

The species of the ant genus *Recurvidris* Bolton, 1992 (Hymenoptera: Formicidae: Myrmicinae) in Thailand

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Abstract

The Thai ant species of the genus *Recurvidris* Bolton, 1992 is revised to include three species: *Recurvidris browni* Bolton, 1992, *R. chanapaithooni* sp. n., and *R. recurvispinosa* Forel, 1890. *R. browni* is newly recorded as found in Thailand and *R. chanapaithooni* is new to science. A key to the Thai species of the genus is presented, based on the worker caste. All species were collected from the forest floor.

Keywords: ant, *Recurvidris*, Thailand, new species, distribution, Myrmicinae.

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Introduction

Recurvidris Bolton, 1992 is a small myrmicine genus of the tribe Crematogastrini (Bolton, 2003; Ward *et al.*, 2015). The genus was first described from India by Forel (1890) as *Trigonogaster*, with *Trigonogaster recurvispinosus* as the type species. Unfortunately, this name was preoccupied by a chalcid genus, *Trigonogaster* Guérin-Meneville, 1844 (Hymenoptera: Pteromalidae). Bolton (1992) proposed *Recurvidris* to replace *Trigonogaster*, treated seven species and classified them into two species groups (*R. kemneri* and *R. recurvispinosa* groups).

Until now, ten species have been described in the *Recurvidris* genus from the Oriental and Indo-Australian regions (Bolton, 1992; Xu and Zheng, 1995; Zhou, 2000; Zettel, 2008). Jaitrong and Nabhitabhata (2005) recorded only one species, *Recurvidris recurvispinosa* (Forel, 1890), from Thailand. Having further examined specimens of this genus from Thailand, three species were recognized; one of which is new to science and one is newly recorded as found in Thailand. In this paper the *Recurvidris* species from Thailand is revised, describing a new species

and provides a key to species identification, based on the worker caste.

Materials and Methods

This study is mainly based on the materials deposited in the Ant Museum of Kasetsart University (Thailand) and The Natural History Museum of the National Science Museum, Thailand. Most morphological observations were made with an Olympus SZX12 stereoscope. Materials used in this study were compared with the images of paratypes of *Recurvidris browni* Bolton, 1992, *R. pickburni* Bolton, 1992, *R. proles* Bolton, 1992, and *R. recurvispinosa* (Forel, 1890), (Antweb, 2015).

Multi-focused montage images were produced using Axio Vision SE64 [IP-ExtendedFocusImage-10 (locked:1)*] from a series of source images taken by a Digital AxioCam ICc 5 camera attached to a ZEISS Discovery.V12 stereoscope. Worker measurements were made using an ocular micrometer, recorded to the nearest 0.01 mm.

The abbreviations used for the measurements and indices are as follows (edited from Bolton, 1987):

- TL Total length. Roughly measured from the anterior margin of head to the tip of gaster in stretched specimens.
- HL Head length. Length of head proper, excluding mandibles, measured in straight line from anterior clypeal margin to the mid-point of a line drawn across the posterior margin of head.
- HW Head width. Maximum width of head, in full-face view measured behind eyes (excluding eyes).
- CI Cephalic index. $HW/HL \times 100$.
- SL Scape length. Maximum straight line length of antennal scape excluding the basal constriction and condylar bulb.
- SI Scape index. $SL/HW \times 100$.
- PW Pronotal width. Maximum width of pronotum in dorsal view.
- ML Mesosoma length. Diagonal length of mesosoma in profile, from the point at which the pronotum meets the cervical shield to the posterior margin of metapleuron.

The abbreviations used for institutions are as follows:

- AMK Ant Museum, Faculty of Forestry, Kasetsart University, Thailand.
- BMNH The Natural History Museum, London, U.K.
- MCZC Museum of Comparative Zoology, Cambridge, MA, U.S.A.
- SKYC SKY Collection at Kitakyushu Museum of Natural History and Human History, Japan.
- THNHM Natural History Museum of the National Science Museum, Thailand.

Systematics

Recurvidris Bolton, 1992

Recurvidris Bolton, 1992: 36, figs. 1-11. [Replacement name for *Trigonogaster* Forel, 1890: cix; junior homonym of *Trigonogaster* Guérin-Méneville, 1844: 1149 (Hymenoptera: Pteromalidae).]

