

***Cystomastacoides* van Achterberg (Braconidae, Rogadinae): first host record and descriptions of three new species from Thailand and Papua New Guinea**

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Abstract

A new species of *Cystomastacoides* van Achterberg, *C. asotaphaga* Quicke **sp. n.**, is described and illustrated based on a series of specimens reared from caterpillars of the erebid moth *Asota plana* Walker from Papua New Guinea. Two other new species without biological data are also described, *C. nicolepeelerae* Quicke & Butcher **sp. n.** also from Papua New Guinea, and *C. kiddo* Quicke & Butcher **sp. n.** from Thailand. A key is provided to the four known species. The new species extend the known range of the genus considerably, it having previously been known only from a single species from mainland China (Yunnan), and additionally provides the first host record for the genus. Other related genera are parasitoids of Sphingidae, Lymantriidae and Crambidae.

Keywords

Cytochrome oxidase I, DNA barcoding, Lepidoptera, hosts, Rogadini, Erebidae

Introduction

Cystomastacoides van Achterberg, 1997, was described based on a single specimen of a new species, *C. coxalis* van Achterberg from Yunnan, China, collected as an adult (in Chen and He 1997). *Cystomastacoides* belongs to the *Colastomion* Baker, 1917, group of genera which additionally includes the tropical Old World genera *Macrostomion* Szépligeti, 1900, *Megarhogas* Szépligeti, 1904, and *Myocron* van Achterberg, 1991 (van Achterberg 1991). This group is distinctive in having the combination of 1st metasomal tergite strongly narrowed subbasally and having the hind tibial spurs strongly curved and largely glabrous. Based on molecular analysis and the morphology of the 1st tergite, the Neotropical genus *Cystomastax* Szépligeti (1904) also belongs to this group (Zaldivar-Riverón et al. 2009), though this genus lacks the curved, glabrous hind tibial spurs. *Cystomastacoides* shares with *Cystomastax* a well-developed tooth on the hind coxa and claws with pointed basal lobes.

Here we describe three new species of *Cystomastacoides*, two from Papua New Guinea, the other from Thailand. Specimens of the first of these were reared from caterpillars of the erebid moth *Asota plana* Walker, 1854 (Lepidoptera, Erebidae), as part of an extensive herbivore and parasitoid rearing programme (Novotny et al. 2010) which has additionally yielded a number of other interesting rogadine parasitoids including the recently described, highly distinctive genus *Vojtechirogas* Quicke & van Achterberg (Quicke et al. 2012). The Thai species was collected in a Malaise trap as part of the TIGER (Thailand Inventory Group for Entomological Research) programme of sampling insects in 25 national parks in Thailand over a three year period, 2006–2008 (see <http://sharkeylab.org/tiger>). These new species thus greatly extend the known range of *Cystomastacoides* and provide the first host record for the genus.

Terminology

Terminology follows van Achterberg (1979, 1988). Measurements of the height and horizontal length of the eye are approximations because the very bulbous face and very large eyes make it difficult to measure consistently; in our attempts to do so, the head was orientated so that the face (defined as running from the anterior edge of the toruli to the dorsal margin of the clypeus) was horizontal or perpendicular to the measurement axis.

Abbreviations: BMNH (The Natural History Museum, London); QSBG (Queen Sirikit Botanic Gardens, Chiang Mai, Thailand); USNM (United States National Museum, Washington D.C.).

Systematics

Key to species of *Cystomastacoides*

- 1 1st metasomal tergite less than 2.0 × longer than posteriorly wide (Fig. 1); mesoscutum medioposteriorly broadly depressed, without distinct oval pit (Fig. 2); propodeum anteriorly largely shiny with deep punctures (Fig. 3); pterostigma bicolorous, basally nearly black, apically pale yellow (Fig. 5); wing with dark grey transverse band at level of parastigma (Fig. 5); 3rd segment of maxillary palp [female] cylindrical, approximately 7 × longer than wide; length of fore wing less than 10mm [8mm] ***C. kiddo* sp. n.**
- 1st metasomal tergite more than 2.0 × longer than posteriorly wide (Fig. 9); mesoscutum medioposteriorly with deep, narrow oval pit (Fig. 11); propodeum anteriorly largely rugose (Fig. 12); pterostigma unicolorous black or yellow brown (Fig. 9) or dark anteriorly and yellowish posteriorly; wing membrane entirely hyaline or apically infusate; 3rd segment of maxillary palp [female] swollen, approximately 3.5 × longer than wide (Fig. 10); length of fore wing more than 10mm [11.5–12mm] **2**
- 2 Occipital carina strongly wavy (Figs 10, 11); pterostigma entirely black; wing membrane entirely hyaline ***C. asotaphaga* sp. n.**
- Occipital carina more or less evenly rounded; wing membrane at least weakly infusate apically **3**
- 3 Hind wing vein 2-SC+R distinctly transverse, reclivous (Fig. 21); pterostigma largely dark brown, but distinctly black medioanteriorly (Fig. 16); 3rd segment of maxillary palp 5 × longer than maximally wide (Fig. 19) ***C. nicolepeelerae* sp. n.**
- Hind wing vein 2-SC+R quadrate; pterostigma and venation yellow brown; 3rd segment of maxillary palp 3.1 × longer than maximally wide ***C. coxalis* van Achterberg**

