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A new species of *Anagyrus* (Hymenoptera, Encyrtidae) from Malaysia, parasitoid of *Lanceacoccus* sp. (Hemiptera, Pseudococcidae)

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Abstract

A new species of *Anagyrus* Howard, 1896 (Hymenoptera: Encyrtidae), *A. minipedicellus* Zu & Zhang **sp. n.**, is described from Borneo of Malaysia as a parasitoid of *Lanceacoccus* sp. (Hemiptera: Pseudococcidae), and DNA barcoding of the new species is given.

Keywords

Chalcidoidea, Tetracneminae, Anagyrini, new species, Sabah

Introduction

Anagyrus Howard, 1896 is one of the most diverse genus of Encyrtidae, containing 282 species worldwide (Noyes 2017), which are mainly endoparasitoids of mealybugs (Hemiptera: Pseudococcidae), but some Australian species have been recorded as parasitoids of coccinellid (Coleoptera: Coccinellidae) (Noyes and Hayat 1994, Noyes 2000). The members of the genus are very important as biological control agents and 19 species have been used in biological control (Noyes 2000).

The genus has got comparatively little attention in Malaysia. Noyes and Hayat (1994) reviewed 74 species of Oriental *Anagyrus* and 8 species were reported from Malaysia: *A. chrysos* Noyes & Hayat, 1994, *A. ephyra* Noyes & Hayat, 1994, *A. luci* Noyes & Hayat, 1994, *A. malayensis* Noyes & Hayat, 1994, *A. saccharicola* Timberlake, 1932, *A. subtilis* Noyes & Hayat, 1994, *A. thailandicus* (Myartseve, 1979) and *A. tricolor* (Girault, 1913), among them *A. ephyra*, *A. malayensis* and *A. subtilis* were described from Malaysia.

In the present paper, *A. minipedicellus* Zu & Zhang, sp. n. is described as new to science, and a key to Malaysian species of *Anagyrus* is provided.

Material and methods

All the specimens in the present study were collected from Mt. Trus Madi by rearing, then dissected and mounted in Canada balsam on slides following the method described by Noyes (1982). Morphological terminology and abbreviations follow those of Noyes and Hayat (1994) and Noyes (2000) with some modifications. Photographs were taken with a digital CCD camera attached to an Olympus BX51 compound microscope, and most measurements were made from slide-mounted specimens using an eye-piece reticle, except body length, AOL, OCL, OD, OOL, POL.

Molecular studies

Eight individuals of *A. minipedicellus* were used to obtain their DNA barcodes. Total genomic DNA was extracted using the DNeasy Blood & Tissue Kit (Qiagen) following the manufacturer's protocols. Polymerase chain reactions (PCR) were carried out in 50 μL reaction volumes using TaKaRa ExTaq Polymerase kit. Final volumes included 5 μL of 10×Buffer, 25 mM MgCl2, 2.5 mM dNTP mixture, 10 pmol of each primer, 1U of ExTaq and 5 μL of genomic DNA. The COI gene fragment was amplified using the primers FWPTF1 (Li et al. 2010) and Lep-R1 (Hebert et al. 2004). The PCR cycle program for COI followed Hebert et al. (2003). Sequencing was performed directly from positive products in both directions using BigDye v3.1 on an ABI 3730xl DNA Analyzer (Applied Biosystems).

