Morphological and Behavioral Characters of the Two Species Groups of the Ant Genus *Myrmicaria* (Insecta: Hymenoptera: Formicidae: Myrmicinae) from Southeast Asia

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(Received 23 July 2006; Accepted 21 May 2009)

The ant genus *Myrmicaria* from Southeast Asia is clearly divided into two distinct species-groups (the *M. arachnoides* and *M. brunnea* groups) based on their morphology and nesting behaviour, as was suggested by Emery in 1922. We have found many additional characters, not noticed by previous authors, that differentiate the two groups. Male genital characters have also proved useful, not only in defining the groups but also in discriminating species in some cases.

**Key Words:** Insecta, Hymenoptera, Formicidae, Myrmicinae, *Myrmicaria*, Southeast Asia, species-group.

**Introduction**

The ant genus *Myrmicaria* was erected by Saunders (1842) based on *M. brunnea* Saunders, 1842 from India. Species of this genus are widely distributed in the Old World tropics, i.e., Southeast Asia, South Asia, and tropical Africa. Two species-groups were recognized in the genus by Emery (1922), the *M. arachnoides* group and *M. brunnea* group, and this classification was followed by Santschi (1925) and Karavaiev (1935). The taxa of the *M. arachnoides* group have a very slim body, smooth mandibles and head, and a promesonotum that is distinctly raised above the level of the propodeum, laterally tuberculate above, and provided with a flat pronotal dorsum. The Southeast-Asian taxa of the *M. arachnoides* group include *M. arachnoides arachnoides* Smith, 1857, *M. a. adpressipilosa* Santschi, 1928, *M. a. castanea* Emery, 1900, *M. a. lutea* Forel, 1900, *M. a. latituba* Stitz, 1938, *M. birmana* Forel, 1902, and *M. melanogaster* Emery, 1900.

The taxa of the *Myrmicaria brunnea* group have more robust bodies, longitudinally striate mandibles and head, and a promesonotum that is not distinctly raised above the level of the propodeum and has a slightly convex pronotal dorsum. The Southeast- and South-Asian taxa of this group include *M. brunnea brunnea* Saunders, 1842, *M. b. flava* Forel, 1913, *M. b. subcarinata* Smith, 1857, *M. vidua* Smith, 1858, *M. carinata carinata* Smith, 1857, *M. c. gagatina* Wheeler, 1919, *M. c. jacobsonei* Starcke, 1930, *M. castanea* Crawley, 1924, *M. fodica* Jerdon, 1851, *M. gibbosa* (Smith,
1858), and *M. rugosa* Smith, 1860 (cf. Emery 1922; Santschi 1925; Karavaiev 1935; Bolton 1995). Some of these taxa were originally referred to as varieties, not subspecies. The taxonomy at the species level is still unstable, awaiting the accumulation of a richer material and careful reexamination of type specimens.

Various authors have also noted behavioural differences between the two species-groups, particularly in relation to their nesting habits (Forel 1911; Wheeler 1919; Emery 1922; Karavaiev 1935; also see Kenne and Dejean 1999a, b). Species of the *Myrmicaria brunnea* group construct huge underground nests, while those of the *M. arachnoides* group construct carton nests on trees.

In this study we examined many structural and metric characters of the worker, queen, and male that have not previously been used to diagnose the species-groups. We also present more comprehensive observations on the nesting habits of *Myrmicaria arachnoides arachnoides* from Java (see also Bakhtiar and Yamane 2006), as well as fragmentary observations on the habits of other species of both species-groups. Our observations demonstrate that the current division of the genus into two species-groups is supported by numerous additional characters for at least the Asian fauna.

**Materials and Methods**

The specimens examined were collected from various regions in Southeast Asia. A few specimens from other localities in Asia (China, India, Bangladesh, Pakistan, and Sri Lanka) were also included, as well as specimens loaned from various institutions. We principally follow Bolton's (1995) system for the names of *Myrmicaria* taxa, although some of his subspecies should be raised to species rank in the future. We currently recognize 22 different taxa of the two species groups, which come from various parts of Borneo, the Malay Peninsula, and other parts of tropical Asia. We use species codes for undescribed taxa that are known to us.

