, 25.VI.1953, 28.VI.1953, 15.XII.1953. Sabe, 16.XII.1953. Bezaha, 19.XII.1953. Mahagi [2.156° N, 31.236°E], 15.II.1954. Le materiel étudié est déposé dans les collections de l'Institut royal des Sciences naturelles de Belgique." Misidentification.

Parasetodes respersellus (Rambur, 1842): Malicky 1983: 270. Drawings prepared by Malicky for his Atlas of European Trichoptera from unknown specimen represent *Parasetodes sudanensis*, not *Parasetodes respersellus*. Misidentification.

Parasetodes respersellus (Rambur, 1842): Malicky 2004: 341. Drawings prepared by Malicky for his Atlas of European Trichoptera from unknown specimen represent *Parasetodes sudanensis*, not *Parasetodes respersellus*. Misidentification.

Material examined. Syntype series: 2 males, 1 female, "Bahr el Ghasal, 5.3.1913, Dr. Le Roi leg"/" Zoologisches Museum Hamburg, coll. G. Ulmer, Eingangs Nr. 6 - 1963"/ "Genitalia slide Mey 55/23 and 56/23". The material is in alcohol, but completely de-coloured. The specimens are transparent, difficult to handle. The abdomens of this old material could not be examined anymore. Staining did also not work. We have made drawings, as we saw the structures in alcohol. The remains of the abdomina were embedded into Euparal and mounted on glass slides. We have chosen the male with the genitalia slide as lectotype. The other are paralectotypes.

Remarks. Here we reproduce Ulmer's original drawing as well as present our drawings of the lectotype male and of the female. It is remarkable how well the original lateral drawing of Ulmer and our lateral drawing correspond. The ventral view of the gonopods, particularly the ventral profile of the dorsal arm of gonopods missing in the original drawing were drawn from the lectotype.

Re-diagnosis. The mesal dentate titillating structure of the dorsal arm of the gonopod, the probable speciation trait of the *Parasetodes* genus is a very characteristic elongated narrow plate with mesal dentation and with a short apicolateral slender finger in *P. sudanensis*. This particular structure clearly delineates *Parasetodes sudanensis* Ulmer, 1922 from all its relatives.

The female genitalia with mesal dorsoapical lobe rounded in lateral view; dorsal profile of segment X regular short semicircular, lateral shape straight with sharply pointed apex; lamellae produced, downwardly directed, with narrowing apex.

Parasetodes tanganicanus Marlier, 1956 stat. nov.

(Map 5)

Parasetodes sudanensis tanganicana Marlier, 1956: 359. „Provenance: Holotype mâle: Uvira, lac Tanganika, à la lumière, 22.V.1952. *Parasetodes sudanensis tanganicana* est capturé régulièrement à la lumière à Uvira (côte de sable et de galets) au bord du lac Tanganika. „La sous-espèce *tanganicana* est fondée sur la coloration des ailes."

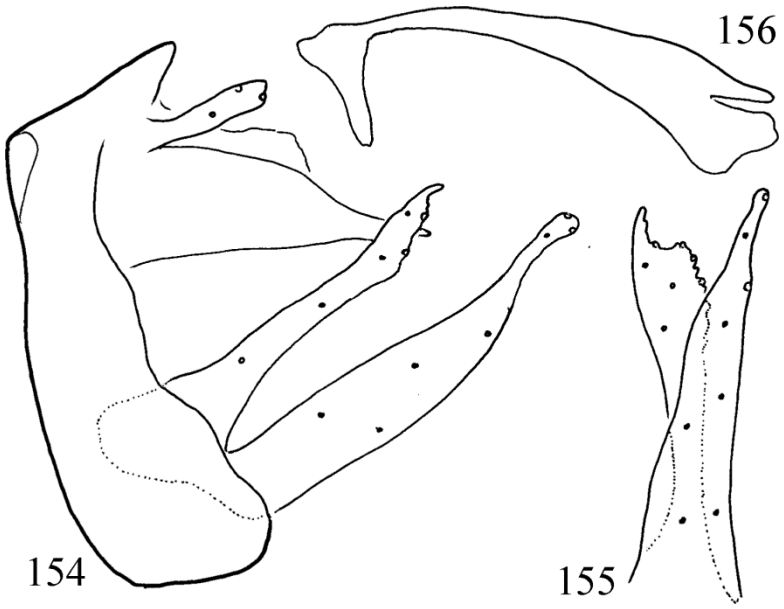
Remarks. The subspecies was established upon the presence of a unique forewing colour and pattern. Only wind drawings are available, nevertheless we increased its taxonomic status to species rank according to previous taxonomic practise elevating subspecies and race to species level when appropriate (Oláh *et al.* 2018).

Parasetodes tinko Oláh & Johanson, sp. nov.

(Figures 154–156, Map 5)

Material examined. Holotype: **République du Mali,** Kayes Region, Bafing River, at Tinko, 13.4984°N, 10.7555°W, 11.VIII.1993, light trap, 20:30–22:30h, leg. W. Tobias (1 male, SMNH). Paratype: same as holotype (1 male, OPC).

Diagnosis. This species resembles *P. sikasso* sp. nov., but differs by the small, not long cerci; by the straight, not downward curving segment X, the small apical digitate process on the dorsal arm of gonopod, the ventral arm of gonopod capitate, longer than the dorsal arm, not narrowing and shorter than the dorsal arm, the lateral profile of the phallic organ very thin basally and broadening apicad and with bilobed head.



Figures 154–156. *Parasetodes tinko* sp. nov. Holotype: 154 = left lateral view of genitalia, 155 = left gonopod with apicomesal lobe in ventral perpendicular view, 156 = phallic organ in lateral view.

Description. Small-sized. Forewing length 8 mm. Forewing anastomosis not arranged in straight line, instead arched due to anterad shifted m-cu crossvein; hyaline window on middle section of M stem lacking, brown membrane pattern indiscernible. In male genitalia the lateral profile of segment X tapering with pointed apex; two times longer than cerci and straight, not curving downward. Cerci small. Ventral profile of dorsal arm of gonopods with gradually downward narrowing mesal lobe and small digitiform apical process; ventral arm of gonopods slightly longer than dorsal arm, straight and slightly capitate. The lateral profile of phallic organ arching and significantly broadening apicad, with bilobed apex.

Etymology. *tinko* coined from the name of the *locus typicus*, as a noun in apposition.

Parasetodes tumbanus Marlier, 1958

(Figures 157–159, Map 5)

Parasetodes tumbana Marlier, 1958: 304–30. Holotype: Lake Tumba [0.7286°S, 18.1225°E], a shallow lake in northwestern part of the Democratic Republic of the Congo, in the Bikoro Territory of the Province of Équateur.

Remarks. A distinct species with slightly bilobed cerci; elongated, narrow mesal plate on the dorsal arm of gonopods and the straight phallic organ with clavate head.

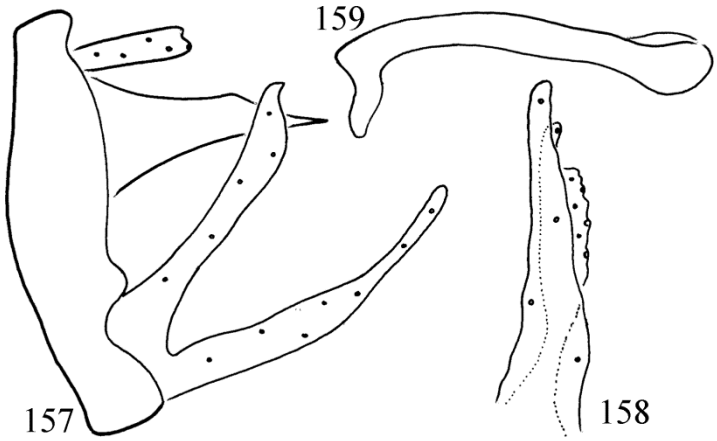
Parasetodes weytus Mey & Oláh, sp. nov.

(Figures 160–162, Map 5)

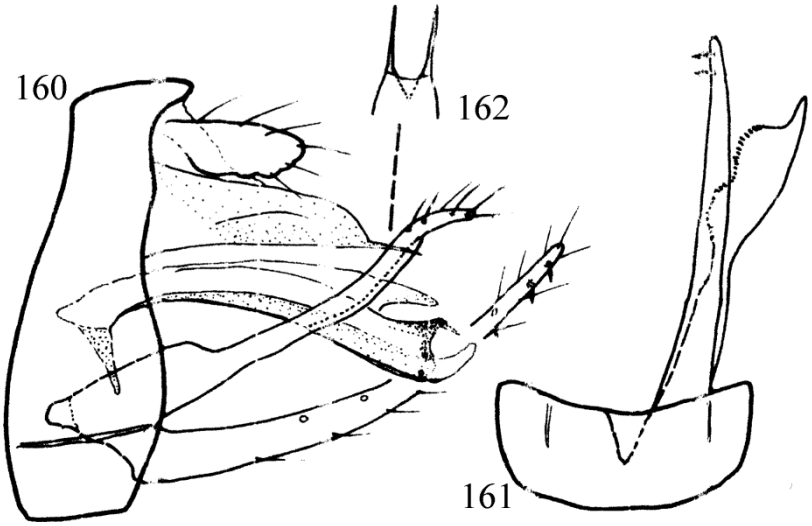
Material examined. Holotype: **Ethiopia**, Southern Province, 6 km ENE Weyto, Segen River, 05°21’18”N, 37°02’34”E, 600 m, 11.XI. 2010, leg. H. Hacker & H.-P. Schreiner (1 male, ZMB, pinned). Paratypes: same as holotype (2 males, ZMB, pinned).

Diagnosis. This species resembles *P. barnardi* sp. nov., but differs by the lateral shape of segment X, having long terminal filament; by lateral profile of dorsal arm of the gonopods without pronounced ventral angle, as well as by lateral profile of the phallic organ with trilobed apex.

Description. Small sized animal with forewing length 7 mm. In male genitalia lateral profile of segment X slightly tapering with elongated pointed filament; together with the long terminal filament almost double longer than cerci. Cerci



Figures 157–159. *Parasetodes tumbanus* Marliers, 1958. Reproduced from original drawings: 157 = left lateral view of genitalia, 158 = left gonopod with apicomesal lobe in ventral perpendicular view, 159 = phallic organ in lateral view.



Figures 160–162. *Parasetodes weytus*. Holotype: 160 = left lateral view of genitalia, 161 = gonopods with apicomesal lobe of dorsal arm in ventral perpendicular view 162 = dorsal view of the head of segment X.

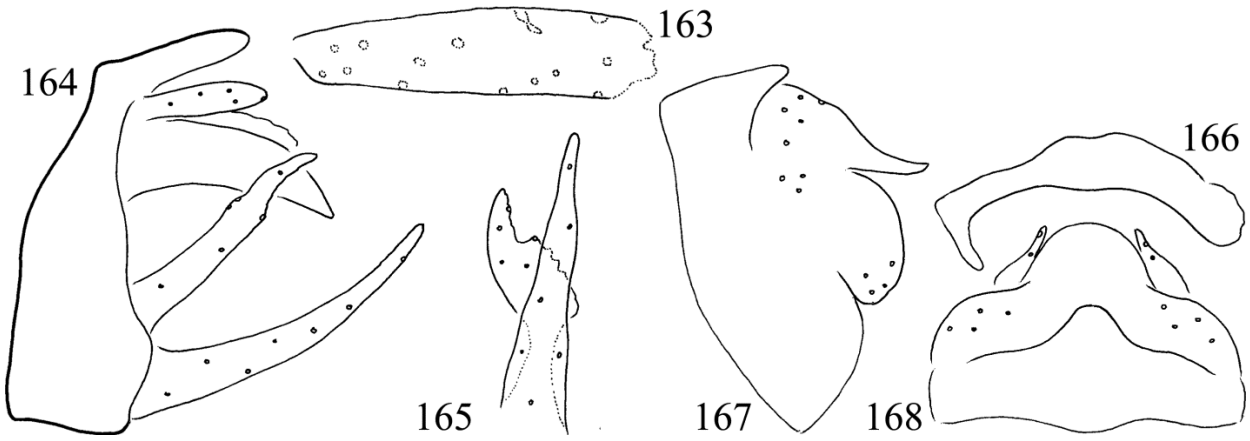
short, broad with rounded apex. Ventral profile of dorsal arm of gonopods with mesally constricted plate terminated in digitate process; ventral arm of gonopods little longer than dorsal arm, slightly curving upward. The lateral profile of phallic organ almost straight, gradually broadening apically, ending in trilobed apex.

Etymology. *weytus* coined from the name of the *locus typicus*, as a noun in apposition.

***Parasetodes zambicus* Oláh & Johanson, sp. nov.**

(Figures 163–168, Map 5)

Material examined. Holotype: **Zambia**, North-Western Province, Ikelenge District, Hillwood Farm, 1395 m, 11.2669°S, 24.3166°E, loc#Tr08, stream at campsite, in riverine forest, light trap, 11.XII.2011, leg. M. Espeland & R. Vila (1 male, SMNH, NHRS-HISI, 000001207). Allotype:



Figures 163–168. *Parasetodes zambicus* sp. nov. Holotype: 163 = forewing brown membrane pattern, 164 = left lateral view of genitalia, 165 = left gonopod with apicomesal lobe in ventral perpendicular view, 166 = phallic organ in lateral view. Allotype: 167 = female genitalia in lateral view, 168 = female genitalia in dorsal view.

same as holotype (1 female, SMNH). Paratypes: same as holotype (2 males, 5 females, SMNH; 2 males, 2 females; OPC).

Diagnosis. This species resembles *P. meyan* sp. nov., but differs by the strongly produced tergite IX, by the segment X without needle-pointed apex, by the quadrangular mesal lobe on the dorsal arm of gonopods and by the phallic organ without trilobed apex.

Description. Middle-sized. Forewing length 9 mm. Forewing anastomosis arranged not in straight line, but step-wise due to anterad shifted m-cu crossvein; hyaline window on middle section of M stem lacking; brown membrane pattern distinct with 15 patches. In male genitalia the lateral profile of segment X tapering at apex without distinct point; longer than cerci and slightly curving downward. Cerci long. Ventral profile of dorsal arm of gonopods with quadrangular mesal lobe and broad digitiform apical process; ventral arm of gonopods slightly longer than dorsal arm, slightly upward turning. The lateral profile of phallic organ arching and significantly broadening on dorsoapical half.

The female genitalia with mesal dorsoapical lobe rounded; dorsal profile of segment X regular semicircular, lateral shape pointed digitiform with slightly upward directed apex; lamellae short, but downwardly directed, lateral shape slightly elongated.

Etymology. *zambicus* named after the *locus typicus*.

Acknowledgement – We acknowledge the accessibilities of type materials of *Parasetodes bakeri* (Banks, 1913) for the Museum of Comparative Zoology, Cambridge, USA and of *Parasetodes sudanensis* Ulmer, 1922, for the Zoologisches Museum Hamburg, Germany. The first author is grateful to the Hungarian Academy of Sciences and to the Scientific Centre of Vietnam for the agreement signed and supported this long lasting research project on the Trichoptera of Vietnam and particularly thankful for the unlimited collecting and logistic helps provided by many local colleagues producing this rich material of the very rare species of *Parasetodes* genus. We are grateful to the great collectors, the French R. Paulian and the Hungarian S. Endrődy-Younga, J. Balogh, and A. Zicsi for the Afrotropical specimens of these rare animals.

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Three new additions to the earthworm (Clitellata: Megadrili) fauna of Kerala state from the Western Ghats biodiversity hotspot, south-western India

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Abstract. In India, studies on above-ground biodiversity have received more attention than those on below-ground biodiversity. With this view, systematic surveys for earthworms were carried out in the Western Ghats mountain range of Kerala state in southwestern corner of Peninsular India. This research resulted in three new records for the state, *viz*. *Drawida nandiensis* Stephenson, 1924, *D. nepalensis* Michaelsen, 1907 and *Celeriella bursata* Jamieson, 1977. Among these, *D. nandiensis* and *D. nepalensis,* are recorded for the first time from the Western Ghats biodiversity hotspot. Previously *D. nandiensis* and *C. bursata* were known only from their respective type localities. With the addition of three species the total number of earthworm taxa reported from Kerala state has raised to 128 and now the Western Ghats mountain ranges has 271 species of earthworms.

Keywords. *Celeriella*, *Drawida,* endemic, Moniligastridae, Oligochaeta, Pampadum Shola National Park.

INTRODUCTION

Western Ghats is a chain of mountain runs through the southwest Peninsular India and is considered as a refugium of the relict biota of the former Indian plate (Myers *et al.* 2000). The Western Ghats-Sri Lanka biodiversity hotspot exhibits exceptionally high diversity of earthworms with 328 taxa recorded, of these 264 are endemic (Narayanan *et al.* 2020*a*, 2021*a, b*, 2022, 2023*a*, *b*, Lone *et al.* 2022). In India, the Western Ghats and western coastal plains stand out as the area with highest level of earthworm species richness (Julka *et al.* 2009, Narayanan *et al.* 2020*a*, 2023*a*), which holds about 58.4% of the hitherto known earthworm diversity of the country (Narayanan *et al.* 2020*a*). Due to varied geological history, physiography, climate and vegetation types, the earthworm fauna of the Western Ghats shows exceptionally high level of endemism both at genera (31%) and species (77%) level (Narayanan *et al.* 2020*a*). A number of earthworm species of the Western Ghats are recognized only from the original description or from their respective type localities (Narayanan *et al.* 2020*a*, 2023*a*).

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Several workers have investigated the earthworm fauna of the Western Ghats and have published detailed taxonomical works and short communications. The list of earthworms from the Western Ghats and west coast region is continuously growing with the discovery of several new taxa and new reports (Julka *et al*. 1997, 2004, Nair *et al.* 2010, Narayanan *et al.* 2017, 2016*a*, 2019*a*, 2021*a*, 2022, 2023*b*, George *et al.* 2017, Lone *et al.* 2022). Kerala state, a narrow coastal equatorial tract situated in the southwestern corner of Peninsular India (between 8°17'–12°47'N and 74°52'–77°24'E) is an integral part of the Western Ghats. State-wise analysis of earthworm distribution showed that Kerala state harbours highest earthworm diversity in the Western Ghats biodiversity hotspot region with 125 species (Narayanan *et al.* 2020*a*, 2023*a*, *b*, *c*).

Taxonomical studies on the earthworms of Kerala were initiated during the last part of the 19th century (Bourne 1894) and quite a few species are known only from their original description, and majority of them were reported about a century back (Narayanan *et al.* 2016*b*). In the absence of revisionary works, the taxonomic status of many of the species published in the earlier centuries, their level of morphological variation, status, *etc*. cannot be considered as confirmed (Narayanan *et al.* 2016*b*, 2023*d*). New species are continuously being discovered and previously unreported species are being reported from the state indicating the fact that much remains to be learned about the earthworm diversity of the state (Julka *et al*. 1997, Nair *et al.* 2010, Narayanan *et al.* 2016*a*, *c*, 2017, 2019*a*, *b*, *c*, 2020*b*, 2021*a*, 2022, 2023*b*, *c*, George *et al.* 2017, Anuja *et al.* 2020, Lone *et al.* 2022). Hence, we made a thorough survey of the earthworms in different parts of the Western Ghats of Kerala state, which revealed the occurrence of three previously unreported earthworms from the state, namely, *Drawida nandiensis* Stephenson, 1924, *D. nepalensis* Michaelsen, 1907 and *Celeriella bursata* Jamieson, 1977. Here, we are providing details of the specimens collected along with its ecological notes.

MATERIALS AND METHODS

Earthworms were collected by digging and hand sorting method (Julka 1990). Collected specimens were washed and then preserved in 5% formalin for further taxonomic identification. All relevant morphological and anatomical characterization of the earthworms was carried out under a Nikon stereomicroscope (Model: SMZ800N). Photos were taken with the help of a camera attached to the microscope. Collected specimens were identified with the help of standard literature (Stephenson 1923, 1924, Gates 1972, Jamieson 1977, Julka 1988, Blakemore 2012). The collected specimens are deposited in the museum of Advanced Centre of Environmental Studies and Sustainable Development (ACESSD), Mahatma Gandhi University, Kerala, India. Family and genera level classification follows the recent publications of Brown *et al.* (2023) and Mısırlıoğlu *et al.* (2023).

General abbreviations of the terms used are as follows. C. – Clitellum; Fp. – Female pore, lhs – Left hand side, Mf. – Male field, Mp. – Male pore, P. – Prostate, Pc. – Prostatic capsule, Pd. – Prostatic duct, Pp. – Penes-like papillae, rhs – Right hand side, Sa. – Spermathecal ampulla, Sat. – Spermathecal atrium, Sd. – Spermathecal duct, Sdi. – Spermathecal diverticulum, Sg. – Seminal groove, Sp. – Spermathecal pore, Ts. – Testis sac, Vd. – Vas deferens.

Acronyms of type hosting institutions are as follows: BMNH = British Museum (Natural History), London (now NHM (Natural History Museum), United Kingdom; ZMUH = Zoologisches Museum Universität Hamburg, Hamburg (now ZMH- Zoological Museum Hamburg), Germany; ZSIC = Zoological Survey of India, Kolkata, India.

TAXONOMY

Order Moniligastrida Brinkhurst & Jamieson, 1971

Family Moniligastridae Claus, 1880

***Drawida nandiensis* Stephenson, 1924**

(Figures 1A–D)

Drawida nandiensis Stephenson, 1924: 326.
Drawida nandiensis Stephenson: Narayanan *et al.* 2023*a*: 30. Narayanan *et al.* 2024: 32.

Type locality. Nandi Hills (13.3702°N; 77.6835°E), Karnataka State, India.
Type material. ZSIC 1111; BMNH 1925:5:12: 29–30.

Material examined. 2 clitellates (Reg. No. ACESSD/EW/1010), Chethalayam, Wayanad District, Kerala State, India, *ca*. 950 m a.s.l., coffee plantation, 2 June 2018, leg. B. Thomas.

Brief description. Length 70–168 mm, diameter 4–5 mm, segments 147–205. Setae lumbricine, begin from segment 2. Prostomium prolobic. Dorsal pores absent. Clitellum on segments 9–14 (6), light orange in preservation, 10–13 particularly visible (Figs. 1 A, B). Spermathecal pores paired, in intersegmental furrow 7/8, at *c* setal line. Male pores paired in intersegmental furrow 10/11, between *bc* setal lines, nearer to *b*; pores situated on small papillae, which resembles small penes (Figs. 1 A, B). Gizzards 3, in the region of segments 13–17. Testis sacs paired; moderate-sized, irregularly shaped, chiefly in segment 10, but project into segment 9. Vas deferens coiled in mass of loops. Prostates paired, glandular, roughly spheroidal from dorsal view (Fig. 1 C),

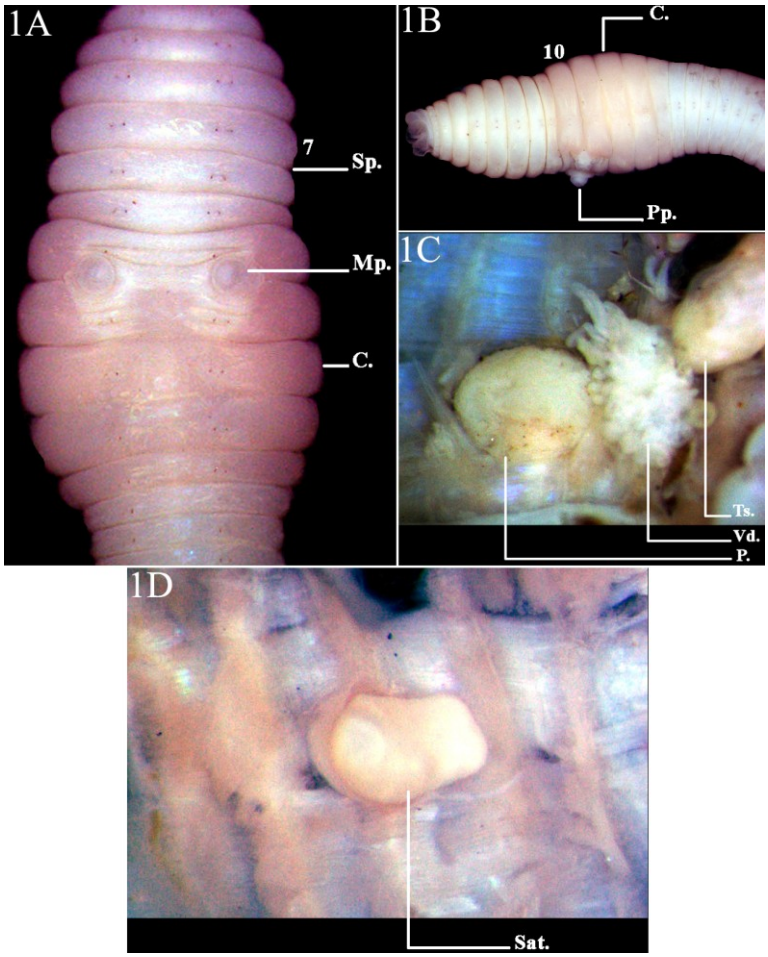

Figure 1. *Drawida nandiensis* Stephenson, 1924: A = Male field, ventral view; B = Anterior lateral view; C = Prostate and mass of vas deferens, lhs, dorsal view; D = Spermathecal atrium, rhs, dorsal view.

duct thick, vas deferens enters the prostate at its anterior face. Prostatic capsule spheroidal. Spermathecae paired in segment 8, ampulla ovoidal, duct coiled, thin, pierces through the septum 7/8, joins at about near the ectal end of the atrium in segment 7, atrium irregular shaped, concave (Fig. 1 D). Ovarian chamber complete. Ovisacs short, cylindrical. Nephridiopores are on *cd* setal lines. Genital markings absent.

Ingesta. Colloids of soil, pebbles, and a few tiny bark like organic matter. Seems to be an endogeic species.

Habitat. Coffee plantation in Kerala.

Distribution. India: Kerala (present record), Karnataka (Stephenson 1924).

Remarks. Endemic. Dimensions of the present specimens - length 167–168 mm, diameter 4 mm, segments 147–162. It has 3 gizzards in segments 13–15. Hence the earlier diagnosis of the species has been updated based on the present new materials. It is reported for the first time from the Western Ghats. Previously it was known only from the type locality (Narayanan *et al.* 2023*a*, 2024).

Drawida nepalensis **Michaelsen, 1907**

(Figures 2A–C)

Drawida nepalensis Michaelsen, 1907: 146.
?Drawida jalpaigurensis Stephenson, 1916: 307. (synonymy with *D. nepalensis* is doubtful – see Narayanan *et al.* 2023*a*)
Moniligaster ivaniosi Manazhy *et al.*, 2011: 11. For further list of synonyms see Gates (1972) and Blakemore (2012).

Type locality. Gowchar near Kathmandu, Nepal.

Type material. ZMUH 7140 (Reynolds & Wetzel 2024).

Material examined. 1 clitellate, 6 aclitellates, 4 juveniles (Reg. No. ACESSD/EW/1186), Urulanthanni in Thattekkad Bird Sanctuary (10°7’34.6” N 76°45’35.9” E), Ernakulam District, Kerala State, *ca*. 60 m a.s.l., lowland evergreen forest, 1 September 2016, leg. S.P. Narayanan and S. Sathrumithra; 2 clitellates, 9 aclitellates (Reg. No. ACESSD/EW/1189), Njayapillimudi in Thattekkad Bird Sanctuary (10°8’1.9” N 76°42’55.6” E), Ernakulam District, Kerala State, ca 530 m a.s.l., hill top grassland with stunted deciduous trees, 2 September 2016, leg. S.P. Narayanan and S. Sathrumithra; 5 clitellates, 9 aclitellates (Reg. No. ACESSD/EW/1188), Bhoothathankettu (Thundathil Forest Range) (10°8’28.7” N 76°39’35.8” E), Ernakulam District, Kerala State, *ca.* 55 m a.s.l., degraded lowland evergreen forest, 31 August 2016, leg. S.P. Narayanan and S. Sathrumithra; 2 aclitellates (Reg. No. ACESSD/EW/1478), Perumbankuthu (10°8’27.6” N 76°54’7.1” E), Idukki District, Kerala State, 390 m a.s.l., evergreen forest with reeds, 30 August 2016, leg. S.P. Narayanan, T. Augustine and S. Sathrumithra.

Brief description. Length 50–128 mm, diameter 1.5 mm, segments 149–180. Setae lumbricine. Prostomium prolobic. Dorsal pores absent. Clitellum in segments 9¼–13 (4¼), reddish maroon in colour in preservation (Fig. 2A). Spermathecal pores paired, at intersegmental furrow 7/8, in *cd* setal lines. Male pores paired in intersegmental furrow 10/11, between *bc* setal lines. Gizzards 2–3 or more, in the region of segments 13,14,15–17,18, 19,20. Testis sac paired; inter septal 9/10. Vas deferens coiled in mass of loops, mass smaller than testis sacs (Fig. 2B). Prostates paired, glandular, U-shaped loop; vas deferens enters the prostate at its ental end. Prostatic capsule tubular. Spermathecae paired in segment 8, ampulla pear-shaped, duct undulating, thin, pierces through the septum 7/8 to enter the atrium in segment 7, atrium large, sac-like (Fig. 2C). Ovarian chamber complete. Ovisacs extend back through several segments. Nephridiopores are on *cd* setal lines. Genital markings present or absent.

Ingesta. Chiefly soil, with sparse mica, rootlets, plant fibers and bark portions.

Habitat. Forest (lowland evergreen, degraded lowland evergreen), hill top grassland with stunted deciduous trees.