Trigonogaster Forel, 1890: cviii. Type species: *Trigonogaster recurvispinosus* Forel, 1890: cix. [Junior homonym of *Trigonogaster* Guérin-Méneville, 1844: 1149 (Hymenoptera: Pteromalidae).]

Worker diagnosis: for a more extensive description of the worker caste of the genus, see Bolton (1992). Some of the important characteristics described by Bolton (1992) are reproduced here. Clypeus broad from front to back; antenna 11-segmented, with a conspicuous apical club of three segments; mandible with 4-5 teeth on masticatory margin; palp formula 4, 3; frontal carinae and antennal scrobes absent; propodeal spine present, curving upwards and forwards from its base; petiole pedunculate, with spiracle at about midlength of the peduncle, and node low and weakly conical in profile; first gastral segment in profile almost flat dorsally and strongly convex ventrally, with tergite strongly overlapping sternite laterally.

Key to Thai species, based on worker caste

1. Head entirely smooth and shiny; basal margin of mandible with a small tooth which is widely separated from basal (fourth) tooth (Fig. 2B); basal tooth acute apically; propodeal declivity lacking infradental lamella or ridge linking propodeal spine to metapleural lobe; dorsum of propodeum with 2 pairs of standing hairs (Fig. 2A).....*R. chanapaithooni* sp. n.
- Head largely sculptured (reticulate, reticulate-punctate to reticulate-granular); basal margin of mandible unarmed (Fig. 3B); basal (fourth or fifth) mandibular tooth blunt or bidenticate apically; propodeal declivity with narrow infradental lamella or ridge linking propodeal spine to metapleural lobe; dorsum of propodeum without standing hairs (figs. 1A and 3A).....2
2. Masticatory margin of mandible with four teeth, basal tooth bidenticate; much smaller species (HW 0.36-0.41 mm); head in full-face view narrow, rectangular and slightly longer than broad.....*R. recurvispinosa* (Forel)
- Masticatory margin of mandible with five teeth, basal tooth blunt or truncate at apex; larger species (HW 0.53-0.56 mm); head in full-face view round and almost as long as broad.....*R. browni* Bolton

***Recurvidris browni* Bolton, 1992**

(Fig. 1)

Recurvidris browni Bolton, 1992: 43, figs. 1, 3. Holotype and 32 paratype workers from E. Malaysia, Sarawak, 4th Div. G. Mulu Nat. Pk., RGS Expd., Long Pala, lowl. Rainfor., forest floor, 5.x.1977, B. Bolton leg. (BMNH, MCZC).

Measurements: Non-type workers (n = 12): TL 2.50-2.60 mm, HW 0.53-0.56 mm, HL 0.56-0.58 mm, SL 0.50-0.51 mm, PW 0.28-0.30 mm, ML 0.73-0.76 mm, CI 91-97, SI 91-97.

Description: Head in full-face view round and almost as long as broad, with posterior margin strongly convex. Eye 0.12 mm in maximum diameter, with seven ommatidia along the longest axis. Antennal scape extending posteriorly, reaching posterolateral corner of head. Masticatory margin of mandible with five teeth, fifth (basal) tooth much larger than fourth, blunt or truncate apically; basal margin of mandible unarmed. Clypeus with indistinctly paired carinae. Mesosoma slender; promesonotum in profile weakly convex dorsally and sloping gradually to metanotal groove. Propodeum in profile with weakly convex dorsal outline; recurved propodeal spine long and narrow. Propodeal declivity with a fine but distinct infradental lamella or ridge linking propodeal spine to metapleural lobe. Peduncle of petiole relatively long, with its dorsal outline distinctly concave and ending posteriorly in sharp angle, its ventral outline weakly convex with long acute subpetiolar process.

Dorsum of head superficially reticulate, with some short fine longitudinal rugulae near mandibular base. Pronotum and mesonotum glassy smooth and shiny; mesopleuron, metapleuron, and propodeum finely reticulate; propodeal spines sculptured. Petiole and postpetiole finely punctate. Gaster smooth and shiny.

Head with relatively dense hairs that are very short; promesonotum sparsely with longer hairs (less than ten hairs); longest pronotal hairs 0.10-0.13 mm long; hairs absent from propodeal dorsum. Petiole with two short dorsal pairs of hairs. Postpetiole with three short dorsal pairs and one short ventrolateral pair of hairs. Body colour yellow.