The external morphology of the worker, male, and queen (including the alate virgin queen) was compared between the species-groups. Structure, sculpture, pilosity, and coloration were examined. Measurements were carried out of various body parts mentioned in Snelling (1976), Kugler (1994), Eguchi (2001), and Ward (2001) for other groups of ant. Measurements were made using a micrometer fixed to a stereoscopic microscope (Nikon SMZ1000). Mature larvae of some taxa in both species-groups were also examined.

Male genitalia together with two or three apical segments of the gaster were removed from the body of both wet and dry specimens with very sharp forceps. The genitalia were soaked in small pots filled with 10% potassium hydroxide, then transferred into lacto-phenol, aceto-salicylate, and finally carbo-xylol. The cleaned genitalia were mounted on glass slides in Canada balsam.

Nesting habits were compared between the species-groups. Nests of arboreal colonies were collected for some taxa: *M. arachnoides arachnoides* from Java (cf. Bakhtiar and Yamane 2006), *M. a. lutea* from Borneo and Malay Peninsula, and *M. melanogaster* from Borneo. Some colonies of a species resembling *M. luteiventris* were also collected from Khao Yai National Park, northeastern Thailand. Information on the nesting habits of the ground-nesting species came from field observations in Borneo and Malay Peninsula. In most cases data are incomplete due to the
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difficulty in digging the nests.

The following abbreviations are used below: m, male; q, queen; w, worker; BEY, Bakhtiar Effendi Yahya; KE, Katsuyuki Eguchi; SKY, Seiki Yamane; TVB, Tuan Viet Bui; F.R., Forest Reserve; N.P., National Park; Sg., Sungai (river); W.S., Wildlife Sanctuary.

Most of the specimens listed below are deposited in the entomological collection at the Institute of Tropical Biology and Conservation (ITBC), Universiti Malaysia Sabah, and the SKY collection at the Faculty of Science, Kagoshima University.

Material examined during this study

*Myrmicaria arachnoides* group

*Myrmicaria arachnoides arachnoides*: **Indonesia**. East Kalimantan (Borneo), Kutai N.P., Sangkimah, 11.ix.1993, 6 w, coll. SKY; West Java, Palaboean Ratoe, south coast of West Java, 1 w, coll. unknown. **Malaysia**. Sabah (Borneo), Kinabalu Park, Poring, 17.iii.1995, 1 w, coll. SKY.

*Myrmicaria arachnoides adpressipilosa*: **Indonesia**. West Bali, 1998, 7 w, coll. I. K. T. Ginarsa. **Malaysia**. Sabah (Borneo), Sandakan, Sepilok, 22.i.1997, 3 w, 2 m, coll. KE.

*Myrmicaria arachnoides lutea*: **Indonesia**. East Kalimantan (Borneo), Sungai Wain Protection Area, 1.iii.2002, 2 w, 1 winged q, coll. unknown; Lombok, Pesoren Lambah Sempoga Narmada, Kumbi, 14.v.2006, 24 w, 3 m, coll. KE; South Sumatra, Lampung, 11.xii.1921, 15 w, coll. Karny; West Java, Palaboean Ratoe, south coast of West Java, 4.v.1921, 3 w, 1 m, coll. unknown. **Malaysia**. Pahang (Malay Peninsula), Taman Negara, Merapoh, vi.2005, 6 w, coll. BEY and Rushdi; Sabah (Borneo), Danum Valley, 1 w, coll. SKY; Sarawak (Borneo), Lambir Hills N.P., Tower Region, 20.i.1993, 2 w, coll. SKY. **Thailand**. Chanthaburi Province, Khao Ang Reu Nai W.S., Klong Ploi, 1 w, coll. W. Jaitrong.


*Myrmicaria melanogaster*: **Malaysia**. Sabah (Borneo), Tenom, Sg. Kelang, 23.ii.1997, 4 w, 1 dealated q, coll. SKY; Sarawak (Borneo), Lambir Hills N.P., 31.1.1993, 2 w, coll. SKY.

