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Taxonomic revision of two wide-ranging Asian ants, *Pheidole fervens* and *P. indica* (Insecta: Hymenoptera, Formicidae), and related species

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Abstract

Pheidole fervens F. SMITH, 1858 and *P. indica* MAYR, 1879 are wide-ranging in the warmer parts of Asia. They are very similar to each other, not only in their external morphology but also in habitat preference and other ecological features. This has brought about much taxonomic confusion regarding these common species. In the present paper, based on my examination of type materials and non-type specimens, I recognize both *P. fervens* and *P. indica* as good species, raise *P. javana jacobsoni* FOREL, 1911, *P. javana jubilans* FOREL, 1911, *P. javana protea* FOREL, 1912 and *P. indica* var. *coonoorensis* FOREL, 1902 to species level, and solve synonymy of taxa related to these species.

Key words: Formicidae, Myrmicinae, *Pheidole fervens*, *Pheidole indica*, lectotype designation, synonymy, rank change, Asia.

Zusammenfassung

Pheidole fervens F. SMITH, 1858 und *P. indica* MAYR, 1879 sind in den warmen Regionen Asiens weit verbreitet. Beide Arten sind einander nicht nur morphologisch, sondern auch in Bezug auf Habitatpräferenz und weitere ökologische Ansprüche, sehr ähnlich. Dies hat zu taxonomischer Verwirrung bezüglich dieser beiden häufigen Arten geführt. In der vorliegenden Arbeit, die sowohl auf meinen Untersuchungen des Typenmateriales als auch weiteren Materiales basiert, werden *P. fervens* und *P. indica* als eigene Arten anerkannt, *P. javana jacobsoni* FOREL, 1911, *P. javana jubilans* FOREL, 1911, *P. javana protea* FOREL, 1912 und *P. indica* var. *coonoorensis* FOREL, 1902 werden in den Artrang erhoben, und die Synonymie verwandter Arten wird geklärt.

Introduction

Pheidole fervens F. SMITH, 1858 is known from Japan (southern part of Kyushu, the Ryukyus and Daito Is.), Taiwan, China, Southeast Asia (type locality: Singapore), Sri Lanka and Oceania; and *P. indica* MAYR, 1879 from Japan (southern coasts of Honshu, Shikoku, Kyushu and the Ryukyus), Taiwan, through Southeast Asia to India (type locality: Calcutta) and Sri Lanka (TERAYAMA 1999). *P. fervens* inhabits urban area to forest edge (rarely inside well-developed forest, based on my field experience in Iriomote I., S. Ryukyus), and nests in the soil or under stones (rarely in rotting wood); and *P. indica* nests in the soil and under stones in open and dry habitats. Thus, their habitat preferences seem to largely overlap each other. Mainly due to their wide geographical ranges and sympatry as well as scarcity of distinguishing characteristics, taxonomy

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of these species has been confused. WILSON & TAYLOR (1967) synonymized *P. javana* MAYR, 1867, *P. oceanica* ssp. *cavanae* EMERY, 1887 [Emery originally described this taxon as a species and later demoted it to a subspecies of *P. oceanica* MAYR, 1866] and *P. oceanica* var. *nigriscapa* SANTSCHI, 1928a with *P. fervens* F. SMITH, 1858, but they did not deal with nomenclature of intraspecific taxa of *P. javana*. BOLTON (1995), however, enumerates the following taxa as current subspecies of *P. fervens*: *desucta* [*P. javana* var. *desucta* WHEELER, 1929], *dharmsalana* [*P. javana* var. *dharmsalana* FOREL, 1902], *dolenda* [*P. javana* var. *dolenda* FOREL, 1912], *jacobsoni* [*P. javana* var. *jacobsoni* FOREL, 1911a], *jubilans* [*P. javana* var. *jubilans* FOREL, 1911a], *pectinata* [*P. javana* var. *pectinata* STITZ, 1912], *protea* [*P. javana* ssp. *proteus* FOREL, 1912], *soror* [*P. javana* var. *soror* SANTSCHI, 1937]. EGUCHI (2001) treated *P. javana* var. *desucta* as a junior synonym of *P. fervens*. For *Pheidole indica* the following three subspecies are currently recongnized (BOLTON 1995): *coonoorensis* FOREL, 1902, *himalayana* FOREL, 1902 and *rotschana* FOREL, 1902. In the present paper, based on my examination of type materials of almost all of the forms under consideration and non-type specimens, I recognize both *P. fervens* and *P. indica* as good species, raise *P. javana jacobsoni*, *P. javana jubilans*, *P. javana protea* and *P. indica* var. *coonoorensis* to species level, and solve synonymy of taxa related to these species.

Materials and Methods

Type materials and part of non-type materials were loaned by the following institutions: The Natural History Museum (BMHN; Cromwell Road, London SW7 5BD, England); Museum of Comparative Zoology (MCZ; Harvard University, Cambridge, Massachusetts 02138, USA); Muséum d'Histoire Naturelle, Genève (MHNG; Case Postale 6434, CH-1211 Genève 6, Swisse); Naturhistorisches Museum, Basel (NHMB; Augustinergasse 2, CH-4001 Basel, Schweiz); Naturhistorisches Museum, Wien (NHMW; Postfach 417, Burgring 7, 1040 Wien, Austria); Hope Entomological Collections, The University Museum (OXUM; Parks Road, Oxford OX1 3PW, England).

Photographs were taken using a digital microscope (KEYENCE Digital HF Microscope VH-8000). Abbreviations of measuring points are as follows: HL, maximal length of head capsule; HW, maximal width of head capsule excluding eyes; EL, length of maximal diameter of eye; SL, length of antennal scape excluding the basal condylar bulb; LASX, Length of antennal segment X; FL, length of hind femur; CI, cephalic index = HW/HLx100; SI, scape index = SL/HWx100; FI, hind femur index = FL/HWx100. Colonies collected by me are given a colony code, like Eg96-BOR-009 or 96-JPN-001 where 96 means 1996. Colonies collected by Seiki Yamane are given a colony code, like SU02-SKY-76 where 02 and SKY mean 2002 and Sk. Yamane. In the case where a SKY-colony code is applied to colonies collected by other persons, the name of collector always follows.

Status of *Pheidole fervens* and *P. indica*, and related forms

The ratio of maximum length of eye to length of 10th antennal segment in both the major and minor workers, and shape of propodeal spine in the major have been proposed

as diagnostic characters separating *P. fervens* (with smaller eye and apically curved propodeal spine) from *P. indica* (with larger eye and straight propodeal spine) for sympatric populations in southern Japan (TERAYAMA 1999). Based on my examination of types and non-type materials of them I have confirmed both *P. fervens* and *P. indica* are good species, and partly modified Terayama's diagnoses as follows: in *P. fervens* maximal diameter of eye (EL) as long as or shorter than length of 10th antennal segment (LAS10) in the major, and EL much shorter than LAS10 in the minor, but in *P. indica* EL much longer than LAS10 in the major, and EL as long as or longer than LAS10 in the minor; in the major of *P. fervens* propodeal spine narrowly based and slightly curved apically, but in that of *P. indica* propodeal spine relatively broadly based and not curved apically (Tab. 1). OGATA (1982) gave line drawings of aedeagal plate of male genitalia for *P. fervens* and *P. indica*, showing a conspicuous difference in the shape of the apical lobe (in the former its apicoventral part produced as an acute angle). Judging from the result of a more extensive study of the male genitalia in *Pheidole* (EGUCHI 2003), such a difference in the shape of aedeagal plate may strongly support the present recognition of these two forms as different species (type series of both *P. fervens* and *P. indica*, however, do not include the male, preventing us from confirming this character in the types). I examined the following intraspecific forms of "*P. javana*": nominotypical form, *P. javana* var. *dharmsalana*, *P. javana* var. *dolenda*, *P. javana* ssp. *jacobsoni*, *P. javana* r. *jacobsoni* var. *taipingensis* FOREL, 1913 [unavailable name], *P. javana* var. *jubilans*, *P. javana* ssp. *jubilans* var. *formosae* FOREL, 1912 [unavailable name] and *P. javana* ssp. *protea*. The observations have shown that the nominotypical subspecies of *P. javana*, *P. javana dolenda* and *P. javana soror* are junior synonyms of *P. fervens*. On the other hand, *P. javana* ssp. *jubilans* var. *formosae* [unavailable name] should be placed under *P. indica* but not with *P. fervens*. I have concluded that *P. javana dharmsalana* is a junior synonym of *P. fervens*, but some questions remain with this conclusion: eyes of both the major and minor of *dharmsalana* are intermadiate in size between *P. indica* and *P. fervens* (EL/LASX = 1.06 in the major, and 0.89 - 1.00 in the minor), but shape of propodeal spine of the major is more similar to *P. fervens* than to *P. indica* (this is the main reason for my view).