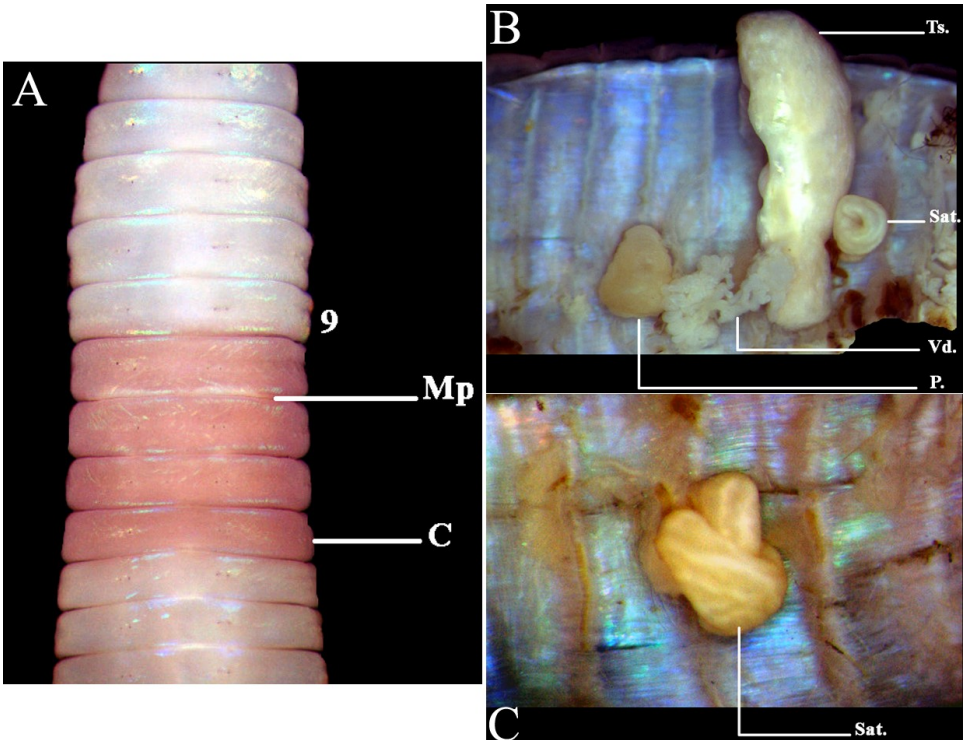

Figure 2. *Drawida nepalensis* Michaelsen, 1907: **A** = Anterior ventral view; **B** = Prostate, mass of vas deferens, testes sac and spermathecal atrium, dorsal view; **C** = Spermathecal atrium, rhs, dorsal view.

Distribution. India: Kerala (present records), Andaman and Nicobar Islands, Arunachal Pradesh, Assam, Bihar, Haryana, Himachal Pradesh, Jammu and Kashmir, Karnataka, Manipur, Meghalaya, Mizoram, Sikkim, Tamil Nadu, Tripura, Uttarakhand, West Bengal (Michaelsen 1909, Stephenson 1917, 1922, 1924, 1925, Gates 1962, Julka 1976, Soota & Halder 1981, Chaudhuri & Bhattacharjee 1999, Paliwal & Julka 2005, Mandal *et al*. 2011, 2013, Sharma & Bhardwaj 2014, Haokip & Singh 2017, Lalthanzara & Zodinpuii 2021). *Elsewhere*. Bangladesh, China, Indonesia, Myanmar, Nepal and Pakistan (Reynolds *et al.* 1995, Blakemore 2012, Narayanan *et al.* 2023*a,* 2024).

Remarks. Male pores are prominent, at *bc* setal lines or median to mid *bc* setal lines, each usually on or near end of protuberant papillae (Stephenson 1923, Gates 1972, Blakemore 2012). But such kind of protuberant papillae are absent in the present specimens. It is considered a cosmopolitan species among moniligastrids (Mısırlıoğlu *et al.* 2023, Narayanan *et al.* 2024). In India it is regarded as a native peregrine species (Narayanan *et al.* 2023*a*). This is its first report from the Western Ghats. An Urulanthanni specimen has 2 gizzards, whereas, Bhoothathankettu specimens are with 3 gizzards. Genital markings are absent in the present specimens.

Order Crassiclitellata Jamieson, 1988

Family Megascolecidae Rosa, 1891

Celeriella bursata Jamieson, 1977

(Figures 3A–D)

Celeriella bursata Jamieson, 1977: 487.
Celeriella bursata Jamieson: Julka 1988: 78.

Type locality. Vandaravu range, Tamil Nadu State (near Kerala border) (10.13°N; 77.27°E), India.

Type material. Paris Museum AH328 (Holotype) (Jamieson 1977).

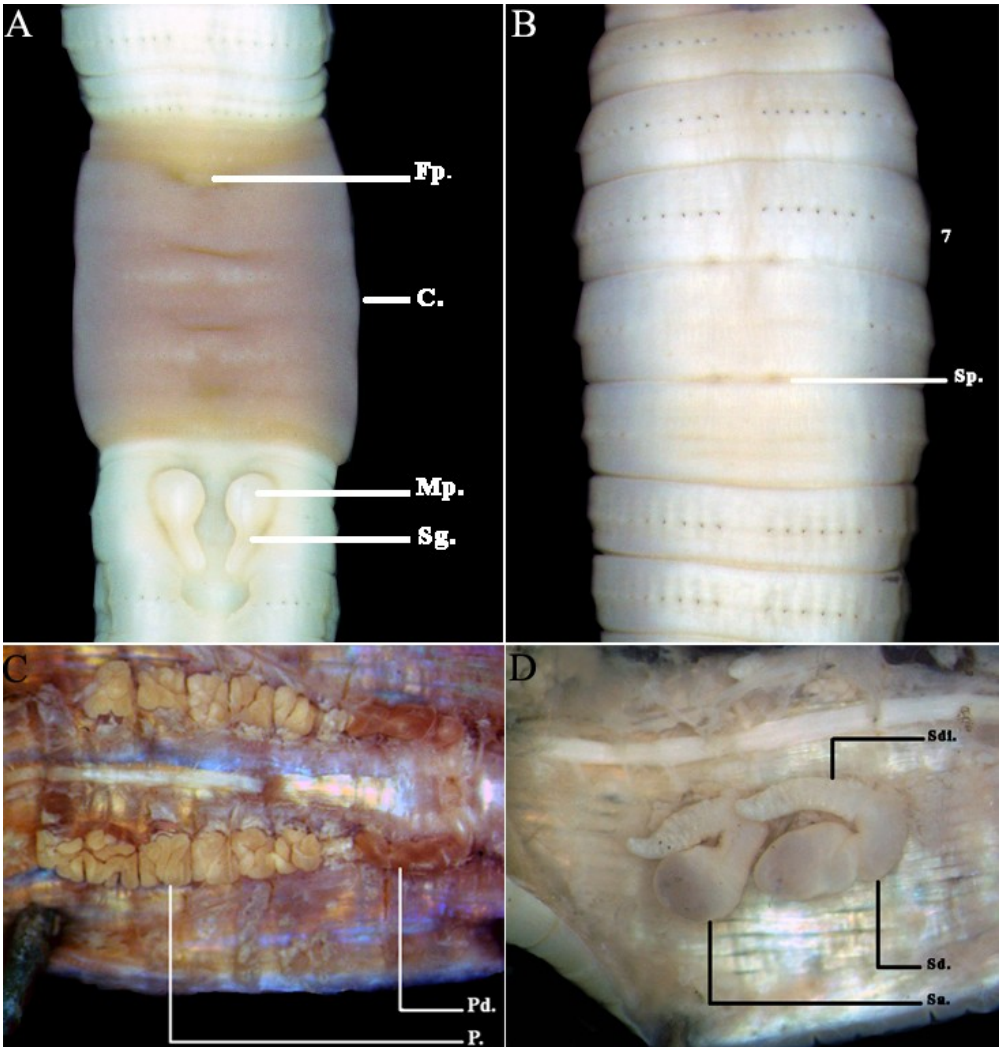

Figure 3. *Celeriella bursata* Jamieson, 1977: **A** = Male genital region, ventral view; **B** = Spermathecal pores, dorsal view; **C** = Prostates, dorsal view; **D** = Spermatheca, rhs, dorsal view.

Material examined. India: 10 clitellates, 11 aclitellates (Reg. No. ACESSD/EW/582), Mottakunnu in Bandar (Vandaravu) in Pampadum Shola National Park (10°7'38"N 77°16'5.8"E), Idukki District, Kerala State, *ca*. 2450 m a.s.l., higher altitude grassland, 27 May 2013, leg. T. Augustine, S.P. Narayanan, A. Sasi and S. Sathrumithra.

Brief description. Length 77–144 mm, diameter 2.6–5 mm, segments 110–135. Perichaetine. Prostomium epilobic, tongue open. First dorsal pore at intersegmental furrow 5/6. Clitellum annular in segments ¼12–¾17 (= 5), setae visible, intersegmental furrows indistinct. Male field is longitudinal depression, occupying whole segment 18 and extending to setal arc of segment 19, broad at segment 18 and pond like at segment 19; male porophores at the anterior end of a broad, comma-like raised area, seminal groove comma-shaped, which extends posteriomedianly to the posterior margin of segment 18 (Fig. 3A). Spermathecal pores minute, at intersegmental furrows 7/8/9, in line with *ab* setal lines (Fig. 3B). Genital markings absent. Septa 4/5–9/10 slightly muscular, 10/11/12 muscular. Oesophagus with paired pouches with calciferous lamellae, in seg-

ment 13–14. Intestine begins in segment 17. Holandric, seminal vesicles racemose, in segment 11 and 12. Prostates extend posteriorly to segment 27–33 (Fig. 3C). Spermathecae paired in segment 8 and 9, each with a digitiform ectal diverticulum, about as long as combined length of the duct and ampulla, duct short (Fig. 3D).

Ingesta. Chiefly colloids of organic matters, also tiny portions of woody materials, barks, moss leaves etc. Seems to be an epigeic species.

Habitat. Higher altitude grassland of shola-grassland complex.

Distribution. India: Kerala (present record) (Fig. 4), Tamil Nadu (Jamieson 1977).

Remarks. Endemic to Bandar (Vandaravu) in Kerala and Tamil Nadu part of the Western Ghats (Palani Hills). Dimensions of the present specimens - length 106–144 mm, diameter 4–5 mm, segments 128–131. Hence the diagnosis of the species has been updated based on the present new material. In the current specimens the prostate extends posteriorly to segments 27–28 (Fig. 3C). The spermathecal diverticulum is slightly longer than the combined length of duct plus ampulla.

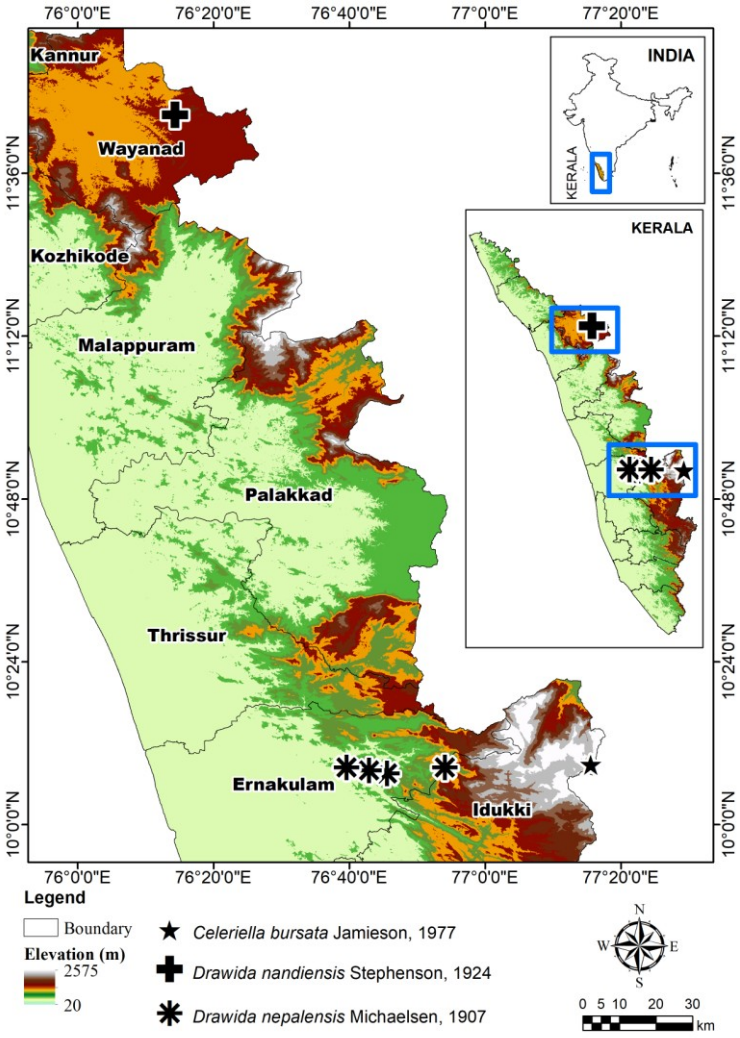

Figure 4. Distribution of *Drawida nandiensis* Stephenson, 1924, *D. nepalensis* Michaelsen, 1907 and *Celeriella bursata* Jamieson, 1977 in Kerala state, India

DISCUSSION

Drawida nandiensis, *D. nepalensis* and *Celeriella bursata* are recorded for the first time from the state. *D. nandiensis* is rediscovered after its original description in 1924 by Stephenson from the isolated Nandi Hills of Karnataka state (Narayanan *et al.* 2023*a*, 2024). Meanwhile *D. nepalensis* is a widespread native peregrine species within the country (Narayanan *et al.* 2023*a*, 2024), it seems that they have expanded its range to the Kerala state for the first time. Remarkably both these species are reported for the first time from the Western Ghats. *Celeriella bursata* was described from the Vandaravu range, border between Kerala and Tamil Nadu states, but within Tamil Nadu (Jamieson 1977, Kathireswari *et al.* 2005). Hence its present report from the Mottakunnu in Bandar (Vandaravu) Kerala side of the border is not that unexpected. However, its description was based on an aclitellate specimen (Jamieson 1977). Present study has expanded its characterizations by adding more details about the male-genital region, clitellum and associated features. Exotic invasive earthworm *Amynthas corticis* (Kinberg, 1867) has recently colonized various parts of the Idukki district including Bander in Pampadum Shola National Park (Narayanan *et al.* 2016*c*). But it was not recorded in the extensive survey of earthworms of Vandaravu range (= Bander) of Tamil Nadu – Kerala border by Jamieson (1977). Hence it is presumed that the presence of the invasive *A. corticis* may prevent persistence of many native earthworms in this region.

With the addition of three new species the total number of earthworm species occurring in Kerala state are increased to 128 (Jaya *et al.* 2011, Narayanan *et al.* 2016*a*, *b*, *c*, 2017, 2019*a*, *b*, *c*, 2021*a*, 2022, 2023*a, b, c,* George *et al.* 2017, Anuja *et al.* 2020, Lone *et al.* 2022). And now the species recorded from the Western Ghats mountain ranges has increased to 271 species (Narayanan *et al.* 2023*a, b*). Addition of three species to the earthworm fauna of Kerala indicates its importance for earthworms in the Western Ghats biodiversity hotspot. Surveys of underexplored and unexplored areas of Kerala may unearth many more earthworm species.

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Trichoptera of northeastern Algeria: New species, noteworthy records, and a review of the genus *Hydropsyche* (Hydropsychidae)

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Abstract. Freshwater biodiversity in the Maghreb region remains largely unexplored, providing significant opportunities for further discovery. Algerian caddisflies have received relatively little attention. The present study aims to fill gaps in caddisfly taxonomy and distribution by conducting a comprehensive survey of rivers and streams in northeastern Algeria, with a focus on collecting adult caddisflies. Through our research, we identified a total of 28 species from Algeria, and a new caddisfly species, *Hydropsyche tenerifa,* collected in the Canary Islands, expanding our knowledge of the caddisfly fauna in North Africa. Among these discoveries, we describe 15 new species (*H. cherfa*, *H. makhloufa*, *H. seybousa*, *H. algirica*, *H. dbabcha, H. farrahae*, *H. guitna*, *H. chenioura, H. edougha*, *H. louara*, *H. vinconi*, *H. linae*, *H. nardjissae*, *Agapetus ferrerasi*, *A. yasminae*) from Algeria and reclassify three subspecies or varieties as distinct species (*Wormaldia numidica*, *Thremma africanum*, *Mesophylax hoggarensis*). In addition, our surveys led to the discovery of three previously unrecorded caddisfly species (*Lype reducta*, *Lepidostoma kumanskii*, and *Adicella syriaca*) in Algeria, as well as the expansion of the known range of seven additional species. These results underscore the importance of the Maghreb's freshwater biodiversity and highlight the need for a more comprehensive understanding of caddisfly taxonomy in the region. By providing a clearer taxonomy and distributional framework for caddisflies, our research establishes a solid foundation for future monitoring and conservation initiatives targeting these important aquatic insects and the ecosystems they inhabit.

Keywords. Aquatic insects; caddisflies; freshwater biodiversity; distribution; Maghreb; taxonomy.

INTRODUCTION

The field of biodiversity conservation faces several challenges characterized by seven deficits or knowledge gaps. The best known of these are the Linnean, Wallacean, and Darwinian shortfalls (Diniz-Filho *et al.* 2013). These deficits relate to an inadequate understanding of taxonomy, distribution, and phylogeny. These knowledge gaps represent a significant obstacle to the effective conservation of biodiversity (Hortal *et al*. 2015). While it is widely recognized that sufficient taxonomic knowledge is critical for effective biodiversity conservation (Mace 2004), other knowledge gaps or deficits related to abundance, abiotic tolerance, species traits, and biotic interactions must also be addressed to enable evolution-based conservation planning and management that mitigates the effects of the current rapid erosion of biodiversity (Novacek & Cleland 2001, Mora & Sale 2011, Hortal *et al*. 2015). However, these approaches, which focus on filling knowledge gaps, are neither the only nor always the best option for biodiversity conservation, and they contrast with other approaches that favor the "save first, study later" line of action (Janzen 1986, Hoekstra 2005).The biodiversity crisis, triggered by global changes resulting from human activi-

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ties, has serious consequences, such as habitat loss and degradation, leading to rapid decline in species populations across all taxonomic groups (Janzen 2004, Laurance *et al*. 2012). Among the most threatened ecosystems are freshwater habitats, which are particularly affected by anthropogenic stressors such as land conversion, pollution, invasive species, and climate change (Dudgeon *et al*. 2006, Heino *et al*. 2009, Vörösmarty *et al*. 2010, Reid *et al*. 2019). This has led to documented declines in aquatic insects (Sánchez-Bayo *et al*. 2019), which account for about 80% of aquatic animal biodiversity (Dijkstra *et al*. 2014). There is therefore an urgent need to monitor riverine ecosystems to take effective action.

The Mediterranean region is recognized worldwide as a biodiversity hotspot and center of endemism, with remarkable biodiversity (Myers *et al*. 2000, Mittermeier *et al*. 2004). It is also one of the regions with the highest number of newly discovered freshwater insects (Morse 2016, Sánchez-Campaña *et al*. 2023), indicating that well-studied and developed areas of the world play a crucial role as reservoirs of previously unknown species (Fontaine *et al*. 2012). Similarly, Algeria, located on the southern shore of the Mediterranean Sea, has a rich freshwater biodiversity that includes a variety of micro-endemic aquatic insects, several of which have been recently documented (Yasri-Cheboubi *et al*. 2013, Samraoui *et al*. 2021b, 2021c).

Caddisflies (Trichoptera) play a critical role in stream and river communities and serve as important bioindicators of water quality and ecological integrity of river ecosystems (Wiggins 2004). Their occurrence and responses to environmental changes provide valuable insights into the overall condition of freshwater habitats (Houghton 2004). Therefore, a comprehensive understanding of caddisfly taxonomy and distribution is essential for implementing successful monitoring and conservation strategies.

Unfortunately, knowledge of caddisflies in Algeria has until recently been relatively neglected compared to neighboring Maghrebian countries such as Morocco (Dakki 1978, 1982, El Alami & Dakki 1998, Hajii *et al*. 2013, Mabrouki *et al*. 2020) and Tunisia (Malicky & Lounaci 1987, Allaya 2003, Allaya *et al*. 2003).

The first studies on caddisfly biogeography began in the late 19th century with pioneering studies by McLachlan (1880) and Morton (1896, 1898). A detailed account of subsequent research which extended into the following century was provided by Dambri *et al.* (2020) and Samraoui *et al*. (2020). In the last two decades, however, there has been a marked increase in publications on Algerian caddisflies. These recent publications (Arab *et al*. 2004, Sekhi *et al*. 2016, 2019, Bemmoussat-Dekkak *et al*. 2021a, 2021b, 2021c, Khettar *et al*. 2022) have been instrumental in expanding our understanding of the caddisfly fauna in Algeria and addressing the previous lack of comprehensive research in this area.

Given the limited knowledge of Algerian caddisflies, this study fills a gap in the literature by providing results of a survey conducted in northeastern Algeria. The main focus of this study was on two aspects: (1) The collection, identification, and distribution of adult caddisflies, as these life stages provide important taxonomic and ecological information and (2) development of a deeper comprehension of the evolutionary patterns within *Hydropsyche* Pictet, 1834 (Hydropsychidae) by investigating potential trends in the evolution of phallic traits.

MATERIALS AND METHODS

Study area. Three regions (El Kala, Wadi Seybouse, and Mount Edough) were selected for caddisfly sampling which was carried out across various catchments of three geographically different regions situated in northeastern Algeria (Figs 1, 2; Table 1). Two additional specimens were collected outside of the three specified sampling regions, one collected at Tizagban, Collo (Boucenna *et al.* 2023) (37°0’39.41”N, 6°22’ 29.57”E) and the other at Tenerife in the Canary Islands (28°22’1.71” N, 16°42’49.52”W). The climate of the study area is typically Mediter

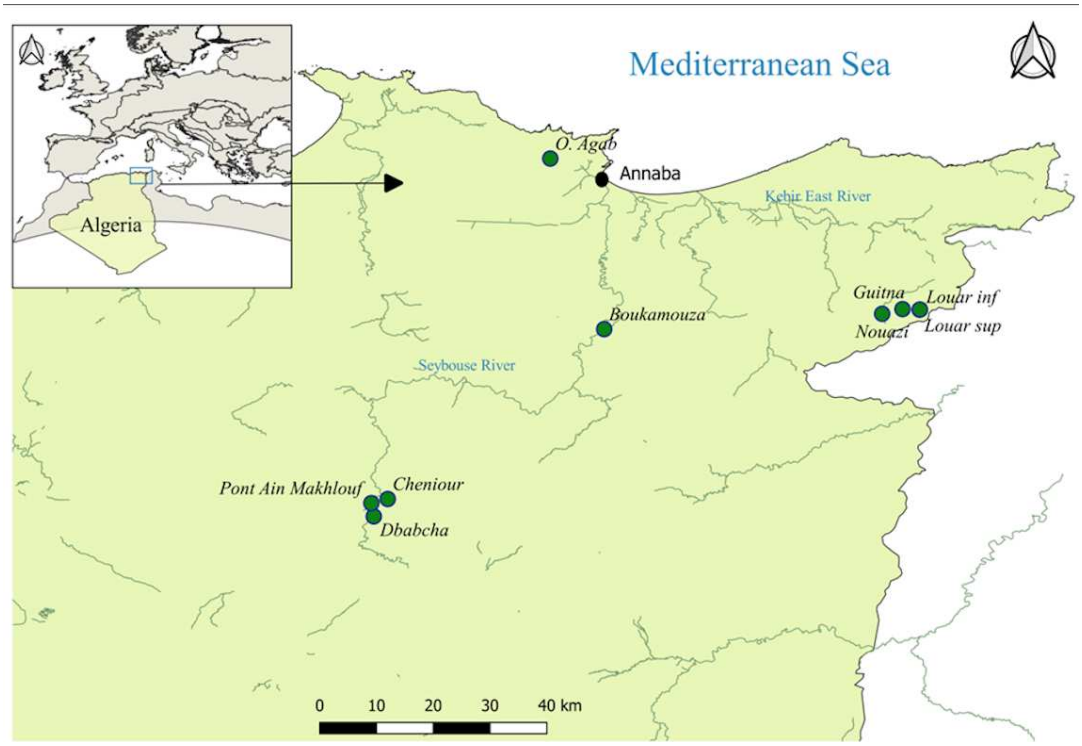

Figure 1. Map of Algeria (inset) and the study area, including the sampling sites where adult caddisflies were collected.

Figure 2. Views of sampling sites in northeastern Algeria. 2a, Nouazi, El Kala. 2b, O. Agab, Mount Edough. 2c, Dbabcha, Seybouse River, 2d, Tizagban, Collo.

Table 1. Sampling sites for adult caddisflies in the El Kala, Seybouse, Collo and Mount Edough regions, northeastern Algeria.

Region	Name	Latitude (N)	Longitude (E)	Altitude (m)	Stream type	Substrate
El Kala						
	Louar sup	36°37'01"	8°22'47"	593	Intermittent	Coarse
	Louar inf	36°37'02"	8°22'49"	588	Intermittent	Coarse
	Guitna inf	36°37'05"	8°20'47"	476	Intermittent	Coarse
	Nouazi	36°36'32"	8°18'24"	296	Intermittent	Mixture
O. Seybouse						
	Dbabcha	36°12'50"	7°18'58"	610	Intermittent	Mixture
	Cheniour	36°14'52"	7°20'36"	602	Permanent	Coarse
	Aïn Makhlouf Bridge	36°14'23"	7°18'41"	590	Intermittent	Coarse
	Boukhamouza	36°34'44"	7°45'54"	53	Permanent	Mixture
Mount Edough						
	O. Agab	36° 54.708'	7°39.605'	750	Intermittent	Coarse

ranean, characterized by a hot, dry period between May and October, and a mild, rainy season from November to April. However, the El Kala region and Mount Edough are characterized by a climate ranging from humid to subhumid. Conversely, the climate along the Wadi Seybouse exhibits a gradient, varying from a subhumid climate near Annaba, where it meets the Mediterranean Sea, to semi-arid climate in its upstream reaches. The Maghreb (sensu stricto) consists of Tunisia, Algeria, and Morocco. The Great Maghreb or Grand Maghreb is a cultural and political entity made up of Libya, Tunisia, Algeria, Morocco, and Mauritania. The word Oued/wadi (intermittent stream/ river) is abbreviated as " O.".

The El Kala region in the Wilaya of El Tarf is located close to the Algerian-Tunisian border. This region includes a variety of ecologically important wetlands that serve as habitat for numerous breeding and migratory waterfowls. In addition, the area is recognized as an Afrotropical relict pocket for freshwater organisms and is home to several endangered species (Samraoui *et al*. 1993). The hills and mountains in the El Kala region are drained by the Oued El Kebir East, whose tributaries are refuges for several Algerian or Maghrebian endemic aquatic insects (Yasri-Cheboubi *et al*. 2016, Samraoui *et al*. 2021b, 2021c).

The Seybouse River, the most important waterway in the region, is fed by two main tributaries: Wadi Cherf and Wadi Bouhamdane. These tributaries originate in the eastern Hauts Plateaux at an elevation of about 900 meters, flow northward, and eventually join to form the Seybouse River. From there, the river continues its course toward the Mediterranean Sea, flowing through Annaba and encompassing the largest catchment area in northeastern Algeria. The upper reaches of the Seybouse River are characterized by scattered settlements and agricultural and pastoral activeties, while the lower reaches are mainly characterized by intensive agriculture, industrial facileties, and urban settlements. The Seybouse River provides invaluable ecosystem services throughout its course and serves as a refuge for three threatened odonate species on the IUCN Red List for North Africa (Samraoui *et al*. 2010): *Calopteryx exul* Selys, 1853 (EN), *Coenagrion mercuriale* (Charpentier, 1840) (EN), and *Gomphus lucasii* Selys, 1849 (VU) (Bouhala *et al*. 2019).

Mount Edough lies above the city of Annaba in north-east Algeria and is one of the wettest regions in North Africa with an annual rainfall of often more than 1200 mm. The mountain is adorned with lush forests consisting mainly of *Quercus suber* and *Quercus faginea*. A dense understory of *Pteridium aquilinum*, *Erica arborea* and *Rubus ulmifolius* thrives under the canopy (Samraoui & Alfarhan 2015).

Sampling. Monthly sampling was conducted over a period of at least one year at 51 different sites, from January 2020 to June 2023. This comprehensive census included three distinct regions: A collection of 20 sites distributed across the O. El Kebir-East and Oum Teboul watersheds (Sam-

raoui *et al*. 2021a, 2021b), and an additional cluster of 30 sites along the Seybouse River and its main tributary, O. Cherf (Samraoui *et al*. 2021a). In addition, one site (O. Agab) on Mount Edough was also sampled (Samraoui & Alfarhan 2015).

At each of these sites, a 15-minute diurnal sampling of adults was conducted. Flying adults were captured with a butterfly net, while resting adults were captured by sweeping the net through vegetation or, if they were moving on rocks, with tweezers. Following collection, all specimens were preserved in ethanol and carefully sorted under a stereomicroscope. The abdominal segments of the male genitalia were carefully separated and then subjected to a clearing process. They were heated in a 10% KOH solution at 70°C for 30 minutes and thoroughly cleaned with superfine-tipped forceps for examination. The morphological terminology used for adult genitalia follows Oláh and Johanson (2008). The illustrations were made using a Wild drawing tube with a Wild Type 308700 stereomicroscope from Heerbrugg, Switzerland. For higher magnifycation, we also used a Carl Zeiss drawing tube in conjunction with a Carl Zeiss compound microscope. Maps of sampling sites where adult caddisflies were collected were drawn using QGIS 3.8.

*Depositories.*Voucher specimens, including type specimens, are deposited in the following institutions:

- British Museum (Natural History), London (BMNH)
- Oláh Private Collection, Debrecen, Hungary, under national protection by the Hungarian Natural History Museum, Budapest (OPC).
- Musée Cantonal de Zoologie de Lausanne, Switzerland (MCZL).
- Private Collection of Hans Malicky, Lunz am See, Austria (CHM)).