Cystomastacoides kiddo Quicke & Butcher, sp. n.

[urn:lsid:zoobank.org:act:B08D1758-3EFE-4FE4-AC76-E79A7D0C1106](https://zoobank.org/act:B08D1758-3EFE-4FE4-AC76-E79A7D0C1106)

http://species-id.net/wiki/Cystomastacoides_kiddo

Figs 1–8

Material examined. Holotype female, Thailand, Phetchabun Province, Thung Salaeng Luang NP, Kaeng Wang Nam Yen, 29.xi–6.xii.2006, 16°37.531'N, 100°53.745'E, Malaise trap (collection code T1165; voucher BCLDQ00783; Genbank JX034704; BOLD: ASQSQ064_09) (QSBG)

Morphology. Length of body 9 mm, of fore wing 8 mm and of antenna 12 mm.

Head. Antenna with 59 flagellomeres. Terminal flagellomere acuminate. Median flagellomeres approximately 3 × longer than wide. 3rd segment of maxillary palp and



Figures 1–4. *Cystomastacoides kiddo* sp. n. holotype, Cell^{AD}® light photomicrographs. **1** Habitus **2** head and anterior mesosoma, dorsal view **3** propodeum, dorsal view **4** metasomal tergites 2-6, dorsal view.

2nd segment of labial palp not swollen, rather elongate, 3rd segment 6 × longer than maximally deep. Face rather protruding and with well developed transverse striation. Frons with strong oblique striation reaching to midlongitudinal groove. Distance between posterior ocelli: transverse diameter of posterior ocellus: shortest distance be-



Figures 5–8. *Cystomastacoides kiddo* sp. n. holotype, Cell[^]D[®] light photomicrographs. **5** Fore wing **6** metasoma, lateral view **7** apex of hind tibia showing spurs **8** hind coxa showing dorsal tooth (arrowed).

tween posterior ocellus and eye = 1:3.2:2.5. Vertex with strong groove running from stemmaticum to occipital carina. Occipital carina complete, strongly lamelliform laterally, weak mediodorsally.

Mesosoma. Notauli very deep, crenulate posteriorly, meeting before scutellar sulcus. Mesoscutum without midposterior pit. Scutellar sulcus wide with single carina medially. Mesopleuron largely smooth and shiny with some small punctures, precoxal sulcus long, weakly impressed, largely smooth. Median area of metanotum with complete midlongitudinal ridge. Propodeum largely shiny with deep punctures, with lateral carinae distinct posteriorly and protruding.

Fore wing. Vein 2-CU1 $5.0 \times$ longer than 1-CU1. Vein 3-SR $3.0 \times$ longer than r. Vein SR1 $1.45 \times$ longer than 3-SR.

Hind wing. Vein M+CU approximately as long as 1-M. Vein 2-SC+R quadrate (interstitial). Vein m-cu absent.

Metasoma. 1st metasomal tergite $1.65 \times$ longer than posteriorly wide; posteriorly with well-developed shoulders. 2nd metasoma $1.15 \times$ longer than 3rd tergite, and $1.1 \times$ wider than long. Metasomal tergites 1-3 with strong midlongitudinal carina. Tergites 1-6 densely deeply punctate with punctures forming irregular longitudinal rows separated by striae. Hypopygium weakly curved ventrally.

Coloration. Antennae largely black. Body and legs largely pale brown yellow, apex of hind tibia and hind tarsus and stemmaticum black. Wing venation largely brown yellow, basal 0.6 of pterostigma and veins at same level dark brown; membrane uniformly hyaline.

Etymology. Named after the character Beatrice Kiddo in the Quentin Tarantino 'Kill Bill' films because of the deadly biology to the host.

