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Camponotus (*Tanaemyrmex*) *sirindhornae* sp. nov., A New Cave-dwelling Ant (Hymenoptera: Formicidae) from Thailand, with Its Ecological Notes

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ABSTRACT.– A newly cavernicolous ant species was discovered from cave environments and a man-made underground tunnel in Kanchanaburi Province, western Thailand based on worker and dealate queen. This represents the first record of the genus *Camponotus* nesting in subterranean habitats. The new species, described herein as *Camponotus* (*Tanaemyrmex*) *sirindhornae* Jaitrong, Jantarit & Pitaktunsakul, sp. nov. is specialized to the subterranean lifestyle, displaying a set of troglobiotic traits i.e. reduced pigmentation, elongated antennae and appendages, and a slender head and body. It can be distinguished from its closely related congeners by a distinct combination of the following characters: 1) head of minor worker in full-face view, narrowed and prolonged behind eye, narrowest just in front of posterior margin, occipital carina forming distinct flange; 2) body entirely (head, mesosoma and metasoma) reticulate with smooth and shiny interspaces; 3) head, mesosoma and petiole bright yellowish; 4) anterior half of each metasomal segments III–VI yellowish brown, while posterior half dark brown. The new species was observed preying on other cave-dwelling arthropods such as crickets, cockroaches, moths, and beetles. The ecology traits of this new species, along with its troglobiotic adaptation is also discussed.

KEYWORDS: cave, distribution, new species, taxonomy, troglobiotic species, subterranean habitat

INTRODUCTION

Thailand is considered as one of the regions with the highest ant biodiversity in the world (antmaps.org, Janicki et al., 2016; Guénard et al., 2017; Khachonpisitsak et al., 2020). The country has extensive cave-containing karst areas across almost the whole country, containing over 6,000 natural caves (Jantarit and Ellis, 2023). However, cave fauna, especially invertebrates, remain poorly known with cave-dwelling ants receiving little attention, resulting in a recognized gap in knowledge.

Recently, 567 valid ant species and subspecies across 110 genera and ten subfamilies have been documented, from various habitats throughout the country (AntWiki, 2025; Bolton, 2025). Among them, only seven species have been recorded from Thai caves (Jaitrong et al., 2021; Jantarit and Ellis, 2023; Wimolsuthikul et al., 2024; Duanchay et al., 2024). Many of ants living in caves are also found in subterranean environmentals and outsite the caves (i.e., Roncin et al., 2001; Tinaut and Lopez, 2001; Moulds, 2006; Batucan and Nuñeza, 2013; Pape, 2016). However, only a subset of species can be considered as troglobiotic species, those truly adapted to cave life, including: *Leptogenys khammouanensis* Roncin & Deharveng, 2003 from caves in Laos; *Aphaenogaster gamagumayaa* Naka & Maruyama, 2018 from a cave in Okinawa, Japan; and *Camponotus* sp. from the Philippines (Pape, 2016 after Batucan and Nuñeza, 2013). These species are exclusively found in the dark zone of caves, inhabit cave system that host various troglobiotic traits or cave fauna characteristics (Roncin and Deharveng, 2003; Naka and Maruyama, 2018).

The ant genus *Camponotus* Mayr, 1861 (subfamily Formicinae) is one of the larger ant genera in the world, presenting a global distribution (AntWeb, 2025; AntWiki, 2025; Bolton, 2025). Currently, 1,088 valid species and 411 valid subspecies are recognized within the genus (Bolton, 2025), of which 392 species and subspecies have been described and recorded from Asia. Most Asian *Camponotus* species present a roundly convex posterior margin of the head in minor workers. However, three Asian species: *Camponotus ager* (Smith, 1858), *C. angusticollis* (Jordon, 1851), and *C. ashokai* Karmaly & Narendran, 2006, are distinguished by a strongly constricted and elongate occiput, forming a neck, along with an elongate and slender antennae and legs (Karmaly and Narendran, 2006).

During our survey on cave arthropods in Kanchanaburi Province, western Thailand, the largest limestone

area in the country called "western karst complex", we encountered an unidentified *Camponotus* species there. This species is closely related to *C. ager*, *C. angusticollis*, and *C. ashokai*, sharing key features such as an elongate head (narrowed and prolonged posterior to the eyes, narrowest just before the posterior margin of the head, and broadest anteriorly), the occipital carina forming a distinct flange, long and slender antennae and legs, and a slender body. After a thorough examination of the specimens, we concluded that this species is new to science. In the present paper, we provide a description of the species based on the worker caste and dealate queen. The new species is considered here to be a troglobiotic species and represents the fourth official record of its kind in Thailand.