The following abbreviations are used in the text:

F1–6 funicular segments 1–6
AOL minimum distance between a posterior ocellus and anterior ocellus
OCL minimum distance between a posterior ocellus and occipital margin
OD longest diameter of an ocellus
OOL minimum distance between a posterior ocellus and eye margin
POL minimum distance between posterior ocelli
MT length of mid tibia
OL length of the ovipositor
IZCAS Institute of Zoology, Chinese Academy of Sciences, Beijing, China

Systematics

Key to species of *Anagyrus* from Malaysia (females)

1	Fore wing infuscate in apical 2/3	***A. thailandicus***
–	Fore wing hyaline	**2**
2	Head unicolorous, dark brown or black	**3**
–	Head at least partially orange	**5**
3	Antenna with F1–F5 dark brown	***A. tricolor***
–	Antenna with at least F4 and F5 yellow or white	**4**
4	Ovipositor clearly exserted, the exserted part at least about 2/3 length of mid tibial spur; occipital margin behind posterior ocelli with a sharp raised carina	***A. malayensis***
–	Ovipositor not or hardly exserted; occipital margin behind posterior ocelli sharp but without a raised carina	***A. luci***
5	Only F1 dark brown, remaining segments of funicle white	**6**
–	Funicle with at least F1–F3 completely or partially dark brown	**7**
6	Body quite flattened and elongate; fore wing nearly 2.5× as long as broad; ovipositor about 1.5× as long as mid tibia	***A. saccharicola***
–	Body stout, not elongate and not dorsoventrally flattened; fore wing about 2× as long as broad; ovipositor slightly shorter than mid tibia	***A. chrysos***
7	F1 clearly longer than pedicel; F6 brown	***A. minipedicellus* sp. n.**
–	F1 at least slightly shorter than pedicel; F6 yellow or white	**8**
8	Ovipositor about 0.69× as long as mid tibia; F1 much shorter than any other funicular segments	***A. subtilis***
–	Ovipositor about 1.17× as long as mid tibia; F1 similar to others	***A. ephyra***

Anagyrus minipedicellus Zu & Zhang, sp. n.

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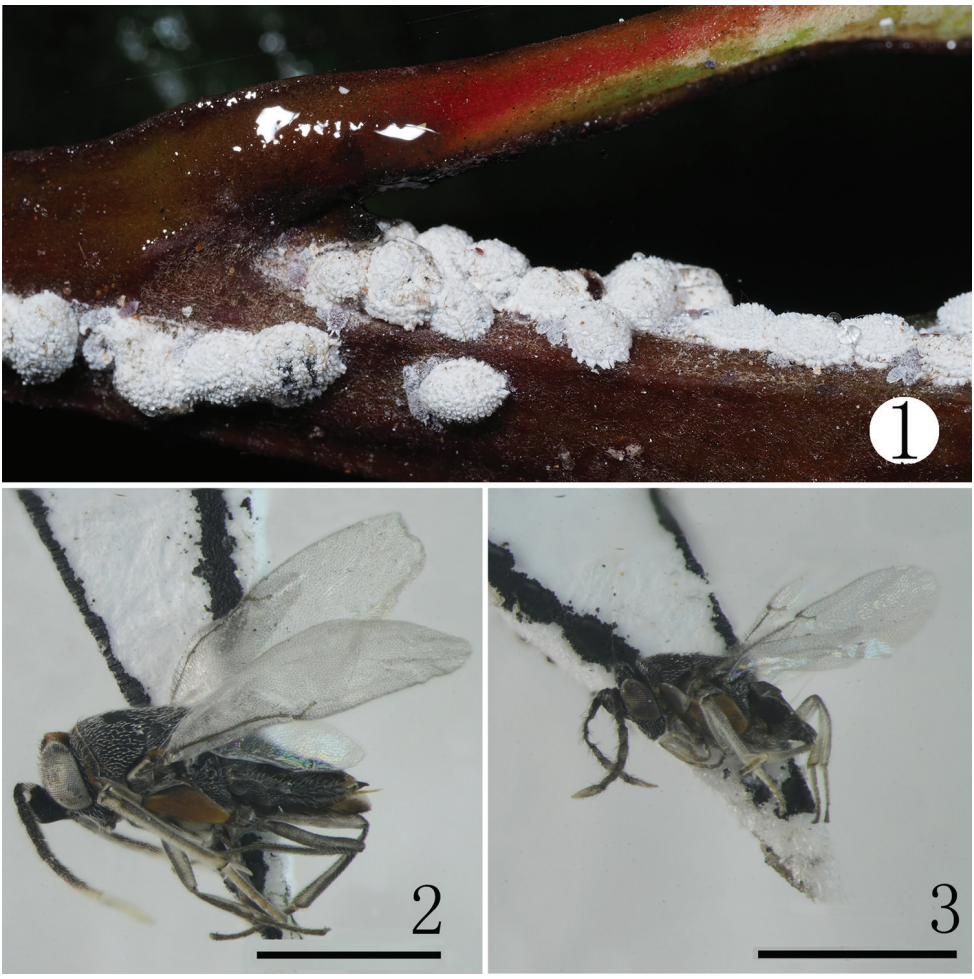
Figs 1–18

