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On *Heterotrephes* Esaki & Miyamoto, 1959 (Hemiptera: Heteroptera: Helotrephidae)

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Abstract

The status of *Heterotrephes* Esaki & Miyamoto, 1959, a genus of Helotrephini, is re-evaluated based on morphology. Hitherto this genus was monotypic, with type species *Heterotrephes admorsus* Esaki & Miyamoto, 1959 from southern Japan. Comparison of key characters, chiefly the medio-ventral thoracic carinae and genitalia of males, of numerous Asian Helotrephini indicates that the nine species previously described in the *Hydrotrephes mirus* group (sensu Zettel) and the two species previously described in the *Hydrotrephes sarawakensis* group (sensu Zettel) should be placed in *Heterotrephes*. The following new combinations are proposed: *Heterotrephes busuanganus* (Zettel, 2003) comb.n., *Heterotrephes hybridus* (Zettel, 2000) comb.n., *Heterotrephes kalimantanensis* (Zettel, 2000) comb.n., *Heterotrephes minutus* (Zettel, 2003) comb.n., *Heterotrephes mireki* (Zettel, 2009) comb.n., *Heterotrephes mirus* (Zettel, 1998) comb.n., *Heterotrephes mixtus* (Papáček & Kovac, 2001) comb.n., *Heterotrephes palawanensis* (Zettel, 2003) comb.n., *Heterotrephes sarawakensis* (Zettel, 2000) comb.n., *Heterotrephes schillhammeri* (Zettel, 1998) comb.n., and *Heterotrephes yangae* (Zettel, 2000) comb.n. The known distribution range of *Heterotrephes* comprises Japan, Indochina, Borneo, and the Palawan region of the Philippines. A key to genera of Helotrephini in Southeast Asia is provided.

Keywords. Helotrephidae, Helotrephini, *Heterotrephes*, *Hydrotrephes*, taxonomy, new combinations, key to Oriental genera.

Zusammenfassung

Der Status von *Heterotrephes* Esaki & Miyamoto, 1959, einem Genus der Helotrephini, wird anhand morphologischer Merkmale neu beurteilt. Diese bisher monotypische Gattung basierte auf der Typusart *Heterotrephes admorsus* Esaki & Miyamoto, 1959 aus dem südlichen Japan. Der Vergleich wichtiger Merkmale wie der medioventralen Thoraxkiele und der Genitalstrukturen der Männchen bei zahlreichen asiatischen Helotrephini unterstützt die Hypothese, dass die neun Arten der *Hydrotrephes mirus*-Gruppe (sensu Zettel) und die zwei Arten der *Hydrotrephes sarawakensis*-Gruppe (sensu Zettel) in die Gattung *Heterotrephes* überstellt werden sollen. Die folgenden neuen Kombinationen werden vorgeschlagen: *Heterotrephes busuanganus* (Zettel, 2003) comb.n., *Heterotrephes hybridus* (Zettel, 2000) comb.n., *Heterotrephes kalimantanensis* (Zettel, 2000) comb.n., *Heterotrephes minutus* (Zettel, 2003) comb.n., *Heterotrephes mireki* (Zettel, 2009) comb.n., *Heterotrephes mirus* (Zettel, 1998) comb.n., *Heterotrephes mixtus* (Papáček & Kovac, 2001) comb.n., *Heterotrephes palawanensis* (Zettel, 2003) comb.n., *Heterotrephes sarawakensis* (Zettel, 2000) comb.n., *Heterotrephes schillhammeri* (Zettel, 1998)

comb.n. und *Heterotrephes yangae* (Zettel, 2000) comb.n. Die nun bekannte Verbreitung von *Heterotrephes* erstreckt sich von Japan, Indochina und Borneo bis in die Palawan-Region der Philippinen. Ein Bestimmungsschlüssel zu den Gattungen der Helotrephini Sudostasiens ist beigefügt.

Introduction

Helotrephidae are a family of predatory aquatic bugs that is found in the tropics and subtropics. The highest species diversity occurs between the Southeast Asian mainland and Sulawesi. Most species are very small, with a body length range of 1–5 mm.