MATERIALS AND METHODS

The materials were collected from western Thailand in Kanchanaburi Province, specifically from Thong Phaphum District, Pu Toei and Sahakorn Nikhom Villages. The new species was found nesting in two small caves (3–20 m from the entrance) on an isolated limestone hill, which was covered by mixed deciduous forest, as well as in a man-made tunnel within a mine (23 m from the entrance). The holotype and paratypes of this new species were pin-mounted dry specimens. The type material was compared with the high resolution images of the holotypes and syntypes of the most closely related species, *Camponotus ager* (F. Smith, 1858), *C. angusticollis* (Jordon, 1851), and *C. ashokai* Karmaly & Narendran, 2006, available on AntWeb (2025). Most morphological observations were made with a ZEISS Stemi 305 stereoscope.

Multi-focused montage images were produced using NIS-Elements-D from a series of source images captured with a Nikon Digital Sight-Ri1 camera attached to a Nikon AZ100M stereoscope. The holotype and 20 paratypes were measured for various morphological features using a micrometer accurate to 0.01 mm. Additionally, the head width and scape length were measured for 101 paratype workers from the same colony (TH21-WJT-001) from which the holotype was designated.

The abbreviations used for the measurements and indices are as follows:

- HW Head width. Maximum width of head in full-face view (excluding eyes).
- HL Head length, maximum length of head in full-face view, excluding mandibles, measured from anterior clypeal margin to posterior-most point of head vertex.
- MaL Mandibular Length. With head in full-face view, length of mandible measured along outer margin, as the chord distance from lateral insertion to mandible apex.
- SL Scape length. Maximum length of antennal scape in dorsal view excluding basal neck and condyle.
- EL Eye length. Maximum diameter of compound eyes, measured in lateral view.
- ML Mesosoma length, measured laterally from anterior surface of pronotum (where the pronotum meets the cervical shield) diagonally to posterior extension of propodeal lobes.
- FeL Femur length. Maximum length of metafemur, measured from base to apex.
- PL Petiole length measured from the anterior margin of the peduncle to the posteriormost point of the tergite in profile.
- CI Cephalic index. HW / HL × 100.
- SI Scape index. SL / HW × 100.
- EI Eye index. EL / HW × 100.
- FeI Femur index. FeL / HW × 100.

Abbreviations of the type depositories are as follows:

- NHM-PSU Princess Maha Chakri Sirindhorn Natural History Museum, Prince of Songkla University, Songkhla, Thailand
- SKYC Seiki Yamane's Collection at Kitakyu-shu Museum of Natural History and Human History, Japan
- THNHM Natural History Museum of the National Science Museum, Thailand

RESULTS

Taxonomy

Subfamily Formicinae Latreille, 1809
Genus *Camponotus* Mayr, 1861

Camponotus (*Tanaemyrmex*) *sirindhornae* Jaitrong, Jantarit & Pitaktunsakul, sp. nov.

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(Figs 1–3, 5A, D, 6A, E)

Types.– Holotype: minor worker (THNHM-I-00024278, THNHM), West Thailand, Kanchanaburi Province, Thong Pha Phum District, Ban Sahakorn Nikhom, 14.7417ºN, 98.8153ºE, in a man-made tunnel (ca. 23 m from the entrance), 30.III.2021, W. Jaitrong leg., colony no. TH21-WJT-001. Paratypes: 75 minor