*Myrmicaria* sp. A: **Malaysia**. Sabah (Borneo), Lahad Datu, Danum Valley, 23.xi.2002, 29 w, 2 m, coll. BEY and Azri; Sarawak (Borneo), Sabal F.R., 25.x.1996, 1 q, coll. A. Rahman; Pahang (Malay Pen.), Merapoh, Taman Negara, Kuala Luis, 19.vi.2005, 2 w, 1 q, coll. BEY and R. Bakar.

*Myrmicaria brunnea* group

Myrmicaria brunnea flava: Brunei (Borneo). Temburong, Kuala Belalong, date not indicated, coll. Davidson. Indonesia. West Sumatra, Lubuk Gadang, Sukabumi, 22.vii.1985, 1m, 1w, coll. SKY. Malaysia. Sabah (Borneo), Danum Valley, 16–18.i.2001, 1m, coll. SKY; Sarawak (Borneo), Lambir Hills N.P., Old Tower Region, 30.xii.1997, 3w, coll. SKY; Selangor (Malay Pen.), Ulu Gombak, Universiti Malaya Field Centre, x.2005, coll. M. Yoshimura.

Myrmicaria brunnea subcarinata: Indonesia. West Java, Cikaniki, Gunung Halimun N.P., 950 m alt., 1w, 1q, coll. Woro et al.; East Kalimantan (Borneo), Bukit Soehart, 1w, coll. SKY; North Sumatra, Medan, Kaban Djaki, 1w, coll. D. Fairchild. Malaysia. Sabah (Borneo), Danum Valley, 1w, coll. A. Y. C. Chung; Sarawak (Borneo), Lambir Hills N.P., Tower Region, 1w, coll. SKY; Selangor (Malay Pen.), Frasers Hills, Hemmant Trail, 15.vi.2005, 19w, coll. BEY, Ruslan, and Fauzi.


Myrmicaria carinata gagatina: Malaysia. Sabah (Borneo), Sayap Kinabalu, 15.vii.1996, 3w, 2m, coll. KE; Sarawak (Borneo), Kubah N.P., 5.xii.1993, 2w, coll. SKY.


Myrmicaria sp. B01: Brunei (Borneo). Temburong, Kuala Belalong, date not indicated, 1w, 1q, coll. Davidson. Indonesia. West Sumatra, Maninjau, 1w, coll. So. Yamane and SKY. Malaysia. Sabah (Borneo), Tawau Hills Park, 10–25.vi.2002, 6w, 3q, 1m, coll. BEY and Azri; Sarawak (Borneo), Kubah N.P., date unknown, 1w, coll. SKY.


Myrmicaria sp. B05: Malaysia. Sabah (Borneo), Sayap Kinabalu, ca. 1000 m alt., 14.vii.1996, 5w, 1q, coll. SKY.


Results

Many characters separating the two species-groups have been found not only in the external morphology but also in the nesting habit. They are listed and discussed below. The abbreviations w, q, and m indicate worker, queen, and male, respectively. Characters that have already been mentioned by previous authors are marked with an asterisk (*).

**Body size** (character 1)

1. *Overall body size* (q, m) (Fig. 1A, B). Reproductives of the *M. arachnoides* group are relatively small compared to those of the *M. brunnea* group. The former are about the same size or only slightly larger than the respective workers, while the latter are considerably larger than the respective workers.

**Head** (characters 2–17)

2. *Sculpture on head* (w, q) (Fig. 2A–D). In the *M. arachnoides* group, the temple, gena, clypeus, mandible, area around the eye, and area between the frontal carina and the frontal lobe are generally completely smooth with no striations (a few weak carinae or striae are occasionally present). These areas are clearly striated in members of the *M. brunnea* group.

3. *Shape of head seen from above* (w, q, m) (Fig. 3A–D). In the *M. arachnoides* group, the occipital margin is weakly concave, and the sides of the head behind the eyes are distinctly convex. In the *M. brunnea* group, the occipital margin is deeply

Fig. 1. *Myrmicaria arachnoides lutea* Emery, 1900 (*M. arachnoides* group), male (top) and worker (bottom) (A) and *M. brunnea brunnea* Saunders, 1842 (*M. brunnea* group), worker (top) and male (bottom) (B).
concave, and the sides of the head are almost straight; the whole head looks a cashew nut.