***Cystomastacoides asotaphaga* Quicke, sp. n.**

[urn:lsid:zoobank.org:act:88ADE279-A5EC-436D-A9DC-DB8935839809](http://www.zoobank.org/act:88ADE279-A5EC-436D-A9DC-DB8935839809)

http://species-id.net/wiki/Cystomastacoides_asotaphaga

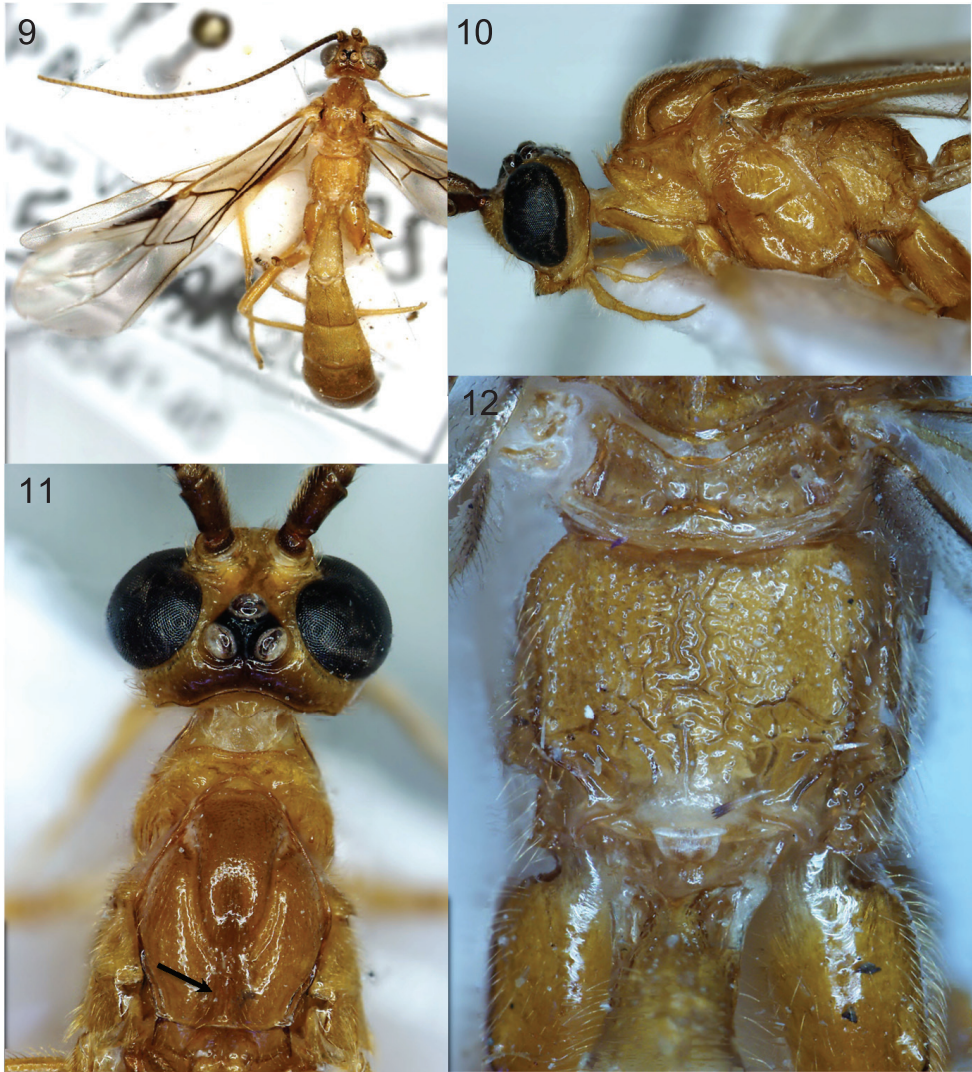
Figs 9–15

Material examined. Holotype female, Papua New Guinea, East Sepik Province, Yapsiei, 5.iii.04, $4^{\circ}37.695'S$, $141^{\circ}05.839'E$, 100m, PAR, CATJ085, reared ex caterpillar of *Asota plana* (Walker) (Erebidae, formerly Noctuidae: Erebinini) on *Ficus pachyrrhachis* K. Schum. & Laut. (Moraceae). Voucher USNM ENT 00454146; Genbank JF271304; BOLD: ASQSP054-08) (USNM).

Paratypes, 2 females and 1 male, same data as holotype: (USNM ENT 00454262, Genbank JX034706, BOLD ASQSP050-08; USNM ENT 00454362, Genbank JX034703, BOLD ASQSP051-08; USNM ENT 00454359, Genbank JX034707, BOLD ASQSP052-08) (USNM, BMNH, USNM respectively).

Morphology. Length of body 12 mm, of fore wing 16 mm and of antenna 14 mm.