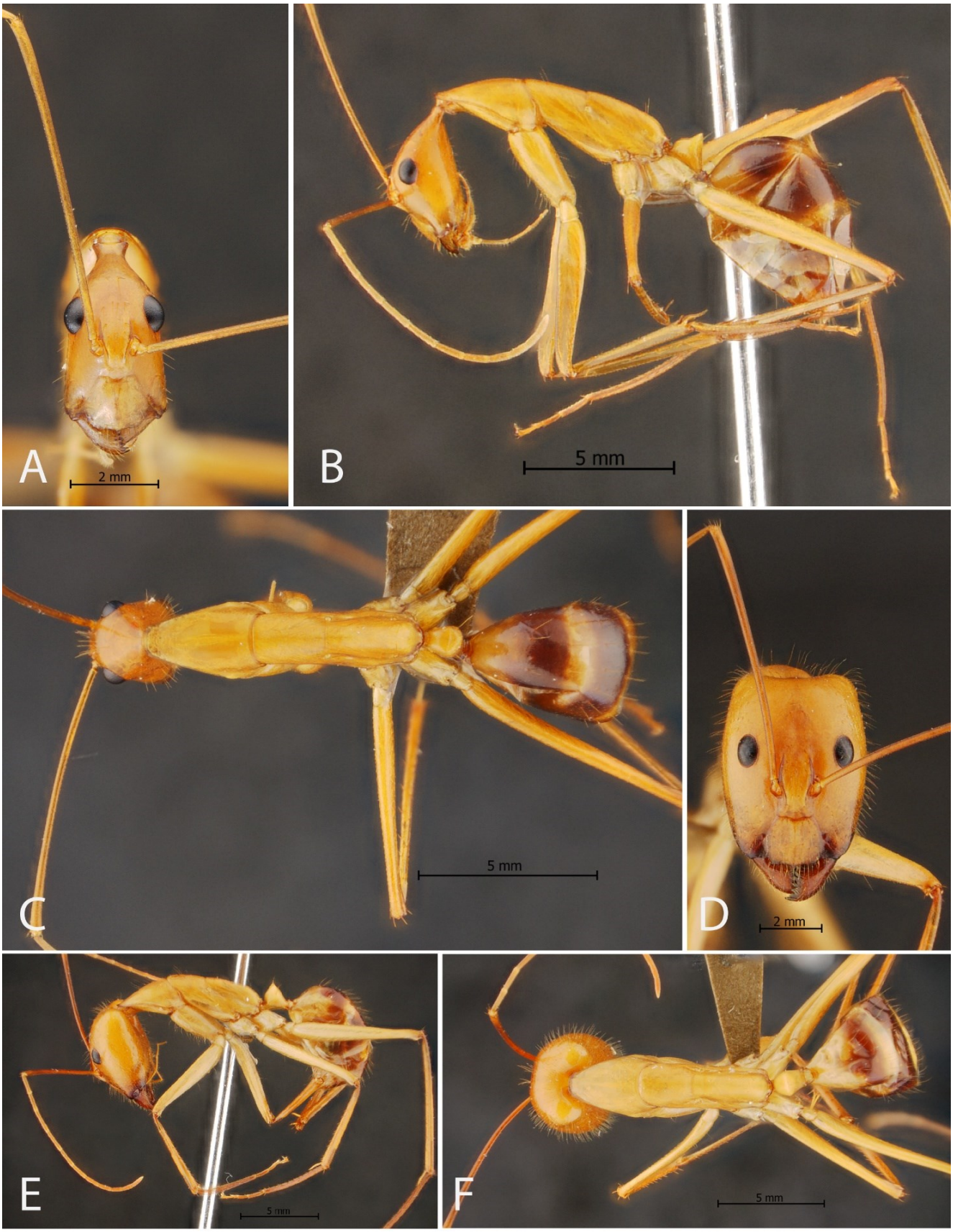

FIGURE 1. *Camponotus sirindhornae* sp. nov. **A–C.** minor worker (holotype, THNHM-I-00024278). **D–F.** major worker (paratype, THNHM-I-00030101). **A, D.** head in full-face view. **B, E.** body in profile view. **C, F.** body in dorsal view.