P. javana ssp. *jacobsoni*, *P. javana* r. *jacobsoni* var. *taipingensis* [unavailable name] and *P. orophila* EGUCHI, 2001 have proved to be conspecific, but are well distinguished from both *P. fervens* and *P. indica*. Differences are: frontal carina of the major less conspicuous in *jacobsoni* than in the latter two; lateral part of occipital lobe very weakly punctured or almost smooth and shining in *jacobsoni* (Tab. 1). Thus I raise the status of *P. javana jacobsoni* FOREL, 1911 to species level. Non-type material from various localities in the Malay Archipelago indicates that *P. jacobsoni* and *P. fervens* are geographically sympatric, but the former inhabits mountain vegetation around 1500 m alt. (EGUCHI 2001). The type series of *P. javana jubilans* is very similar to that of *P. indica*, but differs from the latter in the following features: dorsum of propodeum of the major bearing only one pair of standing hairs which are located near its anterior margin in the former but at least 3 pairs in the latter; sculpture on promesonotal dome of the minor more conspicuous in the former than in the latter; propodeal spine of the minor much reduced in the former (Tab. 1). I raise the status of *P. javana jubilans* to species level. The major of *P. javana protea* has a conspicuously reticulate occipital lobe and massive postpetiole and is well distinguished from *P. fervens*, *P. indica*, *P. jacobsoni* and

Table 1: Diagnostic characteristics for the species treated in the present paper (important characteristics in bold letters).

	coonoorensis (Fig. 1)	*fervens* (Fig. 2)	*indica* (Fig. 3)
Ratio of EL to LASX (Ma, major; Mi, minor)	EL > LASX (Ma) EL ≈ LASX (Mi)	**EL ≤ LASX (Ma)** **EL << LASX (Mi)**	**EL >> LASX (Ma)** **EL ≥ LASX (Mi)**
Frontal carina (Ma)	conspicuous	more conspicuous than in *jacobsoni*	more conspicuous than in *jacobsoni*
Lateral face of occipital lobe (Ma)	rugoso-reticulate	rugoso-reticulate	rugoso-reticulate
Paired tubercles on dorsal portion of promesonotal dome (Mi)	absent	absent	absent
Surface on promesonotal dome (Mi)	**weakly rugoso-reticulate, with enclosures punctured weakly**	almost smooth	almost smooth
Shape of propodeal spine (Ma)	relatively broadly based, not curved apically	**narrowly based, slightly curved apically**	relatively broadly based, not curved apically
Size of propodeal spine (Mi)	not useful	not useful	longer than in *jubilans*
Standing hairs on propodeal dorsum (Ma)	**≥3 pairs**	≥ 3 pairs	**≥3 pairs**
Ratio of length of postpetiole excluding helcium (PpL) to that of petiole (PL) (Ma)	PpL << PL	PpL << PL	PpL << PL

	jacobsoni (Fig. 4)	*jubilans* (Fig. 5)	*protea* (Fig. 6)
Ratio of EL to LASX (Ma, major; Mi, minor)	EL ≤ LASX (Ma) EL < LASX (Mi)	EL >> LASX (Ma) EL > LASX (Mi)	EL > LASX (Ma) EL ≤ LASX (Mi)
Frontal carina (Ma)	**less conspicuous than in *fervens* and *indica***	conspicuous	conspicuous
Lateral face of occipital lobe (Ma)	**very weakly rugoso-punctate or almost smooth**	rugoso-reticulate	reticulate
Paired tubercles on dorsal portion of promesonotal dome (Mi)	absent	absent	**present**
Surface on promesonotal dome (Mi)	almost smooth	**very weakly rugoso-punctate anteriorly and dorsolaterally**	**rugoso-reticulate irregularly and coarsely**
Shape of propodeal spine (Ma)	narrowly based, not curved apically	relatively broadly based, not curved apically	relatively broadly based, not curved apically
Size of propodeal spine (Mi)	not useful	shorter than in *indica*	not useful
Standing hairs on propodeal dorsum (Ma)	usually ≥ 3 pairs	**1 pair**	≥ 3 pairs
Ratio of length of postpetiole excluding helcium (PpL) to that of petiole (PL) (Ma)	PpL << PL	PpL << PL	**PpL ≈ PL**

P. jubilans (Tab. 1), this making certain of its species-level status. Both *Pheidole amia* FOREL, 1912 (type locality: Taiwan) and *P. pungens* (F. SMITH, 1861) (type locality: Taiwan) are junior synonyms of *P. fervens* F. SMITH, 1858.

Pheidole striativentris MAYR, 1879 (type locality: Calcutta) and *P. indica* MAYR, 1879 are conspecific. These two species were originally described in the same publication (MAYR 1879), *P. striativentris* on p. 678 and *P. indica* on p. 679. The International Code of Zoological Nomenclature, 4th edition (Japanese text) (International Commission on Zoological Nomenclature 2000) does not give priority to a particular page in a single publication. I propose that *P. indica* deserves to be the senior synonym, because this name has almost exclusively been used in most of the publications to date (e.g. BINGHAM 1903, EMERY 1921, FOREL 1902, OGATA 1982, WILSON 1984, TERAYAMA 1999, ZHOU 2001). Of current subspecies of *P. indica* MAYR, *himalayana* FOREL, 1902 and *rotschana* FOREL, 1902 agree well with the nominotypical subspecies of *P. indica*, and should be synonymized with the latter. In the major *P. indica coonoorensis* FOREL, 1902 agrees well with *P. indica indica*, but in the minor the alitrunk and anterior part of first gastral tergite are conspicuously punctured in the former, suggesting that the former is different from the latter at species level.

SANTSCHI (1941) described an infraspecific taxon, *P. nodus* st. *azumai*, under *P. noda* F. SMITH, 1874. From my examination of the type material of *azumai* (including both the major and minor), however, his misidentification is obvious, because *azumai* completely lacks such diagnostic features of *P. noda* as well-developed postpetiole in the worker, and long and thick standing hairs sparsely arranged among dense short and decumbent hairs on dorsal surface of occipital lobe in the major. I have concluded that *P. nodus azumai* is a junior synonym of *P. fervens*. Despite notable myrmecological activity in Japan, *P. fervens* has not been recorded in Honshu, while the type locality of *azumai* is Tennooji, Osaka (southwestern Honshu). Because *P. fervens* has apparently spread through human commerce (WILSON & TAYLOR 1967), occasional and temporary establishment of its populations in Osaka has been likely to occur when considering that Osaka has a long history as one of the centers for Japanese economy, distribution-industry and international-trade.

Pheidole coonoorensis, *P. fervens*, *P. indica*, *P. jacobsoni*, *P. jubilans* and *P. protea* recognized as good species share the following set of morphological characteristics: **major**: body covered with standing hairs; head in profile at most very weakly impressed on vertex; median hypostomal processes ill developed or almost absent; frontal carina never extending horizontally nor overhanging antennal scrobe; antennal club 3-segmented; dorsal portion of promesonotal dome at most very weakly prominent laterad, never having paired spines/tubercles; posterior declivity of promesonotal dome with prominence; propodeal spine well developed but never spatulate; petiole at least as long as postpetiole; subpetiolar process absent; **minor** (only non-type material is available for *P. protea*): body covered with standing hairs; head in full-face view oval, without a neck; occipital carina conspicuous; scape extending far beyond posterior border of head; antennal club 3-segmented; dorsum of head sculptured at most weakly, never strongly punctured nor reticulate; posterior declivity of promesonotal dome with prominence; petiole at least as long as postpetiole; **male genitalia** (OGATA 1982 for *P. fervens* and *P. indica*, EGUCHI 2003 for *P. jacobsoni* and *P. protea*; no information is available for

P. coonoorensis and *P. jubilans*): aedeagal plate with conspicuous ventral or apicoventral concavity.

Because of lacking any solid characteristics shared exclusively among them, the reality of "*P. fervens* group" seems to be much more tenuous than that of *P. nodifera* group, *P. quadricuspis* group, etc. informally recognized by EGUCHI (2001, 2003). Furthermore, in the course of my ongoing work on Oriental *Pheidole*, I have continuously added species possibly related to *P. fervens*, and ambiguous species around the margin of "*P. fervens* group" as well. Thus, the status of "*P. fervens* group" should be justified based on a large-scale analysis including all Oriental species. But this would be premature, and far beyond the initial aim of the present study. At present, I refrain from proposing an informal species group like "*P. fervens* group".

Key to the species treated in the present paper

In this key and Tab. 1 I aim to distingish *Pheidole coonoorensis*, *P. fervens*, *P. indica*, *P. jacobsoni*, *P. jubilans* and *P. protea* from each other, and to justify their status at species level. I further recognize several described species (*P. annexus* EGUCHI, *P. inornata* EGUCHI and *P. plagiaria* F. SMITH) and dozens of undetermined species, which are morphologically similar to the above six species, from Southeast Asia. Although comprehensive keys will be given in my future monograph of Indo-Chinese *Pheidole*, for the moment the keys given in EGUCHI (2001) are also helpful.

1a Major: postpetiole (excluding helcium) almost as long as petiole. Minor: dorsal portion of promesonotal dome having a pair of tubercles laterally. ..... ***P. protea*** (Fig. 6)

1b Major: postpetiole (excluding helcium) much shorter than petiole. Minor: dorsal portion of promesonotal dome lacking a pair of tubercles laterally. 2

2a Minor: promesonotal dome weakly rugoso-reticulate, with enclosures punctured weakly. Major: propodeal dorsum having three or more pairs of standing hairs. ..... ***P. coonoorensis*** (Fig. 1)

2b Minor: promesonotal dome smooth mediodorsally and laterally, and very weakly rugoso-punctate anteriorly and dorsolaterally. Major: propodeal dorsum having only one pair of standing hairs. ..... ***P. jubilans*** (Fig. 5)

2c Minor: promesonotal dome almost smooth and shining entirely. Major: propodeal dorsum having one or more pairs of standing hairs. 3

3a Major: Lateral face of occipital lobe very weakly rugoso-punctate or almost smooth. ..... ***P. jacobsoni*** (Fig. 4)

3b Major: Lateral face of occipital lobe well rugoso-reticulate. 4

4a Major: maximal length of eye as long as or a little shorter than 10th antennal segment; propodeal spine relatively narrowly based, slightly curved apically. Minor: maximal length of eye much shorter than 10th antennal segment. ..... ***P. fervens*** (Fig. 2)

4b Major: maximal length of eye much longer than 10th antennal segment; propodeal spine relatively broadly based, not curved apically. Minor: maximal length of eye as long as or longer than 10th antennal segment. ..... ***P. indica*** (Fig. 3)

Descriptions and synonymy

Pheidole coonoorensis FOREL, 1902, stat.n. (Fig. 1a - h; Tab. 1)

Pheidole indica var. *coonoorensis* FOREL, 1902: 185, 199. Type locality: Coonoor [India]. Subspecies of *P. indica*: BOLTON 1995 (catalogue). One major among the 4 syntypes examined (2 majors and 2 minors, MHNG) is designated as the **lectotype** (Fig. 1a).

