Zootaxa 2274: 45–50 (2009)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

A new *Arthula* Cameron (Ichneumonidae, Cryptinae) parasitoid of *Ropalidia plebeiana* Richards (Vespidae) and host of *Amoturoides breviscapus* Girault (Torymidae) (Hymenoptera)

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Abstract

Arthula plebeja Ubaidillah and Kojima, **sp. nov.**, a parasitoid of the Australian paper wasp *Ropalidia plebeiana* Richards, and host of the torymid hyperparasitoid *Amoturoides breviscapus* Girault, is described and illustrated. Both *A. plebeja* and *A. breviscapus* are estimated to have a bivoltine life cycle, the first overwintering in the pupal stage, and the second in the prepupal and/or pupal stage.

Key words: Cryptinae, *Arthula*, *Ropalidia plebeiana*, Torymidae, Vespidae

Introduction

Girault (1932) described *Amoturoides breviscapus* based on specimen(s) collected in Townsville, Queensland, Australia. Bouček (1978) designated the lectotype, and mentioned "[…] identified as *breviscapus* a long series […] reared from a nest of a wasp, *Ropalidia plebeiana*". Later, Bouček (1988: 138) referred to the biology of *A. breviscapus* mentioning "[…] a recent record of the same *Amoturoides* species from India reveals that it develops as a secondary parasite in the nest of the wasps via the tachinid fly *Koralliomyia portentosa*", which "is also supposed to occur in Australia". Yet, it is still unknown whether this torymid parasitoid is the primary parasite of *R. plebeiana* Richards or hyperparasitic on a primary parasite of *R. plebeiana*.

We successfully reared *A. breviscapus* from nests of *R. plebeiana* and found that it is a hyperparasitoid of an *Arthula* species; this genus is part of the Sphecophagina, and three valid species have been recognized. Gauld (1984: 150), dealing with *Arthula*, stated "Australian species. I have seen two undescribed species", without giving any data of the specimens; since then, no species of this genus has been formally described from Australia. As shown below, our Australian *Arthula* parasitoid is distinctly different from the three valid *Arthula* species recorded from the Oriental and the eastern part of palearctic region.

The aim of this paper is to describe a new *Arthula* parasitoid, as well as provide biological information about its association with *R. plebeiana*, and its torymid hyperparasitoid, *A. breviscapus*.

Materials and methods

Nests of *R. plebeiana* were collected in the fall (late March through late April) and in the winter (July) of 2004, and in early May of 2005, in Canberra, and at four sites along Kings Highway, about 5 to 20 km from

Accepted by A. Aguiar: 17 Sept. 2009; published: 28 Oct. 2009

Batemans Bay, New South Wales. The collected nests, except those from Canberra, were found in dense aggregations, each consisting of a few hundred colonies (see Saito & Kojima 2005). The nests were dissected in laboratory to remove the brood rearing cells that contained ichneumonid cocoons. The cocoons were gently opened with a sharp forceps, at their caps, to examine the contents, and kept separately in a small plastic bag at room temperature to collect emerging adult parasites.

Observation on the morphology and color pattern of ichneumonid specimens were made on pinned, dry specimens under a dissecting stereoscopic microscope. Drawings were made with the aid of a drawing tube. Morphological terminology in the description of the new *Arthula* species follows Gauld and Hanson (1995).

Genus *Arthula* Cameron

Arthula Cameron, 1900. Type species: *Arthula brunneocornis* Cameron, 1900, by monotypy.
Orientocryptus Uchida, 1931. Type species: *Orientocryptus formosanus* Uchida, 1931, by original designation.
Kuniocryptus Sonan, 1937. Type species: *Orientocryptus flavofasciatus* Uchida, 1931, by original designation.