Head. Antenna with 74 flagellomeres. Terminal flagellomere acuminate. Median flagellomeres approximately twice as long laterally as wide. 3rd segment of maxillary palp and 2nd segment of labial palp with rather large flattened, triangular flange, 3rd segment $3.0 \times$ longer than maximally wide. Face with rather strongly protruding midlongitudinal area, largely densely punctate with punctures largely confluent giving rise



Figures 9–12. *Cystomastacoides asotaphaga* sp. n. holotype, Cell^{AD} light photomicrographs. **9** Habitus **10** head and mesosoma, lateral view **11** head and anterior mesosoma, dorsal view, arrow indicating medioposterior pit **12** propodeum.

to transverse rugulose appearance. Frons weakly obliquely striate on lateral half only. Distance between posterior ocelli: transverse diameter of posterior ocellus: shortest distance between posterior ocellus and eye = 1:1.8:0.6. Vertex with strong groove running from stemmaticum to occipital carina. Occipital carina complete, distinctly wavy, produced to a point mediodorsally strongly lamelliform laterally, weak mediodorsally.

Mesosoma. Notauli very deep, almost smooth though with weak crenulation posteriorly, almost meeting just anterior to deep midposterior pit on mesoscutum. Scutellar sulcus wide with single carina medially. Mesopleuron largely smooth and shiny with



Figures 13–15. *Cystomastacoides asotaphaga* sp. n. holotype, Cell[^]D[®] light photomicrographs. **13** Hind wing **14** hind coxae **15** metasomal tergites 2-6, dorsal view.

moderately dense small punctures, precoxal sulcus long, moderately impressed, rather narrow, with weak rugulose sculpture. Propodeum strongly and extensively rugose, with lateral carinae distinct posteriorly and protruding.

Fore wing. Vein 2-CU1 3.6 × longer than 1-CU1. Vein 3-SR 2.1 × longer than r. Vein SR1 1.3 × longer than 3-SR.

Hind wing. Vein M+CU 1.8 × length of 1-M. Vein 2-SC+R distinctly transverse, reclinous. Vein m-cu absent.

Metasoma. 1st metasomal tergite 2.2 × longer than posteriorly wide. Metasomal tergites 1, 2 and 3 with strong midlongitudinal carina. Tergites 1-4 densely deeply punctate with punctures forming longitudinal rows separated by weak longitudinal to sublongitudinal striae. Tergite 4 densely finely punctured with little trace of striation. Tergite 5 largely smooth and shiny with few punctures. Hypopygium strongly curved ventrally.

Coloration. Antennae blackish basally becoming yellow brown gradually from near middle to apex. Body and legs largely brown yellow, posterior metasomal tergites and hypopygium somewhat darker, stemmaticum black. Wing venation and pterostigma largely black brown, fore wing veins C+SC+R and 1-R1 brown yellow, membrane uniformly hyaline.

Etymology. Name means feeding on *Asota*.

***Cystomastacoides nicolepeelerae* Quicke, sp. n.**

[urn:lsid:zoobank.org:act:21D6462F-AB7A-42BC-9F26-433D27EF27CD](https://zoobank.org/act:21D6462F-AB7A-42BC-9F26-433D27EF27CD)

http://species-id.net/wiki/Cystomastacoides_nicolepeelerae

Figs 16–24

Material examined. Holotype female, Papua New Guinea, Kokoda I, ix–x.1933, 200ft, L. E. Cheesman (museum code B.M. 1933-427) (BMNH)

Paratype [probably] female, Papua New Guinea, Oro Province, Kokoda, x.1933, 1200ft, L. E. Cheesman (museum code B.M. 1933-321) (BMNH)

Morphology. Length of body 13 mm, and of fore wing 11.2 mm.

Head. Antenna incomplete, with at least 44 flagellomeres. Median flagellomeres approximately $2.5 \times$ as long laterally as wide. 3rd segment of maxillary palp $5 \times$ longer than maximally wide with weak expansion; 2nd segment of labial palp with rather large flattened, triangular flange. Face with moderately protruding midlongitudinal area, largely densely punctate with punctures largely confluent giving rise to transverse rugulose appearance. Frons with two oblique striae between antennal socket and eye, extending slightly behind antennal socket, otherwise smooth. Distance between posterior ocelli: transverse diameter of posterior ocellus: shortest distance between posterior ocellus and eye = 1.25:4.5:1.0. Vertex with weak groove running from stemmaticum to occipital carina. Occipital carina complete, more or less smoothly rounded.