Major (measurements are given for the lectotype; those for the paralectotype are in brackets): HL 1.45 [1.43] mm, HW 1.33 [1.31] mm, EL 0.19 [0.20] mm, SL 0.76 [0.74] mm, LASX 0.17 [0.16] mm, FL 1.06 [1.08] mm, CI 91 [92]; SI 58 [56], FI 80 [82]. Head broadest about 3/5 distance of head (as measured from the mid-point of a transverse line spanning the anteriormost and posteriormost projecting points of cranium, respectively); head in profile not impressed on vertex. Hypostoma with three inconspicuous median processes. Clypeus with a weak median longitudinal carina. Eye situated around 2/5 distance of head; distance between mandibular insertion and anterior margin of eye 1.6 [1.5] times as long as maximal diameter of eye; maximal diameter of eye 1.11 [1.28] times as long as 10th antennal segment. Frontal carina slightly extending just behind 7/10 distance of head. Antennal scrobe very weak, running along frontal carina. Antenna with 3-segmented club; terminal segment shorter than preceding two segments together. Promesonotal dome with distinct prominence on its posterior declivity; the prominence in anterior view slightly concave medially; dorsal portion of promesonotal dome very weakly prominent laterad. Propodeal spine relatively broadly based, almost straight, blunt apically, 3 - 4 times as long as diameter of propodeal spiracle. Petiole cuneiform, ca. 1.5 times as long as postpetiole (excluding helcium); petiolar node low, in posterior view very weakly emarginate at apex. Postpetiole ca. 2.2 times as broad as petiolar node. Frons to vertex longitudinally rugose with interspaces weakly punctured on vertex; dorsum of occipital lobe with rugulae curved toward occipital corner, with interspaces very weakly punctured and slightly dull; lateral face of occipital lobe rugoso-reticulate with interspaces weakly punctured and dull; promesonotal dome transversely rugose, with interspaces almost smooth and shining; mesopleuron and lateral face of propodeum weakly rugoso-reticulate, with enclosures punctured weakly and dull; petiole smooth and shining anterodorsally, and weakly punctured posterodorsally and laterally; postpetiole weakly punctured; first gastral tergite weakly punctured anteriorly. Body brown.

Minor (paralectotypes; measurements are given for a paralectotypes which remains intact): HL 0.61 mm, HW 0.53 mm, EL 0.14 mm, SL 0.68 mm, LASX 0.14 mm, FL 0.73 mm, CI 87, SI 129, FI 139. Head in full-face view oval; occipital carina conspicuous. Clypeus with very weak median longitudinal carina only apically. Eyes situated around midlength of head; distance between mandibular insertion and anterior margin of eye 0.9 times as long as maximal diameter of eye; maximal diameter of eye 0.98 times as long as 10th antennal segment. Antenna with 3-segmented club; terminal segment almost as long as preceding two segments together. Promesonotal dome with prominence on its posterior declivity. Propodeal spine small, ca. 2.0 times as long as diameter of propodeal spiracle. Petiole cuneiform, ca. 1.5 times as long as postpetiole (excluding helcium); petiolar node low, in posterior view not emarginate at apex. Postpetiole ca. 2.0 times as broad as petiolar node. Head including clypeus almost smooth and shin-

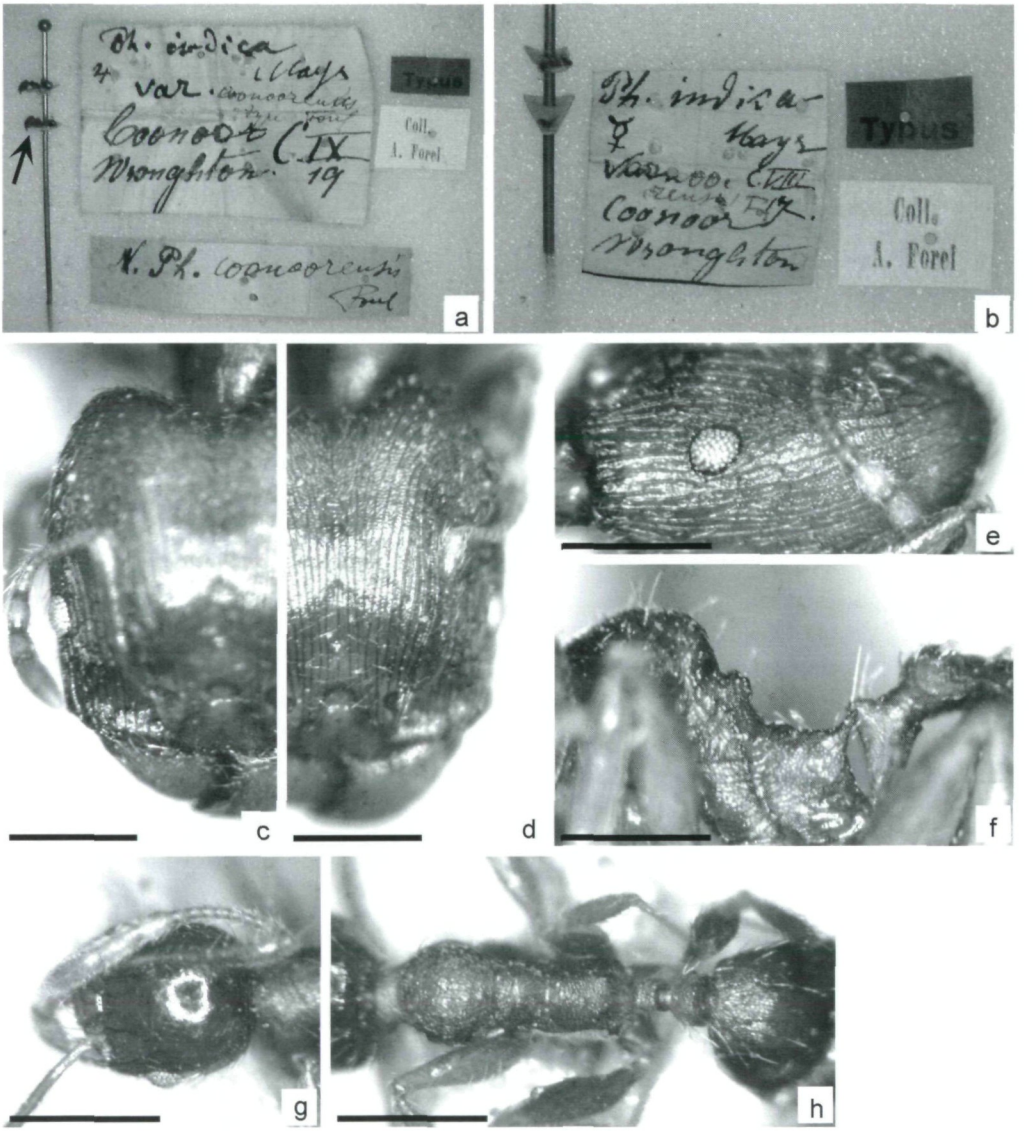


Fig. 1: Lectotype (major) and a paralectotype (minor) of *Pheidole coonoorensis*: (a) labels attached to the lectotype and paralectotype (major), arrow indicating lectotype; (b) labels attached to paralectotypes (minor). (c - f): lectotype: (c, d) head in full-face view; (e) head in lateral view; (f) alitrunk in lateral view; (g, h) paralectotype: (g) head in dorsal view; (h) alitrunk in dorsal view. Scale bars: 0.5 mm.

ing; promesonotal dome weakly rugoso-reticulate, with enclosures punctured weakly and dull; mesopleuron and lateral face of propodeum punctured and dull; petiole smooth and shining anterodorsally, and very weakly punctured posterodorsally and laterally; dorsum of postpetiole and anterior part of first gastral tergite weakly punctured. Body brown.