*Taxonomy***.** In our revision of the possibly new taxa within the genera *Wormaldia*, *Hydropsyche*, *Agapetus*, *Thremma*, and *Mesophylax* in Algeria, we applied the principles and procedures of our refined phenomics approach, defined as fine-structure analysis of reproductive traits, particularly stable and consistent morphological divergences at the paramere and aedeagus of the phallic organ. Therefore, we focused primarily on non-neutral adaptive speciation traits. In particular, we examined the structures of the paraproct and phallic organ that play critical roles in mating. These structures likely led to reproductive isolation through prezygotic processes, including cryptic female choice (Oláh *et al.* 2014, 2015, 2017).

RESULTS

A total of 103 adult caddisflies were examined, comprising 28 species from Algeria and one species from the Canary Islands (Table 2). The distribution of *Hydropsyche* spp. and *Agapetus* spp. in the study area is shown in Fig. 3.

TAXONOMY

Philopotamidae Stephens, 1829

Wormaldia numidica Vaillant, 1974 stat. nov.

Wormaldia variegata numidica Vaillant, 1974:981. "La saillie dorsale du segment abdominal X est bien plus rapprochée de son extrémité que chez *W. variegata vercorsica* et la position est la même que chez *W. variegata variegata*. Phallus: 4 épines à peu près de même taille, mais celle que j'ai nommée B est parfois dédoublée, les deux éléments restant alors l'un contre l'autre." Six spécimens ont été examinés. Ils proviennent d'un gîte madicole dans les gorges du Chabet el Akra, entre Bougie et Kherrata, Algérie, 220 m."

Type material: Syntype: ALGERIA, Chabet el Akra, between Béjaïa et Kherrata, 14.ii.1950, leg François Vaillant (1 male, MCZL, GBIFCH 00331276).

Material examined. ALGERIA: Mount Edough, Oued Agab, 5.vi.2021, leg Boudjéma Samraoui (2 males, OPC). Collo, Tizagban, 24.xii.2022, leg Boudjéma Samraoui (2 males, OPC).

Remarks. The original detailed drawings that were published perfectly indicate the divergences

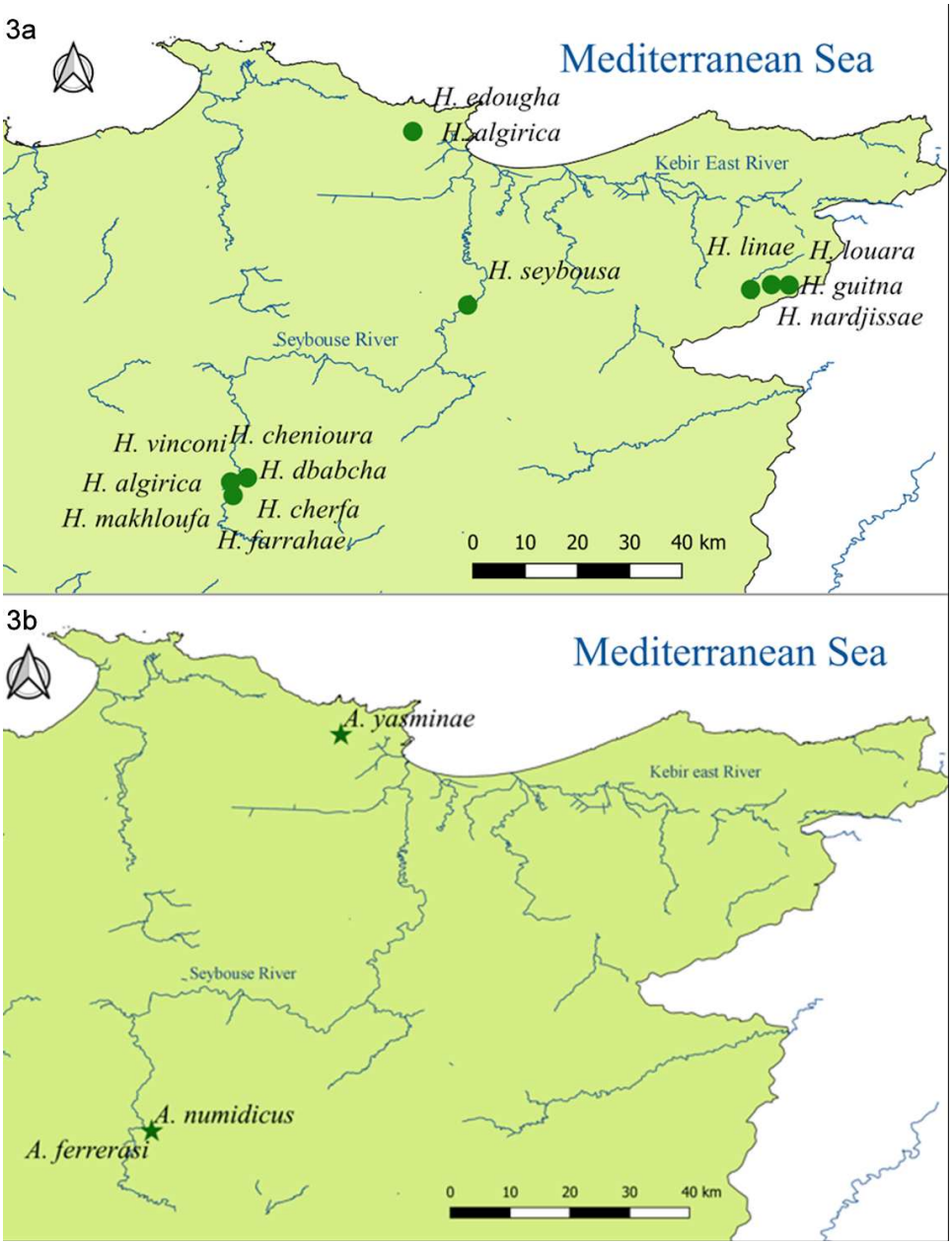

Figure 3. Distributions of *Hydropsyche* spp. and *Agapetus* spp. in this study. 3a, *Hydropsyche* spp. 3b, *Agapetus* spp.

between *Wormaldia variegata* Mosely, 1930 and *Wormaldia numidica* Vaillant, 1974 (Vaillant 1974). The fine structure of the head of segment X exhibits a different shape. The upward and anterior turn of the head is less pronounced, more pointed, and longer. The cerci are characterized by a low apical region. The four spines of the endotheca are less curved and are accompanied by an integrated smaller spine. Based on the genital divergences, as well as the theories of the phylogenetic species concept that exclude subspecies and race from scientific classification (Burbrink 2022), we elevate the subspecies status of *Wormaldia variegata numidica* Vaillant, 1974 to the species rank as *Wormaldia numidica* Vaillant, 1974.

Psychomyiidae Walker, 1852

***Lype reducta* (Hagen, 1868)**

Material examined. ALGERIA: Mount Edough, O. Agab, 26.iv.2021, leg. Boudjéma Samraoui (1 male, OPC). Mount Edough, O. Agab, 5.vi.2021, leg Boudjéma Samraoui (1 male, OPC).

Remark. This is a new addition to the caddisfly fauna of Algeria.

Hydropsychidae Curtis, 1835

***Cheumatopsyche lepida* (Pictet, 1834)**

Material examined. ALGERIA: Nouazi, 16.vi. 2021, leg. Boudjéma Samraoui (1 male, OPC).

Remark. The status of the closely related *C. atlantis* deserves further investigation (Arab *et al.* 2004).

***Hydropsyche* Pictet, 1834**

Hydropsyche, one of the largest caddisfly genera, has an almost worldwide distribution, and thrives in various types of streams. This genus contributes significantly to nature's ecosystem services as its huge populations produce immense biomass in the world's largest rivers (Morse *et al.* 2019). To gain a deeper understanding of evolutionary patterns within this genus, we conducted a comprehensive analysis of phallic organization, tracing the possible trends from a simple membranous structure to more intricate forms of sclerotized phallothecal terminalia. Research successfully identified nine species groups, nine species clades, and ten species clusters within this important genus (Oláh & Johanson 2008). Since these assemblages were identified solely on the basis of diagnostic characters without the use of phylogenetic analysis, we will henceforth replace 'lineage' with 'subgroup' and 'clade' with 'unit'.

In the Maghreb faunal region, which includes Algeria, all known *Hydropsyche* species belong to the *Hydropsyche angustipennis* Species Group. These species exhibit immovable, sclerotized endothecal processes that are completely fused to the apical region of the phallotheca. In the various ranges of the Atlas Mountains spanning Morocco, Algeria, and Tunisia, the highly specialized species group of *Hydropsyche angustipennis* is represented by three distinct subgroups: The *Hydropsyche guttata* Subgroup, the *Hydropsyche instabilis* Subgroup, and the *Hydropsyche pellucidula* Subgroup.

This study is the first comprehensive taxonomic study of adult *Hydropsyche* in Algeria. Previous taxonomic studies focused mainly on larvae (Bemmoussat-Dekkak *et al*. 2021a, 2021c).

Our results show a remarkably high diversity of filter-feeding caddisflies in the largest country in Africa. Each of the sites studied has a unique species composition, with multiple species often observed in the adult stage, suggesting that they may colonize different microhabitats within streams.

***Hydropsyche angustipennis* Species Group**

The *Hydropsyche* genus comprises various groups with immovable, highly sclerotized, and fused endothecal processes (Oláh & Johanson 2008). Most species groups within the *Hydropsyche* genus exhibit well-developed, membranous, or sclerotized endothecal processes, which are often diverse in shape, number, and complexity. However, in the *H. angulata*, *H. asiatica*, and *H. burgersi* Species Groups, these endothecal processes are reduced to a pair of small, scleratized lobes that are still somewhat movable. In the *H. angustipennis* Species Group, which is distributed in the Palearctic and Nearctic faunal regions, the endothecal processes take the form of reduced lobe-like structures. These structures are firmly and completely fused to the phallothecal head, creating a tube-like formation without any visible sutures. The *Hydropsyche angustipennis* Species Group comprises three distinct Subgroups: *Hydropsyche guttata*, *Hydropsyche pellucidula*, and *Hydropsyche instabilis*.

Hydropsyche guttata Species Subgroup

Species in this Subgroup are characterized by the fused sclerotized endothecal processes, absence of an angular, subapical lateral projection before the cleaved apex of the phallotheca of the *Hydropsyche pellucidula* Subgroup, and absence of digitiform apicoventral setose lobes otherwise found in the *Hydropsyche instabilis* Subgroup. Based upon the basal curvature of the phallic organ in lateral view, we have identified two units within the *H. guttata* Species Subgroup, each containing several species complexes (Oláh *et al*. 2020). The *Hydropsyche angustipennis* Unit displays a deep curvature, while the *Hydropsyche modesta* Unit exhibits a shallow curvature.

Hydropsyche angustipennis Species Unit

This unit has a deep or high basal curvature in the lateral view of the phallic organ. The phallic organ is tubular, with a phallotheca headed by sclerotized and fully fused endothecal processes. The basal curvature of the phallotheca tube is downward and deeply curved rather than shallowly curved or arched.

Hydropsyche cherfa Oláh & B. Samraoui, sp. nov.

(Figures 4a–4e)

Material examined. Holotype: ALGERIA: Pont Ain Makhlouf, O. Cherf, main tributary of the Seybouse River, 4.vii.2021, leg Boudjéma Samraoui (male, OPC).

Diagnosis. This new species belongs to the *Hydropsyche guttata* subgroup. It is characterized by fused, sclerotized endothecal processes, absence of a digitiform, apicoventral, setose lobe, and absence of angular, subapical lateral projecttions anterior to the cleft apex of the phallotheca. It also has a strong basal curvature of the phallic organ, which makes it a member of the *Hydropsyche angustipennis* Species Unit (Oláh *et al*. 2020). This species is small and light brown and has similarities with *Hydropsyche seybousa* sp. nov. However, it differs in having a narrow dorsal keel of the segment IX (as opposed to a broad keel), a shallow intersegmental profile (as opposed to a deep profile), less pronounced ventroapical setose lobes, clavate harpagones (as opposed to parallel sided harpagones), and a distinct lateral and ventral profile of the phallic organ.

Description. Male (in ethanol). Small sized species; length of each forewing 7 mm (n = 1). Body light brown; dorsal thoracic sclerites darker. Forewing brown, marbled with lighter spotted pattern.

Male genitalia. Segment IX fused-annular and short, particularly on its ventrum; its dorsomedian keel narrow, longer than following dorsum of segment X; apical lobe on posterolateral margin short and rounded-triangular. Intersegmental profile between segments IX and X shallow, triangular. Segment X short with less-produced, triangular, setaless winglets in lateral view and triangular lobes in dorsal view; lateral setose area (cerci) circular and located in midlength position; ventroapical setose lobes less produced. Coxopodite of each gonopod not quite reaching apex of segment X; harpago clavate in caudal view. Phallic organ with parallel-sided tube arching high in lateral view; subapicolateral dilatation on phallic head weakly produced, long, and without any preceding dilatation in ventral view.

Etymology. Coined from the name of the type locality, as a noun in apposition.

Hydropsyche makhloufa Oláh & B. Samraoui, sp. nov.

(Figures 4f–4j)

Material examined. Holotype: ALGERIA: Pont Ain Makhlouf, O. Cherf, main tributary of the Seybouse River, 31. iii. 2023, leg Boudjéma Samraoui (male, OPC). Paratype: ALGERIA: Pont Ain Makhlouf, O. Cherf, main tributary of the Seybouse River, 22. iii. 2023, leg Boudjéma Samraoui (1 male, OPC).

Diagnosis. This new species belongs to the *Hydropsyche guttata* Subgroup. It is characterized by fused, sclerotized endothecal processes, ab

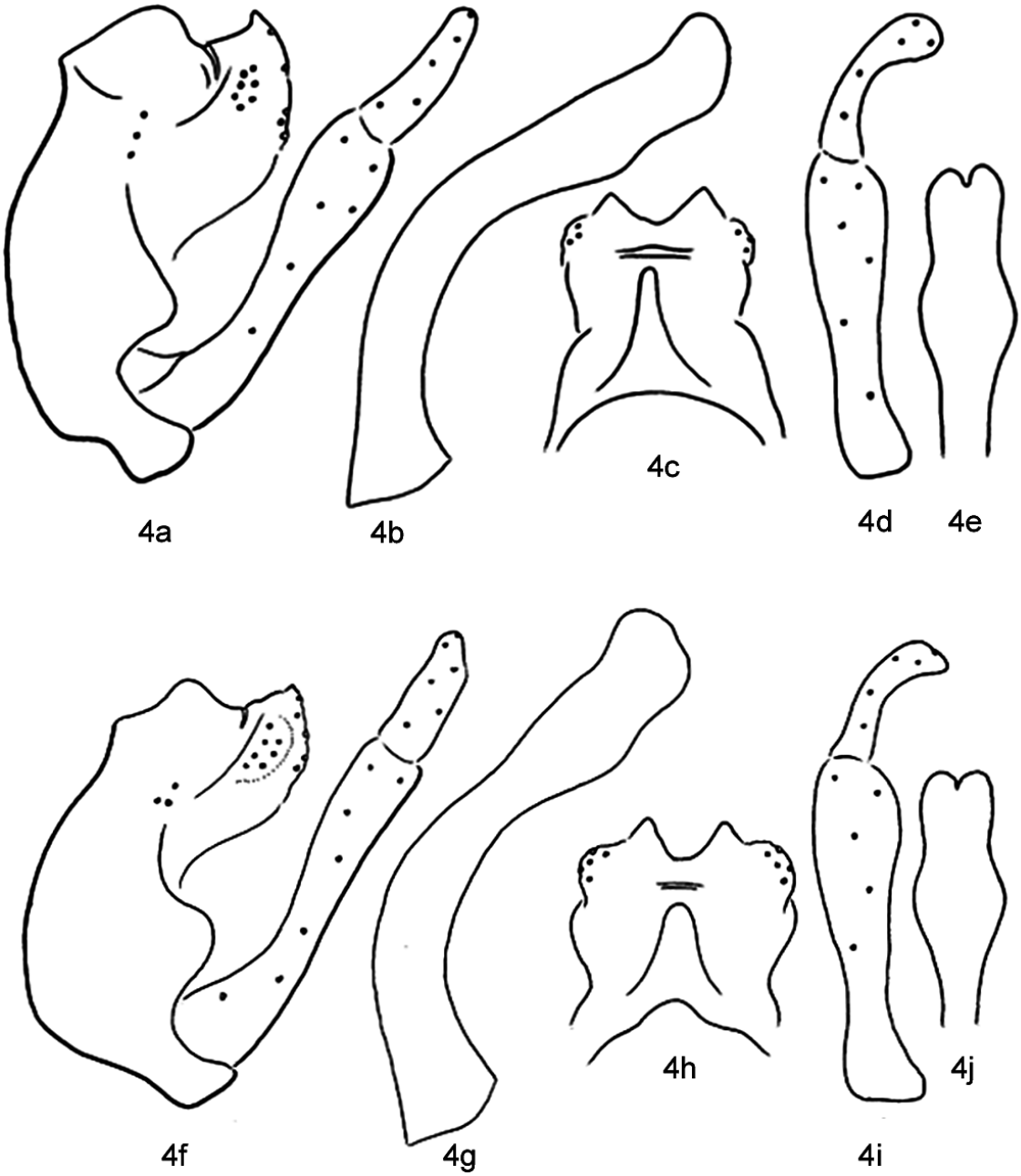

Figure 4. Genitalia of *Hydropsyche* spp. 4a–4e, *Hydropsyche cherfa* Oláh & B. Samraoui sp. nov. Holotype: 4a = left lateral; 4b = phallic organ, left lateral; 4c = segments IX and X, dorsal; 4d = left gonopod, ventral; 4e = phallic apex, ventral. 4f–4j, *Hydropsyche makhloufa* Oláh & B. Samraoui sp. nov. Holotype: 4f = left lateral; 4g = phallic organ, left lateral; 4h = segments IX and X, dorsal; 4i = left gonopod, ventral; 4j = phallic apex, ventral.

sence of a digitiform, apicoventral setose lobe, and absence of angular, subapical lateral projections anterior to the cleft apex of the phallotheca. In addition, it has a strong basal curvature of the phallic organ, which makes it a member of the *Hydropsyche angustipennis* Species Unit (Oláh *et al*. 2020). This medium-sized species has a dark, castanea-brown coloration. Although it shares some similarities with *Hydropsyche cherfa* sp. nov., it differs in several aspects. First, it is not

small and is light brown. It also differs from *Hydropsyche cherfa* sp. nov. in having a broad dorsal keel of segment IX instead of a narrow one, a concave lateral profile of the dorsal keel instead of a straight one, a different dorsal pattern on segment X, and a narrowing harpago instead of a clavate one. It also has a different lateral profile of the phallic organ.

Description. Male (in ethanol). Medium sized species. Body dark brown, almost castanean black; dorsal thoracic sclerites even darker. Forewing dark brown; length of each forewing 8 mm.

Male genitalia. In lateral view, segment IX fused annular and longitudinally short, particularly on ventrum; dorsomedian keel broad; apical lobe on each posterolateral margin short and round-triangular; intersegmental profile between segments IX and X triangular. Segment X short with tiny triangular setaless winglets in lateral view and small triangular lobes in dorsal view; lateral setose area (cerci) circular and located in mid-length position; ventroapical setose lobes less produced. Coxopodite of each gonopod extending to apex of segment X; harpago tapering. Phallic organ with parallel-sided tube arching high in lateral view; subapicolateral dilatation on phallic head well produced, short, and without any preceded dilatation in ventral view.

Etymology. Coined from the name of the type locality, as a noun in apposition.

Hydropsyche seybousa **Oláh & B. Samraoui, sp. nov.**

(Figures 5a–5b)

Material examined. Holotype: ALGERIA: Boukamouza, Seybouse River, 26.ii.2020, leg Boudjéma Samraoui (male, OPC).

Diagnosis. This new species belongs to the *Hydropsyche guttata* Subgroup. It is characterized by fused, sclerotized endothecal processes, the absence of a digitiform, apicoventral setose lobe, and the absence of angular, subapical lateral projections anterior to the cleaved apex of the phallotheca. In addition, it has a strong basal curvature of the phallic organ, which places it in the *Hydropsyche angustipennis* Species Unit (Oláh *et al*. 2020). This medium-sized species is brown in color and bears some resemblance to *Hydropsyche cherfa* sp. nov. However, there are notable differences between them. First, this species has a broad dorsal keel in segment IX instead of a narrow one. Second, the intersegmental profile is deep rather than shallow. It also has a more pronounced ventroapicalsetose lobe, a parallel-sided harpago instead of a clavate one, and distinct lateral and ventral profiles of the phallic organ.

Description. Male (in ethanol). Medium sized species. Body brown; dorsal thoracic sclerites darker. Forewing brown, marbled with lighter spotted pattern. Length of forewing 9 mm.

Male genitalia. Segment IX fused annular and short, particularly on ventrum; median keel broad, longer than following dorsum of segment X; apical lobe on posterolateral margin short and rounded. Intersegmental profile between ninth and tenth segments deep triangular. Segment X short with produced triangular setaless winglets in lateral view and triangular lobes in dorsal view; lateral setose area, cerci circular and located in apical position; ventroapical setose lobes produced. Coxopodite of gonopod slightly shorter than apex of segment X; harpago parallel-sided. Phallic organ with parallel-sided tube arching high in lateral view; subapical lateral dilatation on phallic head less produced long and followed by small dilatation in ventral view.

Etymology. Coined from the name of the type locality, as a noun in apposition.

Hydropsyche modesta **Species Unit**

This unit exhibits a shallow or low curvature in the lateral view of the phallic organ. The tube-like phallotheca, characterized by the sclerotized and completely fused endothecal processes, displays a basal curvature. The downward-directed section of the phallothecal tube curves or arches only slightly.

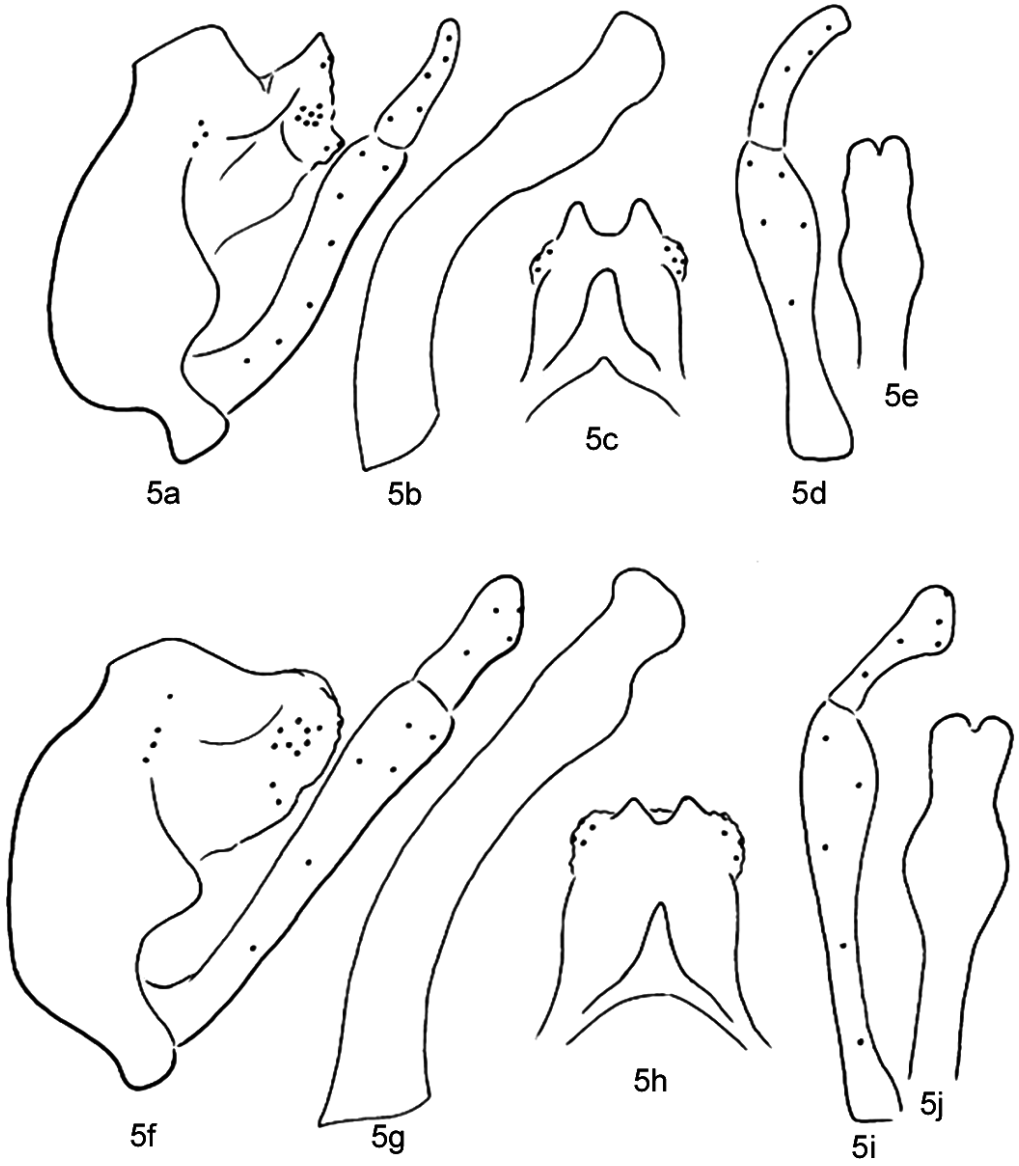

Figure 5. Genitalia of *Hydropsyche* spp. 5a–5e, *Hydropsyche seybousa* Oláh & B. Samraoui, sp. nov. Holotype: 5a = left lateral; 5b = phallic organ, left lateral; 5c = segments IX and X, dorsal; 5d = left gonopod, ventral; 5e = phallic apex, ventral. 5f–5j, *Hydropsyche algirica* Oláh & B. Samraoui, sp. nov. Holotype: 5f = left lateral; 5g = phallic organ, left lateral; 5h = segments IX and X, dorsal; 5i = left gonopod, ventral; 5j = phallic apex, ventral.

Hydropsyche exocellata Species Complex

This species complex, characterized by a shallow or low curvature in the lateral profile of the phallic organ, exhibits a significant and pronounced subapical dilation. This dilatation is observed in certain species within the *Hydropsyche angustipennis* Species Unit, which is associated with a deep or high curvature. The ventral view provides the best visibility of this subapical dilation. This particular character state is so prominent that other character states are often overlooked and not thoroughly examined through fine phenomics. It is possible that many cryptic species are concealed under the name of *Hydropsyche maroccana* and could be distinguished through proper preparation, particularly by examining the genital complex of segment X.

Another important character state is the well-exposed lateral and vertical profile of the phallic organ, which can be observed without requiring additional preparation. The following species belong to this complex: *H. algirica* sp. nov.; *H. dbabcha* sp. nov.; *H. demavenda* Malicky, 1977; *H. exocellata* Dufour, 1841; *H. farrahae* sp. nov., *H. gemecika* Malicky, 1981; *H. guitna* sp. nov.; *H. integrata* Mey, 1981; *H. maderensis* Hagen, 1865; *H. maroccana* Navas, 1935; *H. nador* Ibrahimi, 2023; *H. resmineda* Malicky, 1977; *H. rovnaka* Oláh, 2020; *H. sattleri* Tobias, 1972; *H. tenerifa* sp. nov.

Hydropsyche algirica Oláh & B. Samraoui, sp. nov.

(Figures 5f–5j)

Material examined. Holotype: ALGERIA: Mount Edough, O. Agab, 16.v.2021, leg. Boudjéma Samraoui (male, OPC). Paratypes: Pont Ain Makhlouf, 31.iii.2023, leg Boudjéma Samraoui (1 male, OPC), Pont Ain Makhlouf, 1.ii.2023, leg Boudjéma Samraoui (1 male, OPC).

Diagnosis. This new species belongs to the *Hydropsyche guttata* Subgroup. It is characterized by fused sclerotized endothecal processes, the absence of a digitiform apicoventralsetose lobe, and the absence of angular, subapical lateral projections before the cleaved apex of the phallotheca (Oláh & Johanson 2008). With a low basal curvature of the phallic organ, it is classified as a member of the *Hydropsyche modesta* Species Unit (Oláh *et al*. 2020). This small and light species is part of the *Hydropsyche exocellata* Species Complex, but it differs from other members of the complex through a combination of distinct character states. These include a very dilated, almost triangular head of the harpago in ventral view, a short and narrow triangular dorsal keel of segment IX, a highly developed and elongated subapical dilation of the phallic organ in ventral view, as well as a particularly unique lateral fine structure of the phallic apical region in lateral view.

Description. Male (in ethanol). Small sized species. Body yellowish light brown; dorsal thoracic sclerites slightly darker. Forewing brown, marbled with lighter spotted pattern. Length of forewing 8 mm.

Male genitalia. Segment IX fused annular and short, particularly on ventrum; median keel short, shorter than following dorsum of segment X; long triangular in dorsal view with granulose dorsal surface, less produced keel representing entire dorsum of segment IX shifted posterad; apical lobe on posterolateral margin rounded triangular. Intersegmental profile between ninth and tenth segments just downward directed slope. Segment X short semicircular, with much reduced setaless winglets in lateral view and triangular lobes in dorsal view; lateral setose area, cerci circular and located in apical position; ventroapical setose lobes vestigial. Coxopodite of gonopod slightly longer than apex of segment X; harpago with highly dilated apex. Phallic organ with parallel-sided tube arching low in lateral view; subapical lateral dilatation on phallic head highly produced and long in ventral view.

Etymology. Coined from the name of the type locality, as a noun in apposition.