Non-type material examined: S. Thailand, Nakhon Si Thammarat Prov., Thasala, 5°78'971"N / 99°53'378"E, 765 m alt., 17.iv.2007, W. Jaitrong leg., WJT07-TH675 (THNHM: THNHM-I2013-03922 THNHM-I2013-03923, THNHM-I2013-03924, THNHM-I2013-03925, THNHM-I2013-03926, THNHM-I2013-03927, THNHM-I2013-03928, THNHM-I2013-03929. AMK: THNHM-I2013-03928); S. Thailand, Narathiwat Prov., Wang Dist., 24.ii.2002, S. Hasin leg. (AMK).

Distribution: Indonesia (Kalimantan), Malaysia (Sarawak and W. Malaysia) (Bolton, 1992), and Thailand (new record, fig. 4).

Remarks: *Recurvidris browni* belongs to the *R. recurvispinosa* species group (sensu Bolton, 1992) that has the following characteristics: basal tooth on masticatory margin of mandible is enlarged and usually blunt, truncated or bidenticulate apically; basal margin of mandible unarmed; propodeal declivity with infradental lamella that links the spine to metapleural lobe. This species is closely related to *Recurvidris williami* Bolton, 1992, sharing the same form of mandibular dentition. *R. browni* is notably larger, has more slender propodeal spines. Furthermore, *R. williami* has a strongly reticulate-punctate sculpture, which is absent in *R. browni*. In Thailand *R. browni* is restricted to the primary evergreen rainforest in the south. The single colony from Nakhon Si Thammarat Province (WJT07-TH675) was collected by sifting leaf litter.

***Recurvidris chanapaithooni* Jaitrong and Wiwatwitaya, sp. n.**

(Fig. 2)

[urn:lsid:zoobank.org:act:E1E10341-99C8-4FD9-9C40-9CC4B162EA9B](https://zoobank.org/urn:lsid:zoobank.org:act:E1E10341-99C8-4FD9-9C40-9CC4B162EA9B)

Types: Holotype (THNHM-I2015-00295) and three paratype workers (THNHM-I2015-00296, THNHM-I2015-00297, and THNHM-I2015-00298) from E. Thailand, Chanthaburi Prov., Soi Dao Dist., honey bait trap, 17.i.2008, W. Jaitrong leg., WJT170108-1 (THNHM).

Measurements: Holotype and paratypes (n = 4): TL 2.00-2.10 mm, HW 0.38-0.41 mm, HL 0.36-0.40 mm, SL 0.35-0.36 mm, PW 0.21-

0.25 mm, ML 0.53-0.54 mm, CI 104-105, SI 88-96.

Non-type (n = 7): TL 1.95-2.10 mm, HW 0.36-0.41 mm, HL 0.36-0.40 mm, SL 0.35-0.36 mm, PW 0.21-0.25 mm, ML 0.53-0.54 mm, CI 100-105, SI 88-96.

Description: (Holotype and paratypes). Head in full-face view round and almost as long as broad, with posterior margin convex. Eye 0.11-0.13 mm in maximum diameter, with eight ommatidia along longest axis. Antennal scape extending posteriorly slightly beyond posterolateral corner of head. Masticatory margin of mandible with four sharp teeth, fourth (basal) tooth larger than third; basal margin with a small tooth. Clypeus without paired carinae, its anterior margin convex. Promesonotum in profile strongly convex dorsally and sloping gradually to metanotal groove. Propodeum in profile with strongly convex dorsal outline; propodeal spines slender, divergent, and in caudal view very narrow. Propodeal declivity lacking infradental lamella or ridge linking propodeal spine to metapleural lobe. Peduncle of petiole relatively long, with its dorsal outline concave and ending posteriorly in right angle, its ventral outline convex with long acute subpetiolar process.

Head entirely smooth and shiny, lacking sculpture except some short longitudinal rugulae near mandibular base. Mandible and antennal scape smooth and shiny. Promesonotum and lateral face of propodeum smooth and shiny; mesopleuron reticulate, partly smooth and shiny; propodeal dorsum and propodeal spine superficially reticulate. Petiole entirely reticulate; dorsum of postpetiole smooth and shiny. Gaster smooth and shiny.