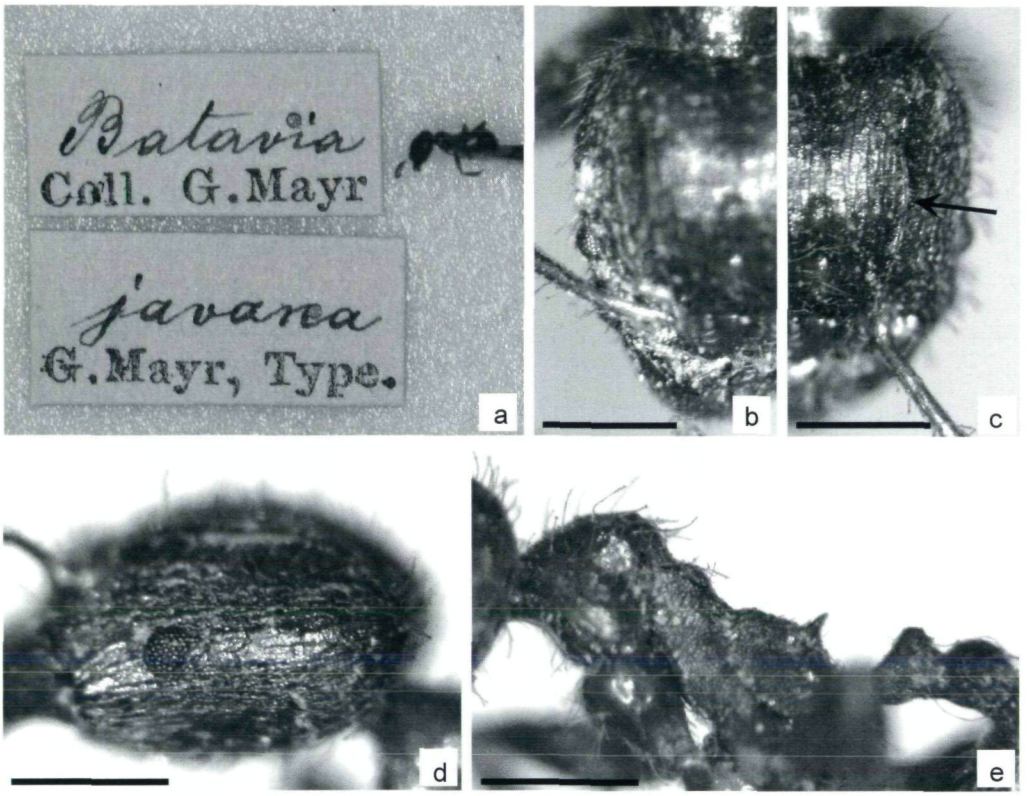


Fig. 2: Lectotype (major) of *Pheidole javana*: (a) labels attached; (b, c) head in full-face view, arrow in (c) indicating frontal carina; (d) head in lateral view; (e) alitrunk and waist in lateral view. Scale bars: 0.5 mm.

***Pheidole fervens* F. SMITH, 1858** (Figs. 2a - e, 7a, d, e, h, 8 a, b; Tab. 1)

Pheidole fervens F. SMITH, 1858: 176. Type locality: Singapore. Three **syntypes** (1 major and 2 minors labelled as syntype, BMNH) were examined.

Pheidole cavannae EMERY, 1887: 464. Type locality: New Caledonia. Subspecies of *P. oceanica*: EMERY 1914. Junior synonym of *P. fervens*: WILSON & TAYLOR 1967: 45. Not examined.

Pheidole javana MAYR, 1867: 98. Type locality: Batavia [= Jakarta, Java]. Junior synonym of *P. fervens*: WILSON & TAYLOR 1967: 45. One major among the 5 syntypes examined (3 majors and 2 minors, NHMW) is designated as the **lectotype** (Fig. 2a - e; see also "Remarks").

Pheidole (*Pheidole*) *oceanica* var. *nigriscapa* SANTSCHI, 1928a: 48. Type locality: Apia, Samoa. Junior synonym of *P. fervens*: WILSON & TAYLOR 1967: 45. One syntype minor (NHMB) was examined.

Pheidole oceanica ssp. *nigriscapa* var. *tahitiana* SANTSCHI, 1928b: 516. Described from Tahiti. Unavailable name; material referable to *P. fervens*: WILSON & TAYLOR 1967: 45. Not examined.

Pheidole amia FOREL, 1912a: 60 - 61. Type locality: Takao [= Kaohsiung, Taiwan]. One syntype major among the 4 syntypes examined (1 major and 3 minors, MHNG) is designated as the **lectotype** (Fig. 7a). **Syn.n.**

Pheidole javana var. *desucta* WHEELER, 1929: 2. Type locality: Back Liang, China. Subspecies of *P. fervens*: BOLTON 1995 (catalogue). **Lectotype** designation and solution of synonymy: EGUCHI 2001.

Pheidole javana var. *dharmsalana* FOREL, 1902: 184, 198. Type locality: Dharmsala [India]. Subspecies of *P. fervens*: BOLTON 1995 (catalogue). One syntype major among the 3 syntypes examined (1 major and 2 minors, MHNG) is designated as the **lectotype** (Fig. 7d). **Syn.n.**

Pheidole javana var. *dolenda* FOREL, 1912a: 60. Type locality: Akau [Taiwan]. Subspecies of *P. fervens*: BOLTON 1995 (catalogue). One syntype major among the 5 syntypes examined (2 majors and 3 minors, MHNG) is designated as the **lectotype** (Fig. 7e). **Syn.n.**

Pheidole javana var. *soror* SANTSCHI, 1937: 369. Type locality: Hokuto, Formose [= Taiwan]. Subspecies of *P. fervens*: BOLTON 1995 (catalogue). One syntype major among the 5 syntypes examined (1 major and 4 minors, NHMB) is designated as the **lectotype** (Fig. 7h). **Syn.n.**

Pheidole nodus st. *azumai* SANTSCHI, 1941: 274. Type locality: Tennooji, Osaka, Japan. Subspecies of *P. noda*: BOLTON 1995 (catalogue). One syntype major among the 3 syntypes examined (1 major and 2 minors, NHMB) is designated as the **lectotype** (Fig. 8a). **Syn.n.**

Solenopsis pungens F. SMITH, 1861: 48 - 49. Type locality: Menado [Sulawesi]. Combination in *Pheidologeton*: DONISTHORPE 1932; in *Pheidole*: BOLTON 1995 (catalogue). One syntype major among the 3 syntypes examined (2 majors and 1 minor, OXUM) is designated as the **lectotype** (Fig. 8b). **Syn.n.**

Additional material examined: Japan: S. Kyushu: Toso, Kagoshima City (Colony 021105-1, T. Akiyama leg.). Ryukyu Is.: Azufu, Okinoerabu-jima (1 minor from Litter shift-3, A. Shimono leg.); Iriomote-jima (96-JPN-001, 96-JPN-003, K. Eguchi leg.). **China:** Macau: Taipa I. (Eg99-MAC-01, Eg99-MAC-02); Hac-Sa, Coloane I. (6 minors, K. Eguchi leg.). Hong-Kong: Victoria Park, Hong-Kong I. (2 minors, K. Eguchi leg.). **Thailand:** Chanthaburi Prov: Yay-am Dist. (Eg01-TH-66B). **Philippines:** Palawan: Pupok, Napsan, in a cottage (2 minors, H. Fukuda leg.). **Malaysia:** Borneo (E. Malaysia): Tawau Hills Park, Sabah (Eg96-BOR-009, Eg96-BOR-021); Niah N. P., Sarawak (1 minor, Sk. Yamane leg.). **Indonesia:** W. Sumatra: Maninjau, (1 major and 1 minor, SNS col.); Sako, nr. Tapan (1 major and 1 minor, SNS col.); Sukarami, Padang (colony No. 9/28a, M. Kawamura leg.); Ulu Gadut, nr. Padang (1 minor, SNS col.). W. Java: Bogor (colony No. 153, M. Kawamura leg.). Java: Air Panas Cargar, 1600 m alt., Bumiaji, Batu (1 minor, JV02/03-SKY-71, 72, F. Yamane leg.; JV02/03-SKY-73, 75, 80); Sumberbrantas, 1600 m alt., Tulungrejo, Batu (2 minors, F. Yamane leg.). **Samoa:** Apia (1 major, H. Swole leg., NHMB).

Remarks: Among 7 specimens (labelled "*javana* G. Mayr, Type.") of "*P. javana*" (nominotypical subspecies), two majors are labelled "Borneo" but not "Batavia [= Jakarta]" for their locality. These two Bornean majors are actually not types, but conspecific. The two minors from Jakarta disagree with the examined syntype minors of *P. fervens* in the following characters: posterior declivity of promesonotal dome with a more distinct prominence in the former than in the latter; standing hairs on dorsum of alitrunk shorter and fewer in the former; relative size of eye to cranium much larger in the former. I conclude that these two syntype minors of "*P. javana*" are not conspecific with *P. fervens*. Their identity has not yet been established. Of the three majors from Jakarta, one remaining intact is designated as the lectotype here; one has lost its head, the last retaining only its head.

Type material of *P. javana* var. *pectinata* STITZ, 1912 has not yet been examined by me, and its status is still unsettled.

Pheidole indica MAYR, 1879 (Figs. 3a - f, 7b, c, 7g, 8c; Tab. 1)

Pheidole indica MAYR, 1879: 679. Type locality: Calcutta [India]. One syntype major among the 5 syntypes examined (2 majors and 2 minors and 1 queen labelled type, NHMW) is designated as the **lectotype** (Fig. 3a).

