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The morphological diversity of Mymaridae (Hymenoptera): an atlas of scanning electron micrographs. Part 3. Structure of the metasoma

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Abstract

This is the third in a series of studies that aim to provide an overview of the morphological diversity of Mymaridae (Hymenoptera) or fairyflies, a monophyletic family of small parasitic wasps postulated as the sister group of all other Chalcidoidea. The external morphology of the metasoma of about half of the 115 currently valid described genera and subgenera is described and illustrated with about 460 scanning electron micrographs. Fifteen annotated figures of external metasoma structures and the male genitalia are included. The names of the 75 genera and subgenera illustrated, at least in part, are tabulated. An appendix lists the 23 acronyms used for morphological terms. The variety of characters and their features that could be used to help define morphologically the genera, and possibly also the species, of Mymaridae is briefly discussed.

Key words: morphology, terminology, fairyflies

Introduction

The first and second papers (Huber *et al.* 2023a, 2023b) on external morphology of Mymaridae (Hymenoptera) treated and illustrated with scanning electron micrographs, respectively, the head and mouthparts, and the mesosoma. The present paper covers the external morphology of the metasoma, again using micrographs to illustrate at least one species for ~65–75 of the ~115 currently recognized valid extant genera and subgenera of Mymaridae. The taxa illustrated cover most of the morphological diversity in the family because at least one genus of all the tribes or clusters of similar genera are included. Structures not usually treated in taxonomy of Mymaridae, e.g., the ventral, anterior, and posterior surfaces of the metasoma, may well yield new morphological features that could be useful to include in generic or perhaps even species descriptions, thus helping to distinguish the taxa.

Materials and methods

The methods described in Huber *et al.* (2023a) apply also to this study. Huber *et al.* (2023a) tabulated all the valid fairyfly genera and subgenera and, for the taxa illustrated, their provenance. We refer readers to that paper to avoid repetition, but include an abbreviated version here (Table 1) that lists only the genera and subgenera illustrated in the present paper. Terms used in the text are illustrated (Figs 1–15), mostly following Burks *et al.* (2024, in press) for Chalcidoidea. Most specimens were imaged by K. Bolte between 1998 and 2004, using the preparation method described in Bolte (1997). Specimens must be appropriately prepared by critical point or chemical drying to reduce or prevent shriveling and to maintain more or less correct proportions for measurement because the metasoma, or at least the gaster and, rarely, the petiole, are often less sclerotized than the head or mesosoma.

The gold coated specimens are deposited on metal stubs preserved in the CNC. Uncoated specimens of some genera were imaged by J. Read from 2006–2016, using an environmental scanning electron microscope, and the pinned specimens on triangular card points were returned to the collections (usually the CNC) to which they belong.

The number of genera illustrated varies, depending on structure and view. As much as possible only one species per genus was illustrated, usually from female specimens. To see all views of the metasoma it must be detached from the mesosoma. To see the anterior view of the entire gaster as well as the dorsal view of the petiole properly it is best to not only detach the metasoma but also the petiole from the gaster, though this is rarely done, even in the present paper. Where possible, dorsal, ventral, and lateral views of the detached petiole are shown, though often the dorsal view is shown less often because of its orientation relative to the gaster makes this difficult. The anterior and posterior views of the petiole are not shown as these were not considered to be morphological relevant.

Morphological terms and acronyms used are given in Appendix 1. They are limited mainly to those used in taxonomic papers on Mymaridae. Because this is a morphological paper it should be used to understand structure only, not identify taxa even though some genera may be identifiable from a particular micrograph. Other than the female and male genitalia, almost no internal sclerotized parts of the metasoma are presently considered of potential taxonomic use.

Viggiani (1973, 1989, 1991, 2004) illustrated with line drawings the sclerotized structures of male genitalia, which he used to help define many genera of Mymaridae, and Viggiani (1970, 1994) used male genitalia to define and distinguish species of *Anagrus* Haliday and *Anaphes* Haliday, respectively. For externally visible parts of the male genitalia, we use the terms given in Burks *et al.* (2024, in press) for consistency with those used in Chalcidoidea. Because the most obvious male structures are the aedeagus and parameres, only those terms are used and illustrated (Figs 10, 11). Otherwise, the male genitalia are not treated except to show their general appearance *in situ*. Dal Pos *et al.* (2023) discussed in detail all the terms used for male genitalia and their musculature throughout Hymenoptera.

For the female genitalia, the only two terms used in taxonomy of Mymaridae (and also used in this paper) are: "ovipositor", which consists of the three ovipositor stylets (**ost**), and "ovipositor sheath" (**ovs**), which consists of two sclerites that protect the ovipositor when it is not in use. King and Copland (1969) introduced two terms for associated sclerites of the ovipositor complex: the "**inner plate of the ovipositor**" (**iop**) = 2^{nd} valvifer (**2vf**) (Fig. D5), which is an appendage of gt_7, and the "**outer plate of the ovipositor**" (**opo**), which is gt_{7+8}. Other terms (valvulae and valvifers) for the various parts are given in Appendix 1 and illustrated.

The first 15 figures identify the morphological features of the metasoma, with both photographs and micrographs. Following these, the micrographs are grouped alphabetically by genus for each view in the following order: dorsal, lateral, ventral, anterior, posterior. Because the anterior and posterior view of the gaster are hardly ever examined or used in descriptions very few are given.

Figure letter/number combinations are used for the different view to distinguish them from the introductory figures with the structures named (Figs 1–15). For brevity in the text, the genera mentioned are followed by the relevant figure without stating each time "Fig. or Figs", except for the 15 figures with acronyms of structures mentioned in the text. Not every genus has every view; a separate number is given for every genus and subgenus but the same number with different letters is given for different species or different sexes within the same genus or subgenus.

List of genera and subgenera of Mymaridae illustrated, followed by figure numbers.

[When species were identified within respective genera illustrated their names appear after the appropriate figure(s). Collecting localities for specimens micrographed are given in Huber *et al.* (2023a)].

Acmopolynema Ogloblin, 1946. Figs A1, B1, C1, D1, E1, F1.
Agalmopolynema Ogloblin, 1960. Figs A2, B2, C2, D2, E2, F2, G1, H1, I1, J1.
Alaptus Westwood, 1839. Figs B3, C3, D3, E3, F3, G2, H2, I2.
Anagroidea Girault, 1915. Figs A3, B4, C4, D4, E4, F4.
Anagrus (***Anagrus***) Haliday, 1833. Figs B5, C5, D5, E5, F5.
Anaphes (***Patasson***) Haliday, 1833. Figs B6, C6, D6, E6, F6, H3, I3, J2.
Anneckia Subba Rao, 1970. Figs B7, C7, D7, E7, F7. All *A. oophaga* Subba Rao.
Arescon Walker, 1846. Figs B8, C8, D8, E8, F8, I4. All *A. dimidiatus* (Curtis).
Australomymar Girault, 1929. Figs B9, C9, D9, E9, F9, H4, I5, J3.
Boudiennyia Girault, 1937. Figs A4, B10, C10, D10, E10, F10, G3, H5, I6, J4.
Callodicopus Ogloblin, 1955. Figs B11, C11.
Camptoptera Foerster, 1856. Figs A5, B12, C12.
Camptopteroides Viggiani, 1974. Figs E11, F11.
Camptopteroides **(*Alalinda*)** Huber 1999. Figs A6, B13, C13, D11, E12.
Ceratanaphes Noyes & Valentine, 1989. Figs B14, C14, D12, E13, F12, G4.
Chrysoctonus Mathot, 1966. Figs B15, C15, D13, E14, F13.
Cleruchus Enock, 1909. Figs B16, C16, D14, E15, F14, H6, J5.
Cnecomymar Ogloblin, 1963. Figs A7, B17, C17, D15, E16, F15, H7, J6.
Cosmocomoidea Howard, 1908. Figs A8, B18, C18, D16, E17, F16, G5, H8, I7, J7.
Cosmocomopsis Huber, 2015. Figs B19, C19. All *C. sevae* (Risbec).
Cremnomymar Ogloblin, 1952. Figs A9, B20, C20, D17, E18, F17.
Dicopomorpha Ogloblin, 1955. Figs B21, C21, D18, E19, F18.
Dicopomorpha **(*Dicopulus*)** Ogloblin, 1955. Figs D19, E19b, G6, H9, I8, J8. Subgenus synonymized by Yoshimoto (1990) and still also treated as a synonym here.
Dicopus Enock, 1909. Figs B22, C22, D20, E20, F19.

Entrichopteris Yoshimoto, 1990. Figs A10, B23, C23, D21, E21, F20.
Erdosiella Soyka, 1956. Fig. E22.
Erythmelus (***Erythmelus***) Enock, 1909. Figs B24, C24, D22, E23, F21, G7, H10, I9, J9.
Erythmelus (***Parallelaptera***) Enock, 1909. Figs B25, C25, G8, H11, I10. All *E. panis* (Enock).
Eustochomorpha Girault, 1915. Fig. F22. *E. haeckeli* Girault.
Eubroncus Yoshimoto, Kozlov & Trjapitzin, 1972. Figs C26, D23.
Eustochus (***Eustochus***) Haliday, 1833. Figs A11, B26, C27, D24, E24, F23.
Eustochus (***Caraphractus***) Walker, 1846. Figs A12, B27, C28, D25. All *E. cinctus* (Walker).
Gahanopsis Ogloblin, 1946. Figs B28, C29, D26, E25, F24. All *G. deficiens* (Goblin).
Gastrogonatocerus Ogloblin, 1935. Figs B29, C30, D27, E26, F25, G9, H12, I11, J10.
Gonatocerus Nees, 1834. Figs A13, B30, C31, D28, E27, F26. All *G. rivalis* Girault.
Heptagonatocerus Huber, 2015. Fig. C32. *H. madagascarensis* Huber.
Ischiodasys Noyes & Valentine, 1989. Figs A14, B31, C33, D29, E28, F27, H13, I12.
Kalopolynema Ogloblin, 1960. Figs A15, B32, C34, D30, E29, F28. All *K. ema* (Schauff & Grissell).
Krokella Huber, 1993. Figs B33, E30.
Litus Haliday, 1833. Figs B34, C35, D31, E31, F29. All probably *L. cynipseus* Haliday.
Lymaenon Walker, 1846. Figs B35, C36, D32, E32, F30, H14, J11.
Macrocamptoptera Girault, 1910. Figs A16, B36, C37, D33, E33, F31. All *M. metotarsa* (Girault).
Mymar Curtis, 1829. Figs A17, B37, C38, D34, E34, F32.
Narayanella Subba Rao, 1976. Figs B38, C39, G10, H15.
Neomymar Crawford, 1913. Figs A18, B39, C40, D35, E35, F33, G11, H16, I13, J12.
Neostethynium Ogloblin, 1964. Figs B40, C41, D36, E36, F34.
Neotriadomerus Huber, 2017. Fig. C42. *N. gloriosus* Huber.
Nepolynema Triapitsyn, 2014. Figs A19, C43, D37. All *N. grande* (Taguchi).
Notomymar Doutt & Yoshimoto, 1970. Figs C44, D38. Both N. *aptenosoma* Doutt & Yoshimoto.
Octomicromeris Huber, 2015. Figs B41, C45. Both *O. pulchellus* Huber.
Omyomymar (***Omyomymar***) Schauff, 1983. Figs B42, C46, D39, E37, F35, H17, I14, J13.
Omyomymar (***Caenomymar***) Yoshimoto, 1990. Figs B43, C47, E38, F36, G12, I15, J14. Subgenus synonymized by Yoshimoto (1990) and still also treated as a synonym here.
Ooctonus Haliday, 1833. Figs A20, B44, C48, D40, E39, F37, I16, J15. All *O. hemipterus* (Haliday).
Palaeoneura (***Palaeoneura***) Waterhouse, 1915. Figs A21, B45, C49, D41, E40, F38, G13, H18, J16. All *P. mymaripennis* Dozier.
Palaeoneura (***Chaetomymar***) Ogloblin 1946. Figs A22, B46, C50, D42, E41, F39. All *P. sophoniae* (Huber). Subgenus synonymized by Yoshimoto (1990) and still also treated as a synonym here.
Paracmotemnus Noyes & Valentine, 1989. Figs A23, B47, C51, D43, E42, F40.
Parastethynium Lin & Huber, 2011. Figs B48, C52, D44, E43, F41. All *P. maxwelli* (Girault).
Platyfrons Yoshimoto, 1990. Figs A24, B49, C53, D45, E44, F42, G14, H19, I17.
Platystethynium Ogloblin, 1946. Figs B50.
Platystethynium **(*Platypatasson*)** Ogloblin, 1946. Fig. B51.
Polynema (***Polynema***) Haliday, 1833. Figs G15, H20, I18, J17.
Polynema (***Doriclytus***) Foerster, 1847. Figs A25, B52, C54, D46, E45, F43. Subgenus synonymized by Yoshimoto (1990) and still also treated as a synonym here.
Polynema (***Restisoma***) Yoshimoto, 1990. Figs A26, B53, C55, D47, E46, F44, G16, H21, I19, J18. Subgenus synonymized by Yoshimoto (1990) and still also treated as a synonym here.
Proarescon Huber, 2017. Fig. B8. *P. similis* (Huber).
Progonatocerus Huber 2015. Fig. B54. *P. albiclava* Huber.
Pseudanaphes Noyes & Valentine, 1989. Figs B55, C56, D48, E47, F45, G17, H22, J19.
Ptilomymar Annecke & Doutt, 1961. Figs A27, B56, C57, D49, E48, F46.
Richteria Girault, 1920. Figs A28, C58, D50, E49, F47, G18, H23, I20, J20.
Schizophragma Ogloblin, 1949. Figs B57, C59, D51, E50, F48. All *S. bicolor* (Dozier).
Steganogaster Noyes & Valentine, 1989. Figs B58, C60, D52, E51, F49, G19, H24, I21, J21.
Stephanocampta Mathot, 1966. Figs A29, B59, C61, D53, E52, F50.

Stephanodes Enock, 1909. Figs A30, B60, C62, D54, E53, F51, H25, I22, J22.
Stethynium Enock, 1909. Figs B61, C63, D55, E54, F5, I23. All *S. triclavatum* Enock.
Tanyxiphium Huber, 2015. Figs B62, C64, E55.
Tetrapolynema Ogloblin, 1946. Figs A31, B63, C65, D56, E56, F53, G20, H26, I24, J23.
Tinkerbella Huber & Noyes, 2013. Figs C66, F54. Both *T. nana* Huber & Noyes.
Yoshimotoana Huber, 2020. Figs A32, B64, C67, E57, F55, H27, I25, J24. All *Y. masneri* (Yoshimoto).
Zeyanus Huber, 2015 Figs A33, B65, C68, D57, E58, F56, J2

Results

METASOMA (general)

The metasoma is the posterior-most of the three main body parts—head, mesosoma, and metasoma. The metasoma consists of 9 dorsal sclerites and 6 ventral sclerites. The dorsal sclerites are **metasomal terga** 1–9 (Fig. 5: **mt_1–mt_{8+9}**) and the ventral sclerites are **metasomal sterna** 1–6 **(**Fig. 5: **ms_1–ms_6**). As in almost all other Chalcidoidea, in Mymaridae the apical tergum apparently is a composite structure that consists of two fused terga, mt_8+mt_9, that form a **syntergum** so there are only 8 distinguishable gastral terga. The metasoma has two, mostly distinct, body sections, the **petiole** or mt_1 (ms_1 is apparently absent or at least completely hidden by mt_1), and the **gaster** (mt_2–mt_{8+9}) containing the female or male genitalia. Detaching the metasoma from the mesosoma is fairly easy to do when the petiole is long and narrow (*Acmopolynema*-C1, *Entrichopteris*-C23, *Mymar*-C38) but much more difficult to do when the petiole is short and narrow (*Anagroidea*-C4, *Anagrus*-C5, *Anaphes*-C6, *Camptoptera*-C12, *Camptopteroides* (*Alalinda*)-C13) and practically impossible to do when it is short and almost as wide as the anterior apex of the gaster (*Alaptus*-C3, *Dicopomorpha*-C21, *Dicopus*-C22).

The metasoma is usually as long as or longer than the mesosoma (up to ~2.6× as long—*Neotriadomerus longissimus* Huber), rarely shorter than the mesosoma (~0.75× as long—*Kikiki*, *Tinkerbella*, *Dicopomorpha*). If the petiole length is excluded, the gaster (excluding the exserted portions of the genitalia in females) is sometimes much shorter than the mesosoma: exceptionally only 0.4× as long in the male of *Erdosiella* (in this extreme case, the petiole is 1.2× as long as the gaster). The female gaster, excluding the exserted part of the ovipositor, is often slightly longer than the male gaster. It is more intuitive, and therefore best, to number the gastral segments as **gastral terga** 1–8 (**gt_1–gt_{7+8}**) and **gastral sterna** 1–5 (**gs_1–gs_5**). i.e., one less than the corresponding metasomal terga and sterna (Fig. 14). This numbering system is used below.

PETIOLE

General. The **petiole** (Figs 2, 5, 6, 13–15: **pet**) connects the gaster to the mesosoma. It is distinguished from the gaster and treated separately here because it is usually tube-like and more or less distinctly narrower than the rest of the metasoma (A1–A33). Although barely visible in some genera and thus apparently absent, the petiole is present in all Mymaridae. It apparently consists of the tergum only; if a petiolar sternum is present it is either fused indistinguishably with the tergum or is entirely invaginated within the tergum, but in either case a separate sternum is not visible. Petioles with a ventrolongitudinal suture (*Acmopolynema*-A1b, *Kalopolynema*-A15b, *Stephanodes*-A30ab,bb, *Tetrapolynema*-31b) may indicate the presence of an invaginated sternum, visible as a small triangular sclerite near the anterior apex (*Agalmopolynema*-A2b). Anteriorly, the petiole inserts into the mesosoma under the slightly protruding adpetiolar strip at the posteromedial apex of the propodeum. Posteriorly, the petiole either abuts (*Anagroidea*-A3a,b,c, *Ptilomymar*-A27a,b,c) or more often overlaps (*Mymar*-A17b,c, *Platyfrons*-A24b,c) a short, tubular anterior prolongation of gs_1; apparently, the petiole only rarely (or never?) connects to gt_1. The most noticeable difference among the genera is in the length/width ratio of the petiole so that is treated first, followed by its other structural differences.

Measurements. Various authors, e.g., Annecke & Doutt (1961), classified the metasoma into rather vague categories based on petiole morphology—“sessile”, “subsessile”, “subpetiolate”, and “petiolate” based on relative length of the petiole. Based on the length/width ratios of the petiole as measured in dorsal view, these categories may be condensed and defined less arbitrarily as three categories: 1) metasoma "sessile"—petiole almost as wide as gt_1 and very short so the petiole is almost indistinguishable from the propodeum and gt_1 (Huber *et al.* 2020: *Alaptus*-fig. 49, *Anagrus*-fig. 110, *Dicopus*-fig. 376a; and Huber *et al.* 2023b: *Alaptus*-figs A3a,b, *Dicopomorpha*-figs A21a,b, *Dicopomorpha* (*Dicopulus*-fig. A22), *Dicopus*-fig. A23); 2) metasoma "subpetiolate"—petiole distinctly narrower than gt_1, and usually not longer than wide (Huber *et al.* 2023: *Anagrus*-fig. A5, *Anneckia*-fig. A7, *Omyomymar*-fig. A52, *Omyomymar* (*Caenomymar*)-fig. A53, *Proarescon*-fig. A63, *Schizophragma*-fig. A68, *Stethynium*-fig. A72, *Tinkerbella*-fig. A75); and 3) metasoma "petiolate"—petiole distinctly narrow than gt_1, moderately sclerotized and about as long as wide (mainly species of Gonatocerini) to strongly sclerotized and either about as long as wide [mainly species in *Camptoptera* group of genera *sensu* Huber & Lin (1999)] or, more often, much longer than wide [most Polynematini *sensu* Annecke & Doutt (1961)]. Considerable overlap between the subsessile and petiolate groups occurs so it is best to avoid them completely, but if the terms are to be used it is better to use sessile for when the gaster is separated from the mesosoma by a wide petiole and petiolate when the gaster is separated from the mesosoma by a distinctly narrow petiole. Regardless of their length, cleared slide mounts in dorsal view are needed to see the petioles clearly, especially the anterior and posterior junction with the propodeum and gaster, respectively, and measure them accurately.

The images presented here are mostly of genera in the subsessile and petiolate groups because, as mentioned above, it is essentially impossible to detach the metasoma from the mesosoma in taxa with sessile metasomas without damaging (usually by tearing) the petiole or base of the gaster (*Dicopus*-B22) and sometimes also the propodeum. In these genera the petioles in dorsal view are narrow transverse bands and in lateral and ventral views are barely or not at all visible. The petiole varies from 0.2× as long as wide (*Dicopus*-B22, but petiole not clearly distinguishable) to 9.0× as long as wide (*Narayanella*-C39) and the extreme of 16.0× as long as wide in some males of *Erdosiella venezuelaensis* (Yoshimoto). The petioles in genera with subsessile metasomas, e.g., *Anagrus*, *Anaphes*, *Arescon*, *Cleruchus*, *Lymaenon*, and petiolate metasomas, e.g., *Ooctonus,* many genera of Polynematini, are illustrated when the petiole is still attached to the gaster because it was pointless and sometimes too difficult to separate the petiole from the propodeum and/or the gaster and orient it correctly on the stub for micrography. The descriptions of petiole structure below are almost all for genera with subsessile and petiolate metasomas.

Structure. In dorsal or ventral views, the petiole is generally fairly uniform in width along most of its length (*Acmopolynema*-A1a, *Boudiennyia*-A4a, *Cosmocomoidea*-A8ba, *Platyfrons*-A24a, *Yoshimotoana*-A32a), but sometimes is wider towards the anterior apex (*Cremnomymar*-A9a), widest (*Kalopolynema*-A14a) or narrowest (*Eustochus*-A11a) medially or wider towards the posterior apex (*Cosmocomoidea*-A8ba). The anterior apex sometimes narrows gradually (*Acmopolynema*-A1a, *Agalmopolynema*-A2a) but more often narrows abruptly and distinctly (*Boudiennyia*-A4a, *Cnecomymar*-A7a, *Mymar*-A17a). A ring of thickened cuticle often forms a raised rim at the extreme anterior apex of the petiole (*Acmopolynema*-A1a, *Anagroidea*-A3a, *Cnecomymar*-A7a, *Ptilomymar*-A27a, *Tetrapolynema*-A31a). Occasionally, the short, narrowed anterior apex is separated posteriorly, at least dorsally and laterally, from the rest of the petiole by a thin flange (*Boudiennyia*-A4a, *Entrichopteris*-A10a, *Mymar*-A17a, *Richteria*-A28b). At least one genus has a short and narrow but distinct petiole (*Litus*-C35) that is visible in lateral view but in dorsal view is hidden entirely by gt_1 (*Litus*-B34). Dissections of *Litus* specimens in ethanol show that the petiole is almost as high and wide as gt_1, and is correlated with a huge opening in the propodeal foramen through which the second mesosomal phragma extends slightly into the gaster.

In lateral view, the petiole appears straight or almost so (*Boudiennyia*-A4c, *Camptoptera*-A5c, *Stephanodes*-A30ac, 30bc) to slightly but distinctly curved (*Polynema* (*Doriclytus*)-A25c, *Richteria*-A28c). The anterior and posterior apices of the petiole are truncated at a right (*Anagroidea*-A3c, *Camptoptera*-A5c, *Eustochus* (*Caraphractus*)-A12c), or at a slightly oblique angle (*Richteria*-A28c) relative to the length of the petiole or at least to the length of the narrowed anterior apex, which itself is straight (*Boudiennya*-A4c) or directed slightly ventrally (*Cremnomymar*-A9c, *Neomymar*-A18c) at a slight angle relative to most of the petiole length.

In ventral view, the petiole is either not divided longitudinally (*Boudiennyia*-A4b, *Camptopteroides* (*Alalinda*)-A6b, *Ischiodasys*-A14b, *Macrocamptoptera*-A16b, *Platyfrons*-A24b, *Stephanocampta*-A29ba,bb. *Yoshimotoana*-A32b) or it is longitudinally divided medially by a narrow and incomplete sulcus (*Eustochus*-A11b, *Ooctonus*-A20b) or, more often, a complete sulcus (*Acmopolynema*-A1b, *Cnecomymar*-A7b). Sometimes the sulcus is fairly wide along its length (*Polynema* (*Restisoma*)-A26b). Occasionally, the two halves abut each other in the anterior half but are increasingly widely separated in the posterior half (*Cosmocomoidea*-A8ab, 8bb, *Kalopolynema*-A15b). Rarely, the petiole has a dorsolateral lamina extending the length of the petiole and posteriorly extending dorsally as a long, curved strap that contacts gt_1 (*Ischiodasys*-A14a,c) or a reticulated translucent keel ventrally that extends part or most of the length of the petiole and continues without interruption posteriorly onto gs_1 (*Ptilomymar*-A27b,c).

Sculpture. The petiole is often entirely smooth (*Agalmopolynema*-A2, *Cnecomymar*-A7, *Cosmocomoidea*-A8, *Ischiodasys*-A14, *Neomymar*-A18), sometimes slightly sculptured dorsally with some transverse wrinkles (*Acmopolynema*-A1a, *Mymar*-A17a, *Platyfrons*-A24a, *Stephanodes*-A31aa) or a transverse depression (*Camptoptera*-A5a) or with coarse longitudinal wrinkles, at least laterally (*Anagroidea*-A3a, *Cosmocomoidea*-A8ba, *Ptilomymar*-A27a) or occasionally strongly sculptured with distinct polygonal reticulations (*Eustochus*-A11a, *E.* (*Caraphractus*)-A12a, *Ooctonus*-A20c, *Yoshimotoana*-A33a). Laterally there may be distinct sculpture (*Anagroidea*-A3c, *Camptoptera*-A5c, *Eustochus*-A11c). Ventrally, some sculpture may also be present and more distinct (*Anagroidea*-A3b, *Chrysoctonus*-C7b, *Eustochus* (*Caraphractus*)-A12b, *Ptilomymar*-A26b, *Yoshimotoana*-A32b) or less distinct (*Boudiennyia*-A4b).

Setation. In dorsal, lateral and ventral views the thickened anterior rim or the narrow area just posterior to it has a short, inconspicuous seta laterally (*Eustochus* (*Caraphractus*)-A12a) or lateroventrally (*Agalmopolynema*-A2b, *Camptopteroides* (*Alalinda*)-A6b) or ventrally (*Camptoptera*-A5b) and sometimes one or two mostly inconspicuous setae elsewhere (*Ooctonus*-A20b). Exceptionally, several short setae apparently in pits occur posterodorsally (*Kalopolynema*-A15a).

GASTER

General. Compared to the head and mesosoma fewer characters of the gaster (excluding the genitalia) are useful to help distinguish or define the genera and they are mostly structural; sculpture and setation often appears similar among the genera. The **gastral terga** (Figs 1–15: **gt**) are numbered from gt_1 to gt_7+gt_8. In females, the ventrolateral area of gt_{7+8}, best seen in ventral view (D1–D57), is conveniently named the **outer plate of the ovipositor** (Figs 6, 14, 15: **opo**) rather than gt_{7+8}. The countable number of **gastral sterna** (Figs 3, 6, 14: **gs**) differs with the sex. Females have five visible sterna: gs_1–gs_5, with the **hypopygium** (gs_5) (Fig. 3: **hyp**) often being the longest sternum. Males have seven visible sterna and gs_7 is not particularly different from the remaining sterna (*Arescon*-D8, *Lymaenon*-C36b, *Ooctonus*-D40). Whereas the gastral terga are usually all visible in dorsal or lateral views (lateral view is often better to count the terga), one or more of the anterior sterna may be hidden by gt_1. In dorsal and lateral views of either sex, the membranous (so usually shrivelled or wrinkled) **anal sclerite** (Fig. 11: **asc**) is visible and consists apparently of a dorsal flap and ventral flap surrounding the anal opening (*Alaptus*-H2) that are best identified when they are separated, thus exposing the anal opening (*Steganogaster*-J21).

Among the gastral terga, the greatest diversity of structure occurs in gt_1, gt_2 and, to a lesser extent, gt_7+gt_8, the **syntergum** (Figs 9, 11, 13: **syn**). The terga usually become shorter from gt_2 to gt_5, with the shortest tergum usually gt_5. Among the sterna, the structural differences are relatively less, mainly in gs_1 and the hypopygium (gs_5). It is often best to count the terga backwards from gt_6 (bearing the spiracle) or gt_{7+8} (bearing the cercus) in order to number them correctly. This is because gt_1 may be short or hidden, or sometimes apparently fused with gt_2, or perhaps even gs_1. Therefore, they may not been clearly seen and properly delimited, resulting, for example, in gt_2 being mistaken for gt_1. A gastral spiracle occurs only on gt_6 and only in females, and is absent even in females in some genera, e.g., *Parastethynium*. The spiracle is almost always visible only in lateral view (also in dorsal view in *Anagrus*-C5); however, it is small and easily overlooked. Depending on the view, dorsal or lateral, gt_1 may be more or less visible (compare *Anaphes*-B6 with C6, *Lymaenon*-B35 with C35); both views may be needed to determine correctly the tergum number. The posterior margin of a tergum (often gt_1) may separate from the following tergum (*Alaptus*-B3, *Anaphes*-B6, *Cosmocomoidea*-B18b, *Stephanocampta*-B59, C61, *Yoshimotoana*-B64, C67). Although this makes it easier to identify the posterior margin of each tergum it is an artefact of preparation, perhaps due to critical point drying. In live specimens the posterior margins of a tergum or sternum presumably remain appressed to the following tergum or sternum, giving the gaster a smooth contour in dorsal, lateral, ventral and posterior views.

Measurements. Measurements may sometimes be useful even though length/width, length/height and width/height of the entire gaster may vary due to preparation method. In soft bodied specimens, the terga may be shrivelled or collapsed. Conversely, they may be unduly separated from one another by stretched intersegmental membrane. In hard-bodied specimens some terga may be telescoped one inside another so that there appear, in dorsal view at least, to be fewer than seven terga (*Ischiodasys*-B31, C33, *Macrocamptoptera*-B36). Ratios therefore provide only a general idea of the range of gaster lengths, widths and heights. The extremes are as follows. In dorsal (or ventral) view, the female gaster excluding the exserted part of the ovipositor is 1.1× (*Kikiki*, Huber & Noyes 2013, fig. 46) to 4.1× (*Australomymar*-B9) as long as wide. In lateral view, the gaster is 1.2× (*Alaptus*-C3) to 3.8× (*Ceratanaphes*-C14) as long as high. Both dorsal (or ventral) and lateral views are needed to calculate the width/height ratio of the gaster. The gaster in cross section is usually more or less cylindrical or somewhat triangular (narrower ventrally than dorsally), with the width more or less the same as the height. However, some gasters are relatively narrow (dorsal view) and high (lateral view), e.g., width/height 0.44× in *Australomymar* and some relatively wide (dorsal view) and thin (lateral view), e.g., width/height 1.4× in *Ceratanaphes*.

Measurements of the individual terga are rarely used, though relative lengths of the individual terga are sometimes useful. The sterna are almost never measured. Tergum lengths appear to vary depending on the degree of shrivelling or telescoping of the various terga. Measured along the dorsal midline, the length of one tergum is usually compared to that of the tergum immediately following.

TERGA

Structure. **Tergum gt_1**. In dorsal view (Figs B1–B65), gt_1 is short, with most of the tergum vertical before it becomes more or less horizontal dorsally for a short distance (*Alaptus*-B3, *Anaphes*-B6, *Arescon*-B8, *Cosmocomoidea*-B18b, *Dicopomorpha*-B21, *Dicopus*-B22), to long, with most of the panel oblique or horizontal dorsally for a long distance (*Acmopolynema*-B1, *Anagroidea*-B4, *Eustochus* (*Caraphractus*)-B27, *Polynema* (*Doriclytus*)-B52). The largest/longest terga sometimes occupy much more than half the length of the gaster (*Cnecomymar*-B17, *Litus*-B34, *Ptilomymar*-B56). In dorsal view, gt_1 is occasionally crescent-shaped and so short that it is apparently absent (*Parastethynium*-B48) or gt_1 is hidden under gt_2 (*Gahanopsis*-B28, *Litus*-B34). Sometimes gt_1 is longitudinally divided medially (*Anaphes*-B6, *Erythmelus*-B24, *Erythmelus* (*Parallelaptera*)-B25, *Schizophragma*-B57, *Platystethynium*-B50, *Platystethynium* (*Platypatasson*)-B51, possibly *Stethynium*-B61). The posterior margin of gt_1 is straight (*Agalmopolynema*-B2, *Lymaenon*-B35, *Neomymar*-B39, *Polynema* (*Doriclytus*)-B52, *Pseudanaphes*-B55), slightly convex (*Acmopolynema*-B1, *Platyfrons*-B49, *Polynema* (*Restisoma*)-B53), slightly concave (*Mymar*-B37, *Stephanodes*-B60), strongly concave (*Ptilomymar*-B56), slightly V-shaped (*Ceratanaphes*-B14, *Cleruchus*-B16), strongly V-shaped (*Boudiennyia*-B10) or notched medially (*Cosmocomoidea*-B18a, *Yoshimotoana*-B64), or both notched medially and sinuate sublaterally (*Cosmocomopsis*-B19). Rarely, the posterior margin of gt_1 is wavy or crenulate (*Tanyxiphium*-B62, *Yoshimotoana*-B64). Two genera have gt_1 with a distinct median panel separated at least posteriorly from each lateral panel, with the median panel width along its posterior margin about 1.2× the length of a lateral panel and either straight (*Ooctonus*-B44) or M-shaped ((*Stephanocampta*-B59).

In lateral view (Figs C1–C68), in genera with a short and narrow but distinct petiole, gt_1 has the anterior face usually vertical or almost so (*Agalmopolynema*-C2, *Anaphes*-C6, *Arescon*-C8, *Boudiennyia*-C10, *Ceratanaphes*-C14, *Eustochus*-C27, *Gahanopsis*-C29, *Richteria*-C58, *Zeyanus*-C68) before posteriorly becoming horizontal where its posterior margin meets or slightly overlaps gt_2. In genera with a short, wide and barely distinguishable petiole the entire tergum is usually horizontal or almost so (*Alaptus*-C3, *Anagrus*-C5, *Schizophragma*-C59), though sometimes the anterior face is vertical (*Dicopomorpha*-C21). Genera with a narrow and short or, more often, a long petiole (*Acmopolynema*-C1, *Entrichopteris*-C23, *Gonatocerus*-C31, *Macrocamptoptera*-C37, *Polynema* (*Doriclytus*)-C54, *Stephanodes*-C62) have gt_1 more or less oblique from its anterior apex to or almost to its posterior margin. A few genera have gt_1 with a short, partial longitudinal division extending anteriorly from the posterolateral margin (*Acmopolynema*-C1, *Nepolyema*-C43). At least one genus (*Anagroidea*-C4) has a curved, longitudinal division extending posteriorly from the petiole/gt_1 junction about one-third the length of gt_1; this may represent the division between gt_1 and gt_2, which otherwise is apparently united dorsally into a single tergum. Genera with poorly sclerotized (soft bodied) gasters have the gastral terga and sterna each occupying about half the height of the gaster and clearly visible (*Alaptus*-A3, *Anagrus*-A5, *Anaphes*-A6, *Anneckia*-C7, *Arescon*-C8, *Ceratanaphes*-C14, *Cleruchus*-C16, *Dicopomorpha*-C21, *Erythmelus*-C24, *Erythmelus* (*Parallelaptera*)-C25, *Lymaenon*-C36, *Neostethynium*-C41, *Notomymar*-C44, *Omyomymar*-C46, *Schizophragma*-C59, *Stethynium*-C63, *Zeyanus*-C68). Genera with well sclerotized (hard bodied) gasters sometimes have most of the gaster with the terga, or at least gt_1, overlapping the sterna so that the sterna are more or less concealed and visible only in the ventral third or less of the gastral height (*Acmopolynema*-C1, *Anagroidea*-C4, *Boudiennyia*-C10, *Camptoptera*-C12, *Entrichopteris*-C23, *Eustochus* (*Caraphractus*)-C28, *Ischiodasys*-C33, *Litus*-C35, *Macrocamptoptera*-C37, *Mymar*-C38, *Ooctonus*-C48, *Polynema* (*Doriclytus*)-C54, *Steganogaster*-C60). When gt_1 and gs_1 abut without any overlap the junction between them is horizontal (*Anagrus*-A5). When gt_1 overlaps gs_1, gt_1 has the posterior margin at a right angle with the ventral margin, which is horizontal (*Agalmopolynema*-C2, *Richteria*-C58, *Stephanodes*-C62) or more or less obliquely angled dorsoanteriorly (*Cnecomymar*-C17, *Neomymar*-C40) and extends to the anterior margin of the gaster more or less distinctly dorsal to the petiolar junction. Sometimes gt_1 occupies most or all of the side of the gaster, completely or almost completely hiding gs_1 and sometimes other sterna as well (*Boudiennyia*-C10, *Camptoptera*-C12, *Chrysoctonus*-C15, *Litus*-C35, *Macrocamptoptera*-C37, *Mymar*-C38, *Ooctonus*-C48, *Palaeoneura* (*Chaetomymar*)-C50, *Ptilomymar*-C57). Exceptionally on gs_1 anteroventrally there is a reticulated translucent keel (*Ptilomymar*-C57, D49) or a collar (ruff) of longitudinally reticulated mesh (*Stephanocampta*-C61, D53).