Hydropsyche dbabcha Oláh & B. Samraoui, sp. nov.

(Figures 6a–6e)

Material examined. Holotype: ALGERIA: Dbabcha, 28.v.2020, leg Boudjéma Samraoui (male, OPC).

Diagnosis. This new species belongs to the *Hydropsyche guttata* Subgroup within the *H. angustipennis* Species Group. With a slight basal curvature of the phallic organ, it is classified as a member of the *Hydropsyche modesta* Secies Unit (Oláh *et al*. 2020). This small brown species is part of the *Hydropsyche exocellata* Species Complex and has some similarities with *Hydropsyche nador* Ibrahimi, Mabrouki & Taybi, 2023 (Mabrouki *et al*. 2023). However, there are sig

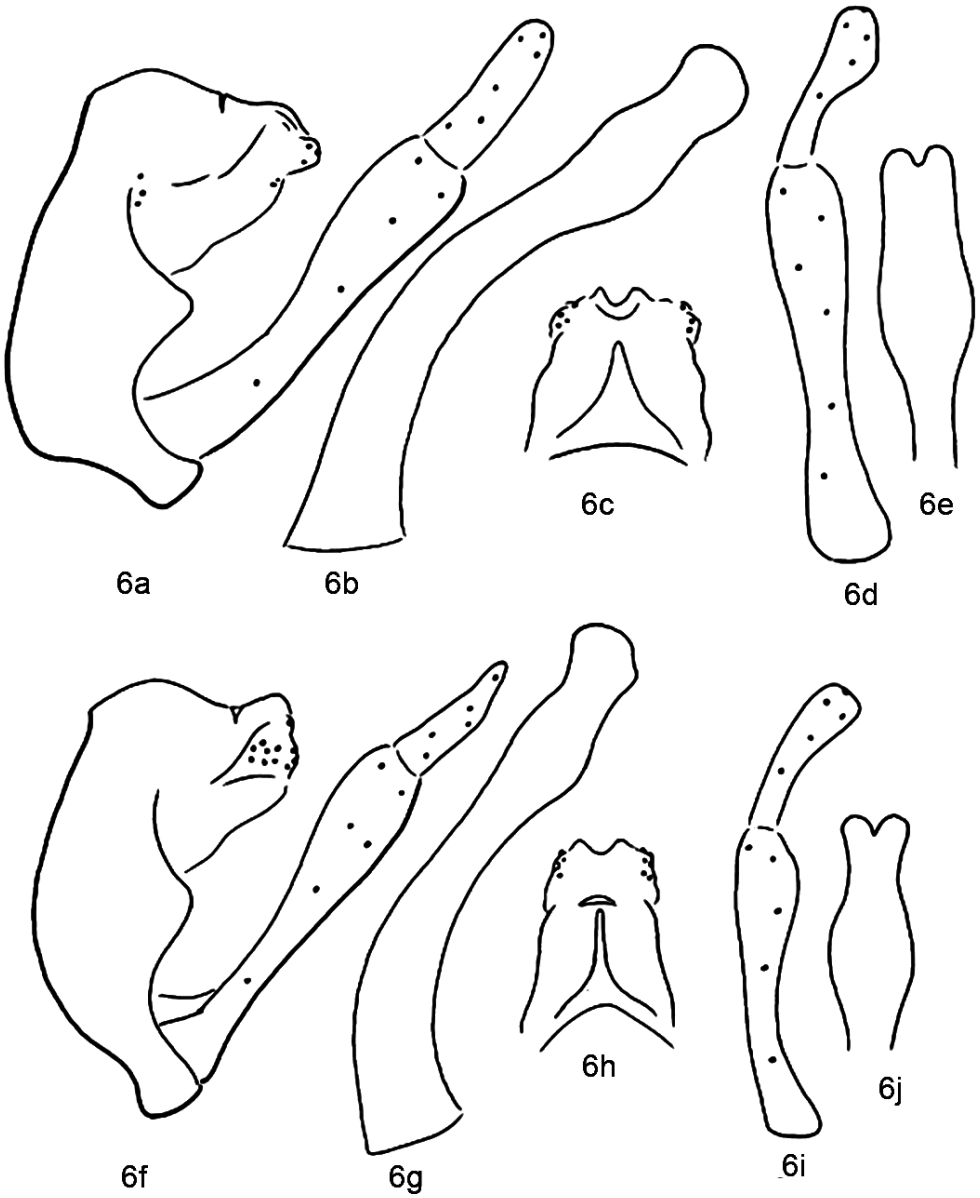

Figure 6. Genitalia of *Hydropsyche* spp. 6a–6e, *Hydropsyche dbabcha* Oláh & B. Samraoui, sp. nov. Holotype: 6a = left lateral; 6b = phallic organ, left lateral; 6c, segments IX and X, dorsal; 6d = left gonopod, ventral; 6e, phallic apex, ventral. 6f–6j, *Hydropsyche farrahae* Oláh & B. Samraoui, sp. nov. Holotype: 6f = left lateral; 6g = phallic organ, left lateral; 6h = segments IX and X, dorsal; 6i = left gonopod, ventral; 6j = phallic apex, ventral.

nificant differences between them. First, this species has a longer dorsal keel in segment IX. Second, it has a triangular apical lobe on the posterolateral margin of segment IX. It also has a more pronounced apicoventral setose lobe fused to the cercus. The harpago is spatulate, and the fine structure of the phallic organ differs in both lateral and ventral profiles. The dilated section is longer, and the apical lobes are rounded and not inclined laterally.

Description. Male (in ethanol). Medium sized species. Body light brown; dorsal thoracic sclerites slightly darker. Forewing brown, marbled with lighter spotted pattern. Length of forewing 8 mm.

Male genitalia. Segment IX fused annular and short, particularly on ventrum; median keel long triangular, longer than following dorsum of segment X; apical lobe on posterolateral margin triangular. Intersegmental profile between ninth and tenth segments just downward directed slope. Segment X short semicircular, with much reduced setaless winglets in lateral view and triangular lobes in dorsal view; lateral setose area, cerci circular and located in apical position; fused with ventroapical setose lobes. Coxopodite of gonopod slightly longer than apex of segment X; harpago with highly dilated apex. Phallic organ with parallel-sided tube arching low in lateral view; subapical lateral dilatation on phallic head highly produced and long, slightly decreasing to apex in ventral view.

Etymology. Coined from the name of the type locality, as a noun in apposition.

Hydropsyche farrahae Oláh & B. Samraoui, sp. nov.

(Figures 6f–6j)

Material examined. Holotype: ALGERIA: Dbabcha, 10.ix.2020, leg Boudjéma Samraoui (male, OPC). Paratypes: Dbabcha, 5.ix.2020, leg Boudjéma Samraoui (1 male, OPC), Dbabcha, 14.vii.2020, leg Boudjéma Samraoui (2 males, OPC), Dbabcha, 28.viii.2020, leg Boudjéma Samraoui (1 male, OPC).

Diagnosis. This new species belongs to the *Hydropsyche guttata* Subgroup within the *H. angustipennis* Species Group. With a slight basal curvature of the phallic organ, it is classified as a member of the *Hydropsyche modesta* Species Unit (Oláh *et al*. 2020). This small, pale species is a member of the *Hydropsyche exocellata* Species Complex, but differs from the other members by a distinct combination of character states. These include a slightly and gradually dilating head of the harpagos in ventral view, a very long and narrow dorsal keel of segment IX, a strongly pronounced and long subapical dilatation of the phallic organ followed by laterally pronounced apical lobes in ventral view, and a particularly shaped lateral fine structure of the phallic apical region in lateral view.

Description. Male (in ethanol). Small sized species. Body yellowish light brown; dorsal thoracic sclerites slightly darker. Forewing brown, marbled with lighter spotted pattern. Length of forewing 6 mm.

Male genitalia. Segment IX fused annular and short, particularly on ventrum; median keel long, much longer than following dorsum of segment X; long and very narrow in dorsal view with granulose dorsal surface; apical lobe on posterolateral margin short, rounded triangular. Intersegmental profile between ninth and tenth segments forming shallow concavity. Segment X short quadrangular, with reduced setaless winglets in lateral view and triangular lobes in dorsal view; lateral setose area, cerci circular and located in middle position; ventroapical setose lobes vestigial. Coxopodite of gonopod slightly longer than apex of segment X; harpago with slightly dilating apex. Phallic organ with parallel-sided tube arching low in lateral view; subapical lateral dilatation on phallic head highly produced and long and followed by dilating apical lobes in ventral view.

Etymology. This new species is dedicated to the first author's wife in honour of her contribution and permanent support to these studies.

Hydropsyche guitna Oláh & B. Samraoui, sp. nov.

(Figures 7a–7e)

Material examined. Holotype: ALGERIA: El Kala region, Guitna inf, 7.v.2021, leg Boudjéma Samraoui (male, OPC).

Diagnosis. This newly discovered species belongs to the *Hydropsyche guttata* Subgroup within the *H. angustipennis* Species Group. Due to its low basal curvature of the phallic organ, it is classified as a member of the *Hydropsyche modesta* Species Unit (Oláh *et al*. 2020). Despite belonging to the *Hydropsyche exocellata* Species Complex, this species is distinguished from the other members by the following combination of

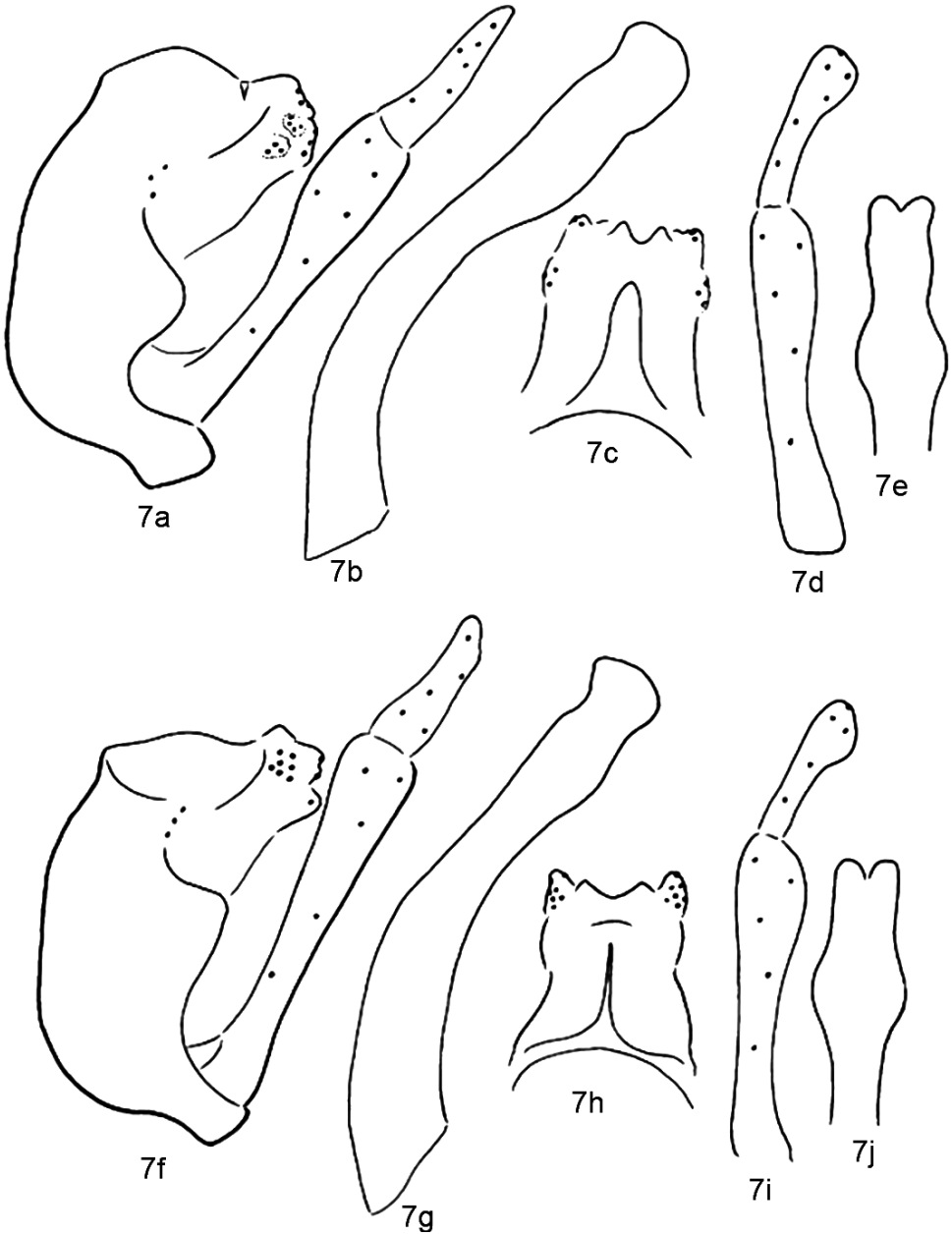

Figure 7. Genitalia of *Hydropsyche* spp. 7a–7e, *Hydropsyche guitna* Oláh & B. Samraoui, sp. nov. Holotype: 7a = left lateral; 7b = phallic organ, left lateral; 7c = segments IX and X, dorsal; 7d = left gonopod, ventral; 7e = phallic apex, ventral. 7f–7j, *Hydropsyche tenerifa* Oláh, sp. nov. Holotype: 7f = genitalia in left lateral view, 7g = phallic organ in left lateral view, 7h = segments IX and X in dorsal view, 7i = left gonopod in ventral view, 7j = phallic apex in ventral view.

character states: a slightly dilating head of the harpago in ventral view, a long and broad dorsal keel of segment IX; a produced and short subapical dilatation of the phallic organ followed by a small recognizable dilatation in front of the apex in ventral view, and a distinct lateral fine structure of the phallic apical region in lateral view.

Description. Male (in ethanol). Small sized species. Body light brown; dorsal thoracic sclerites slightly darker. Forewing brown, marbled

with lighter spotted pattern. Length of forewing 6 mm.

Male genitalia. Segment IX fused annular and short, particularly on ventrum; median keel long, much longer than the following dorsum of segment X; long and broad in dorsal view with granulose dorsal surface; apical lobe on posterolateral margin short, rounded triangular. Intersegmental profile between the ninth and tenth segments forming a rounded triangular shallow concavity. Segment X short quadrangular both in lateral and dorsal views, with reduced setaless winglets in lateral view and triangular lobes in dorsal view; lateral setose area, cerci subdivided and located in middle position; ventroapical setose lobes vestigial. Coxopodite of gonopod slightly longer than apex of segment X; harpago with slightly dilating apex. Phallic organ with parallel-sided tube arching low in lateral view; subapical lateral dilatation on phallic head highly produced, short and followed by small dilatation in ventral view.

Etymology. Coined from the name of the type locality, as a noun in apposition.

***Hydropsyche tenerifa* Oláh, sp. nov.**

(Figures 7f–7j)

Material examined. Holotype: CANARY ISLANDS: Tenerife, Icod de Los Vinos, 150 m, leg. K. M. Guichard & P. H. Ward, 12.vii.1966, (male, OPC). Paratypes: same as holotype (2 males, OPC). Tenerife, El Pinalete, 200 m, leg. K. M. Guichard & P. H. Ward, 13.vii.1966, (3 males, BMNH).

Diagnosis. This new species belongs to the *Hydropsyche guttata* Subgroup within the *H. angustipennis* Species Group.. Due to its low basal curvature of the phallic organ, it is classified as a member of the *Hydropsyche modesta* Species Unit (Oláh *et al*. 2020). This small and light species is part of the *Hydropsyche exocellata* Species Complex but differs from others within the complex through a combination of distinct character states. These include a dilated, rounded triangular head of the harpago in ventral view, a long and very narrow dorsal keel of segment IX that resembles a knife-like shape, a highly developed and elongated subapical dilation of the phallic organ in ventral view, as well as a particularly unique lateral fine structure of the phallic apical region in lateral view.

Description. Male (in ethanol). Small sized species. Body light brown; dorsal thoracic sclerites slightly darker. Forewing brown, marbled with lighter spotted pattern. Length of forewing 8 mm.

Male genitalia. Segment IX fused annular and short, particularly on ventrum; median keel long, longer than following dorsum of segment X; long narrow in dorsal view with granulose dorsal surface, narrow, knife-like produced keel representing entire dorsum of segment IX shifted posterad; apical lobe on posterolateral margin rounded triangular. Intersegmental profile between ninth and tenth segments forming a small triangular concavity. Segment X short trilobed in lateral view, with much reduced pair of setaless winglets triangular both in lateral and dorsal views; lateral setose area, cerci circular and located in apical position; ventroapical setose lobes small. Coxopodite of gonopod slightly longer than apex of segment X; harpago with highly dilated apex. Phallic organ with parallel-sided tube arching low in lateral view; subapical lateral dilatation on phallic head highly produced and long in ventral view.

Etymology. Coined from the name of the type locality, as a noun in apposition.

***Hydropsyche instabilis* Species Subgroup**

The species of this Subgroup show a complete fusion of the sclerotized endotheca with the apex of the phallotheca. The apical region of the phallic organ may or may not have an angular subapical lateral projection preceding the cleft apex of the phallotheca, while it consistently has digitized apicoventral setose lobes of varying development.

***Hydropsyche chenioura* Oláh & B. Samraoui, sp. nov.**

(Figures 8a–8e)

Material examined. Holotype: ALGERIA: Cheniour, 1.vii.2021, leg Boudjéma Samraoui (male, OPC). Paratypes: Cheniour, 10.v.2021, leg Boudjéma Samraoui (1 male, OPC), Cheniour, 8.ii.2021, leg Boudjéma Samraoui (2 males, OPC).

Diagnosis. This newly discovered species belongs to the *Hydropsyche instabilis* Subgroup within the *H. angustipennis* Species Group. It is characterized by fused, sclerotized endothecal processes that have a digitiform, apicoventral, setose lobe, and the presence or absence of angular, subapical, lateral projections anterior to the split apex of the phallotheca (Oláh & Johanson 2008). However, the angular subapical projection is absent in this species. It resembles *Hydropsyche morla* Malicky & Lounaci, 1987, but differs in the longer dorsal keel of segment IX, the presence of longer, setaless winglets on segment X, the ventral position of the digitiforms (instead of dorsal), and the divergent fine structure of the phallic organ, both in lateral and dorsal view.

Description. Male (in ethanol). Medium sized species. Body brown; dorsal thoracic sclerites darker. Forewing brown, marbled with lighter spotted pattern. Length of forewing 9 mm.

Male genitalia. Segment IX fused annular and short, particularly on ventrum; median keel long and broad in dorsal view with granulose dorsal surface, well produced keel representing entire dorsum of segment IX shifted posterad; apical lobe on posterolateral margin well produced, rounded triangular. Intersegmental profile between ninth and tenth segments short and shallow concavity. Segment X as long as keel, with produced elongated setaless winglets in lateral view and elongated trough in dorsal view; lateral setose area, cerci circular and located in middle position; ventroapical setose lobes forming short digitiform process with apical setae accompanied by small ventroapical setose rounded lobe in lateral view. Coxopodite of gonopod as long as apex of segment X, harpago parallel-sided with slight apical dilatation and mesad curving in ventral view. Phallic organ almost parallel-sided tube, basal bending very low in lateral view; subapical lateral projection on phallic head lacking, apical region slightly constricted.

Etymology. Coined from the name of the type locality, as a noun in apposition.

***Hydropsyche edougha* Oláh & B. Samraoui, sp. nov.**

(Figures 8f–8j)

Material examined. Holotype: ALGERIA: Mount Edough, O. Agab, 1.vii.2021, leg Boudjéma Samraoui (male, OPC). Paratypes: Mount Edough, O. Agab, 20.vi.2021, leg Boudjéma Samraoui (1 male, OPC), Mount Edough, O. Agab, 11.vii.2021, leg Boudjéma Samraoui (1 male, OPC), Mount Edough, O. Agab, 5.vi.2021, leg Boudjéma Samraoui (1 male, OPC).

Diagnosis. This new species belongs to the *Hydropsyche instabilis* Subgroup in the *H. angustipennis* Species Group. The angular subapical projection being almost lacking or vestigial. In terms of the shape of the long dorsal keel of segment IX, it closely resembles *H. obscura* Navas, 1928. However, it differs from *H. obscura* in having a shorter segment IX and a lower apical lobe of segment IX, which are more similar to *H. morla* Malicky & Lounaci, 1987. Furthermore, both the lateral and ventral shape of the phallic organ distinguishes it from both species.

Description. Male (in ethanol). Small sized species. Body dark brown; dorsal thoracic sclerites darker. Forewing brown, marbled with lighter spotted pattern. Length of forewing 8 mm.

Male genitalia. Segment IX fused annular and short, particularly on ventrum; median keel long, slightly dilated on midway in dorsal view with granulose dorsal surface, well produced keel representing entire dorsum of segment IX shifted posterad; apical lobe on posterolateral margin

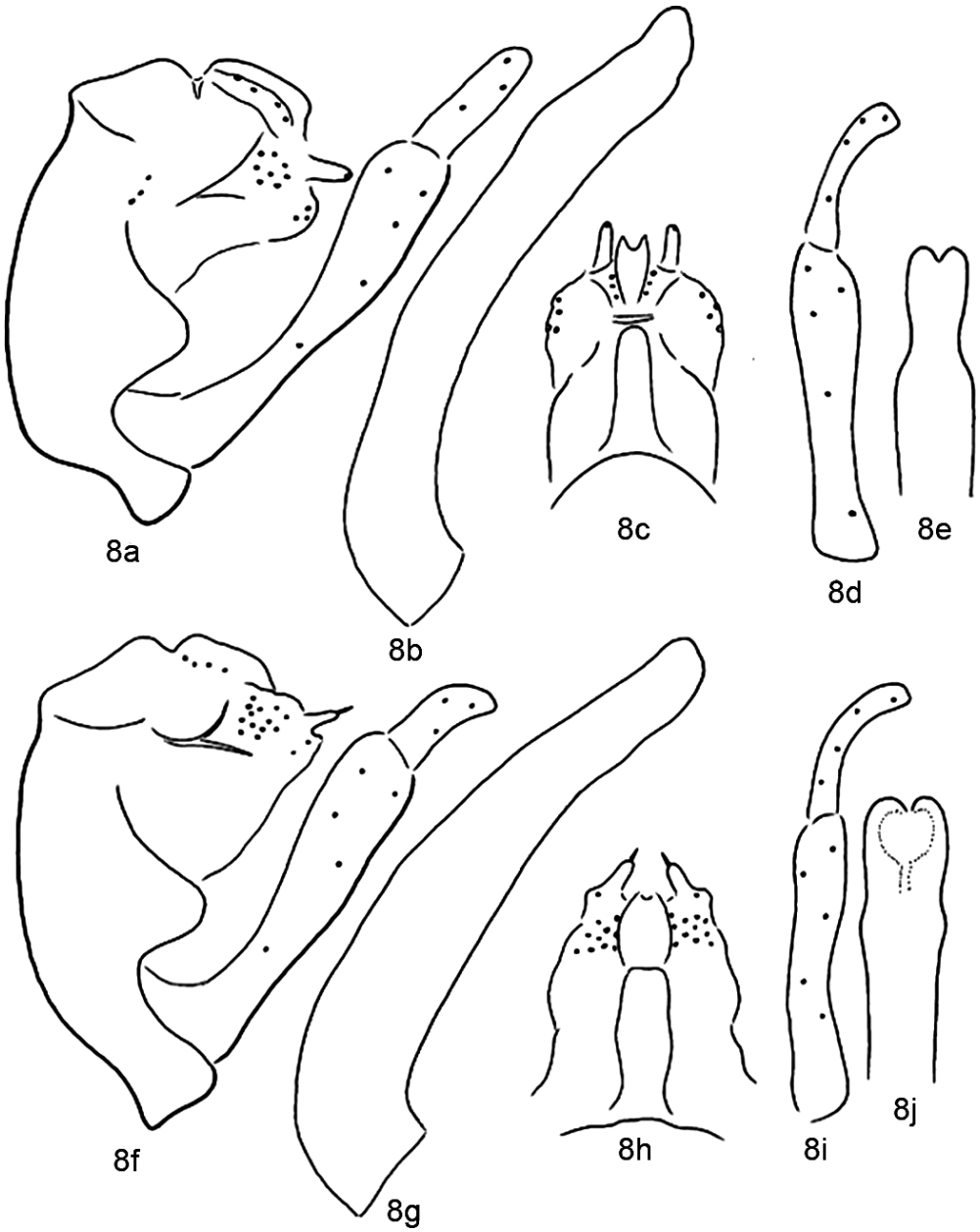

Figure 8. Genitalia of *Hydropsyche* spp. 8a–8e, *Hydropsyche chenioura* Oláh & B. Samraoui, sp. nov. Holotype: 8a = genitalia in left lateral view, 8b = phallic organ in left lateral view, 8c = segments IX and X in dorsal view, 8d = left gonopod in ventral view, 8e = phallic apex in ventral view, 8f–8j, *Hydropsyche edougha* Oláh & B. Samraoui, sp. nov. Holotype: 8f = genitalia in left lateral view, 8g = phallic organ in left lateral view, 8h = segments IX and X in dorsal view, 8i = left gonopod in ventral view, 8j = phallic apex in ventral view.

rounded triangular. Intersegmental profile between ninth and tenth segments small triangular. Segment X short triangular, with produced elongated setaless winglets in lateral view and elongated trough in dorsal view; lateral setose area, cerci circular and located in apical position; ventroapical setose lobes forming short digitiform process with apical setae accompanied by small ventroapical setose lobe in lateral view. Coxopodite of gonopod as long as apex of segment X, harpago parallel-sided and mesad curving in ventral view. Phallic organ with robust basal two

thirds and slightly narrower on apical third, basal bending very low in lateral view; subapical lateral projection on phallic head vestigial, almost lacking.

Etymology. Coined from the name of the type locality, as a noun in apposition.

Hydropsyche louara Oláh & B. Samraoui, sp. nov.

(Figures 9a–9e)

Material examined. Holotype: ALGERIA: El Kala region, Louar inf., 22.v.2021, leg Boudjéma Samraoui (male, OPC).

Diagnosis. This newly discovered species belongs to the *Hydropsyche instabilis* Subgroup within the *H. angustipennis* Species Group. The angular subapical projection is present in this species. Although it bears a resemblance to *Hydropsyche edougha* sp. nov., it can be distinguished by several features. First, the dorsoapical setose lobe is displaced anteriorly. Second, it has upwardly directed, triangular, setaless winglets on segment X. Third, the digitiform processes are located ventrally rather than dorsally. In addition, the fine structure of the phallic organ differs in both lateral and dorsal views. It looks more slender and has a distinct apical area in both lateral and ventral views.

Description. Male (in ethanol). Large sized species. Body brown; dorsal thoracic sclerites darker. Forewing brown, marbled with lighter spotted pattern. Length of forewing 11 mm. *Male genitalia*. Segment IX fused annular and short, particularly on ventrum; median keel long and broad in dorsal view with granulose dorsal surface, well produced keel representing entire dorsum of segment IX shifted posterad; apical lobe on posterolateral margin well produced, rounded triangular. Intersegmental profile between ninth and tenth segments very short and shallow gap, occupied by anterad shifted dorsoapical setose lobe accompanying setaless winglets. Segment X as long as keel, with upward produced triangular setaless winglets in lateral view and elongated trough in dorsal view; lateral setose area, cerci circular and located in middle position; ventroapical setose lobes forming short digitiform process with apical setae accompanied by small, almost vestigial ventroapical setose rounded lobe in lateral view. Coxopodite of gonopod as long as apex of segment X, harpago parallel-sided and mesad curving in ventral view. Phallic organ almost parallel-sided tube, basal bending very low in lateral view; subapical lateral projection on phallic head present and small.

Etymology. Coined from the name of the type locality, as a noun in apposition.

Hydropsyche vinconi Oláh & B. Samraoui, sp. nov.

(Figures 9f–9j)

Material examined. Holotype: ALGERIA: Cheniour, 15.iv.2023, leg Boudjéma Samraoui (male, OPC). Paratypes: Cheniour, 22.iv.2021, leg Boudjéma Samraoui (2 males, OPC), Cheniour, 8.v. 2021, leg Boudjéma Samraoui (3 males, OPC).

Diagnosis. This newly discovered species belongs to the *Hydropsyche instabilis* Subgroup within the *H. angustipennis* Species Group. The angular subapical projection is present in this species. Although it bears similarity to *Hydropsyche morla* Malicky & Lounaci, 1987, it can be distinguished by several features. First, it differs by having a much more pronounced dorsal keel of segment X. It also has upwardly directed, traingular, setaless winglets on segment X. The digitiform processes are located inferiorly rather than dorsally. In addition, the fine structure of the phallic organ differs in both lateral and dorsal views. In ventral view, it is characterized by a more pronounced basal curvature and a subapical constriction instead of a dilation subapicad.

Description. Male (in ethanol). Large sized species. Body brown; dorsal thoracic sclerites darker. Forewing brown, marbled with lighter spotted pattern. Length of forewing 11 mm.