This paper establishes taxonomic changes in the tribe Helotrephini that were already considered – but not implemented – by Zettel & Papáček (2008), when they redescribed *Heterotrephes admorsus* Esaki & Miyamoto, 1959, a previously little-known species from Japan. A continuation of the studies on Helotrephini was interrupted by the illness and untimely passing of Miroslav Papáček (1953–2019). Moreover, molecular data of relevant species are not available until today.

The new taxonomic treatment of Oriental Helotrephini genera remains in some way preliminary – as discussed below – chiefly, because the African taxa need further examination. The relationships of *Heterotrephes* and *Esakiella* China, 1932 from Africa and Madagascar are not yet fully understood. *Heterotrephes* and the small genus *Ascetotrephes* Polhemus & Polhemus, 2003 from Malaysia and Indonesia remain difficult to separate by essential characters. Molecular data – not yet available – could improve the unsatisfying situation.

The preparation of a chapter on aquatic Heteroptera of Southeast Asia, including a key to genera of Helotrephidae, and the need to draw an adjusted line between two main genera in the region, *Hydrotrephes* China, 1935 and *Heterotrephes* Esaki & Miyamoto, 1959 were the main drivers for the present article.

Material and methods

Besides the data from published literature, the large collection of Helotrephidae in the Natural History Museum Vienna was used to confirm relevant characters.

The stacked digital images (Figs 1–13) were taken with a Leica DFC490 camera attached to a Leica Z16APO optics carrier, using Leica Application Suite V3.8. Images were stacked with ZereneStacker 64-bit and processed with Adobe Photoshop 7.0. Illustrated specimens are deposited in the Natural History Museum Vienna (except holotype of *Ascetotrephes schawalleri* in the State Museum of Natural History, Stuttgart, Germany).

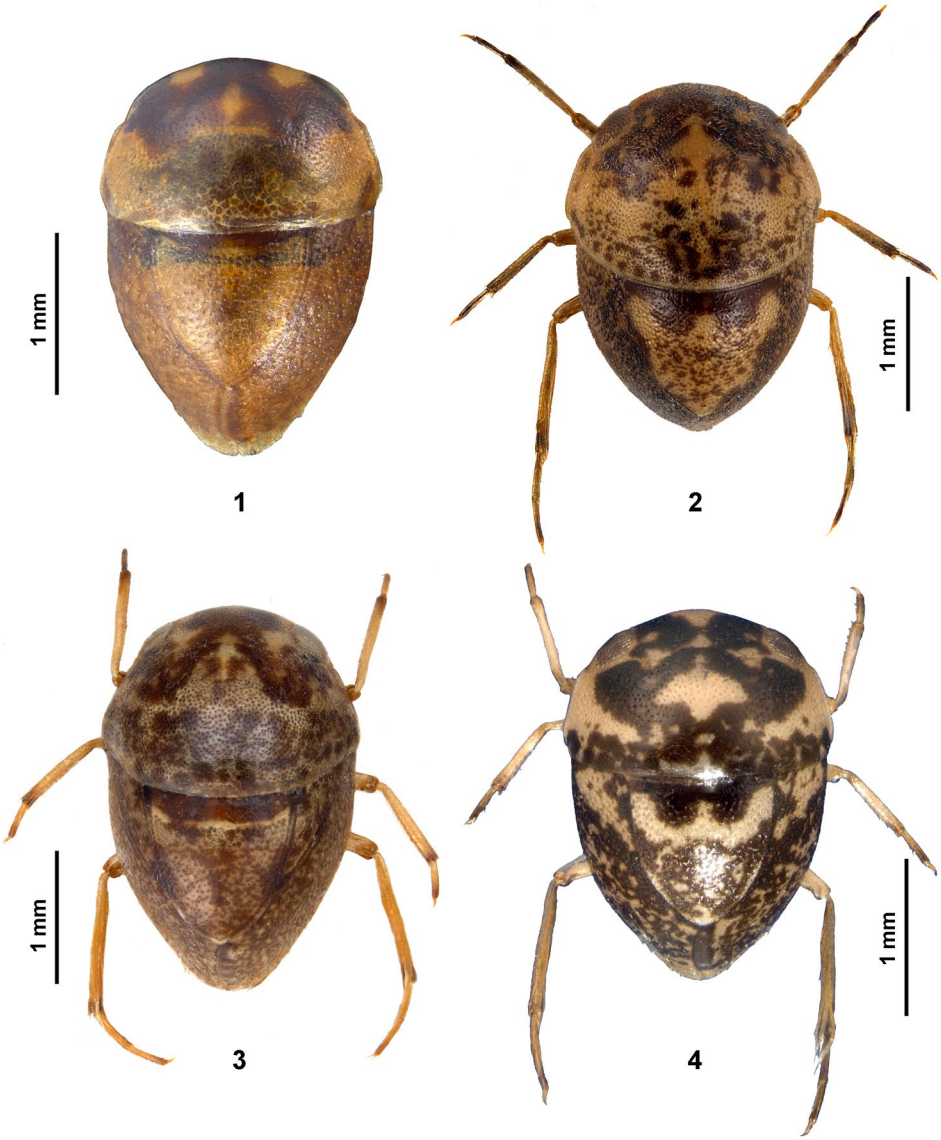
The schematic line drawings (Figs 14–56) were reproduced based on drawings in previous publications of the author.