The genus *Arthula* is one of three closely related genera forming the subtribe Sphecophagina, and is characterized by the basal transverse carina of propodeum being strong, and the short and broad *2r-m* of the forewing being opposite or slightly basad of *2m-cu* (also see Townes *et al.* 1965, Gauld 1984). Three valid species have been previously recognized in the genus: *A. brunneocornis* Cameron, from India, *A. formosanus* (Uchida), from Taiwan, and *A. flavofasciata* (Uchida), known as a parasitoid on paper wasps of the genus *Polistes* in Taiwan and Japan.

Arthula plebeja Ubaidillah and Kojima, sp. nov.

(Figs 1–10)

Diagnosis. Body mostly brown. Antenna with 23–24 flagellomeres in female, 27–28 flagellomeres in male; propleuron densely punctured; first metasomal tergum not strongly widened posteriorly, its apical width about 1.5x basal width, not very long, about 2.7x as long as its apical width; second tergum slightly shorter than or about as long as its apical width.

Female. Body length about 7.5–10 mm (n = 5) (holotype about 10 mm), forewing length about 6–7.5 mm (n = 5) (holotype about 7.5 mm).

Body mostly brown; stained with black along anterior margin of pronotum and anterior margin of mesoscutum, on prepectus, median part of mesopleoron, sub-lateral and sub-ventral parts of propodeum, and all coxae (Fig. 1). Head and mesosoma with following yellow marks: stripe encircling eye and connected to transverse wide band below toruli, ill-defined band along apical margin of clypeus, narrow band along posterior margin of pronotum, paired oval anterolateral spots on mesoscutum, oval anterior spot on axilla, paired semi-rounded spots on dorsellum, posterior half of propodeum medially, and transverse stripe along posterior margin of each of second to fifth metasomal terga.

Head in frontal view (Fig. 2) suboval, nearly 1.4x as wide as high, in dorsal view (Fig. 3) about 2x as wide as long; occipital carina complete. Area among ocelli weakly raised, unmargined by either carina or suture; anterior and posterior ocelli nearly the same size; distance between inner margins of posterior ocelli about 1.5x their diameter, and about 0.8 of distance between outer margin of posterior ocellus and inner eye margin. Eye oval, bare, in frontal view inner margins nearly parallel; in profile maximum width of eye about 2x that of gena. Malar space about 0.4 of eye height. Face slightly raised medially, with paired broad and shallow oblique grooves diverging dorsally from bases of toruli. Clypeus oval, slightly convex, depressed ventromedially, separated from supraclypeal area by shallow arched groove, which is deeper in the ventrolateral corners. Maxillary palpus with five palpomeres; labial palpus with four palpomeres. Mandible

tapering apically, with two teeth; dorsal tooth slightly larger and longer than ventral one (Fig. 4). Antenna filiform, narrowing apically, with 23 (holotype) or 24 flagellomeres (3 paratypes), or number asymmetric (1 paratype); first flagellomere about 2.7x as long as its apical width, about 1.6x as long as second flagellomere; second to seventh flagellomeres nearly equal in length; subsequent flagellomeres becoming narrower and shorter towards apical part of flagellum; terminal flagellomere bullet-shaped, nearly 2x as long as its basal width (but 1.4–1.6x as long as wide when the flagellum has 24 flagellomeres).

Mesonotum closely punctured, densely covered with short setae; notaulus narrow, impressed, traceable in anterior half of mesoscutum; disk of mesoscutum moderately punctured, strongly wrinkled along notauli and over broad area behind their terminus, and alongside margins of lateral disk. Scutellum slightly convex dorsally, finely, closely punctured. Propodeum densely covered with short setae, coarsely reticulated to densely punctured medially and laterally, with short longitudinal rugae on anterior margin; median longitudinal carina absent. Mesopleuron densely covered with short setae, closely punctured, most coarsely on median disk; propodeal spiracle elliptical.

Forewing (Fig. 5) radial cell 3.0–3.5x as long as wide; costal notch distinct; *2m-cu* with two bullae. Hind wing with distal abscissa of *1A* complete.