P. indica r. *himalayana* FOREL, 1902: 185, 199. Type locality: Cachemire [= Kashmir], Darjeeling and Dharmsala [India]. Raised to species: BINGHAM 1903. Subspecies of *P. indica*:

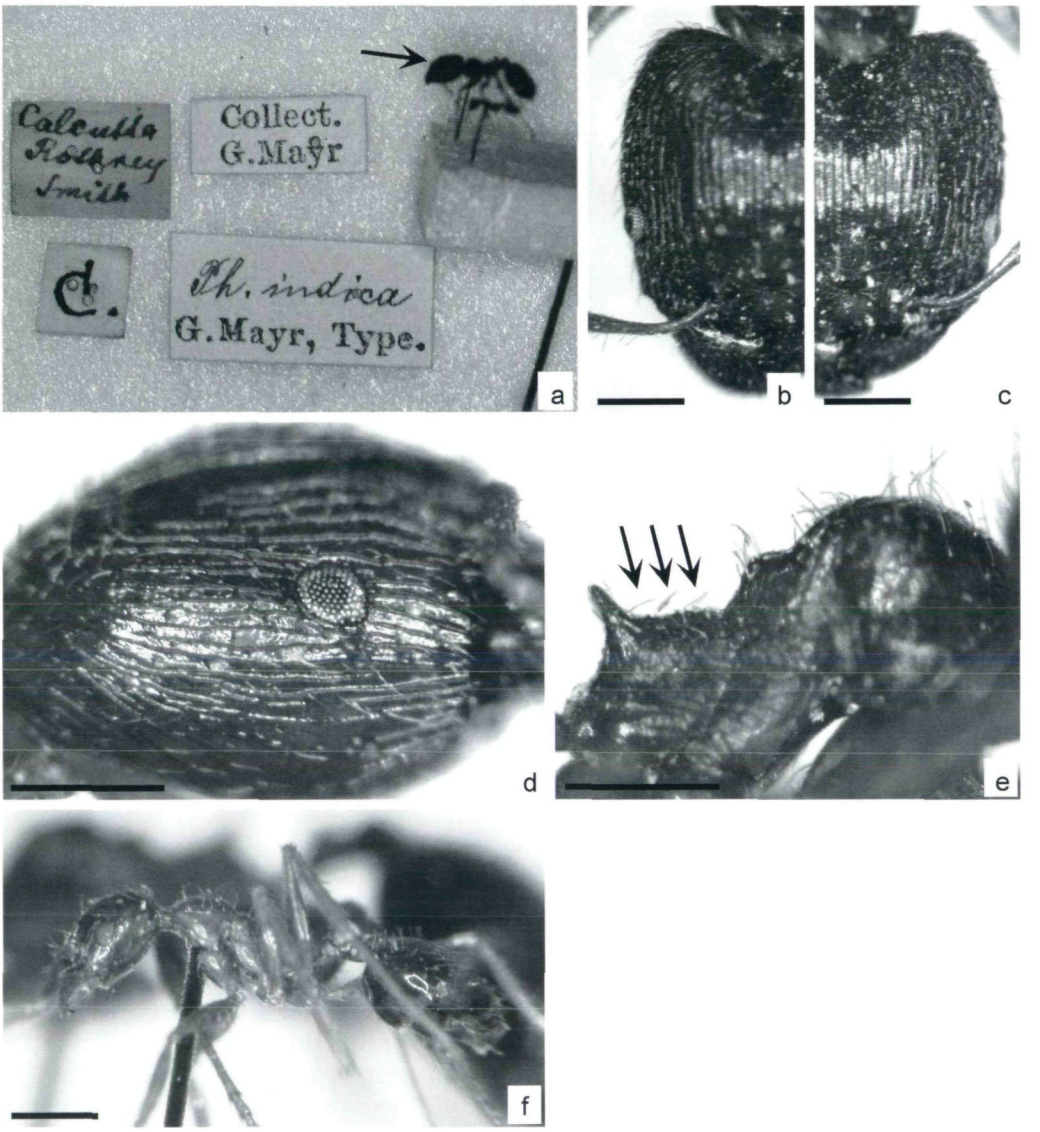


Fig. 3: Lectotype (major) and a paralectotype (minor) of *Pheidole indica*: (a) labels attached, arrow indicating lectotype. (b - e): lectotype: (b, c) head in full-face view; (d) head in lateral view; (e) alitrunk in lateral view, arrows indicating pairs of standing hairs on dorsal face of propodeum. (f) paralectotype in lateral view. Scale bars: 0.5 mm.

EMERY 1921, MENOZZI 1939, PISARSKI 1967. One syntype major among the 5 syntypes examined (2 majors and 3 minors from Darjeeling, MHNG) is designated as the **lectotype** (Fig. 7b).

P. indica r. *rotschana* FOREL, 1902: 185, 199. Type locality: Poona, Orissa, Trevandrum and Thana [India]. Raised to species: BINGHAM 1903. Subspecies of *P. indica*: FOREL 1909, FOREL 1911b. One syntype major among the 8 syntypes examined (2 majors, 3 minors and 3 males from Poona, MHNG) is designated as the **lectotype** (Fig. 7c).

Pheidole javana ssp. *jubilans* var. *formosae* FOREL, 1912a: 60. Described from Takao [= Kaohsiung, Taiwan]. Unavailable name. Five specimens referable to *P. javana* ssp. *jubilans* var. *formosae* (1 major, 3 minors and 1 male, MHNG) were examined (Fig. 7g).

Pheidole striativentris MAYR, 1879: 678. Type locality: Calcutta [India]. One syntype major examined (NHMW) is designated as the **lectotype** (Fig. 8c). **Syn.n.**

Additional material examined: Japan: S. Kyushu: Korimoto, Kagoshima-shi (Eg00-JPN-001). Ryukyu Is.: Azufu, Okinoerabu-jima (1 minor from Bait trap-41, A. Shimono leg.). **China:** Guangxi Prov.: new campus of Guangxi Normal University, Guilin City (Eg00-GNGX-01, Eg00-GNGX-07). **India:** Calcutta (13 majors and 2 minors, Schulth.-Rechbg., det. by Forel as "*P. indica* MAYR", NHMW; 1 major, 1 minor, 1 queen and 1 male, Forel, det. by Forel as "*indica*", NHMW); Himachal Pradesh, Vic. Jari, 20 km E. Kullu (1 minor, A. Schulz & K. Vock leg., NHMW).

Pheidole jacobsoni FOREL, 1911, stat.n. (Figs. 4a - h, 7f; Tab. 1)

Pheidole javana ssp. *jacobsoni* FOREL, 1911a: 203 - 205. Type locality: Semarang, Java. Subspecies of *P. fervens*: BOLTON 1995 (catalogue). One major among the 8 syntypes examined (3 majors, 3 minors, 1 queen and 1 male, MHNG) is designated as the **lectotype** (Fig. 4a).

Pheidole javana r. *jacobsoni* var. *taipingensis* FOREL, 1913: 28. Described from Maxwell's Hill in Taiping, and Birch Hill, Malacca [Malaysia]. Unavailable name. Two specimens referable to *P. javana* r. *jacobsoni* var. *taipingensis* (1 major and 1 minor from Maxwell's Hill, MHNG) are examined (Fig. 7f).

Pheidole orophila EGUCHI, 2001: 85 - 86. Type locality: Cameron Highland, Malaysia (Southern Malay Peninsula). Description of male genitalia: EGUCHI 2003: 330 - 331. **Syn.n.**

Additional material examined: Specimens enumerated under "*Pheidole orophila*" in EGUCHI (2001). **Indonesia:** N. Sumatra: Parapat, 900 m alt., Danau Toba (SU02-SKY-76). Java: Air Panas Cargar, 1600 m alt., Bumiaji, Batu (JV02/03-SKY-74, F. Yamane leg.); G. Anjasmoro, 1400 m alt., Tulungrejo, Batu (JV02/03-SKY-51); Sumberbrantas, 1600 m alt., Tulungrejo (1 minor, F. Yamane leg.; 2 minors, Sk. Yamane leg.); Tangkuban, 1500 m alt. (2 minors, Syaukani leg.).

Major (redescription of the lectotype and two paralectotype majors; measurements are given for the lectotype, with those for the two paralecotypes in brackets): HL 1.21 [1.19 - 1.25] mm, HW 1.18 [1.15 - 1.21] mm, EL 0.18 [0.17 - 0.18] mm, SL 0.85 [0.85 - 0.87] mm, LASX 0.19 [0.18 - 0.19] mm, FL 1.14 [1.11 - 1.14] mm, CI 97 [97]; SI 72 [72 - 74], FI 97 [94 - 97]. Head broadest around midlength of head; head in profile not impressed on vertex. Hypostoma with three very small median processes. Median longitudinal carina of clypeus evanescent. Eye situated just behind 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.3 times as long as maximal diameter of eye; maximal diameter of eye 0.98 [0.94 - 0.95] times as long as 10th antennal segment. Frontal carina less conspicuous, extending backward to around 3/4 distance of head. Antennal scrobe inconspicuous, running along frontal carina. Antenna with 3-segmented club; scape extending backward to about 9/10 distance of head; terminal segment shorter than preceding two segments together. Promesonotal dome with distinct prominence on its posterior declivity; the prominence in anterior view not concave medially; dorsal portion of promesonotal dome not prominent laterad. Propodeal spine horn-like, narrowly based, not curved apically, ca. 2.0 times as long as diameter of propodeal spiracle. Petiole cuneiform, ca. 1.6 times as long as postpetiole (excluding helcium); petiolar node low, in posterior view not emarginate at apex. Postpetiole ca. 1.7 times as broad as petiolar node. Frons and vertex longitudinally rugose; posterior and lateral faces of occipital lobe almost smooth and shining;