Mesosoma. Notauli very deep, punctate anteriorly, crenulated posteriorly, almost meeting just anterior to deep midposterior pit on mesoscutum. Scutellar sulcus wide with single carina medially. Mesopleuron largely smooth and shiny with some small punctures at the bases of setae, precoxal sulcus long, moderately impressed, rather narrow, almost completely smooth. Propodeum strongly and extensively rugose, with lateral carinae distinct posteriorly and protruding.

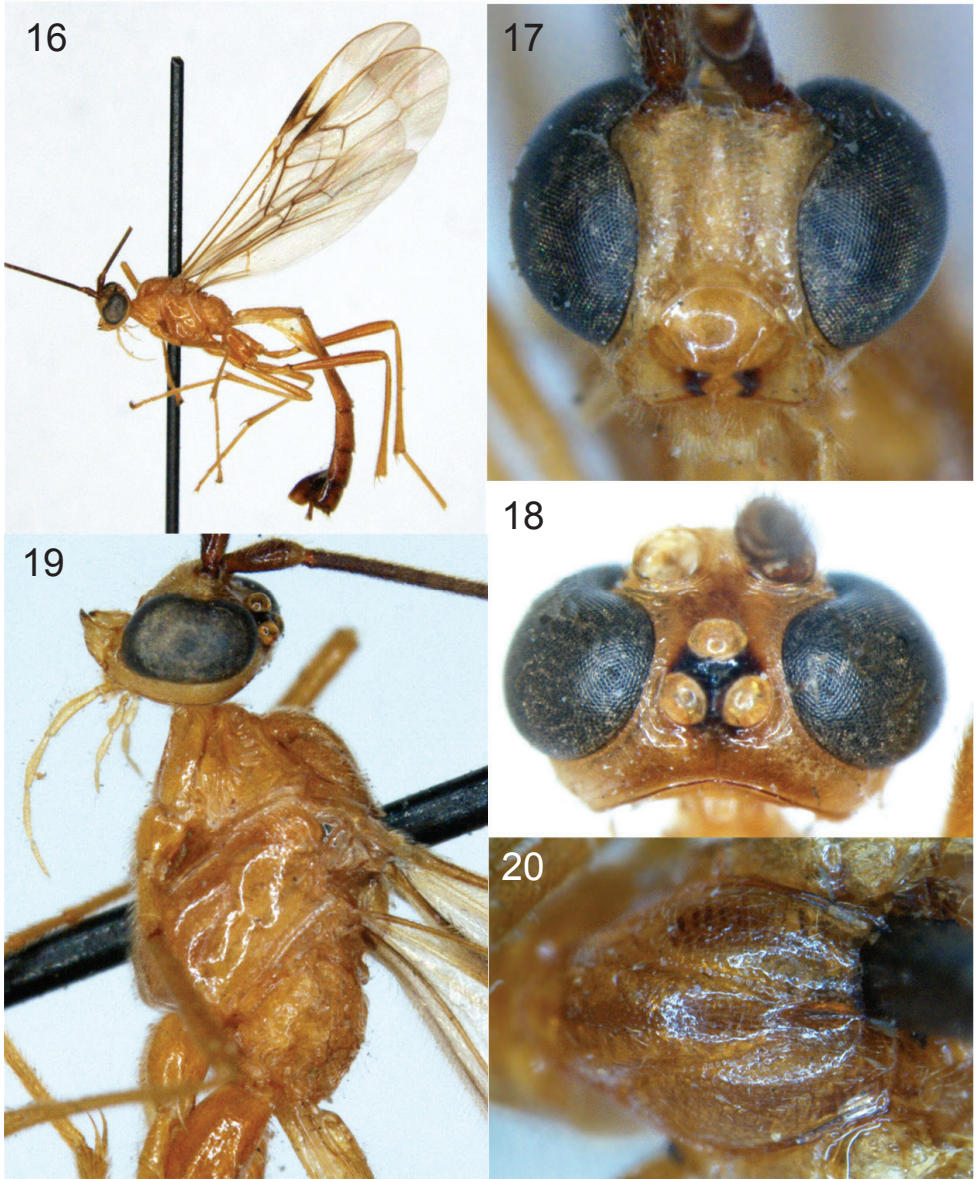
Fore wing. Vein 2-CU1 $4.1 \times$ longer than 1-CU1. Vein 3-SR $2.3 \times$ longer than r. Vein SR1 $1.1 \times$ longer than 3-SR.

Hind wing. Vein M+CU $1.4 \times$ length of 1-M. Vein 2-SC+R distinctly transverse, reclivous. Vein m-cu absent.