Taxonomy

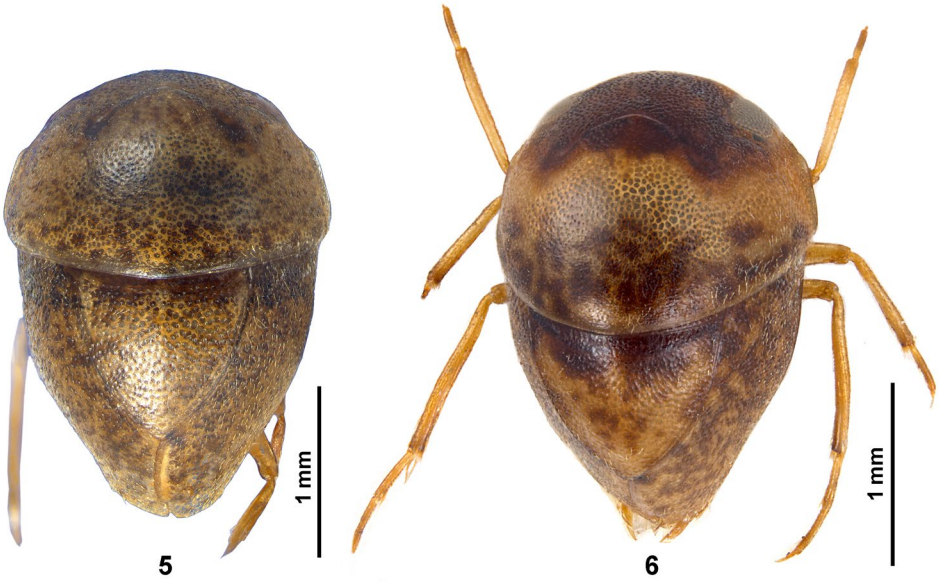
Heterotrephes Esaki & Miyamoto, 1959

Type species. *Heterotrephes admorsus* Esaki & Miyamoto, 1959 (by monotypy)

Diagnosis (after Zettel 1998b and 2000 for *Hydrotrephes mirus* group, modified). Size variable, body length 1.9–2.9 mm. Body highly domed, more or less semi-globular.



Figs 1–4. Habitus, dorsal view, of *Heterotrephes* species. (1) *H. admorsus* (from Zettel & Papáček 2008). (2) *H. hybridus*. (3) *H. mirus*. (4) *H. palawanensis*. Photos: 1, 4: H. Bruckner / NHMW; 2, 3: A. Demelius / NHMW.