Holotype. ♀ [on slide], MALAYSIA, Sabah, Mt. Trus Madi, 5°26'27"N; 116°27'0"W, c. 1180m, 8.II.2017, Guo-Hao Zu, rearing from *Lanceacoccus* sp. (Hemiptera: Pseudococcidae) (Fig. 1) (IZCAS).

Paratypes. 4♀, 4♂ [4♀, 2♂ on slides], the same data as holotype (IZCAS). 15♀, 3♂ [2♀, 1♂ on slides], MALAYSIA, Sabah, Mt. Trus Madi, 5°26'27"N; 116°27'0"W, c. 1180m, 3.IV.2017, Xu Zhang rearing from *Lanceacoccus* sp. (Hemiptera: Pseudococcidae) (IZCAS).

Diagnosis. *Female.* Length, excluding ovipositor, 1.38–1.83 mm. Body stout (Fig. 2); head generally orange with interantennal prominence and gena below mid eye level dark brown; scape dark brown, with a white subapical band; pedicel and funicle generally dark brown; clava white; mesosoma and metasoma mostly dark brown, except mesopleuron orange; frontovertex nearly 0.4× head width; clypeal margin slightly



Figures 1–3. 1 *Lanceacoccus* sp.; *A. minipedicellus* sp. n.: **2** habitus, lateral view (female, paratype) **3** habitus, lateral view (male, paratype). Scale bars: 1mm.

emarginate; antennal scape strongly broadened, about twice as long as broad; pedicel shorter and narrower than F1; all funicular segments at least 1.5× as long as broad; fore wing completely hyaline, 2.15× as long as broad; costal cell broad, with four complete lines of setae ventrally; ovipositor about 0.7× as long as mid tibia.

Male (length, 1.22–1.33 mm): Color similar to female (Fig. 3), except head completely black, flagellum black, gradually becoming yellowish distad; antenna with scape about twice as long as broad, all funicular segments much longer than broad, F1 the longest; scale-like sensilla present only on F6; frontovertex nearly half head width; fore wing 2.08× as long as broad, costal cell ventrally with four lines of setae; metasoma shorter than mesosoma; phallobase without digiti; aedeagus about 1.6× as long as mid tibia.

Description. *Female.* Holotype. Length, 1.83 mm (excluding ovipositor). Head generally orange, interantennal prominence dark brown, gena dark brown to mid eye level, occiput mostly dark brown. Antenna with radicle dark brown; scape dark brown

with a white subapical band; pedicel and funicle black, funicle gradually becoming paler distad and ventrally paler, clava white. Mesosoma dark brown; mesopleuron orange. Wings hyaline. Legs generally yellowish white, except dorsal and ventral margins of fore coxa, fore and mid femora, hind tibia dark brown, mid coxa mostly dark brown, hind coxa brown, all tarsi yellowish brown. Metasoma dark brown.