Terga gt_2–gt_6. The terga between gt_1 and gt_7 (the cercus-bearing tergum) are fairly similar to one another, varying mainly in their relative lengths; the lengths also vary depending on view and whether the sclerites are telescoped inside one another. In dorsal and/or lateral views gt_2 is the longest (*Acmopolynema*-B1, C1, *Agalmopolynema*-B2, C2, *Anagroidea*-B4, C4), or gt_3 is the longest (*Anaphes*-B6, C6), or gt_2–gt_6 are subequal, with a slight shortening of the distal terga (*Alaptus*-B3), or gt_6 is the longest, with a slight shortening of the proximal terga (*Arescon*-B8, C8), or gt_2 and gt_6 are longer than the intervening terga (*Neomymar*-B39). In lateral view, gt_6 is the longest (*Anaphes*-C6, *Arescon*-C8), or occasionally gt_2 is the longest (*Ischiodasys*-C33, *Ooctonus*-C48). The only tergum with a gastral spiracle (Fig. 9: gsp) is gt_6; the spiracle is dorsolateral and present in most females (*Acmopolynema*-C1, *Australomymar*-C9, *Eustochus*-C27, *Mymar*-C38, *Palaeoneura* (*Chaetomymar*)-C50, *Tanyxiphium*-C64, *Zeyanus*-C68a), but is absent in some females and all males (*Cleruchus*-B16, C16, *Erythmelus* B24, C24, *Erythmelus* (*Parallelaptera*)-B25, C25, *Schizophragma*-B57, C59, *Stethynium*-B61, C63). The spiracle is often difficult to see and is hidden if gt_6 is telescoped inside gt_5 so it may appear to be absent. In dorsal view, gt_2–gt_5 have the posterior margin transverse and either straight or slightly uneven (*Agalmopolynema*-B2, *Alaptus*-B3, *Cleruchus*-B16, *Neostethynium*-B40, *Omyomymar*-B42, *Platystethynium*-B51, *Schizophragma*-B57, *Stephanodes*-B60, *Tanyxiphium*-B62), or one or more terga are slightly concave medially (*Anaphes*-B6, *Arescon*-B8, *Cosmocomoidea*-B18a,b, *Erythmelus*-B24, *Kalopolynema*-B32, *Stethynium*-B61), or one or more terga are slightly convex medially (*Entrichopteris*-B23, *Litus*-B34, *Palaeoneura* (*Chaetomymar*)-B46, *Polynema* (*Doriclytus*)-B52) or, rarely, one or more terga are strongly convex and almost pointed medially (*Steganogaster*-B58). Among gt_2–gt_6 the greatest variation in the posterior margin is in gt_6, which is concave (*Agalmopolynema*-E2, *Anagrus*-E5, *Ceratanaphes*-E13, *Entrichopteris*-E21, *Krokella*-E30, *Ooctonus*-E39, *Palaeoneura*-E40), straight (*Cnecomymar*-E16, *Ischiodasys*-E28, *Mymar*-E33, *Neostethynium*-E36, *Polynema* (*Doriclytus*)-E45, *Richteria*-E49), convex (*Litus*-E31), slightly V-shaped (*Dicopomorpha*-19a) or, as sometimes best seen in lateral view, is more or less strongly sinuate because it sometimes wraps around the cerci laterally (*Anagroidea*-F4, *Anaphes*-F6, *Dicopomorpha*-E19b, *Erdosiella*-E22, *Macrocamptoptera*-E33, *Stephanocampta*-E52, F50).

Terga $gt_7 + gt_8$ (syntergum). In both sexes, gt_7 always has a **cercus** (Figs 9, 11, 13, 14: **cer**) laterodorsally, visible in dorsal view (Figs E1–E58) and usually also in lateral view (Figs F1–F56). In females, the ventral area of gt_{7+8} (outer ovipositor plate) is discussed below under the sterna because that is where it is completely visible. In dorsal view, the cercus is oval, flat or slightly convex, and slightly depressed relative to gt_7 surrounding it; its medial margin is often straighter and sometimes less defined (*Anaphes*-E6) than its more convex and better defined lateral margin (*Richteria*-E49, *Yoshimotoana*-E57) or vice versa (*Anagrus*-E5, *Mymar*-E34), or both margins are equally well defined (*Cremnomymar*-E18, *Ischiodasys*-E28). A cercus bears 4 **cercal setae** (Fig. 9: **cst**) usually in a slightly curved vertical line but occasionally with the dorsal two setae at the same, horizontal, level (*Anaphes*-F6, *Erythmelus*-F21, *Neostethynium*-E36). The dorsal three setae are distinctly socketed with the sockets in a slight depression, whereas the ventral seta is sometimes slightly separated from the other three and on a slightly raised tubercle, and often on the ventral edge of the cercus so it sometimes appears not to be on the cercus. Exceptionally, the cercus is small, distinctly raised and button-like (*Australomymar*-F9) or almost so (*Eustochomorpha*-F22). The longest cercal setae are often at least about 1.5–2.0× as long as the setae on the syntergum (*Acmopolynema*-F1, *Agalmopolynema*-E2, *Anagrus*-E5, *Ceratanaphes*-E13, *Neomymar*-E35), and sometimes several or many times as long (*Anagroidea*-B4, *Chrysoctonus*-B15a,b, *Dicopomorpha*-B21, *Gonatocerus*-B30, *Litus*-B34, *Yoshimotoana*-E57). The cercal setae may be difficult to measure accurately, even in lateral view, because they are often curved or apically curled (*Dicopomorpha*-E19a,b); this is possibly an artefact of preparation. The cercus usually abuts the anterior margin of gt_6 (*Anagrus*-E5, F5, *Anaphes*-E6, F6, *Chrysoctonus*-E14, F13, *Cosmocomoidea*-E17, F16, *Parastethynium*-E43) though it can be partly hidden by the posterior margin of gt_6 (*Anneckia*-E7, F7, *Camptopteroides*-F11, *Camptopteroides* (*Alalinda*)-E12, *Litus*-E31, F29, *Schizophragma*-E50, F48, *Zeyanus*-E58, F56), possibly as an artefact due to telescoping of gt_7 inside gt_6. The cercus is sometimes also separated from the anterior margin of gt_6 by a gap that is narrow (*Agalmopolynema*-E2, *Anagroidea*-E4, F4, *Neostethynium*-E36, *Richteria*-E49, *Yoshimotoana*-E57) to sometimes almost as long as the cercus width (*Cremnomymar*-E18, F15). The cerci are sometimes narrowly separated from each other (*Mymar*-E34, *Ptilomymar*-E48), rarely almost abutting medially (*Anagrus*-E5), but more often they are more or less widely separated (*Anaphes*-E6, *Cnecomymar*-E16, *Macrocamptoptera*-E33); the amount of separation appears to be largely dependent on the shape of gt_7. In dorsal view, gt_7 is narrowly to widely conical (*Acmopolynema*-E1, *Anagrus*-E5, *Cnecomymar*-E16, *Polynema* (*Doriclytus*)-E45, *Yoshimotoana*-E57), sometimes with concave lateral margins (*Kalopolynema*-E29), or more or less trapezoidal (*Anaphes*-E6, *Chrysoctonus*-E14, *Cosmocomoidea*-E17, *Neostethynium*-E36), or narrowly or widely rectangular (*Cleruchus*-E15, *Ptilomymar*-E48, *Stethynium*-E54) to rectangular in its basal half and conical in its apical half (*Schizophragma*-E50). The apex is pointed (*Anagrus*-E5, *Tanyxiphium*-E55, *Yoshimotoana*-E57), narrowly rounded (*Agalmopolynema*-E2), widely rounded to truncate (*Anaphes*-E6, *Anneckia*-E7, *Mymar*-E34, *Neostethynium*-E36, *Tetrapolynema*-E56) or, rarely, W-shaped (*Ceratanaphes*-E13).

Sculpture. In most genera, the sculpture of gt_2–gt_6 is usually similar to that of gt_1. In genera with a relatively hard-bodied gaster gt_1 is entirely smooth or apparently so (*Acmopolynema*-B1, C1, *Anagroidea*-B4, C4, *Chrysoctonus*-B15, C15, *Cremnomymar*-B20, C20, *Eustochus*-B26, C27, *Ischiodasys*-B31, C33, *Narayanella*-B38, C39, *Palaeoneura* (*Chaetomymar*)-B46, C50, *Polynema* (*Doriclytus*)-B52, C54, *Stephanodes*-B60, C62). In some other genera, but especially those with a soft-bodied gaster, superficial longitudinal wrinkles occur (*Gastrogonatocerus*-B29, *Gonatocerus*-B30, *Lymaenon*-B35), due most likely to slight shrivelling and perhaps exacerbated by preservation method. A few genera have more or less distinct longitudinal folds or striations, mostly in the posterior half (*Ceratanaphes*-B14, *Cleruchus*-B16, *Platystethynium*-B50) and sometimes only laterodorsally (*Cosmocomoidea*-B18b, *Erythmelus*-B24, *Omyomymar*-C46, *Tanyxyphium*-B62) or laterally (*Alaptus*-C3, *Lymaenon*-C36a,b). Exceptionally (*Steganogaster*-C60), gt_1 and gt_2 (at least) have a thin translucent covering sculptured like a honeycomb. The apical half of gt_5 and gt_6 dorsally have distinct reticulate sculpture (*Schizophragma*-B57) or only gt_6 has distinct sculpture (*Stethynium*-B61). A patch of minute spicules are present dorsomedially on gt_5 and gt_6 (*Erythmelus*-B24, *Erythmelus* (*Parallelaptera*)-B25) or gt_2–gt_6 have a dorsal transverse row of a few to many spicules (*Stethynium*-B61). Although usually smooth, gt_7 sometimes has faint, transverse (*Anaphes*-E6) or reticulate sculpture (*Dicopomorpha*-E19b, *Macrocamptoptera*-E33) or minute spicules together with indistinct transverse wrinkles or reticulations (*Omyomymar*-E37, *Omyomymar* (*Caenomymar*)-E38).

Setation. The most variable arrangement of gastral setae is on gt_1 and gt_7. In genera with a well sclerotized gaster gt_1 is usually asetose (*Acmopolynema*-B1, C1, *Australomymar*-B9, C9, *Cnecomymar*-B17, C17, *Cosmocomopsis*-B19, C19, *Kalopolynema*-B32, C34, *Macrocamptoptera*-B36, C37, *Platyfrons*, B49, C53, *Stephanodes*-B60, C62, *Zeyanus*-C68). A few genera have gt_1 with a distinct setal pattern, either as a cluster of several setae on the lateral panel (*Ooctonus*-C48) or a submedian line of closely-set setae anteriorly (*Ischiodasys*-C33), or a group of sublateral, more widely spaced, setae about midway between its anterior and posterior margins (*Eustochus* (*Caraphractus*)-B27). There are one or more setae on gt_2–gt_6, often in a single horizontal line dorsally, dorsolaterally, and/or laterally on at least one of the terga, where the setae are almost always in the distal half of a tergum (*Alaptus*-B3, *Anagrus*-B5, *Camptoptera*-B12, *Ceratanaphes*-B14, *Erythmelus*-B24, *Neostethynium*-B40, *Ooctonus*-B44, *Stephanocampta*-B59). The gastral setae are short (*Neomymar*-B39, *Palaeoneura*-B45) or, usually, long (*Anaphes*-B6, *Erythmelus*-B24, *Neostethynium*-B40, *Progonatocerus*-B54). There are usually 2 setae (*Acmopolynema*-E1, *Anagroidea*-E4, *Kalopolynema*-E29, *Neomymar*-E35, *Richteria*-E49) or 4 setae (*Anaphes*-E6, *Anneckia*-E7, *Erythmelus*-E23, *Mymar*-E34, *Polynema* (*Restisoma*)-E46, *Pseudanaphes*-E47, *Steganogaster*-E51) on gt_7, though infrequently there are 3 setae (*Anagrus*-E5, *Cosmocomoidea*-E17, *Dicopomorpha*-E19a, *Dicopus*-E20, *Neostethynium*-E36, *Yoshimotoana*-E57). When 4 setae are present they usually are in a horizontal row but sometimes are in two rows (*Macrocamptoptera*-E33) and usually about midway between the anterior and posterior margins of gt_7 or in its apical half or, exceptionally, at the posterior apex (*Ceratanaphes*-E13). In lateral view (rarely also visible in dorsal view), a more or less dense cluster of setae forms a **cercal brush** (Fig. 9: **cbr**) just anterior (sometimes extending also dorsal and lateral) to the cercus. The cercal brush has numerous setae (*Acmopolynema*-F1, *Agalmopolynema*-F2, *Australomymar*-F9, *Boudiennyia*-F10, *Cremnomymar*-F17, *Entrichopteris*-F20, *Polynema* (*Doriclytus*)-E45, F43, *Steganogaster*-F49, *Stephanodes*-F51a,b) or, occasionally, only very few setae, perhaps two or three (*Palaeomymar* (*Chaetomymar*)-F39, *Ptilomymar*-F46, *Tinkerbella*-F54, *Yoshimotoana*-F55, *Zeyanus*-F56). The cercal brush may appear to continue ventroanteriorly onto the apex of the outer ovipositor plate (*Australomymar*-F9, *Steganogaster*-F49).

STERNA

General. There are five sterna in females, gs_1–gs_5, but often not all are visible (D1–57 except D8, D29, D38, D40, D43, D54b). The apical sternum (gt_5) is the hypopygium, which usually is completely exposed (not partially or completely hidden laterally under the terga) and usually is longer and differently shaped from gt_1–gt_4. Gastral sterna gt_1–gt_4 usually are fairly similar in shape and length, and laterally are often partly hidden under the terga; it is sometimes difficult to determine correctly which segment is which, especially when gs_1–gs_4 are reduced in length ventrally and appear compressed together towards the anterior apex of the gaster, as is the case in many genera (*Chrysoctonus*-C15, *Neomymar*-D35, *Omyomymar*-D35). There are seven sterna in males, gs_1–gs_7 (*Arescon*-D8, *Ischiodasys*-D29, *Notomymar*-D38, *Ooctonus*-D40, *Paracmotemnus*-D43, *Stephanodes*-D54b). The apical sternum (gt_7) is the **subgenital plate** (Figs 7, 10–12: **sgp**).

Structure. **Sternum gs_1**. The petiole almost always connects to gs_1. Rarely, the petiole may connect or appear to connect at least dorsally to gt_1 in genera with a short and wide petiole (*Alaptus*-C3, *Dicopomorpha*-C21, *Dicopus*-D20) or narrow(er) petiole (*Anagrus*-C5, *Anaphes*-C6, *Erythmelus*-C24, *Gastrogonatocerus*-C30, *Schizophragma*-C59, *Stethynium*-C63), but it is sometimes is difficult or not possible to see it or to determine exactly how the petiole is attached. The type of attachment could perhaps be verified by examining a lateral view of cleared slide mounts or by using micro-computed tomography. In genera with a distinctly narrow, usually long petiole, gs_1 has a short, narrow tubular anterior extension that inserts inside the posterior apex of the petiole (*Boudiennyia*-C10, *Eustochus*-C27, *Eustochus* (*Caraphractus*)-C28, *Ischiodasys*-C33, *Mymar*-C38, *Platyfrons*-C53, *Richteria*-C58, *Stephanodes*-C62). Sometimes gs_1 appears to abut against the petiole instead of inserting inside it (*Anagroidea*-C4, *Anneckia*-C7, *Arescon*-C8, *Camptopteroides* (*Alalinda*)-C13, *Gonatocerus*-C31, *Lymaenon*-C36, *Paracmotemnus*-C51, *Tanyxiphium*-C64). When gt_1 appears large in lateral view with a high side, it hides gs_1 either partly (*Boudiennyia*-C10, *Chrysoctonus*-C15, *Entrichopteris*-C23, *Eustochus* (*Caraphractus*)-C28, *Polynema* (*Doriclytus*)-C54) or more or less completely (*Camptoptera*-C12, *Kalopolyema*-C34, *Litus*-C35, *Mymar*-C38, *Ptilomymar*-C57). When gt_1 is relatively small, about the same height as the gs_1, it meets gs_1 without any overlap and gs_1 is clearly visible in lateral view (*Anagrus*-C5, *Anaphes*-C6, *Arescon*-C8, *Cleruchus*-C16, *Cosmocomoidea*-C18, *Omyomymar*-C46, *Parastethynium*-C52, *Schizophragma*-C59, *Zeyanus*-C68). In ventral view, gs_1 is at least partly visible in all genera, although often only anteriorly (*Chrysoctonus*-D13); it sometimes narrows anteriorly, appearing keel-like (*Alaptus*-D3, *Ceratanaphes*-D12, *Dicopomorpha*-D18, *Dicopomorpha* (*Dicopulus*)-D19, *Erythmelus*-D22, *Eubroncus*-D23, *Litus*-D31, *Macrocamptoptera*-D33)

In lateral view, among gs_1–gs_4, gs_1 (if visible) often appears to be the longest sternum, from slightly so (*Anagrus*-C5, *Anaphes*-C6, *Arescon*-C8, *Ceratanaphes*-C14, *Cleruchus*-C16, *Cosmocomoidea*-C18, *Erythmelus*-C24, *Lymaenon*-C36a, *Omyomymar*-C46) to distinctly so (*Agalmopolynema*-C2, *Anagroidea*-C4, *Cnecomymar*-C17, *Neomymar*-C40, *Stephanodes*-C62).

In ventral view, the relative length proportions among gs_1–gs_4 change (compared to the corresponding terga) in females but not in males. Consequently, gs_1 (if visible) may still appear to be the longest segment, but usually it appears to be short because of apparent ventral compression of gs_1–gs_4 anteriorly to allow the ovipositor to swing ventrally for oviposition (*Acmopolynema*-C1, *Anagrus*-D5, *Anaphes*-D6, *Cremnomymar*-D17, *Kalopolynema*-D30, *Mymar*-D34, *Omyomymar*-D39, *Schizophragma*-D51, *Stephanodes*-D54a). Compression of gs_1–gs_4 occurs in genera with an ovipositor that arises in the anterior half of the gaster or sometimes at its anterior apex. Extreme compression of the ventral area of one or more of the sterna occurs when the ovipositor extends ventrally to a lesser or greater extent under the mesosoma; the sterna then project anteriorly as a **gastral sac** that encloses the anterior portion of the ovipositor. The anterior compression is slight (some *Alaptus*-D3, some *Anaphes*-D6, some *Steganogaster*-D52) to extreme (*Gahanopsis*-D26, some *Gastrogonatocerus*-D27) and the gastral sac is correspondingly short or long. In genera with a short ovipositor that arises in the apical half of the gaster (*Anagroidea*-D4, *Ceratanaphes*-D12, *Cleruchus*-D14, *Neostethynium*-D36), gs_1 appears as distinctly to slightly the longest segment, just as it appears in lateral view.

Sterna gs_2–gs_4 (females) **and gs_2–gs_6** (males). The sterna gs_2–gs_4 (in females) and gs_2–gs_6 (in males) vary little among themselves in shape but may be longer or shorter relative to one another; sometimes with gs_2 the longest (*Acmopolynema*-D1, *Anagroidea*-D4, *Eubroncus*-D23, *Ischiodasys*-D29), occasionally with gs_5 the longest (*Pseudanaphes*-D48), but mostly with the sterna subequal in length. The posterior margins of these sterna in males are usually transverse (*Arescon*-D8, *Ischiodasys*-D29, *Notomymar*-D38, *Ooctonus*-D40, *Paracmotemnus*-D43) or occasionally slightly V-shaped (*Stephanodes*-D54b) and in females more or less transverse (*Alaptus*-D3, *Cleruchus*-D14, *Cosmocomoidea*-D16, *Erythmelus*-D22, *Eubroncus*-D23, *Macrocamptoptera*-D33, *Stephanocampta*-D53) to strongly V-shaped (*Acmopolynema*-D1, *Anagrus*-D5, *Cremnomymar*-D17, *Eustochus*-D24, *Omyomymar*-D39, *Richteria*-D50, *Tetrapolynema*-D56) and, occasionally convex (*Ceratanaphes*-D12).

Sterna gs_5 (females) and **gs_7** (males). In females, the **hypopygium** (gs_5) should be examined in ventral and/or lateral views to determine its relative length (compared to the more anterior gastral sterna) because different views give different apparent relative lengths. It can be the longest gastral sternum (*Acmopolynema*-C1, D1, *Agalmopolynema*-C2, D2, *Anaphes*-D6, *Palaeoneura*-D41, *Pseudanaphes*-C56, D48, *Stethynium*-C63, D55), or only about as long as gs_1 (*Alaptus*-C3, D3, *Anagroidea*-C4, D4, *Cleruchus*-C16, D14, *Cosmocomoidea*-C18, D16, *Cremnomymar*-C20, D17, *Macrocamptoptera*-C37, D33, *Palaeoneura*-D41, *Palaeoneura* (*Chaetomymar*)-C50) or, rarely, is the shortest sternum (*Paracmotemnus*-C51, D43). The posterior margin is usually deeply V-shaped, with the arms of the V relatively close together, at least basally (*Anaphes*-D6, *Eustochus*-D24, *Litus*-D31, *Mymar*-D34, *Richteria*-D50, *Stephanodes*-D54a), to the arms diverging widely (*Acmopolynema*-D1, *Anneckia*-D7, *Omyomymar*-D39, *Nepolynema*-D37, *Paracmotemnus*-D43, *Schizophragma*-D51). Sometimes the posterior margin is almost transverse (*Stethynium*-D55) or convex (*Ceratanaphes*-D12, *Cleruchus*-D14). Occasionally, the hypopygium is trough-like, enclosing the ovipositor laterally for more than just its base or basal half, and it may extend at least to the apical half and, rarely, beyond the posterior apex of the gaster as a narrow **mucro (**Fig. 3: **muc**) (*Boudiennyia*-C10, D10, *Erythmelus*-C24, D21, *Neotriadomerus*-C42). In males, the posterior margin of gs_7, the **subgenital plate** (**sgp**) (Figs 7, 10–12), is slightly (*Arescon*-D8) to deeply concave, either U-shaped (*Ischiodasys*-D29, *Ooctonus*-D40, *Paracmotemnus*-D43), or narrowly or widely V-shaped (*Notomymar*-D38, *Stephanodes*-D54b). Tergum gt_7 is the **outer plate of the ovipositor = lateral and ventral area of gt_7**, and no sternal sclerites correspond to male tergal sclerites gt_6 and gt_7. Instead, gt_7 curves ventrally and anteriorly, and thus superficially appears to be a sternal sclerite that extends anteriorly under gs_5. As such, it is best treated here instead of in the terga section. The outer ovipositor plate is visible as a more or less oval plate that extends laterally along the side of each **ovipositor sheath** (Figs 1, 2, 9, 13–15: **ovs**); the sheaths usually conceal the **ovipositor stylets** (Figs 3–5, 14, 15: **ost**). In lateral view, the outer ovipositor plate is often hidden under the sides of the terga and/or the hypopygium or other sterna, so it is best seen in ventral view. Sometimes it is clearly visible, at least its apical half or less (*Agalmopolynema*-C2, *Anagrus*-C5, *Arescon*-C8, *Neotriadomerus*-C42, *Omyomymar*-C46, *Omyomymar* (*Caenomymar*)-C47, *Palaeoneura* (*Chaetomymar*)-C50, *Stethynium*-C63, *Tetrapolynema*-C65). When, rarely, it is completely visible ventrally, gt_7 appears long and narrow (*Omyomymar*-D39), fairly short and wide (*Cosmocomoidea*-D16, *Palaeoneura*-D41) or long and fairly wide (*Anagrus*-D5, *Gastrogonatocerus*-D27, *Kalopolynema*-D30).

Sculpture. Sculpture is absent or, if present, is inconspicuous on most sterna except gs_1. When present on gs_1, the sculpture is faintly reticulate (*Alaptus*-D3, *Dicopomorpha*-D18) or distinct and either longitudinally striate (*Ceratanaphes*-D12, *Cleruchus*-D14) or, anteriorly, with deep isodiametric cells (*Anagroidea*-A3c, D4, *Camptopteroides* (*Alalinda*)-A6c, C13, D11, *Eubroncus*-D23, *Macrocamptoptera*-D33, *Ooctonus*-D40). The anterior projection of gs_1 that extends into the petiole is sometimes sculptured (*Eustochus* (*Caraphractus*)-C28, D25). Occasionally, gs_2–gs_4 and sometimes part or all of gs_5 are longitudinally striate (*Ceratanaphes*-D12, *Cleruchus*-D14) or have transverse row(s) of minute spicules (*Erythmelus*-D22) or have faint reticulations (*Stethynium*-D55) that sometimes are anterior only (*Cosmocomoidea*-C18, *Lymaenon*-C36a).

Setation. In most genera, the sterna, especially the anterior three or four (anterior six in males) are asetose. Rarely, in females, one or more have a seta submedially/sublaterally (*Australomymar*-D9, *Eubroncus*-D23) and, rarely, in males, one or more sterna have one seta (*Notomymar*-D38, *Ooctonus*-D40, *Paracmotemnus*-D43). In females, the hypopygium occasionally has one or two submedian/sublateral setae (*Alaptus*-D3, *Anagrus*-D5, *Cleruchus*-D14, *Cosmocomoidea*-D16, *Dicopomorpha*-D18, *Pseudanaphes*-D48) to about 10 setae more or less in a longitudinal row (*Anaphes*-D6). In males, the subgenital plate has one or two setae (*Arescon*-D8, *Notomymar*-D38, *Ooctonus*-D40, *Paracmotemnus*-D43, *Stephanodes*-D54b). The setae are short (*Cleruchus*-D14) to long (*Anneckia*-D7).

In females of all genera, most of the setae of the gastral sternum occur on the outer ovipositor plate. They vary in number from 1 to 3 or 4, and are mostly subapical or in the apical half (*Anagrus*-D5, *Anaphes*-D6, *Cosmocomoidea*-D16, *Palaeoneura*-D41), but sometimes more basal (*Dicopomorpha*-D18, *Dicopomorpha* (*Dicopulus*)-D19).

MALE GENITALIA

General. The male genitalia are illustrated best with micrographs of the dorsal, lateral, ventral and posterior views of the gastral apex to show the position of the genitalia relative to other structures. At the same time, the size and shape of gt_{7+8} is visible for comparison with the corresponding females, when both sexes are illustrated. In lateral view, the male genitalia (*Alaptus*-H2, *Anaphes*-H3, *Dicopomorpha*-H9, *Erythmelus*-H10, *Narayanella*-H15) when not in use are in line with the long axis of the gaster, with their apex usually close to gs_7 and gt_{7+8}, and the **aedeagus** (Figs 10, 11: **aed**) is parallel with the **parameres (**Figs 10, 11: **par**) (*Neomymar*-H16a). The entire genitalia when in use move ventrally far from these sclerites and the aedeagus rotates anteroventrally, clearly separating from the parameres, which remain in line with the long axis of the genitalia (*Neomymar*-H16b, *Platyfrons*-H19).

Structure. In dorsal view (G1–G20) the male genitalia are rarely visible, and then almost always their apex only, though rarely almost the entire genitalia are visible (*Erythmelus* (*Parallelaptera*)-G8). Sometimes only the aedeagus is visible (*Agalmopolynema*-G1, *Neomymar*-G11, *Palaeoneura*-G13) but more often the parameres or at least their apices are also visible lateral to the aedeagus (*Alaptus*-G2, *Boudiennyia*-G3, *Dicopomorpha* (?*Dicopulus*)-G6, *Erythmelus*-G7, *Erythmelus* (*Parallelaptera*)-G8, *Omyomymar* (*Caenomymar*)-G12, *Pseudanaphes*-G17, *Steganogaster*-G19). The aedeagus is more (*Boudiennyia*-G3) or less (*Steganogaster*-G19) wide, but narrows posteriorly, sometimes as an abruptly narrow projection (*Agalmopolynema*-G1), sometimes gradually (*Palaeoneura*-G13, *Steganogaster*-G19). Rarely, the aedeagus has a mediolongitudinal sulcus (*Boudiennyia*-G3).

In lateral view (H1–H27), the aedeagus is either completely straight (*Agalmopolynema*-H1, *Erythmelus*-H10, *Erythmelus* (*Parallelaptera*)-H11) or, perhaps more often, is slightly curved ventrally for most of its length (*Arescon*-F8, *Cleruchus*-H6, *Narayanella*-H15, *Omyomymar*-H17, *Stephanodes*-H25) or only distally (*Anaphes*-H3), though it can be abruptly curved ventrally (*Australomymar*-H4, *Cleruchus*-H6). The parameres are thin, and short (*Agalmopolynema*-H1, *Platyfrons*-H18) to long (*Stephanodes*-H25), to thicker and long (*Australomymar*-H4, *Omyomymar*-H17, *Polynema* (*Restisoma*)-H21, *Steganogaster*-H24). In dorsal, lateral or ventral views, the genitalia appear symmetrical except they are asymmetrical in one genus (*Stethynium*-I23).

In ventral view (I1–I25), the genitalia are often entirely visible or almost so. The subgenital plate extends to varying degrees lateral to the genitalia, sometimes even slightly past their posterior apex (*Richteria*-I20). The gap between the posterolateral extensions of gs_7 forms a narrow V (*Agalmopolynema*-I1, *Neomymar*-I13, *Platyfrons*-I17, *Polynema*-I18, *Stephanodes*-I22, *Tetrapolynema*-I24), a wide V (*Alaptus*-I2, *Arescon*-I4), or a wide U (*Ischiodasys*-I12, *Ooctonus*-I16, *Richteria*-I20, *Yoshimotoana*-I25). The sides of the subgenital plate are short (*Alaptus*-I2) to long (*Agalmopolynema*-I1) and extending as far as the apex of the aedeagus.

In posterior or ventroposterior view (J1–J25), the relative positions of the apical gastral sclerites, especially gt_{7+8} and gs_7, and the genitalia are clearest. The genitalia are close to the ventral margin of gt_{7+8} (*Boudiennyia*-J4, *Richteria*-J20) or, if apparently widely separated from it (*Agalmopolynema*-J1, *Neomymar*-J12), it is because the aedeagus and parameres extend more or less ventrally, i.e., they are not completely retracted dorsally against the subgenital plate where they are protected. The aedeagus is narrow and occasionally higher than wide, at least apically (*Anaphes*-J2, *Australomymar*-J3, *Steganogaster*-J21), but is usually flattened, slightly wider than high (*Cnecomymar*-J6, *Dicopus*-J8, *Stephanodes*-J22) and sometimes extremely wide (*Boudiennyia*-J4, *Cleruchus*-J5, *Erythmelus*-J9). The parameres are lateral (*Richteria*-J17, *Steganogaster*-J21) or ventrolateral (*Cnecomymar*-J6, *Polynema*-J17) to the aedeagus and, depending on their position at the time of preservation, are closely appressed or more or less widely separated from the aedeagus. Sometimes the parameres appear dorsal to the aedeagus (*Anaphes*-J2, *Zeyanus*-J25). The parameres are usually narrow and more or less cylindrical (*Dicopomorpha*-J8, *Steganogaster*-J21, *Stephanodes*-J22) to wide (*Erythmelus*-J9).

Setation. One or more setae usually occur on each paramere, apically (*Arescon*-I4), subapically (*Steganogaster*-H24), and/or medially (*Richteria*-I20, *Stephanodes*-H25). They also may occur laterally on other parts of the genitalia (perhaps the volsella?) (*Richteria*-I20) but it is difficult to determine which structure they occur on based on micrographs only. The setae vary in length, from short (*Alaptus*-I2) to longer (*Polynema* (*Restisoma*)-H21).

Discussion and conclusions

The present study and our two previous ones (Huber *et al.* 2023a, 2023b) illustrate with scanning electron micrographs the range of external structure of Mymaridae other than for the antennae, legs, wings and the terminalia for all the proposed groups of genera (Lin *et al.* 2007). Internal structure also remains to be studied. Three-dimensional imaging technologies such as micro-computed tomography (micro-CT) and confocal laser scanning microscopy offer excellent possibilities to study internal structure, not only of hard structures such as the internal skeleton, but also soft structures such as muscles, with minimum or no disruption to their relative size and position, e.g., Lieberman *et al.* (2021).

The metasoma of Mymaridae is no different in general structure from that of other Chalcidoidea. The gaster is relatively uniform except in a few genera (*Ptilomymar*, *Steganogaster*, *Stephanocampta*) that have some unique and remarkable features. In contrast, structure of the petiole appears to show as much variation within the family as across all the remaining families of Chalcidoidea together. Nevertheless, the metasoma does not appear to have as many potentially useful features as the head (Huber *et al.* 2023a) and mesosoma (Huber *et al.* 2023b) to distinguish the genus-group taxa. For many views (mainly dorsal and lateral), at least half the total number of genera are illustrated, with the emphasis on diversity, not on minute detail. The micrographs show that numerous characters could be used to help define the genera of Mymaridae morphologically. *In situ* views of the genitalia of some males and females are also included in this study to show the relative position of structures. Examining fewer genera in greater detail may well yield even more morphological characters worthy of study to determine their use for identification and delimitation of the taxa.

A combination of cleared specimens mounted in different views (dorsal, lateral, ventral) is needed to study thoroughly the morphology of the various body structures. The number and position of setae, especially on the metasoma are especially difficult to determine using micrographs alone. It would be useful to make a comparative study of wings, using photographs to show the shape and distribution of microtrichia on the wing surfaces and, if accompanied by line drawings of the venation, details of setation and position of the various campaniform sensilla. The legs are not particularly variable among the genera but a comparative set of inner and outer views of each of the three pairs, using micrographs and/or photographs would be useful to have. Finally, a comparative study of the antennae of both sexes, and the male genitalia and the female ovipositor complex of as many genera as possible would be worth having.

Acknowledgements

Over many years, Ann Fook Yang (AAFC, retired) quietly and efficiently maintained the scanning electron microscope in top working condition, which allowed us to obtain excellent results without worrying about whether it would break down or otherwise create problems. He also taught us how to use it and was always there to trouble shoot. We are very grateful for his considerable help. I thank Brendon Boudinot (Senckenburg Naturmuseum, Frankfurt, Germany) for insights into the composition of the gastral petiole and Istvan Mikó (University of New Hamphire, Durham, New Hampshire, USA) for clarifying some terms used for parts of the ovipositor.