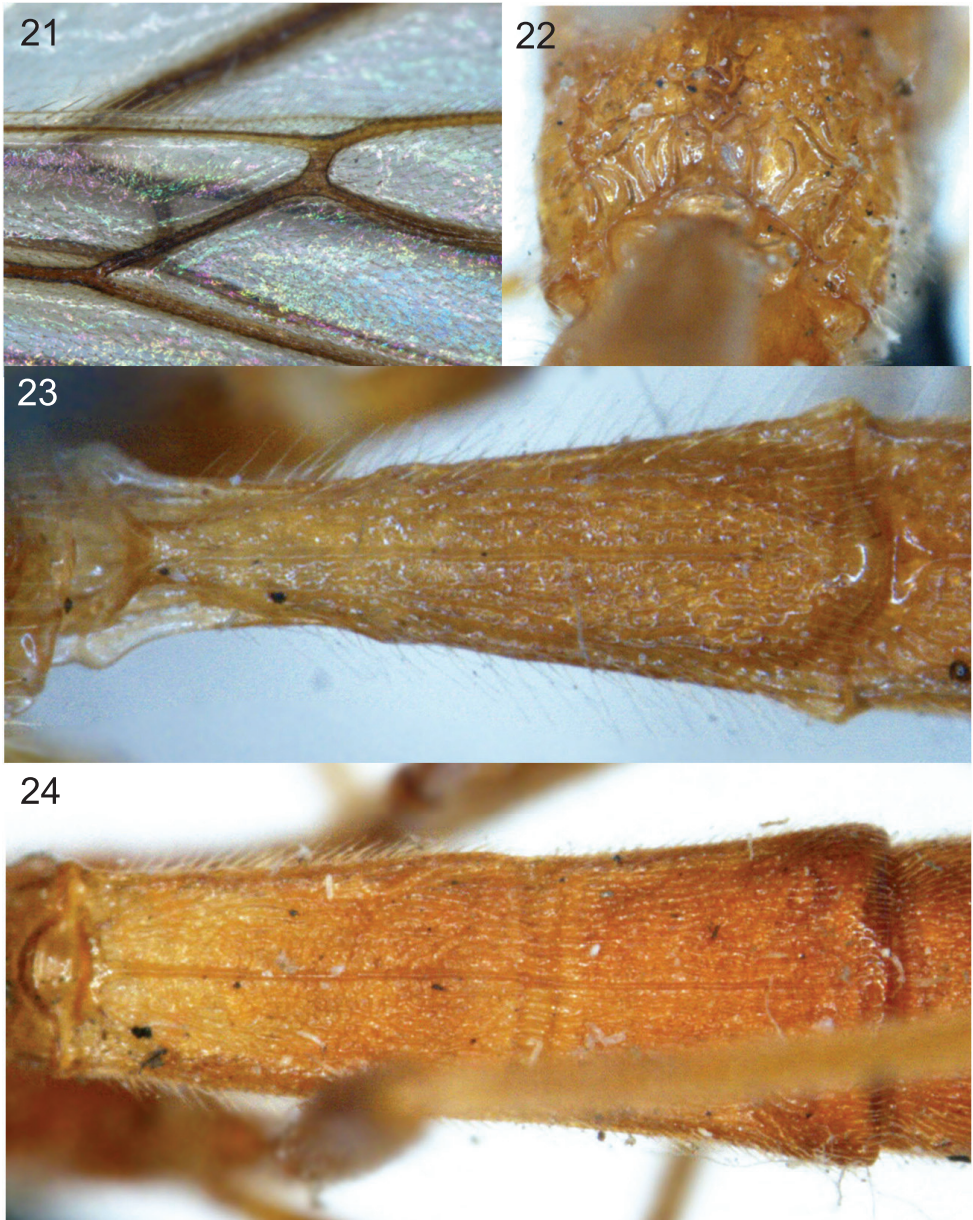
Metasoma. 1st metasomal tergite $2.3 \times$ longer than posteriorly wide. Metasomal tergites 1, 2 and 3 with strong midlongitudinal carina. Tergites 1–4 densely deeply punctate with punctures forming longitudinal rows separated by weak longitudinal to sublongitudinal striae. Tergite 4 densely finely punctured with little trace of striation. Tergite 5 largely smooth and shiny with few punctures. Hypopygium strongly curved ventrally.

Coloration. Antennae blackish basally becoming yellow brown gradually from near middle to apex. Body and legs largely brown yellow, posterior metasomal tergites somewhat darker, hypopygium and sides of tergite 6 brown-black, stemmaticum black. Pterostigma largely dark brown but with anteromedially black. Fore wing veins C+SC+R and basal half of M+CU, paler brown yellow, wing membrane largely hyaline but distinctly apically infuscate.

Etymology. Named in honour of Nicole Peeler, one of DQ's favourite authors.