Male genitalia. Segment IX fused annular and short, particularly on ventrum; median keel long

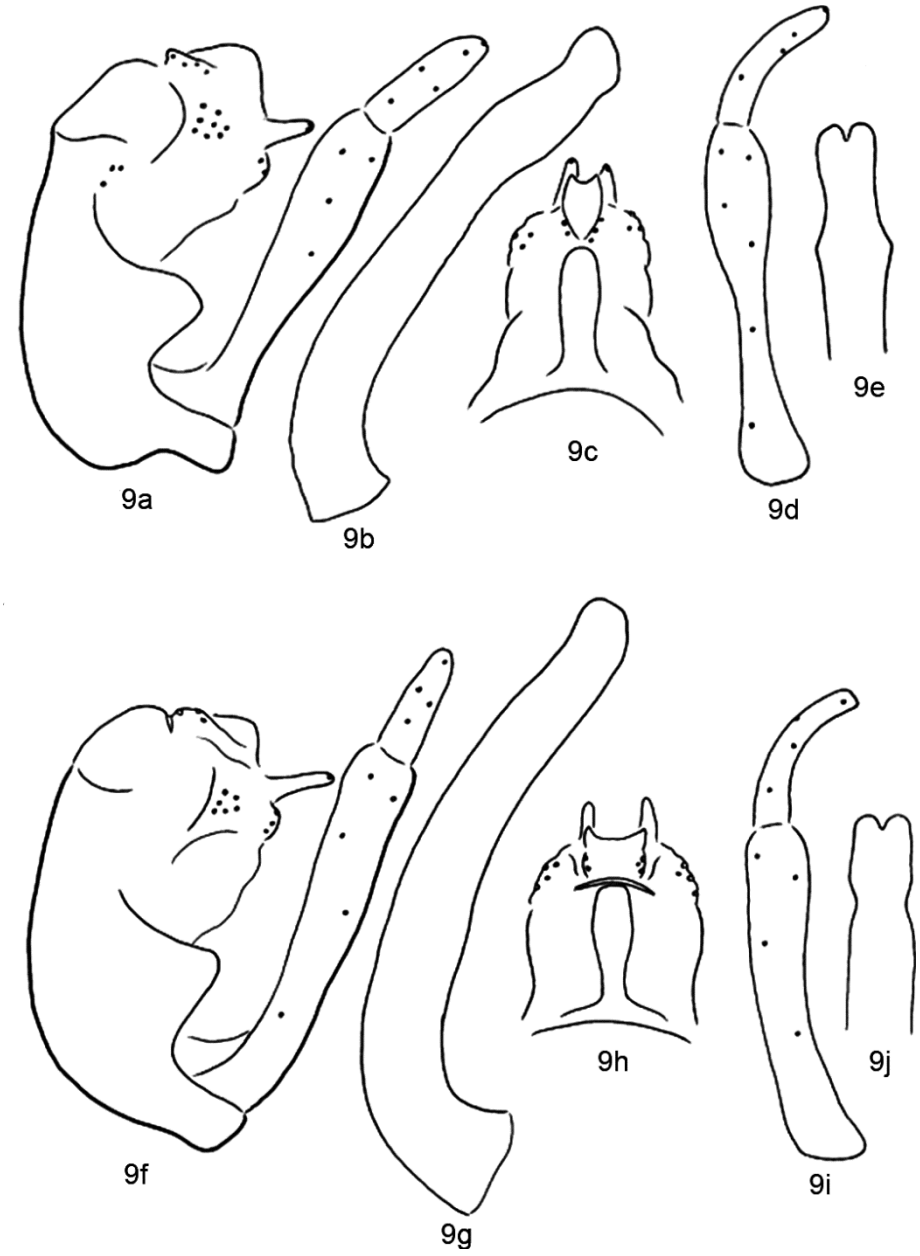

Figure 9. Genitalia of *Hydropsyche* spp. 9a–9e, *Hydropsyche louara* Oláh & B. Samraoui sp. nov. Holotype: 9a = genitalia in left lateral view, 9b = phallic organ in left lateral view, 9c = segments IX and X in dorsal view, 9d = left gonopod in ventral view, 9e = phallic apex in ventral view, 9f–9j, *Hydropsyche vinconi* Oláh & B. Samraoui sp. nov. Holotype: 9f = genitalia in left lateral view, 9g = phallic organ in left lateral view, 9h=segments IX and X in dorsal view, 9i = left gonopod in ventral view, 9j = phallic apex in ventral view.

and broad in dorsal view with granulose dorsal surface, well produced keel representing entire dorsum of segment IX shifted posterad; apical lobe on posterolateral margin well produced, triangular. Intersegmental profile between ninth and tenth segments very short and shallow gap, occupied by anterad shifted dorsoapical setose lobe accompanying setaless winglets. Segment X as long as keel, with upward produced triangular setaless winglets in lateral view and elongated

trough in dorsal view; lateral setose area, cerci circular and located in middle position; ventroapical setose lobes forming short digitiform process with apical setae accompanied by small, ventroapical setose rounded lobe in lateral view. Coxopodite of gonopod as long as apex of segment X, harpago parallel-sided and mesad curving in ventral view. Phallic organ almost parallel-sided tube, basal bending produced in lateral view; subapical constriction on phallic head present in ventral view.

Etymology. Named in honour of the renowned French entomologist, Gilles Vinçon, who has dedicated his scientific life to aquatic insects.

Hydropsyche pellucidula species Subgroup

The species of this Subgroup show a complete fusion of the sclerotized endotheca with the apex of the phallotheca. The apical region of the phallic organ is characterized by an angular subapical lateral projection in front of the cleaved apex of the phallotheca, although the digitiform apicoventral setose lobes are absent.

We have discovered two new species, *Hydropsyche linae* and *Hydropsyche nardjissae*, which we assign to the species Subgroup of *Hydropsyche pellucidula*. It is worth noting that although the subapical lateral projection of the phallic organ is not perfectly angular but appears rounded, especially in *H. nardjissae* sp. nov., the lateral profile of their short and stout phallic organ establishes a clear relationship between them. In addition, the lateral projection of *H. linae* sp. nov. shows similarity to *Hydropsyche lobata* McLachlan, 1884; *Hydropsyche brevis* Mosely, 1930; and *Hydropsyche artax* Malicky & Lounaci, 1987, all of them belong to the *H. pellucidula* Subgroup.

It is important to note, however, that such character incongruences are not uncommon in the process of lineage formation. In the context of speciation, chimerism is supported by both morphological character analysis and molecular taxonomy (Bapteste *et al*. 2013). Tree species often have an infinite number of incongruent traits. Species are inherently more chimeric than Mayr's species concept allows. Reticulation tends to dominate over branching, and retigeny or dictiongeny takes precedence over phylogeny (Oláh *et al*. 2019).

Hydropsyche linae Oláh & B. Samraoui, sp. nov.

(Figures 10a–10e)

Material examined. Holotype: ALGERIA: El Kala region, Nouazi, 16.vii.2021, leg. Boudjéma Samraoui (male, OPC).

Diagnosis. This new species belongs to the *Hydropsyche pellucidula* Subgroup within the *H. angustipennis* Species Group. It is characterized by fused, sclerotized endothecal processes, the absence of a digitiform, apicoventral, setose lobe, and the presence of angular subapical and lateral projections anterior to the split apex of the phallotheca (Oláh & Johanson 2008). The angular subapical projection is present but not distinct. The species bears a resemblance to *Hydropsyche artax* Malicky & Lounaci, 1987, but can be distinguished by several features. These include a longer but narrower dorsal keel on segment X, the presence of small triangular winglets without upwardly projecting setae on segment X, the presence of a recognizable apicoventral setose lobe on segment X, and distinct differences in the fine structure of the phallic organ when viewed both laterally and dorsally. In addition, the basal curvature is less pronounced, almost rudimentary, resulting in an almost straight horizontal dorsum instead of a curved dorsum. In lateral view, the tip of the phallotheca narrows and shifts downward.

Description. Male (in ethanol). Small sized species. Body light brown; dorsal thoracic sclerites darker. Forewing brown, marbled with lighter spotted pattern. Length of forewing 8 mm.

Male genitalia. Segment IX fused annular and short, particularly on ventrum; median keel long and narrow in dorsal view with granulose dorsal surface, well produced keel representing entire dorsum of segment IX shifted posterad; apical lobe on posterolateral margin well produced,

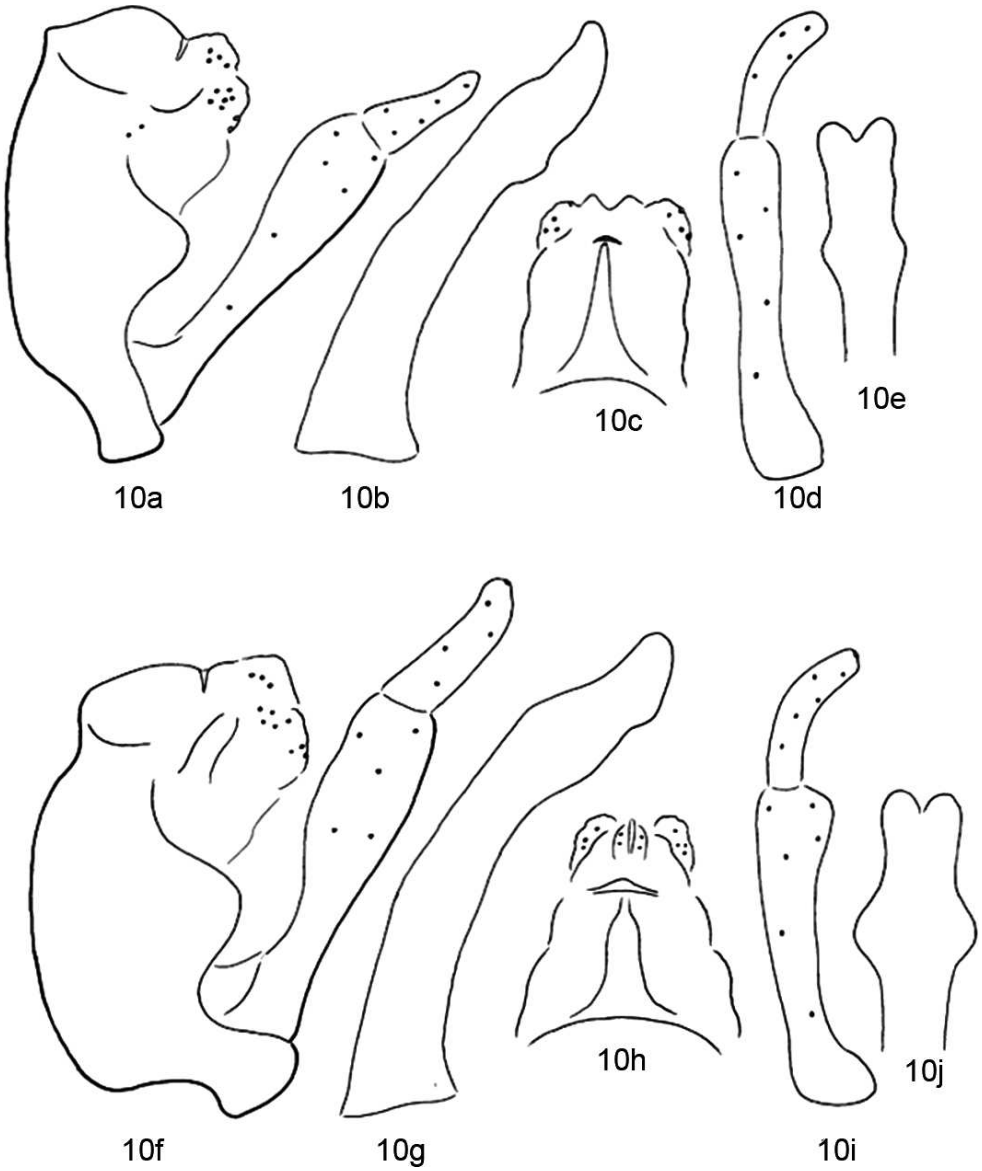

Figure 10. Genitalia of *Hydropsyche* spp. 10a–10e, *Hydropsyche linae* Oláh & B. Samraoui, sp. nov. Holotype: 10a = genitalia in left lateral view, 10b = phallic organ in left lateral view, 10c = segments IX and X in dorsal view, 10d = left gonopod in ventral view, 10e = phallic apex in ventral view. 10f–10j, *Hydropsyche nardjissae* Oláh & B. Samraoui, sp. nov. Holotype: 10f = genitalia in left lateral view, 10g = phallic organ in left lateral view, 10h = segments IX and X in dorsal view, 10i = left gonopod in ventral view, 10j = phallic apex in ventral view.

rounded triangular. Intersegmental profile between ninth and tenth segments very shallow triangular gap. Segment X half as long as keel, with upward produced small triangular setaless winglets in lateral view and triangular lobe in dorsal view; dorsoapical setose lobe present below setaless winglets; lateral setose area, cerci circular and located in subapical position; ventroapical setose lobes present and small in lateral view. Coxopodite of gonopod as long as apex of segment X, harpago parallel-sided and mesad curving in ventral view. Phallic organ forms an almost horizontal tube short and broad without basal bending; subapical lateral projection present, but small and rounded and followed by tiny just discernible dilatation before apex.

Etymology. Named in honour of the first author's twin daughter Halima Lina.

Hydropsyche nardjissae Oláh & B. Samraoui, sp. nov.

(Figures 10f–10j)

Material examined. Holotype: ALGERIA: El Kala region, Nouazi, 14.v.2023, leg. Boudjéma Samraoui (male, OPC). Paratypes: El Kala region, Nouazi, 16.vi.2023, leg. Boudjéma Samraoui (2 males, OPC), El Kala region, Nouazi, 25.vii.2023, leg. Boudjéma Samraoui (2 males, OPC).

Diagnosis. This new species belongs to the *Hydropsyche pellucidula* Subgroup within the *H. angustipennis* Species Group. The subapical lateral projection on the phallic organ of *Hydropsyche nardjissae* is present and strongly developed, but it is rounded rather than angular. These subapical lobes resemble those of the *Hydropsyche exocellata* Species Complex of the *Hydropsyche modesta* Species Unit. However, the overall structure of the phallic organ resembles that of *Hydropsyche linae* sp. nov., which associates this species with the *Hydropsyche pellucidula* Species Subgroup. *Hydropsyche nardjissae* sp. nov. differs from *Hydropsyche linae* sp. nov. in several aspects. These include the broader dorsal keel of segment X, the more pronounced development of segment X, and the distinct fine structure of the phallic organ in both lateral and dorsal views. The subapical lateral lobes are also larger and rounded, and the apical region is displaced downward and less pointed.

Description. Male (in ethanol). Medium sized species. Body brown; dorsal thoracic sclerites darker. Forewing brown, marbled with lighter spotted pattern. Length of forewing 10 mm.

Male genitalia. Segment IX fused annular and short, particularly on ventrum; median keel long and broad in dorsal view with granulose dorsal surface, well produced keel representing entire dorsum of segment IX shifted posterad; apical lobe on posterolateral margin well produced, rounded triangular. Intersegmental profile between ninth and tenth segments almost without any gap or depression, only vestigial suture visible delineating fusion line of segment IX and X. Segment X little more than half as long as keel, with upward produced small triangular setaless winglets dorsoapicad in lateral view; dorsoapical setose lobe present below setaless winglets; lateral setose area, cerci circular and located in subapical position; ventroapical setose lobes present and small in lateral view. Coxopodite of gonopod as long as apex of segment X, harpago parallel-sided and mesad curving in ventral view. Phallic organ forms an almost horizontal tube short and broad without basal bending; subapical lateral projection present, large and rounded.

Etymology. Named in honour of the first author's twin daughter Nardjissa Nesrine.

Rhyacophilidae Stephens, 1836

Rhyacophila munda McLachlan, 1862

Material examined. ALGERIA: El Kala region, O. Louar sup, 25.ii.2020, leg. Boudjéma Samraoui (1 male, 1 female, OPC).

Remark. This species starts flying before the end of the winter.

Glossosomatidae Wallengren, 1891

Agapetinae Martynov, 1913

Agapetus Curtis, 1934

The genus *Agapetus* occurs primarily in first-order streams and is mainly observed in habitats that remain unaffected by anthropogenic stressors (Figs. 11a-d). This particular characteristic makes *Agapetus* a potentially valuable indicator species for assessing and monitoring the ecological integrity of freshwater ecosystems (Nijboer 2004). The genus *Agapetus* is characterized by a phallic organ that exhibits various stages of development, often with reduced structural components. In more complex character states, the phallic organ consists of the phallobase, endotheca, and aedeagus with dorsal and ventral arms and typically a single fused paramere on the dorsal side. How-

ever, the phallic organ is usually deeply retracted into the genitalia, so its structure is often hidden, poorly visible, and sometimes even unrecognizable. For this reason, its structure is rarely described in detail in species descriptions.

Agapetus incertulus Species Complex

The *Agapetus incertulus* Species Complex includes a small group of species such as *Agapetus dakki* Malicky & Lounaci, 1987; *A. ferrerasi* sp. nov.; *A. fuscus* Vaillant, 1954; *A. incertulus* McLachlan, 1884; *A. numidicus* Vaillant, 1954; and *A. yasminae* sp. nov. These species possess a phallic organ consisting of the phallobase, the variously developed phallotheca, the endotheca, the aedeagus, and the paramere. The aedeagus consists of a dorsal branch and a ventral branch. The dorsal branch is formed by the independently developed ejaculatory duct. The bilobed apex of the ventral branch is greatly elongated, forming a divergent structure that has diagnostic potential for distinguishing closely related, incipient sibling species. Unfortunately, the original descriptions of the species in this complex do not clearly depict the complex structure of the phallic organ. However, in this study, we use the lateral profile structure of the bilobed ventral branch of the aedeagus to distinguish two new species from Algeria within the complex without performing a comprehensive revision of the entire complex. A comprehensive review would require a larger number of specimens for each species, including type specimens that are not currently available. In addition to the lateral profile of the bilobed ventral arm of the aedeagus, we have identified the fine structure of the lateral profile of the gonopods and the spine-like ventral process of the sternite VI as reliable diagnostic characters.

Agapetus ferrerasi Oláh & B. Samraoui, sp. nov.

(Figures 12a–12d)

Material examined. Holotype: ALGERIA: Cheniour, 10.ix.2020, leg. Boudjéma Samraoui (male, OPC). Paratype: same as holotype (1 male, OPC).

Diagnosis. This new species is closely related to *Agapetus numidicus* Vaillant, 1954, but differs in the fine phenomics of genital structure. In particular, the lateral profile of the spine-like ventral process of sternite VI is characterized by a short, upwardly curved structure with a blade-like apex rather than a simple digitiform shape. In addition, the bilobed ventral arm of the aedeagus has a capitate-like appearance rather than a slight constriction in the anterior region. In addition, the gonopod of this new species is straight with a ventral concavity and a tapering apex, in contrast to the upwardly curved shape with a blunt apex in *Agapetus numidicus*.

Description. Small, almost black animal. Forewing length is just over 3 mm. General body and colour character states are almost identical with *Agapetus numidicus*.

Male genitalia. Segment IX subquadrangular in lateral view forms a complete fused ring-like structure with ventral suture or sulcus, remnant of pleuron and sternite fusion. Segment X less pigmented, except narrow basoventral more sclerotized strengthening structure. Cerci are lacking. Paraproct difficult to discern, but present as sclerotized lateral vertical plate supporting phallic organ, somehow copying shape of sclerotized part of segment X. Gonopod narrowing apicad with some ventral concavity in lateral profile; in ventral view with three mesal teeth and with single basal tooth. Phallic organ comprised of phallobase, endotheca, aedeagus and paramere; bilobed ventral arm of aedeagus capitate abruptly narrowing anterad.

Etymology. Species is named in honour of the first author's friend, Professor Manuel Ferreras Romero, a Spanish entomologist, who has dedicated his scientific life to aquatic insects.

Agapetus numidicus Vaillant, 1954

Material examined. ALGERIA: Cheniour, 10.ix.2020, leg. Boudjéma Samraoui (5 males, OPC), Cheniour, 8.iv.2021, leg. Boudjéma Sam raoui (15 males, OPC), Cheniour,ix. 3.2020, leg. Boudjéma Samraoui (10 males, OPC).

Figure 11. *Agapetus numidicus'* mating behavior (a, b, c). Stone with larvae of *A. numidicus* (d).

Remarks. The type specimen collected in Algeria, more precisely in the 'Ruisseau des Singes' near La Chiffa (Atlas de Bilda) between 210 and 300 m, was not available for our study. Therefore, we compare our two new species with the high-quality and detailed original drawings in the species description of Vaillant (1954). This species is relatively common at Cheniour and closely matches the original description and drawings. The gonopods have a slightly upcurved shape and are characterized by a rounded apex in lateral view, which is more rounded compared to *Agapetus yasminae* sp. nov. and *A. ferrerasi* sp. nov. The lateral profile of the bilobed ventral arm of the aedeagus tapers gradually anteriorly rather than abruptly. The species description does not include a drawn illustration of the lateral profile of the spine-like ventral process of the sternite VI; it is merely described as being as long as that of *A. fuscipes*. In our study, we provide detailed and finely drawn illustrations of the spine-like process for the two new species. The spine-like process on segment VI of our *Agapetus numidicus* specimens collected at Cheniour differs from that of *Agapetus yasminae* sp. nov. and *A. ferrerasi* sp. nov.

Agapetus yasminae Oláh & B. Samraoui, sp. nov.

(Figures 12e–12h)

Material examined. Holotype: ALGERIA: Mount Edough, O. Agab, 19.vi.2021, leg Boudjéma Samraoui (male, OPC).

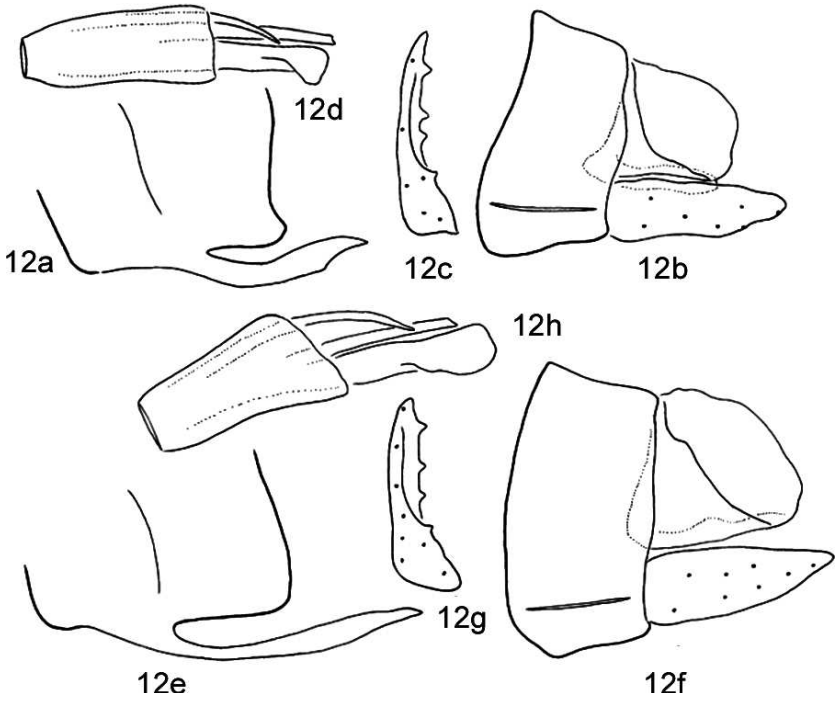

Figure 12. Genitalia of *Agapetus* spp. 12a–12h, *Agapetus ferrerasi* Oláh & B. Samraoui, sp. nov. Holotype: 12a = sternite VI with spine-like ventral process, 12b = genitalia in left lateral view, 12c = left gonopod in ventral view, 12d= phallic organ in left lateral view. (12e–12h), *Agapetus yasminae* Oláh & B. Samraoui, sp. nov. Holotype: 12e = sternite VI with spine-like ventral process, 12f=genitalia in left lateral view, 12g = left gonopod in ventral view, 12h = phallic organ in left lateral view.

Diagnosis. This new species is closely related to *Agapetus numidicus* Vaillant, 1954, but differs in the fine phenomics of the genitalia. In particular, the lateral profile of the spine-like ventral process of the sternite VI is long, almost straight, and slightly broadened in the middle, rather than exhibiting a simple digitiform shape. In addition, the bilobed ventral arm of the aedeagus has a clavate appearance rather than simply narrowing slightly anteriorly. In addition, the gonopod of this new species is straight with a tapering, almost pointed apex, as opposed to the upwardly curved shape with a blunt apex found in *Agapetus numidicus*.

Description. Small, almost black animal. Forewing length just over 3 mm. General body and colour character states almost identical with *Agapetus numidicus*.

Male genitalia. Segment IX subquadrangular in lateral view forms complete fused ring-like structure with ventral suture or sulcus, remnant of pleuron and sternite fusion. Segment X less pigmented, except broad basoventral more sclerotized strengthening structure. Cerci lacking. Paraproct difficult to discern, but present as sclerotized lateral vertical plate supporting phallic organ. Gonopod narrowing apicad with pointed apex in lateral profile; in ventral view with three mesal teeth and with single basal tooth. Phallic organ comprised of phallobase, endotheca, aedeagus and paramere; bilobed ventral arm of aedeagus clavate gradually narrowing anterad.

Etymology. Species is named in honour of the first author's daughter, Yasmina.

Uenoidae Iwata, 1927

Thremmatinae Martynov, 1935

Thremma africanum Malicky & Lounaci, 1987 stat. nov.

(Figures 13a–13i)

Thremma sardoum africanum Malicky & Lounaci, 1987:12." Die algerischen Exemplare sind von den

sardischen und korsischen kaum zu unterscheiden, aber sie haben ventral am 7. abdominal Segment einen dichten Kamm aus ungefähr 7 Stacheln, die distal geknöpft und halb so lang wie das Segment sind. Bei den Tieren von Sardinien und Korzika befindet sich dort nur ein kurzer Stachel, der auch fehlen kann." Holotypus ♂: Algerien, Tizi-Ouzou, obere Bachregion des Oued Aissi, 26.V.1986, Lounaci leg., coll. Malicky. Mehrere Paratypen vom gleichen Ort mit verschiedenen Daten in den Sammlungen Malicky und Lounaci."

Type material. Holotype: Algeria, Tizi-Ouzou, upper stream region of O. Aissi, 1084 26.V.1986, Lounaci leg. (1 male, CHM).

Material examined. ALGERIA: Mount Edough, O. Agab, 26.iv.2021, leg. Boudjéma Samraoui (1 male, OPC).

Remarks. Malicky and Lounaci found no differences in the general or genital structures between the Sardinian, Corsican, and Algerian specimen of *Thremma sardoum* Costa, 1884, except for the presence of a well-produced and heavily sclerotized comb structure on the ventrum of segment VII in the Algerian specimens, which is lacking or variably vestigial in the Sardinian and Corsican specimens.

Applying the principles and procedures of fine phenomics, we have recognised significant differences in character states between specimens available for comparative examination from Algeria and Corsica. We have identified two character states that are reliable and stable for differentiating species within the *Thremma* genus. *(1)* The first trait is the ventral profile/contour/horizon of the fused gonopods and basal plate of gonopods. This highly serrated structure appears to have a key function in sexual integration and is a non-neutral adaptive speciation trait, sometimes referred to as a "magic trait" (Servedio *et al*. 2011). *(2)* The second trait is the lateral profile of the phallic organ. The highly sclerotized phallotheca with its apicoventral lip probably has a stimulatory function during copulation and is another non-neutral speciation trait. Based on both of these speciation traits, the specimen from Algeria differs from all the other species in the genus. The ventral profile of the serrated mesal ridge of the fused gonopods is entirely different in shape compared to all other species. In comparison to *Thremma sardoum,* the Algerian specimen has a longer mesal process and an angled lateral corner, rather than a rounded one. The apicoventral lip of the phallotheca in the Algerian specimen is very short, unlike the long one seen in the Corsican specimen. Furthermore, the lateral shape of the phallotheca and the basoventral lip of the phallotheca, which provides the attachment surface to the basal plate of the fused gonopod, are also different in shape and not as prominently produced. Based on the theories of phylogenetic species concept, which suggest excluding subspecies and races from scientific classification (Oláh & Johanson 2008), and considering these pronounced divergences, we propose elevating the subspecies status of *Thremma sardoum africanum* Malicky & Lounaci, 1987 to species rank as *Thremma africanum* Malicky & Lounaci, 1987 stat. nov.

Lepidoptomatidae Ulmer, 1903

***Lepidostoma kumanskii* (Malicky, 1982)**

Material examined. ALGERIA: Mount Edough, O. Agab, 1.vii.2021, leg Boudjéma Samraoui (1 male, OPC), Mount Edough, O. Agab, 11.vii.2021, leg Boudjéma Samraoui (1 male, OPC), Mount Edough, O.Agab, 5.vi.2021, leg Boudjéma Samraoui (2 males, OPC).

Remark. This is a new addition to the caddisfly fauna of Algeria.

Goeridae Ulmer, 1903

***Silonella aurata* (Hagen, 864)**

Material examined. ALGERIA: Mount Edough, O. Agab, 1.xi.2021, leg Boudjéma Samraoui (1 male, OPC), Mount Edough, O. Agab, 26.iv.2021, leg Boudjéma Samraoui (2 males, 2 females; OPC).