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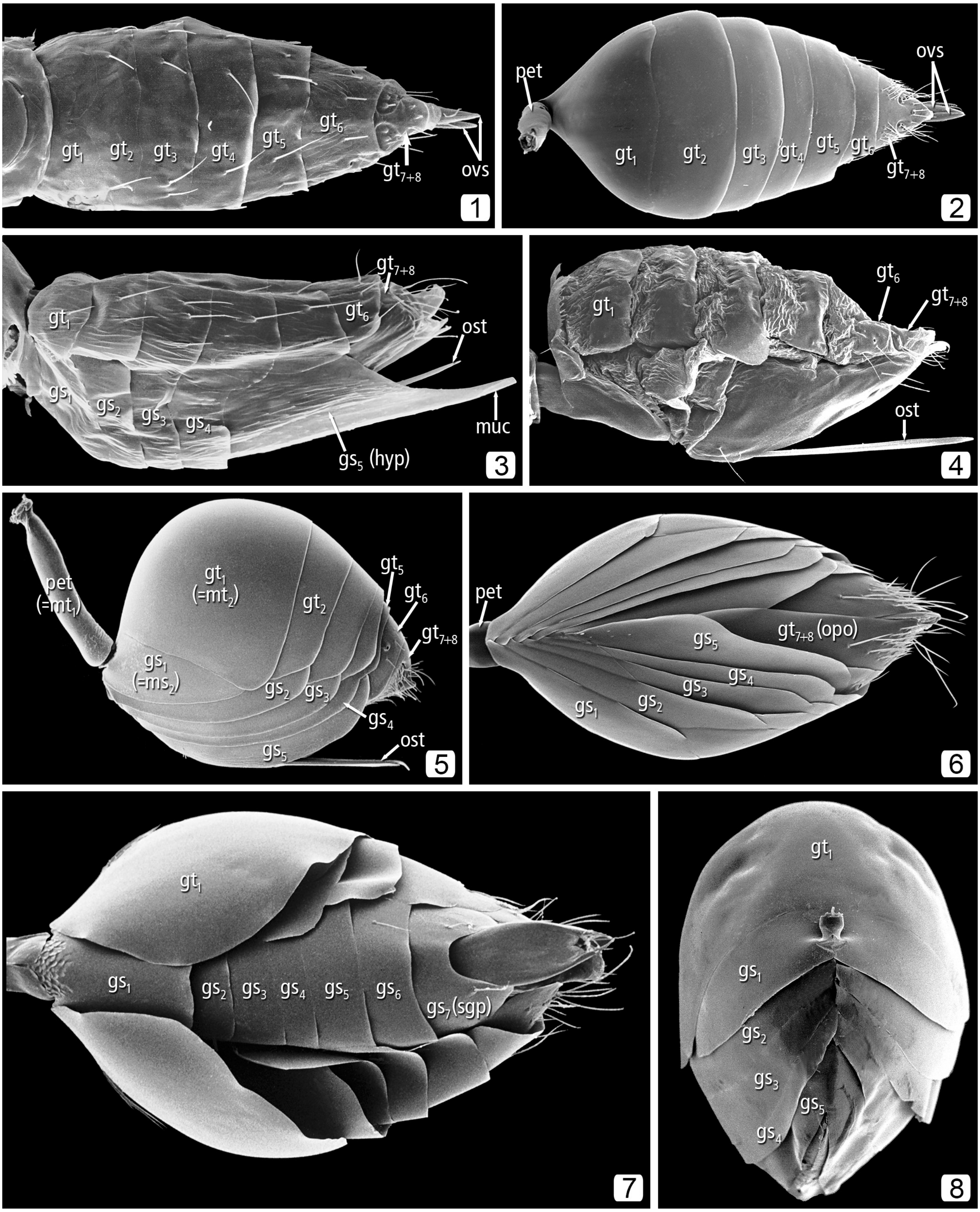
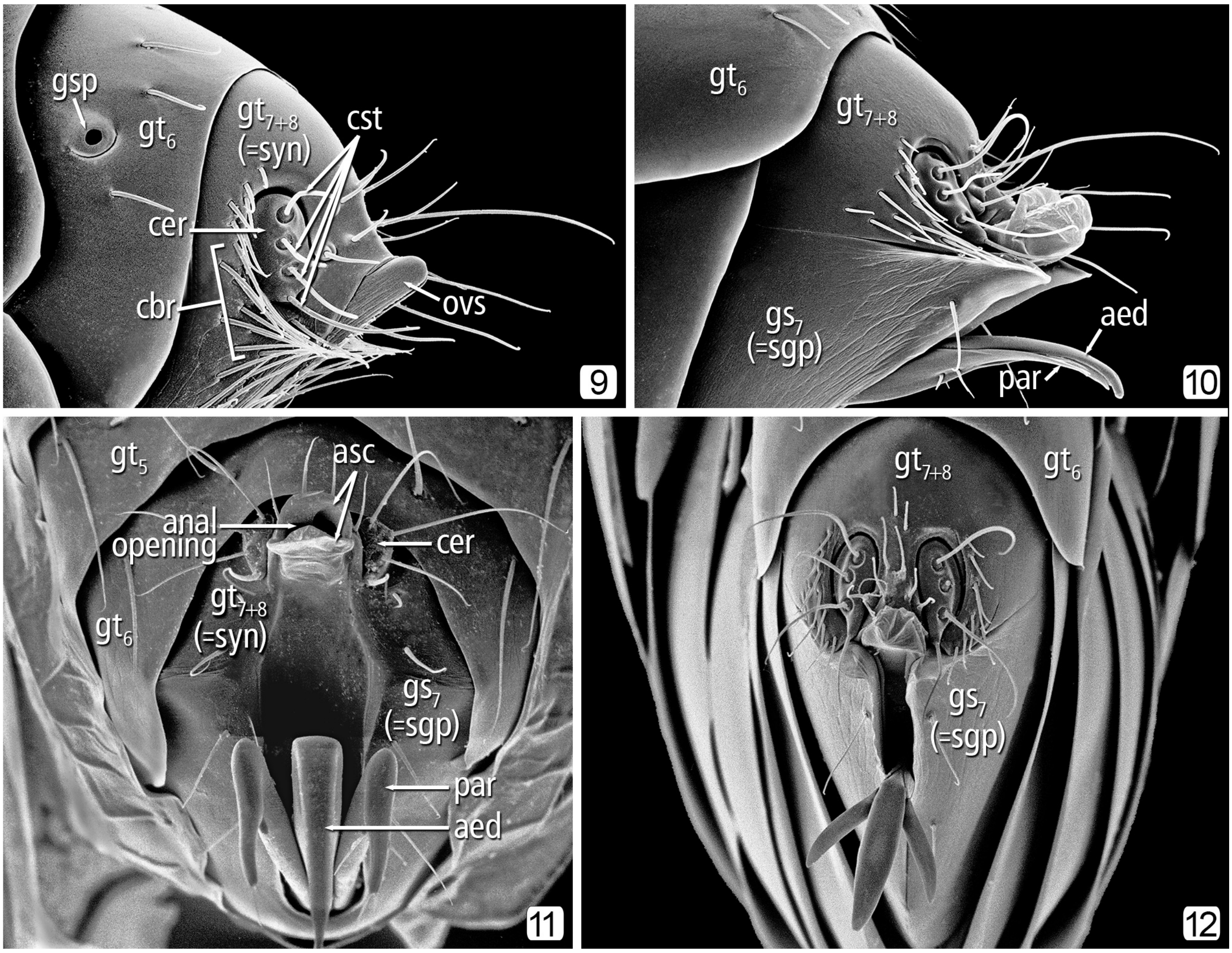
Appendix 1. List of acronyms used on Figures 1–15.

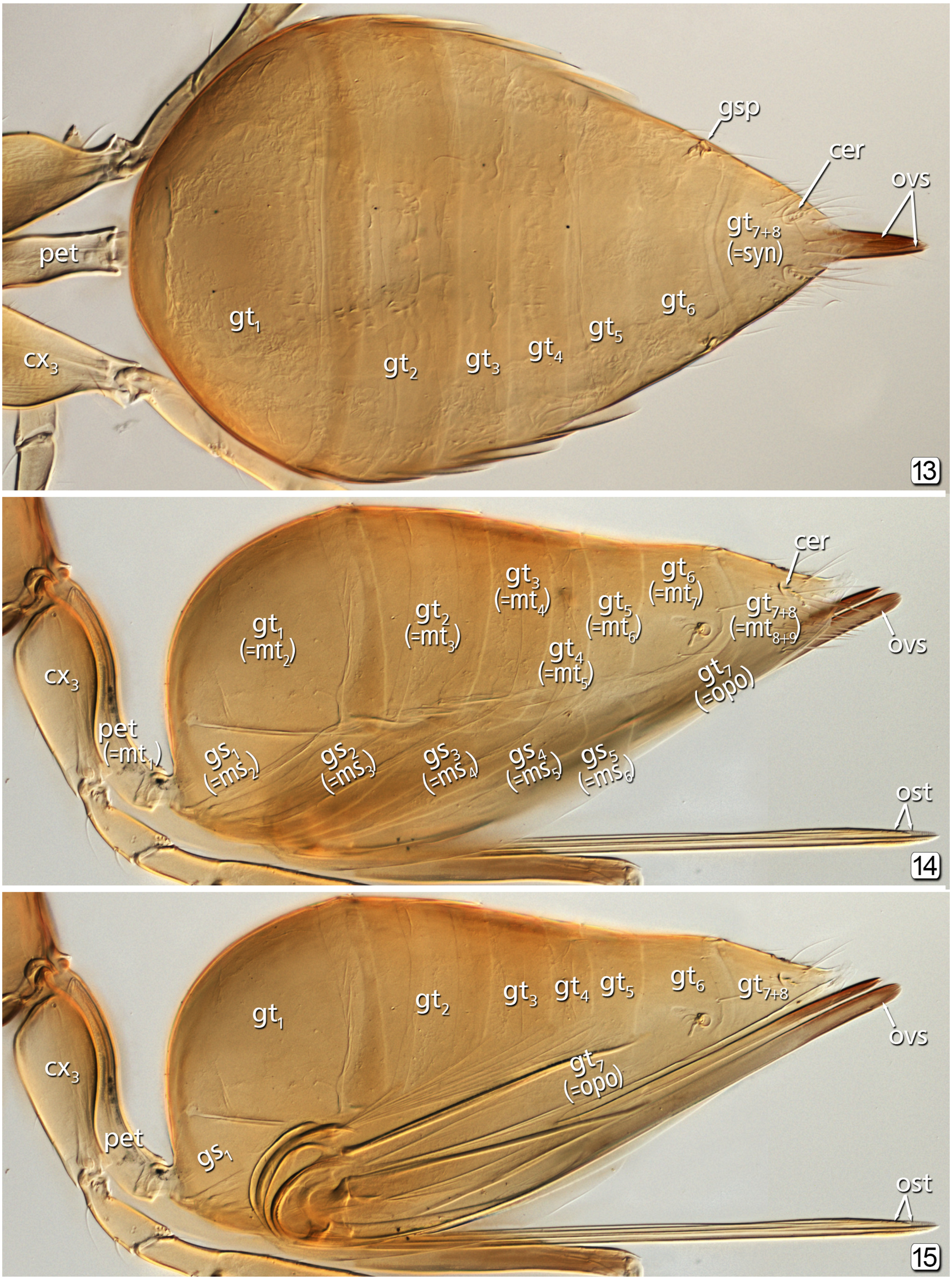
aed—aedeagus (Figs 10, 11)
asc—anal sclerite (Fig. 11)
cbr—cercal brush (Fig. 9)
cer—cercus (Figs 9, 11, 13, 14)
cst—cercal setae (Fig. 9)
cx_3—metacoxa (Figs 13–15)
gs—gastral sternum (gs_1–gs_5) (Figs 3, 5–8, 10–12, 13, 14)
gsp—gastral spiracle (Fig. 9)
gt—gastral tergum (gt_1–gt_{7+8}) (Figs 1–15)
hyp—hypopygium (gs_5) (Fig. 3)
iop—inner plate of the ovipositor (Figs D3, D36) [= 2vf (Fig. 39)]
ms—metasomal sternum (ms_x) (Figs 5, 14)
mt—metasomal tergum (mt_x) (Figs 5, 14)
muc—mucro (Fig. 3)
opo—outer plate of the ovipositor (Figs 6, 14, 15) = gt_{7+8}
ost—ovipositor stylets (Figs 4, 5, 14, 15)
ovs—ovipositor sheath (Figs 1, 2, 9, 13–15, D36)
par—paramere (Figs 10, 11)
pet—petiole (Figs 2, 5, 6, 13–15)
sgp—subgenital plate [= gt_7] (Figs 7, 10–12)
syn—syntergum (gt_7 + gt_8) (Figs 9, 11, 13)
2vf—2nd valvifer (Figs D5, D39) = iop
3vv—3rd valvula (Figs D5, D39) = ovs



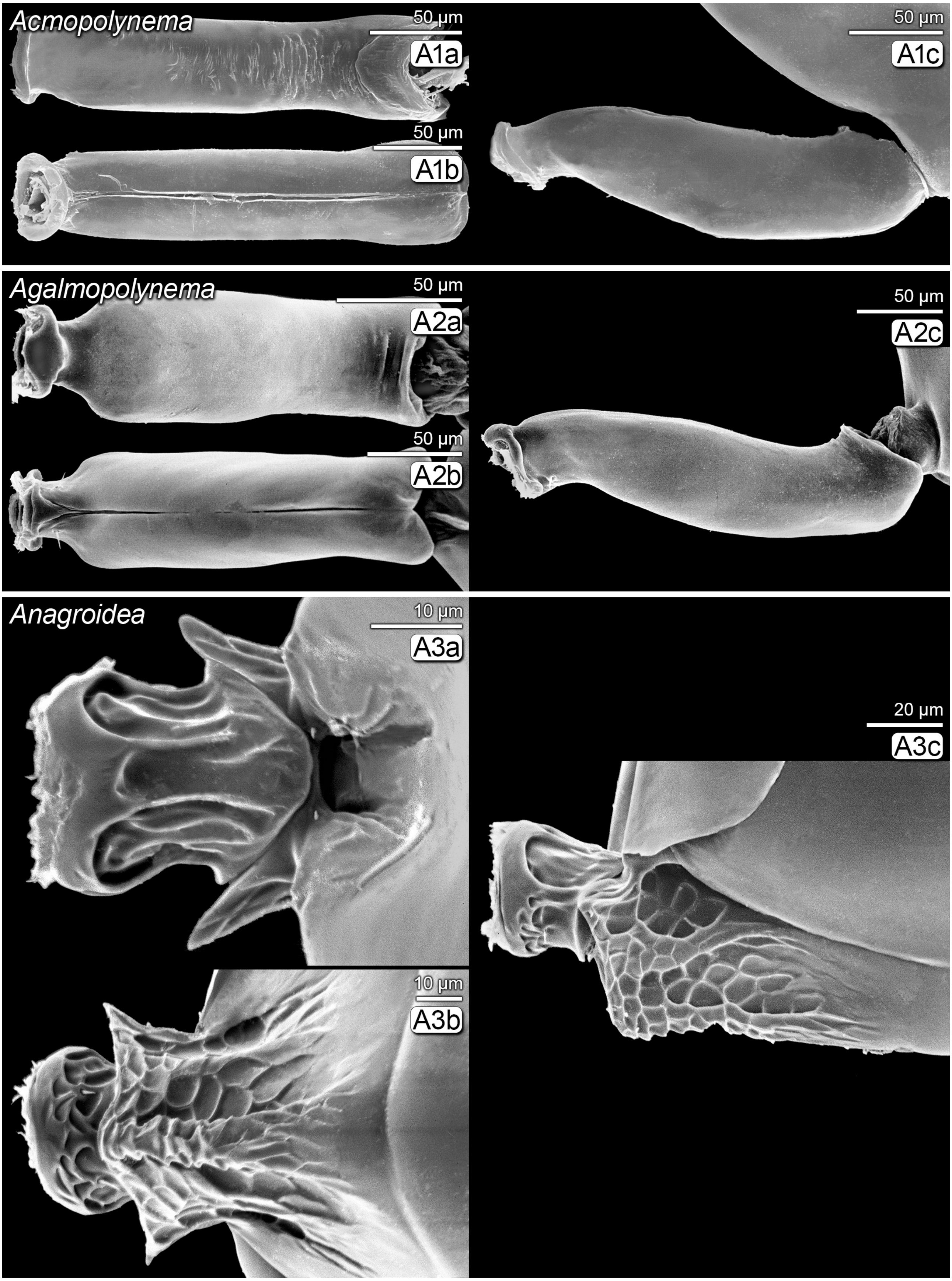
FIGURES 1–8. 1–6, female metasomas. 1, *Anagrus*, dorsal; 2, *Palaeoneura* (*Chaetomymar*), dorsal; 3, *Erythmelus*, lateral; 4 *Cosmocomoidea*, lateral; 5, *Stephanodes septentrionalis*, lateral; 6, *S. septentrionalis*, ventral. 7 & 8, male gasters.7, *Ooctonus*, ventral; 8, *Stephanodes polynemoides*, anterior. Acronyms explained in Appendix 1.



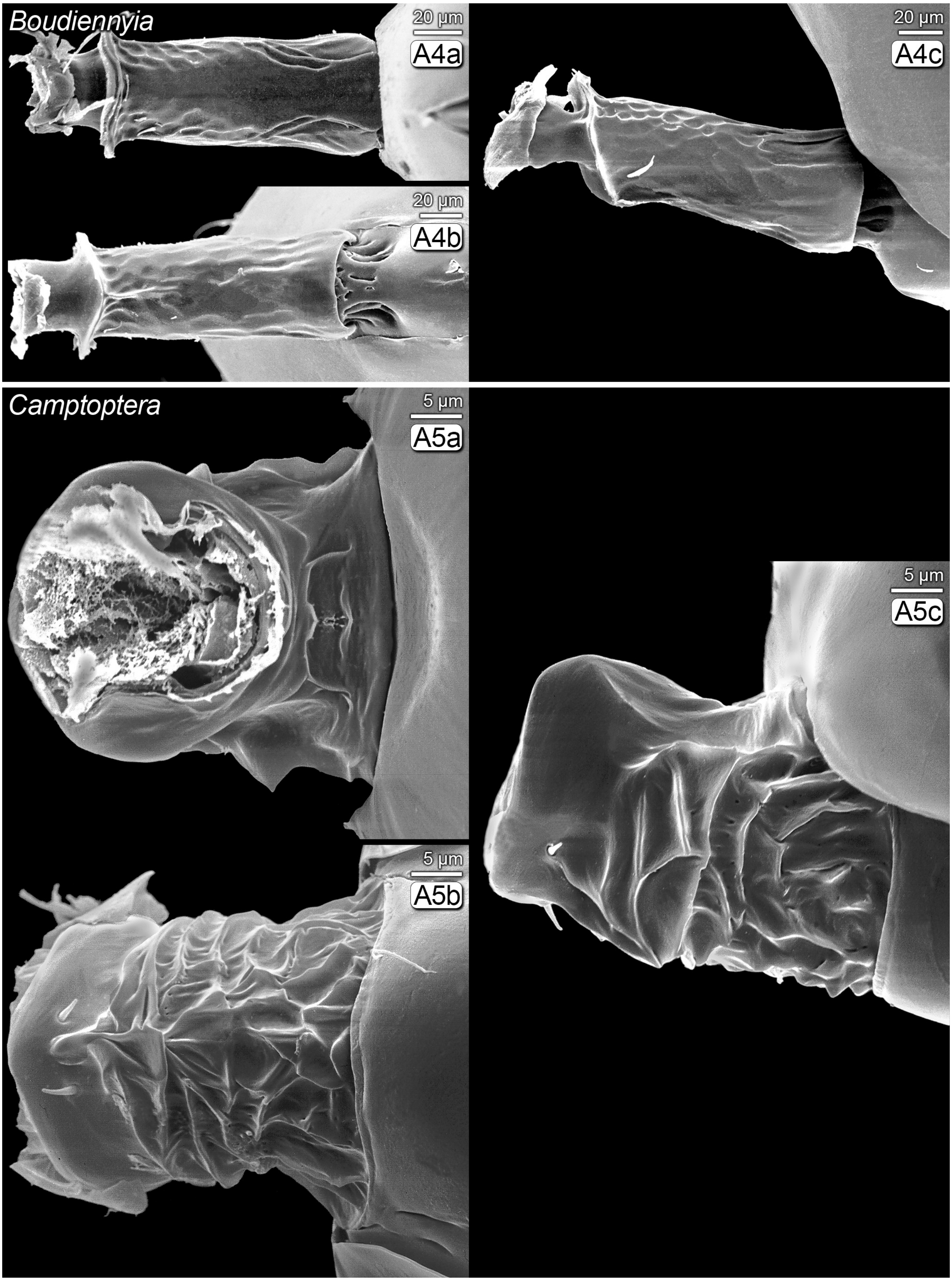
FIGURES 9–12. Apex of gaster. 9, *Stephanodes septentrionalis*, female, lateral; 10, *S. septentrionalis* male, lateral; 11, *Steganogaster*, male, posterior; 12, *Stephanodes septentrionalis*, male, posterior. Acronyms explained in Appendix 1.



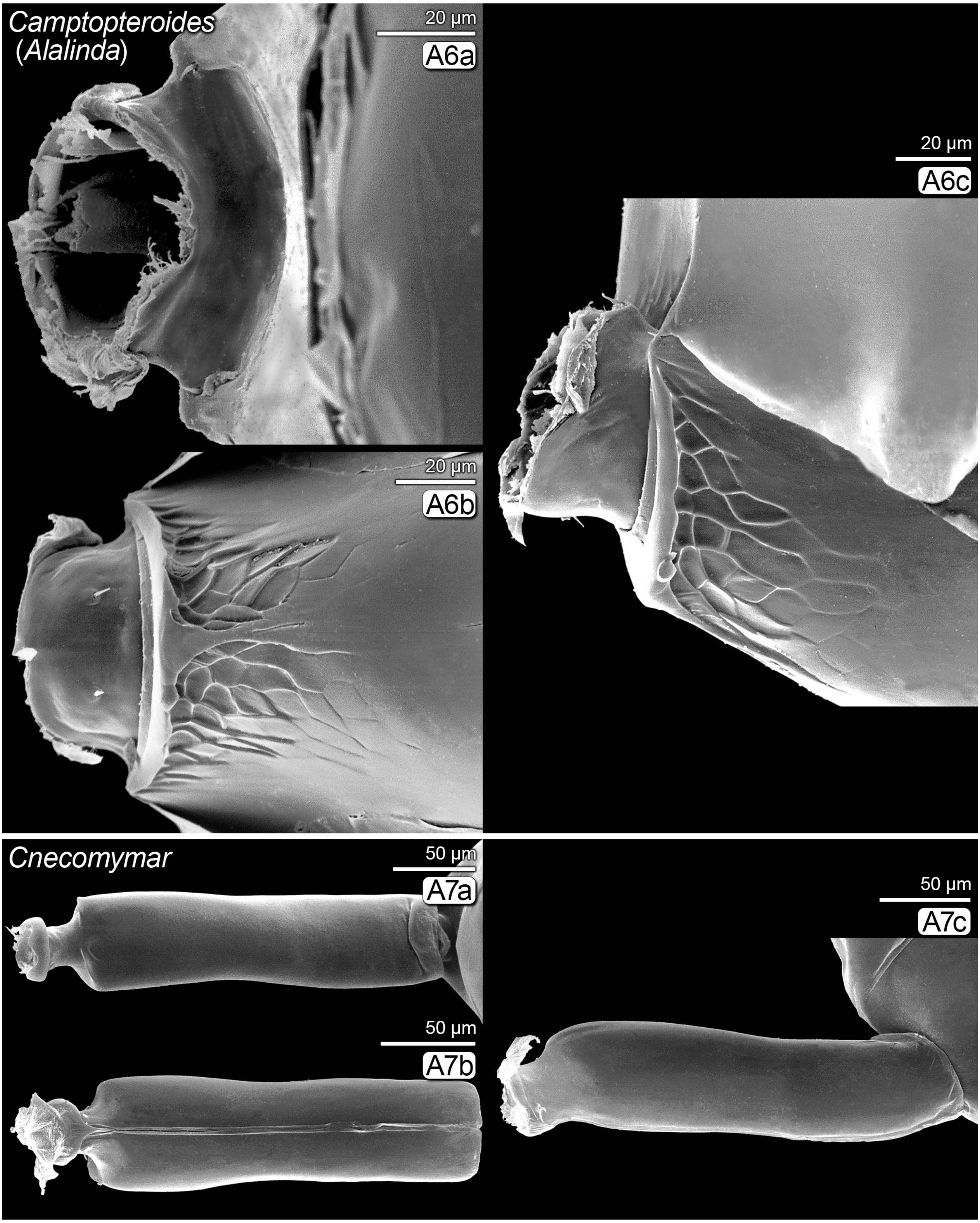
FIGURES 13–15. *Neomymar vierecki* Crawford, female. 13, metasoma, dorsal; 14 & 15, metasoma, lateral and median. Acronyms explained in Appendix 1.



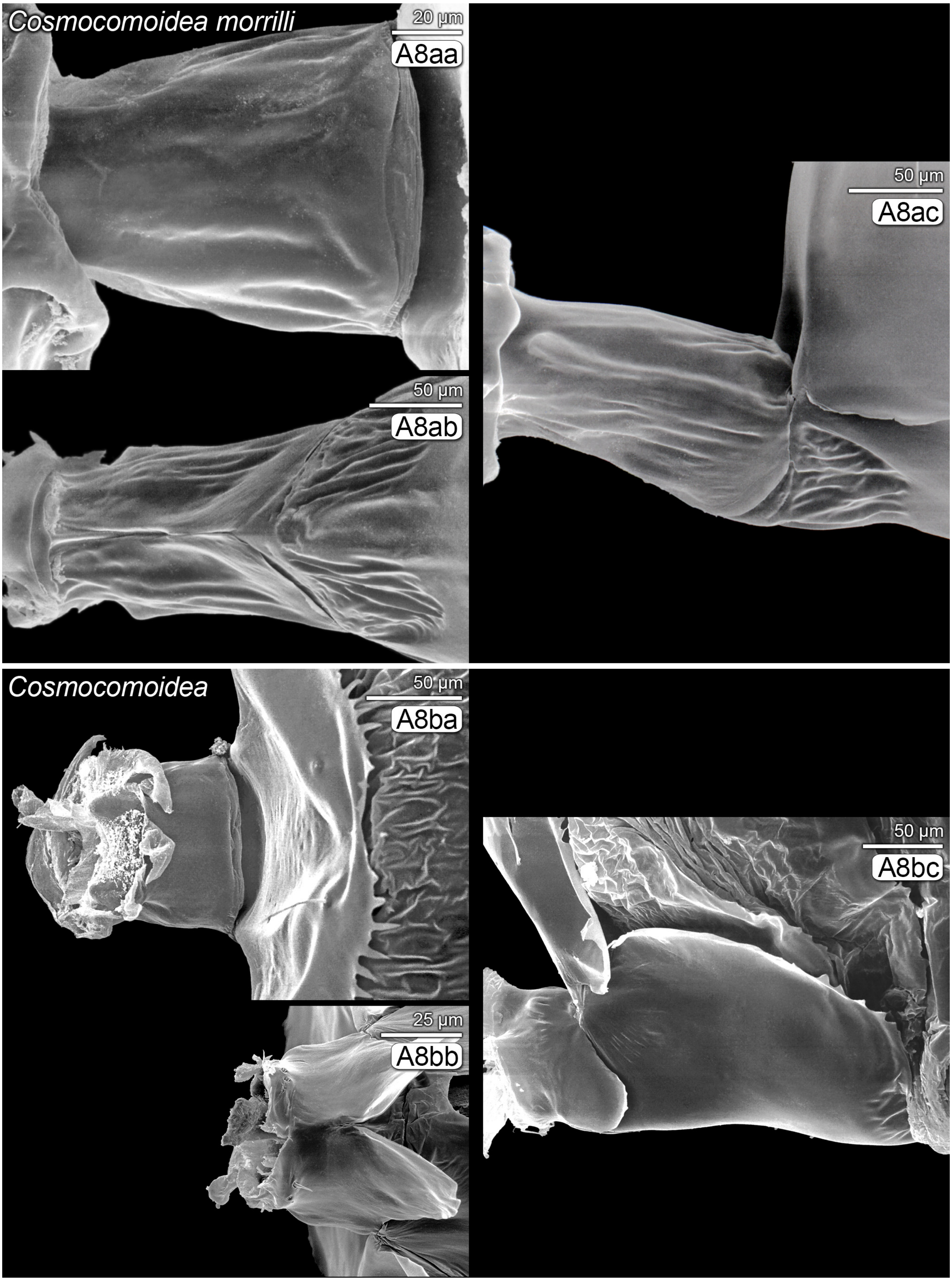
FIGURES A1–**A3**. Mymaridae petioles: a, dorsal; b, ventral; c, lateral.



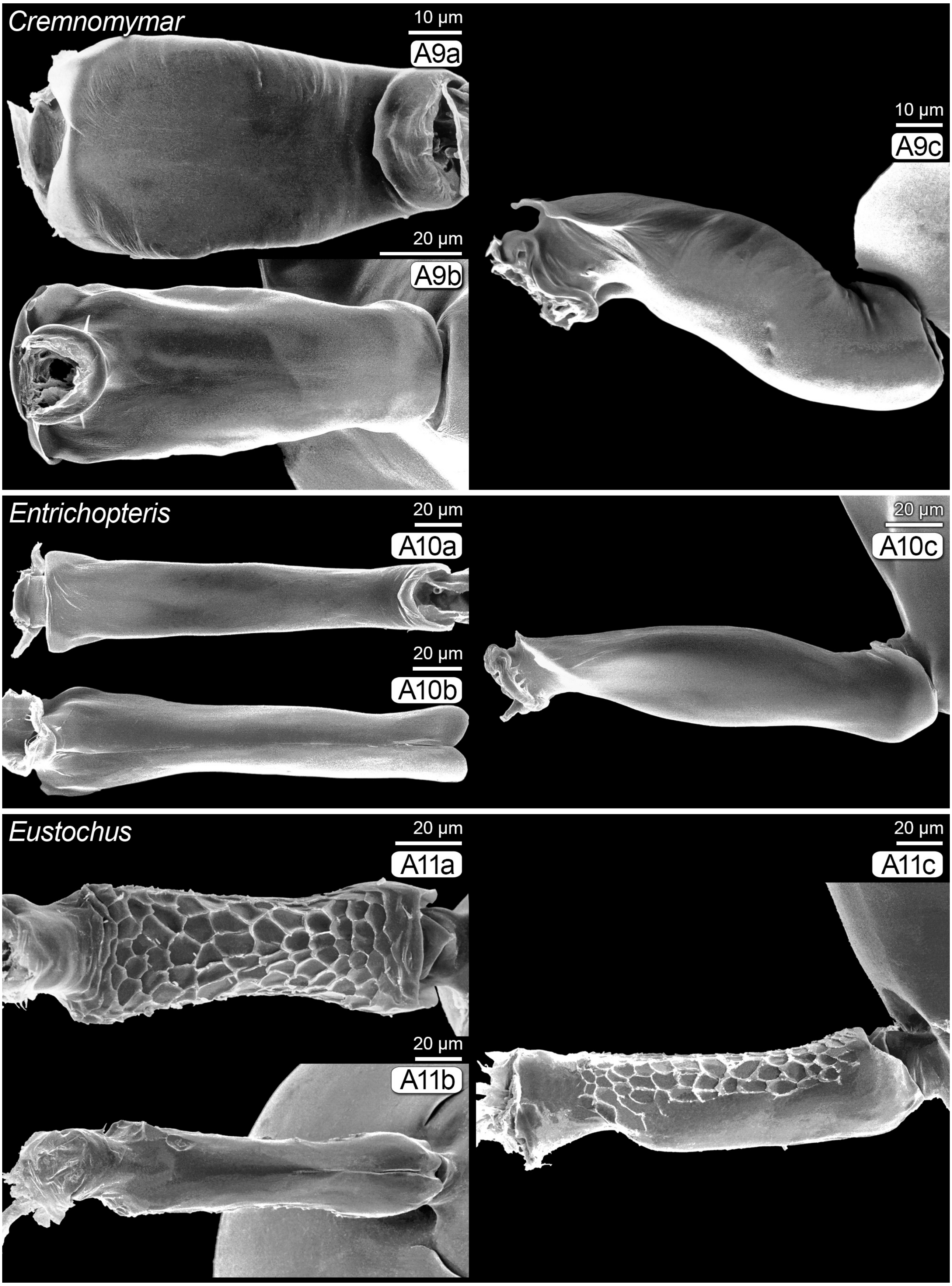
FIGURES A4, A5. Mymaridae petioles: a, dorsal; b, ventral; c, lateral.



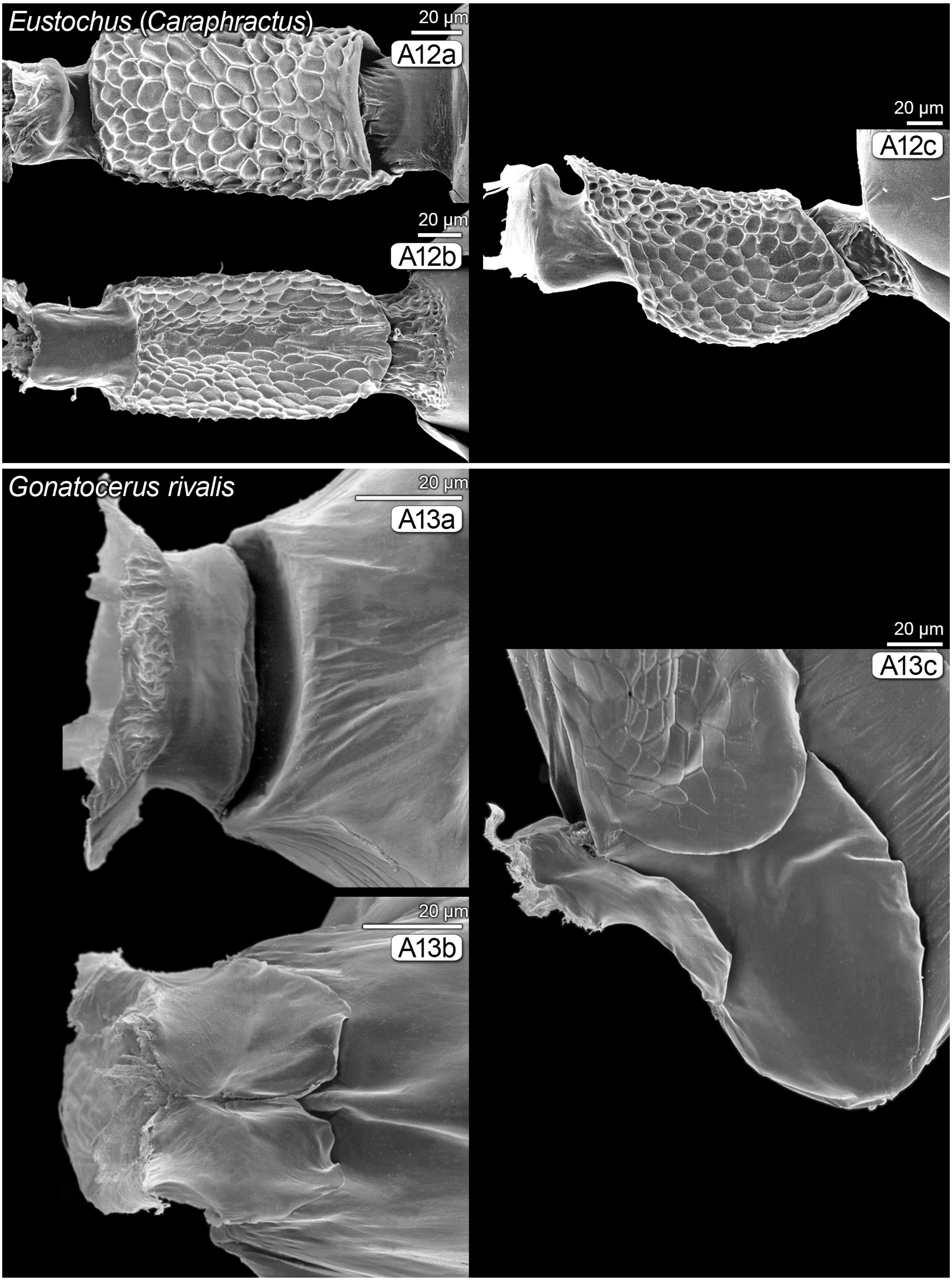
FIGURES A6, **A7**. Mymaridae petioles: a, dorsal; b, ventral; c, lateral.



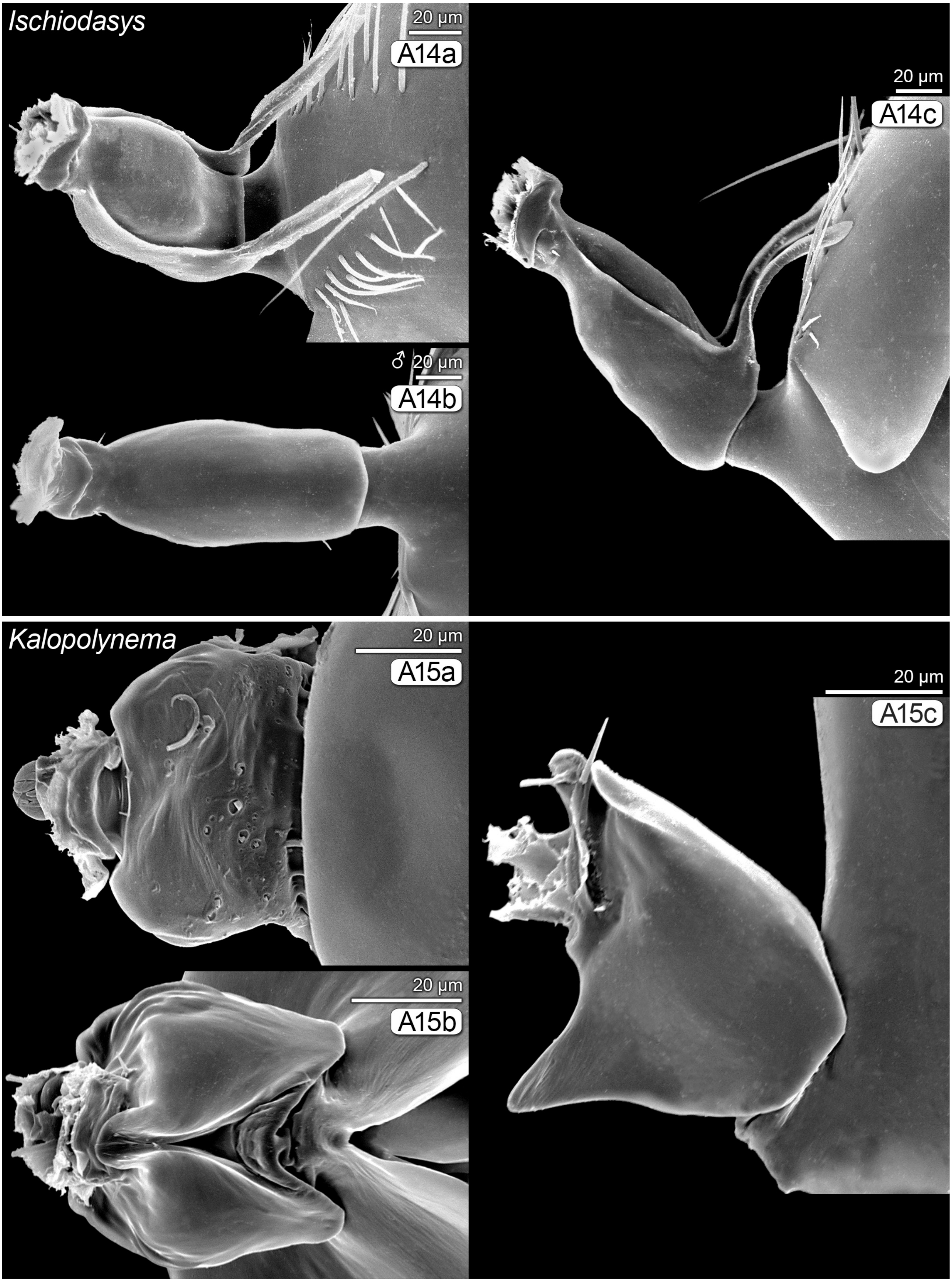
FIGURES A8. Mymaridae petioles: a, dorsal; b, ventral; c, lateral.