Head with relatively dense short hairs; promesonotum with sparse longer hairs (11-13 hairs); longest pronotal hairs 0.10-0.13 mm long; propodeum dorsally with two pairs of short standing hairs in front of spiracles. Petiole with two dorsal pairs of long hairs. Postpetiole with two dorsal pairs of long hairs and one ventrolateral pair of short hairs. Body colour yellow.

Non-type material examined: E. Thailand, Chachoengsao Prov., Thathakiab Dist., 30.xii.2002, W. Jaitrong leg., WJT301202-1

(THNHM); S. Thailand, Trang Prov., Nayong Dist., Khao Chong B.G., 29.ix.2001, C. Bourmas leg. (AMK, SKYC, and THNHM).

Etymology: The specific name is dedicated to Mr. Sakorn Chanapaithoon, Vice President and Acting President of National Science Museum, Thailand who has supported W. Jaitrong in his myrmecological research in Thailand and Laos.

Distribution: Thailand (Chanthaburi, Chachoengsao and Trang Provinces) (fig. 4).

Remarks: *Recurvidris chanapaithooni* sp. n. is closely related to *R. kemneri* Bolton, 1992, *R. nigrans* Zettel, 2008, and *R. proles* Bolton, 1992 (all belonging to the *R. kemneri* group) in having 4 teeth on the masticatory margin of the mandible, sharp basal tooth, a small tooth on the basal margin. This species is most similar to *R. kemneri*, both sharing a small body size and clear yellow body colour. However, *R. chanapaithooni* is distinguished from *R. kemneri* by the presence of 2 pairs of hairs on propodeal dorsum (hairs absent in *R. kemneri*). It can be separated from *R. proles* by the following characteristics: body colour uniformly yellow in *R. chanapaithooni* (head brown, much darker than yellowish mesosoma in *R. proles*); petiole with a long acute anteroventral process in *R. chanapaithooni* (subpetiolar process- a small triangular tooth in *R. proles*); body much smaller (HW 0.38-0.41 mm in *R. chanapaithooni*; 0.66-0.68 mm in *R. proles*). *R. chanapaithooni* is easily separated from *R. nigrans* by the following characteristics: a much smaller body size (HW 0.38-0.41 mm in *R. chanapaithooni*; HW 0.61-0.65 mm in *R. nigrans*); clear yellow body colour in *R. chanapaithooni* (body colour dark in *R. nigrans*); tooth on basal margin of mandible smaller than fourth tooth in *R. chanapaithooni* (almost as large as fourth tooth in *R. nigrans*); promesonotum with 11-13 hairs in *R. chanapaithooni* (with nine hairs in *A. nigrans*); dorsum of propodeum superficially reticulate in *R. chanapaithooni* (smooth and shiny in *R. nigrans*); petiole finely reticulate in *R. chanapaithooni* (smooth and shiny in *R. nigrans*). The type series was collected using honey baits from the forest floor in a lowland evergreen forest in the areas noted above.