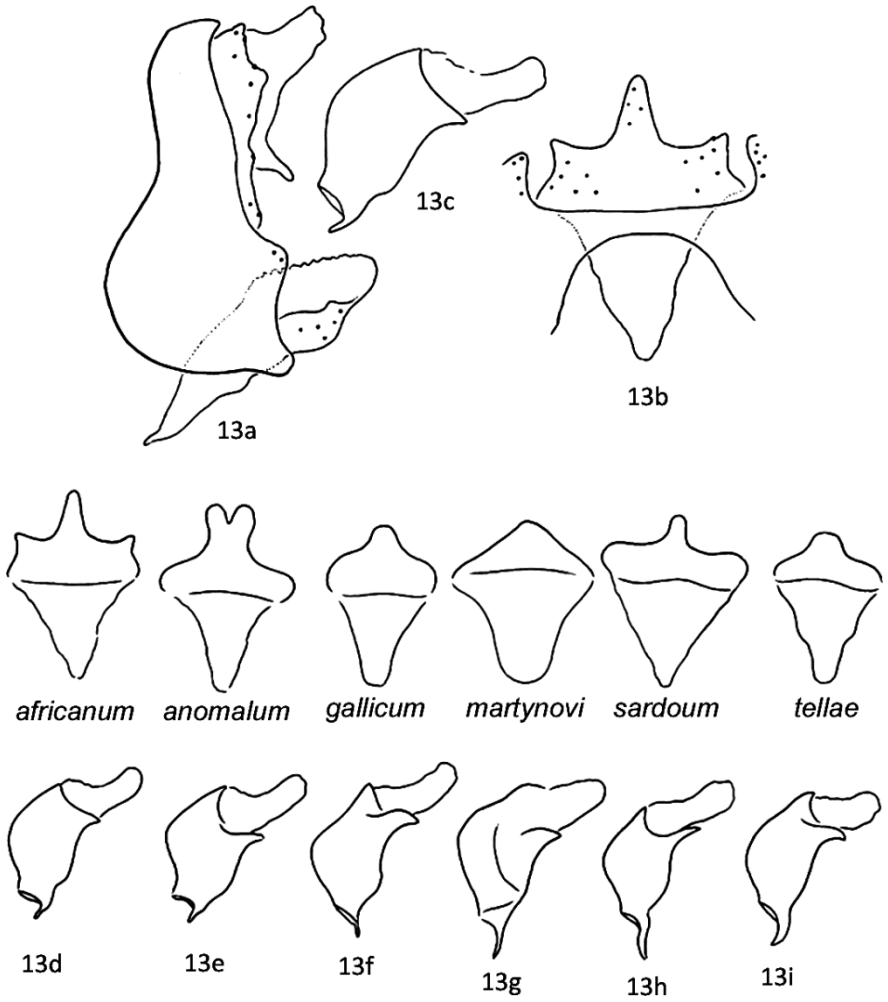

Figure 13. Genitalia of *Thremma* spp. 13a–13i, *Thremma africanum* Malicky & Lounaci, 1987: 13a = genitalia in left lateral view, 13b = fused gonopod and basal plate of gonopod in ventral view, 13c = phallic organ in left lateral view. 13d–13i, Speciation traits of the fused gonopod and basal plate of gonopod in ventral view and of the phallic organ in left lateral view of the six *Thremma* species. 13d = *Thremma africanum* Malicky & Lounaci, 1987; 13e = *Thremma anomalum* McLachlan, 1876; 13f = *Thremma gallicum* McLachlan, 1880; 13g = *Thremma martynovi* Malicky, 1976 13h = *Thremma sardoum* Costa, 1884; 13i = *Thremma tellae* Gonzalez, 1978.

Remark. This species has a relatively long flight period.

Limnephilidae Kolenati, 1848

Mesophylax McLachlan, 1882

Mesophylax McLachlan, 1882:157. "Very closely allied to *Stenophylax* typically; differs especially in the spur of the anterior tibiae of ♂ being so much reduced as to be microscopic, whereas the corresponding spur in the ♀ is long; hence the spur-formula is *quasi* 1,3,4 and 1,3,4 ♀." Type of this genus is *Stenophylax aspersus*, Rambur."

Remarks. It should be noted that in McLachlan's taxonomy, the spur formula was once considered an important character state for delimiting genera within the order Trichoptera, especially in the family Limnephilidae. However, it later became clear that this character state is highly variable and not reliable. In Schmid's taxonomy (1955), the architecture of the genital structure became essential for delimiting genera within the

family Limnephilidae. Malicky's revision of the taxonomy of the genus *Mesophylax* (1998) included extensive research on a large sample but reached rather pessimistic conclusions regarding reliable character states for delineating taxa.

In our studies on parameres as a species trait (Oláh *et al.* 2014, 2015, 2017), we found that the hooked shape of parameres serves as an adaptive, non-neutral structure that is highly reliable for distinguishing closely related sibling species within the genus *Mesophylax*.

Mesophylax aspersus (Rambur, 1842)

Material examined. ALGERIA, Pont Ain Makhlouf, 1.ii.2023, leg Boudjéma Samraoui (male, OPC).

Remark. Mesophylax aspersus (Rambur, 1842) represents a sibling species characterized by short gonopods, in contrast to the species represented by *Mesophylax impunctatus*, which has elongate and slender gonopods.

Mesophylax hoggarensis Malicky, 1998 stat. nov.

Mesophylax aspersus hoggarensis Malicky, 1998:135–136. "Die Tiere aus dem Hoggar-Gebirge stimmen weitgehend mit den typischen *aspersus* überein, haben aber konstant die Spornformel 022 (♂) 4nd 122 (♀). Holotypus ♂: Gueltas Imeleoulaouene, 16 km NE Tamanrasset."

Type material: Holotype: ALGERIA: Gueltas Imeleoulaouene, 16 km NE Tamananrasset, 22° 53'N, 5°38'E, 1400 m, 5.IV.1984, leg Aspöck, Rausch, Hölzel & Ohm (1 male, CHM).

Material examined. ALGERIA: Mount Edough, O. Agab, 1.xi.2021, leg Boudjéma Samraoui (1 male, OPC), Cheniour, 15.iv.2023, leg Boudjéma Samraoui (1 female, OPC), Cheniour, 30.iv.2023, leg Boudjéma Samraoui (2 females, OPC), Cheniour, 1.iv.2023, leg Boudjéma Samraoui (1 male, OPC).

Remarks. The specimens from Mount Edough have a tibial spur formula of 022, similar to *Mesophylax sardous* Moretti & Gianotti, 1981, and not 034 as observed in *Mesophylax aspersus.* The lateral shape of gonopods and paramere is identical to the specimens from the Ahaggar Mountains. The divergences in the genital structure, along with the principles of phylogenetic species concept (Burbrink *et al*. 2022), suggests elevating the subspecies *Mesophylax aspersus hoggarensis* Malicky, 1998 to the species rank as *Mesophylax hoggarensis* Malicky, 1998, stat. nov.

Beraeidae Wallengren, 1891

Beraea auresi Vaillant, 1953

Material examined. ALGERIA: Mount Edough, O. Agab, 11.vii.2021, leg Boudjéma Samraoui (2 males, OPC).

Remark. This record expands considerably the range of this Algerian endemic species.

Leptoceridae Leach, 1815

Adicella syriaca Ulmer, 1907

Material examined. ALGERIA: Mount Edough, O. Agab, 18.viii.2021, leg Boudjéma Samraoui (1 male, OPC).

Remark. This is a new addition to the caddisfly fauna of Algeria.

Athripsodes ygramul Malicky & Lounaci, 1987

Material examined. ALGERIA: Mount Edough, O. Agab, 19.vi.2021, leg Boudjéma Samraoui (2 males, OPC).

Remark. This record expands considerably the range of this Algerian endemic species.

DISCUSSION

This study represents a significant advance in the field of Algerian caddisfly taxonomy, providing convincing morphological evidence for the existence of 15 new species belonging to the genera *Hydropsyche* and *Agapetus*. The newly

identified species from the genus *Hydropsyche* include *Hydropsyche cherfa, H. makhloufa, H. seybousa, H. algirica*, *H. dbabcha*, H. *farrahae*, *H. guitna*, *H. chenioura, H. edougha*, *H. louara*, *H. vinconi*, *H. linae,* and *H. nardjissae*. In addition, two new species were discovered in the genus *Agapetus*: *Agapetus cheniour* and *A. yasminae*. This research also suggested elevating three subspecies to species rank: *Wormaldia numidica*, *Mesophylax hoggarensis*, and *Thremma Africanum*. It is noteworthy that these three species are Maghrebian endemics, with the first one occurring exclusively in Algeria. In addition to the study of the genus *Hydropsyche*, a new species, *H. tenerifa* sp. nov., was described from the Canary Islands. Taken together, these results greatly improve our understanding of caddisfly diversity in North Africa (Table 2).

In addition, this study has provided valuable insights into the distribution patterns of caddisflies in Algeria and has greatly increased our knowledge in this field. The discovery of previously unrecorded species such as *Lype reducta*, *Lepidostoma kumanskii*, and *Adicella syriaca* contributes to our understanding of caddisfly diversity and distribution in Algeria. In particular, *L. kumanskii*, a Maghrebian endemic, had previously been documented only once in Tunisia (Malicky & Lounaci 1987), making this the first record of its occurrence in Algeria. *Lype reducta* and *Adicella syriaca* were also recorded in Algeria for the first time in this study.

Mount Edough, more specifically O. Agab, proved to be the site with the highest species richness, hosting a remarkable number of 12 caddisfly species. In comparison, Cheniour, a tributary of the Seybouse River, had a species richness of 5. The presence of numerous endemic species at Mount Edough, the El Kala region, the Seybouse River, and other parts of the Maghreb region underscores the extraordinary evolutionary history and ecological importance of freshwater ecosystems in this area. These habitats, located primarily at mid-elevations of 400–800 meters, are critical to protecting diverse caddisfly populations and maintaining ecological integrity in this freshwater hotspot.

Furthermore, the taxonomic advances made in this study have shed more light on the genus *Hydropsyche* in the Maghreb. Indeed, this study highlights the remarkable diversity of the genus *Hydropsyche* in northeastern Algeria with the discovery of 13 new species. In particular, the Seybouse River stands out as the catchment with the greatest *Hydropsyche* species richness, where eight new *Hydropsyche* species were identified. Following closely behind is the El Kala region, where four new *Hydropsyche* species were documented. A previous study focusing on larvae had already identified the Seybouse River as a notable hotspot for *Hydropsyche* species (Samraoui *et al*. 2020). To further our understanding, future studies that include both larvae and adults would be immensely valuable.

The trichopteran net-spinning family Hydropsychidae, which includes the genus *Hydropsyche*, displays impressive ecological diversity (Rutherford *et al*. 1986, Gordon & Wallace 1975). The genus *Hydropsyche*, which comprises a group of caddisflies known for their sensitivity to environmental conditions, plays a critical role in assessing the health of aquatic ecosystems (Stuijfzand *et al*. 1999, Pirvu & Pacioglu 2012, Awrahman *et al*. 2016). Understanding the taxonomy and ecology of *Hydropsyche* larvae is critical for effective water quality monitoring, as they contribute significantly to macroinvertebrate populations in aquatic environments (Ruiz García & Ferreras-Romero 2008, Statzner *et al*. 2010). These larvae colonize different lotic habitats and have different ecological requirements, although there may be some intraspecific variability and adaptations (Boon 1984). Furthermore, it is noteworthy that a single habitat may harbor multiple species of *Hydropsyche* (Fuller & MacKay 1980), highlighting the need for accurate identification. By improving our understanding of *Hydropsyche* taxonomy in the Maghreb, this study provides a valuable basis for investigating the ecological responses of these species to environmental

Table 2. Checklist of recorded adult caddisflies with their regional distribution and flight period.

Family	Species	Localities	Flight period
Philopotamidae			
	Wormaldia numidica Vaillant 1974 stat.nov.	O. Agab; Tizagban (Collo)	June, December
Psychomyiidae			
	Lype reducta (Hagen 1868)	O. Agab	April, June
Hydropsychidae			
	Cheumatopsyche lepida (Pictet 1834)	Nouazi	June
	Hydropsyche cherfa Oláh & B. Samraoui sp. nov.	Pont Aïn Makhlouf	July
	Hydropsyche makhloufa Oláh & B. Samraoui sp. nov.	Pont Aïn Makhlouf	March
	Hydropsyche seybousa Oláh & B. Samraoui sp. nov.	Boukamouza	February
	Hydropsyche algirica Oláh & B. Samraoui sp. nov.	O. Agab; Pont Aïn Makhlouf	February, March, May
	Hydropsyche dbabcha Oláh & B. Samraoui sp. nov.	Dbabcha	May
	Hydropsyche farrahae Oláh & B. Samraoui sp. nov.	Dbabcha	July-September
	Hydropsyche guitna Oláh & B. Samraoui sp. nov.	Guitna	May
	Hydropsyche tenerifa Oláh sp. nov.	Tenerife, Canary Islands	July
	Hydropsyche chenioura Oláh & B. Samraoui sp. nov.	Cheniour	February, May, July
	Hydropsyche edougha Oláh & B. Samraoui sp. nov.	O. Agab	June, July
	Hydropsyche louara Oláh & B. Samraoui sp. nov.	Louar inf	May
	Hydropsyche vinconi Oláh & B. Samraoui sp. nov.	Cheniour	April, May
	Hydropsychae linae Oláh & B. Samraoui sp. nov.	Nouazi	July
	Hydropsyche nardjissae Oláh & B. Samraoui sp. nov.	Nouazi	May-July
Rhyacophilidae			
	Rhyacophila munda McLachlan 1862	Louar sup	February
Glossosomatidae			
	Agapetus ferrerasi Oláh & B. Samraoui sp. nov.	Cheniour	September
	Agapetus numidicus Vaillant 1954	Cheniour	All-year round
	Agapetus yasminae Oláh & B. Samraoui sp. nov.	O. Agab	June
Uenoidae			
	Thremma africanum Malicky & Lounaci 1987 stat. nov.	O. Agab	April
Lepidostomatidae			
	Lepidostoma kumanskii (Malicky 1982)	O. Agab	June, July
Goeridae			
	Silonella aurata (Hagen 1864)	O. Agab	April, November
Limnephilidae			
	Mesophylax aspersus (Rambur 1842)	Pont Aïn Makhlouf	February
	Mesophylax hoggarensis Malicky 1998 stat. nov.	O. Agab, Cheniour	April, November
Beraeidae			
	Beraea auresi Vaillant 1953	O. Agab	July
Leptoceridae			
	Adicella syriaca Ulmer 1907	O. Agab	August
	Athripsodes ygramul Malicky & Lounaci 1987	O. Agab	June

change and serves as a basis for future monitoring and conservation efforts.

While identification of *Hydropsyche* larvae plays a critical role in water quality assessment, especially considering how sensitive certain species are to pollution, comprehensive identifycation keys for Hydropsychidae in the Maghreb region are currently lacking. Despite the dominance of western Palearctic elements in the *Hydropsyche* fauna of the Maghreb, existing European identification keys for *Hydropsyche* larvae (Bournaud *et al*. 1982, Zamora-Muñoz *et al*. 1995, Múrria *et al*. 2010, Karaouzas 2018) are of limited practical use because of the many endemic species in the Maghreb. A major obstacle to the development of a comprehensive key to Maghrebian *Hydropsyche* larvae is the lack of taxonomic progress of this poorly studied caddisfly genus in the region (Dakki 1978, Allaya 2003,

Bonada *et al*. 2008). To address this critical gap, two recent publications focused on the taxonomy of *Hydropsyche* species in western Algeria and partially addressed this pressing need (Bemmoussat-Dekkak 2021a, 2021c). These advances in identification tools improve our ability to accurately assess water quality and monitor the status of aquatic ecosystems in the Maghreb, contributing to effective conservation and management measures.

Our understanding of the genus *Agapetus* in Algeria has benefited greatly from the seminal work of Vaillant (1954). Vaillant's research brought to light the existence of two previously unknown species of *Agapetus*: *A. numidicus* and A. *fuscus*. In addition, he also collected a third species, *A. incertulus* McLachlan, 1884. Building on Vaillant's fundamental contributions, our study expands the *Agapetus* checklist by introducing two new species: *A. ferrerasi* and *A. yasminae,* both endemic to Algeria. While *A. numidicus* has considerable local abundance, its syntopic counterpart, *A. ferrerasi* sp. nov., appears to be comparatively rare.

Thremma africanum was previously identified by Malicky & Lounaci (1987) as a subspecies of *Thremma sardoum* Costa, 1884. With the recent reassessment of *T. africanum* as a distinct species, the genus *Thremma*, which is distributed around the Mediterranean, now includes six species, three of them microendemic to specific zoogeographic areas (González *et al*. 1989). These include *T. tellae* González, 1978 in the Cantabrian Mountains of Spain, *T. sardoum* in Corsica, France, and Sicily, Italy, and *T. africanum* in the eastern Maghreb. Similar to its European relatives *T. gallicum* McLachlan, 1880 and *T. anomalum* McLachlan, 1876 (Kehl 2005, Živić *et al*. 2013, Macher *et al*. 2015), *T. africanum* is also patchy in its range. It has been recorded in the Djurdjura Mountains and on Mount Edough, both located in northern Algeria, and in a single stream in northwestern Tunisia (Malicky & Lounaci 1987, Allaya *et al*. 2003, this study). These Maghrebian mountains serve as refugia for *T. africanum* and other aquatic insects (Samraoui & Alfarhan 2015, Boucenna *et al*. 2023).

The identification of new records, including *Wormaldia numidica*, *Thremma africanum*, *Mesophylax hoggariensis*, *Cheumatopsyche lepida*, *Rhyacophila munda*, *Agapetus numidicus*, *Silonella aurata*, *Beraea auresi*, and *Athripsodes ygramul* contributes to our knowledge of the distribution patterns of caddisflies in Algeria. This information is important for mapping their geographic ranges, identifying potential hotspots for species conservation, and developing effective management strategies. The presence of Algerian endemics such as *Beraea auresi* Vaillant, 1953 and *Athripsodes ygramul* Malicky & Lounaci, 1987 in northeastern Algeria for example, is an important finding in this regard, highlighting the need for further studies on their distribution and ecological requirements.

The results of this study highlight the importance of the Maghreb region as a hotspot of biodiversity and a center of endemism. These results are consistent with recent research on several taxa, including fishes, amphibians, and aquatic insects, demonstrating the presence of endemic species in Algeria (Boucenna *et al*. 2023). They also confirm previous results showing faunal and floristic similarities between the Kroumiria region on the Algerian-Tunisian border and Mount Edough (Samraoui & Alfarhan 2015). The cumulative evidence highlights the urgent need for local authorities and managers to mitigate the taxonomic impediment such as lack of expertise, funds, and environmental education (Giangrande 2003), establish monitoring programs, and develop conservation measures that specifically target freshwater biodiversity.

By prioritizing and protecting these habitats, we not only value caddisfly conservation but also preserve the intricate web of ecological interactions they support. Aquatic insects, with their various life stages and ecological functions, play an important role in maintaining the balance and health of freshwater ecosystems (Corbet 1999,

Sartori & Brittain 2015 Morse *et al*. 2019). In addition, the mid-elevation range of 400–800 meters is a critical zone for biodiversity conservation because it hosts a number of Palearctic relict species (Samraoui & Alfarhan 2015) and an exceptional diversity of freshwater fauna (Samraoui *et al*. 2021a, 2021b, 2021c, Boucenna *et al*. 2023). Implementation of measures such as habitat restoration, sustainable land management, and targeted conservation initiatives will be critical. By recognizing the importance of these unique habitats and taking proactive conservation measures, we can ensure the continued existence of this unique Maghrebian freshwater hotspot.

CONCLUSIONS

In summary, the taxonomic advances and new distributional records presented in this study contribute significantly to our understanding of Algerian caddisflies. The description of new endemic species as well as the discovery of new records demonstrate the importance of conserving and managing the freshwater biodiversity of the Maghreb. By filling knowledge gaps and providing insights into the taxonomy, distribution, and conservation of Algerian caddisflies, this research sets the stage for future studies and conservation initiatives aimed at preserving these valuable aquatic ecosystems.

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Amynthas aspergillum (Perrier, 1872) (Clitellata, Megascolecidae): A new addition to the South Asian earthworm fauna

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Abstract. The presence of the exotic and potentially invasive pheretimoid earthworm *Amynthas aspergillum* (Perrier, 1872) of the family Megascolecidae is reported for the first time from South Asia. Specimens were collected from Dehradun of the Uttarakhand state in the Western Himalayan biodiversity hotspot of India. This work provides the detailed description of the specimens collected along with figures. Besides, certain biological aspects are also discussed.

Keywords. Annelida, India, Oligochaeta, peregrine, Uttarakhand, Western Himalaya.

INTRODUCTION

The family Megascolecidae is the most speciose among the earthworms of the world with over 2,335 species/subspecies (Mısırlıoğlu *et al.* 2023). Among the megascolecid earthworms, the "pheretimoids" are considered to be one of the most evolved group of earthworms (Blakemore 2012). They are recognizable from other members of the family by the existence of an oesophageal gizzard in segment 8 and often also in segments 9 and 10 (Easton 1982). Pheretimoid species are alien to the Indian mainland, but a few species are endemic to the Andaman and Nicobar Island groups of India (Narayanan *et al.* 2023), which biologically share close affinities with Southeast Asia, the pheretimoid stronghold. Currently, 36 pheretimoid species, belonging to 5 genera are recorded from India, viz., *Amynthas* Kinberg, 1867; *Metaphire* Sims & Easton, 1972; *Pheretima* Kinberg, 1867; *Pithemera* Sims & Easton, 1972 and *Polypheretima* Michaelsen, 1934 (Narayanan *et al.* 2023). About a quarter of these species were reported during the last fifteen years (Siddaraju *et al.* 2010, Ahmed & Julka 2017, Vishwakarma & Yadav 2017, Kharkongor 2018, Narayanan *et al.* 2019, Lone *et al.* 2021, Vabeiryureilai *et al.* 2020, Tiwari *et al.* 2022). Nevertheless, a number of these entries are without any detailed taxonomic information, hence requiring further validation (Narayanan *et al.* 2023). The genus *Amynthas* is the most speciose with 713 nominal species/subspecies in the Megascolecidae family (Mısırlıoğlu *et al.* 2023) and widespread among the pheretimoid earthworm genera (Blakemore 2012). However, Blakemore (2012) stated that possibly more than half of the named *Amynthas* species are synonyms. They are widely distributed in the East and Southeast Asia, Australasia and Oceania regions, with unusually large number of peregrine species (Sims & Easton 1972, Blakemore 2012, Nguyen *et al.* 2016).

Until now, 20 *Amynthas* species were reported from India, including 4 species which are indigenous to the Andaman and Nicobar Islands

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(Narayanan *et al.* 2023). Recently, a couple of unusually large earthworms were collected from the urban Dehradun, the capital of the Indian state of Uttarakhand in the Western Himalayan biodiversity hot spot. Later, they were identified as the exotic pheretimoid earthworm *Amynthas aspergillum* (Perrier, 1872) by one of the authors (SPN). Through literature review, we affirmed that this species has never been recorded from South Asia prior to this study (Stephenson 1923, Gates 1972, Blakemore 2007*a,* Narayanan *et al.* 2021, 2023). In this paper, we report the details of the *A. aspergillum* specimens collected in India.

MATERIALS AND METHODS

Earthworms were collected in Dehradun, Dehradun District, Uttarakhand State in 2023, while they were found slowly moving over the land in the night time. Collected specimens were preserved in 5% formalin. All relevant morphological and anatomical characterisation of the earthworms were carried out under Nikon stereomicroscope (Model: SMZ800N). Colour images were taken by a camera attached directly to the microscope. Raw images were improved using Adobe Photoshop. Specimens were identified following Chang *et al.* (2009) and Blakemore (2012). Collected specimens are housed in the earthworm museum of the Advanced Centre of Environmental Studies and Sustainable Development (ACESSD), Mahatma Gandhi University, Kottayam, Kerala, India.

TAXONOMY

Family Megascolecidae Rosa, 1891

Genus *Amynthas* Kinberg, 1867

Type species. *Amynthas aeruginosus* Kinberg, 1867, by monotypy (Sims & Easton 1972).

Amynthas aspergillum (Perrier, 1872)

(Figures 1A–D, 2A–D)

Perichaeta aspergillum Perrier, 1872: 118.
Perichaeta takatorii Goto & Hatai, 1898: 76.
Pheretima aspergillum: Michaelsen 1900: 253
Amynthas aspergillum: Blakemore 2007b: 9.
For further synonyms see Chang *et al.* (2009), Blakemore (2012) and Nguyen *et al.* (2016).

Type locality. Amoy and Kowloon, China (Blakemore 2012).

Type material. At Muséum national d'Histoire naturelle, Paris, France - MNHN 575 (Reynolds & Wetzel 2024).

Material examined. 2 clitellates (one specimen missing most of the posterior region), Reg. No. ACESSD/EW/1697, Forest Department Colony in Dehradun (30.3373403°N, 78.0559959°E), Uttarakhand State, Dehradun District, India, 640 m a.s.l., urban home garden, 14 August 2023, leg. Harshita Verma and Akash Kumar Verma.

Description of the present specimens. *External*: Large size, body cylindrical, colour brownish red on dorsum and pale brown on ventrum in life. Length 224 mm, diameter 9–11 mm (mid clitellum), segments 138. Setae perichaetine, on raised rings, 61–69 in segment 8 (n = 2), 73 in segment 20 (n = 1), 14 between male pores (n = 1). Prostomium open epilobic, with a visible central groove (Fig. 1A). First dorsal pore on intersegmental furrow 11/12. Spermathecal pores two pairs, widely separated in intersegmental furrows 7/8/9 (Fig. 1B), 0.36 body circumference ventrally apart (n = 1). Clitellum annular, in segments 14–16, coffee brown colour (in preserved specimens), furrows obliterated, seta absent, arc not prominent (Fig. 1C), dorsal pores absent. Female pore single, ventro-median, in a lightly depressed area, on segment 14 (Fig. 1C). Male pores paired, widely separated on segment 18, porophore on the top of a slightly raised equatorial round papilla (Fig. 1C), surrounded by several circular folds (Fig. 1D), 0.26 body circumference apart (n = 1), setae visible between male pores. Genital papillae present, single, lateral to spermathecal pores (Fig. 1B), multiple papillae in 2–3 transverse rows medial to male pores, number 1–4 in each row, number higher in the rows closer to setal arc (Fig. 1D). Nephridiopores not recognisable.

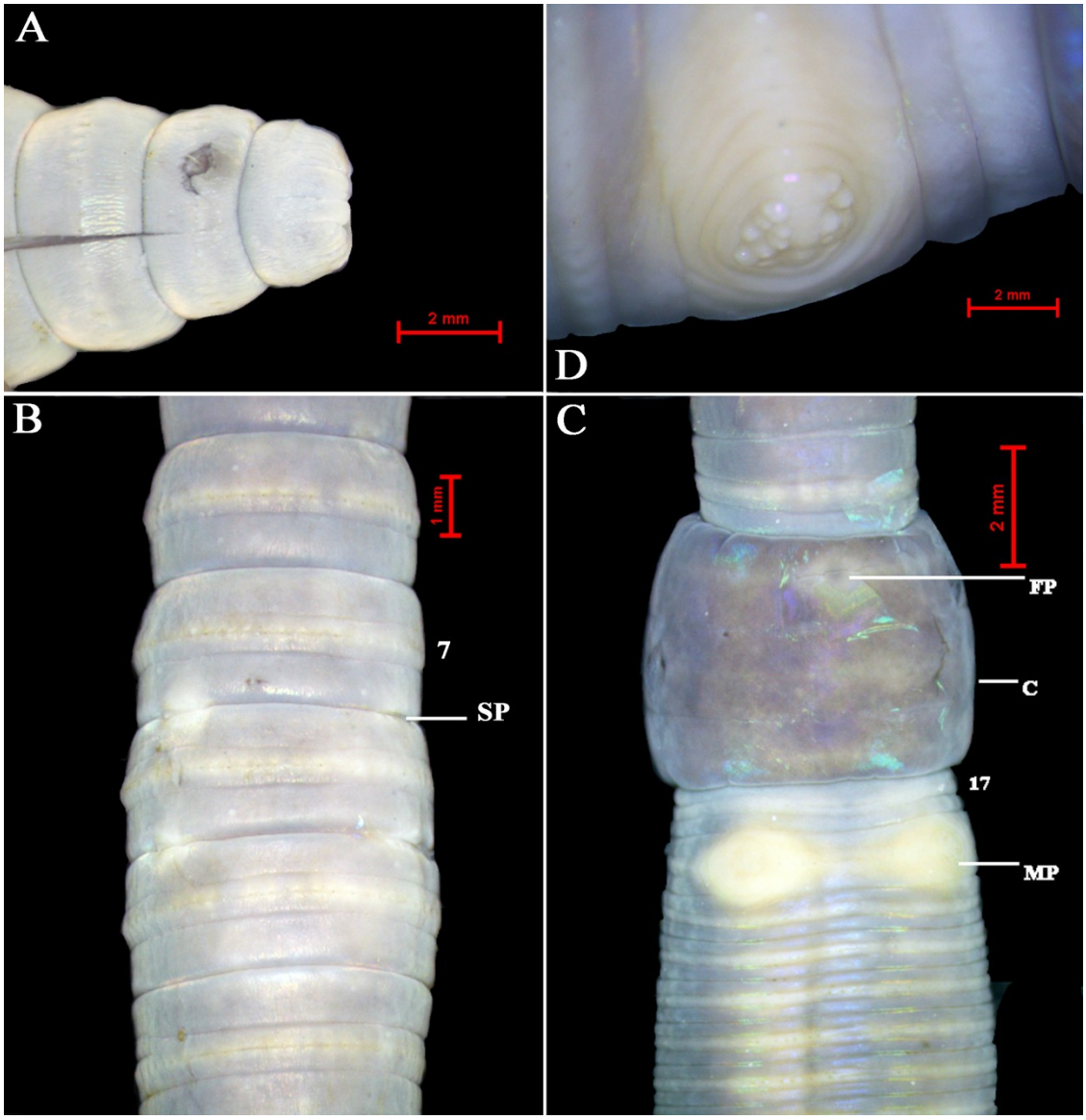

Figure 1. *Amynthas aspergillum* (Perrier, 1872) external features, A = Prostomium, dorsal view, B = Spermathecal pore region, ventral view, C = Clitellum and male field, ventral view, D = Genital papillae at male pore region, ventral view, rhs. *Abbreviations*. C – Clitellum; FP – Female pore; MP – Male pore; rhs – right hand side; SP – Spermathecal pore.