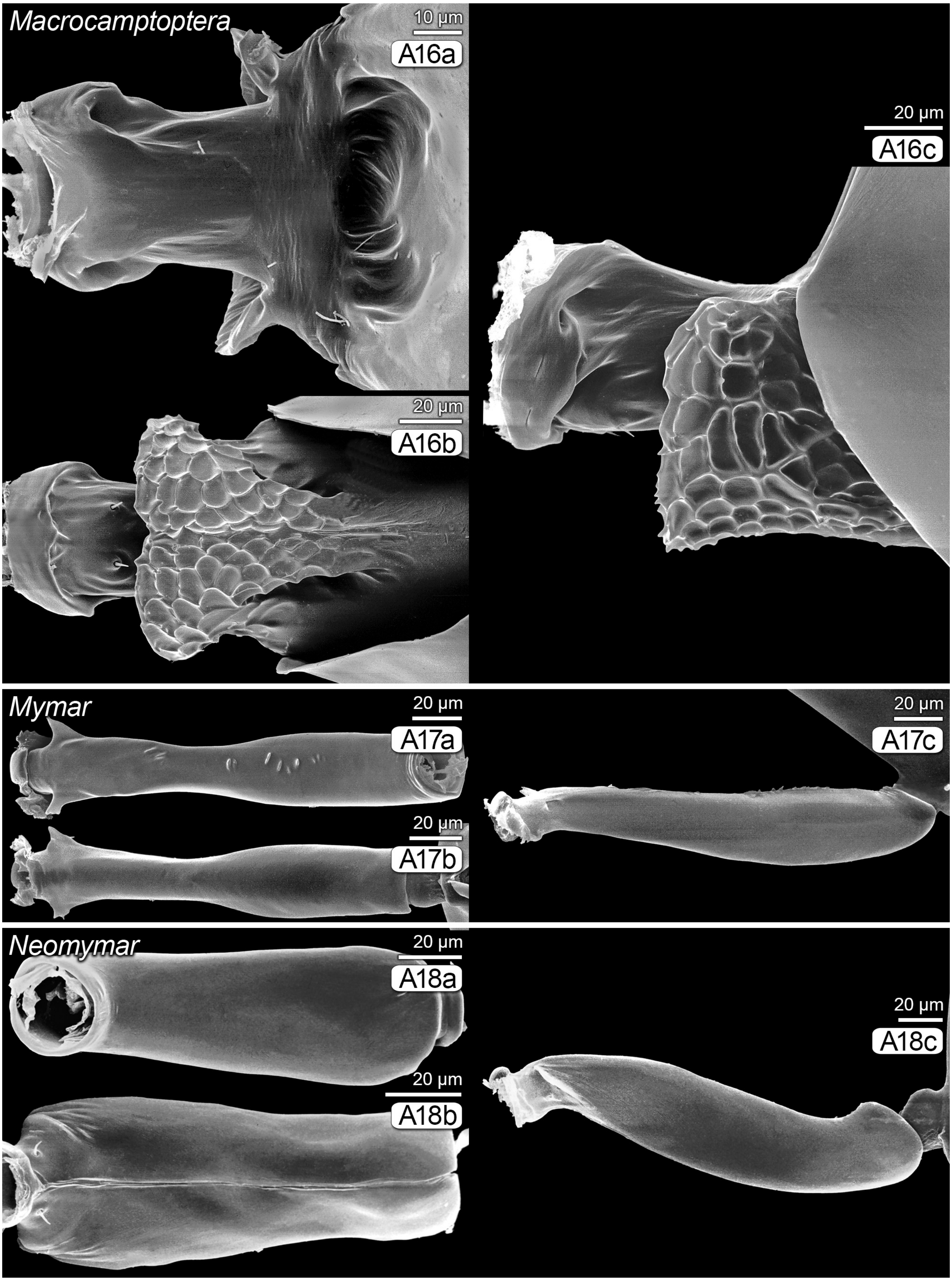
FIGURES A9–A11. Mymaridae petioles: a, dorsal; b, ventral; c, lateral.



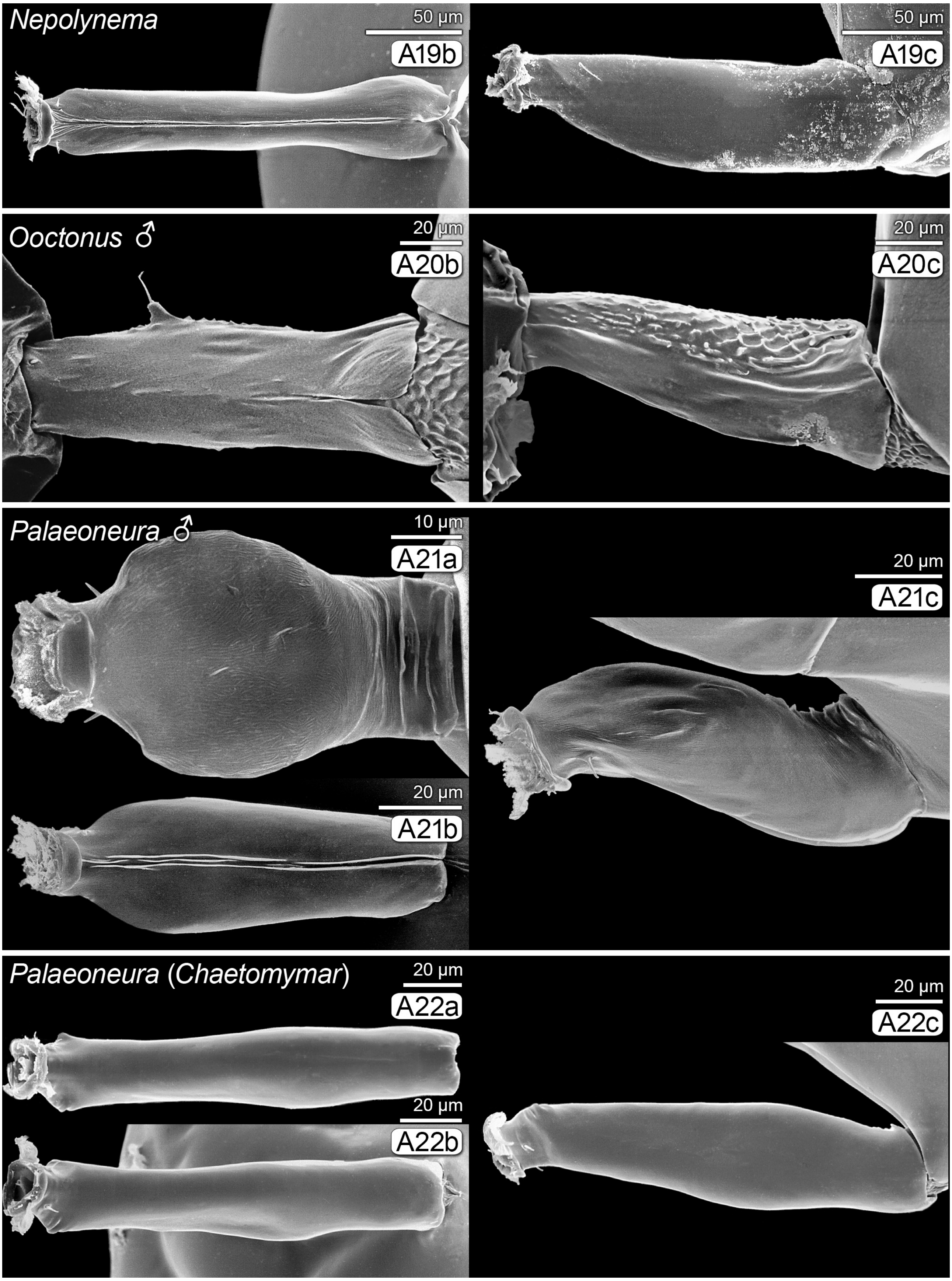
FIGURES A12, A13. Mymaridae petioles: a, dorsal; b, ventral; c, lateral.



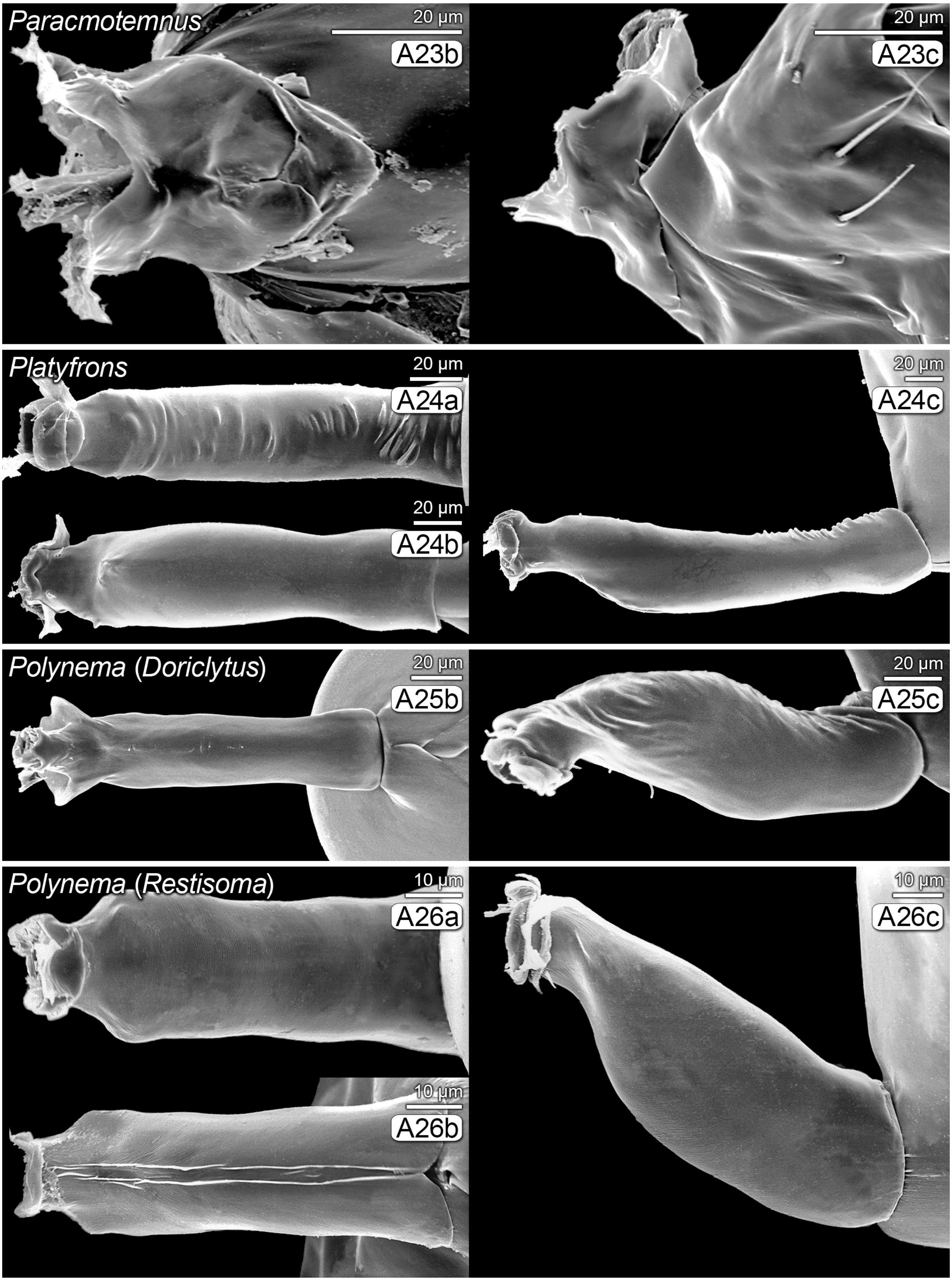
FIGURES A14, A15. Mymaridae petioles: a, dorsal; b, ventral; c, lateral.



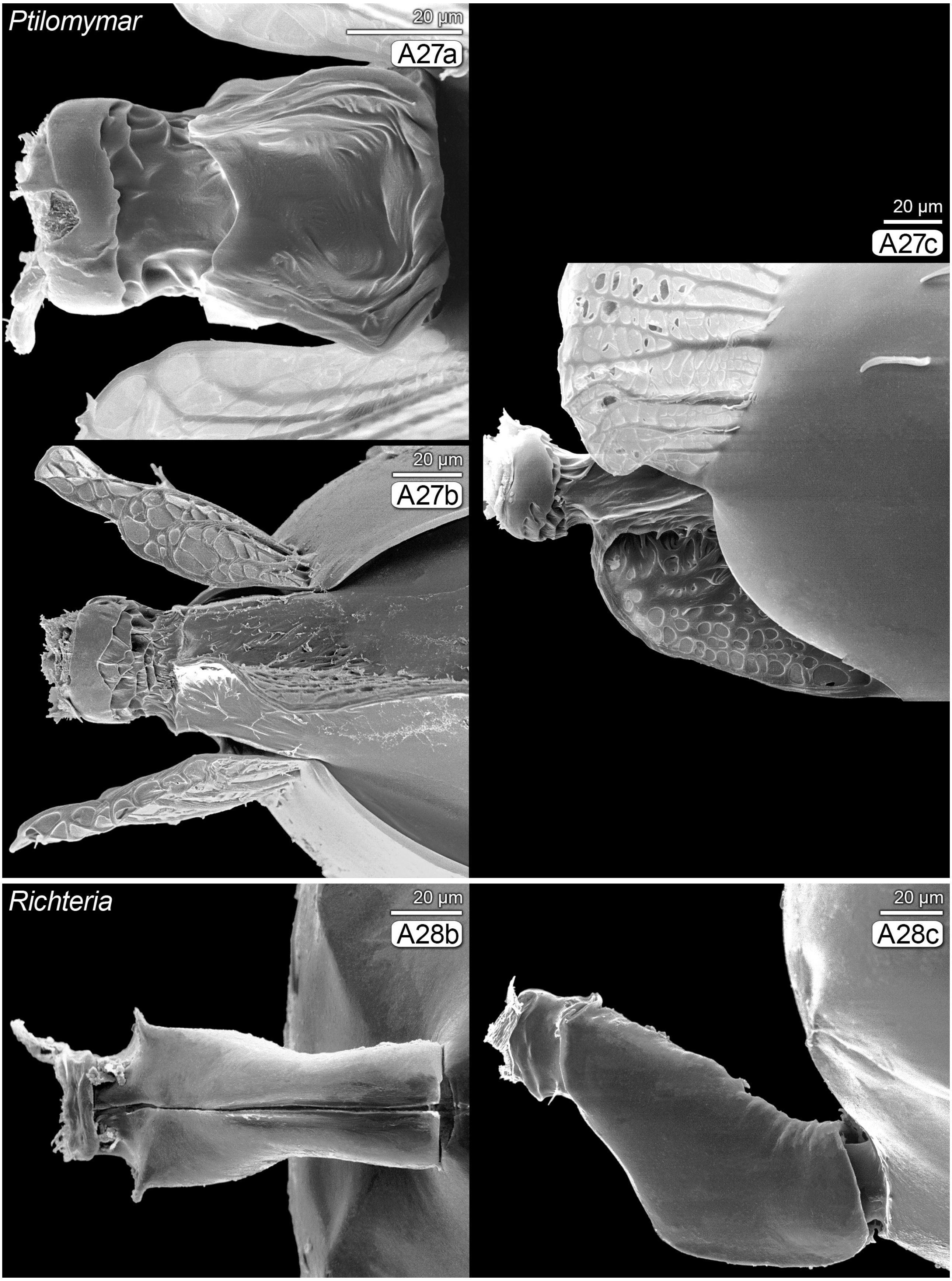
FIGURES A16–A18. Mymaridae petioles: a, dorsal; b, ventral; c, lateral.



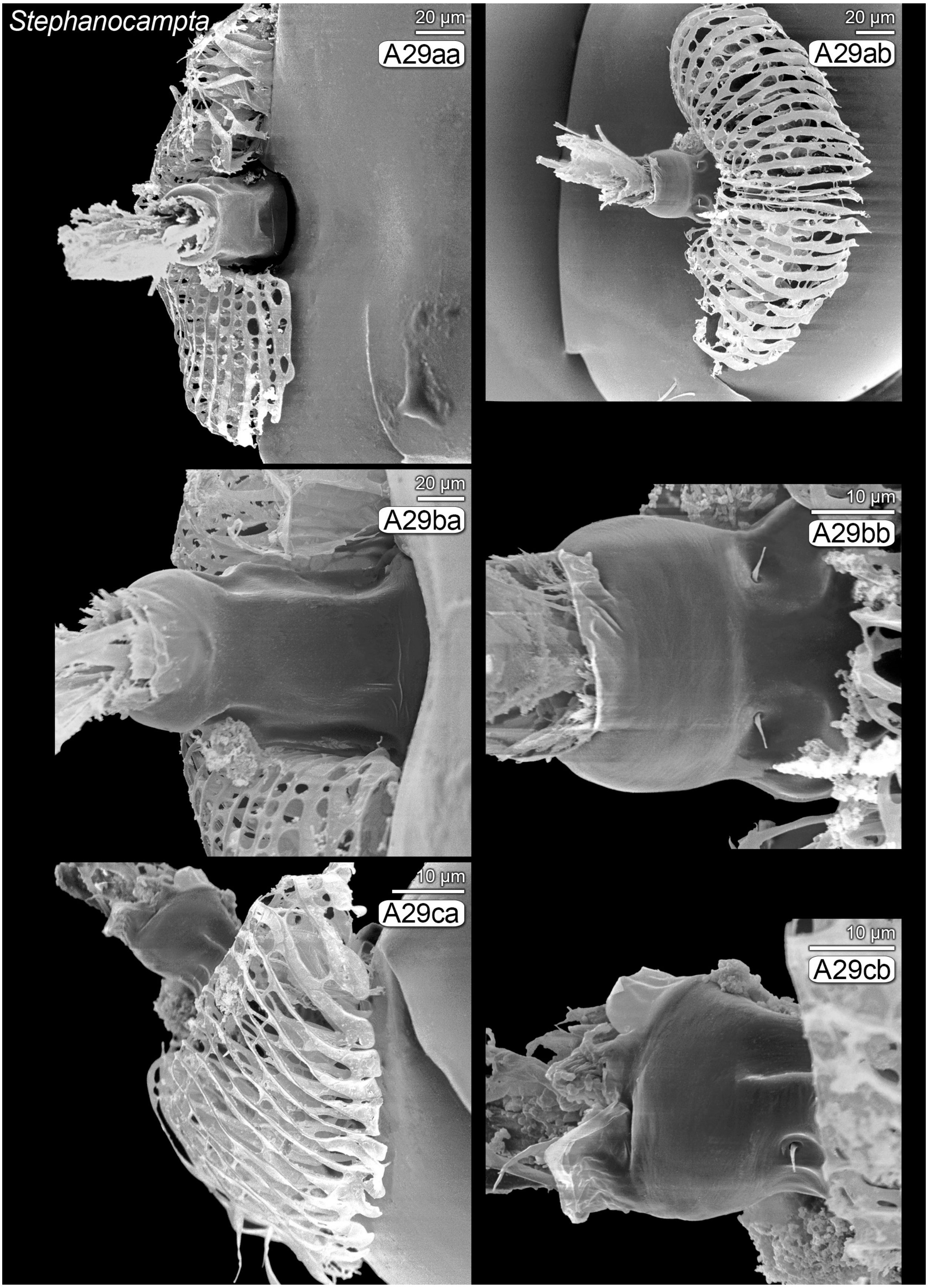
FIGURES A19–A22. Mymaridae petioles: a, dorsal; b, ventral; c, lateral.



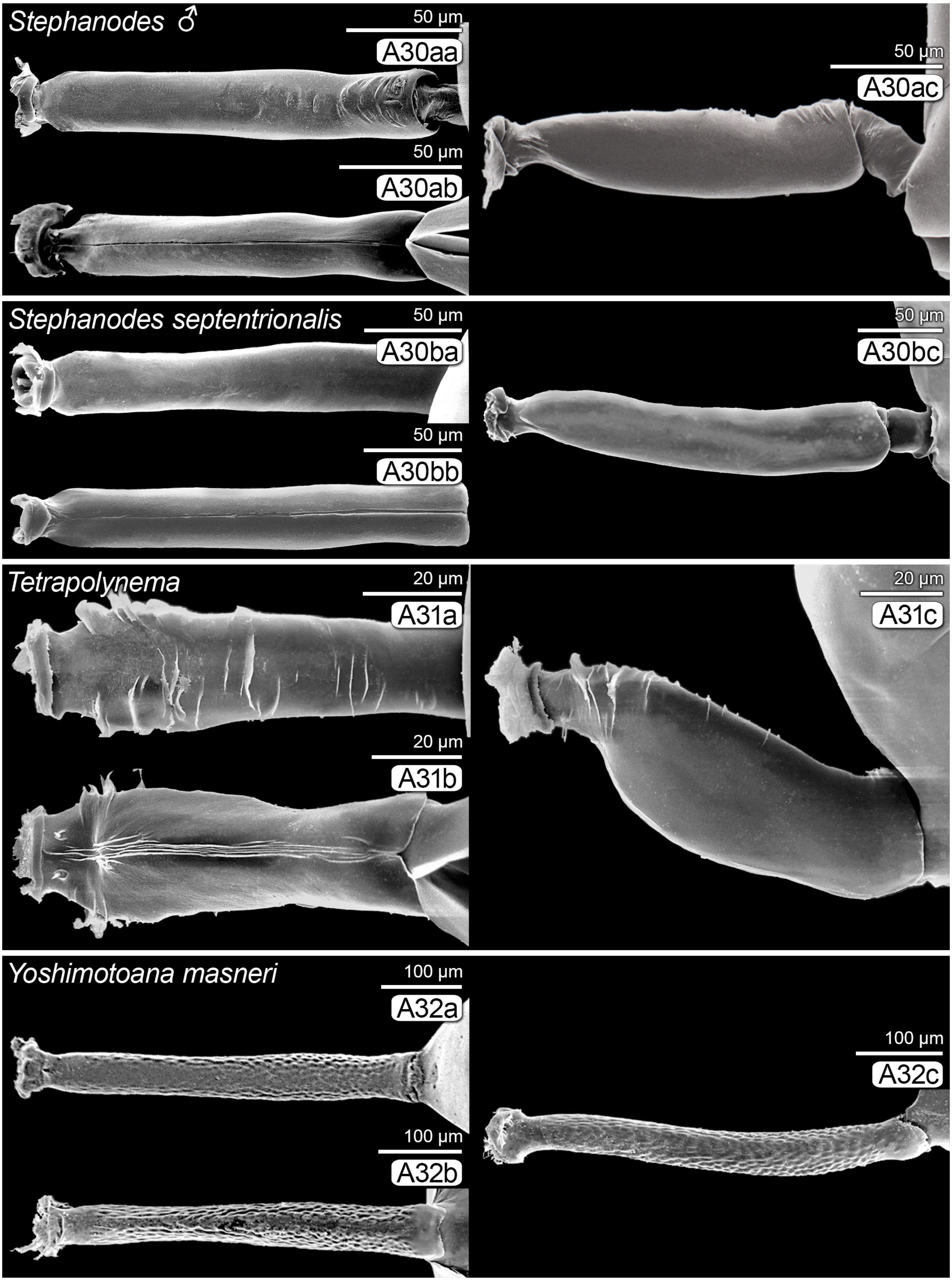
FIGURES A23–A26. Mymaridae petioles: a, dorsal; b, ventral; c, lateral.



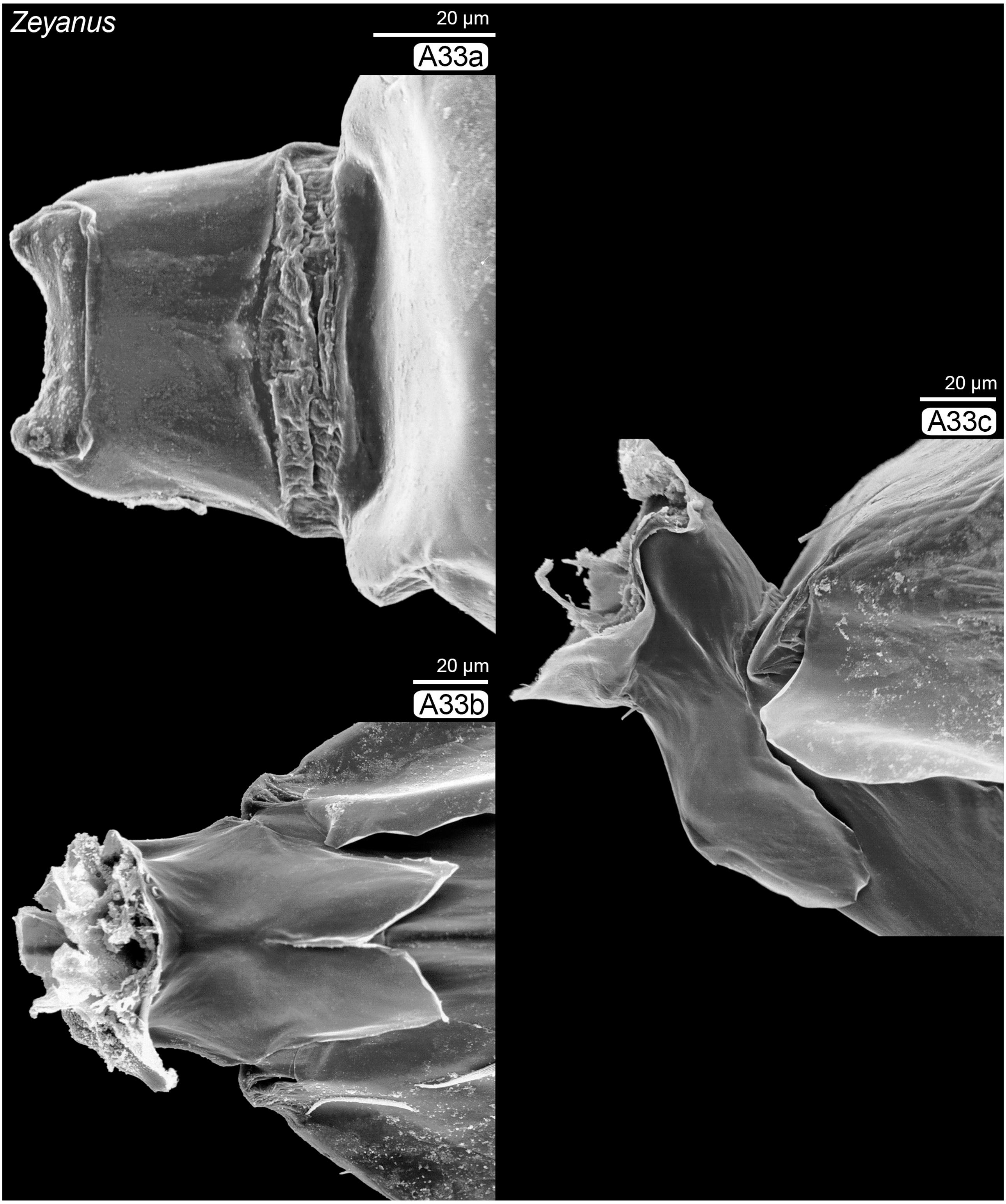
FIGURES A27, A28. Mymaridae petioles: a, dorsal; b, ventral; c, lateral.



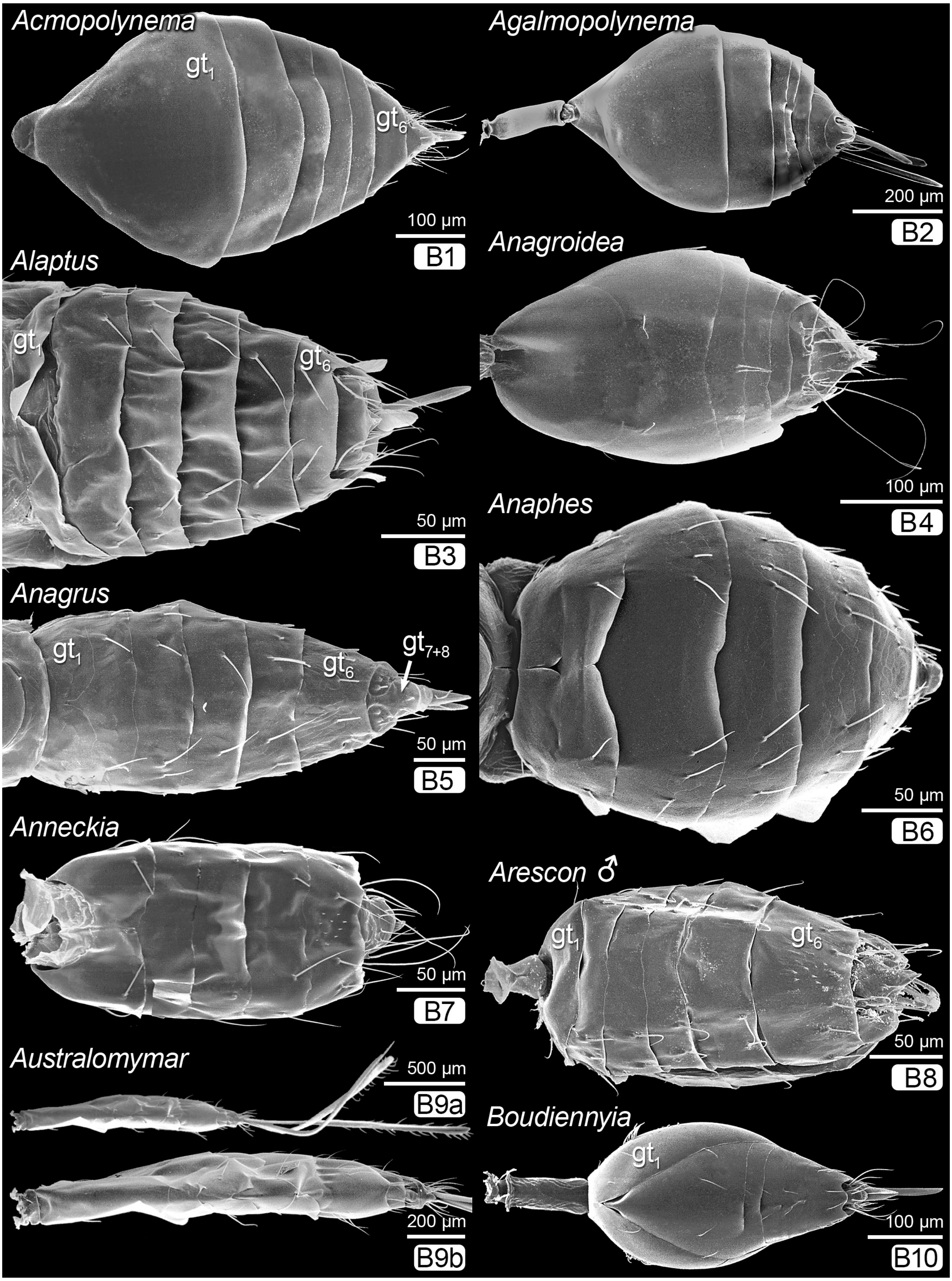
FIGURES A29. Mymaridae petioles: a, dorsal; b, ventral; c, lateral.



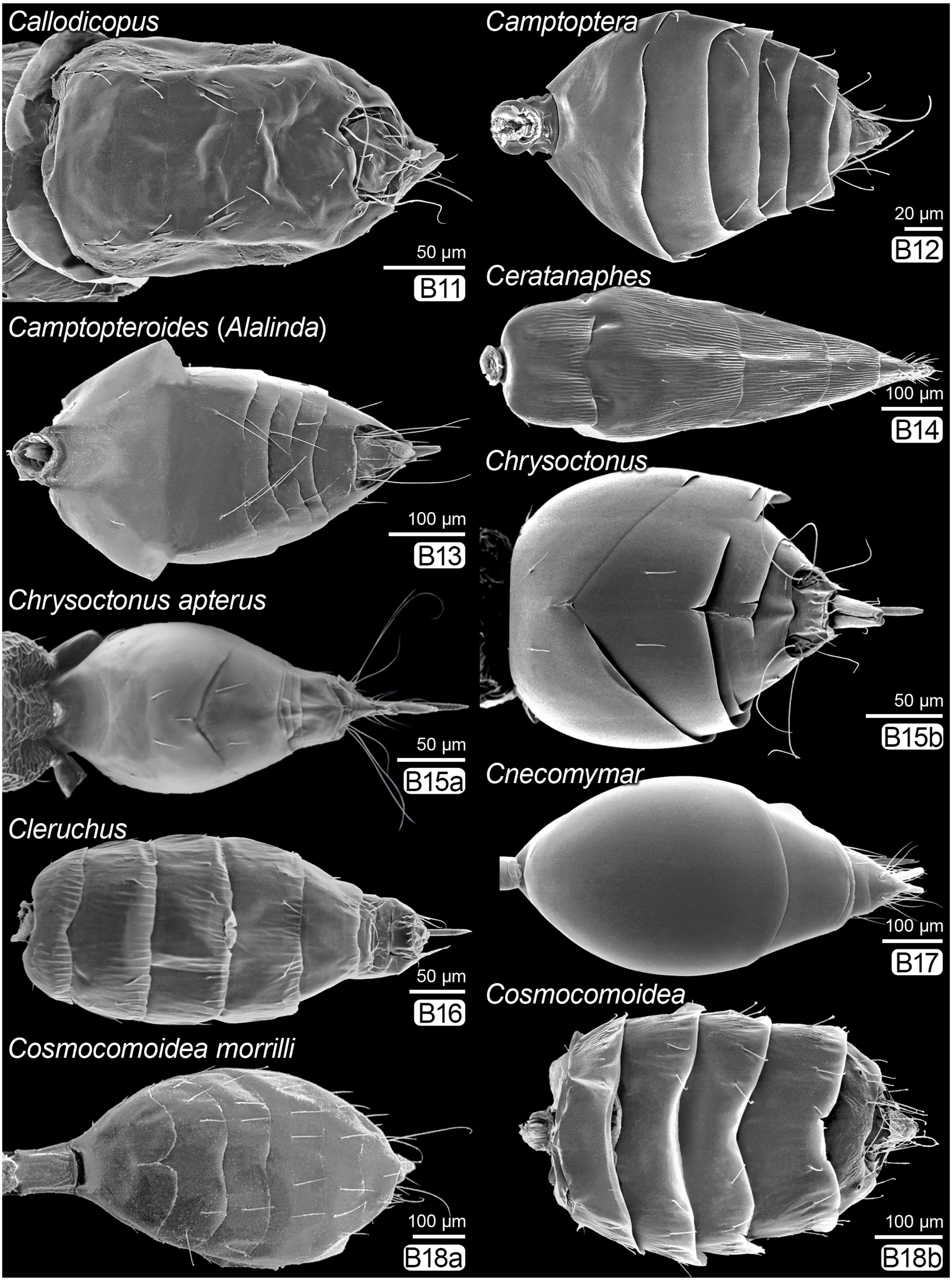
FIGURES A30–A32. Mymaridae petioles: a, dorsal; b, ventral; c, lateral.