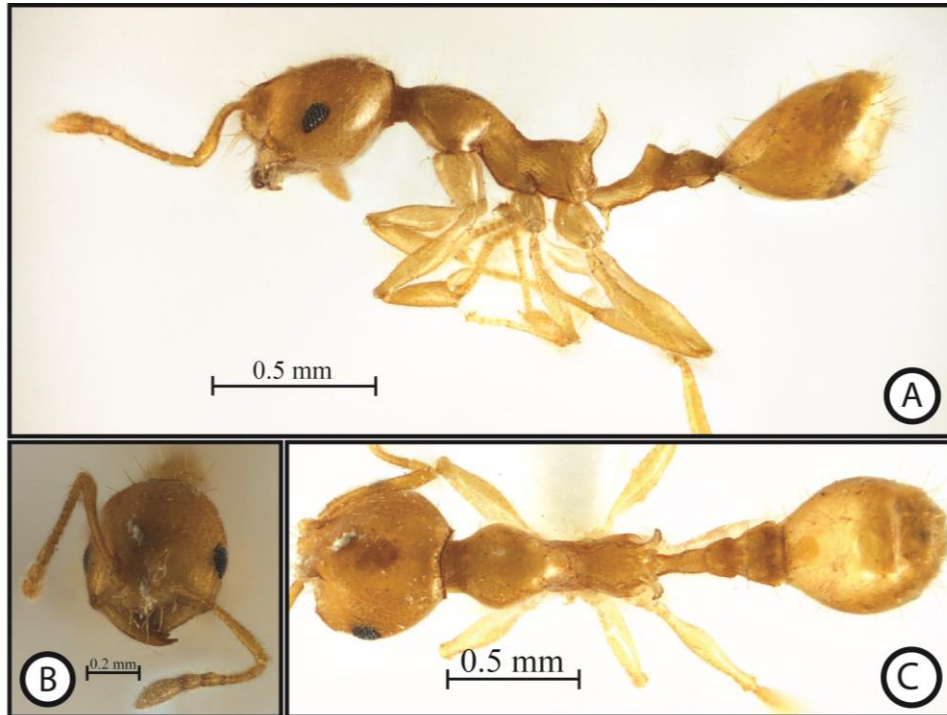


Fig. 1. *Recurvidris browni* (non-type worker from S. Thailand, THNHM-I2013-03924). A. Habitus in profile; B. Head in full-face view; C. Dorsal view of body.



Fig. 2. *Recurvidris chanapaithooni* sp. n. (Holotype, THNHM-I2015-00295). A. Habitus in profile; B. Head in full-face view; C. Dorsal view of body.



Fig. 3. *Recurvidris recurvispinosa* (non-type worker from W. Thailand, THNHM-I2015-00299).
A. Habitus in profile; B. Head in full-face view; C. Dorsal view of body.

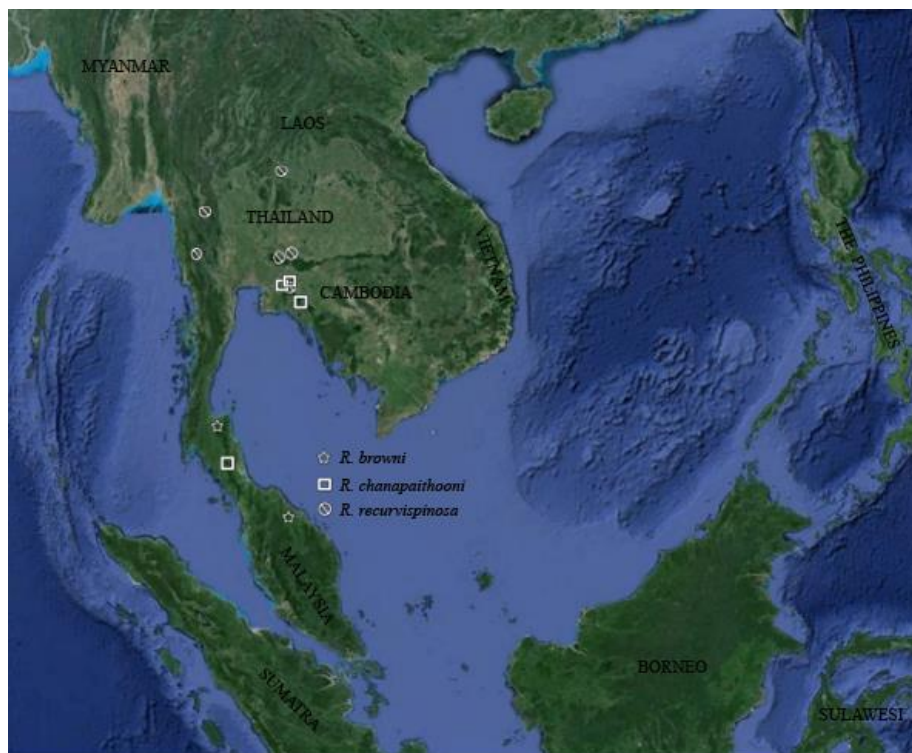


Fig. 4. Distribution of *Recurvidris browni*, *R. chanapaithooni* and *R. recurvispinosa* in Thailand.

***Recurvidris recurvispinosa* (Forel, 1890)**

(Fig. 3)

Trigonogaster recurvispinosus Forel, 1890: cix, Syntype workers from India, Poona (R.C. Wroughton) (MHNG).

Trigonogaster recurvispinosa: Wheeler, 1927: 5 (description of male).

Recurvidris recurvispinosa: Bolton, 1992: 46; Bolton, 1995: 377; Jaitrong and Nabhitabhata, 2005: 41.

Measurements: Non-type workers (n = 15). TL 1.70-1.85 mm, HW 0.36-0.41 mm, HL 0.41-0.43 mm, SL 0.33-0.35 mm, PW 0.21-0.25 mm, ML 0.53-0.54 mm, CI 85-96, SI 87-95.