Internal: Septa 5/6/7/8 thickly muscular, 8/9/10 absent and 10/11/12/13 strongly muscular. Gizzard large, globular, in segments 8–9, oesophagus and gizzard attached to the parietes via several longitudinal muscular fibre strands piercing through the septa; intestine origin in segment 15; intestinal caeca paired, simple, in segments 27–24, bent upwards, projected back into segment 25, margins indented or lobate (Fig. 2B); typhlosole present, simple. Last pair of hearts in segment 13. Holandric; seminal vesicles two pairs (Fig. 2A), in segments 11 and 12, racemose, compact, dorsally lobulated. Spermathecae two pairs, in segments 7 and 8, ampulla peach-shaped or elongated, duct stout, shorter than ampulla; unidiverticulate, ectal diverticulum, diverticulum stalk long, slender, sinuous, coiled, seminal chamber oval or elongated, diverticulum longer

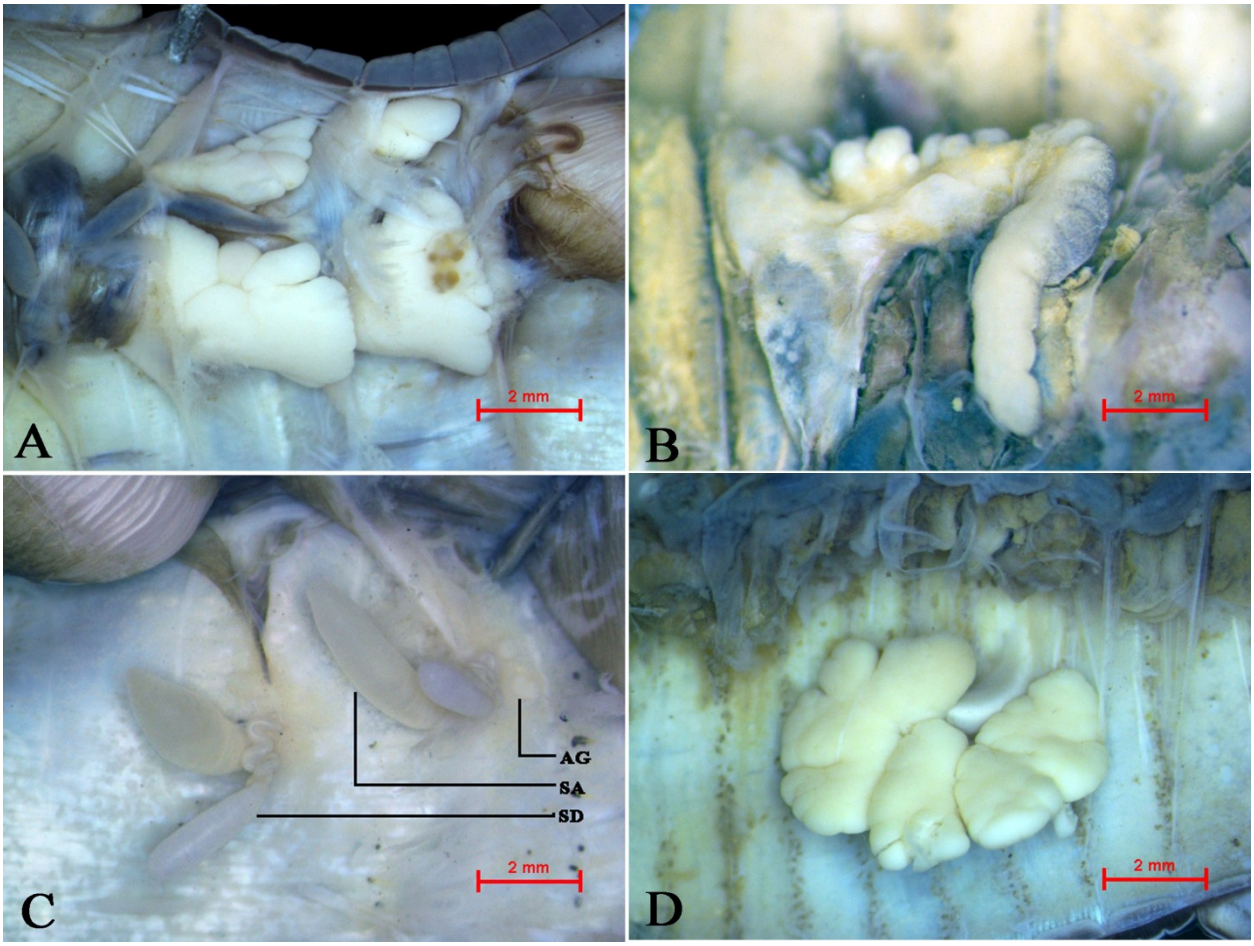

Figure 2. *Amynthas aspergillum* (Perrier, 1872) internal features, A = Seminal vesicles, dorsal view, B = Caecum, lhs, dorsal view, C = Spermathecae and accessory glands, rhs, dorsal view, D = Prostate, rhs, dorsal view. *Abbreviations*. AG – Accessory glands; lhs – left hand side; rhs – right hand side; SA – Spermathecal ampulla; SD – Spermathecal diverticulum.

than the duct plus ampulla (Fig. 2C). Prostates paired, large, thickly racemose, multi-partite, in segments 16–20, prostatic duct, muscular, stout, bent, thick at ectal end (Fig. 2D). Meronephric. Accessory glands present, small spheroidal mass, attached to parietes near spermathecae and prostates.

Habitat. Home garden in an urban area.

Natural history. The earthworms were found moving over the land surface during night, possibly actively migrating to nearby area.

Distribution. Forest Department Colony in Dehradun, Uttarakhand State, India: (present record) (Fig. 3); *Elsewhere*. Asia: China, Taiwan and Vietnam (Chang *et al.* 2009, Blakemore 2012, Nguyen *et al.* 2016).

Remarks. According to Chang *et al.* (2009), it is an anecic earthworm. Its anatomical peculiarity, the presence of several strong longitudinal muscular fibre strands that attaches oesophagus and gizzard to the parietes agrees with Chang *et al.*'s (2009) ecological observation. Specimens collected from Taiwan have large prostates occupying segments 18–22 or 17–21 and with 8–19 setae between male pores (Tsai 1964, Chang *et al.* 2009, Wang & Shih 2010), whereas those from western Himalaya have prostates in segments 16–20 and 14 setae between male pores. According to

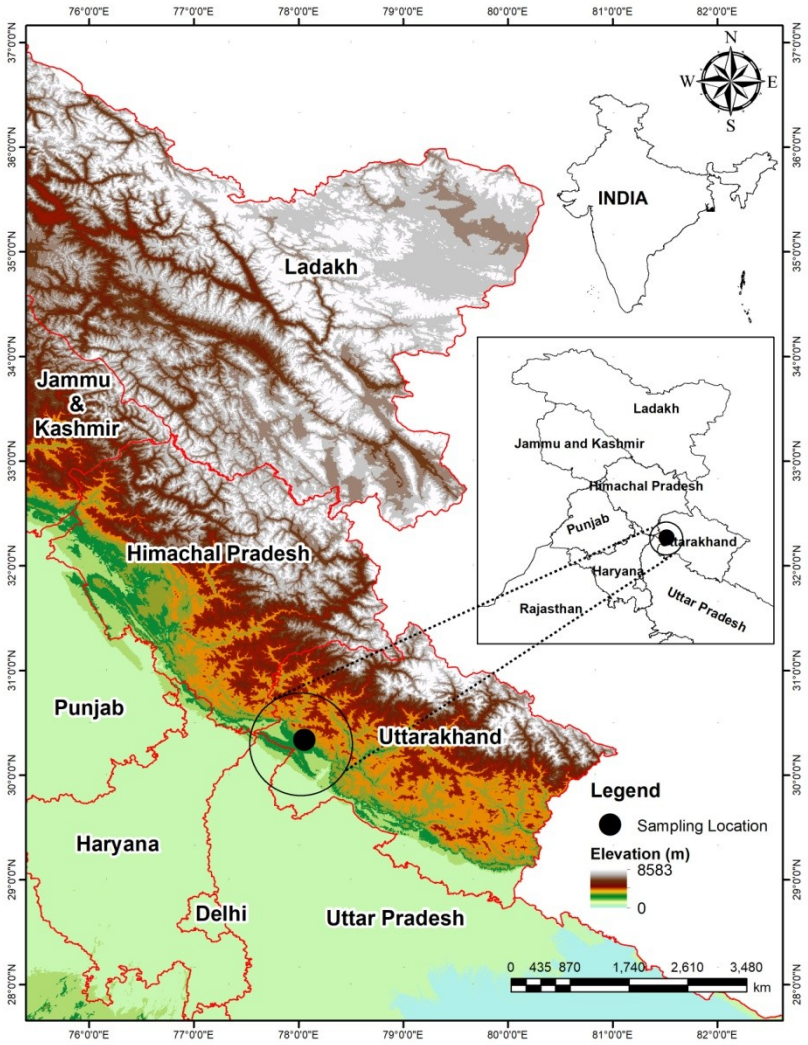

Figure 3. Collection locality of *Amynthas aspergillum* (Perrier, 1872) in India.

Chang *et al.* (2009), spermathecal ampulla of the specimens from Taiwan is peach-shaped, whereas in the Indian specimens, it is peach-shaped or elongated. Differences in external and internal features are definitely intraspecific variations.

DISCUSSION

Apart from the present record from India, *A. aspergillum* is known from three Asian countries *viz.,* China, Taiwan and Vietnam. The species was described based on the specimens from China (Perrier 1872), and in China it is known from Amoy, Fuchow, Kowloon and Hainan Island (Blakemore 2012). In Taiwan, it is widely distributed in low elevation regions and also in the Lanyu and Kinmen Islands (Chang *et al.* 2009). It is commonly found in the northern and central regions of Vietnam (Nguyen *et al.* 2016). According to Chang *et al.* (2009), in Taiwan, it is frequently found on lawns of schools and parks even in big cities. Present record of the species from India is also from an urban garden; this indicates its wide adaptability to the urban conditions.

Most of the native Indian earthworms are found in undisturbed natural ecosystems concentrated in the Western Ghats-West Coast Plains

and Eastern Himalaya-Northeast Hills (Narayanan *et al.* 2020, 2023). Deforestation of the Himalayas as part of the commercial purposes started with the British rule, and after independence exploitation continued as a source of revenue, for agriculture expansion and urbanization (Pandit *et al.* 2014). In the Western Himalayan region exotic and native peregrine species are the most common ones and native endemic species are confined to the remaining natural ecosystems (Narayanan *et al.* 2023). A number of studies are available on the earthworm fauna of the Dehradun and Dehradun Valley, which starts from the last quarter of the 19th century to present day (Bourne 1889, Fedarb 1898, Gates 1951, Soota 1966, Soota & Halder 1980, Mandal *et al.* 2021). Together they have reported the presence of 11 pheretimoid species from the area, which are, *Amynthas alexandri* Beddard, 1901, *A. corticis* (Kinberg, 1867), *A. gracilis* (Kinberg, 1867), *A. morrisi* (Beddard, 1892), *A. pallidus* (Michaelsen, 1892), *A. robustus* (Perrier, 1872), *Metaphire anomala* (Michaelsen, 1907), *M. birmanica* (Rosa, 1888), *M. californica* (Kinberg, 1867), *M. houlleti* (Perrier, 1872), *M. peguana* (Rosa, 1890) and *M. posthuma* (Vaillant, 1868). They might have been introduced into the country, presumably by anthropochorous activities and other agencies (Julka 1988, 2014, Julka & Paliwal 2005). Now, exotic species have successfully established their colonies in disturbed habitats subsequent to deforestation and intensive cultivation, showing their inherent ability to withstand disturbance and interference (Julka & Paliwal 2005c).

None of the above studies reported the occurrence of *A. aspergillum* from the Dehradun areas, hence it can be concluded that this species has been introduced to the region only recently. A total of 57 exotic earthworm species belonging to 8 families have been reported from the country (Narayanan *et al.* 2023) and with the addition of *A. aspergillum,* the number rose to 58 species. India has been a trade centre for millennia and hence many new exotic species records from the country are likely (Narayanan *et al.* 2019).

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Helodrilus bavaricus, a remarkable new earthworm species from Bavaria, Germany (Crassiclitellata, Lumbricidae)

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Abstract. Here we report on a new *Helodrilus* species found in Rotthalmünster, Southern Germany. This unique new species has four pairs of spermathecae and long protruding tubercles. Besides *Lumbricus badensis* Michaelsen, 1907 from Schwarzwald forest, this is the second earthworm species from Germany that appears to be endemic, suggesting that the southern part of present-day Germany may represent the northern limit of the distribution of endemic earthworm species.

Keywords. Annelida, Oligochaeta, Megadrili, endemism, Bayern.

INTRODUCTION

The genus *Helodrilus* Hoffmeister, 1845 is the second oldest valid earthworm genus after *Lumbricus* Linneaus, 1758. Throughout its history, the genus was treated very differently by different authors (Szederjesi *et al.* 2014) until Perel (1976) recognized that the type species *H. oculatus* Hoffmeister, 1845 has no nephridial vesicles and narrowed the genus *Helodrilus* accordingly. Another significant change was made by Zicsi (1985), who separated the genus *Proctodrilus*, which is characterized by an enteroic excretory system as opposed to the exoic system of *Helodrilus*.

Even early molecular phylogenetic studies indicated that the loss of nephridial vesicles could occur in different lineages, and therefore this character, like many other ones in Lumbricidae, may be polyphyletic (Domínguez *et al*. 2015).

Lately, Szederjesi *et al.* (2023) have carried out a detailed molecular phylogenetic study on the genus *Helodrilus* and showed that the genus is polyphyletic, consisting of three unrelated genera *Helodrilus* Hoffmeister, 1845, *Imetescolex* Szederjesi, Marchán & Csuzdi, 2023 and *Coventina* Marchán, Szederjesi & Csuzdi, 2023. The restricted *Helodrilus,* apart from the type species *H. oculatus* contains only four other species; *H. cernosvitovianus* (Zicsi, 1967), *H. phillipei* Qiu & Bouché, 1998, *H. samniticus* (Cognetti, 1914) and *H. turquini* Qiu & Bouché, 1998.

Recently, colleagues from the Bavarian State Research Center for Agriculture carried out a soil fauna survey on an agriculture field with no-till farming near Rotthalmünster, Southern Germany. Together with several widely distributed species (*Lumbricus terrestris* Linneaus, 1758, *Lumbricus castaneus* (Savigny, 1826), *Lumbricus rubellus* Hoffmeister, 1843, *Aporrectodea caliginosa* (Sa-

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vigny, 1826), *Allolobophora chlorotica* (Savigny, 1826), *Aporrectodea rosea* (Savigny, 1826), *Octolasion lacetum* (Örley, 1881), *Proctodrilus tuberculatus* Černosvitov, 1935) an interesting species of *Helodrilus* was observed, which proved to be new to science and is described here.

MATERIAL AND METHODS

Earthworms were collected on 8 randomly distributed samples in an agriculture field near Rotthalmünster, Southern Germany (*ca*. 48°22'N, 13°12'E) first by an expulsion method with a highly diluted formaldehyde solution (0.2%) and then by hand-sorting of the excavated soil material. The investigated site is located on a slope and has been cultivated with no-till farming since 2021. It is characterized by Haplic Luvisol and loess loam and has a good water holding capacity. The earthworms collected were killed and preserved in 75% ethanol. The holotype of the new species is deposited in the Zoological Collection of the Eszterházy Károly Catholic University (EKCU).

TAXONOMY

Helodrilus bavaricus sp. nov.

Type material. Holotype: EKCU-OLIG-18 Germany, Rotthalmünster, no-tillage agricultural research field, 29.04.2024, leg. R. Walter. Paratypes: EKCU-OLIG-19 2 ex., collection of the Bavarian State Research Center for Agriculture 2 ex., Norbert Höser collection 1 ex.; locality and date same as the Holotype.

Diagnosis. Length 31 mm, diameter 2 mm, setae closely paired. Colour pale. Dorsal pores not visible. Clitellum on ½24, 25–33, tubercles on 1/n27–31. Male pores on 15, surrounded by glandular crescents. Nephridial pores not visible. Two pairs of vesicles in 11, 12. Spermathecae four pairs in 9/10–12/13, open in the mid-dorsal line (M). Calciferous glands without diverticulum. Excretory system exoic, nephridial bladders missing.

Description. External characters. Holotype 31 mm long and 2 mm wide. Number of segments 104. Paratypes: one ex. cut specimen, one ex. 31 mm long and 2 mm wide. Number of segments 106. Secondary annulations present between 10–33 with 2–3 ringlets. Colour pale pink alive, greyish preserved. Prostomium epilobous, 1/3 closed. Dorsal pores not visible. Setae closely paired, setal arrangement just behind clitellum: *aa*:*ab*:*bc*:*cd*:*dd* = 12:1:8.4:1:26. Male pores on segment 15, surrounded by glandular crescents, protruding into the neighbouring segments. Nephridial pores not visible. Clitellum saddle-shaped on ½24, 25–33. Tubercula pubertatis as protruding glandular ridges on 1/n27–31. Glandular tumescences on 12 *ab* and 13 *cd* (Fig. 1).

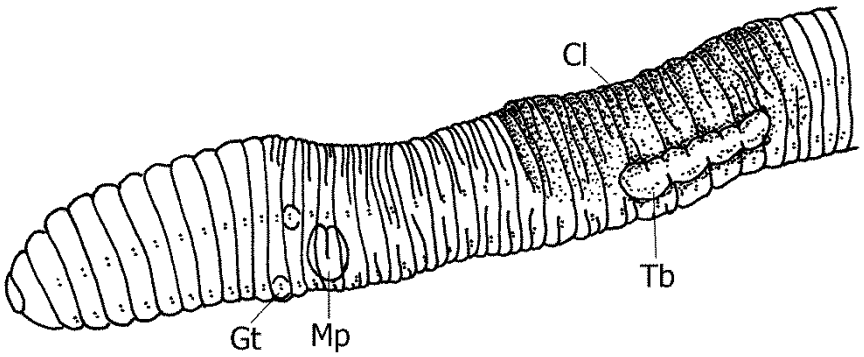

Figure 1. *Helodrilus bavaricus* sp. nov. Gt = genital tumescence, Mp = male pore, Tb = tubercle, Cl = clitellum.

Internal characters. Dissepiments 5/6–8/9 thickened, 9/10–10/11 slightly strengthened. Testes and funnels paired in 10–11, free. Two pairs of seminal vesicles in 11 and 12. Four pairs of spermathecae in 9/10–12/13, small, surrounded by epithelial thickening and external openings near the mid-dorsal line (M). Calciferous glands in 10–11, without distinct diverticula. Last pair of hearts in 11, with a pair of extraoesophageal vessels in 12. Excretory system exoic, nephridial bladders missing. Crop in 15–16, gizzard in 17–18. Typhlosolis T-shaped. Longitudinal musculature fasciculate.

Etymology. The specific epithet refers to the type locality in Bavaria, Germany.

Remarks. The new species is classified in the genus *Helodrilus* on the basis of the absence of nephridial bladders, the position of clitellum and tubercles, the number of vesicles (2 pairs), number of spermathecae (four pairs) and the adiverticulate calciferous glands (Szederjesi *et al.* 2023). Morphologically, the new species is most close to *H. cernosvitovianus* as it has protruding tubercles and dorsally opening spermathecae. However, the position of the clitellum and tubercles and the four pairs of spermathecae distinguish it from all other *Helodrilus* species (Table 1).

DISCUSSION

It is generally accepted that the earthworm fauna in Northern Europe became extinct during the Quaternary due to the thick ice shield present. Areas south of the ice sheet boundary were also affected to some extent by the presence of permafrost, but southern Germany, including southern Bavaria, was ice-free and had continuous and diverse vegetation throughout the Pleistocene (Ellwanger *et al.* 2011, Stebich *et al.* 2020) and might have been suitable for the survival of earthworms. Therefore, this area may fall within the northern limit of the endemic earthworm distributions, as represented by the presence of *Lumbricus badensis* Michaelsen, 1907 in the Black Forest and the newly discovered species *Helodrilus* as well.

According to the last revision (Szederjesi *et al.* 2023), the genus *Helodrilus* has a predominantly Western European distribution, with *H. cernosvitovianus* being the most eastern species recorded from SE Poland (Kostecka & Rozen 1988), W Ukraine (Perel 1976) and NE Hungary (Zicsi 1967, Csuzdi & Zicsi 2003). However, its records from Southern Serbia (Mršić 1991) and Northern Greece (Zicsi & Michalis 1981) are far from the original range and may represent a species close to *Imetescolex balcanicus* (Černosvitov, 1931).

Table 1. Morphological comparision of the *Helodrilus* species

Taxon	Clitellum	Tubercles	Spermathecae (pairs)	Vesicles	Remarks
H. bavaricus **sp. nov**.	½24,25–33	1/n27–31	9/10–12/13 M (4)	11, 12	tubercles protruding
H. cernosvitovianus (Zicsi, 1967)	21,22–28,29	½26–½28	9/10–10/11 M (2)	11, 12	tubercles protruding
H. oculatus Hoffmeister, 1845	21,22–31, 1/n32	29– 30,1/n31	9/10–10/11(11/12) *cd* (2–3)	11, 12	tubercles flat
H. phillipei Qiu & Bouché, 1998	21–32	28–29	9/10–10/11 *cd* (2)	11, 12	tubercles flat
H. samniticus Cognetti, 1914	21,22–32,33	29–32	9/10–10/11 *cd* (2)	11, 12	tubercles flat
H. turquini Qiu & Bouché, 1998	24–32	28–30	9/10–10/11 *cd* (2)	11, 12	tubercles flat

H. bavaricus is similar to *H. cernosvitovianus* in several features, such as the dorsally opening spermathecae or the strongly protruding tubercles, and geographically it is only about 600 km away from the type locality of *H. cernosvitovianus,* so it is assumed that these species may be closely related. However, further DNA studies are needed to determine this using a new 96% ethanol fixed material.

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Megascolex Templeton, 1844 (Clitellata, Megascolecidae): description of a new species from the northern Eastern Ghats, India with taxonomic key to the Indian species

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Abstract. The earthworm fauna of the Eastern Ghats Hills in Peninsular India is still under explored. Here a new species, namely, *Megascolex jamiesoni* Narayanan & Paliwal, sp. nov. is described based on the specimens collected from the Eastern Ghats hills of Koraput district of Odisha state, India. It belongs to the *ratus*-species group. Members of this group are characterized by the following features: spermathecal pores in intersegmental furrows 7/8/9, penial setae absent, holandric, calciferous glands absent, and seminal vesicles in segments 9 and 12. Present work provides a detailed description of the new species along with the illustrations of the key characters. Apart from this, a key for the Indian *Megascolex* species is provided. With the new findings, the range of *Megascolex* genus has been extended to further north in the Eastern Ghats Hills. With the discovery of the new taxa, the total number of species in the *Megascolex* genus has increased to 71, of these, 35 are found in India.

Key words. Annelida, earthworm, endemic, Odisha, Oligochaeta, taxonomy.

INTRODUCTION

India is one of the world's most diverse regions in terms of geography, climate, and habitats and furthermore it is one of the countries with the greatest earthworm diversity (Narayanan *et al.* 2023*a*). Over the past ten years, several new species of earthworms have been described from India (Narayanan *et al.* 2017, 2021*a*, 2022; Lone *et al.* 2020, 2022; Tiwari *et al.* 2021; Ahmed *et al.* 2022, 2023*a*, *b*; Naik *et al.* 2024). Majority of these new species are from the Western Ghats mountain ranges and Northeastern Indian hills. At this juncture, it is also important to note that the earthworm fauna of the Eastern Ghats Hills, especially the remnant forests of these isolated hill ranges are highly unexplored and insufficiently documented, and only three species are recently described from this region (Ahmed *et al.* 2023*a*; Naik *et al.* 2024). Unlike the Western Ghats, the Eastern Ghats form a discontinuous range of hills along the eastern coast of Peninsular India. It begins in the north from Mahanadi Basin in Odisha, traverses southwards through Andhra Pradesh to Central Tamil Nadu, where the Eastern Ghats turn southwest to meet the Western Ghats

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in the Nilgiri Hills, with an average elevation of 600 m and the highest peak in Biligirirangan Hills up to 1816 m (Srinivasan & Prashanth 2006; Kehimkar 2008; Nayaka *et al.* 2013). Much of the Eastern Ghats region has dry deciduous forest, but still it supports pockets of various tropical forests such as moist deciduous, evergreen and semi-evergreen forests (Kehimkar 2008; Nayaka *et al.* 2013).

The earthworms of the genus *Megascolex* Templeton, 1844 belonging to the family Megascolecidae Rosa, 1891 have a multifarious taxonomic history. The first species of an earthworm scientifically described from the Indian subcontinent was *Megascolex caeruleus* by Templeton (1844) from Ceylon (= Sri Lanka) (Narayanan *et al.* 2021*b*). The genus *Megascolex* is an ancient lineage with their origins in the ancient super continent Gondwanaland (Lone *et al.* 2022) but it is one among the advanced megascolecid genera (Blakemore 2012). The genus is restricted to Peninsular India and Sri Lanka (Stephenson 1923; Narayanan *et al.* 2020, 2021*b*, 2023*a*). There are 70 valid taxa in this genus (Narayanan *et al.* 2020, 2021*b*, 2023*a*; Lone *et al.* 2022; Naik *et al.* 2024) but *M. insignis* Michaelsen, 1910 is the only species found in both countries, whereas, 33 and 36 taxa are endemic to Peninsular India and Sri Lanka respectively (Michaelsen 1910; Stephenson 1923; Narayanan *et al.* 2020, 2021*b*, 2023*a*; Naik *et al.* 2024). Several *Megascolex* species described from the Indian subcontinent are known only from their respective type localities (Narayanan *et al.* 2021b, 2023*a*). However, in the recent past, many of these species have been collected from additional localities (Narayanan *et al.* 2014, 2023*b*, *c*; Sathrumithra *et al.* 2018; Anuja *et al.* 2023). *Megascolex* species are showing discontinuous distribution in Peninsular India (Stephenson 1924, 1925; Naik *et al.* 2024), with a stronghold in the southern portions of Western Ghats mountain range and west coast (Narayanan *et al.* 2020). Formerly, only two species of *Megascolex* were described from outside the Western Ghats Hills (Stephenson 1924, 1925). But recently Naik *et al.* (2024) has added two more species from the Eastern Ghats Hills in the Koraput district of Odisha state, India. This discovery has extended its known range to further north in the Eastern Ghats Hills. From the same collection, the presence of another new species of *Megascolex* was also revealed, which is described and illustrated herein this work.

MATERIALS AND METHODS

Earthworms were collected from Jeypore Ghati in Koraput district of Odisha state by digging soil with a spade, hand-sorting the soil for earthworms and also searching for organic microhabitats such as fallen tree trunks and leaf litter. Collected specimens were preserved in 10% formalin and later transferred to 95% ethanol. All relevant morphological and anatomical (through dorsal dissection) characterization of the earthworms was carried out under a Magnus MSZ series stereomicroscope. Illustrations were made with the help of a camera lucida attached to the microscope. Colour images were taken using a Nikon stereomicroscope (Model: SMZ800N). Raw images and line drawings were improved using Adobe Photoshop. The types of the new species are deposited in the 'National Zoological Collection' of the Zoological Survey of India, Western Ghat Regional Centre, Kozhikode (**ZSIK**), Kerala State, India, which is a 'Designated National Repository' for fauna.

TAXONOMY

Family Megascolecidae Rosa, 1891

Genus *Megascolex* Templeton, 1844

Megascolex jamiesoni Narayanan & Paliwal, sp. nov.

(Figures 1A–D, 2A–D)

Material examined. *Holotype.* Clitellate (ZSIK Reg. No. ZSI/WGRC/I.R.INV.26204), Jeypore Ghati (18.83929°N, 82.61730°E), around 10 km away from Jeypore town, Koraput District, Odisha State, India, 862 m a.s.l., moist deciduous forest, collected from beneath the leaf litter in a bed of pebbly soil along with roots of Pteri-

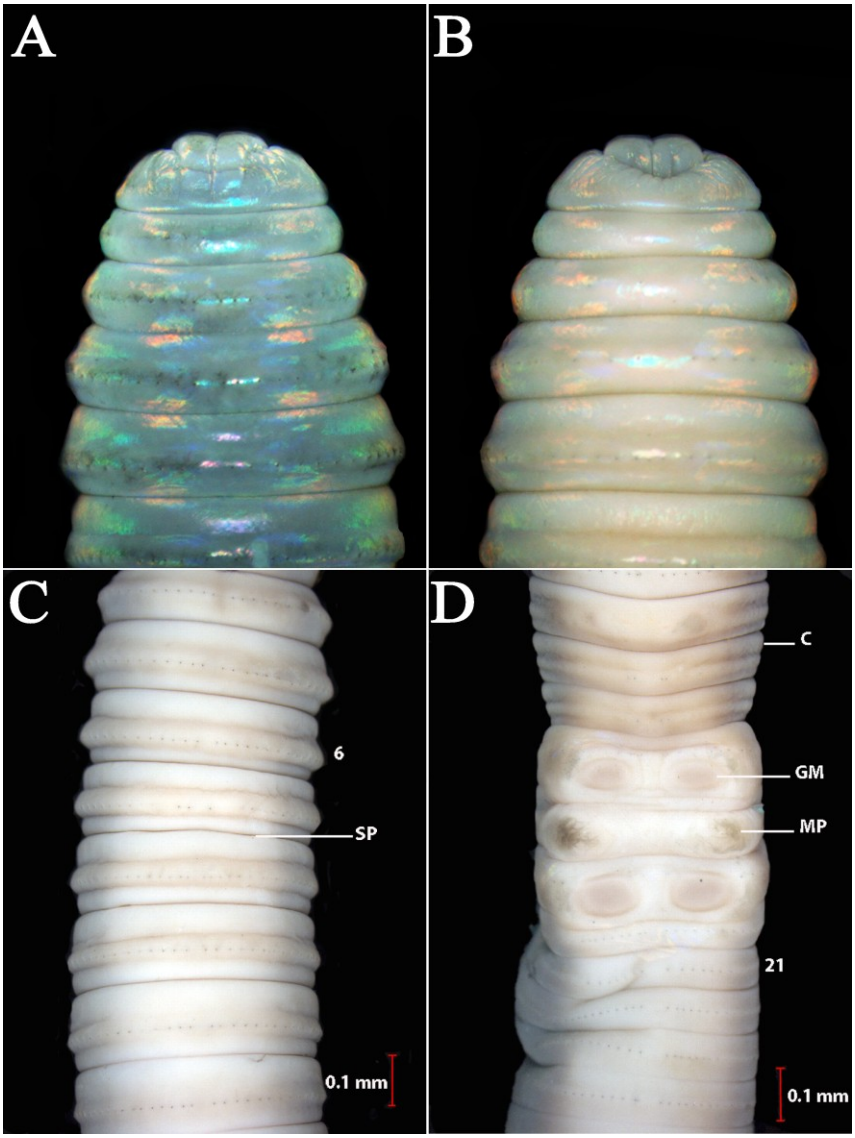

Figure 1. *Megascolex jamiesoni* sp. nov., external characters: A = Prostomium with canalicula, dorsal view; B = Prostomium with canalicula, ventral view; C = Spermathecal pore region, ventral view; D = Male field showing the male pores and genital markings, ventral view. C – Clitellum, GM – Genital marking, MP – Male pore, SP – Spermathecal pore.

dophyte (*Athyrium* sp.), around 10 m away from a non-perennial stream, 5 June 2022, leg. Ayusmita Naik. *Paratype*: 1 clitellate (ZSIK Reg. No. ZSI/WGRC/I.R.INV.26786), same collection data as for holotype.