Figures 16–20. *Cystomastacoides nicolepeelerae* sp. n. Cell^{AD}® light photomicrographs. **16** Habitus **17** face **18** head, dorsal view **19** head and mesosoma, lateral view **20** mesoscutum, dorsal view.



Figures 21–24. *Cystomastacoides nicolepeelerae* sp. n. Cell[^]D[®] light photomicrographs. **21** propodeum, posterodorsal view **22** detail of hind wing vein 2-SC+R **23** metasomal tergite 1, dorsal view **24** metasomal tergites 2-3, dorsal view.

Discussion

The host species, *Asota plana*, is a widespread species from the Oriental tropics to New Guinea, and from lowland to montane habitats, and is known to feed on multiple species of *Ficus* (Moraceae) (Holloway 1988). *Asota* is currently placed in the Erebiidae: Aganainae, following the recent breakup of the Noctuidae s.l. (Mitchell et al. 2006, Holloway 2011).

Other related genera are parasitoids of Arctiidae (*Cystomastax*: Zaldivar-Riverón et al. 2009), Sphingidae (*Macrostomion*; Shaw 2002, Maeto and Arakaki 2005), Lymantriidae (*Megarhogas*: Watanabe 1932) and Crambidae (*Colostomion*: Hrcek et al. 2011). Whilst the Arctiidae and Lymantriidae are strongly supported in a clade along with quadrifine noctuids which includes the Erebiidae (viz. the L.A.Q. clade) (Mitchell et al. 2006), the crambid hosts of *Colostomion* and sphingid hosts of *Macrostomion* belong to separate superfamilies not closely related to the L.A.Q. clade. Thus this apparent clade of rogadines attacks a wide range of hosts within the ‘macrolepidoptera’ group of superfamilies (Kristensen et al. 2007). The apparently more distantly related genera *Canalirogas* and *Rogasodes* (close to *Rogasella*) (Zaldivar-Riverón et al. 2009) similarly attack various ‘macrolepidoptera’ (Quicke and Shaw 2005a, b). However, this appears to have been an independent colonisation of ‘macrolepidoptera’ hosts since what is known of the biologies of the other genera of Rogadini suggests that they initially diversified on Zygaenoidea hosts, though with a few species known also to attack Lycaenidae within the ‘macrolepidoptera’ clade (sensu Zaldivar-Riverón et al. 2009).

On the basis of the barcoding COI gene fragment alone, the above two species of *Cystomastacooides* (the only two for which molecular data are available) do not come out as a monophyletic group when analysed together with all other available sequences for members of the *Colostomion* group using either maximum likelihood or maximum parsimony (Quicke et al. in prep.). Instead both associate with one subgroup of *Colostomion* species, including *Colostomion wanang* Quicke and some other undescribed/unidentified species, members of the genus *Colostomion* also appearing as three rather widely separated groups intermixed with other *Colostomion* group genera, despite all having been reared from Crambidae. To determine whether either of these genera is monophyletic will probably require combined analyses of data from multiple genes as well as denser taxonomic sampling (see Quicke et al. 2012).

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References

- Achterberg C van (1979) A revision of the subfamily Zelinae auct. (Hymenoptera, Braconidae). *Tijdschrift voor Entomologie* 122: 241–479.
- Achterberg C van (1988) Revision of the subfamily Blacinae Foerster (Hymenoptera, Braconidae). *Zoologische Verhandelingen, Leiden* 249: 1–324.
- Achterberg C van (1989) Four new genera of Braconinae and Rogadinae from the Oriental Region (Hymenoptera: Braconidae). *Zoologische Mededelingen, Leiden* 63: 79–85.
- Achterberg C van (1991) Revision of the genera of the Afrotropical and W. Palaearctical Rogadinae Foerster (Hymenoptera: Braconidae). *Zoologische Verhandelingen, Leiden* 273: 1–102.
- Butcher BA, Smith MA, Quicke DLJ (2011) A new derived species group of *Aleiodes* parasitoid wasps (Hymenoptera, Braconidae, Rogadinae) from Asia with descriptions of three new species. *Journal of Hymenoptera Research* 23: 35–42. doi: 10.3897/JHR.23.1663
- Chen X-X, He J-H (1997) Revision of the subfamily Rogadinae (Hymenoptera: Braconidae) from China. *Zoologische Verhandelingen, Leiden* 308: 1–187.
- Holloway JD (1988) The Moths of Borneo: Family Arctiidae, Subfamilies Synthominae, Euchromiinae, Arctiinae; Noctuidae misplaced in Arctiidae (Camptoloma, Aganainae). Southdene Sdn. Bhd., Kuala Lumpur. 101 pages, 6 color plates.
- Holloway JD (2011) The Moths of Borneo: Families Phaudidae, Himantopteridae and Zygaenidae; revised and annotated checklist. *Malayan Nature Journal* 63: 1–548.
- Hrcek J, Miller SE, Quicke DLJ, Smith MA (2011) Molecular detection of trophic links in a complex insect host-parasitoid food web. *Molecular Ecology Resources* 11: 786–794. doi: 10.1111/j.1755-0998.2011.03016.x
- Kristensen NP, Scoble MJ, Karsholt O (2007) Lepidoptera phylogeny and systematics: the state of inventorying moth and butterfly diversity. *Zootaxa* 1668: 699–747.
- Maeto K, Arakaki N (2005) Gregarious emergence of *Macrostomion sumatranum* (Hymenoptera: Braconidae; Rogadinae) from the mummified, full-grown larvae of *Theretra silhetensis* (Lepidoptera: Sphingidae). *Entomological Science* 8:131–132. doi: 10.1111/j.1479-8298.2005.00107.x
- Mitchell A, Mitter C, Regier JC (2006) Phylogeny of Noctuidae (Lepidoptera): evidence from nuclear protein-coding genes. *Systematic Entomology* 31: 21–46.