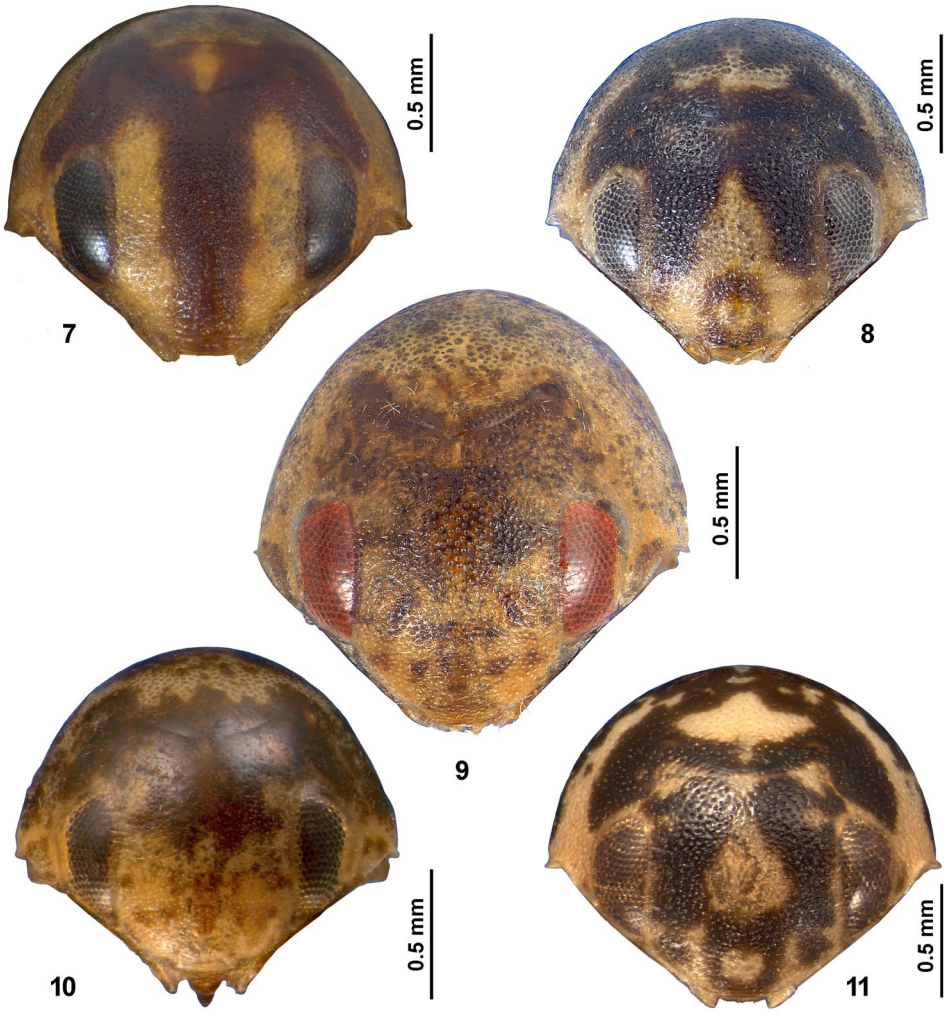
Figs 5–6. Habitus, dorsal view, of *Heterotrephes* species (former *H. sarawakensis* group). (5) *H. kalimantanensis*. (6) *H. sarawakensis*. Photos: 5: A. Demelius / NHMW; 6: H. Bruckner / NHMW.

Pronotum of macropterous specimens simple (this morph unknown in some species). Ventral pronotal plate anteriorly slender, posteriorly variable; incision shallow to deep. Mesoscutellum large (Figs 1–6). Tarsal formula (number of tarsomeres on fore, middle and hind leg) 1–1–2. Medioventral carinae (e. g., Figs 21–28): Both meso- and metasternal carina distally without thin, transparent lamella; mesosternal carina low (at least lower than metasternal carina); metasternal carina long, with straight or concave edge (never convex as in *Hydrotrephes*). Carina of sternum 3 with trapezoidal or rhomboidal apex, rarely with a posteriorly directed spine ("*sarawakensis* group"). Sternum 4 unmodified or with one minute median tooth. Genitalia of males: Aedeagus without posterior modification; apex simple, curved (e. g., Figs 29, 31, 33, 35) or slightly modified by a minute apical plate (Figs 41, 43; in "*sarawakensis* group"). Right paramere long, slender, and more or less undulate (e. g., Figs 30, 34, 36; slightly medially broadened in "*sarawakensis* group", Figs 42, 44). Female: sternum 7 (subgenital plate) often with basal tumescence (not in Philippine species, poorly developed in "*sarawakensis* group"), tongue-shaped or with posteromedial lobe-like lamina (e.g., Figs 51–56).