Diagnosis. Large sized; length 229–269 mm, width 7.5–9 mm at segment 10, 162–167 segments. Prostomium proepilobic, with conspicuous canalicula. Clitellum on segments ¾13, 13–19 (= 6¾–7), 13–16 annular, 17–19 saddle shaped, dorsal pores absent, indication present, setal arc indication present at dorsum, visible on ventrum segment 13. Quadrithecal, spermathecal pores inconspicuous, concealed in intersegmental furrows 7/8/9. Male field light coloured, occupying the whole segment 18, male porophore minute, at the centre of an equatorial swollen papilla, setae absent between male pores. Genital markings two pairs, whitish, transversely elliptical depression, with finite elevated edge, confined to segments 17 and 19. Penial setae absent. Gizzard large, mus-

cular, in segment 7, septa 7/8/9 pushed posteriorly in funnel-like manner, thus take the spaces of segments 8–9. Oesophagus and gizzard are attached to parietes with several crisscrossed muscular fibres; intestine origin in segment 20. Last pair of hearts in segment 13. Holandric. Prostates large, racemose, irregularly oblong, longitudinally placed, incised, lobed at margins, extends in segments 18–19, 20, duct obliquely placed, muscular, moderately stout, fairly equal width throughout, duct shorter than the length of prostate. Spermathecae unidiverticulate, close to anterior margins in segments 8 and 9, ampulla, large, ovoid sac-like, somewhat dorsoventrally flattened, posteriorly directed, ampulla and duct well marked off, duct thick, muscular, *c.* 1/3rd of the width of ampulla, *c.* 1/4th length of duct plus ampulla; ental spermathecal diverticulum, enclosed in duct-wall, projected on lateral face of the duct. Genital markings glands absent.

Description. External. Brownish, dark (in life), restricted to dorsum, pale at ventrum; body circular. Dimensions: Holotype – 229 mm, width 7.5 mm at segment 10, 162 segments; paratype – 269 mm, width 9 mm at segment 10, 167 segments. Prostomium proepilobic, with canalicula (Fig. 1A), cleft visible in ventrum (Fig. 1B). Segments 4–12 biannulate, setae at the centre of elevated ridge. First dorsal pore concealed in intersegmental furrow 5/6. Clitellum dark coffee brown colour in life, light brown in preservation, on segments ¾13, 13–19 (= 6¾–7), 13–16 annular, 17–19 saddle shaped, dorsal pores absent, indication present, intersegmental furrows distinct, seta visible at segment 13, a few visible in segments 15–17 at ventrum, but indication present at dorsum, pale whitish at male field and genital markings. Setae perichaetine throughout, fairly large; setal formula *aa* = 1.81 *ab* = 1.53 *bc* = 1.67 *yz* = 1.33 *zz* on segment 12, *aa* = 2.58 *ab* = 2.58 *bc* = 3.8 *yz* = 2.58 *zz* on segment 24 (n = 1); 54–60 on segment 5, 58–64 on segment 9, 56–58 on segment 12, 58–60 on segment 20, 64–76 on segment 25 (n = 2); 14–16 between spermathecal pores lines on segment 8, setae absent between male pores. Male field pale coloured, male pores paired widely on segment 18, porophore minute, on the top of a swollen equatorial papilla, which is surrounded with 3–5 circular folds, porophore in line with *gh* or *hi* setal lines, 0.17–0.19 body circumference apart. Female pores minute, paired, pre-setal, ventro-median, in transverse depression, at *ab* setal lines, on segment 14. Spermathecal pores paired, inconspicuous, transversely placed, concealed in intersegmental furrows 7/8/9, in line with *fg* or *g* setal lines (Fig. 1C), 0.25–0.29 body circumference apart. Nehridiopores not recognizeable. Genital markings present, two pairs, pale whitish, transversely elliptical depression, with finite elevated edge, confined to segment 17 and 19, rather postsetal, anterior end start from the setal arc (Fig. 1D). Penial setae absent.

Internal. Brownish pigmentation in circular muscle layer. Septum 5/6 muscular, septa 6/7/8/9 membraneous or thin, 9/10/11/12/13 thickly muscular. Oesophagus with large, muscular, barrel-shaped gizzard, in segment 7, septa 7/8/9 pushed posteriorly in funnel-like manner, thus take the space of segments 8, 9; oesophagus and gizzard are attached to the parietes with several criss-crossed muscular fibers, calciferous gland like swelling present in oesophagus at segments 16 and 17; intestine origin in segment 20; intestinal caeca absent, typhlosole, simple, low ridge-like, lamelliform. Dorsal blood vessel, single and complete; supra esophageal vessel single. Last pair of hearts in segment 13. Holandric; testis and funnels, paired, free, in segments 10 and 11; seminal vesicles two pairs, racemose, in segments 9 and 12, anterior pair bushy or elongated branched, attached to posterior face of septum 9/10. Prostates paired in segment 18, fairly large, longitudinally placed, irregularly oblong, thickly racemose, lightly incised, lobed at margins, extending into segments segment 18–19, 20, penetrating through the septa 18/19/20; prostatic duct, obliquely placed, muscular, moderately stout, fairly equal width throughout, duct shorter than the length of prostate (Fig. 2A, B). Spermathecae two pairs, close to anterior margins in segments 8 and 9, posteriorly directed, anterior pair smaller, ampulla large, more or less ovoid, sac-like, wider at ectal end, somewhat dorsoventrally flattened, transversely striped; ampulla and duct well marked off, duct thick muscular, *c.* 1/3rd of the

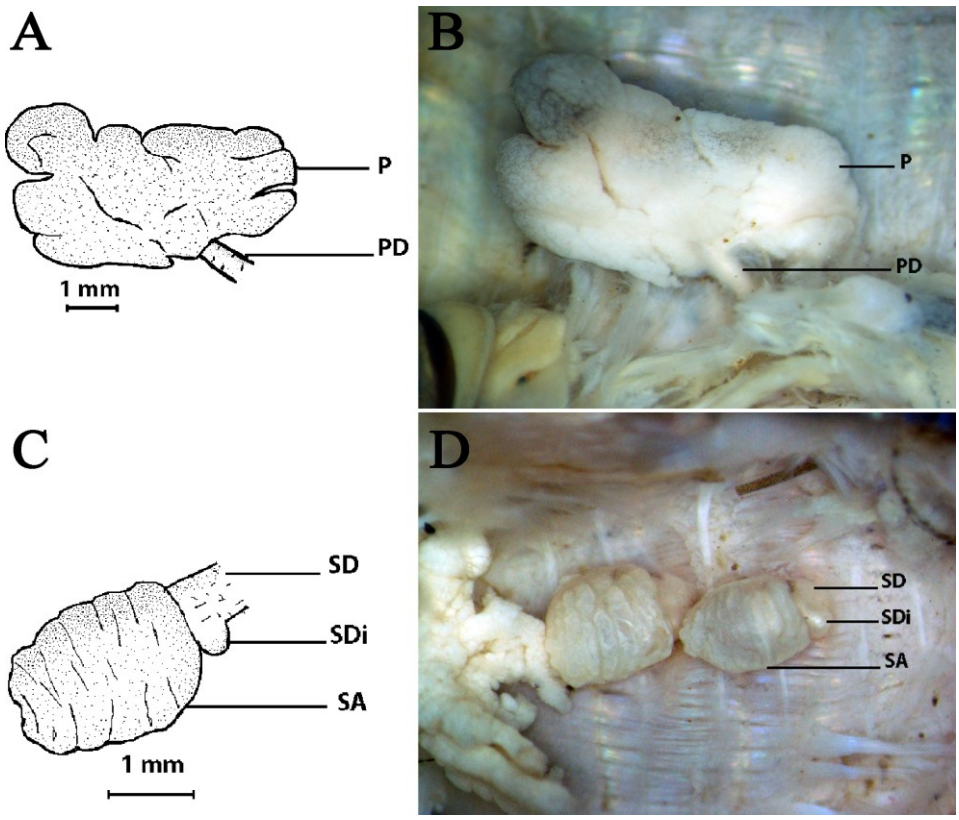

Figure 2. *Megascolex jamiesoni* sp. nov., prostate and spermatheca: A, B = Prostate, left side, dorsal view; C, D = Spermatheca, right side, dorsal view. P – Prostate, PD – Prostatic duct, SA – Spermathecal ampulla, SD – Spermathecal duct, SDi – Spermathecal diverticulum.

width of ampulla, *c.* 1/4th length of duct plus ampulla (Fig. 2C, D); seminal chamber-like ental spermathecal diverticulum, enclosed in duct-wall, projected on lateral surface. Nephridia exo-nephric, astomate micromeronephridia scattered in parietes. Genital marking glands absent.

Variation. In holotype prostates extend in segments 18–19, but bulging into segment 20 through septum 19/20, whereas in the paratype, it extends in segments 18–20. Second specimen also has a pair of pseudovesicles present in segment 13.

Etymology. The specific epithet '*jamiesoni'* is an eponym, named in honor of Prof. B.G.M. Jamieson, renowned Australian biologist and academician, for his tremendous contributions to the taxonomy and systematics of the earthworms of the world.

Ingesta. Significant proportion of coarse soil, pebbles, good quantity of barks and hard woody plant materials.

Habitat. Moist deciduous forest with large rocks, boulders and soil with fine-loamy texture, in the Eastern Ghats Hills, with altitudinal ranges from 600–900 m m.s.l. The collection site has a non-perennial stream and worms were extracted from beneath the leaf litter in a bed of pebbly soil along with roots of Pteridophyte (*Athyrium* sp.). Almost 90% of the vegetation of this area is dominated by *Shorea robusta* trees. Apart from this *Terminalia tomentosa*, *Xylia xylocarpa*, *Pterocarpus marsupium*, *Anogeissus latifolia, Butea monosperma*, *Careya arborea*, *Casaeria tomentosa*, *Lannea coromandelica, Helicteres isora*, *Holarrhena pubescens*, *Curcuma aromatica*, *Clerodendron infortunatum*, *Thysanolaena maxima*, *Cyonodon dactylon*, *Imperata arundina-*

cea, *Arundinella setosa*, *Oxytenanthera monostigma* etc. were found in the site.

Ecology. Seems to be an anecic species, as indicated by large quantity of plant materials and gravely soil in the intestine.

Distribution. Appears endemic to Jeypore Ghati of the Eastern Ghats Hills, Koraput District, Odisha State, India (Fig. 3). It may be found in the nearby hilly regions of the Eastern Ghats.

Remarks. Megascolex jamiesoni sp. nov., belongs to the *ratus* species group, with two pairs of spermathecal pores in intersegmental furrows 7/8/9, penial setae absent, holandric, calciferous glands absent and seminal vesicles in segments 9 and 12. Apart from the new species described in this communication, the group consists of four species, namely, *M. ratus* Cognetti, 1911, *M. pumilio* Stephenson, 1916, *M. quadripapillatus* Narayanan & Paliwal, 2024 and *M. jeyporeghatiensis* Narayanan & Paliwal, 2024. Among the group, the new species shows close similarity with *M. ratus, M. quadripapillatus* and *M. jeyporeghatiensis*, in body dimensions, presence of genital markings, *etc*. Of these *M. ratus* is endemic to the Western Ghats (Narayanan *et al.* 2016, 2023a), whereas the other two were recently described from the Eastern Ghats of Odisha (Naik *et al.* 2024). The differences of these species from *M. jamiesoni* sp. nov., are as follows.

M. jamiesoni sp. nov. is distinguished from the closely related *M. quadripapillatus* by the type of clitellum and its extent (¾13, 13–19 (= 6¾–7), 13–16 annular, 17–19 saddle shaped *vs* annular, in segments ½13–19 (= 6½), extend of genital markings (confined to segments 17 and 19 *vs* markings of the 19 extending into segment 20), spermathecae (unidiverticulate *vs* adiverticulate) and the shape of prostate and its extension (irregularly oblong, extending in segments 18–20 *vs* erect and confined to segment 18). Characters of the prostate (large irregularly oblong extending in segments 18–20 *vs* small, fan-like, confined to segment 18) and type of spermathecae (ental diverticulum *vs* ectal diverticulum) separate *M. jamiesoni* sp. nov. from the sympatric and closely look alike *M. jeyporeghatiensis*. *M. jamiesoni* sp. nov. is distinguished from *M. ratus* by the type of clitellum and its extent (¾13, 13–19 (= 6¾–7), 13–16 annular, 17–19 saddle shaped *vs* saddle-shaped in segments 14–18 [= 5]), number of genital markings (2 pairs *vs.* several), intestinal origin (in segment 20 *vs* in segment 14), etc. It differs from *M. pumilio* by the presence of genital markings. In addition, it can also be distinguished from *M. pumilio* by the large body size, type of clitellum, segmental origin of intestine and the shape of spermathecae. Detailed comparison of the *M. jamiesoni* sp. nov., with the similar-sized species of the *ratus*-group members are provided in Table 1.

DISCUSSION

At present a total of 35 *Megascolex* species are known from India, including the new species described in this work. The southern Western Ghats in the southwest region of Peninsular India are home to almost all of India's *Megascolex* species (Narayanan *et al.* 2020). However, a number of species have been discovered outside of the Western Ghats are either introduced to the area or endemic to their respective type localities (Bourne 1886; Michaelsen 1922; Stephenson 1924, 1925; Narayanan *et al.* 2019; Kumar *et al.* 2021; Naik *et al.* 2024). Karanth (2003), stated that, the current discontinuity of certain species might be representative of a relic of former continuous distribution. In the past *Megascolex* species would have widespread within in the eastern Peninsular India. Hence, the present disjunct distribution of *Megascolex* species in Peninsular India (in the Western Ghats and Eastern Ghats) is of great biogeographical significance (Naik *et al.* 2024). Approximately 74,000 years ago, the Toba volcano located in northern Sumatra erupted, marking the greatest explosive eruption of the Quaternary Period (Williams *et al.* 2009; Petraglia *et al.* 2011). This catastrophic volcanic outburst

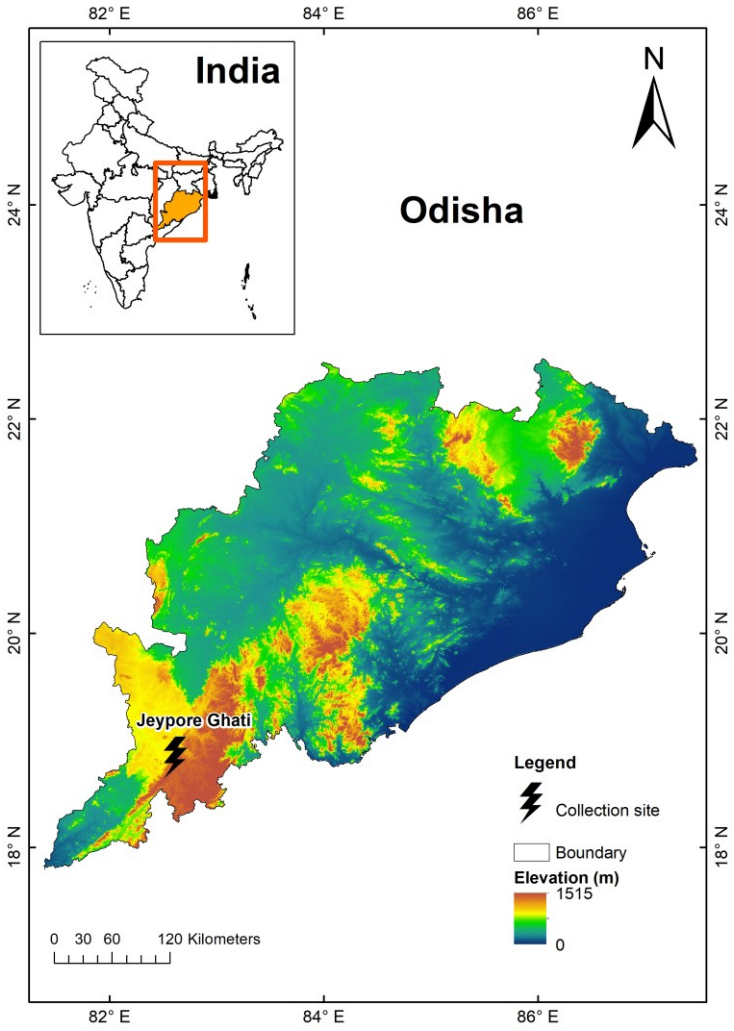

Figure 3. Location of the type locality Jeypore Ghati of *Megascolex jamiesoni* sp. nov. in the Eastern Ghats of Odisha state, India

steered to prolonged drought and deforestation in India, probably lasted for 1000–2000 years (Williams *et al.* 2009). Also Williams *et al.* (2009) stated that, the carbon isotope evidence from fossil soils found immediately beneath and above the Toba ash in central India demonstrates a major isochronous change in vegetation from forest before the eruption to open woodland or grassland thereafter. According to Lal (2016) this particular catastrophe is the reason for the absence of lush forests in areas like eastern Andhra Pradesh and north-eastern Tamil Nadu, because these regions were most severely impacted by the Toba eruption. The after-effects of the aforementioned Toba eruption, vicariance and other climatic effects would have severely affected or wiped out the *Megascolex* species of the Eastern Ghats and eastern Peninsular India. Even though, the remnant moist forests of the isolated Eastern Ghats hill groups may still have relic population of many undescribed species of *Megascolex*. At present, large scale deforestation, habitat modifycations due to urbanization, agriculture expansion, etc. would have further negatively affected the distribution of *Megascolex* range in Peninsular India. As mentioned previously, most of the Eastern Ghats Hills are highly underexplored with reference to earthworm fauna. Therefore, addi-

tional systematic sampling across the varied forest types of Eastern Ghats Hill ranges may uncover more undescribed *Megascolex* species and narrow the gap in the distribution pattern of *Megascolex* within Peninsular India.

Key to the *Megascolex* species from India

1. Spermathecal pores one pair in intersegmental furrow 8/9 …… ***M. hendersoni*** Michaelsen, 1907
- Spermathecal pores more than one pair……..**2**

2. Spermathecal pores 2 pairs in intersegmental furrows 7/8/9 ……**3**
- Spermathecal pores 3 pairs in intersegmental furrows 6/7/8/9, or numerous in each intersegmental furrows 7/8/9……...**30**

3. Spermathecal pores, close together, median to *a* setal line or between *aa* setal lines.……...**4**
- Spermathecal pores otherwise ……..…...……...**8**

4. Spermathecal ampulla and diverticulum single……**5**
- Spermathecal ampulla 3 ovoid sacs joined to single duct; diverticulum 2–5 small shining ovoid sacs …….……***M. tripartitus*** Stephenson, 1925

5. Penial setae present……...**6**
- Penial setae absent……..…**7**

6. Anisochaetine, penial setae almost straight, with paired long narrow pointed spines at intervals, does not extend up to the tip……***M. avicula*** Aiyer, 1929
- Perichaetine, penial setae bow-shaped, spines arranged like pinnae of a fern, reaches up to the tip … ……...***M. filiciseta*** Stephenson, 1915

7. Longer (length 143–150 mm; segments 218); male pores are somewhat elongated slits on lateral sides of the triangle converging posteriorly, lips of the slits are slightly swollen; prostates confined to segment 18, slightly bulging in front and behind……. ……..……***M. triangularis*** Stephenson, 1925
- Smaller (length 80 mm; segments 185); male pores in setal zone on small roundish papillae, a median ventral male field, somewhat depressed, shield-shaped, extending backwards to setal zone of segment 19; prostate extends through 10 segments……. …….***M. travancorensis ghatensis*** Michaelsen, 1910
- Smaller (length 65 mm; segments 85); male pores on slightly raised rather indefinitely circular porophores, in or perhaps slightly in front of setal zone; prostate confined to segment 18…….. ……...…..***M. pheretima*** Michaelsen, 1921

8. Spermathecal pores in line with *a* or *ab* setal lines...**9**
- Spermathecal pores otherwise……..…**15**

9. Penial setae present, curved into semi-circle or s-shaped, tip flattened…….… ……***M. porphyrozonus*** Stephenson, 1924
- Penial setae absent……**10**

10. Male field limited by a transversely elliptical or oval wall……...**11**
- Male field not so limited……...**12**

11. Male field has a kidney-shaped cushion; spermathecal ampulla elongated and cylindrical, without sharp demarcation from the duct…….… ……***M. cochinensis phaseolus*** Stephenson, 1915
- Male field lacks kidney-shaped cushion; spermathecal ampulla ovoid, sharply demarcated from the duct…...***M. cochinensis cochinensis*** Stephenson, 1915

12. Body long > 100 mm……**13**
- Body has more usual proportions < 85 mm……..…**14**

13. Prostomium with a retractable proboscis-like organ; dumbbell-shaped copulatory cushion present at segments 7/8/9; gizzard in segment 5…… ……..……***M. travancorensis proboscidea*** Aiyer, 1929
- Prostomium lacks proboscis-like organ; copulatory cushion absent; gizzard in segment 6…….....…. …***M. travancorensis travancorensis*** Michaelsen, 1910

14. Prostate extends in 7-8 segments; ectal spermathecal diverticulum……***M. papparensis*** Lone, Thakur, Tiwari, James & Yadav, 2022
- Prostate extends in 10 segments; ental spermathecal diverticulum……...***M. travancorensis quilonensis*** Michaelsen, 1910

15. Spermathecal pores in line with *b,* about in *b,* or *bc* setal lines……**16**
- Spermathecal pores in line with *d* setal lines or beyond……..…**25**

16. Metandric……..…**17**
- Holandric……..…**18**

17. Anioschaetine, prostate extends over 3–4 segments ……..***M. auriculata*** Aiyer, 1929
- Perichaetine throughout, prostate extends in 10 segments…..……..…***M. peermadensis*** Aiyer, 1929

18. Spermathecae bidiverticulate; penial setae present ……*M. lawsoni* (Bourne, 1886)
- Spermathecae unidiverticulate; penial setae absent ……**19**

19. Number of segments > 255 segments……...…**20**
- Number of segments < 255 segments……...…**22**

20. Spermathecal ampulla sac-like in its ental end, narrow in its ectal portion … ***M. travancorensis bonaccordensis*** Michaelsen, 1913
- Spermathecal ampulla sausage-shaped, bent……**21**

21. Male field pentagonal in shape, with an inverted T-shaped depression; ental spermathecal diverticulum… ……***M. pentagonalis*** Stephenson, 1916
- Male field with two projected U-shaped grooves connect male pore papillae; ectal spermathecal diverticulum……***M. vazhichlensis*** Lone, Thakur, Tiwari, James & Yadav, 2022

22. Spermathecal ampulla large, ovoid, with ental diverticulum……***M. pumilio*** Stephenson, 1916
- Spermathecal ampulla club-shaped, sac-like, smooth or flattened ovoid, with ectal diverticulum……**23**

23. Intestine begins in segment 21 … ***M. euneprhus*** Cognetti, 1911
- Intestine begins anterior to segment 21 ……...**24**

24. Intestine begins in segment 16; last heart in segment 13…...……***M. trivandranus*** Stephenson, 1916
- Intestine begins in segment 14; last heart in segment 13……..…***M. insignis*** Michaelsen, 1910
- Intestine begins in segment 19; last heart in segment 14……..……***M. kavalaianus*** Stephenson, 1915

25. Genital markings present……...…**26**
- Genital markings absent……...…**29**

26. Genital markings intersegmental, circular, more than 2 pairs……..…..***M. ratus*** Cognetti, 1911
- Genital markings segmental, transversely elliptical depression, 2 pairs……..27

27. Prostate extents in segments 18–20…… ……..……***M. jamiesoni*** Narayanan & Paliwal, sp. nov.
- Prostate confined to segment 18……...…**28**

28. Spermathecae adiverticulate…… ….....***M. quadripapillatus*** Narayanan & Paliwal, 2024
- Spermathecae unidiverticulate, ectal diverticulum….. …….***M. jeyporeghatiensis*** Narayanan & Paliwal, 2024

29. Prostate large, mop-like, duct thick and fairly long; spermathecal ampulla pear-shaped……..… ……..***M. konkanensis konkanensis*** Fedarb, 1898
- Prostate small, bushy, duct short, widens at ectal end; spermathecal ampulla elongated oval……..… …….***M. konkanensis longus*** Stephenson, 1915

30. Spermathecal pores, 3 pairs in intersegmental furrows 6/7/8/9……...….***M. imperatrix*** (Bourne, 1894)
- Spermathecal pores, numerous on each side in inter-segmental furrows 7/8/9……..……**31**

31. Spermathecae adiverticulate……..… …….***M. polytheca polytheca*** Stephenson, 1915
- Spermathecae unidiverticulate……..**32**

32. Spermathecal duct rather longer than ampulla..… ……***M. polytheca zonatus*** Stephenson, 1915
- Spermathecal duct 4 times longer than ampulla…… ……***M. polytheca uniquus*** Aiyer, 1929

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Table 1. Comparison of the characters of *Megascolex jamiesoni* Narayanan & paliwal, sp. nov., with three closely related similar sized species (adapted and modified based on Naik *et al.* 2024).

Character	*M. ratus* Stephenson, 1911 [1,2,3,4,5]	*M. quadripapillatus* Narayanan & Paliwal, 2024[5]	*M. jeyporeghatiensis* Narayanan & Paliwal, 2024[5]	*M. jamiesoni* Narayanan & Paliwal, sp. nov.
Length	230–315 mm	273–308 mm	221–281 mm	229–269 mm
Diameter	7–10 mm	9–10 mm	8–10 mm	7.5–9 mm
Segments	162–218	188–190	168–189	162–167
Prostomium	Tanylobic, epilobic ½ or proepilobic	Proepilobic, with a mid-dorsal groove	Proepilobic or closed epilobic, with a mid-dorsal groove	Proepilobic, with a mid-dorsal groove
Clitellum	Saddle-shaped, in segments 14–18 (= 5)	Annular, in segments ½13–19 (= 6½)	Annular, in segments ½13, 13, 14–18, ½19, 19 (= 6½–7)	In segments ¾13, 13–19 (= 6¾–7), 13–16 annular, 17–19 saddle shaped
Number of setae	About 180 on segment 10, about 135 on each segment at middle regions of the body	58–66 on segment 5, 56–66 on segment 9, 58–66 on segment 12, 65–70 on segment 20, 70–71 on segment 25	58–64 on segment 5, 64–80 on segment 9, 62–82 on segment 12, 64–86 on segment 20, 62–84 on segment 25	54–60 on segment 5, 58–64 on segment 9, 56–58 on segment 12, 58–60 on segment 20, 64–76 on segment 25
Genital markings	Several pairs, about circular, close to mid ventral line, on intersegmental furrows 16/17, 19/20, 20/21, and 21/22, sometimes on 14/15, 15/16, and 22/23	Two pairs, transversely elliptical depression, anterior pair in segments 17–18, posterior pair occupies segments 19–20	Two pairs, segmental, transversely elliptical depression confined to segments 17 and 19, each depression is divided by a longitudinal dyke at the mid-ventral line	Two pairs, segmental, transversely elliptical depression confined to segments 17 and 19, longitudinal dyke absent
Gizzard	Large, in segment 5 or 6?	Large, in segment 7	Large, in segment 6	Large, in segment 7
Intestine origin	In segment 14	In segment 20	In segment 16	In segment 20
Spermathecae	Ampulla more or less ovoid, duct abruptly marked off; unidiverticulate, ental diverticulum	Ampulla large, more or less ovoid, sac-like, ampulla and duct well marked off; adiverticulate	Ampulla sac-like, ampulla and duct well marked off; unidiverticulate, ectal diverticulum	Ampulla large, more or less ovoid, sac-like, ampulla and duct well marked off; unidiverticulate, ental diverticulum
Prostate	Large, in segments 19–22, lobed at the margins; duct strong, cylindrical, curved	Large, erect, incised, lobed, thick, irregularly rectangular, flattish, confined to segment 18; duct hidden in glands, somewhat straight, muscular	Small, fan-like, slightly incised, somewhat dorsoventrally flattened, confined to segment 18; duct thick, straight, ental portion branched	Fairly large, lobed, longitudinally placed, lightly incised, in segments 18–20; duct, obliquely placed, muscular

Data from: [1]Cognetti (1911); [2]Stephenson (1923); [3]Aiyer (1929); [4]Sathrumithra *et al.* (2018); [5]Naik *et al.* (2024)

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