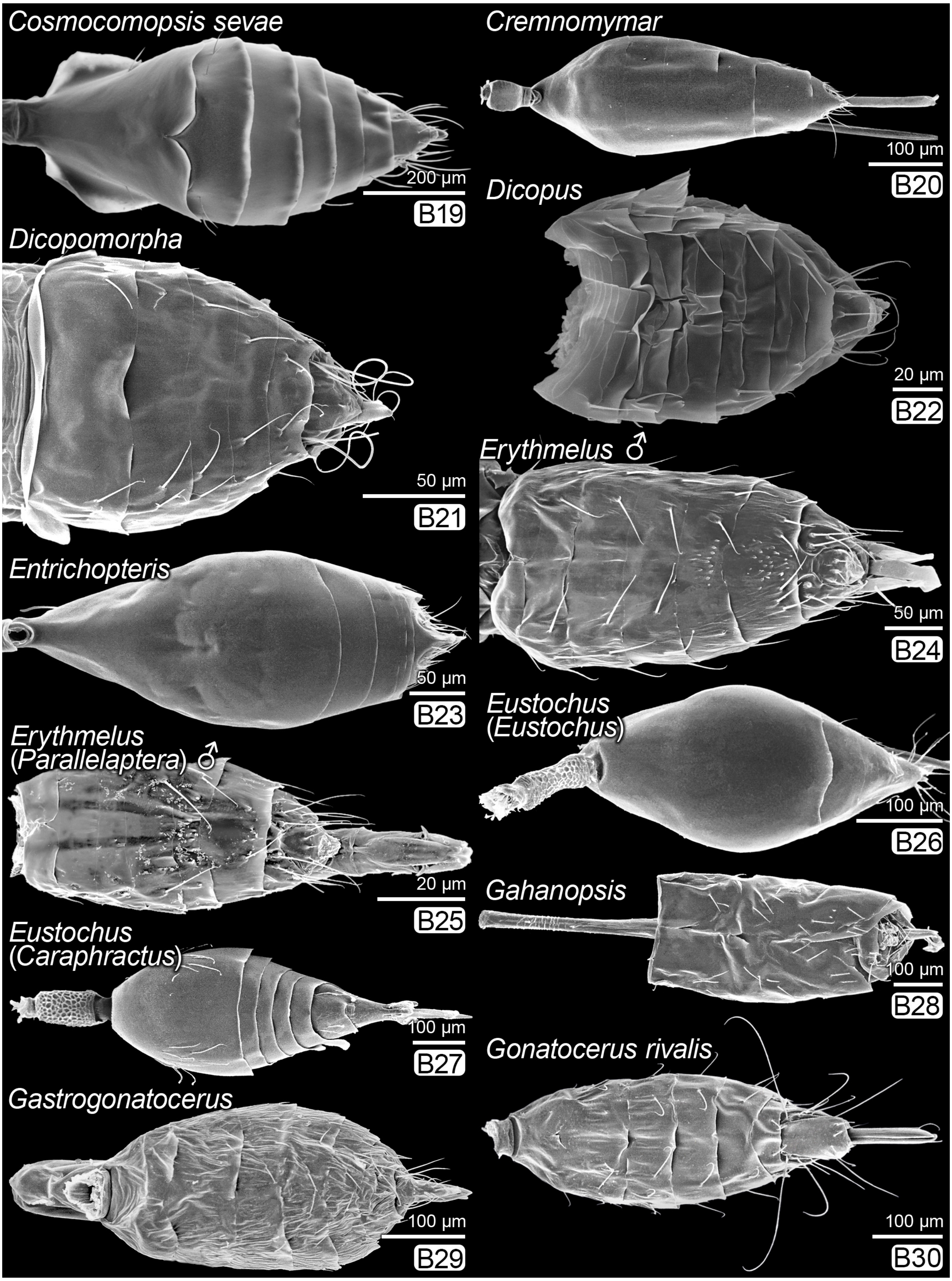
FIGURES A33. Mymaridae petioles: a, dorsal; b, ventral; c, lateral.



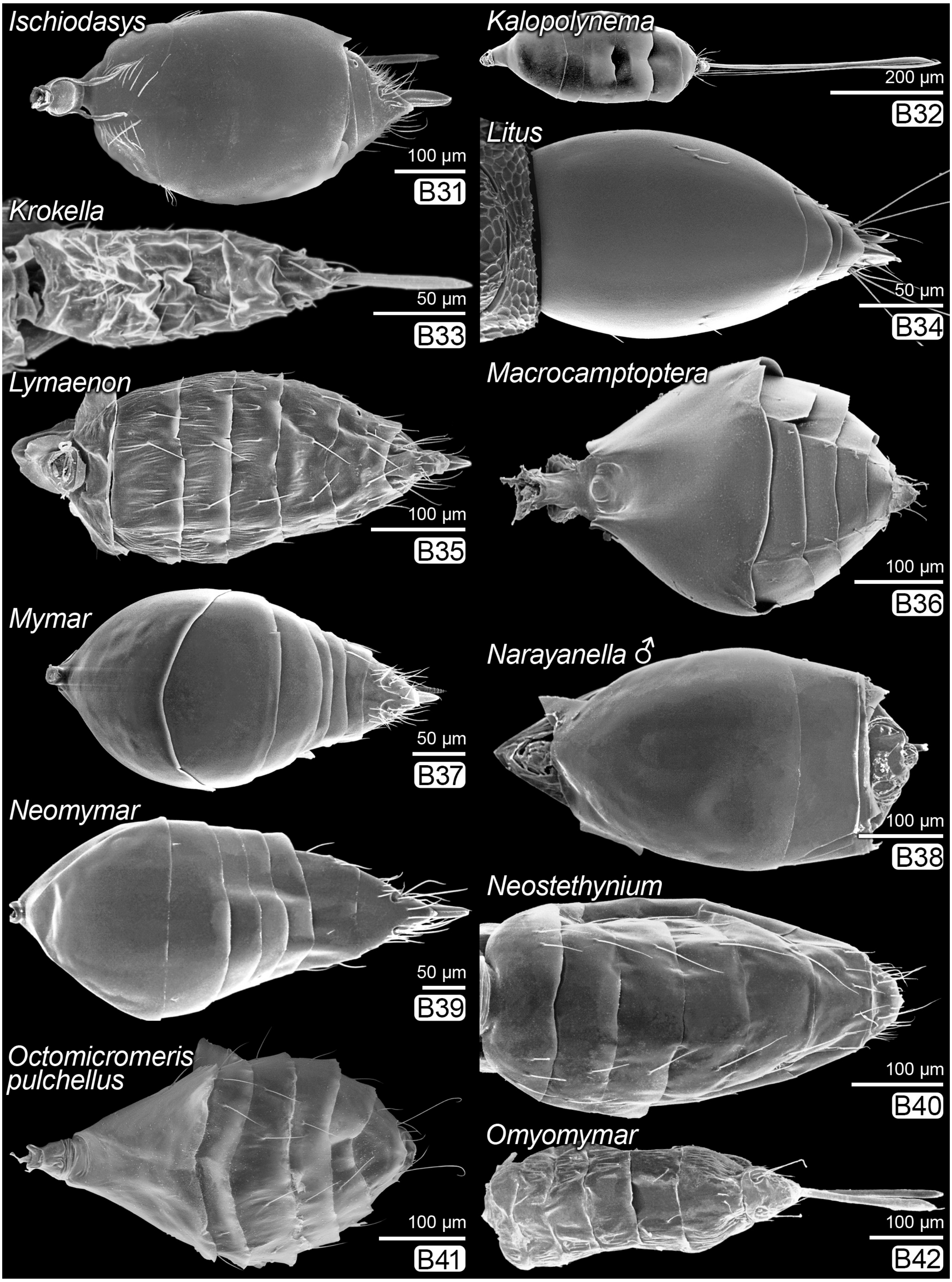
FIGURES B1–B10. Mymaridae metasomas, dorsal (gt = gastral tergum).



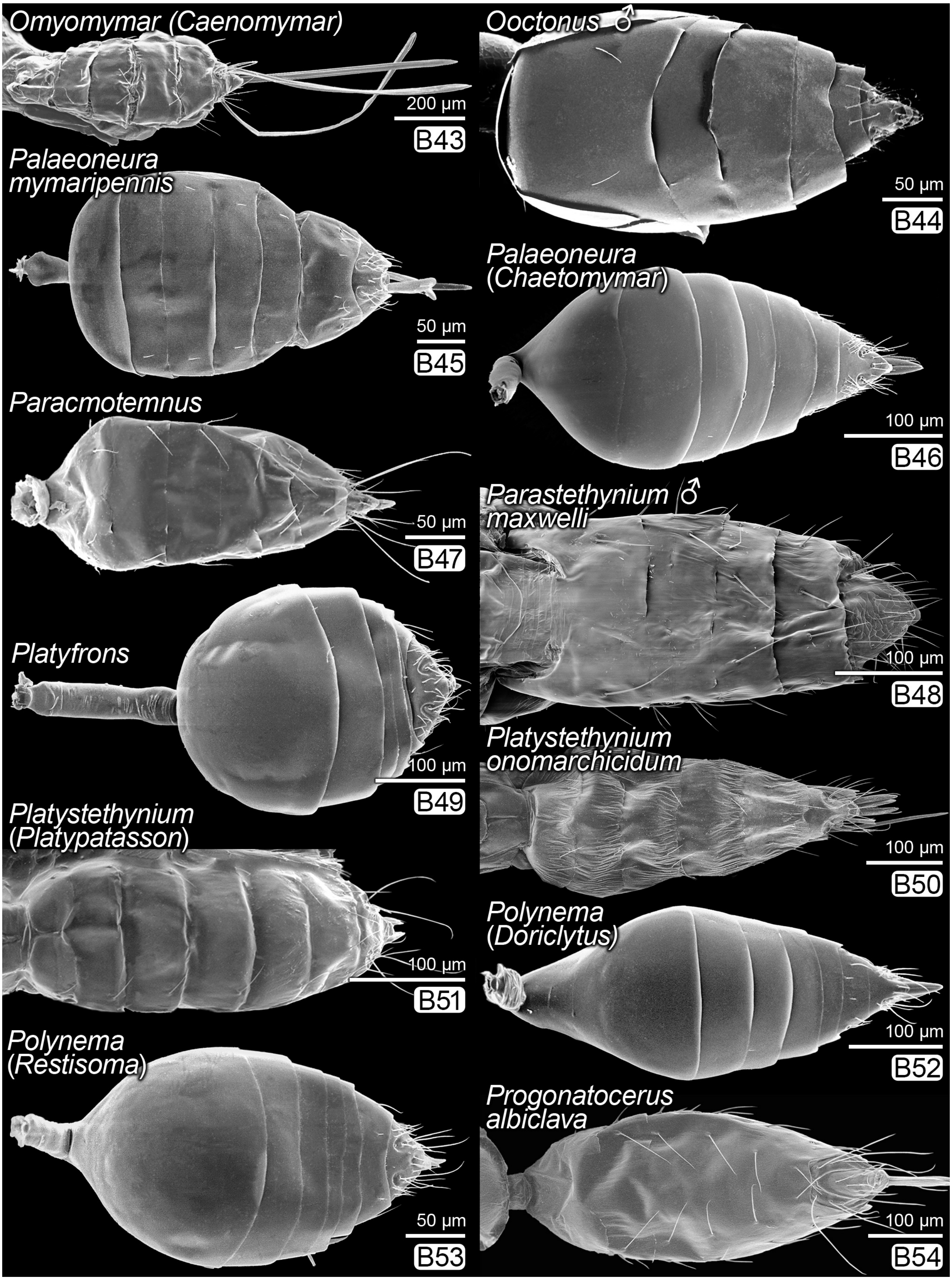
FIGURES B11–B18. Mymaridae metasomas, dorsal.



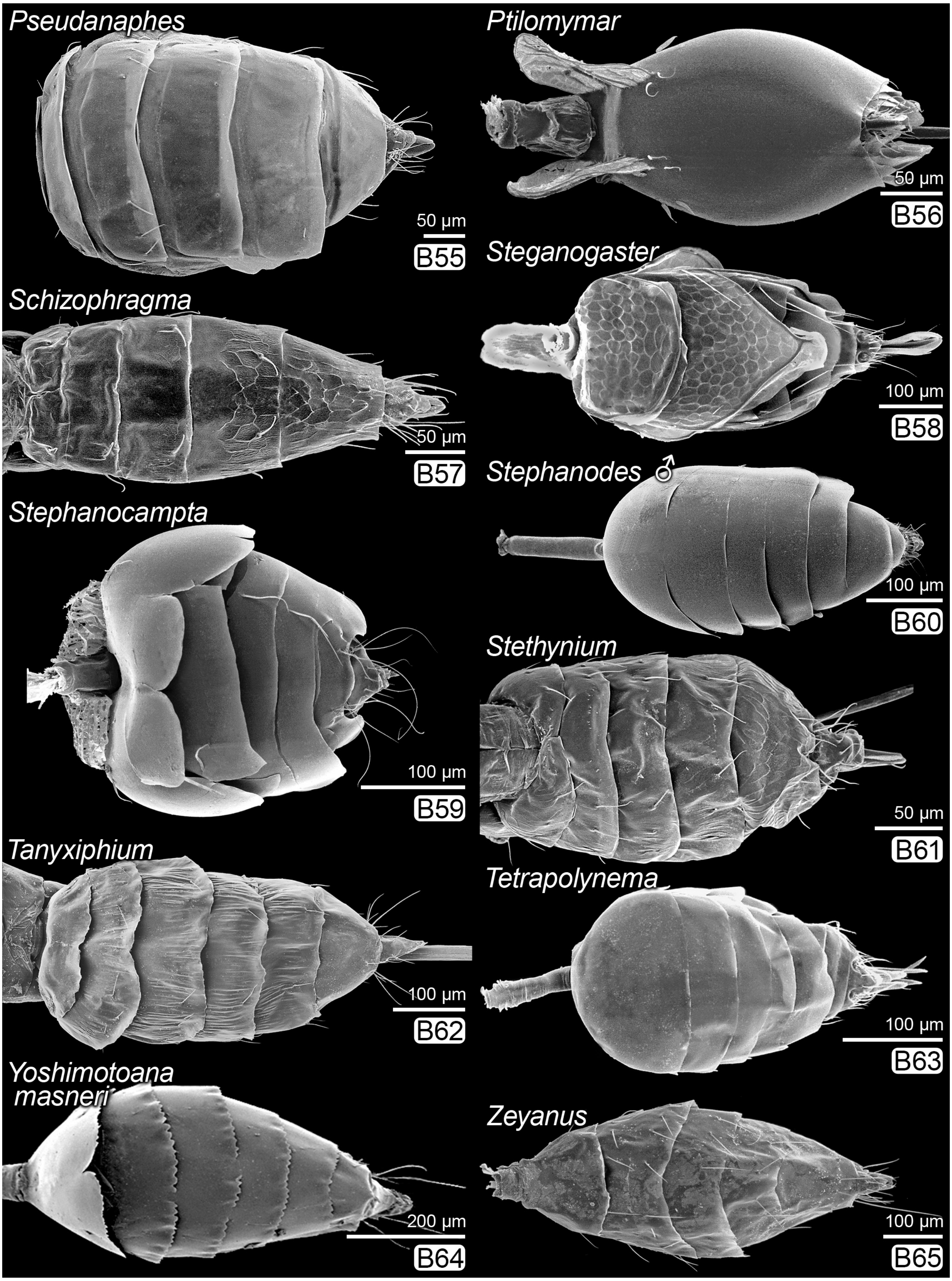
FIGURES B19–B30. Mymaridae metasomas, dorsal.



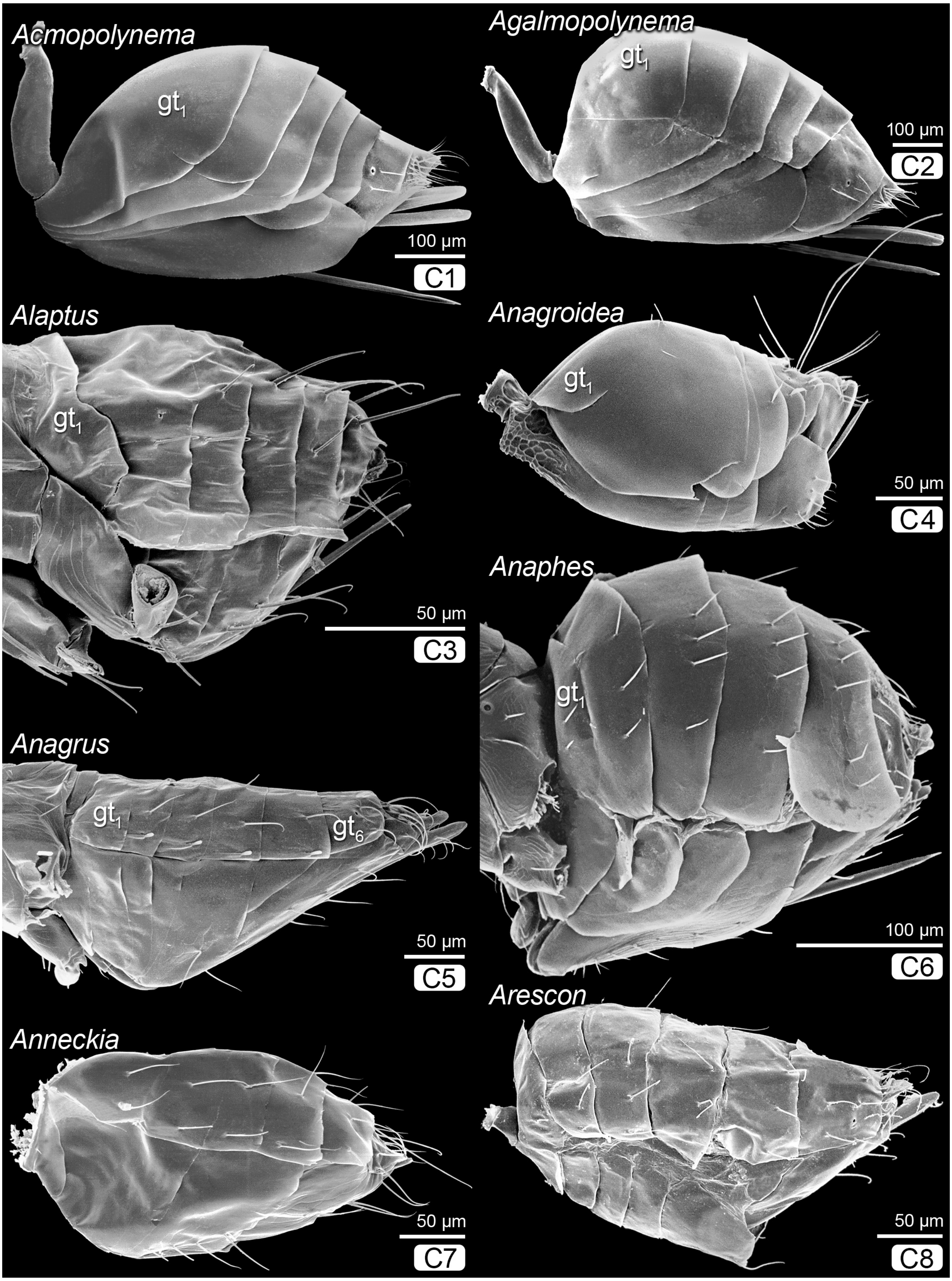
FIGURES B31–B42. Mymaridae metasomas, dorsal.



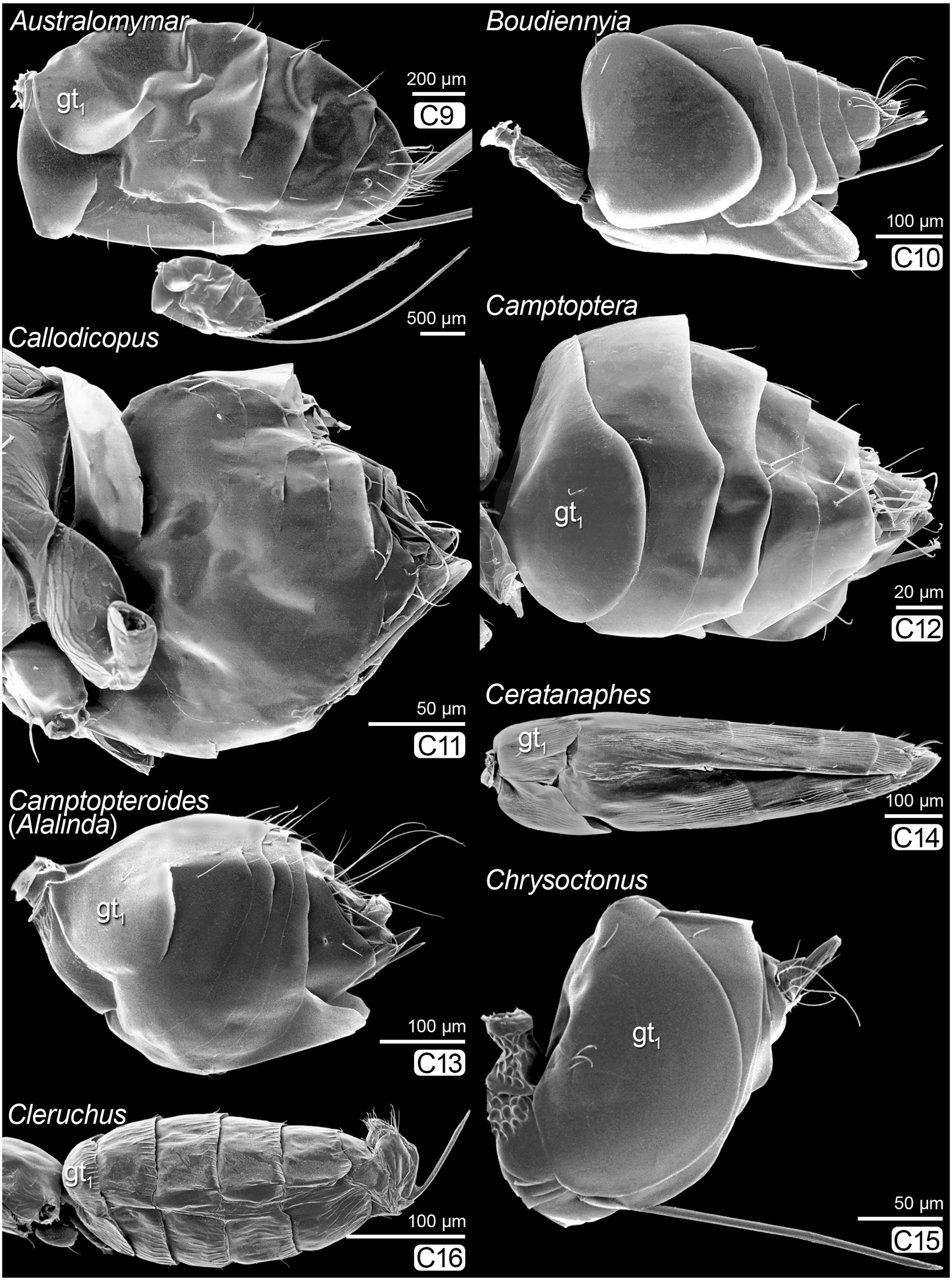
FIGURES B43–B54. Mymaridae metasomas, dorsal.



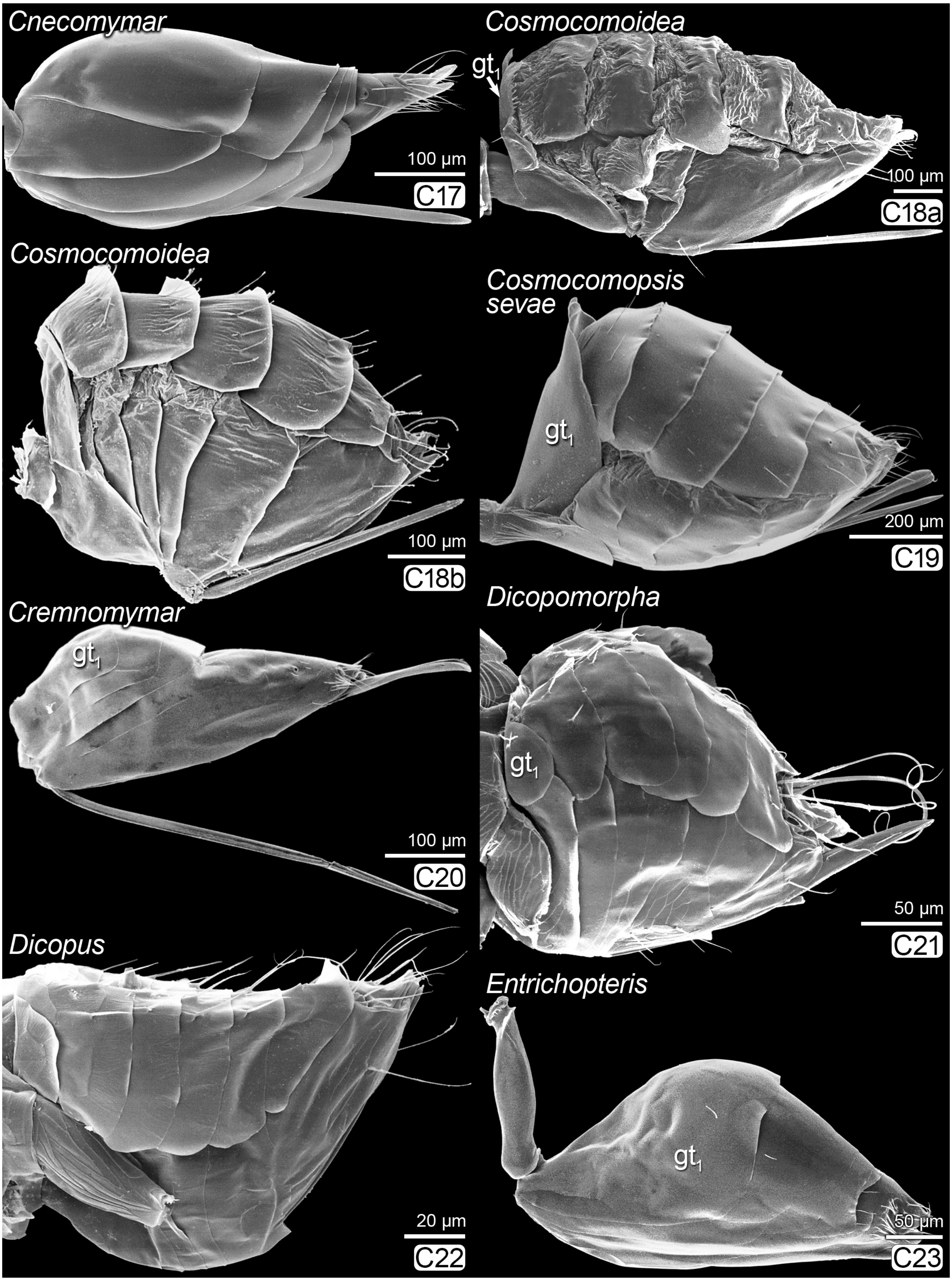
FIGURES B55–B65. Mymaridae metasomas, dorsal.



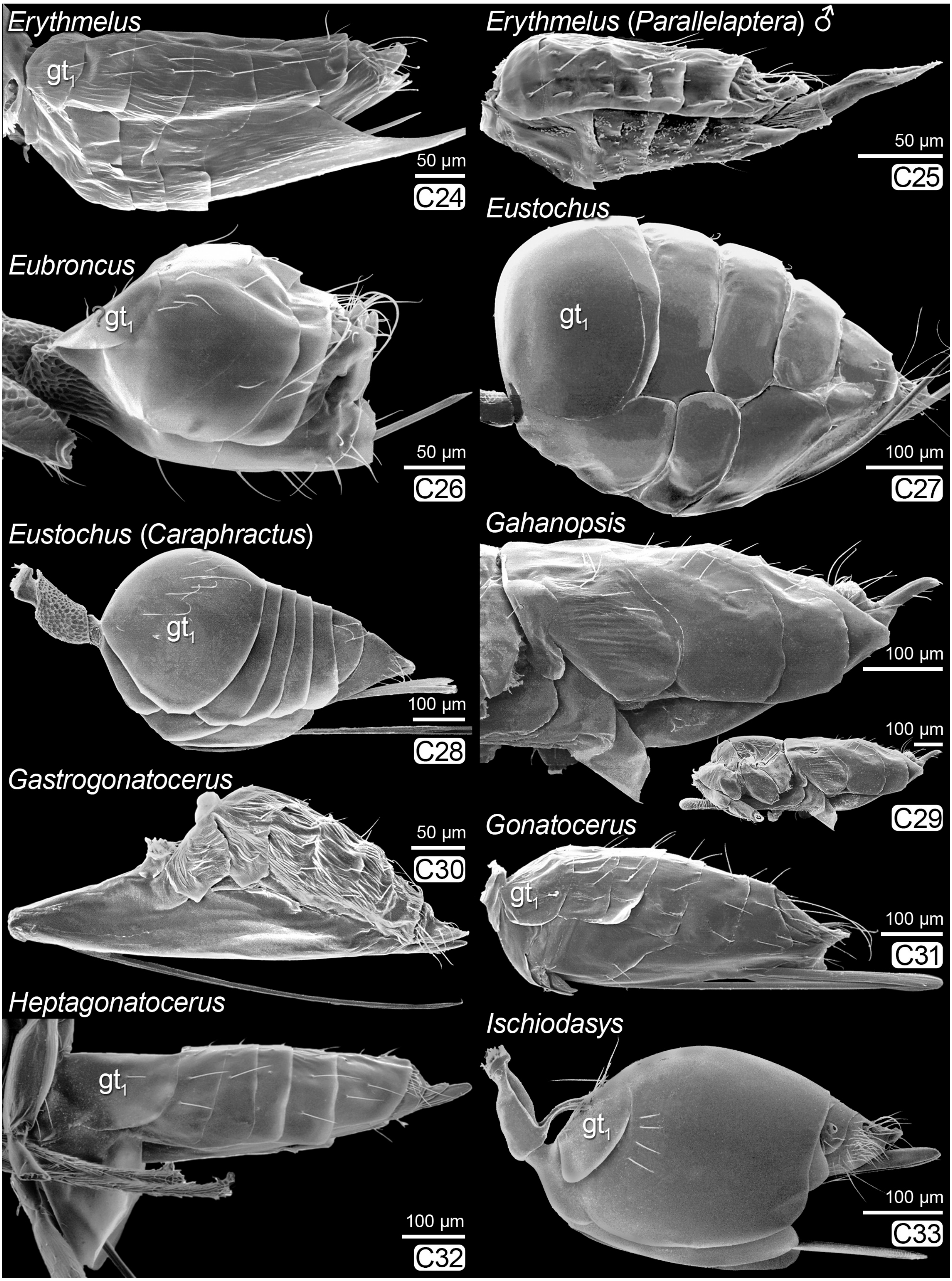
FIGURES C1–C8. Mymaridae metasomas, lateral (gt = gastral tergum).



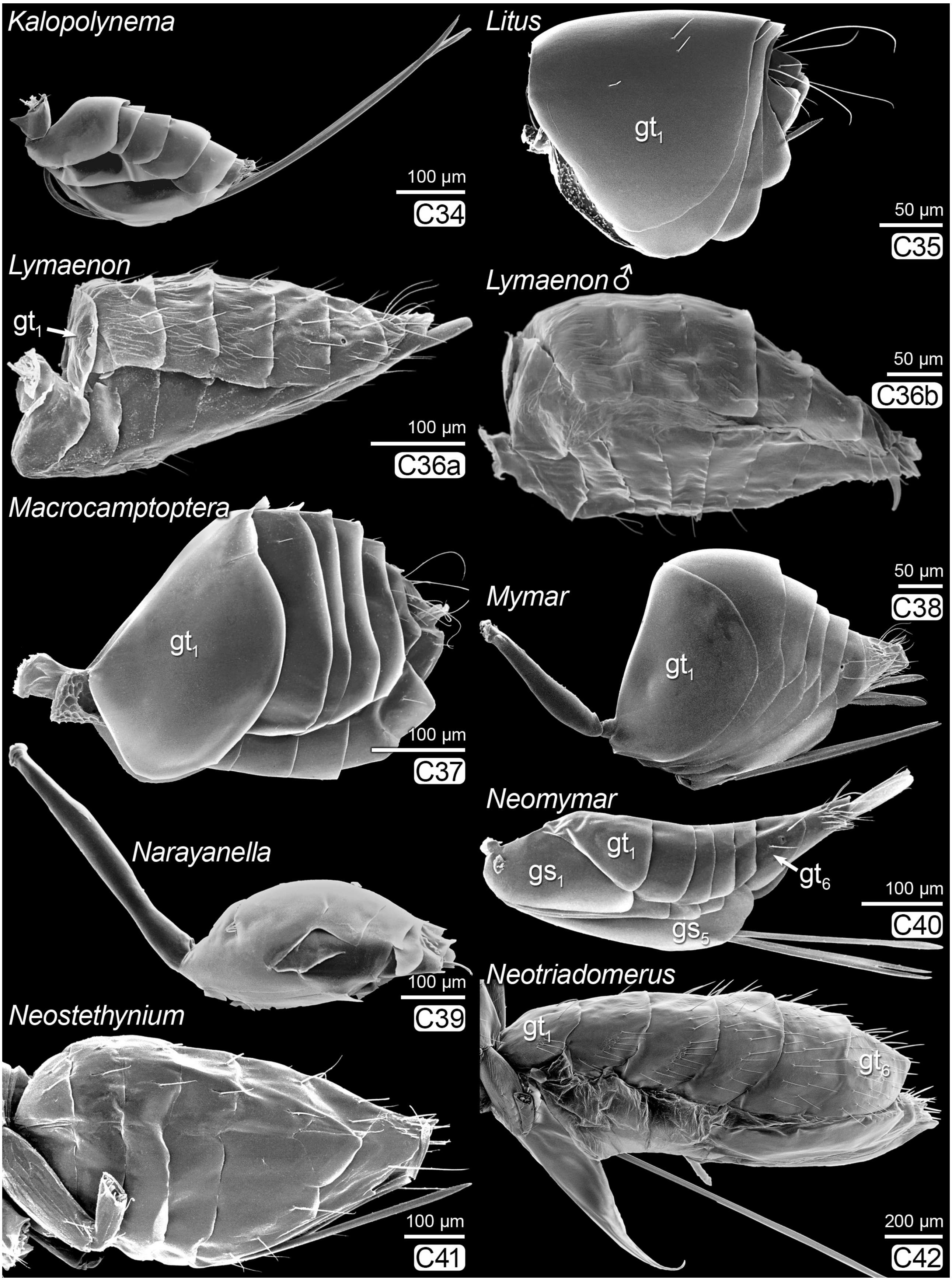
FIGURES C9–C16. Mymaridae metasomas, lateral (gt = gastral tergum).



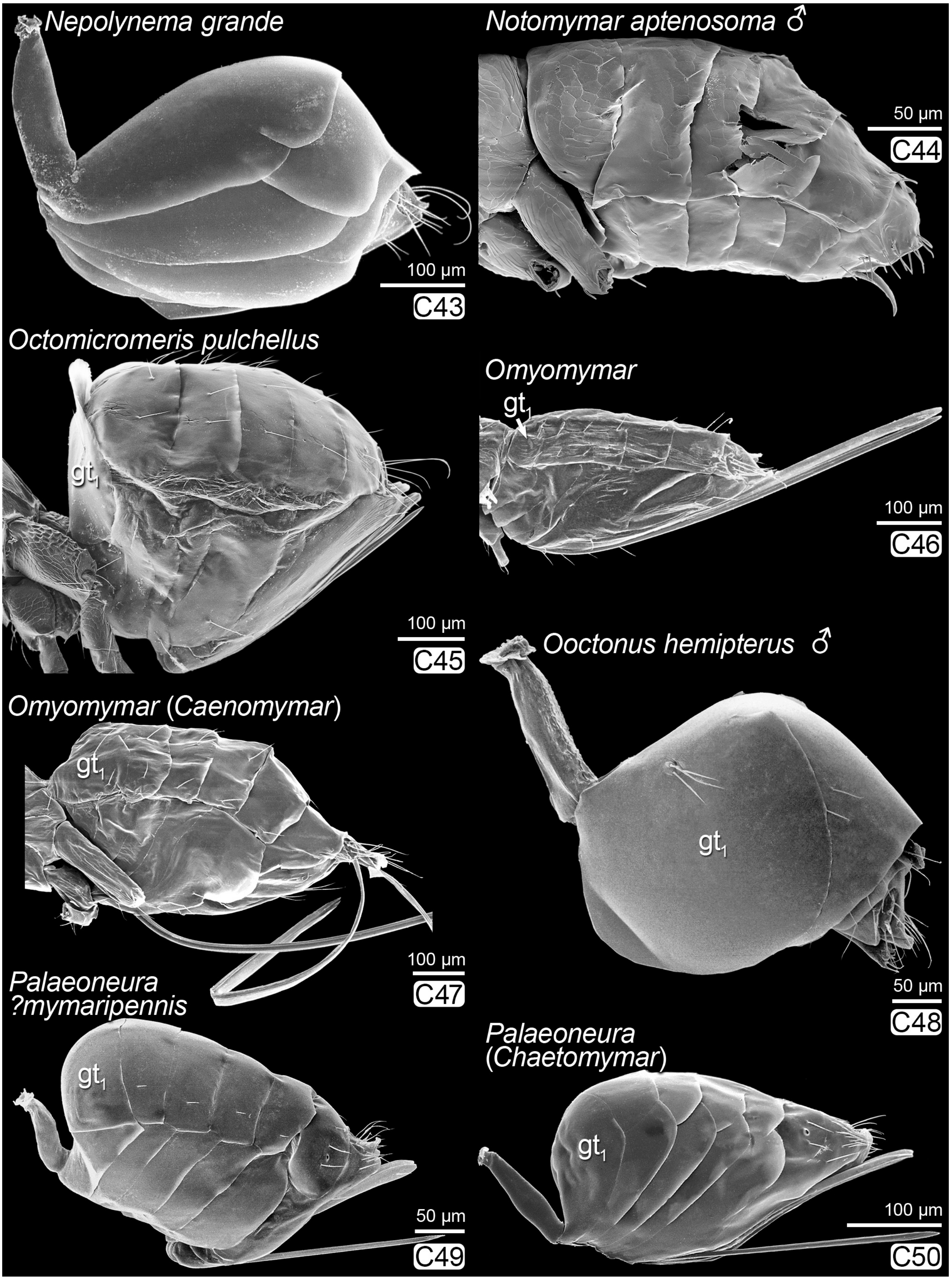
FIGURES C17–C23. Mymaridae metasomas, lateral (gt = gastral tergum).