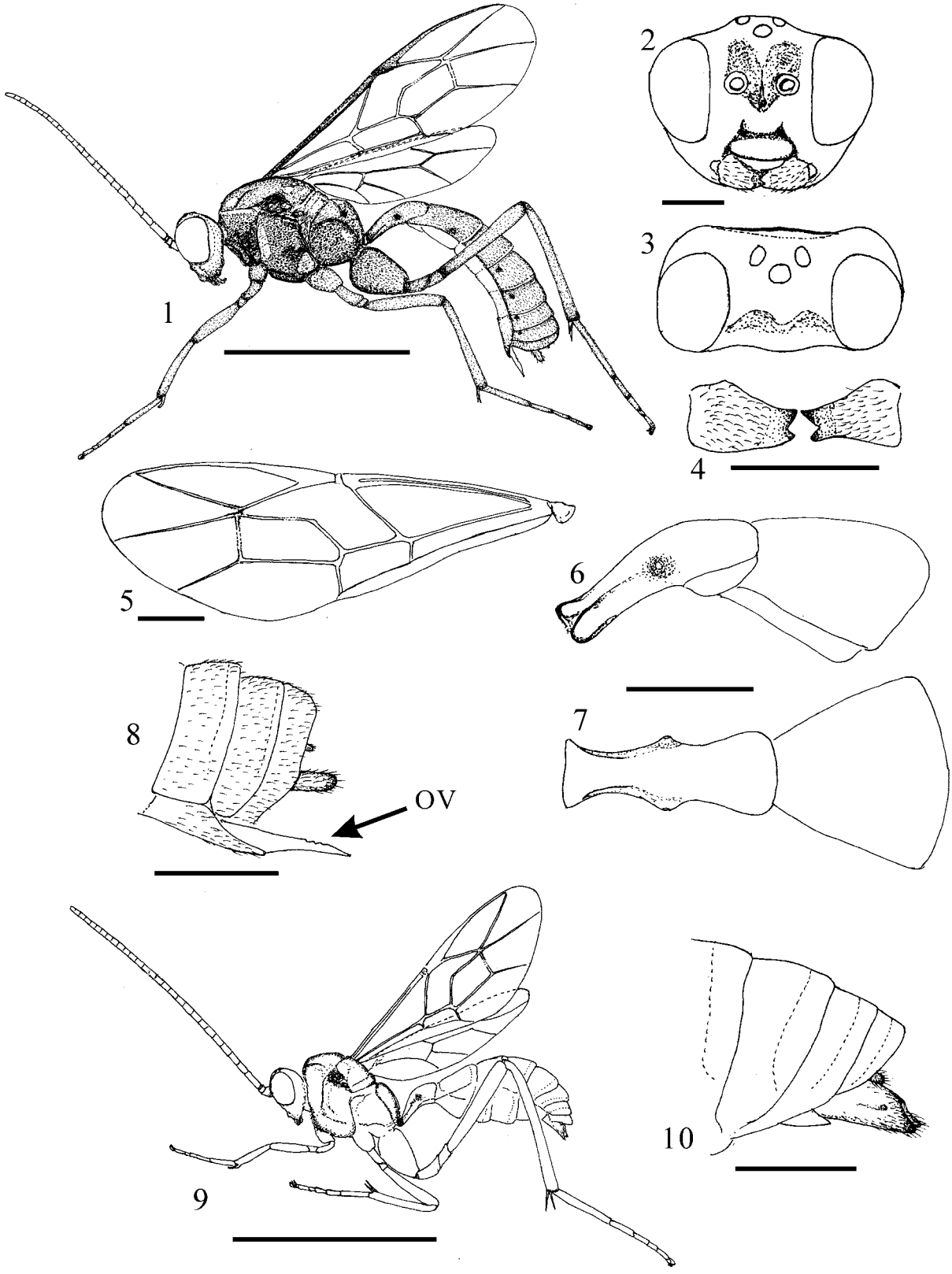
Metasoma finely and closely punctured, densely covered with short setae. First tergum (Figs 6, 7) weakly widening posteriorly, in dorsal view apical width about 1.5x basal width, length (measured in lateral view as the distance from the apical margin of basal slit to posterodorsal corner of the tergum) about 2.7x its apical width, without glymma, basal half with two weak, sub-median carinae; spiracle strongly produced as tubercle at mid-length of the tergum; second tergum 0.9–1.0x as long as its apical width; apical width of second tergum 2.0–2.4 that of first tergum. Ovipositor relatively short (Figs 1, 8), about as long as length of terminal sternum; ovipositor sheath hairy.