- Novotny V, Miller SE, Baje L, Balagawi S, Basset Y, Cizek L, Craft KJ, Dem F, Drew RAI, Hulcr J, Leps J, Lewis OT, Pokon R, Stewart AJA, Samuelson GA, Weiblen GD (2010) Guild-specific patterns of species richness and host specialization in plant-herbivore food webs from a tropical forest. *Journal of Animal Ecology* 79: 1193–1203.
- Quicke DLJ, Shaw MR (2005a) First host record for the rogadine genus *Pholichora* van Achterberg (Hymenoptera: Braconidae) with description of a new species and notes on convergent wing venation features. *Journal of Natural History* 39: 531–537. doi: 10.1080/00222930410001708678
- Quicke DLJ, Shaw MR (2005b) First host records for the rogadine genera *Rogasodes* Chen and He and *Canalirogas* van Achterberg & Chen (Hymenoptera: Braconidae) with description of a new species and survey of mummy types within Rogadinae s.str. *Journal of Natural History* 39: 3525–3542. doi: 10.1080/00222930500392782
- Quicke DLJ, Smith MA, Janzen DH, Hallwachs W, Fernandez-Triana J, Laurenne NM, Zaldivar-Riverón A, Shaw MR, Broad GR, Klopstein S, Shaw SR, Hrcek J, Hebert PDN, Miller SE, Rodriguez JJ, Whitfield JB, Sharkey MJ, Sharanowski BJ, Jussila R, Gauld ID, Chesters D, Vogler AP (2012) Utility of the DNA barcoding gene fragment for parasitic wasp phylogeny (Hymenoptera: Ichneumonoidea): data release and new measure of taxonomic congruence. *Molecular Ecology Resources* 2012: 676–685. doi: 10.1111/j.1755-0998.2012.03143.x
- Quicke DLJ, Yen S-H, Mori M, Shaw MR (2003) First host records for the rogadine genus *Conspinnaria* (Hymenoptera: Braconidae), and notes on Rogadinae as parasitoids of Zygaenidae (Lepidoptera). *Journal of Natural History* 38: 1437–1442.
- Shaw MR (2002) A new species of *Macrostomion* Szépligeti (Hymenoptera: Braconidae: Rogadinae) from Papua New Guinea, with notes on the biology of the genus. *Zoologische Mededelingen, Leiden* 76: 133–140.
- Szépligeti G (1900) Braconiden aus New-Guinea in der Sammlung des Ungarischen National Museums. *Termesztudományi Füzetek*. 23: 49–65.
- Szépligeti G (1904) Hymenoptera. Fam. Braconidae. *Genera Insectorum*. 22: 1–253.
- Watanabe C (1932) Description of new species of genera *Megarhogas*, *Cystomastax* and *Stantonia* (Braconidae) from Formosa. *Insecta Matsumurana* 6: 184–189.
- Walker F (1854) List of the Specimens of Lepidopterous Insects in the Collection of the British Museum 2: 450.
- Zaldivar-Riverón A, Shaw MR, Saez AG, Mori M, Belokobylskij SA, Shaw SR, Quicke DLJ. (2009) Evolution of the parasitic wasp subfamily Rogadinae (Braconidae): phylogeny and evolution of lepidopteran host ranges and mummy characteristics. *BMC Evolutionary Biology* 8: 329. doi: 10.1186/1471-2148-8-329