Notes. The *Hydrotrephes sarawakensis* group was established by Zettel (2000). The following differences from the *Hydrotrephes mirus* group were noted: sternum 3 with modified apex, aedeagus with minute apical lamella, and right paramere shorter.

Heterotrephes shows a strong variety of colour patterns and puncturation. Some examples are shown in Figures 1–11.

Distribution. The type species was described from Southern Japan (Esaki & Miyamoto 1959). In the *Hydrotrephes mirus* group nine species from Thailand, Laos, Borneo,



Figs 7–11. Frontal view of cephalonotum of *Heterotrephes* species. (7) *H. admorsus* (from Zettel & Papáček 2008). (8) *H. mireki* (from Zettel 2008). (9) *H. sarawakensis*. (10) *H. minutus*. (11) *H. palawanensis*. Photos: H. Bruckner / NHMW.

and the Philippines were described; two further species from Borneo were previously described in the *Hydrotrephes sarawakensis* group (see Checklist). In the Philippines, *Heterotrephes* is restricted to areas with probable Pleistocene land-bridges to the Sunda Shelf, i.e., the Palawan region connected to Borneo.

Figs 12–13. Frontal view of cephalonotum of *Ascetotrephes* species. (12) *A. edmundsorum* Polhemus & Polhemus, 2003. (13) *A. schawalleri* Zettel, 2008 (from Zettel 2008). Photos: H. Bruckner / NHMW.

Key to Oriental genera of Helotrephini

1 Abdominal sterna 4 and 5 (or 4–6) with distinct median carina (Fig. 14). ..... ***Helotrephes***

– Abdominal sterna 5 and 6 without median carina; sternum 4 unmodified or with small tooth (Figs 15–28). 2

2 Mesosternal and metasternal carinae usually with distinct thin lamina-like, broadly rounded apex (rarely indistinct on mesosternum, Fig. 16); mesosternal carina almost as high as metasternal carina; metasternal carina short, with rounded outline (Figs 15–18). ..... ***Hydrotrephes***

– Mesosternal carina low or high with pointed apex; metasternal carina long, with straight to concave ventral outline (Figs 19–28). 3