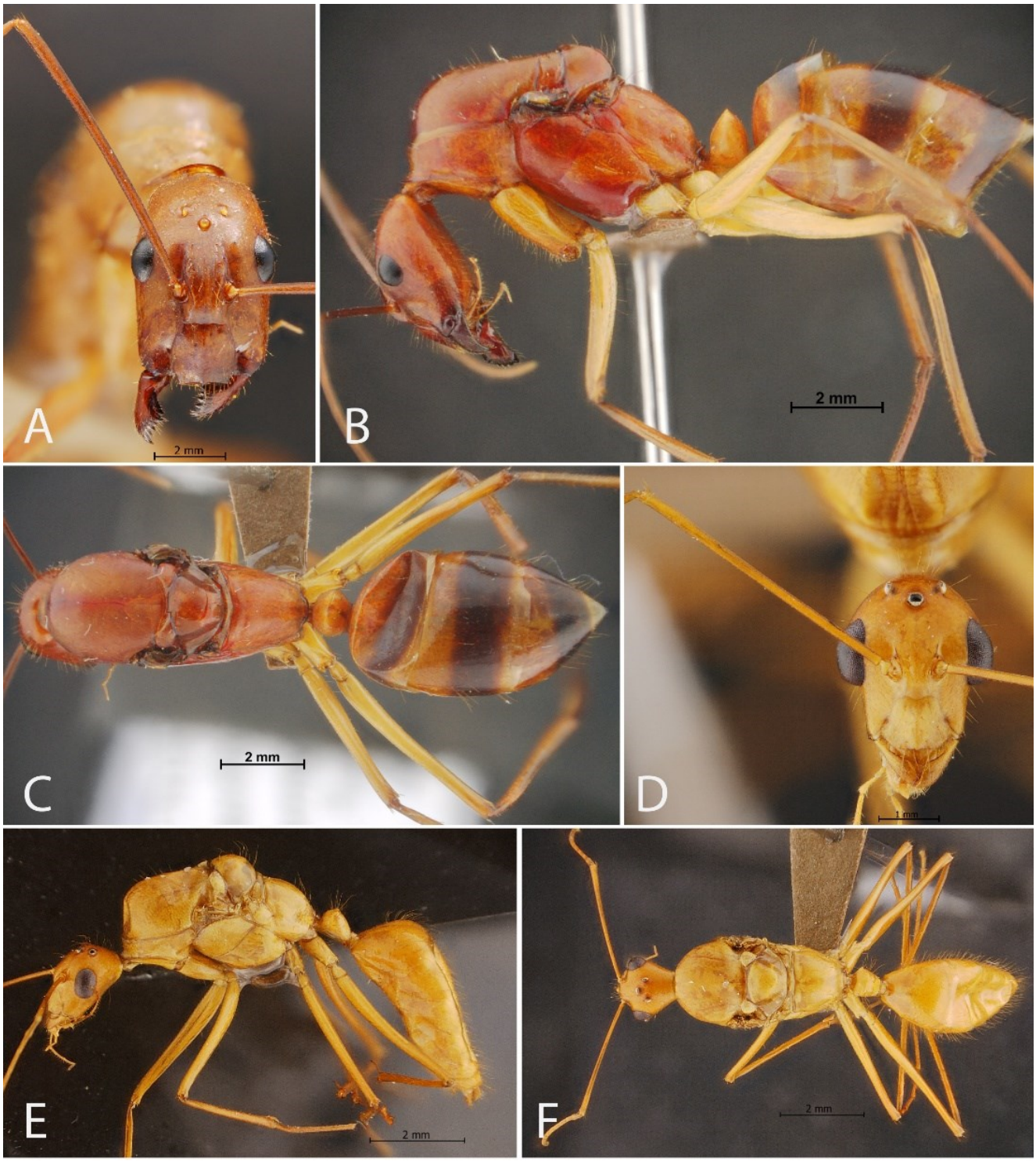

FIGURE 2. *Camponotus sirindhornae* sp. nov. **A–C.** dealate queen (non-type, THNHM-I-00013391); **D–F.** male (paratype, THNHM-I-00030097). **A, D.** head in full-face view. **B, E.** body in profile view. **C, F.** body in dorsal view.

workers (THNHM-I-00024209 to THNHM-I-00024283, THNHM,), 23 major workers (THNHM-I-00024284 to THNHM-I-00024300 and THNHM-I-00024601 to THNHM-I-00024607, NHM-PSU, THNHM), and 6 males (THNHM-I-00030092 to THNHM-I-00030097, THNHM) same data as holotype; 3 minor workers (THNHM-I-00013621 and THNHM-I-00030098 to THNHM-I-00030099, THNHM), 3 major workers (THNHM-I-00013622 and THNHM-I-00030100 to THNHM-I-00030101, THNHM), one alate queen (THNHM-I-00013623, THNHM), West Thailand, Kanchanaburi Province, Thong Pha Phum District, Ban Pu Toei, 14.7393ºN, 98.8689ºE, in a cave (ca. 3 m from

the entrance), 4.III.2019, S. Jantarit leg., colony no. SJ040319-01.

Non-type material examined. 53 minor workers (THNHM-I-00013995, NHM-PSU, SKYC, THNHM), 50 major workers (THNHM-I-00013996, NHM-PSU, SKYC, THNHM), and one dealate queen (THNHM-I-00013391, THNHM), W Thailand, Kanchanaburi Province, Thong Pha Phum District, Ban Pu Toei, 14.7393ºN, 98.8689ºE, in a cave (ca. 19 m from the entra-nce), 26.XI.2019, W. Jaitrong leg., colony no. TH19-WJT-153; 1 minor worker (THNHM-I-13388, THNHM), 65 minor workers (THNHM-I-00013389, NHM-PSU, SKYC, THNHM), 29 major workers (THNHM-I-00013390, NHM-PSU, SKYC, THNHM), and 1 dealate queen (THNHM-I-00013391, THNHM), W Thailand, Kanchanaburi Province, Thong Pha Phum District, Ban Pu Toei, 14.7393ºN, 98.8689ºE, in a cave (ca. 19 m from the entrance), 26.XI.2019, W. Jaitrong leg., colony no. TH19-WJT-151; 9 minor workers (THNHM-I-00030102, THNHM) and 1 major worker (THNHM-I-00030127, THNHM), W Thailand, Kanchanaburi Province, Thong Pha Phum District, Ban Pu Toei, 14.7393ºN, 98.8689ºE, in a cave (ca. 3 m from the entrance), 26.XI.2019, W. Jaitrong, S. Jantarit & P. Pitaktunsakul leg., TH19-WJT-152.