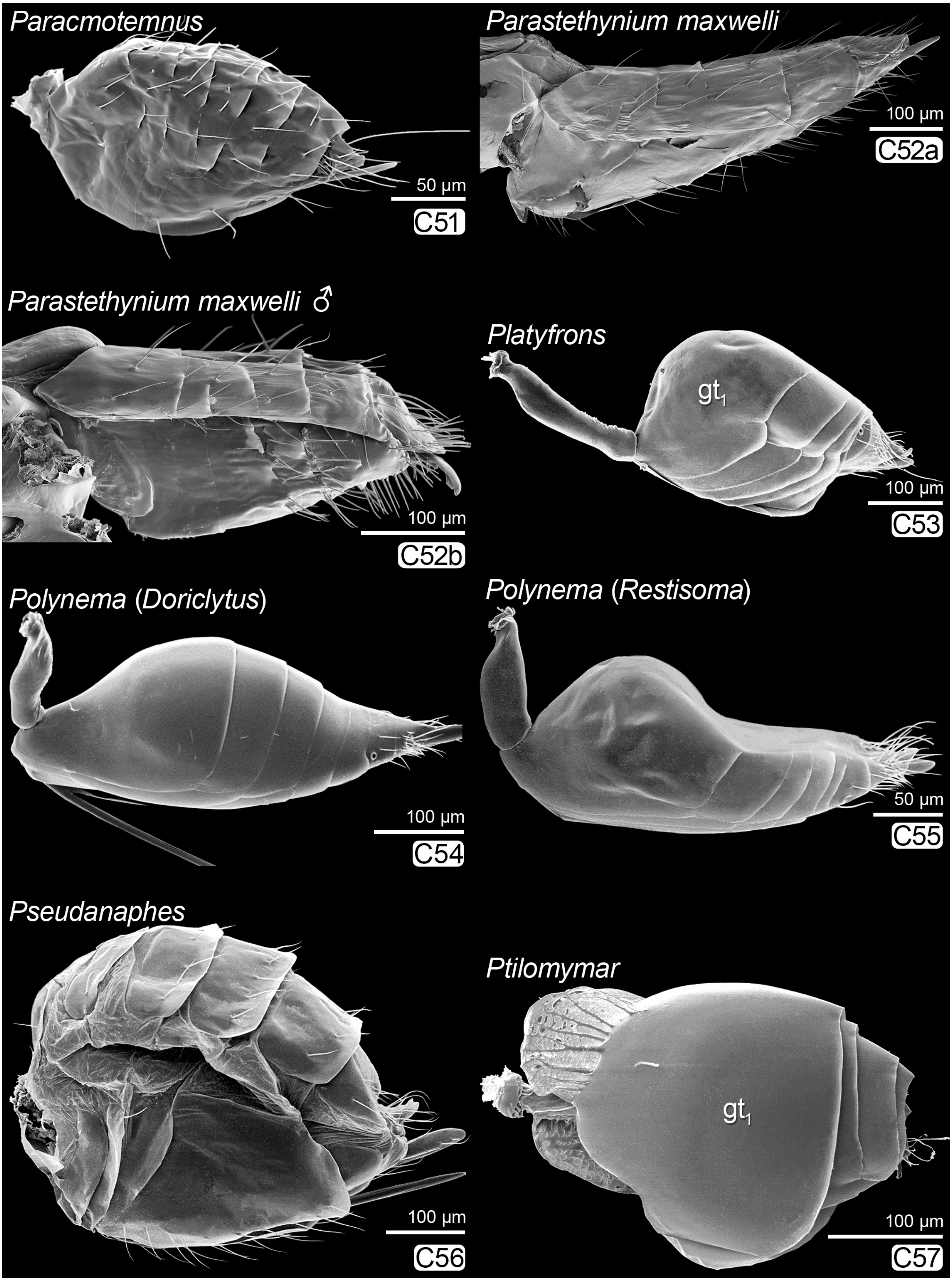
FIGURES C24–C33. Mymaridae metasomas, lateral (gt = gastral tergum).



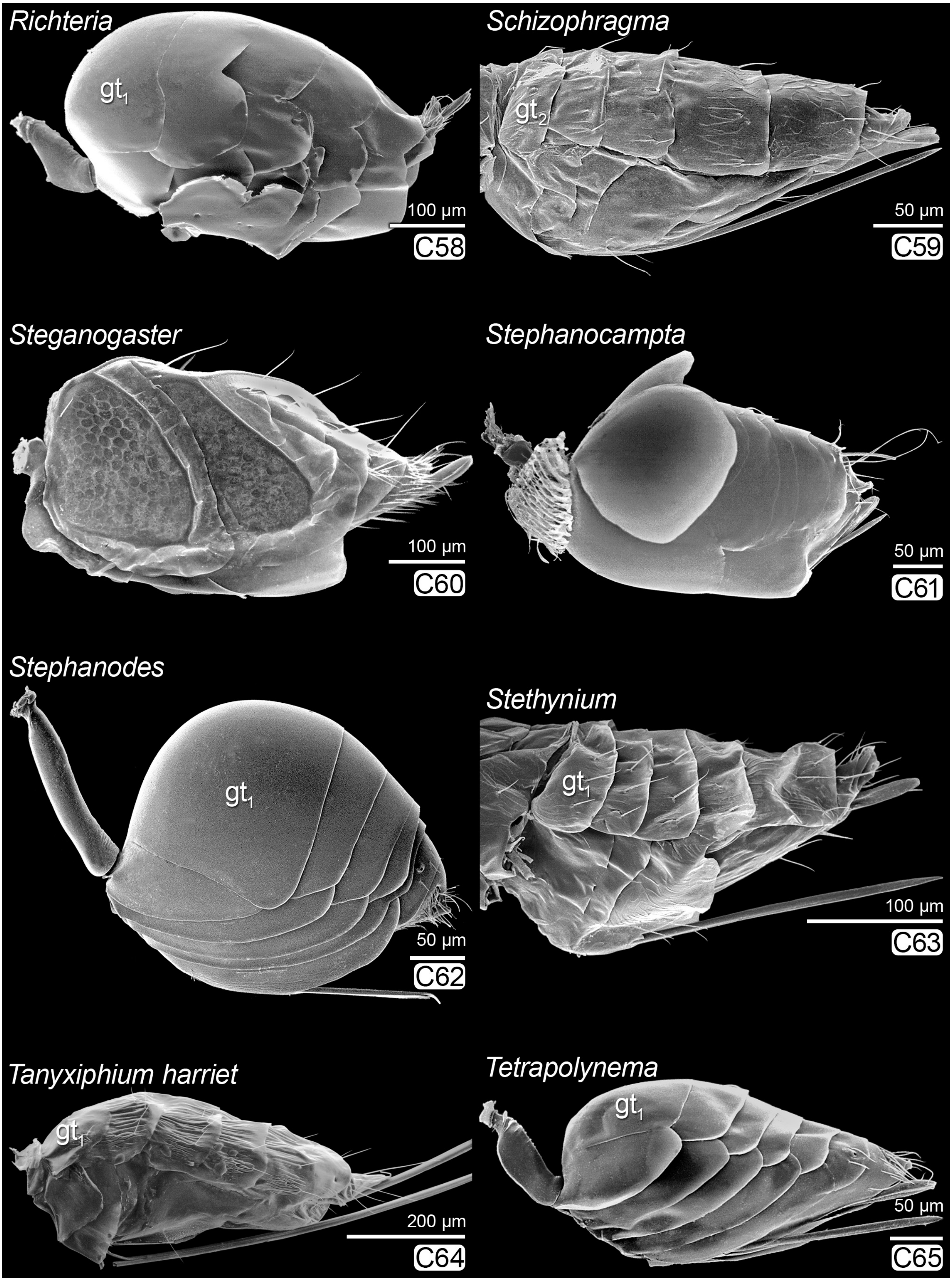
FIGURES C34–C42. Mymaridae metasomas, lateral (gt = gastral tergum, gs = gastral sternum).



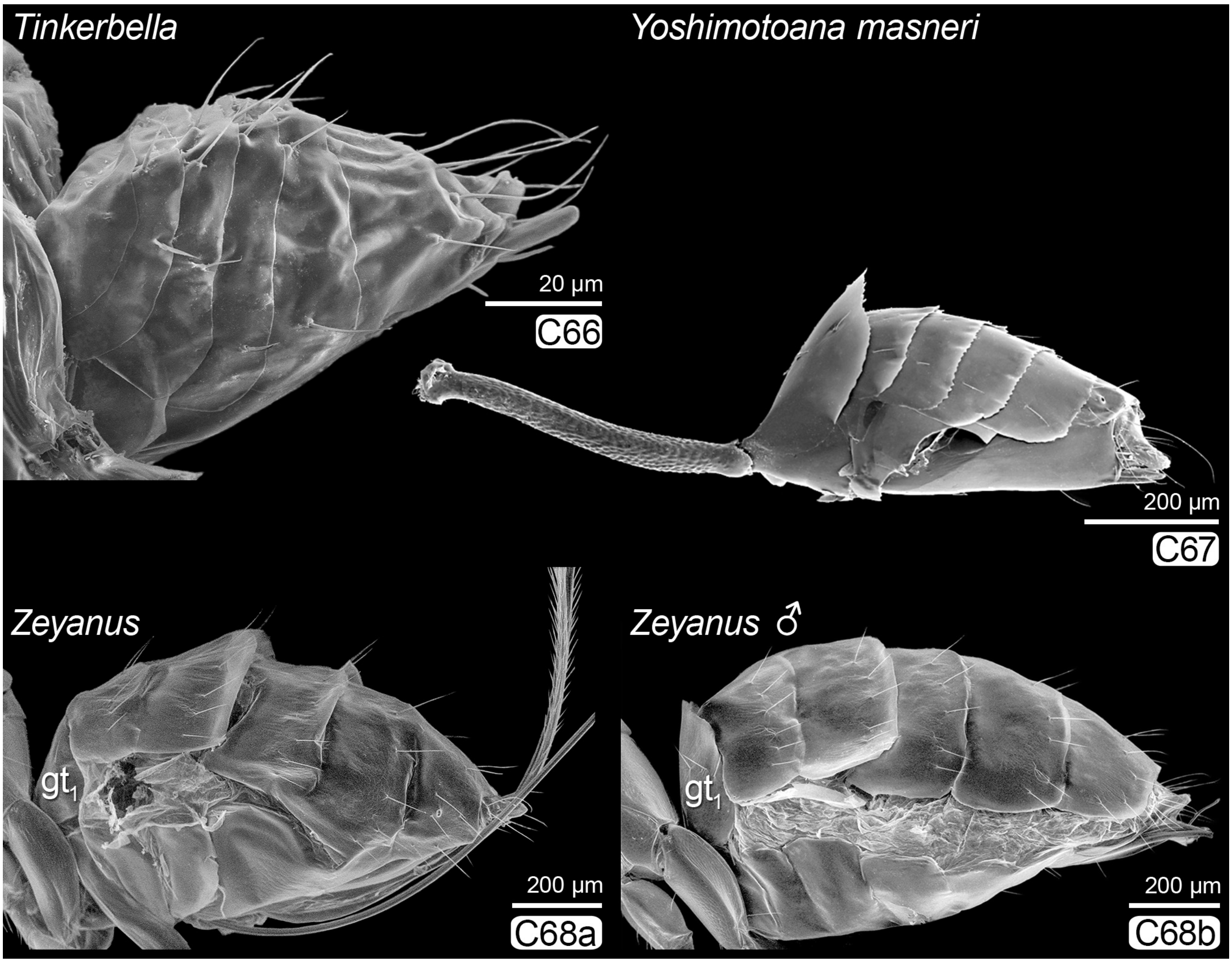
FIGURES C43–C50. Mymaridae metasomas, lateral (gt = gastral tergum).



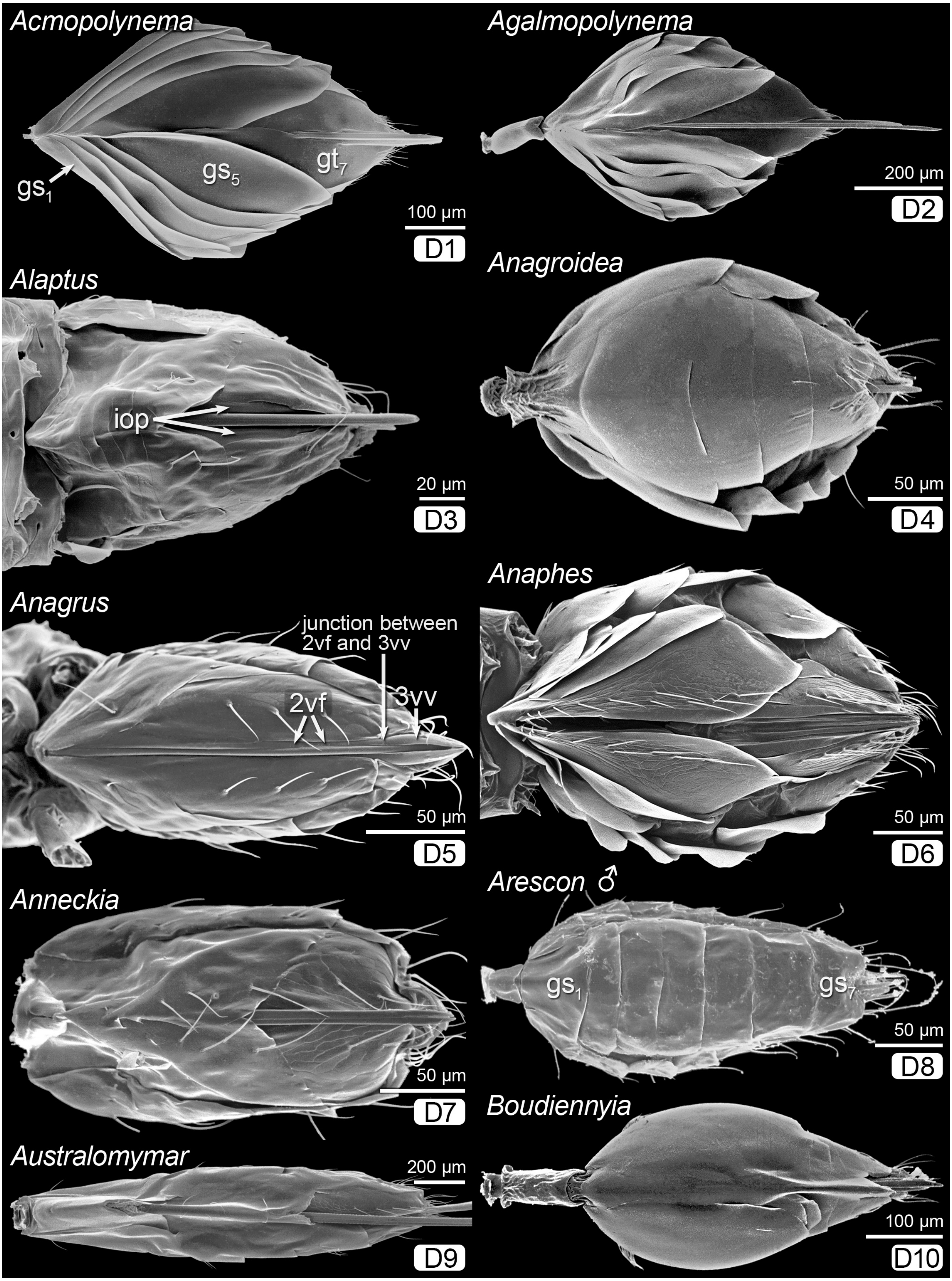
FIGURES C51–C57. Mymaridae metasomas, lateral (gt = gastral tergum).



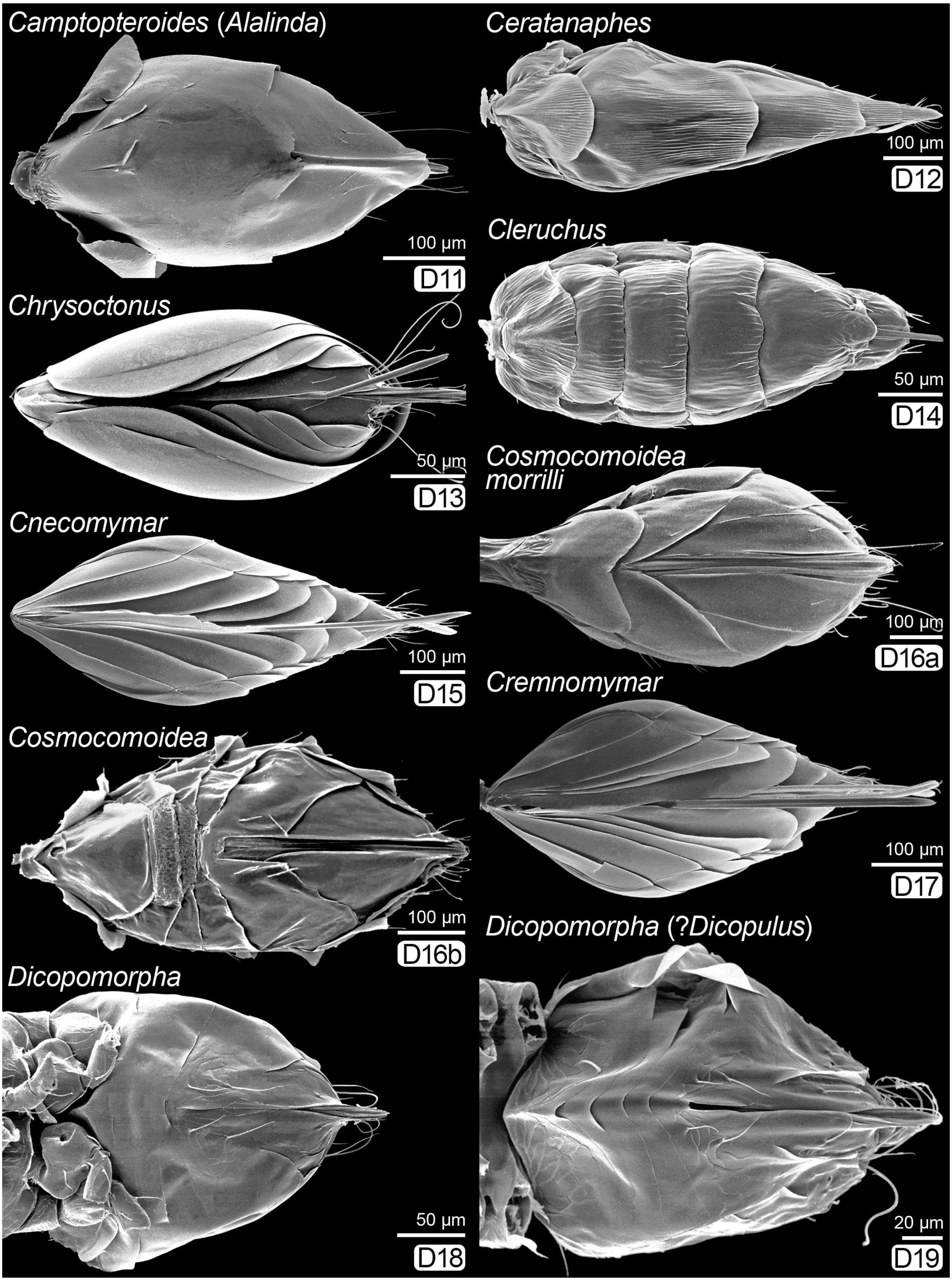
FIGURES C58–C65. Mymaridae metasomas, lateral (gt = gastral tergum).



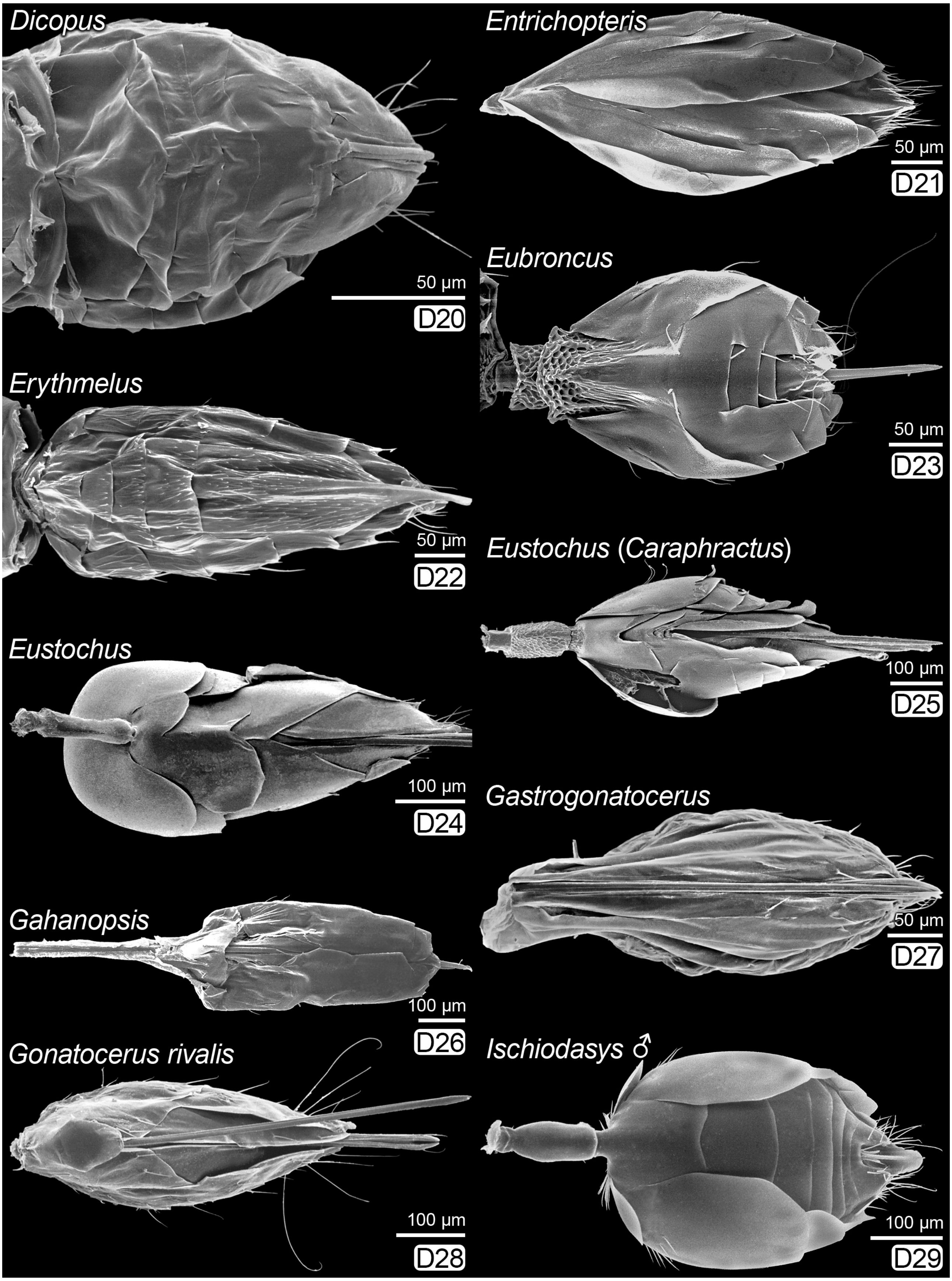
FIGURES C66–C68. Mymaridae metasomas, lateral (gt = gastral tergum).



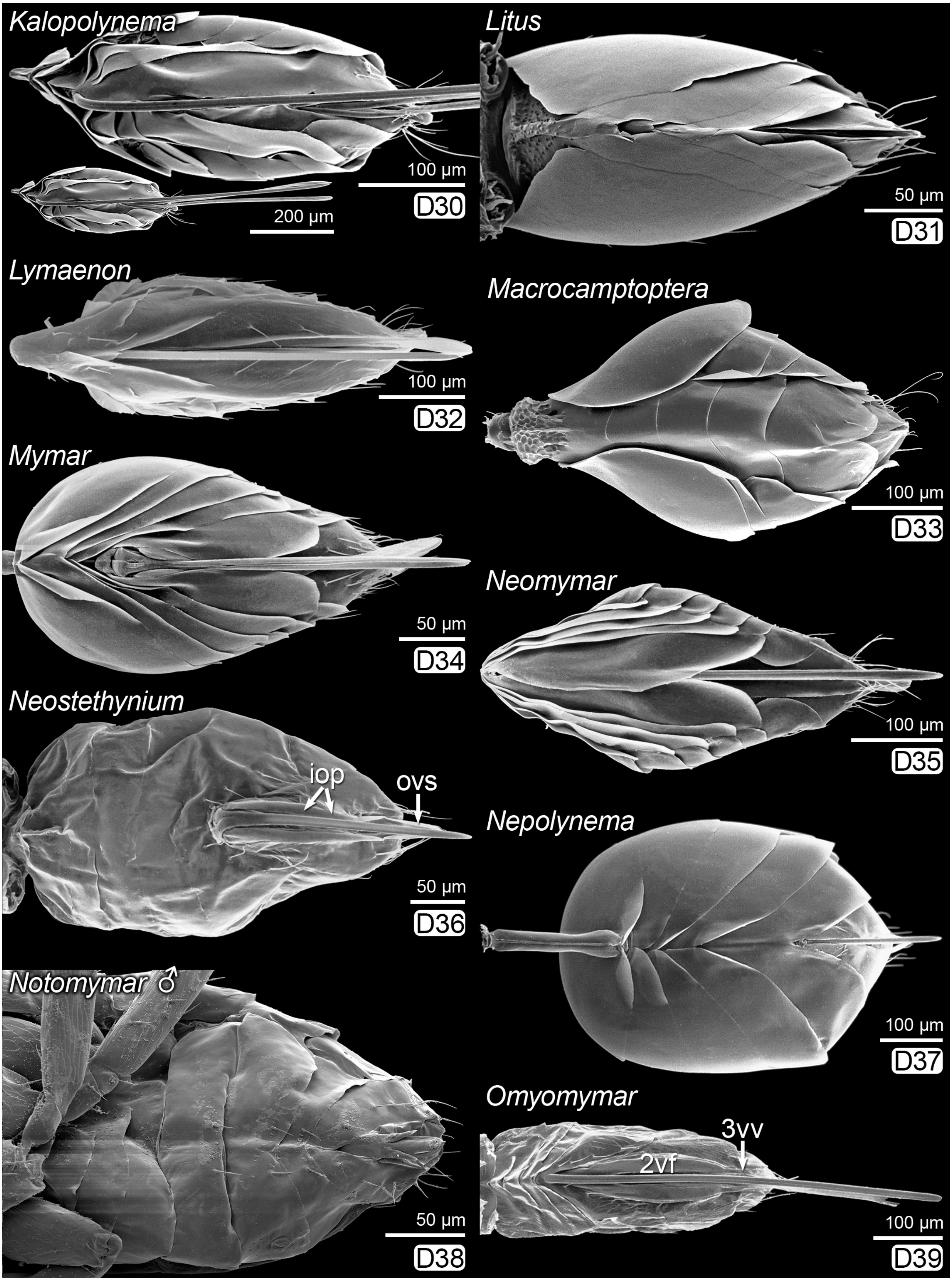
FIGURES D1–D10. Mymaridae metasomas, ventral (gt = gastral tergum, gs = gastral sternum, iop = inner plate of ovipositor, vf = valvifer; vv = valvula).



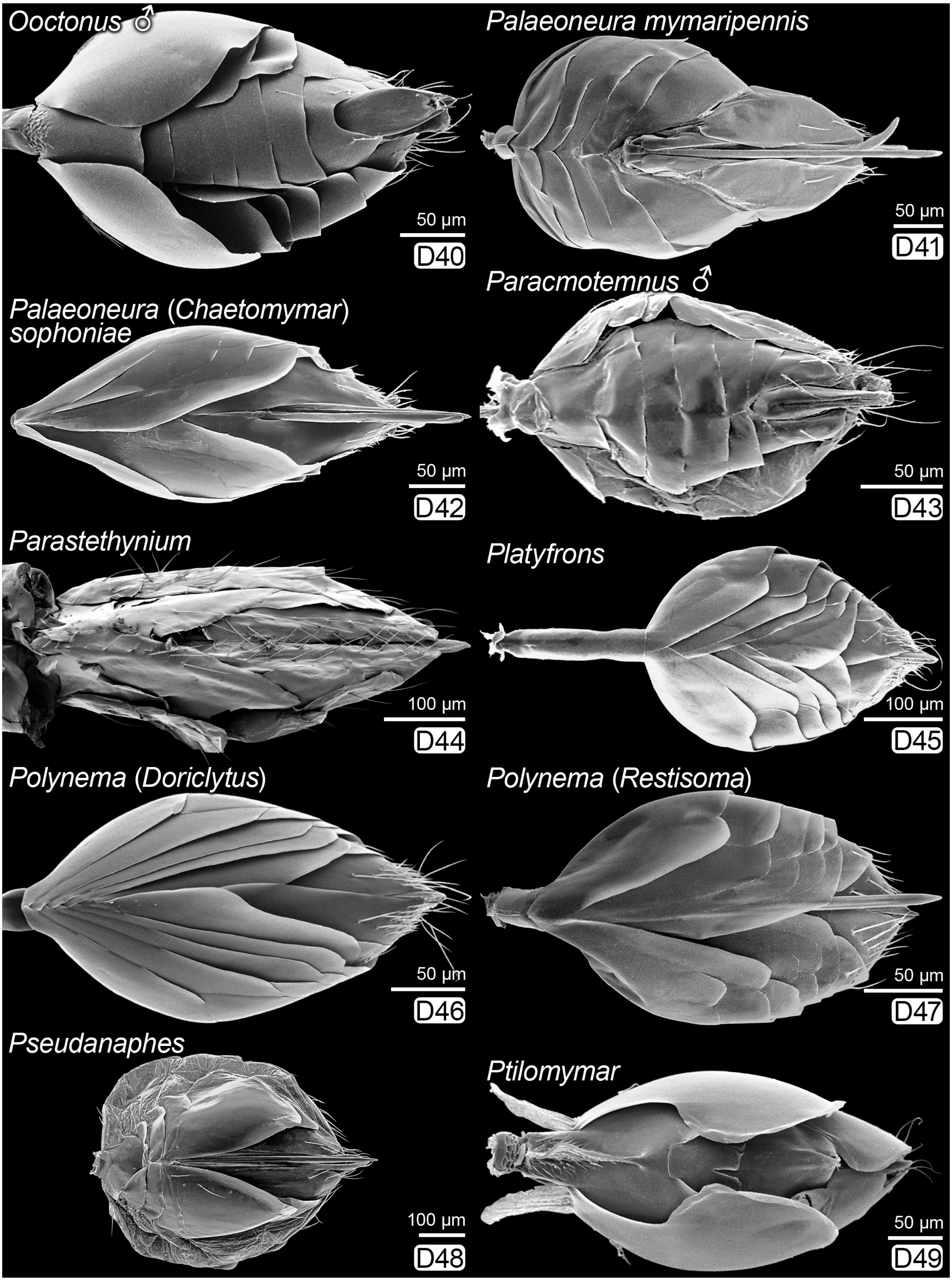
FIGURES D11–D19. Mymaridae metasomas, ventral.



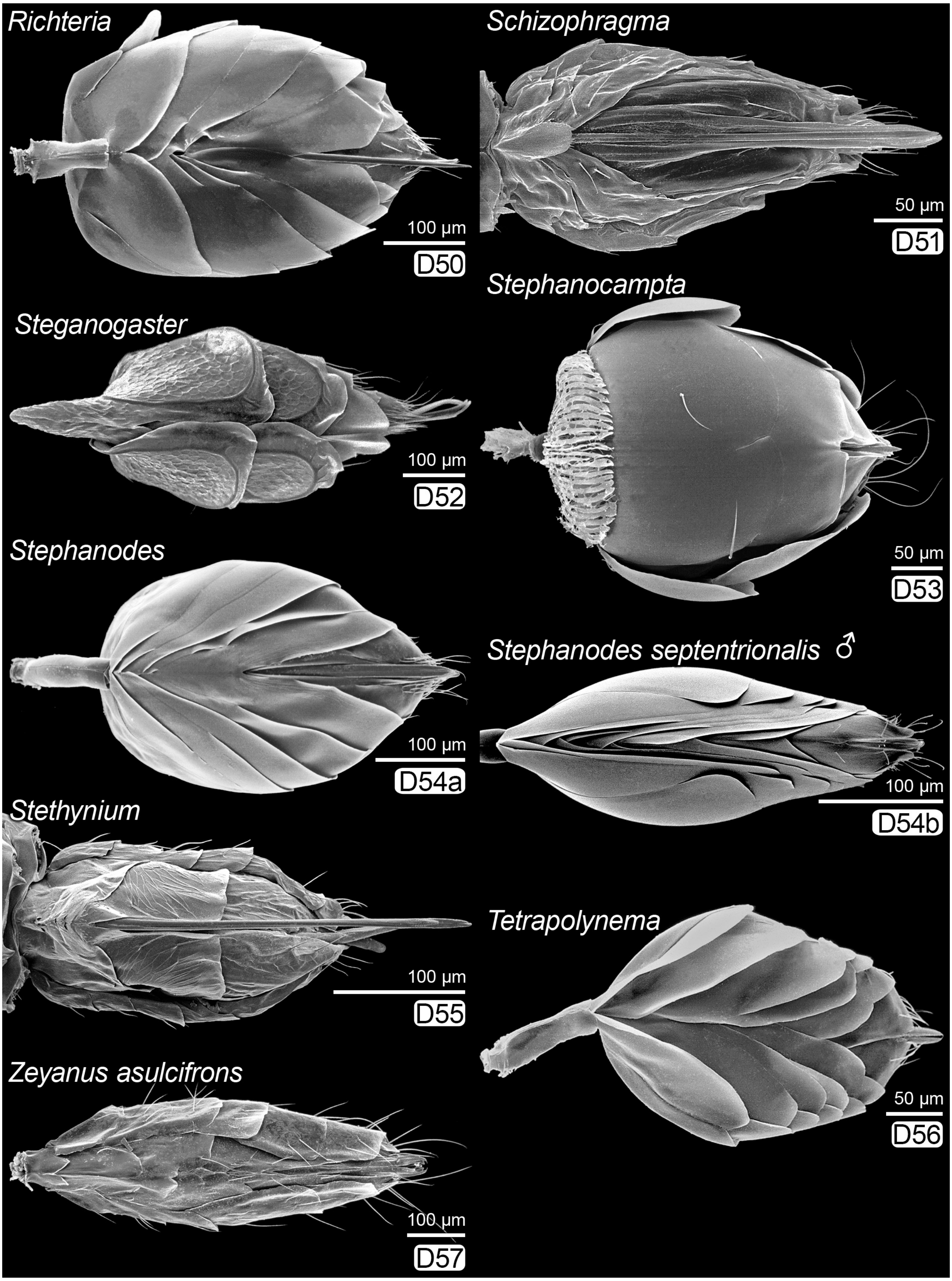
FIGURES D20–D29. Mymaridae metasomas, ventral.