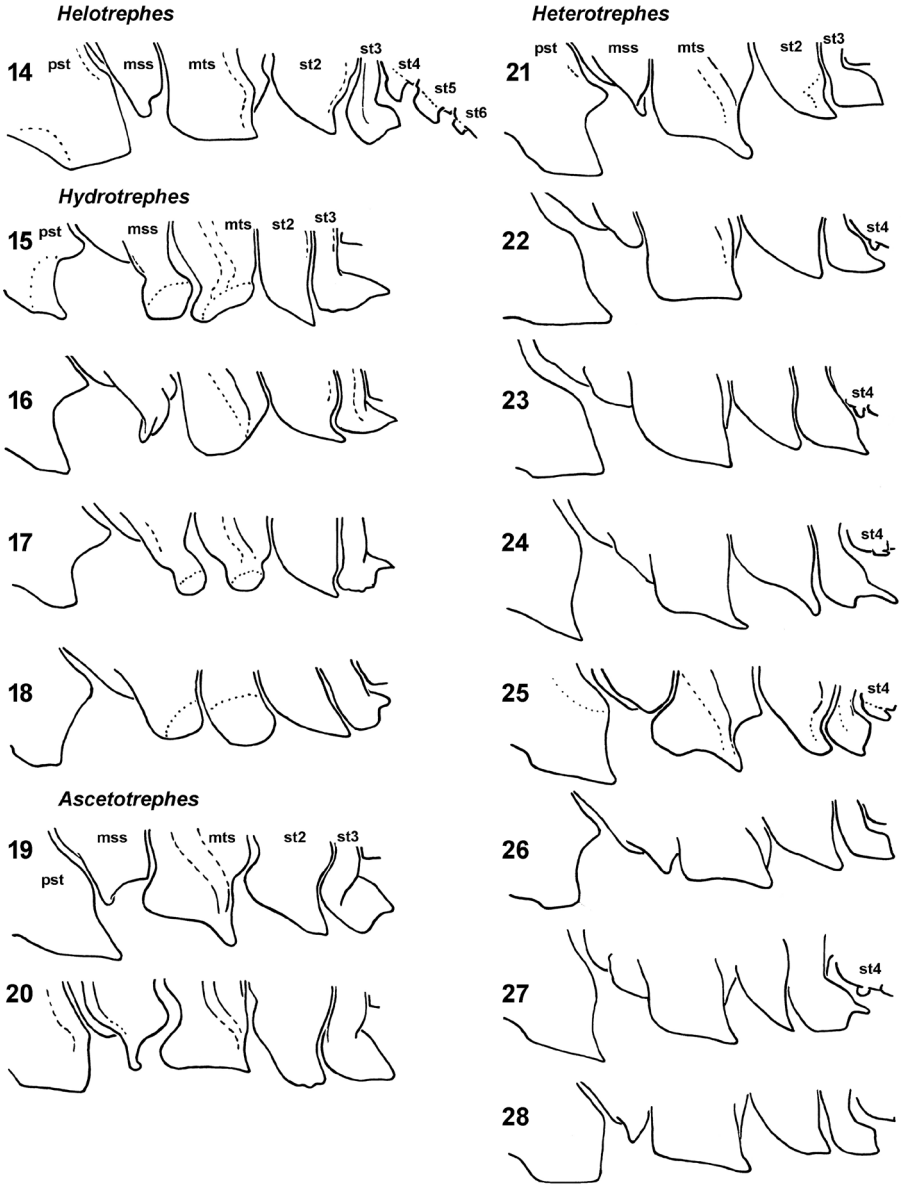
3 Anterior margin of head very broadly rounded in frontal view (Figs 12, 13). Median carina of mesosternum high, highest point anteriorly (Figs 19–20). Body length usually ≥ 3 mm. ..... ***Ascetotrephes***

– Anterior margin of head more narrowly rounded in frontal view (Figs 7–11). Median carina of mesosternum low, if only slightly lower than on metasternum, then highest point posteriorly (Figs 21–28). Body length < 3 mm. ..... ***Heterotrephes***

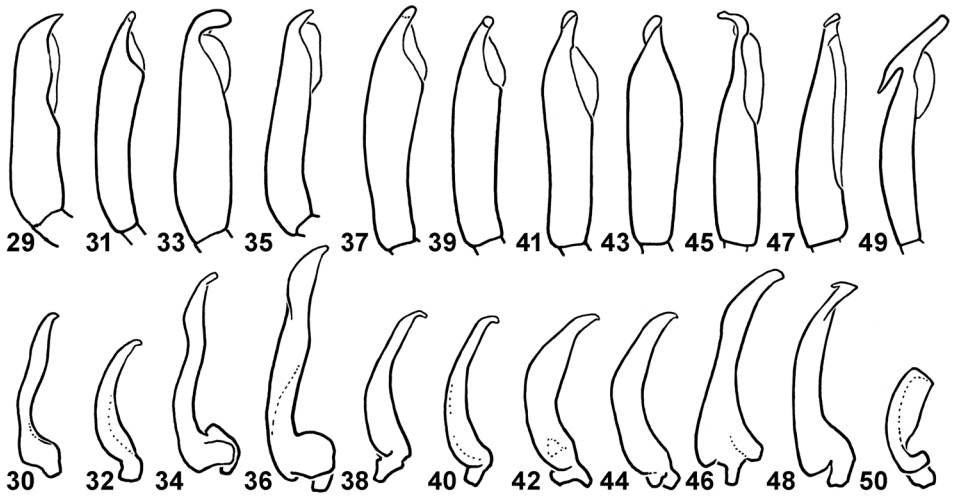
Checklist of species of *Heterotrephes*

Former classification in brackets.