Description.–

Minor worker (holotype and paratypes, Figs 1A–C, 5A, 6A)

Measurements. Holotype HW 1.44; HL 2.80; MaL 1.05; SL 4.45; EL 0.53; ML 4.62; FeL 4.48; PL 0.84; CI 51; SI 310; EI 37; FeI 312. Paratypes (n = 10): HW 1.32–1.44; HL 2.46–2.80; MaL 0.98–1.05; SL 4.48–4.56; EL 0.48–0.56; ML 4.52–4.72; FeL 4.44–4.56; PL 0.80–0.84; CI 49–51; SI 317–342; EI 36–39; FeI 317–339.

Head. In full-face view clearly longer than broad (CI 49–51), narrowed and prolonged behind eyes, narrowest just in front of posterior margin of head, and broadest anteriorly; occipital carina forming distinct flange (Fig. 1A, B). Mandibles subtriangular; masticatory margin with seven teeth, including large apical tooth. Clypeus long and broad; posterior margin concave; lateral margin feebly concave; anterior margin almost straight medially, with median denticle. Eyes convex and located at 2/3 distance of head (measured from anterior margin of clypeus to posterior margin of head); distance between mandibular insertion and anterior margin of eye 2.46 times (in holotype) as long as maximal diameter of eye. Antennal scape long and slender, 1.60–1.82 times as long as head length and almost as long as segments II–XII combined; segment II longer than each of segments X–XII. Frontal lobe narrow, obliquely elevated, in full-face view not covering antennal fossa.

Mesosoma. elongate, in profile with clear convex dorsal outline; in profile view, prothorax subtriangular, narrower anteriorly; mesopleuron not demarcated from mesonotum but separated from metapleuron by indistinct suture; metapleuron not demarcated from lateral face of propodeum; promesonotal suture and metanotal groove present; in dorsal view, propodeum slightly longer than mesonotum but shorter than pronotum; pronotum slightly broader than mesonotum and propodeum in dorsal view. Petiole in profile view, sessile and subtriangular its anterior face shorter than posterior face and faces meet by forming an acute and pointy apical dorsal extremity; subpetiolar process low, not developed, its ventral outline weakly convex. First gastral segment slightly shorter than segments II and III.

Sculpture and pilosity: Entire head smooth and shiny; mesosoma and abdominal segments III–VII reticulate with smooth and shiny interspaces; petiole micropunctate. Pilosity comparatively sparse; dorsum of head (excluding clypeus) with 6–7 pairs of erect hairs; lateral and ventral faces of head with 10–15 erect hairs; dorsum of mesosoma mostly with 2–3 pairs of erect hairs (without hairs in some paratypes); petiole with 0–3 erect hairs on each lateral side; gaster with sparse erect hairs; tibiae with sparse short erect hairs. All erect hairs yellow to yellowish brown.

Head, mesosoma and petiole light yellow, slightly darker on head; anterior half of each of gastral segments I–IV yellowish brown, while middle area dark brown. Legs and antennae yellowish brown. All erect hairs yellow to yellowish brown.

Major worker (paratypes, Figs 1D–F, 5D, 6E)

Measurements. Paratypes (n = 10): HW 2.44–2.88; HL 3.40–3.76; MaL 1.37–1.44; SL 4.68–5.04; EL 0.60–0.72; ML 5.00–5.40; FeL 4.72–4.92; PL 0.72–0.88; CI 72–77; SI 175–192; EI 24–25; FeI 171–197.

Head. In full-face view clearly longer than broad (CI 72–77), subrectangular with lateral margins weakly convex and posterior margin concave; posterolateral corners of head bluntly angulate (Fig. 1D). Mandibles subtriangular; masticatory margin with 6–7 teeth, including small basal tooth and large apical tooth. Clypeus long and broad; posterior margin concave; lateral margin almost straight; anterior margin sinuate, with large medial tooth. Eyes elliptical, facing forward, and located just posterior to mid-length of head; distance between mandibular insertion and anterior margin of eye 2.53–2.63 times as long as maximal