4. Mandibular dentition (q). In the *M. arachnoides* group, the mandible has four well-defined and prominent teeth and no denticles. In the *M. brunnea* group, the mandibular dentition is similar, but a denticle is always present between the

Fig. 2. *Myrmicaria arachnoides* lutea Emery, 1900 (*M. arachnoides* group) (A, C, E) and *M. carinata gagatina* Wheeler, 1919 (*M. brunnea* group) (B, D, F). A, B, Head in lateral view; C, D, head in frontal view, indicating frontal lobes (black arrowheads) in poorly developed (C) or well developed (D) states and anterior clypeal margin (gray arrowhead) with (C) or without (D) sharply edged middle area; E, F, head showing length of first funicular segment (LF1) compared to eye length (EL).

concave, and the sides of the head are almost straight; the whole head looks a cashew nut.

4. Mandibular dentition (q). In the *M. arachnoides* group, the mandible has four well-defined and prominent teeth and no denticles. In the *M. brunnea* group, the mandibular dentition is similar, but a denticle is always present between the
basal and third (counting from apex) teeth.

5. Presence/absence of occipital carina (w, q, m) (Fig. 2A, B). In the M. arachnoides group, the lateral portion of the head is smooth and lacks an occipital carina. In the M. brunnea group, the lateral part of the head has a sharp occipital carina that usually runs from the posteroventral corner of head to the basal articulation of mandible, but occasionally extends only halfway to the mandible.

6. Occipital margin (w, q). In the M. arachnoides group, the occipital margin is prominent, forming a sharp, collar-like carina. In the M. brunnea group, the occipital margin lacks a sharp collar-like carina.

7. Sculpture on antennal scape (w). In the M. arachnoides group, the scape is smooth. In the M. brunnea group, it is striated or otherwise sculptured along its length.

8. Length of the first funicular (second antennal) segment compared to eye length (w, q, m) (Fig. 2E, F). In the M. arachnoides group, the first funicular segment is longer than the eye length. In the M. brunnea group, it is shorter than or subequal to the eye length.

9. Length of second funicular (third antennal) segment compared to width of postpetiole (w). In the M. arachnoides group, the postpetiole width is always less than the length of the second funicular segment. In the M. brunnea group, it is always greater than the length of that segment.

10. Scape length compared to length of second funicular segment (m) (Fig. 3E, F). In the M. arachnoides group, the scape is always longer than the second funicular segment (also in q and w). In the M. brunnea group, it is always shorter than that segment.

11. Pilosity on scape (m). In the M. arachnoides group, the lower surface of the antennal scape has long, suberect hairs, some of which are longer than the diameter of the scape (also in w and q). In the M. brunnea group, this area has shorter fine, decumbent hairs.

12. Frontal lobe and frontal carina* (w, q) (Fig. 2C, D). In the M. arachnoides group, the frontal carina is short, and the frontal lobe is poorly developed; the antennal socket is clearly exposed in full-face view. In the M. brunnea group, the frontal carina is longer and the frontal lobe is well developed, concealing the antennal socket in full-face view.

13. Anterior margin of clypeus (w, q) (Fig. 2C, D). In the M. arachnoides group, the anterior margin of the clypeus is medially produced into a sharp and narrow keel. In the M. brunnea group, it is medially produced into a broader and elongated keel (Fig. 2C, D).

14. Position of eyes in full-face view (w, q). In the M. arachnoides group, the outer margin of the eye protrudes beyond the lateral margin of head in full-face view. In the M. brunnea group, it does not protrude, or very slightly protrudes, beyond the lateral margin of the head, i.e., the eyes are normally within the outline of the head.

15. Relative size of eye (m) (Fig. 3E, F). In the M. arachnoides group, the eye is large, as long as the distance between the eyes. In the M. brunnea group, the eye is smaller, much shorter than the distance between the eyes.

16. Distance between posterior ocelli and oculo-ocellar distance (m) (Fig. 3C, D). In the M. arachnoides group, the distance between the posterior ocelli is much greater than the oculo-ocellar distance. In the M. brunnea group, it is only slightly
greater than the latter.