Description: Head in full-face view narrow, subreticular and slightly longer than broad, with posterior margin almost straight or feebly concave. Eye 0.10 mm in maximum diameter, with 6-7 ommatidia along longest axis. Antennal scape extending posteriorly slightly beyond posterolateral corner of head. Masticatory margin of mandible with four sharp teeth, fourth (basal) tooth enlarged and bidenticulate; basal margin of mandible unarmed. Propodeal spine stout, upcurved. Clypeus with distinct paired carinae, its anterior margin weakly convex. Mesosoma relatively slender; promesonotum in profile weakly convex dorsally and sloping gradually to metanotal groove. Propodeum in profile with feebly convex dorsal outline; recurved propodeal spine long and narrow. Propodeal declivity with infradental lamella or ridge linking propodeal spine to metapleural lobe. Peduncle of petiole relatively short, with its dorsal outline distinctly concave and ending posteriorly in blunt angle, its ventral outline convex. Subpetiolar process varying from a tooth to short spine.

Dorsa of head and mesosoma usually finely reticulate-punctate to reticulate-granular; on head the sculpture usually weaker on dorsum behind frontal lobes, and stronger posteriorly and laterally. Sculpture on pronotum much weaker than that on head. Petiole finely reticulate. Postpetiole superficially reticulate. Gaster smooth and shiny.

Head with relatively sparse short hairs; promesonotum with sparse short hairs (less than ten hairs); longest pronotal hairs 0.07 mm long. Hairs absent from propodeal dorsum.

Petiole with two dorsal pairs of short hairs. Postpetiole with two dorsal pairs and one ventrolateral pair of short hairs. Body colour yellow to yellowish brown.

Non-type material examined: N. Thailand, Chiang Mai Prov., Muang Dist., Chiang Mai University, Teak Plantation, 29.viii.2014, W. Sangtow leg. (THNHM); same loc., Y. Onishi leg., 2.v.2013 (THNHM); Chiang Mai Prov., Doi Chang Khian, 21.vi.2013, Y. Onishi leg. (THNHM); W. Thailand, Tak Prov., Umphang Dist., Umphang W.S., Doi Huar Mod Forest Ranger Station, DDF, 27.i.2015, W. Jaitrong leg., TH15-WJT-248 (THNHM: THNHM-I2015-299, THNHM-I2015-300, THNHM-I2015-301, THNHM-I2015-302); W. Thailand, Kanchanaburi Prov., Thong Pha Phum Dist., 13.ii.2004, C. Bourmas leg. (AMK, THNHM); NE. Thailand, Nakhon Ratchasima Prov., Sakaerat Environmental Research Station, 17.vi.1998, D. Wiwatwitaya leg., THNHM-I2013-03931 (THNHM). NE. Thailand, Nakhon Ratchasima Prov., Pak Chong Dist., 5.xii.1998, W. Jaitrong leg. (AMK); E. Thailand, Chachoengsao Prov., Thathakiab Dist., 29.xii.2002, W. Jaitrong leg., THNHM-I2013-03934 (THNHM); same loc., 30.xii.2002, W. Jaitrong leg., WJT301202-2 (THNHM); same loc., Dry Evergreen Forest, 21.viii.2003, Sk. Yamane leg. (SKYC); E. Thailand, Chanthaburi Prov., Soi Dao Dist., 19.vii.1997, Sk. Yamane leg. (SKYC); same loc., 2.vi.2001, Sk. Yamane leg. (SKYC).

Distribution: India, Nepal, Myanmar, China, Hong Kong, Taiwan, Japan (Bolton, 1992; Xu and Zheng, 1995; Zhou, 2000; Terayama, 2009), and Thailand (Jaitrong and Nabhitabhata, 2005) (fig. 4).

Remarks: *Recurvidris recurvispinosa* is closely related to *Recurvidris hebe* Bolton, 1992 (Sulawesi) in having 4-dentate mandibles, and the basal mandibular tooth being enlarged and bidenticulate apically. *R. recurvispinosa* differs from *R. hebe* in the following points: in profile propodeal spine and petiolar peduncle relatively short and stout (relatively long and narrow in *R. hebe*); with head in full-face view, occipital corners round (more broadly round in *R. hebe*); mesosoma finely reticulate-punctate to reticulate-granular (superficially sculptured in *R. hebe*). All Thai specimens were collected from the forest floor.