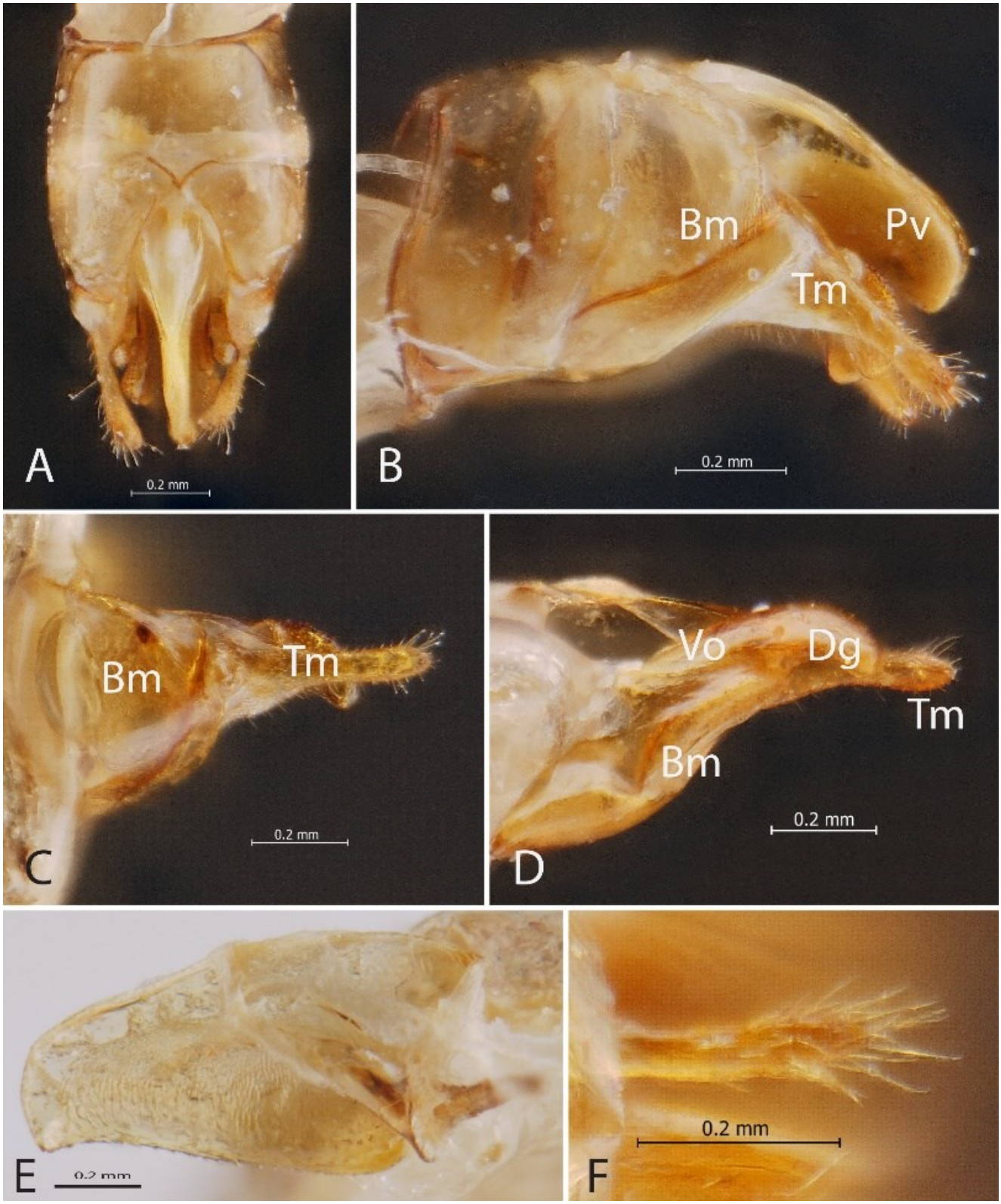

FIGURE 3. Male genitalia of *Camponotus sirindhornae* sp. nov. **A.** genital capsule in dorsal view. **B.** genital capsule in dorsal view. **C.** paramere, right side, in outer view. **D.** paramere and volsella, left side, inner view. **E.** penisvalva, right side, in outer view. **F.** pygostyle in profile. Abbreviations: Bm, basimere; Dg, digitus; Pv, penisvalva; Tm, telomere; Vo, volsella.

diameter of eye; in full-face view, distance between lateral margin of head to lateral margin of eye almost as long as maximum diameter of eye. Antennal scape long and clavate, 1.34–1.38 times as long as head length; segment II longer than each of segments X–XII. Frontal lobe narrowed, obliquely elevated, in full-face view not covering antennal fossa.

Mesosoma. elongate but much thicker than in worker, in profile pronotum and mesonotum weakly convex; metanotal groove distinct, shallowly impressed; propodeum with feebly concave dorsal outline. Petiole in profile view sessile and subtriangular, its anterior face convex, while posterior face almost straight; subpetiolar process low, not developed, its ventral outline weakly convex. First gastral segment slightly shorter and narrower than each of segments II and IV.

Entire body (head, mesosoma and metasoma) reticulate with smooth and shiny interspaces as in minor worker but reticulation slightly stronger in major worker. Pilosity denser than on minor workers; dorsum of head (excluding clypeus) with dense erect hairs, especially on posterior half of head; lateral and ventral faces of head with dense erect hairs; dorsum of mesosoma with 12–20 erect hairs; petiole with 2–3 erect hairs on each lateral side; gastral tergites with dense erect hairs; tibiae with sparse short erect hairs. All erect hairs yellow to yellowish brown. Coloration as in minor worker.