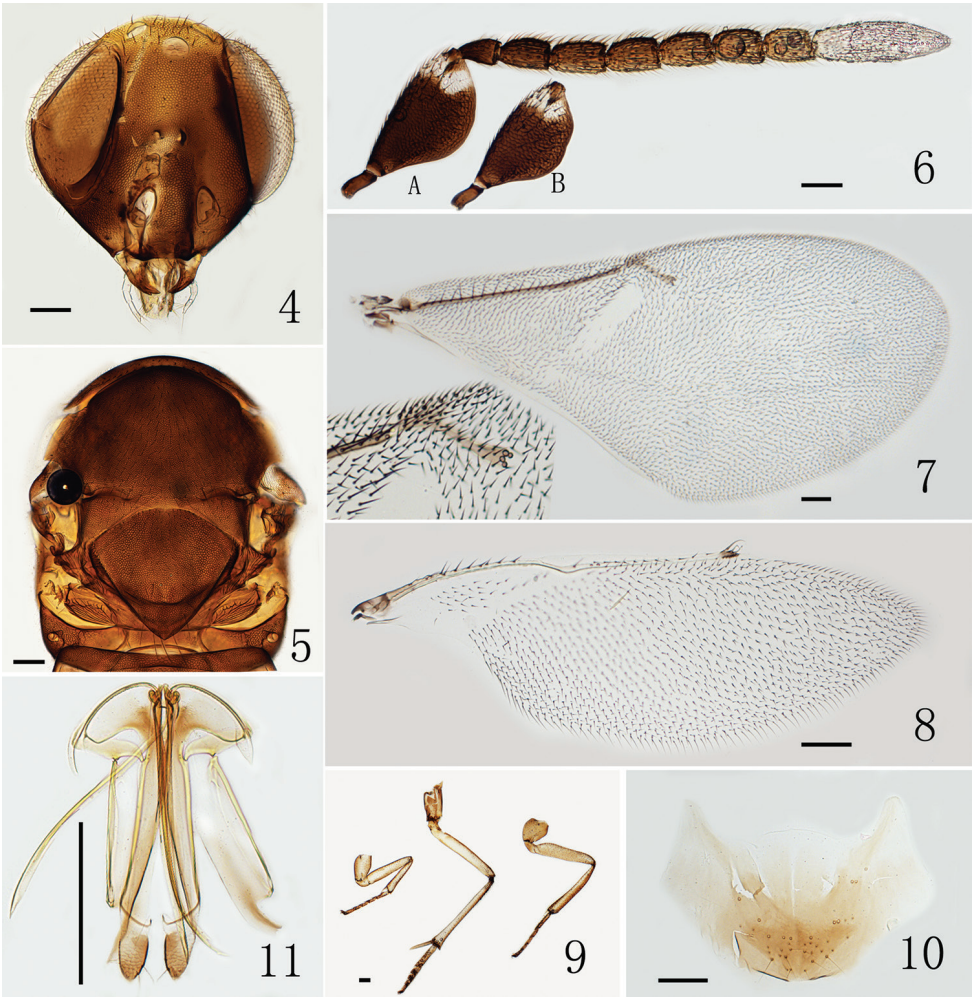
Head. Frontovertex 0.37× head width, with very fine scale-like sculpture; setae on frontovertex about half as long as diameter of anterior ocellus; ocelli forming an angle of about 85°; posterior ocellus slightly closer to occipital margin than to eye margin; eye reaching occipital margin, with dense, dark brown setae, each seta about 1.5× as long as a facet width; head, in frontal view (Fig. 4), slightly (1.12×) wider than high; antennal torulus with its dorsal margin well above lower margin of eyes and separated from mouth margin by about its own height; antennal scrobes moderately deep; clypeal margin slightly emarginate. Antennal scape (Fig. 6) strongly broadened and flattened, 1.9× as long as broad; pedicel short, 1.45× as long as broad, 0.75× as long as F1; all funicular segments at least 1.5× as long as broad and subequal in length; clava 3.3× as long as broad, shorter than preceding three funicular segments combined; funicle with linear sensilla on all segments. Measurements (μm): head high 600; head width 670; frontovertex width 250; OD 66; POL 110; OOL 29; OCL 23; AOL 58; eye length 420; malar space 180; length and (width) – radicle 90; scape 360 (190); pedicel 90 (62); F1 120 (80); F2 130 (80); F3 130 (80); F4 130 (80); F5 120 (80); F6 120 (78); clava 330 (100).