Male. Body length about 8–8.5 mm (n = 6), forewing length about 6.5–7 mm (n = 6). Similar to female, but apical yellow bands on metasomal segments wider than in female (Figs 9, 10); antenna with 27–28 flagellomeres; first flagellomere proportionally slightly longer than in female, nearly 3x as long as its apical width; terminal flagellomere 1.8–2.3x and 1.3–1.7x as long as its basal width for flagellum with 27 and 28 flagellomeres, respectively.

Type series. Holotype: ♀ (repository: Australian National Insect Collection, CSIRO, Canberra), labeled (slash indicates new line) "AUSTRALIA, N.S.W. / Cabbage Tree Creek / (along Kings Highway) / 35°34'S, 105°02'E / emerged 10.vii.2004 from / *Ropalidia plebeiana* nest / kept in laboratory / Nest collected iii-iv.2004 / J. Kojima" and "HOLOTYPE / female / *Arthula plebeja* Ubaidillah & Kojima". Paratypes: 10 specimens (Australian National Insect Collection, Museum Zoologicum Bogoriense and Natural History Collection of Ibaraki University): 2♀2♂, same data as holotype; 1♀, "Australia, N.S.W. / Cabbage Tree Creek / 35°34'S, 105°02'E / 29.ii.2000. J. Kojima"; 1♀1♂, "Australia, ATC / Canberra, emerged in vii.2004 / from *Ropalidia plebeiana* nest / collected in iii-iv 2004 / J. Kojima; 3♂, "Australia, NSW / 35°39'S, 105°09'E / 1.9 km in driveway distance / from Batemans Bay in / direction of Canberra / emerged on 16.vii.2004 [12.viii.2004 (for 2♂)] / from *R. plebeiana* nests / coll. in iii-iv 2004, J. Kojima."

Etymology. The specific name, *plebeja*, is a Latin adjective meaning "plebeian," used after the specific name of the host paper wasp, *Icaria plebeja* de Saussure, 1863, *non* 1862 (= *Ropalidia plebeiana* Richards, 1978).

Remarks. This species is similar to *A. flavofasciata* in the shape of the antenna and metasoma, both of which seem to be key characters to distinguish *Arthula* species, but can be easily distinguished from *A. flavofasciata* by having the first metasomal tergum weakly widened posteriorly (apical width about 1.5x as wide as the basal width vs. about 2.0x in *A. flavofasciata*), and the dorsal surface of the same tergum in profile more or less smoothly curved (angled in *A. flavofasciata*). *Arthula plebeja* is distinctly different from the other two species, *A. brunneocornis* and *A. formosanus*, by the female antenna having the smallest number of flagellomeres (23–24 in *A. plebeja* vs. 26–27 in *A. brunneocornis* vs. 28 in *A. formosanus*), and in the proportionally shorter first two metasomal segments (in *A. brunneocornis* and *A. formosanus*, the first tergum much elongated and the second tergum distinctly longer than the apical width).



FIGURES 1–10. *Arthula plebeja* Ubaidillah and Kojima, **sp. nov.** 1–8, female, holotype. 9–10, male, paratype. 1 and 9, habitus. 2, head, frontal view. 3, head, dorsal view. 4, mandibles. 5, forewing. 6, first and second metasomal segments, lateral view; 7, first and second metasomal segments, dorsal view. 8 and 10, apical part of metasoma, lateral view (OV, ovipositor). Scale bars: 1 mm, but 5 mm for figures 1 and 9.