The species of the ant genus *Recurvidris* Bolton, 1992 in Thailand

The single colony from Tak Province (TH15- WJT-248) was collected by sifting leaf litter.

Table 1. List of the *Recurvidris* species and their distribution. Type localities are marked with *.

Species	Distribution
1. <i>Recurvidris browni</i> Bolton, 1992	Malay Peninsula (W. Malaysia and S. Thailand) and Borneo (Sarawak* and Kalimantan)
2. <i>Recurvidris chanapaithooni</i> sp. n.	Thailand*
3. <i>Recurvidris glabriceps</i> Zhou, 2000	China (Guangxi* and Hainan) and Vietnam
4. <i>Recurvidris hebe</i> Bolton, 1992	Sulawesi*
5. <i>Recurvidris kemneri</i> (Wheeler and Wheeler, 1954)	Borneo (Sarawak), and Java*
6. <i>Recurvidris nigrans</i> Zettel, 2008	Philippines (Negros*)
7. <i>Recurvidris nuwa</i> Xu and Zheng, 1995	China (Guizhou Province*)
8. <i>Recurvidris pickburni</i> Bolton, 1992	Sri Lanka*
9. <i>Recurvidris proles</i> Bolton, 1992	Sulawesi*
10. <i>Recurvidris recurvispinosa</i> (Forel, 1890)	India*, Nepal, Myanmar, China, Hong Kong, Taiwan, Japan and Thailand
11. <i>Recurvidris williami</i> Bolton, 1992	Flores Island* (Indonesia)

Discussion

Until now, eleven species of the genus *Recurvidris* have been known from Asia (Table 1). Among them, three species are found in Thailand and they belong to two species groups (sensu Bolton, 1992): *R. kemneri* group (*R. chanapaithooni* sp. n.) and *R. recurvispinosa* group (*R. browni* and *R. recurvispinosa*).

Mandibular dentition, the presence of hairs on propodeal dorsum and the presence of infradental lamellae or ridges that link the propodeal spines to the metapleural lobes were characters used by Bolton (1992) to distinguish the two species groups mentioned above. These morphological characters were confirmed and used by several authors who described new species of the genus after Bolton (1992) (Xu and Zheng, 1995; Zhou, 2000; Zettel, 2008). The present paper also follows the previous works. In the specimens used in the present paper, the number and shape of teeth on the mandible of the worker (4-5 on masticatory margin and 0-1 on basal margin) are constant within each species even in older specimens (aged individuals). We strongly recommend that whenever preparing dry specimens of the genus, the mandibles of several specimens from each colony must be opened. The peculiar shape of propodeal spine is an important character (curving upwards and forwards from its base) to separate the genus from the others and it seems to be constant in

shape and length within each species. However, for Thai *Recurvidris* the shape, curve, and length of propodeal spine are not very useful to distinguish among the three species. The sculpturing, colour, and pilosity on the body are more important for species identification. The genus is clearly monomorphic in worker caste (at least in Thai species) with a small size variation occurring within species. Thus, body size can be separated into large and small species. In this paper body size has been used, separating *R. browni* from *R. recurvidris* (couplet 2) and *R. chanapaithooni* sp. n. from *R. nigrans*.

Recurvidris recurvispinosa is the most widely distributed member of the genus. It has been recorded from India, Nepal, to Southeast Asia including southern China, Hong Kong, Taiwan, and southernmost part of Japan (Bolton, 1992; Xu and Zheng, 1995; Zhou, 2000; Jaitrong and Nabhitabhata, 2005; Terayama, 2009). In Thailand, *R. recurvispinosa* can be found in the areas north of the Isthmus of Kra and in various types of forest such as dry evergreen forest, mixed deciduous forest and dry dipterocarp forest. *Recurvidris browni* was recorded from lowland rainforests in Sundaland (W. Malaysia, Sarawak and Kalimantan) (Bolton, 1992). In Thailand, this species is recorded for the first time in the lowland evergreen rainforest, south of the Isthmus of Kra. *Recurvidris chanapaithooni* sp. n. inhabits

primary forests and is sympatric with *R. recurvispinosa* in the eastern part and with *R. browni* in the southern part of Thailand (fig. 4).

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