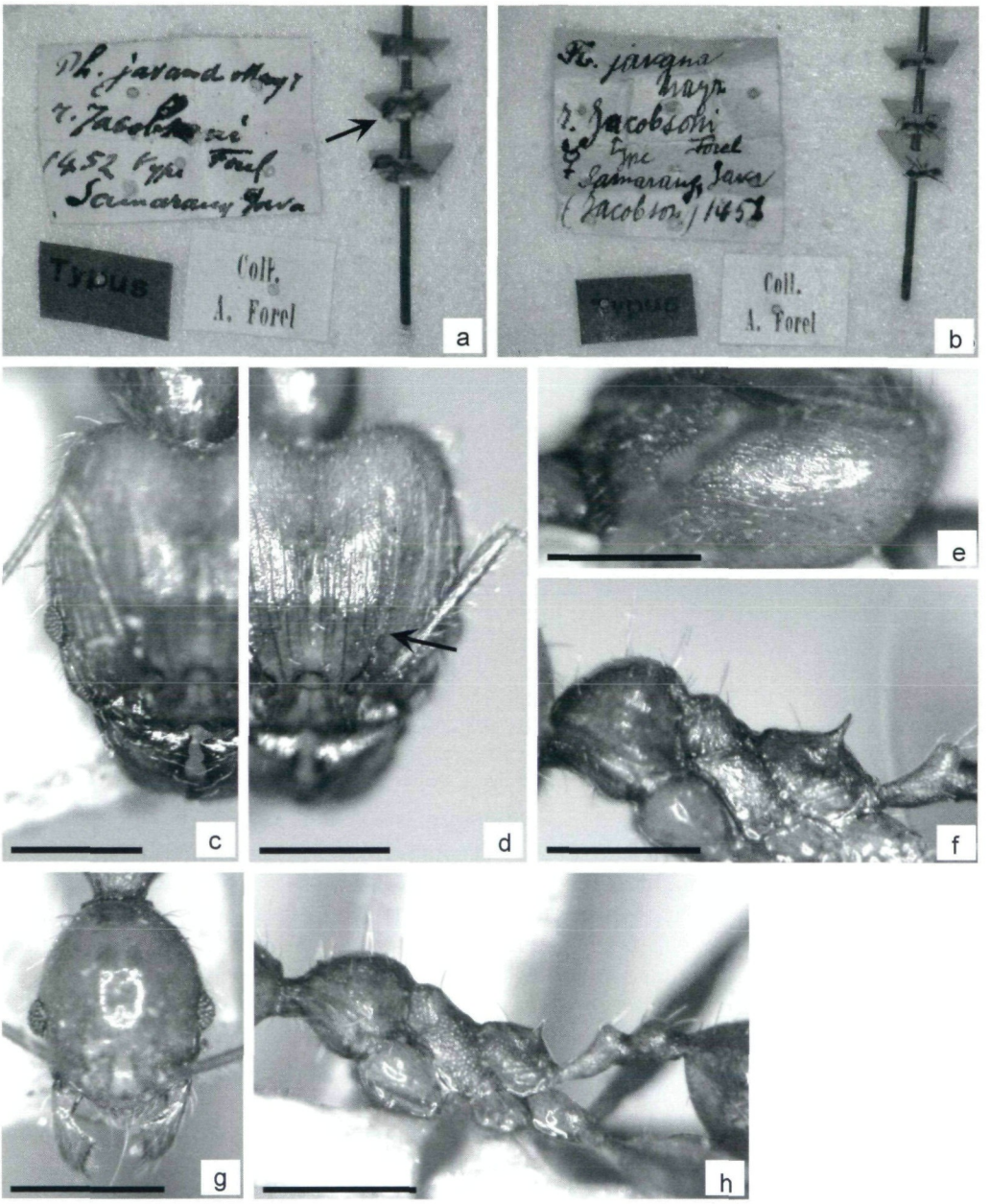


Fig. 4: Lectotype (major) and paralectotypes (majors and minors) of *Pheidole jacobsoni*: (a) labels attached to the lectotype and paralectotypes (major), arrow indicating lectotype; (b) labels attached to paralectotypes (minor). (c - f): lectotype: (c, d) head in full-face view, arrow in (d) indicating frontal carina; (e) head in lateral view; (f) alitrunk in lateral view. (g, h) paralectotype: (g) head in full-face view; (h) alitrunk in lateral view. Scale bars: 0.5 mm.

promesonotal dome smooth and shining dorsally and laterally, and weakly rugose dorsolaterally; upper part of mesopleuron and lateral face of propodeum weakly punctured; lower part of mesopleuron weakly punctured, with median portion smooth and shining; lateral face of petiole very weakly punctured; dorsa of petiole, postpetiole and gaster smooth and shining. Body light brown.

Minor (paralectotypes): HL 0.69 - 0.71 mm, HW 0.54 - 0.55 mm, EL 0.14 mm, SL 0.81 - 0.83 mm, LASX 0.17 mm, FL 0.93 - 0.95 mm, CI 77 - 80, SI 148 - 150, FI 169 - 173. Head in full-face view oval; occipital carina well developed. Median longitudinal carina of clypeus absent or evanescent. Eyes situated in front of midlength of head; distance between mandibular insertion and anterior margin of eye almost as long as maximal diameter of eye; maximal diameter of eye 0.81 - 0.85 times as long as 10th antennal segment. Antenna with 3-segmented club; terminal segment shorter than preceding two segments together. Promesonotal dome with low prominence on its posterior declivity. Propodeal spine small, elongate triangle, 1.5 - 2 times as long as diameter of propodeal spiracle. Petiole cuneiform, ca. 1.5 times as long as postpetiole (excluding helcium); petiolar node low, in posterior view not emarginate at apex. Postpetiole ca. 1.7 times as broad as petiolar node. Head including clypeus almost smooth and shining; promesonotal dome almost smooth and shining, with dorsolateral part very weakly punctured; mesopleuron and lateral face of propodeum weakly punctured and weakly shining; lateral face of petiole very weakly punctured; dorsa of petiole, postpetiole, and gaster smooth and shining. Body yellowish-brown.

Pheidole jubilans FOREL, 1911, stat.n. (Fig. 5a - i; Tab. 1)

Pheidole javana ssp. *jubilans* FOREL, 1911a: 202 - 203. Type locality: Semarang, Java. Subspecies of *P. fervens*: BOLTON 1995 (catalogue). One major among the 5 syntypes examined (2 majors and 3 minors, MHNG) is designated as the **lectotype** (Fig. 5a).

Major (measurements are given for the lectotype, with those for the paralectotype in brackets): HL 1.37 [1.28] mm, HW 1.26 [1.20] mm, EL 0.21 [0.21] mm, SL 0.71 [0.69] mm, LASX 0.16 [0.15] mm, FL 0.96 [0.91] mm, CI 92 [94], SI 56 [57], FI 76 [76]. Head broadest about 3/5 distance of head; head in profile not impressed on vertex. Hypostoma without conspicuous median process. Clypeus with weak median longitudinal carina, with anterior margin emarginate medially. Eye situated around 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.3 [1.2] times as long as maximal diameter of eye; maximal diameter of eye 1.33 [1.42] times as long as 10th antennal segment. Frontal carina extending backward to 3/4 distance of head. Antennal scrobe inconspicuous, running along frontal carina. Antenna with 3-segmented club; terminal segment shorter than preceding two segments together. Promesonotal dome with distinct prominence on its posterior declivity; prominence in anterior view very weakly concave medially; dorsal portion of promesonotal dome very weakly prominent laterad. Propodeal spine relatively broadly based, 3 times as long as diameter of propodeal spiracle. Petiole cuneiform, ca. 1.5 [1.4] times as long as postpetiole (excluding helcium); petiolar node low, in posterior view not emarginate at apex. Postpetiole 2.3 [2.2] times as broad as petiolar node. Frons longitudinally rugose with interspaces almost smooth and shining; vertex and dorsum of occipital lobe longitudinally rugose to rugoso-reticulate, with interspaces very weakly punctured and slightly dull; lateral face