Notes on biology of *Arthula plebeja* and its hyperparasite, *Amoturoides breviscapus*

In the southeastern coastal area of New South Wales (Australia), reproductive females, i.e., females that mate and enter winter hibernation (called "gynes"), and males of *Ropalidia plebeiana*, are both produced as adults in early March through the end of May. The overwintered females start to return to the site of their natal nests in early spring (mid-August to early September) to initiate their own colonies, either by reusing nests of previous season or by building new nests (Saito & Kojima 2005).

From the nests of *R. plebeiana* collected in the fall, and kept at room temperature, emerged most *A. plebeja* specimens, in July. In nature, the month of July in New South Wales (and Canberra) is still cold, and it can be reasonably assumed that in this case *A. plebeja* would have emerged as adults in late spring or summer. The cocoon of *A. plebeja* is, as referred to by Richards (1978), a pale-brown colored capsule composed of thin, film-like layer lining the inside of the wall of a brood-rearing cell of *R. plebeiana*, with its cap being slightly oblique. The structure of the cocoon capsule is nearly the same as that of the summer cocoon of the Cryptinae *Latibulus hokkaidensis* Lee and Seung (Makino 1983, as *L. argiolus* (Rossi); for taxonomic status, see Lee & Seung 2006). All individuals of *Arthula plebeja* observed in the fall (11 individuals including the nine successfully reared to adult) were at the pupal stage, showing that they overwinter as pupae.

Examination of the *A. plebeja* cocoons revealed that the pupae of *A. plebeja* were secondarily parasitized by *Amoturoides breviscapus*, at a high frequency, at all the four sites along Kings Highway, where *R. plebeiana* nests are found in aggregations (85–100%, n = 13–40 *Arthula* cocoons at each site, as collected in 2005). On the other hand, in Canberra, where *R. plebeiana* does not form nest aggregations, the frequency of parasitism reached 71% (n = 17). In the fall, nearly all individuals of *A. breviscapus* were at the larval stage, but some were at the prepupal stage. Individuals in the *Arthula* cocoons collected at the end of July were prepupae or pupae. The number of *A. breviscapus* larvae per *Arthula* cocoon was 10.1 ± 3.3 (mean ± SD; range 3–19; 119 *Arthula* cocoons in 27 *R. plebeiana* nests collected at Cabbage Tree Creek in early May 2004).

Based on the observations of *R. plebeiana* nests collected in fall and winter, and colony cycle of *R. plebeiana* given in Saito and Kojima (2005), and assuming that the hosts of *Arthula plebeja* and *Amoturoides breviscapus* in the area are respectively specific to *R. plebeiana* and *A. plebeja*, both *A. plebeja* and *A. breviscapus* are suggested to have bivoltine life cycle. That is, the adults of *A. plebeja* that have overwintered as pupae would emerge in late spring or early summer to mate and lay eggs on the larvae or young pupae of the first brood of its host social wasp, *R. plebeiana*. Then, adults derived from eggs laid in early summer may emerge from late summer to fall, and lay eggs in *R. plebeiana* nest cells containing mature larvae or young pupae that are to be gynes or males. This assumption is also supported by the fact that an adult female of *A. plebeja* was collected in flight at the end of February (see item Material examined) when the gynes and males of *R. plebeiana* are larval or pupal stages. We did not recognize such distinct differences between the two generations of *A. plebeja* in the cocoon structure and adult morphology as reported for *Latibulus hokkaidensis* by Makino (1983). The life cycle of *Amoturoides breviscapus* could be synchronized with that of *A. plebeja* but might, as can be reasonably assumed, lag behind.

Acknowledgments

This study was partly supported by the RONPAKU (Dissertation PhD) Program of the Japan Society for the Promotion of Science to the first author. We thank J. LaSalle for the identification of *Amoturoides breviscapus*.

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