17. Position of ocelli on the head in full-face view (m) (Fig. 3E, F). In the *M. arachnoides* group, the posterior ocelli are located more posteriad on the head, so that in full-face view they protrude above the posterior margin of the head. In the *M. brunnea* group, they are located more anteriad, only rarely protruding slightly above the posterior margin of the head.

**Alitrunk** (characters 18–24)

18. Shape of promesonotum in profile (w) (Fig. 4A, B). In the *M. arachnoides* group, the...
group, the promesonotum is dome-like, distinctly raised above the level of the propodeum and separated from the propodeum by a deep concavity. In the *M. brunnea* group, the promesonotum is not distinctly raised, being instead continuous from pronotum to propodeum in profile, and separated from the latter by a shallow, but distinct metanotal groove.

19. *Shape of propodeum* (w) (Fig. 4A, B). In the *M. arachnoides* group, the propodeum is raised and dome-like, while it has a rather flat dorsum in the *M.
**brunnea group.**

20. **Condition of anteroventral part of pronotum (w, q)** (Fig. 4C, D). In the *M. arachnoides* group, the anteroventral part of the pronotum is rounded and lacks a projection. In the *M. brunnea* group, it bears a tooth-like projection at the anteroventral corner.

21. **Sculpture on upper and lower subdivisions of mesepisternum (anepisternum sensu Bolton 1994) (q, m).** In the *M. arachnoides* group, both the upper and lower subdivisions of the mesepisternum are smooth and lack striations, while they are striated in the *M. brunnea* group.

22. **Sculpture on dorsal surface of alitrunk* (w, q, m) (Fig. 4E, F).** In the *M. arachnoides* group, the dorsal alitrunk is generally smooth and shiny, or sometimes has incomplete and weak longitudinal striae. In the *M. brunnea* group, it has more complete and distinct longitudinal striae.

23. **Sculpture on front coxal surface* (w, q, m).** In the *M. arachnoides* group, the front coxal surface is generally smooth without any striation. In the *M. brunnea* group, it is clearly striated, although the striation is sometimes weak.

24. **Hair colour (w, q, m).** In the *M. arachnoides* group, the hairs covering the whole body are bright yellow to almost white. In the *M. brunnea* group, the body hairs are brown to black.

**Waist** (characters 25–27)

25. **Shape of petiole (w, q)** (Fig. 5A, B). In the *M. arachnoides* group, the petiole is cone-shaped and, in profile, the slopes of the anterior and posterior faces are similar. In profile, the dorsal surface is short and flat. In the *M. brunnea* group, the petiole is box-shaped, with the posterior face steeper in outline and the dorsal surface longer than in the *M. arachnoides* group.

26. **Petiole node (m) (Fig. 5C, D).** In the *M. arachnoides* group, the petiole node is very low and not clearly separated from the peduncle. In the *M. brunnea* group, it is higher and more distinctly separated from the peduncle.

27. **Pilosity on ventral surface of postpetiole (w, q, m).** In the *M. arachnoides* group, the postpetiole bears numerous hairs ventrally. In the *M. brunnea* group, these hairs are fewer and tend to be confined to the anterior part of the venter.

**Gaster** (character 28)

28. **Size and shape of gaster in dorsal view (m) (Fig. 6A, B).** In the *M. arachnoides* group, the gaster is much longer than wide, and gradually narrows apically. In the *M. brunnea* group, it is as long as broad, and more abruptly narrows apically.

**Male genitalia** (characters 29–31)

29. **Subgenital plate (Fig. 7A, D).** In the *M. arachnoides* group, the posterior margin of the subgenital plate is rounded, and the basal margin is deeply concave with a comparatively long apodeme. In the *M. brunnea* group, the subgenital plate has the posterior margin bilobed and the basal margin more shallowly concave with a shorter apodeme.

30. **Aedeagus (Fig. 7B, E).** In the *M. arachnoides* group, an elongated “horn” is present on the posterodorsal part of aedeagus. In the *M. brunnea* group, this “horn” is absent.

31. **Volsella (Fig. 7C, F).** In the *M. arachnoides* group, the digitus of the volsella never exceeds the upper margin of the apodeme. In the *M. brunnea* group, the digitus does exceed it.
Fig. 5. Lateral views of waists of *Myrmicaria arachnoides lutea* Emery, 1900 (*M. arachnoides* group) (A, C) and *M. carinata gagatina* Wheeler, 1919 (*M. brunnea* group) (B, D). A, B, Worker; C, D, male.