Mesosoma (Fig. 5) dorsally with fine sculpture as on frontovertex; posterior margin of pronotum broadly concave; scutellum 1.13× as wide as long, pointed apically, and almost as long as mesoscutum. Fore wing (Fig. 7) moderately broad, about 2.2× as long as width; linea calva interrupted by 3 rows of setae and closed posteriorly by 2–3 rows of setae; costal cell broad, about 5.2× as wide as submarginal vein and 11× as long as broad, ventrally with four complete lines of setae; stigmal vein longer than marginal and postmarginal veins combined; hind wing (Fig. 8) 3× as long as broad. Length of mid tibial spur (Fig. 9) 0.28× mid tibia and shorter than corresponding basitarsus. Measurements (μm): fore wing length 1825; fore wing width 850; submarginal vein 710; marginal vein 38; postmarginal vein 58; stigmal vein 130; hind wing length 1125; hind wing width 375; MT 760; mid tibial spur 210; mid basitarsus 250.

Metasoma 0.86× as long as mesosoma; ovipositor (Fig. 11) 0.70× as long as mid tibia, hardly exserted. Measurements (μm): ovipositor length 535; gonostylus length 115; last tergite length 640; last tergite width 610.

Variation. Length of female, excluding ovipositor, varies from 1.38–1.83 mm, scape in smaller species as in Fig. 6B, colour of F6 in some specimens is paler, ventral 1/3 dark brown, dorsal 2/3 nearly white mixed with brown, otherwise very little in material available.

Male. Length 1.22–1.33 mm. Color is similar to that of female except head completely black, flagellum gradually going from dark brown to yellowish. Antenna (Fig. 14) with scape about 2.02× as long as broad, all funicular segments much longer than broad, F1 the longest; longest flagellar setae about 1.5× as long as diameter of corresponding segments; scale-like sensilla present only on F6; antennal torulus with