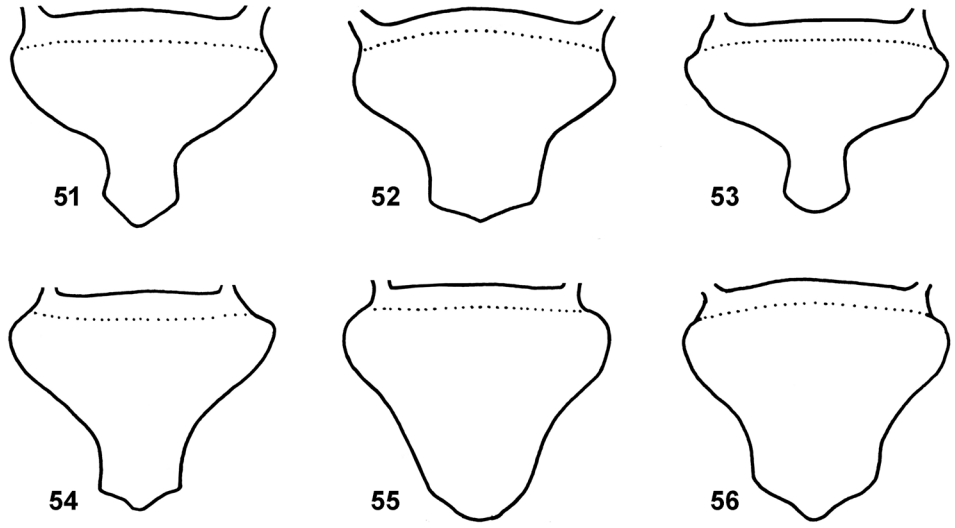
Heterotrephes admorsus Esaki & Miyamoto, 1959 (type species)	Japan (South)
Heterotrephes busuanganus (Zettel, 2003) comb.n. (*Hydrotrephes*)	Philippines (Busuanga)
Heterotrephes hybridus (Zettel, 2000) comb.n. (*Hydrotrephes*)	Borneo (Sabah)
Heterotrephes kalimantanensis (Zettel, 2000) comb.n. (*Hydrotrephes*)	Borneo (Kalimantan)
Heterotrephes minutus (Zettel, 2003) comb.n. (*Hydrotrephes*)	Philippines (Busuanga)
Heterotrephes mireki (Zettel, 2009) comb.n. (*Hydrotrephes*)	Philippines (Palawan)
Heterotrephes mirus (Zettel, 1998) comb.n. (*Hydrotrephes*)	Thailand (North)
Heterotrephes mixtus (Papáček & Kovac, 2001) comb.n. (*Hydrotrephes*)	Thailand (South)
Heterotrephes palawanensis (Zettel, 2003) comb.n. (*Hydrotrephes*)	Philippines (Palawan)



Figs 14–28. Sternal carinae, examples of Oriental Helotrephini; pilosity omitted; not to the same scale. Abbreviation: pst – prosternal carina; mss – mesosternal carina; mts – metasternal carina; st2–st6 – carinae on sterna 2–6. (14) *Helotrephes guizhouensis* Zettel, 2012. (15) *Hydrotrephes ilocanus* Zettel, 2012. (16) *Hydrotrephes mamasanus* Zettel, 2012. (17) *Hydrotrephes schoedli* Zettel, 2012. (18) *Hydrotrephes yupae* Zettel, 2012. (19) *Ascetotrephes edmundsorum*. (20) *Ascetotrephes loedli* Zettel, 2004. (21) *Heterotrephes admorsus*. (22) *H. busuanganus*. (23) *H. hybridus*. (24) *H. kalimantanensis*. (25) *H. mireki*. (26) *H. mirus*. (27) *H. sarawakensis*. (28) *H. schillhammeri*. Figures redrawn from: 14–18, 22–28: original descriptions. 19, 20: Zettel (2004). 21: Zettel & Papáček (2008).