Fig. 6. Dorsal views of male gasters. A, *Myrmicaria arachnoides lutea* Emery, 1900 (*M. arachnoides* group); B, *M. sp. B07* (*M. brunnea* group).
Wing venation (characters 32, 33)

32. Position of first submarginal cell (a) and median cell (b) of forewing (q, m) (Fig. 8A–D). In the *M. arachnoides* group, these two cells are separated by the first discoidal cell (c). In the *M. brunnea* group, they are positioned next to one another and are both bordered by the first discoidal cell.

33. Length of median cell (b) and first submarginal cell (a) of forewing (q, m) (Fig. 8A–D). In the *M. arachnoides* group, the median cell is as long as the first submarginal cell, while in the *M. brunnea* group, it is much longer than first submarginal cell.

Mature larva (character 34)

34. Body hairs (w) (Fig. 9A, B). In the *M. arachnoides* group, the body of the larva is mostly glabrous with a few hairs on the dorsal surface. In the *M. brunnea* group, numerous hairs cover the whole body.

Measurements (character 35)

35. Measurements of various body parts and their combinations separate these two species groups. Figure 11A–D shows some examples. Distinct allometry is not found for the observed body parts.

Nesting habits (characters 36, 37)

36. Nesting site* (Fig. 10A, B). All the observed taxa of the *M. arachnoides* group build nests on the underside of plant leaves; several satellite nests are constructed on different leaves (polydomy) on one plant (Bakhtiar and Yamane 2006). The taxa of the *M. brunnea* group generally nest in the soil. Nest depth varies from a few centimeters around tree bases, to almost 1 m into the soil. Exceptionally, an unnamed taxon of the latter group from Poring, Sabah, was observed in the canopy level of a tree. Its nest has not yet been discovered, but is believed to be constructed within the tree trunk. Another taxon of the *M. brunnea* group was observed nesting close to the ground in a tree hole filled with soil at Mahua, Sabah.
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Fig. 8. Forewing venation of *Myrmicaria arachnoides lutea* Emery, 1900 (*M. arachnoides* group) (A, C) and *M. sp. B07* (*M. brunnea* group) (B, D). A, B, Queen; C, D, male. Abbreviations: a, submarginal cell; b, median cell; c, discoidal cell.

Fig. 9. Mature larvae of *Myrmicaria arachnoides lutea* Emery, 1900 (*M. arachnoides* group) (A) and *M. sp. B07* (*M. brunnea* group) (B) in lateral view.
37. Nest material*. In the *M. arachnoides* group, the nest is constructed of a carton-like material that most probably originates from plant fibres. In the *M. brunnea* group, underground nests generally do not include any distinctive nest material other than soil, but occasionally plant fibres are found in the nest.

**Discussion**

This study has added further new evidence supporting the division of *Myrmicaria* into two species groups as proposed by Emery (1922). We have examined more taxa than previous authors have, and thereby have confirmed that the two species groups are clearly separated. There are no taxa intermediate between them in either morphology or nesting behaviour, at least among Asian species. Arboreal nesting by some taxa of the *M. brunnea* group may be associated with accumulated soil or abandoned termite nests in the trees and is still distinct from the arboreal carton nests of the members of the *M. arachnoides* group. The contention that the spur at the apex of each meso- and metatibia is lost in most or all species of the *M. arachnoides* group (Bolton 2003) appears to be incorrect. All taxa of the *M. arachnoides* group examined in this study possess the spurs.

Fig. 10. Nesting sites in the two species groups of *Myrmicaria*. A, Nest of *M. arachnoides lutea* Emery, 1900 (*M. arachnoides* group) on underside of a leaf; B, nest of *M. carinata carinata* Smith, 1857 (*M. brunnea* group) in soil, indicated by arrowhead.
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The two species groups are easily distinguished by their external morphology and nesting biology, but male genital structure provides another very useful criterion for separating the groups. In addition, we have found that some important characters of the male, including the genitalia, serve to separate species as well as species groups, as was discussed above.