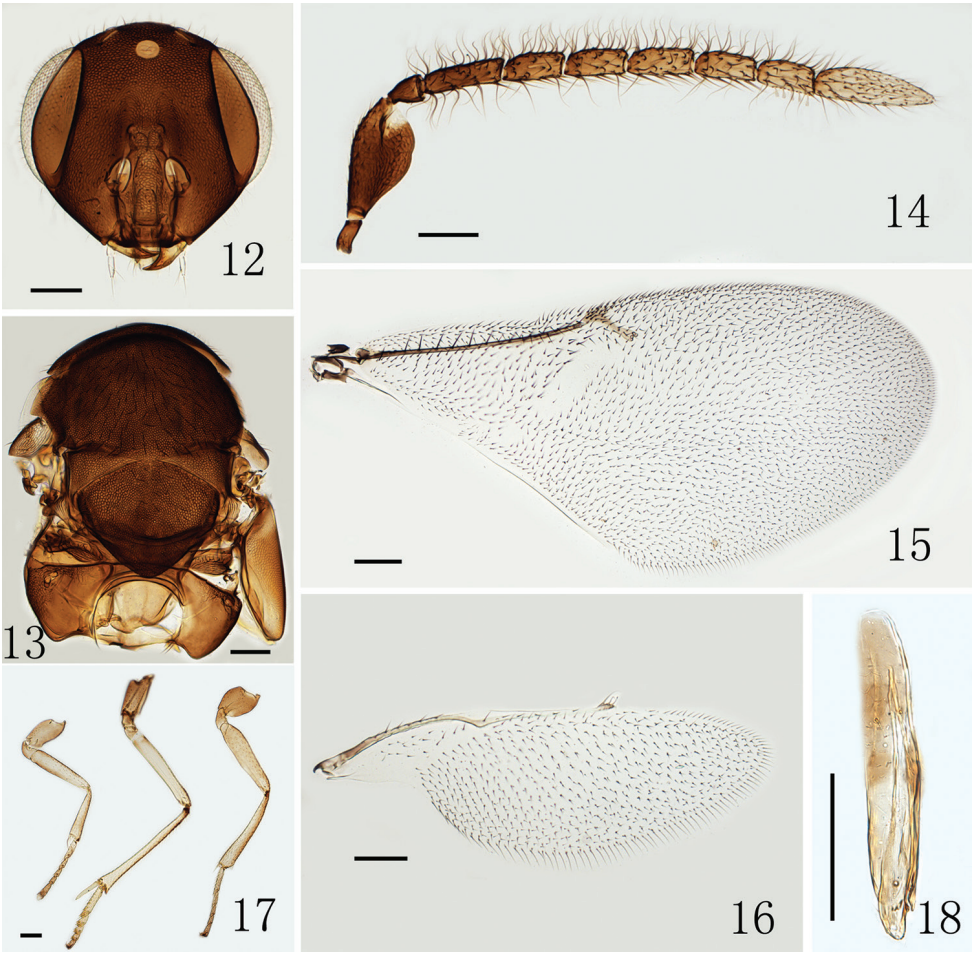
Figures 4–11. *A. minipedicellus* sp. n., holotype female: **4** head, frontal view **5** mesosoma, dorsal view **6** antenna (A holotype, B paratype) **7** fore wing **8** hind wing **9** legs **10** hypopygium **11** ovipositor. Scale bars: 100μm.

lower margin slightly below lower margin of eye and separated from mouth margin by about 1.46× its own height; frontovertex nearly (Fig. 12) 0.49× head width. Fore wing (Fig. 15) 2.08× as long as broad, costal cell ventrally with four lines of setae. Metasoma shorter than mesosoma; phallobase (Fig. 18) without digiti; aedeagus about 1.57× as long as mid tibia. Otherwise similar to female.

Host. *Lanceacoccus* sp. (Hemiptera: Pseudococcidae).

Etymology. The specific name refers to the small pedicel of female antennae.

Comments. This species is similar to *A. alami* Hayat, 1970 in the short and narrow pedicel. However, it can be easily separated from *A. alami* by its dark brown body (generally yellowish in *alami*), F1 1.33× as long as pedicel (twice in *A. alami*), MT 1.42× as long as OL (1.05× in *borneensis*).



Figures 12–18. *A. minipedicellus* sp. n., paratype male: **12** head, frontal view **13** mesosoma, lateral view **14** antenna **15** fore wing **16** hind wing **17** legs **18** genitalia. Scale bars: 100μm.

It is also probably close to *A. subtilis* Noyes & Hayat, 1994 and *A. aceris* Noyes & Hayat, 1994, but differs in the short pedicel, which is 0.75× as long as F1 (at least longer than F1 in *A. subtilis* and *A. aceris*), normal F1, which is similar to other funicular segments (F1 much shorter than any other funicular segments in *A. subtilis*), dark brown radicle (orange in *A. subtilis*), subparallel eye margins (diverging ventrally in *A. aceris*) and generally orange mesosoma (dorsum of mesosoma dark brown in *A. aceris*).

Molecular studies

The COI sequences the eight individuals of *A. minipedicellus* were successfully generated with high quality. All sequences have been deposited in GenBank (Accession Numbers: MH587108–MH587115). Only one base pair changes was detected between

the eight individuals sequenced for COI. Blasting the COI sequences gave no close matches (over 90%) both on BOLD and GenBank. In GenBank, a COI sequence of *Anagyrus* (*Anagyrus* nr. *pseudococci* PLCO02, Accession No. KU499515) differs from those of the new species by about 14%.

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