Dealate and alate queen (paratype and non-type, Fig. 2A–C)

Measurements. Paratype alate queen and non-type dealate queen: HW 2.35–2.36; HL 3.60–3.64; MaL 1.37–1.40; SL 4.48; EL 0.74–0.76; ML 6.60–6.65; FeL 4.52–4.59; PL 0.84–0.88; CI 64–66; SI 190–191; EI 32; FeI 192–196.

Head. slightly smaller than in major worker; shape in full-face view as in major worker, clearly longer than broad; three ocelli present, medial ocellus located at level of posterior margin of eyes; eyes relatively large and convex.

Mesosoma. stout, in profile view mesoscutum much higher than pronotum, with strongly convex anterior portion but almost straight posterior portion; mesoscutellar disc with convex dorsal outline, raised higher than mesoscutum and metanotum; propodeum weakly convex and sloping down posteriorly; pronotum subrectangular; mesopleuron larger than lateral face of propodeum, its anepisternum clearly demarcated from katepisternum by distinct oblique mesopleural sulcus and demarcated from metapleuron by indistinct meso-metapleural suture; metapleuron narrow. In dorsal view, pronotum narrow, with strongly convex pronotal lobe; mesoscutum large, clearly longer than broad, its anterior margin roundly convex; parapsidal lines distinct and long; notauli absent; mesoscutellar disc clearly broader than long; metanotum very short. Petiole in profile view, sessile, clearly shorter than high, its anterior face convex, while posterior face weakly convex, seen from back petiole with medially feebly concave dorsal outline; subpetiolar process low, not developed, its ventral outline weakly convex. First gastral segment slightly shorter and narrower than each of segments II and IV. The dealate queen (THNHM-I-13391) was inseminated, had 14 ovarioles (7:7), and dense yellow bodies and mature oocytes in her ovarioles.

Pilosity and sculpturing similar to those of major worker. Head and mesosoma reddish brown; petiole yellowish; anterior half of each gastral segment reddish brown, while posterior half dark brown. Legs and antennae yellowish brown.

Males (paratypes, Figs 2D–F, 3)

Measurements. Paratypes (n = 5): HW 1.25–1.35; HL 1.70–1.80; MaL 0.70–0.74; SL 2.88–3.00; EL 0.68–0.70; ML 4.10–4.35; FeL 4.10–4.23; PL 0.65–0.70; CI 71–74; SI 222–234; EI 50–56; FeI 313–328.

Head. Head in full-face view clearly longer than broad, but if including eyes, then slightly longer than broad. Clypeus broad, bell-shaped, posteriorly clearly demarcated from frons, with posteromedian margin shallowly emarginate medially, anteriorly broadly convex, with anterior margin entire but weakly serrate. Mandible subtriangular, masticatory margin almost edentate (masticatory margin with small denticles in some specimens) with apex bluntly pointed and almost as long as basal margin. Eye large, positioned at mid-length of lateral face of head; distance between mandibular base and anterior margin of eye (malar space) slightly shorter than maximum diameter of eye; ocelli large, arranged in very low triangle; distance between median and lateral ocelli slightly shorter than distance between lateral ocelli. Antennal scape moderately long, distinctly longer than head width including eyes.

Mesosoma. in dorsal view much larger than head including eyes. Pronotum short (‘narrow’), almost entirely concealed by inflated mesoscutum. Mesoscutum with short longitudinal median line, without notaulus; parapsidal line distinct and long, running along border of lateral and dorsal faces; scuto-scutellar sulcus prominent; mesoscutellum shorter than broad and narrower than mesoscutum, posterior margin roundly convex. Metanotum short (‘narrow’), deeply