At present we do not know whether the more slender body form in the *M. arachnoides* group is associated in some functional way with arboreal nesting. Other features, such as the more complex alitrunk structure seen in this group, are even more difficult to explain, although arboreal nesting species of *Polyrhachis* have a more complex body structure compared to subterranean-nesting species of the same genus (Kohout pers. com.). In contrast, the surface sculpture is generally much stronger in the subterranean-nesting *M. brunnea* group. Another interesting characteristic observed in the *M. brunnea* group is the very hairy body of the mature larva. This may reduce the frequency of direct body contact with the soil in the moist subterranean nest.

Subterranean- or terrestrial-nesting *Polyrhachis* species of the *viehmeyeri* group of the subgenus *Myrmhopla* are always found to be associated with other organisms, particularly with *Rhytidoponera* ants (Kohout 1997). In *Myrmicaria*, only a few terrestrial-nesting taxa in the *M. brunnea* group have been observed to interact with other organisms, most frequently with scale insects and rarely with spiders (Bakhtiari, personal observations).

Hölldobler and Wilson (1990) mentioned that *Myrmicaria* is one of the mound-building ants that produce symmetrical piles of excavated soil. However, observa-

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**Fig. 11.** Bivariate plots of various metric measurements in the *Myrmicaria arachnoides* and *M. brunnea* groups. EL, Eye length; FL, femur length of foreleg; HL, head length; LF₁, length of first funicular segment; LF₂, length of second funicular segment; LHT, length of hind tibia.
tions on *M. opaciventris* by Kenne and Dejean (1999a, b) in Cameroon did not specifically note any construction of mounds. This species built trunk routes that were later transformed into trenches connecting the nest to food sources. Mound nests are also rarely observed in *Myrmicaria* species in tropical Asia. They are found at higher altitudes above 1500 m where the temperature is generally low throughout the year and fluctuates during the day. Irregularly-shaped piles of soil are also found around nest entrances in lowland forests, but it is questionable whether they constitute true mounds.

**Acknowledgements**

Universiti Malaysia Sabah enabled us to conduct field surveys in Sabah through Fundamental Research Grant B0804 11 ER U005. Economic Planning Unit Malaysia (EPU) granted us permission to conduct sampling throughout Malaysia. Yoshiaki Hashimoto and Takuji Tachi actively promoted the BBEC Programme UMS in Sabah, to which we owe much.

The following Indonesian scientists helped us to collect material in Java: Akhmad Rizali (Centre for Conservation and Insect Studies, Bogor), Bahtiar and Anggun (Cibodas Botanical Garden), and Rosichon Ubaidiillah (Lembaga Ilmu dan Penilitian Indonesia-LIPI). We also thank the following Malaysian scientists for their help in various ways: Arthur Chung and Chey Vun Khen (Forest Research Centre Sandakan Malaysia); Jamili Nais, Maklarin Lakim, and staff (Sabah Parks); Sufian and staff (Wildlife Department Sabah); Waidi Sinun and staff (Danum Valley Management Committee); Idris Abdul Ghani and Ruslan Mat Yusop (Centre for Insect Systematics, Universiti Kebangsaan Malaysia, UKM), Husin (UKM), and Rosli Hashim (Universiti Malaya).

Cordial thanks are also offered to many friends of ours for their kind offers/loans of material: Bernhard Merz (Muséum d'Histoire Naturelle, Genève), C. van Achterberg (Leiden Museum), David Lohman (Harvard University), Diane Davidson (Utah University), Hannes Baur (Bern Naturhistorisches Museum), John R. Fellowes (Kadoorie Farm and Botanical Garden, Hong Kong), Nihara Gunawardene (Curtin University), Roy Snelling (Los Angeles County Museum of Natural History), Sopark Jantarit and Nawee Noon-anant (Prince of Songkla University, Hat Yai), and Weeyawat Jaitrong (National Science Museum, Bangkok).

Katsuyuki Eguchi demonstrated genitalia dissection and improved the draft through discussions. Alveron, Azri Alliamat, and Nordin (Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah) helped us in field excursions.

Last but not least, we would like to thank two anonymous reviewers and the editors of Species Diversity for their selfless effort in improving the manuscript.

**References**


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