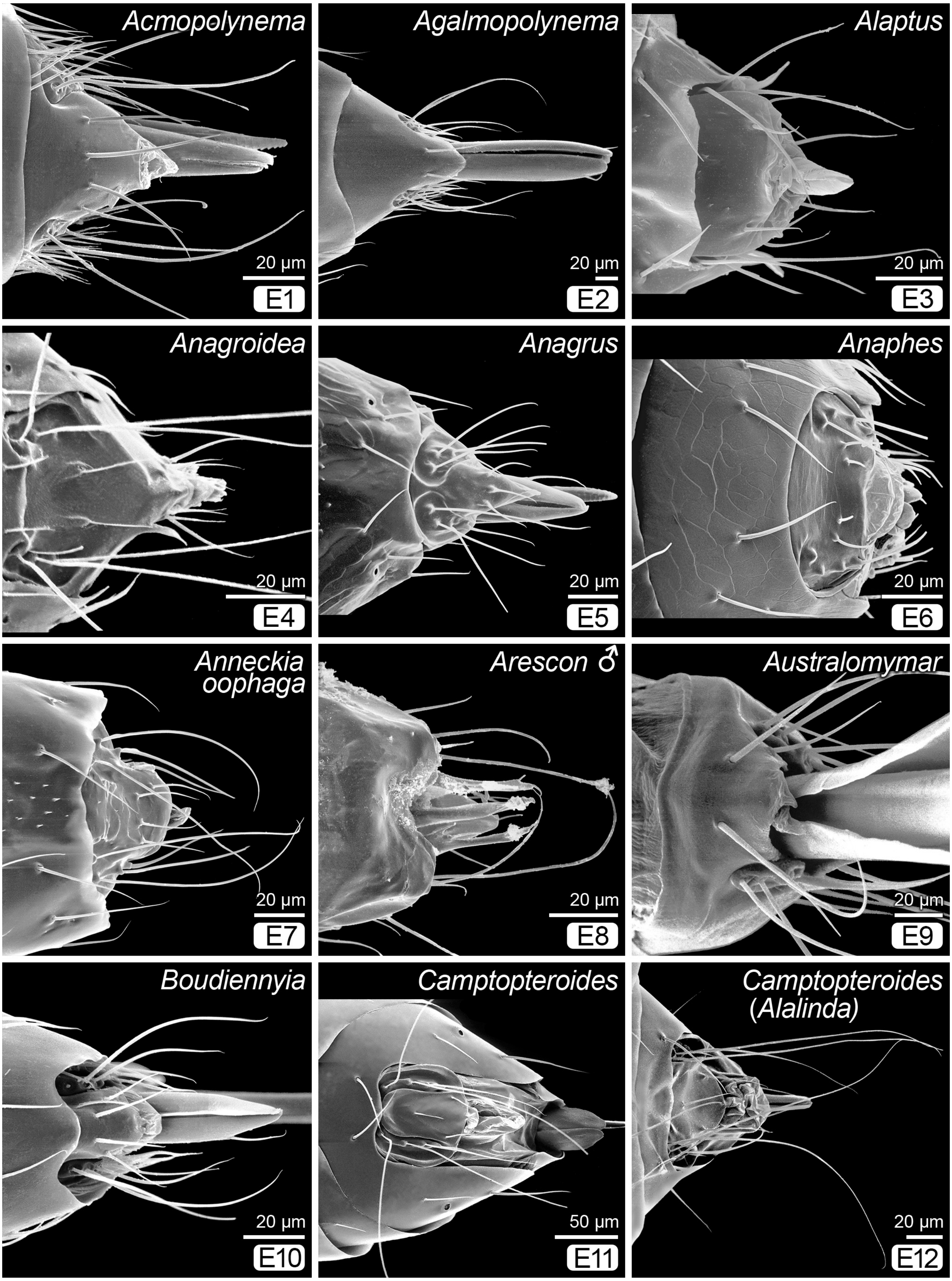
FIGURES D30–D39. Mymaridae metasomas, ventral (iop = inner plate of ovipositor, ovs= ovipositor sheaths, vf = valvifer; vv = valvula).



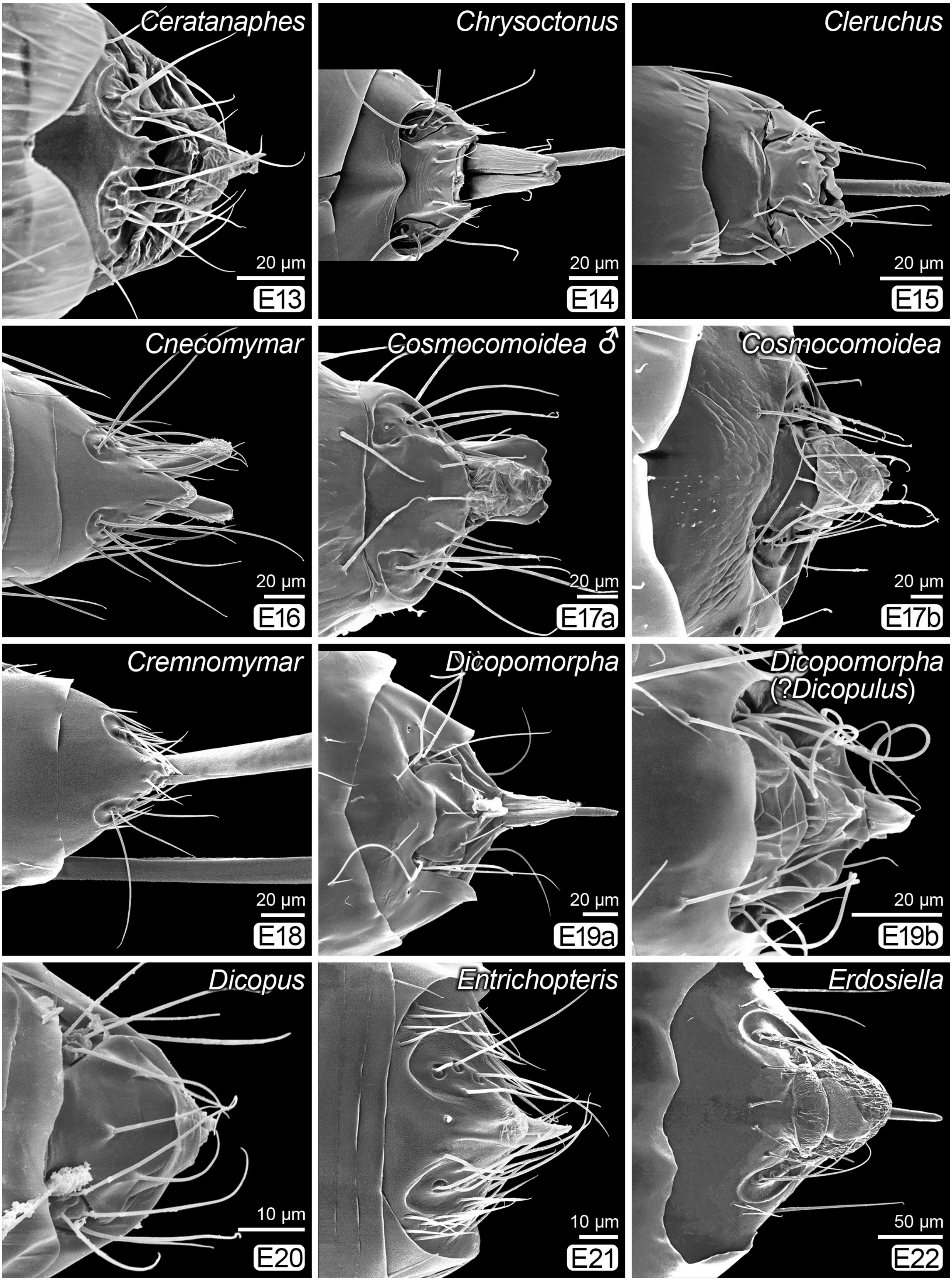
FIGURES D40–D49. Mymaridae metasomas, ventral.



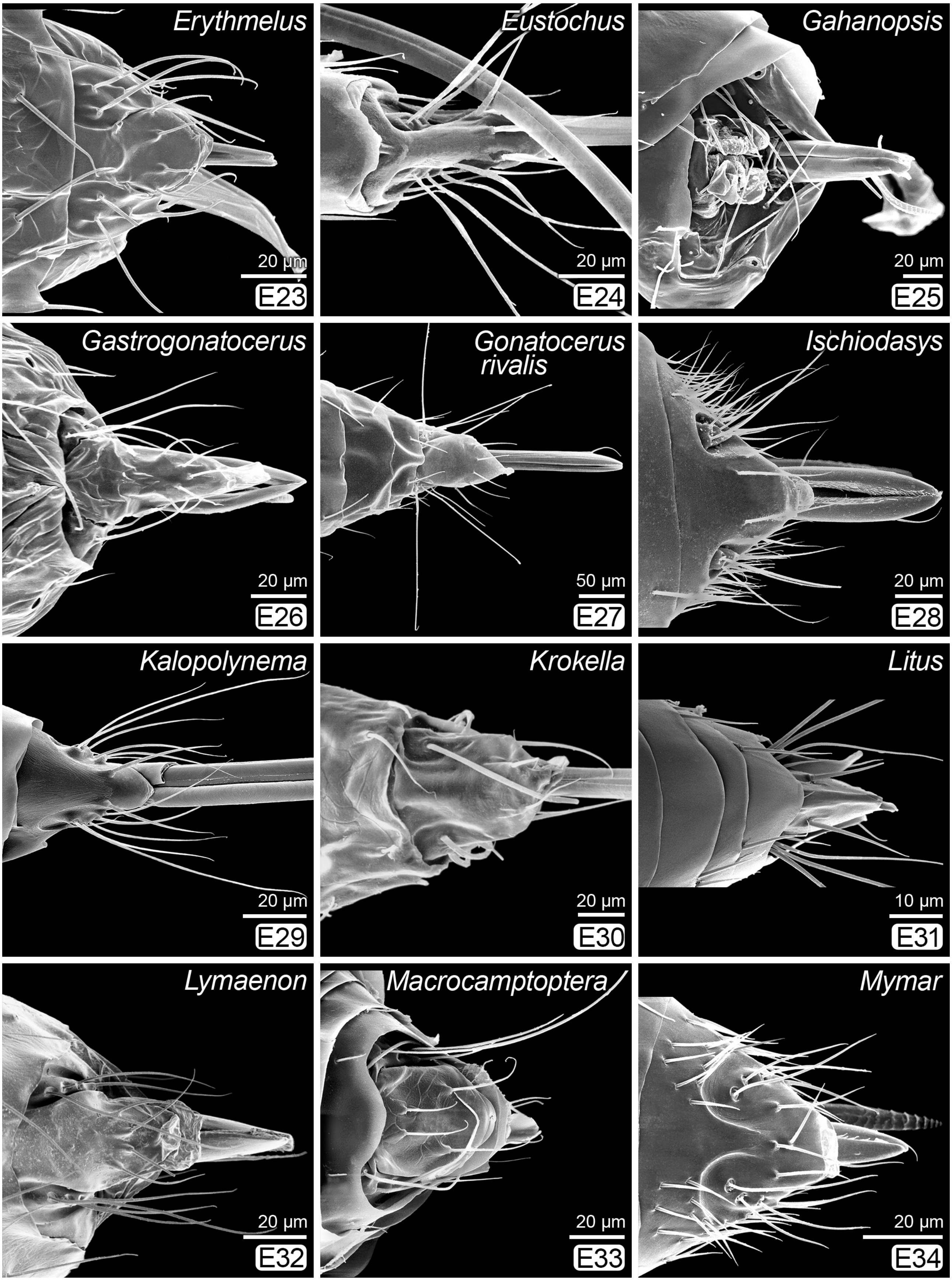
FIGURES D50–D57. Mymaridae metasomas, ventral.



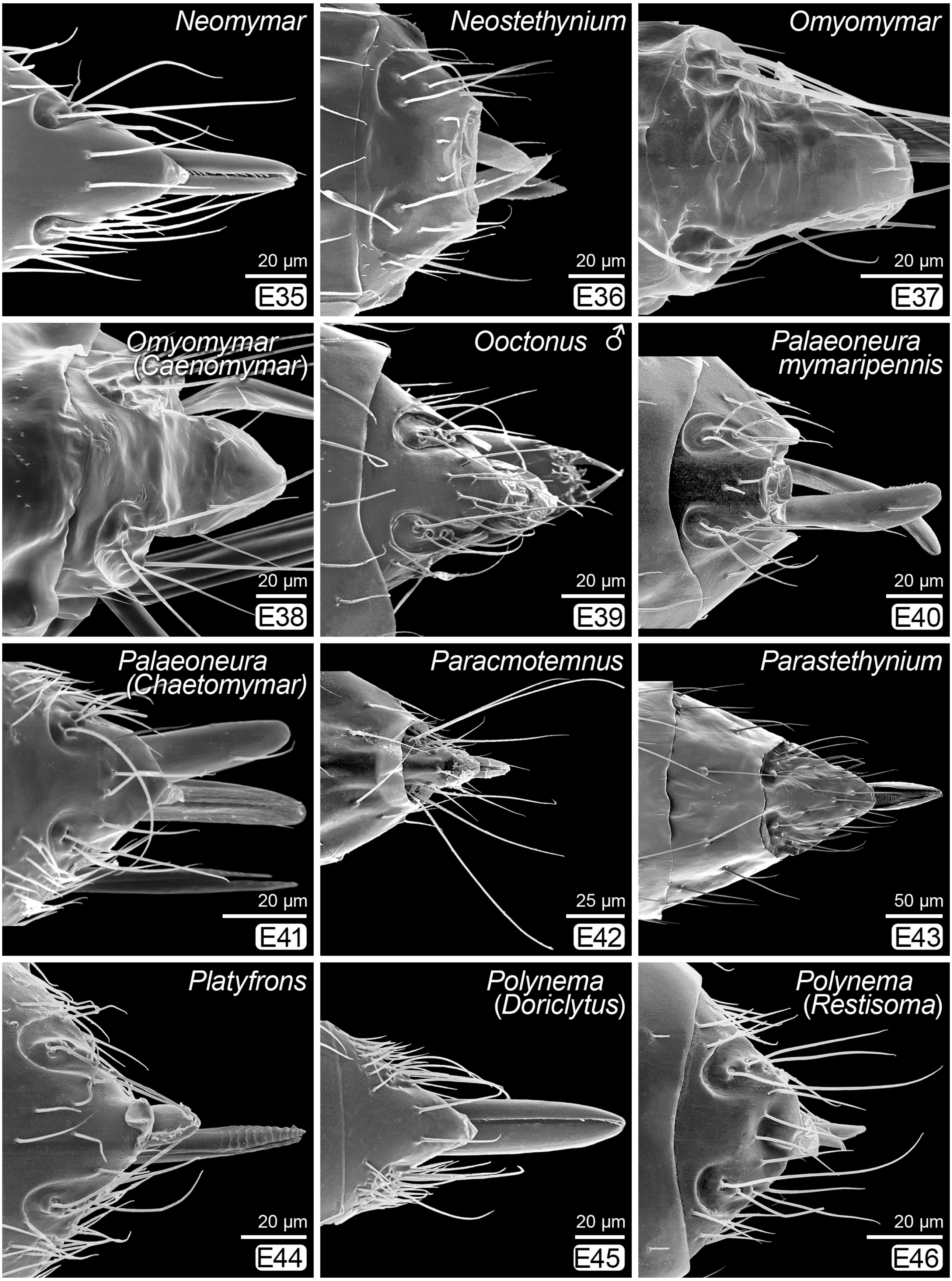
FIGURES E1–E12. Mymaridae, apex of gaster, dorsal (females).



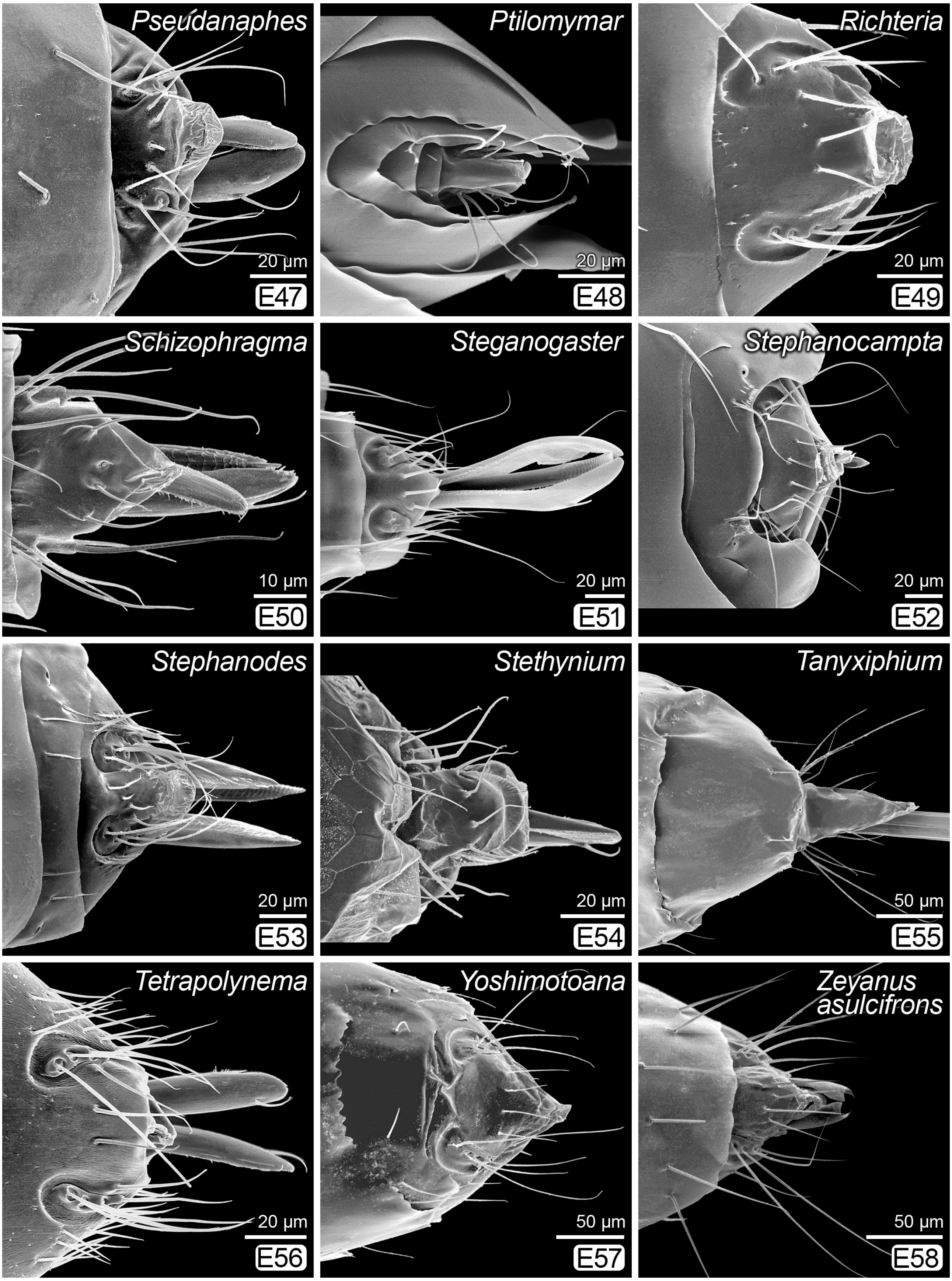
FIGURES E13–E22. Mymaridae, apex of gaster, dorsal (females, except E17a).



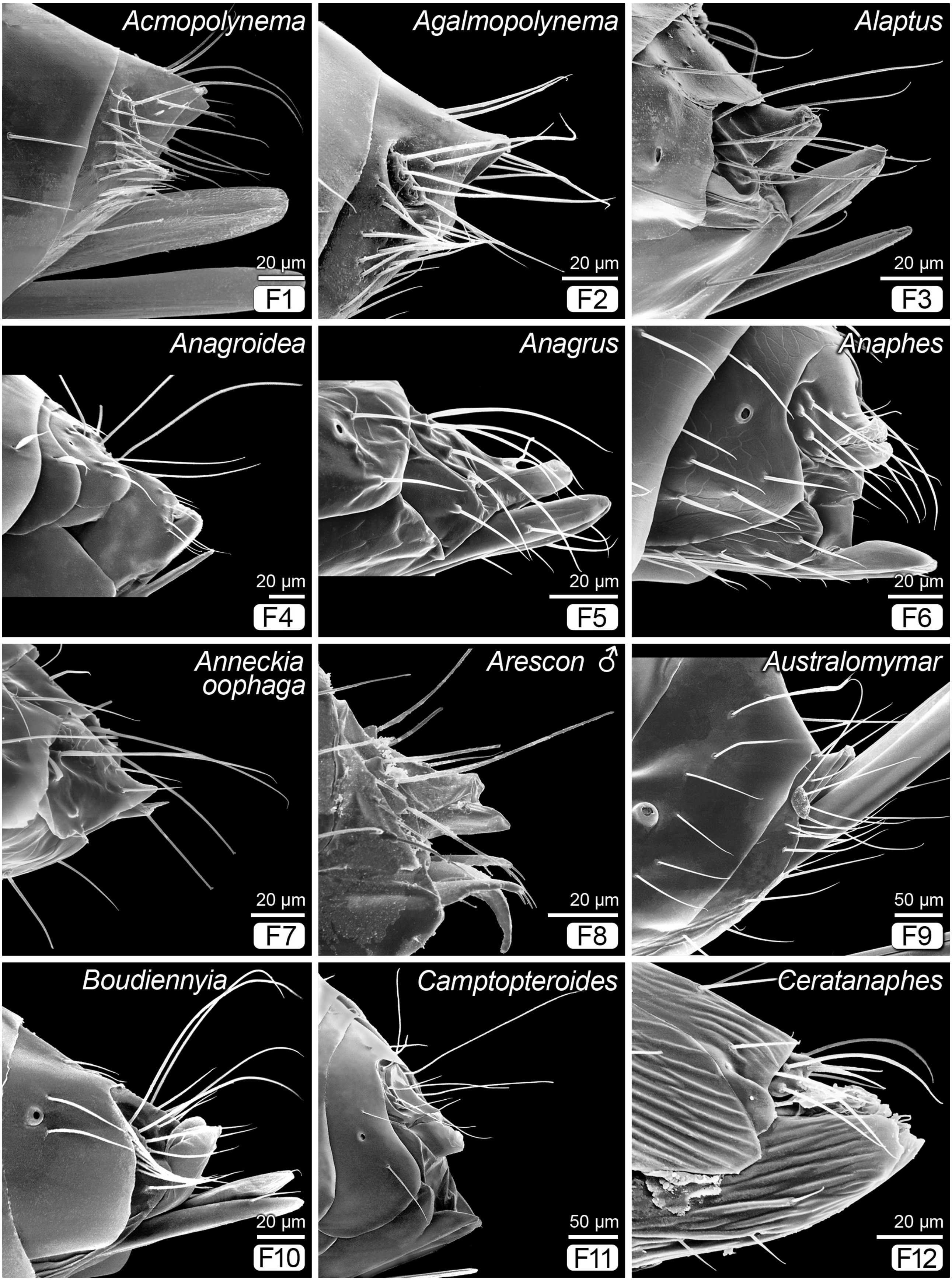
FIGURES E23–E34. Mymaridae, apex of gaster, dorsal (females).



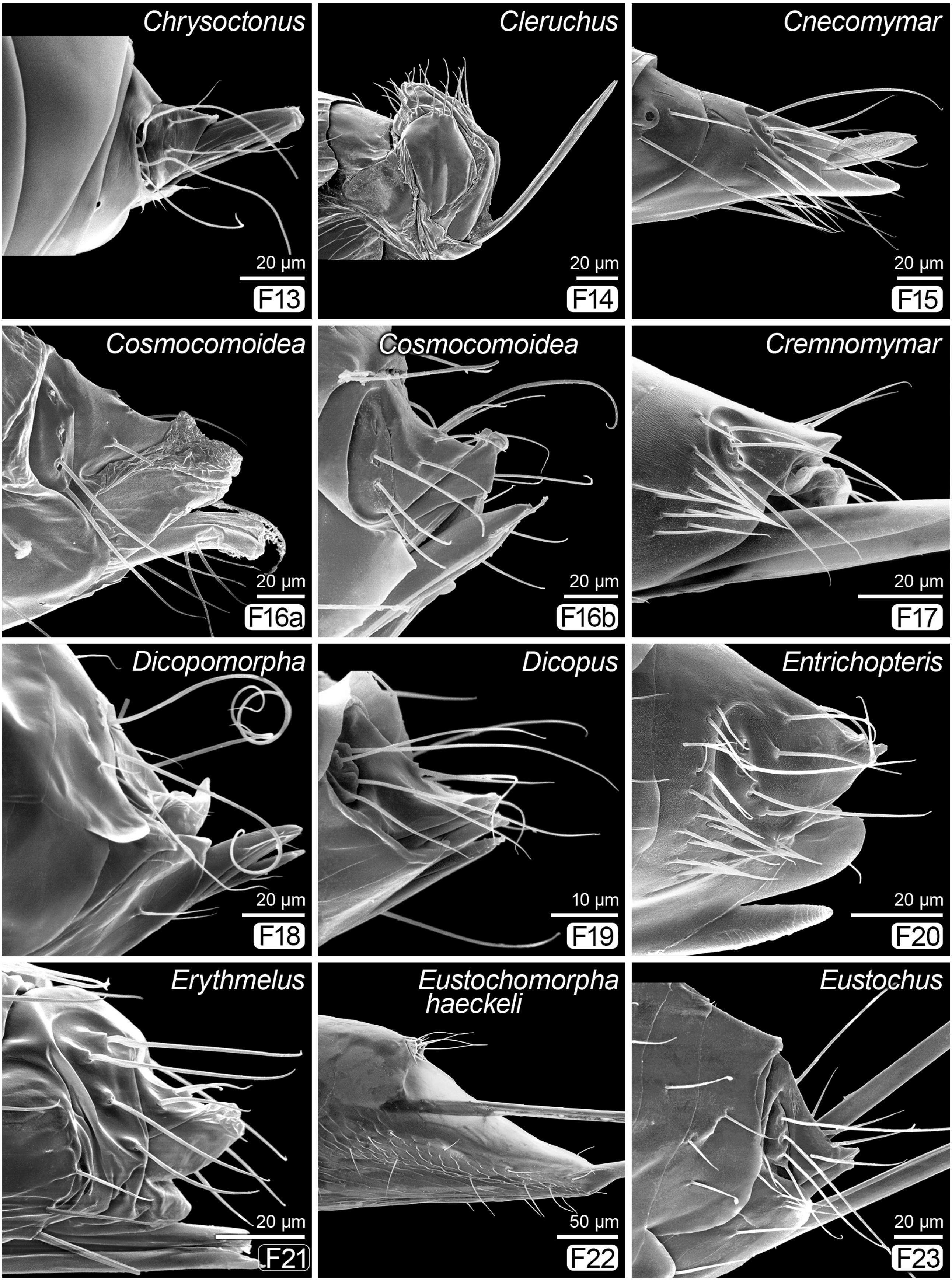
FIGURES E35–E46. Mymaridae, apex of gaster, dorsal (females, except E39).



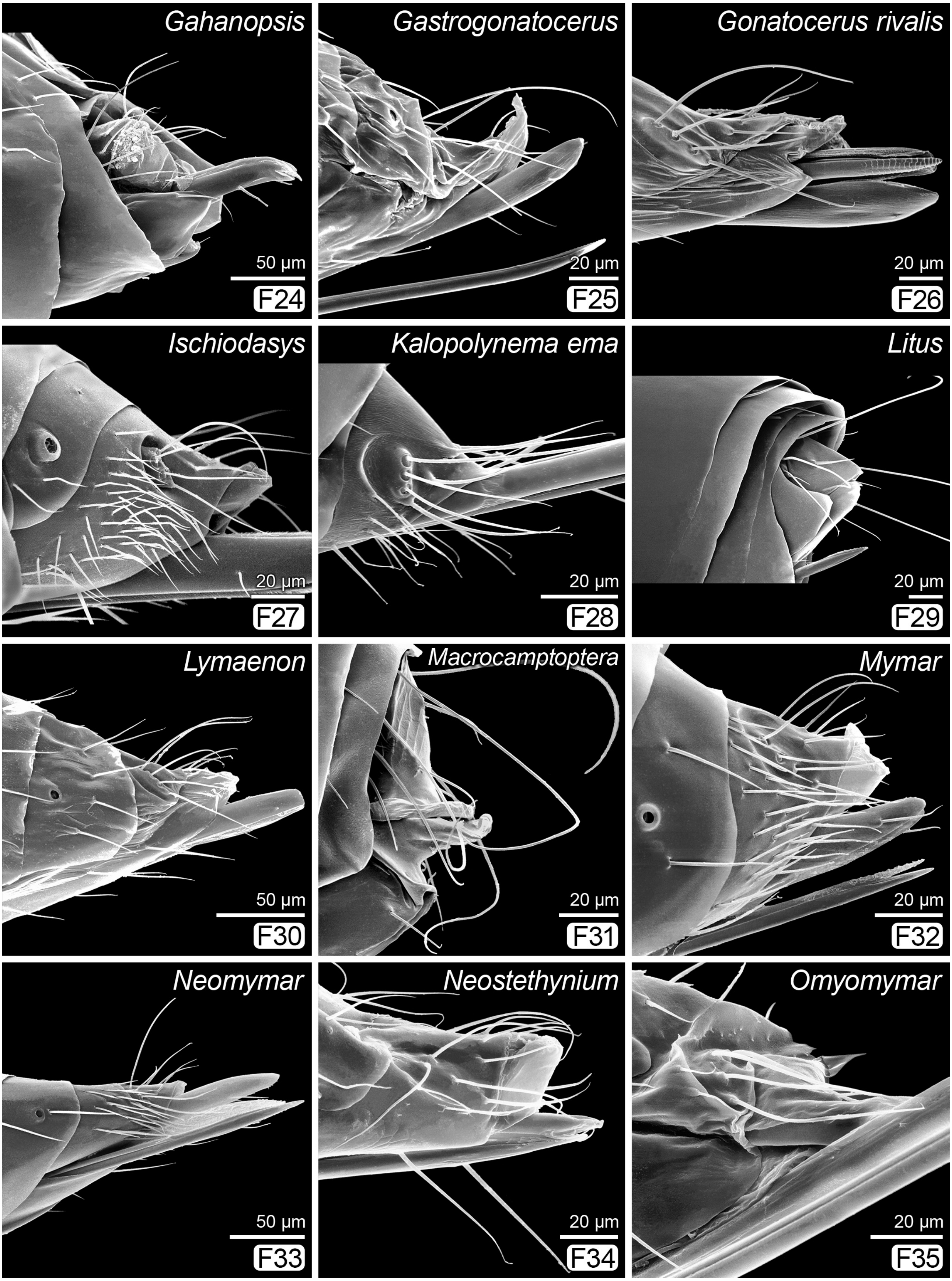
FIGURES E47–E58. Mymaridae, apex of gaster, dorsal (females).



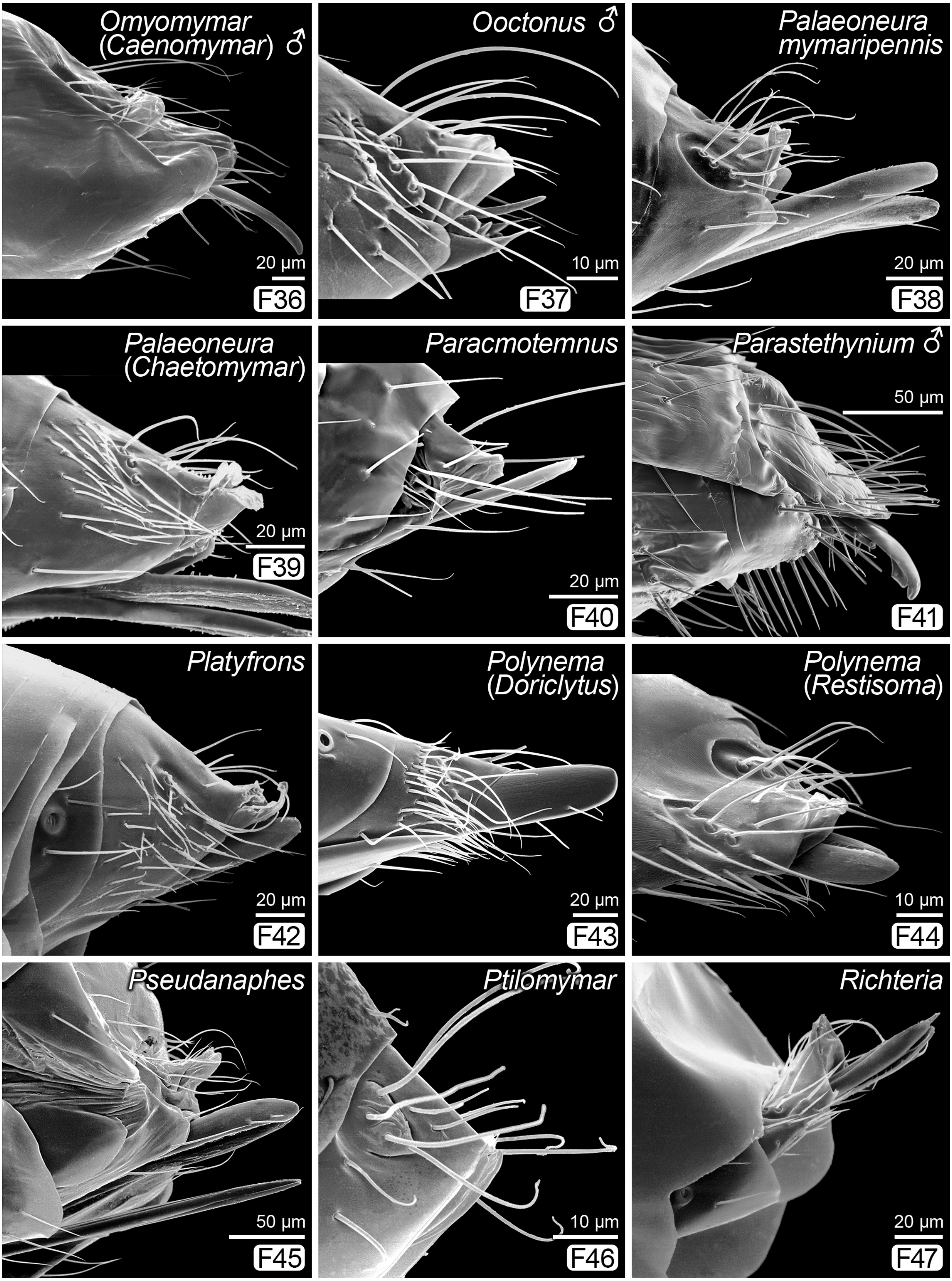
FIGURES F1–F12. Mymaridae, apex of gaster, lateral (females, except F8).



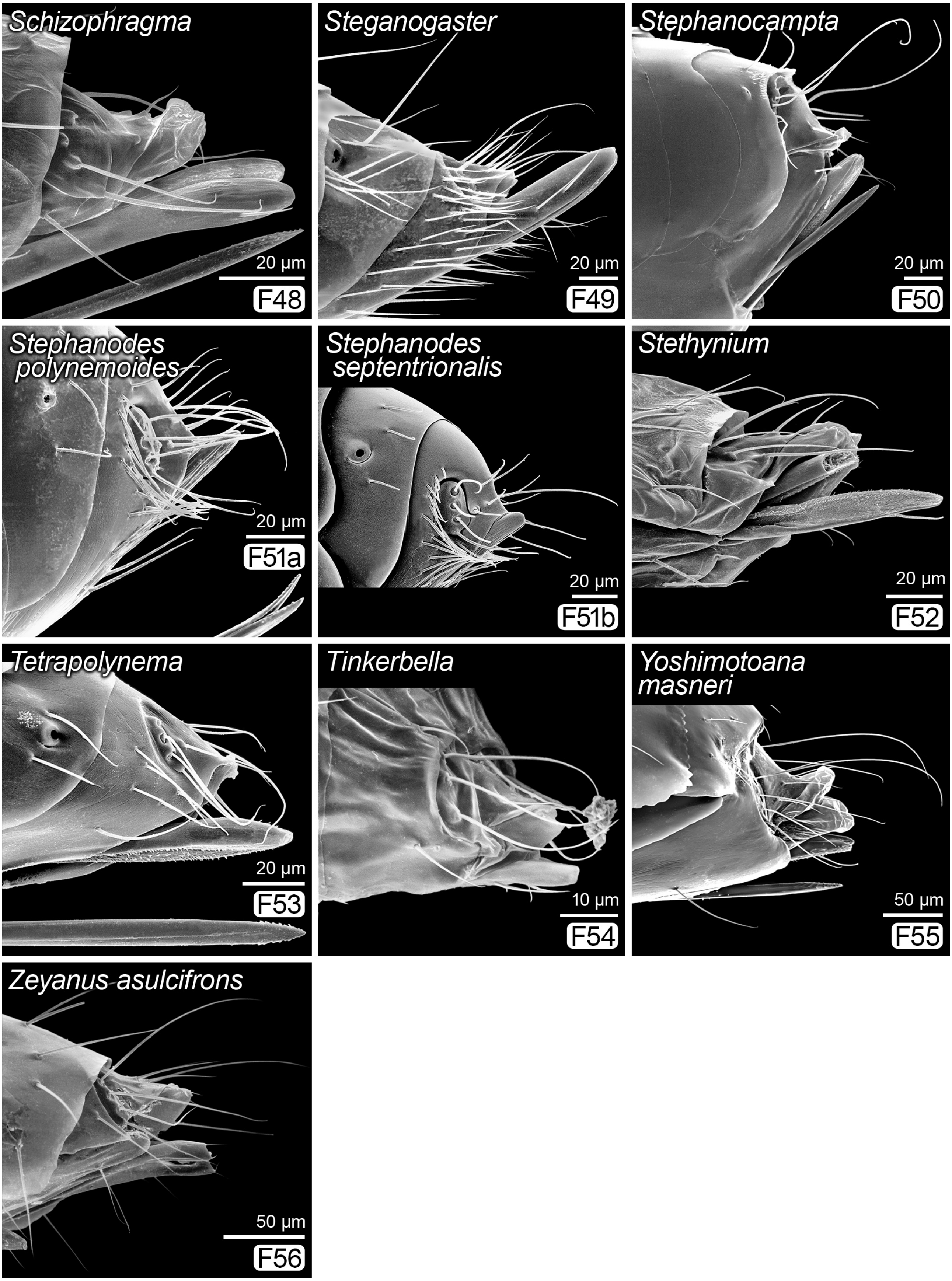
FIGURES F13–F23. Mymaridae, apex of gaster, lateral (females).