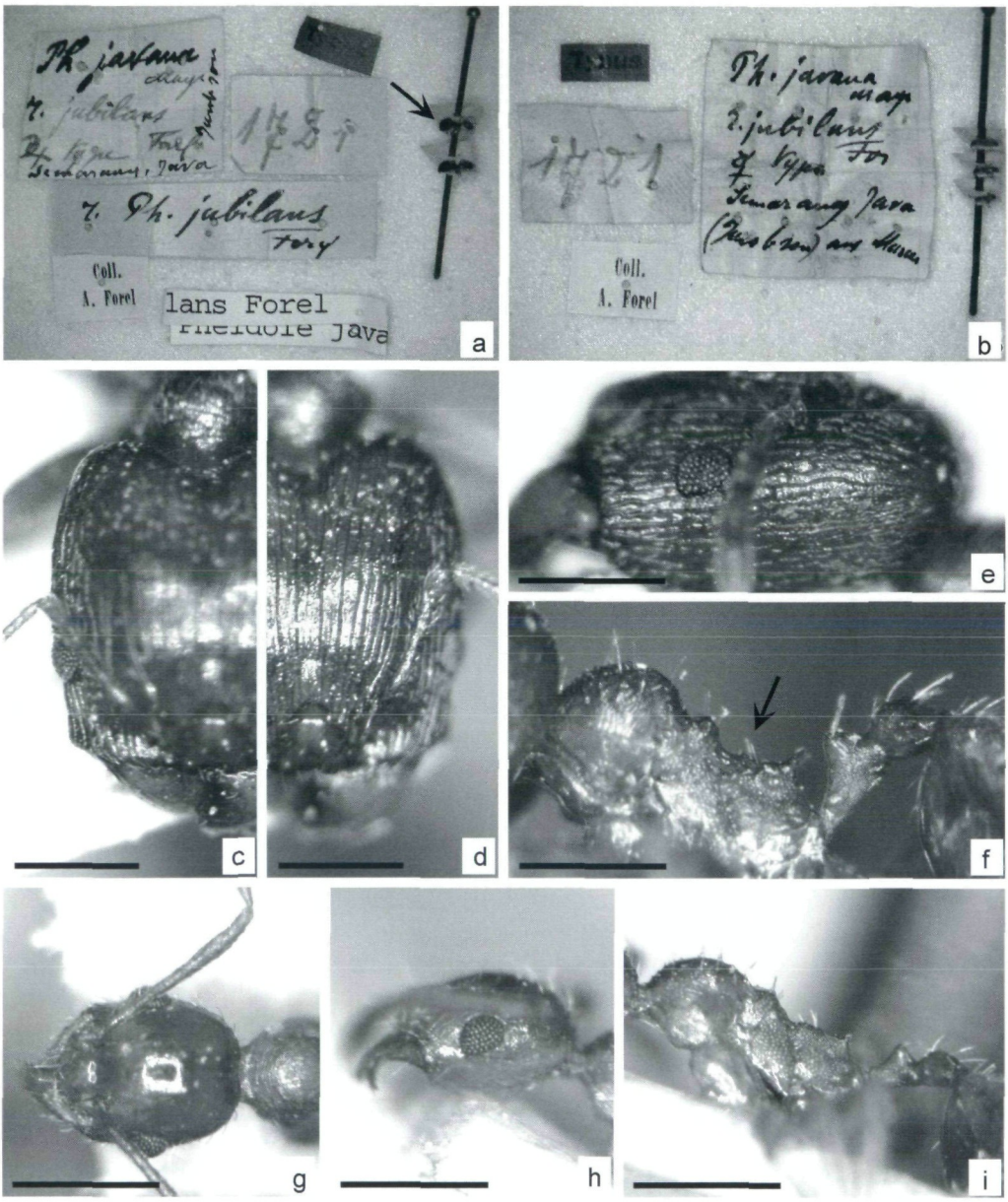


Fig. 5: Lectotype (major) and paralectotypes (majors and minors) of *Pheidole jubilans*: (a) labels attached to the lectotype and a paralectotype (major), arrow indicating the lectotype; (b) labels attached to paralectotypes (minor). (c - f): lectotype: (c, d) head in full-face view; (e) head in lateral view; (f) alitrunk in lateral view, arrow indicating the single pair of hairs on dorsum of propodeum. (g - i): paralectotype: (g) head in full-face view; (h) head in lateral view; (i) alitrunk in lateral view. Scale bars: 0.5 mm.

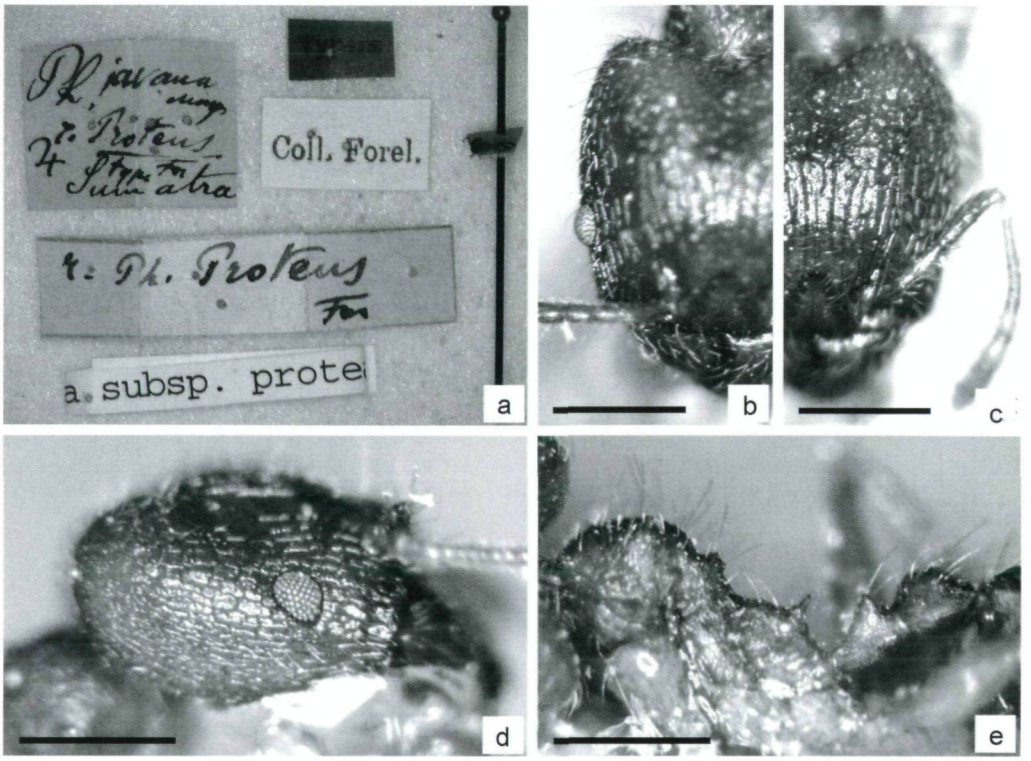


Fig. 6: Lectotype (major) of *Pheidole protea*: (a) labels attached; (b, c) head in full-face view; (d) head in lateral view; (e) alitrunk in lateral view. Scale bars: 0.5 mm.

of occipital lobe rugoso-reticulate, with enclosures very weakly punctured and weakly shining; promesonotal dome transversely rugoso-reticulate; mesopleuron and lateral face of propodeum punctured and dull, with several rugulae; petiole smooth and shining anterodorsally, and punctured and dull posterodorsally and laterally; postpetiole punctured and dull dorsally and laterally, with several transverse rugulae dorsally; first gastral tergite weakly punctured anteriorly. Dorsum of propodeum (including spines) bearing only one pair of standing hairs near its anterior border. Body light brown with darker gaster.

Minor (paralectotypes): HL 0.60 - 0.63 mm, HW 0.48 - 0.50 mm, EL 0.15 - 0.16 mm, SL 0.66 - 0.69 mm, LASX 0.13 - 0.14 mm, FL 0.69 - 0.73 mm, CI 79 - 80, SI 138 - 139, FI 144 - 146. Head in full-face view oval; occipital carina distinct. Clypeus without a median longitudinal carina, or with an evanescent carina only anteriorly. Eyes situated around midlength of head; distance between mandibular insertion and anterior margin of eye 0.7 - 0.8 times as long as maximal diameter of eye; maximal diameter of eye 1.09 - 1.18 times as long as 10th antennal segment. Antenna with 3-segmented club; terminal segment shorter than preceding two segments together. Promesonotal dome with low prominence on its posterior declivity. Mesopleuron without transverse impression. Propodeal spine small, ca. 2 times as long as diameter of propodeal spiracle. Petiole cuneiform, 1.2 - 1.3 times as long as postpetiole (excluding helcium); petiolar node low,

in posterior view not emarginate at apex. Postpetiole 1.9 - 2.0 times as broad as petiolar node. Head including clypeus almost smooth and shining; promesonotal dome almost smooth and shining mediodorsally and laterally, very weakly rugoso-punctate anteriorly and dorsolaterally; mesopleuron and lateral face of propodeum punctured and dull; petiole smooth and shining anterodorsally, very weakly punctured laterally and posterodorsally; postpetiole punctured very weakly and shining; first gastral tergite very weakly punctured around its articulation with postpetiole. Body light brown.

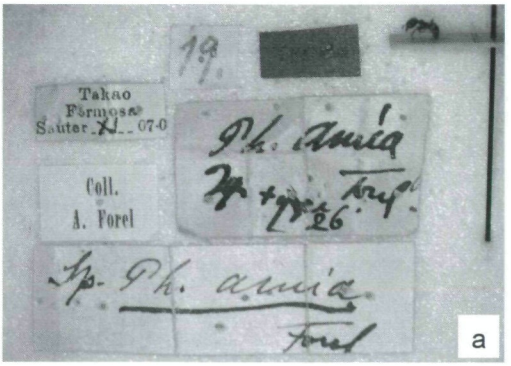
Pheidole protea FOREL, 1912, stat.n. (Fig. 6a - e; Tab. 1)

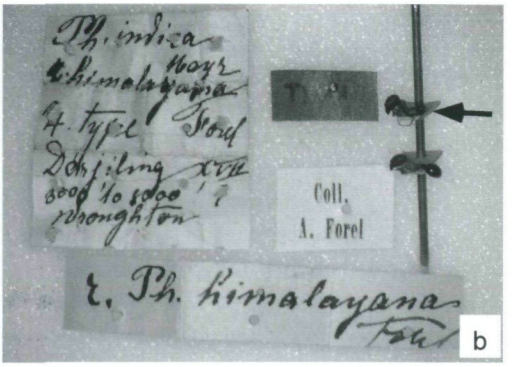
Pheidole javana ssp. *proteus* FOREL, 1912b: 55. Type locality: Sumatra. Subspecies of *P. fervens*: BOLTON 1995 (catalogue). One syntype major (MHNG) is designated as the **lectotype** (Fig. 6a).
Pheidole sp. eg-141: EGUCHI 2003: 338 - 339 (description of male genitalia).