Figs 29–50. Comparison of aedeagi (upper row) and right parameres (lower row) in species of *Heterotrephes*, *Ascetotrephes*, and *Hydrotrephes* (examples); pilosity omitted. Aedeagi are approximately brought to the same size (different scale); paramere lengths are relative in size to aedeagi. (29, 30) *Heterotrephes admorsus*. (31, 32) *H. mireki*. (33, 34) *H. mirus*. (35, 36) *H. schillhammeri*. (37, 38) *H. palawanensis*. (39, 40) *H. minutus*. (41, 42) *H. sarawakensis*. (43, 44) *H. kalimantanensis*. (45, 46) *Ascetotrephes mesilau* Polhemus & Polhemus, 2003. (47, 48) *Ascetotrephes keningau* Polhemus & Polhemus, 2003. (49, 50) *Hydrotrephes yupae*. Figures redrawn from: 14–18, 22–28: original descriptions. 29, 30: Zettel & Papáček (2008). 45–48: Zettel (2004).



Figs 51–56. Examples of sterna 7 of females in various *Heterotrephes* species; outline in ventral view; pilosity omitted; not to the same scale. (51) *H. busuanganus*. (52) *H. minutus*. (53) *H. mireki*. (54) *H. hybridus*. (55) *H. yangae*. (56) *H. sarawakensis*. Redrawn from original descriptions.

Heterotrephes sarawakensis (Zettel, 2000) comb.n. (*Hydrotrephes*)	Borneo (Sarawak)
Heterotrephes schillhammeri (Zettel, 1998) comb.n. (*Hydrotrephes*)	Laos, Vietnam
Heterotrephes yangae (Zettel, 2000) comb.n. (*Hydrotrephes*)	Borneo (Sabah)

Discussion

Hydrotrephes is a speciose genus in Southeast Asia and also known in one species from Sri Lanka. Eastwards, *Hydrotrephes* reaches the Philippines and Sulawesi of Indonesia (Helotrephidae are unknown east of Weber's Line). When Zettel & Papáček (2008) redescribed *Heterotrephes admorsus* Esaki & Miyamoto, 1959, a previously little-known species from southern Japan, they repeated the similarity between *Heterotrephes* and the *Hydrotrephes mirus* group established by Zettel (1998), but did not implement a taxonomic reclassification. Zettel (2000) established the *Hydrotrephes sarawakensis* group with two species from Borneo and highlighted some small differences with the *H. mirus* group, noted in the diagnosis above. However, the diagnostic characters, as given above, are almost identical among *Heterotrephes admorsus*, nine species of the *Hydrotrephes mirus* group and two species of the *Hydrotrephes sarawakensis* group.

Polhemus & Polhemus (2003) did not compare their new genus *Ascetotrephes* with *Heterotrephes*. Both taxa share several characteristics of midventral carinae and parameres of males. However, the mostly large and flattened body of *Ascetotrephes* and the more strongly raised mesosternal carina may presently serve as distinguishing features. In *Ascetotrephes* sternum 7 of females is strongly asymmetrical in several species; others possess a simple tongue-shaped lobe (see Zettel 2004). In *Heterotrephes* sternum 7 is symmetrical and often with a well-defined, narrow lobe (however, not in *H. admorsus*).

Esakiella occurs in tropical Africa and Madagascar. The species of this genus are rather heterogeneous, consisting of several species groups (see, e.g., Zettel & Papáček 2004). At a first glance, *Esakiella* seems to be relatively well defined. When studying the genus diagnosis by China (1932) it should also be kept in mind that China's definition of *Helotrephes* referred to species which were later transferred to *Hydrotrephes*. In fact, *Esakiella* differs from *Helotrephes* and *Hydrotrephes* in about the same main characters as *Heterotrephes*. However, in *Esakiella* the apex of aedeagus and sternum 7 of females are variously modified compared to the rather uniform structures in *Heterotrephes*. Besides geographical vicariance, this must presently serve as a weak difference between the two genera.

Pseudohydrotrephes Poisson, 1956, a monotypic genus of Helotrephini from Madagascar appears well distinguishable by the characters given in the original description (Poisson 1956) (specimens not studied by the author).

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I fondly remember the numerous discussions on the systematics of the Helotrephidae with Mirek (Miroslav Papáček, 1953–2019), who left us much too early. His contribution to this work is considerable.

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