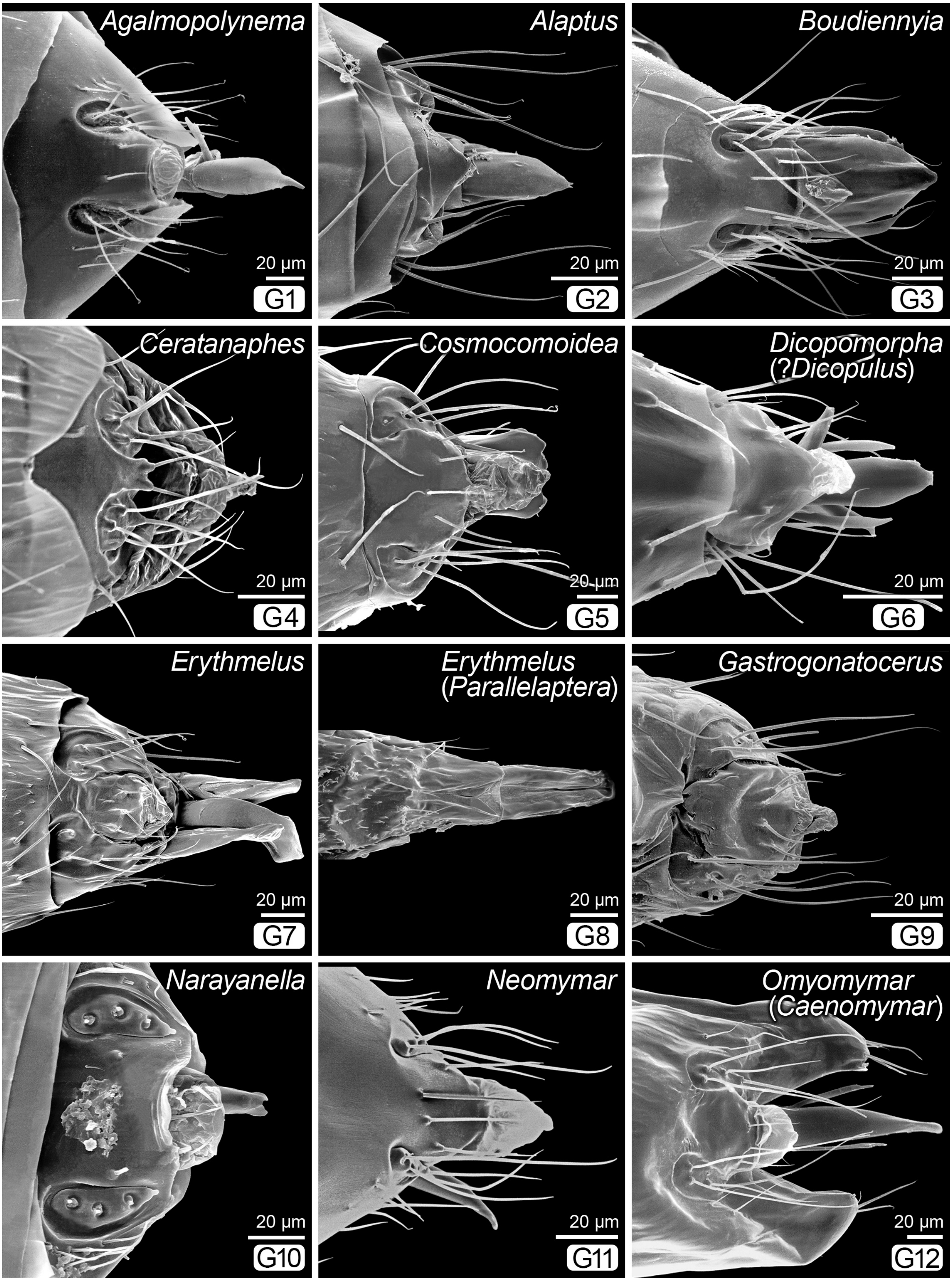
FIGURES F24–F35. Mymaridae, apex of gaster, lateral (females).



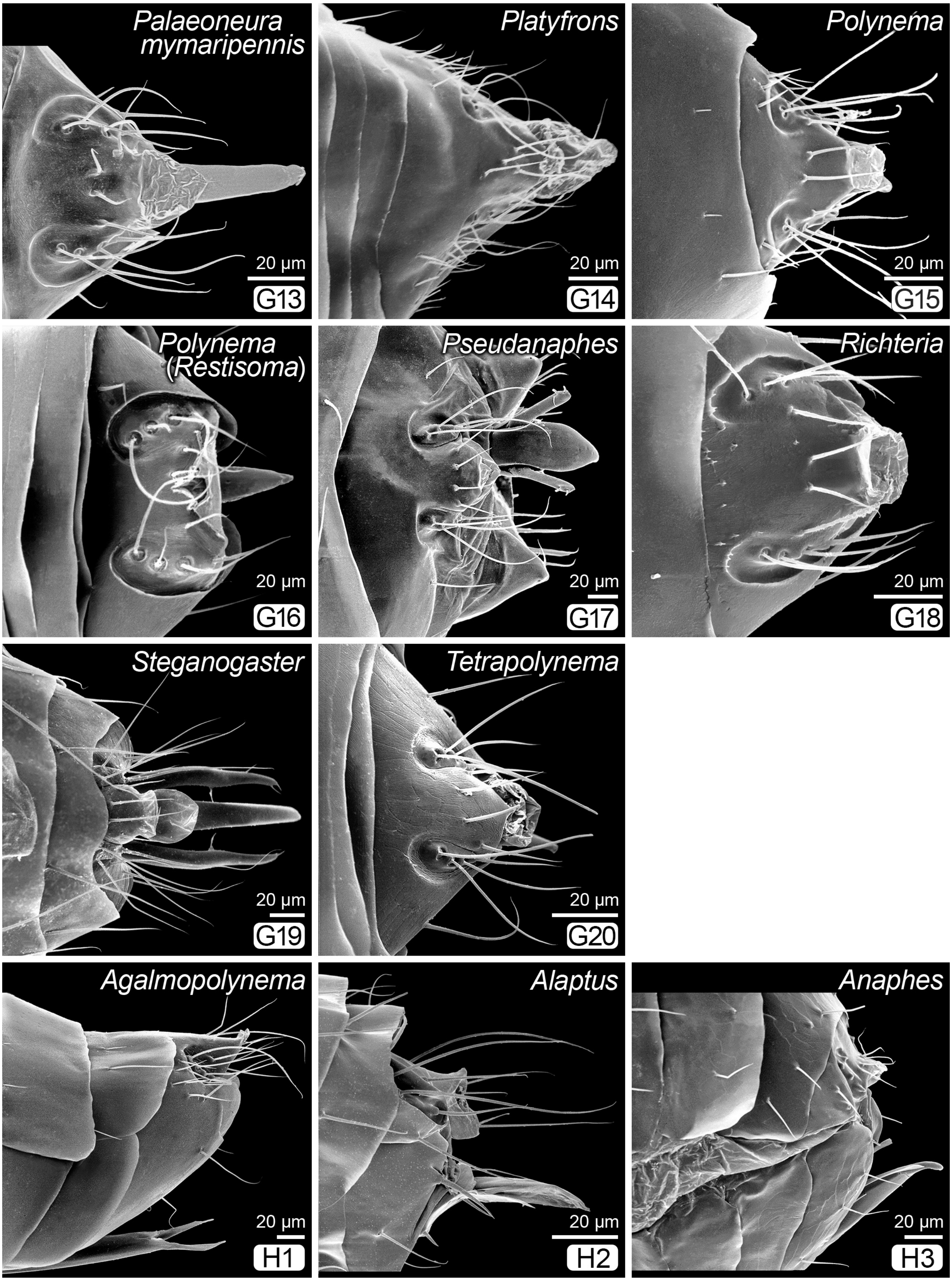
FIGURES F36–F47. Mymaridae, apex of gaster, lateral (females, except F36, F37, F41).



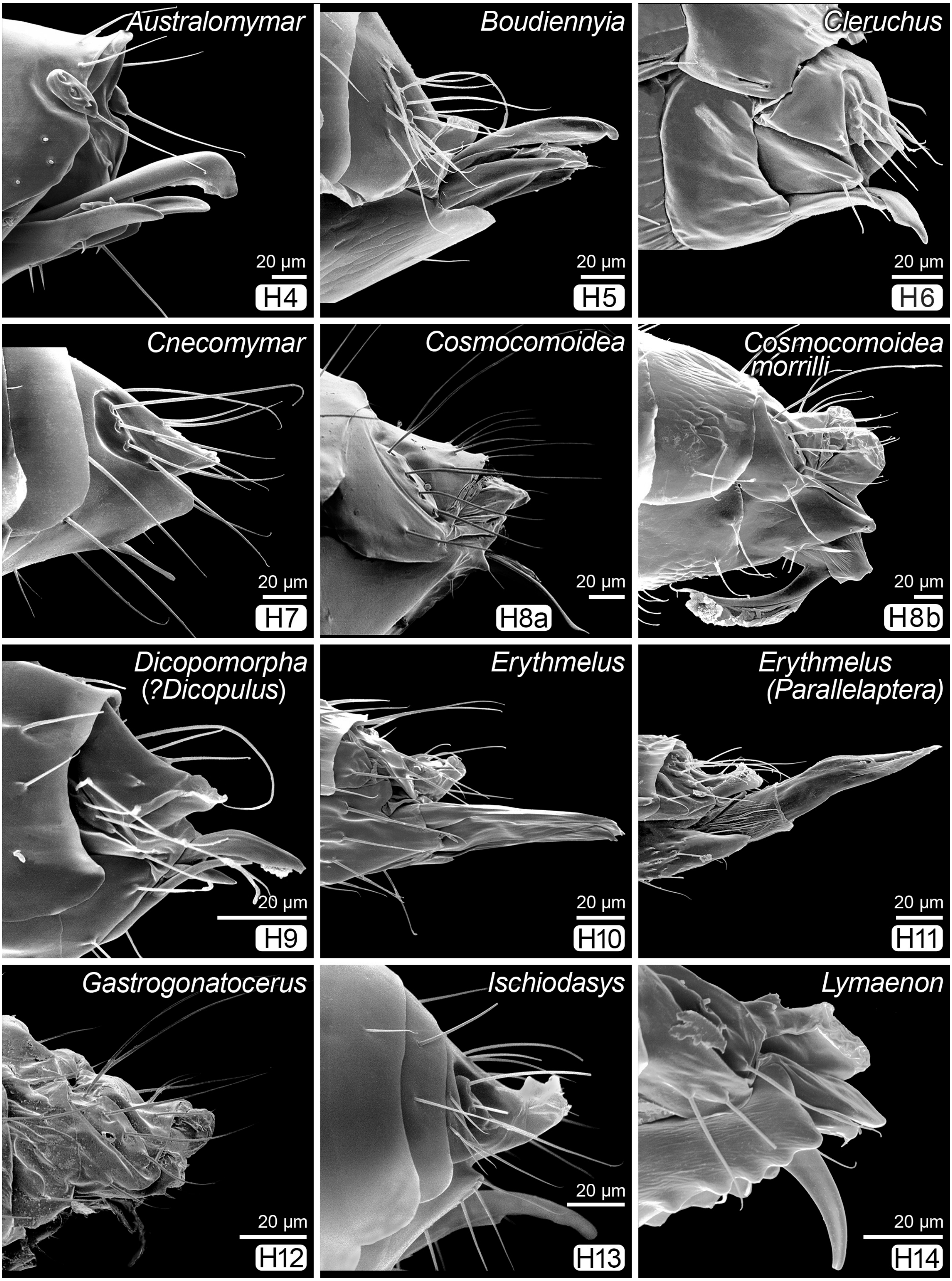
FIGURES F48–F56. Mymaridae, apex of gaster, lateral (females).



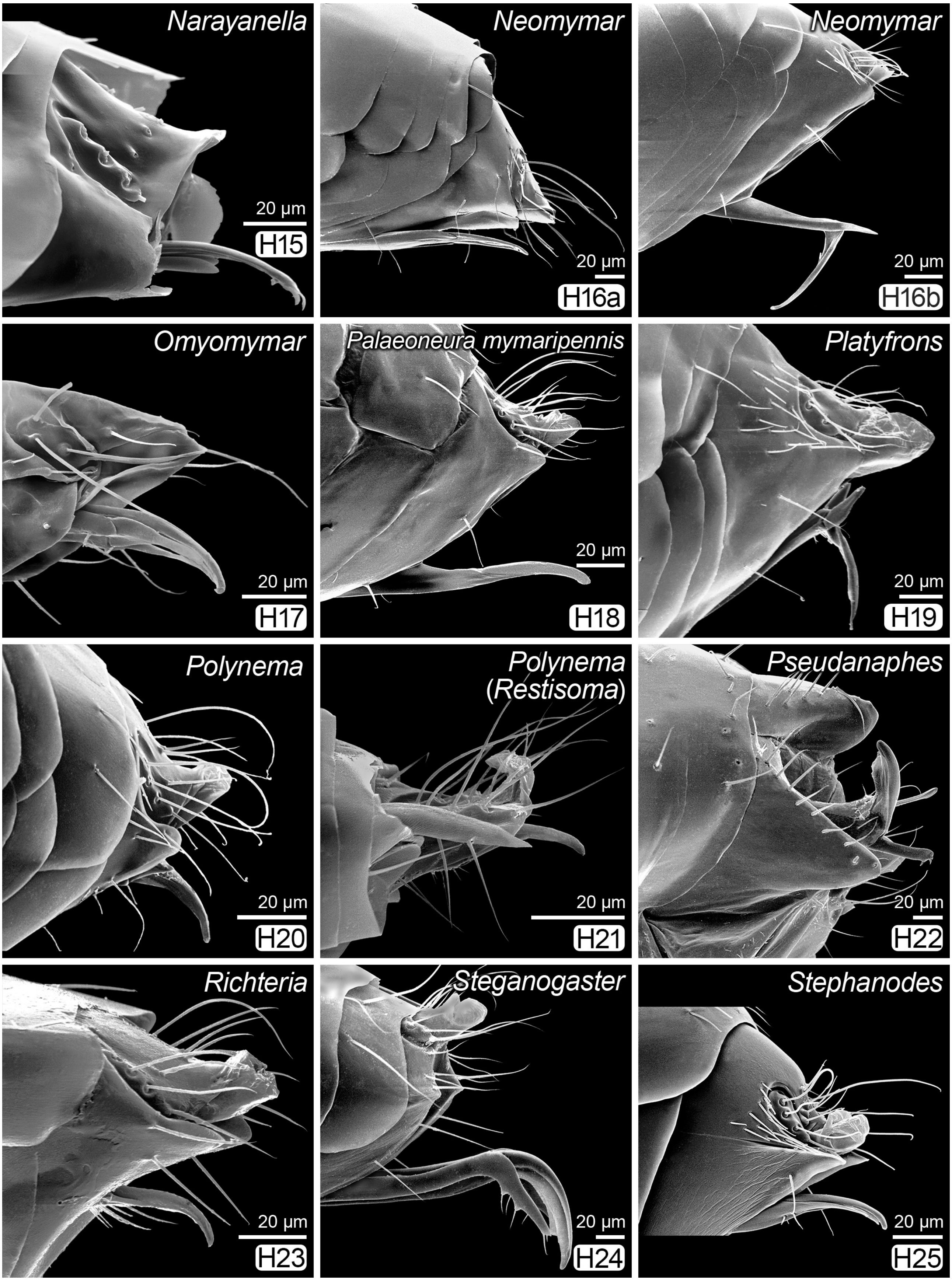
FIGURES G1–G12. Mymaridae, apex of gaster, dorsal (males).



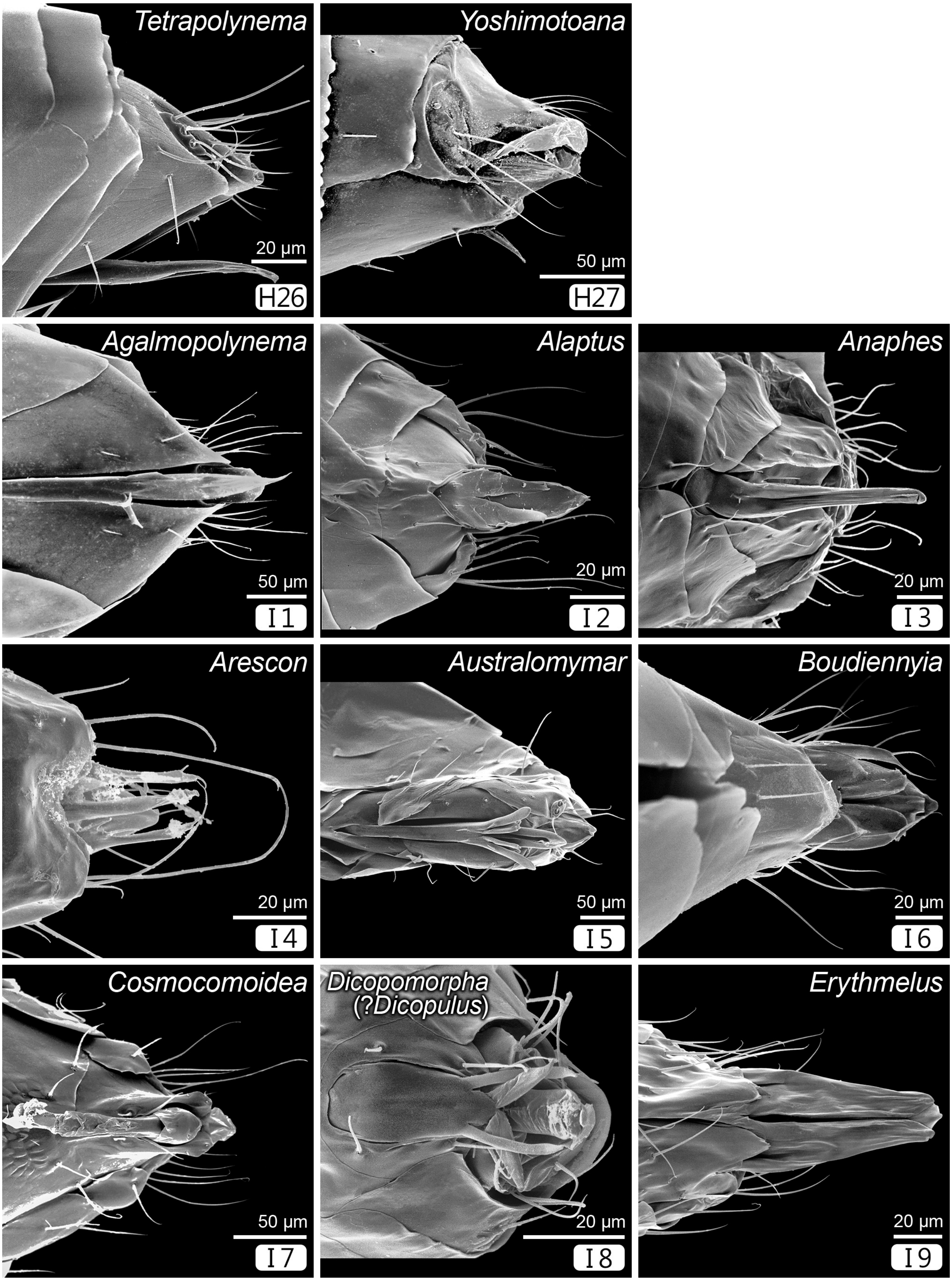
FIGURES G13–H3. Mymaridae, apex of gaster, dorsal (G13–G20), lateral (H1–H3) (males).



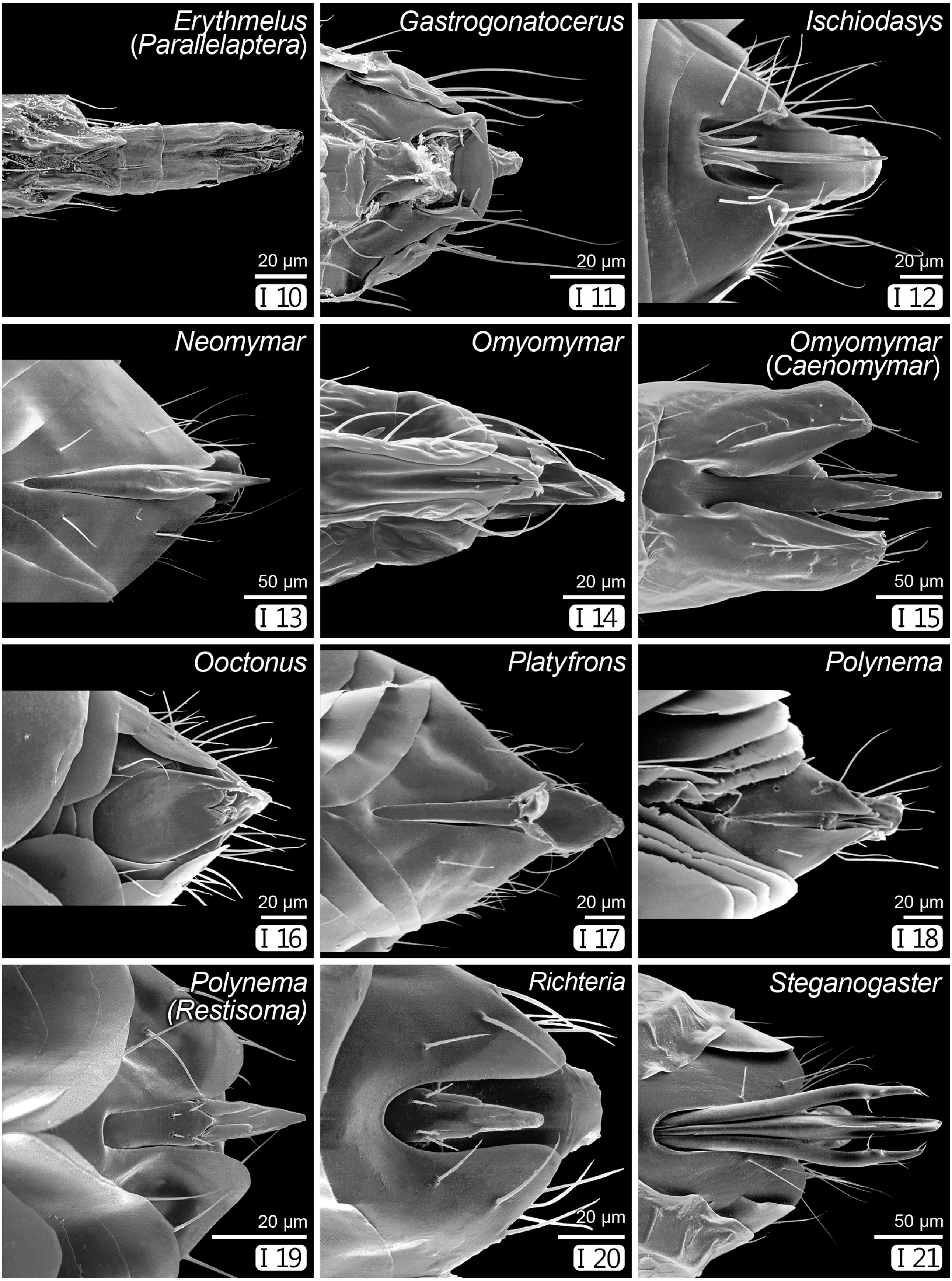
FIGURES H4–H14. Mymaridae, apex of gaster, lateral (males).



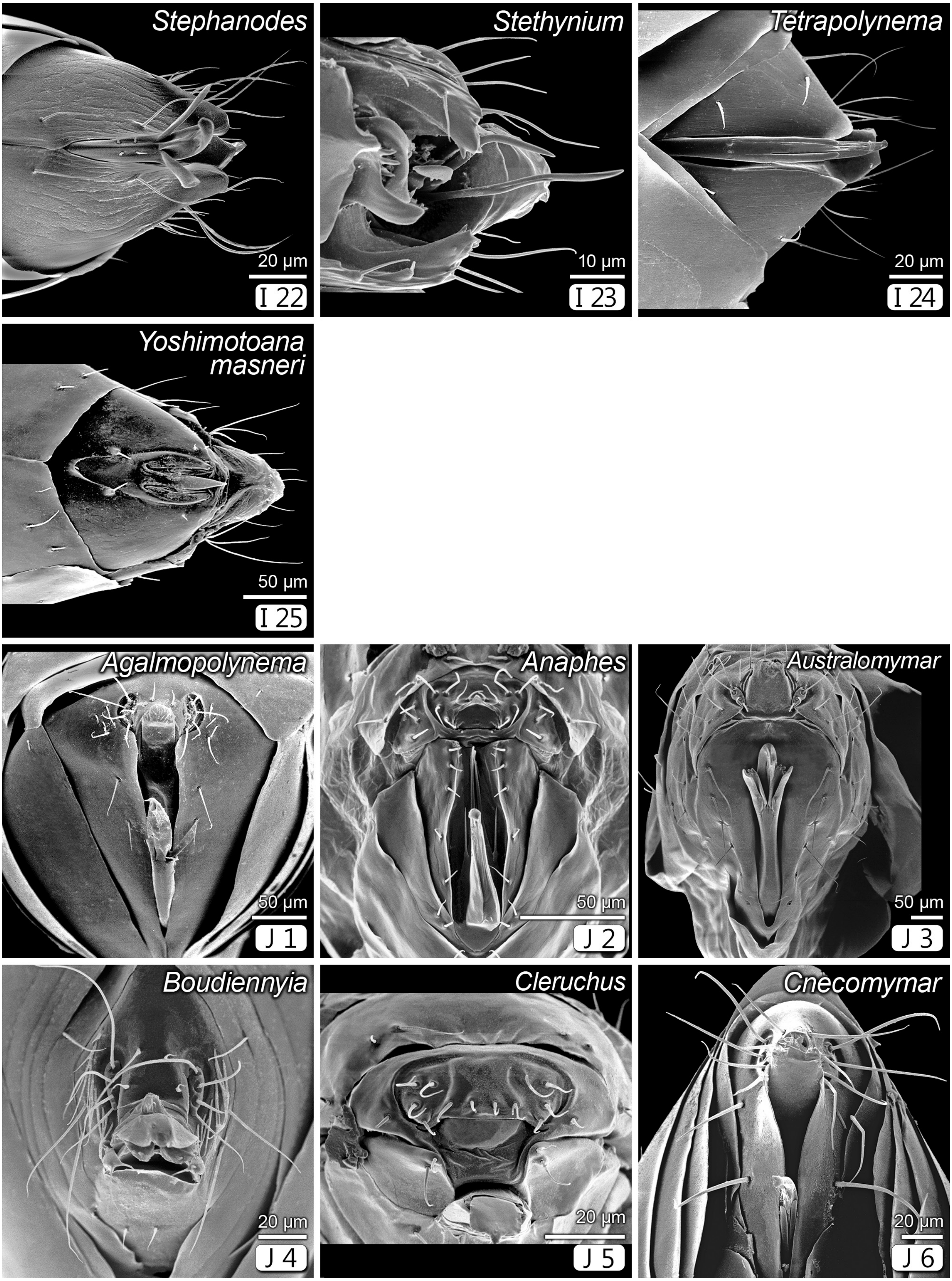
FIGURES H15–H25. Mymaridae, apex of gaster, lateral (males).



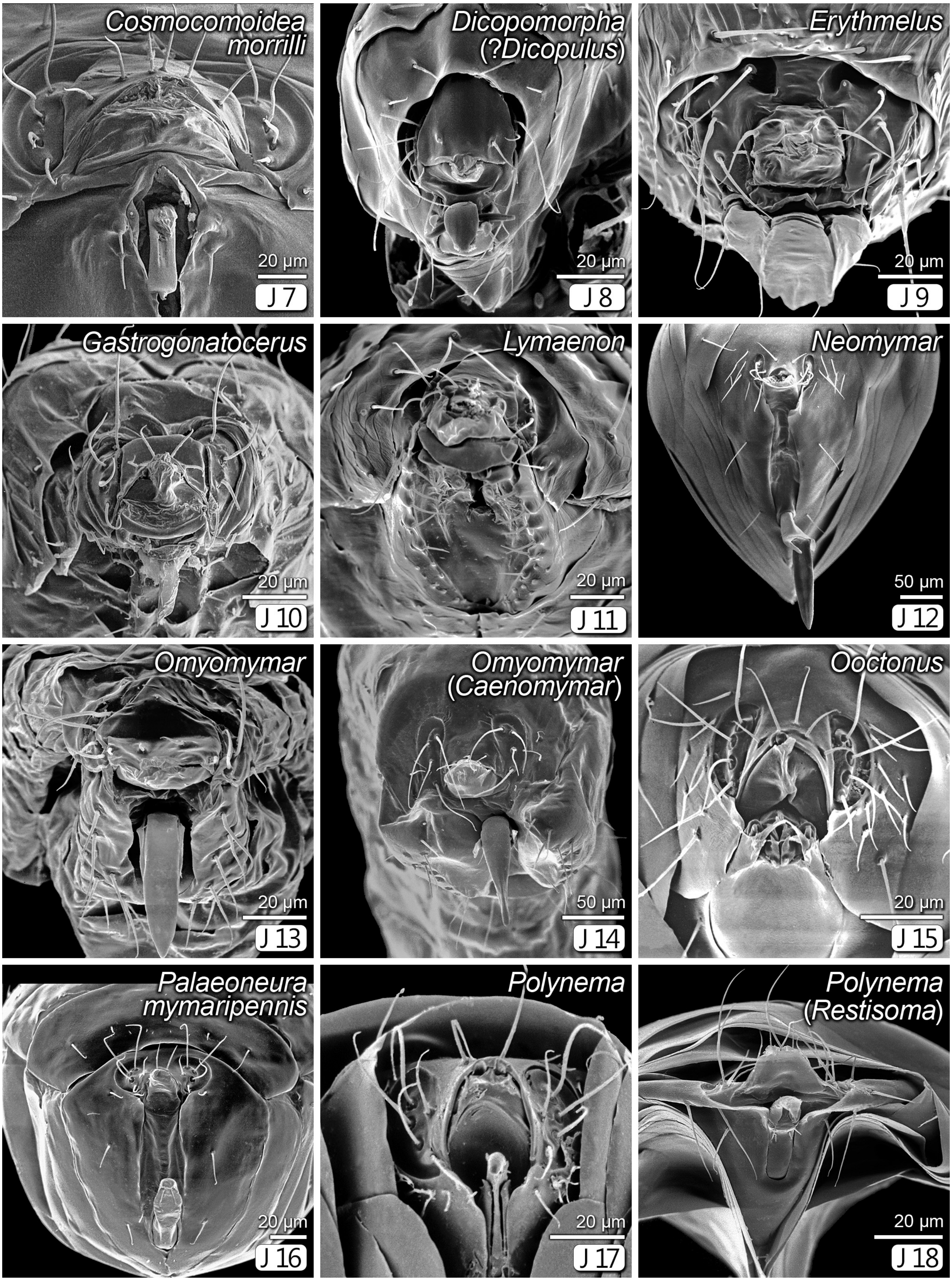
FIGURES H26–I9. Mymaridae, apex of gaster, lateral (H26, H27), ventral (I1–I9) (males).



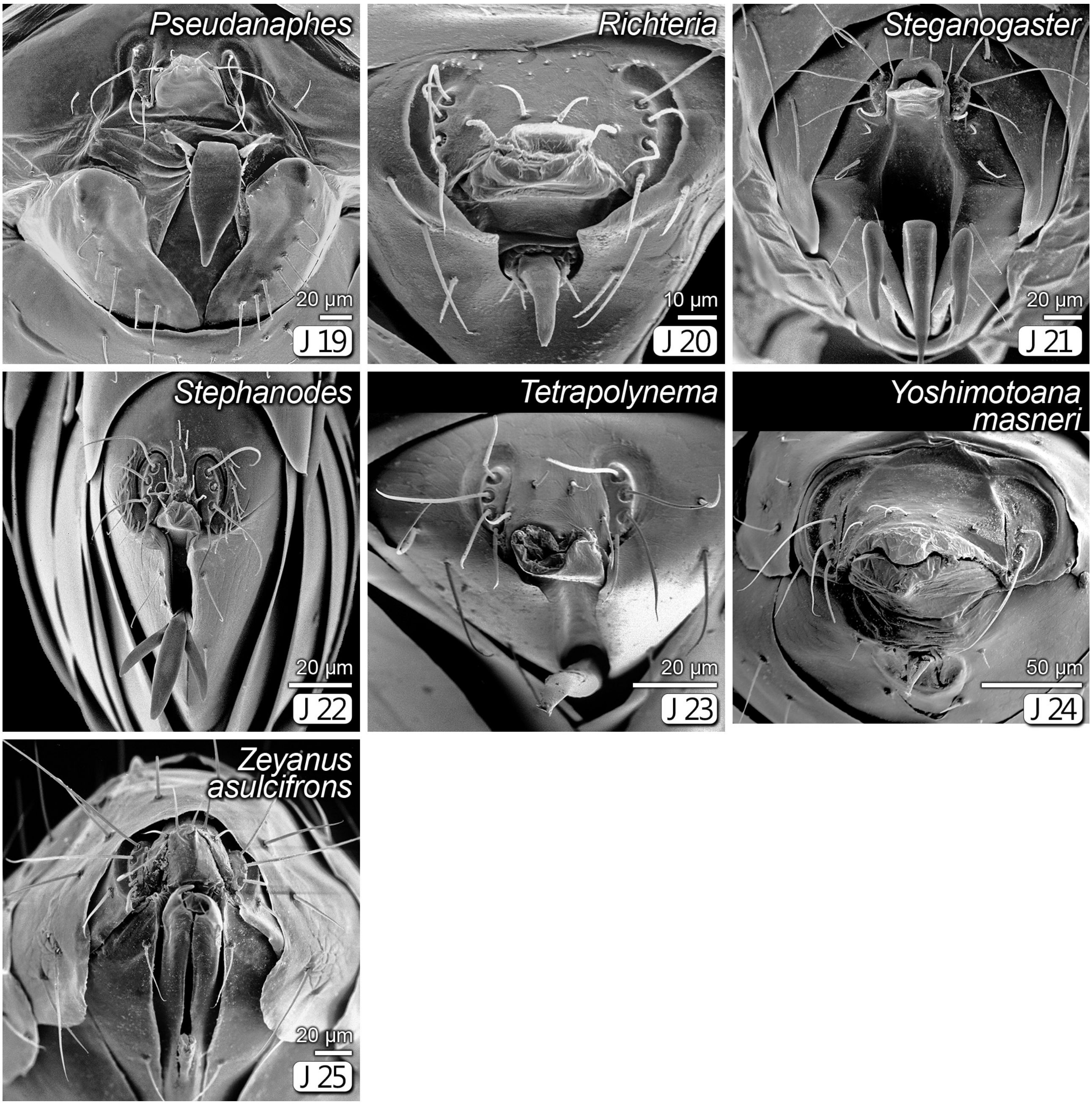
FIGURES I10–I21. Mymaridae, apex of gaster, ventral (males).



FIGURES I22–J6. Mymaridae, apex of gaster, ventral (I22–I25), posteriors (J1–J6) (males).



FIGURES J7–J18. Mymaridae, apex of gaster, posterior (males).



FIGURES J19–J25. Mymaridae, apex of gaster, posterior (males).

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