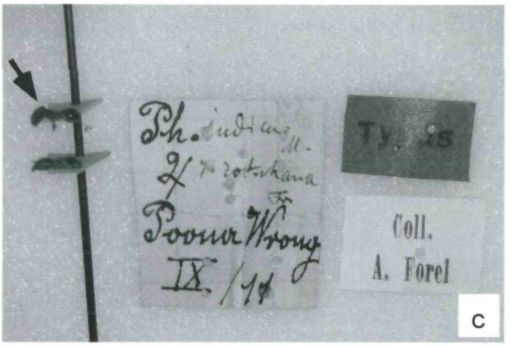
Additional material examined: Thailand: Chanthaburi Prov.: Khao Soi Dao (Eg01-TH-052). Chiang Mai Prov.: Doi Suthep-Pui N. P., ca. 900 m alt. (Eg01-TH-084).

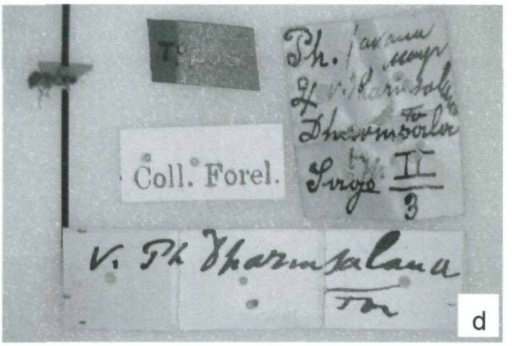
Major (lectotype): HL 1.15 mm, HW 1.09 mm, EL (eye length) 0.19, SL 0.65 mm, LASX 0.14 mm, FL 0.86 mm, CI 95, SI 59, FI 79. Head broadest around 3/5 distance of head; head in profile not concave on vertex. Clypeus without median longitudinal carina; anterior margin of clypeus in full-face view emarginate medially. Eye situated around 1/3 distance of head; distance between mandibular insertion and anterior margin of eye 1.3 times as long as maximal diameter of eye; maximal diameter of eye 1.41 times as long as 10th antennal segment. Frontal carina distinct, extending to just in front of 3/4 distance of head. Antennal scrobe weak, running below frontal carina. Antenna with 3-segmented club; terminal segment almost as long as preceding two segments together. Promesonotal dome with low prominence on its posterior declivity; the prominence in anterior view weakly impressed medially; dorsal portion of promesonotal dome very weakly prominent laterad. Propodeal spine 3 times as long as maximal diameter of propodeal spiracle. Petiole cuneiform, almost as long as postpetiole (excluding helcium); petiolar node in posterior view very weakly impressed medially at apex. Postpetiole in dorsal view subpentagonal, ca. 2.3 times as broad as petiolar node. Frons longitudinally rugose, with interspaces smooth and shining; occiput and dorsal and lateral faces of occipital lobe reticulate; promesonotal dome rugoso-reticulate; mesopleuron and lateral face of propodeum punctured; lateral faces of petiole and postpetiole slightly punctured; dorsa of petiole and postpetiole, and gaster smooth and shining.

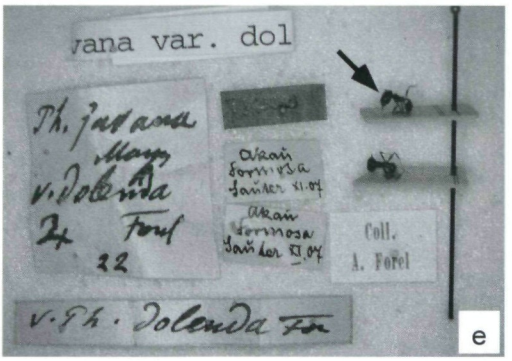
Remarks: *Pheidole protea* was described based solely on the major worker, and description of the minor worker is not available yet. Two colonies of a species that resembled *P. protea* were collected from Thailand together with both minors and majors. Although a close examination of the majors revealed a slight difference between them and the lectotype of *P. protea*, their conspecificity was highly probable and here I determine the Thai specimens as *P. protea* (in the Thai specimens eye is smaller with the maximal diameter being 1.1-1.3 times as long as 10th antennal segment; and prominence on the posterior declivity of promesonotal dome is lower). The minors from these colonies (*P. protea*) are similar to the paralectotype minors of *P. coonoorensis*; however the former are characterized as follows: head weakly rugoso-punctate posterodorsally and laterally; dorsal portion of promesonotual dome with pair of low tubercles laterally; promesonotal dome irregularly and coarsely rugoso-reticulate; and petiole almost as long as postpetiole.

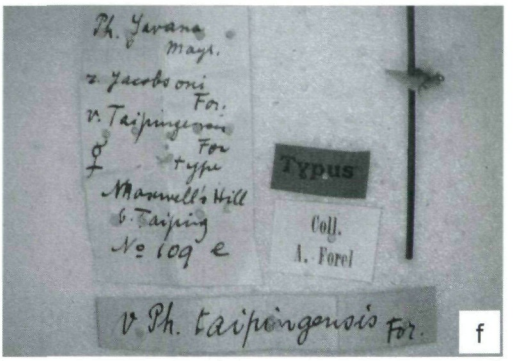


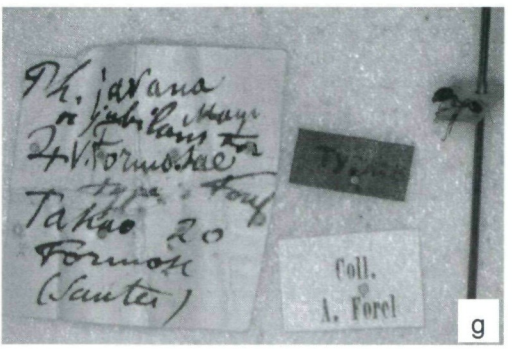


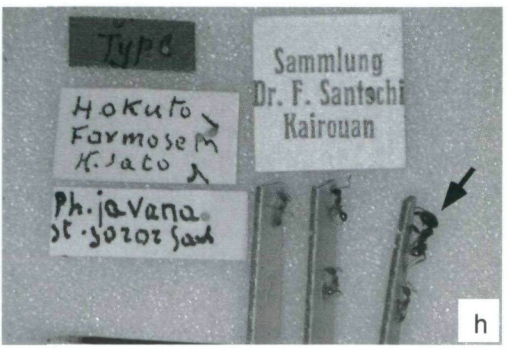












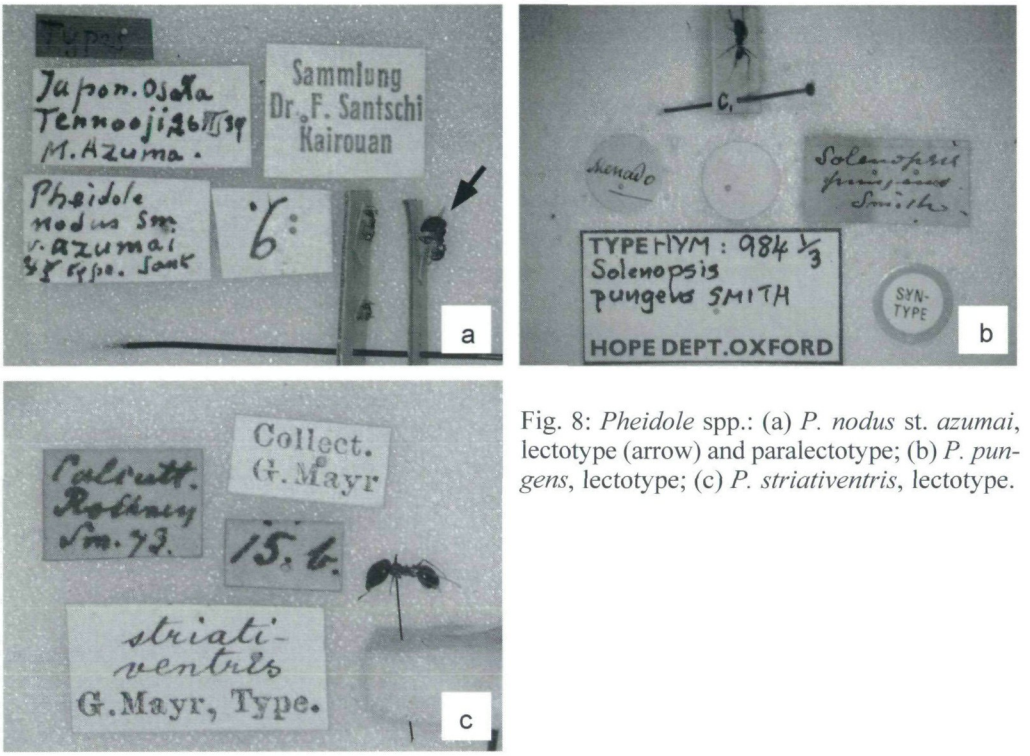


Fig. 8: *Pheidole* spp.: (a) *P. nodus* st. *azumai*, lectotype (arrow) and paralectotype; (b) *P. pungens*, lectotype; (c) *P. striativentris*, lectotype.

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Fig. 7: *Pheidole* spp.: (a) *Pheidole amia*, lectotype; (b) *P. indica* r. *himalayana*, lectotype (arrow) and paralectotype; (c) *P. indica* r. *rotschana*, lectotype (arrow) and paralectotype; (d) *P. javana* var. *dharmsalana*, lectotype; (e) *P. javana* var. *dolenda*, lectotype (arrow) and paralectotype; (f) one of the specimens used in the description of *P. javana* r. *jacobsoni* var. *taipingensis*; (g) one of the specimens used in the description of *P. javana jubilans* var. *formosae*; (h) *Pheidole javana* var. *soror*, lectotype (arrow) and paralectotype.

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