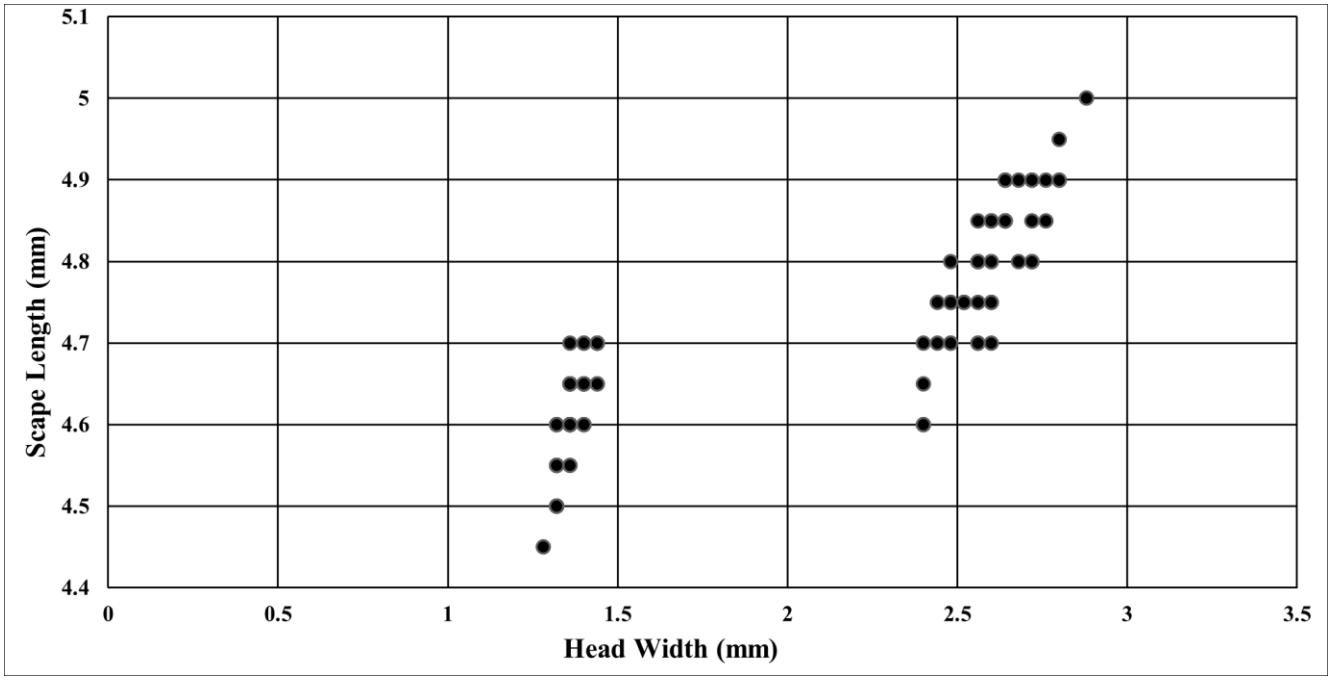

FIGURE 4. Dimorphic pattern of workers of *Camponotus sirindhornae* sp. nov. between the minor (left) and major (right) workers.

indented, clearly defined from propodeum with deep furrow. With mesosoma in profile view, pronotum much lower than mesoscutum, with steep anterior slope, without dorsal face. Mesoscutum convex with gently sloping anterior slope and rather flat posterior portion; mesopleuron in profile large, divided into anepisternum and katepisternum, the latter being slightly larger than the former; mesoscutellum slightly higher than mesoscutum, with rounded posterodorsal corner. Propodeum in profile without distinct separation of dorsum from declivity; spiracle elongate, located on lateral face anterior to posterior margin. Petiole in dorsal view almost as long as broad; in profile globular, slightly longer than high, elevate anteriorly. Gaster relatively long but slightly smaller than mesosoma; gastral tergite II almost as long as each of gastral tergites III–V but shorter and smaller than gastral tergite I.

Sculpturing, pilosity, and coloration are similar to those of the worker, but the gaster is slightly lighter. Mesosomal hairs are denser but shorter than those on the worker.

Genitalia (Fig. 3). Pygostyle clavate, long (about 0.2 mm), posterior two-third golden yellow with dense erect hairs, anterior one-third narrow, smooth, without hairs. Abdominal sternite IX (subgenital plate) subtrapezoid, almost as long as broad; posterior margin of abdominal sternite IX weakly convex with median portion produced; ventral face of the segment, along posterior margin with several erect hairs; anterior margin of abdominal sternite IX roundly convex. Genital capsule longer than broad. Paramere in profile relatively large; telomerer narrow, long, truncate at apex, without articulation to basimere; telomere with dense erect hairs, hairs on its apex longer than elsewhere; basimere in profile large, almost as long as high, without hairs. Volsella linear, dorsal outline weakly convex, but ventral outlines sinuate; digitus short, its apex broadly convex, dorsal margin convex, while ventral margin concave; volsella without hairs. Valviceps in profile broad, broadened anteriorly, clearly longer than high; ventral margin of valviceps serrate, concave posteriorly and convex anteriorly.

Etymology.– The species is named in honor of Her Royal Highness Princess Maha Chakri Sirindhorn, in recognition of her profound interest in natural history and her significant contributions to the promotion of biodiversity conservation and environmental protection in Thailand, as well as to commemorate the occasion of her 70th birthday anniversary.

Distribution.– Thailand (Kanchanaburi Province).

Remarks.– Workers of *Camponotus sirindhornae* sp. nov., exhibit clear dimorphism, with size variation between the major and minor workers castes (Fig. 4). This species shares several morphological traits with *C. ager* (Brazil), *C. angusticollis* (India), *C. angusticollis sanguinolentus* (India), and *C. ashokai* (India) including an elongate head (narrowed and prolonged behind eyes, narrowest just in front of the posterior margin of

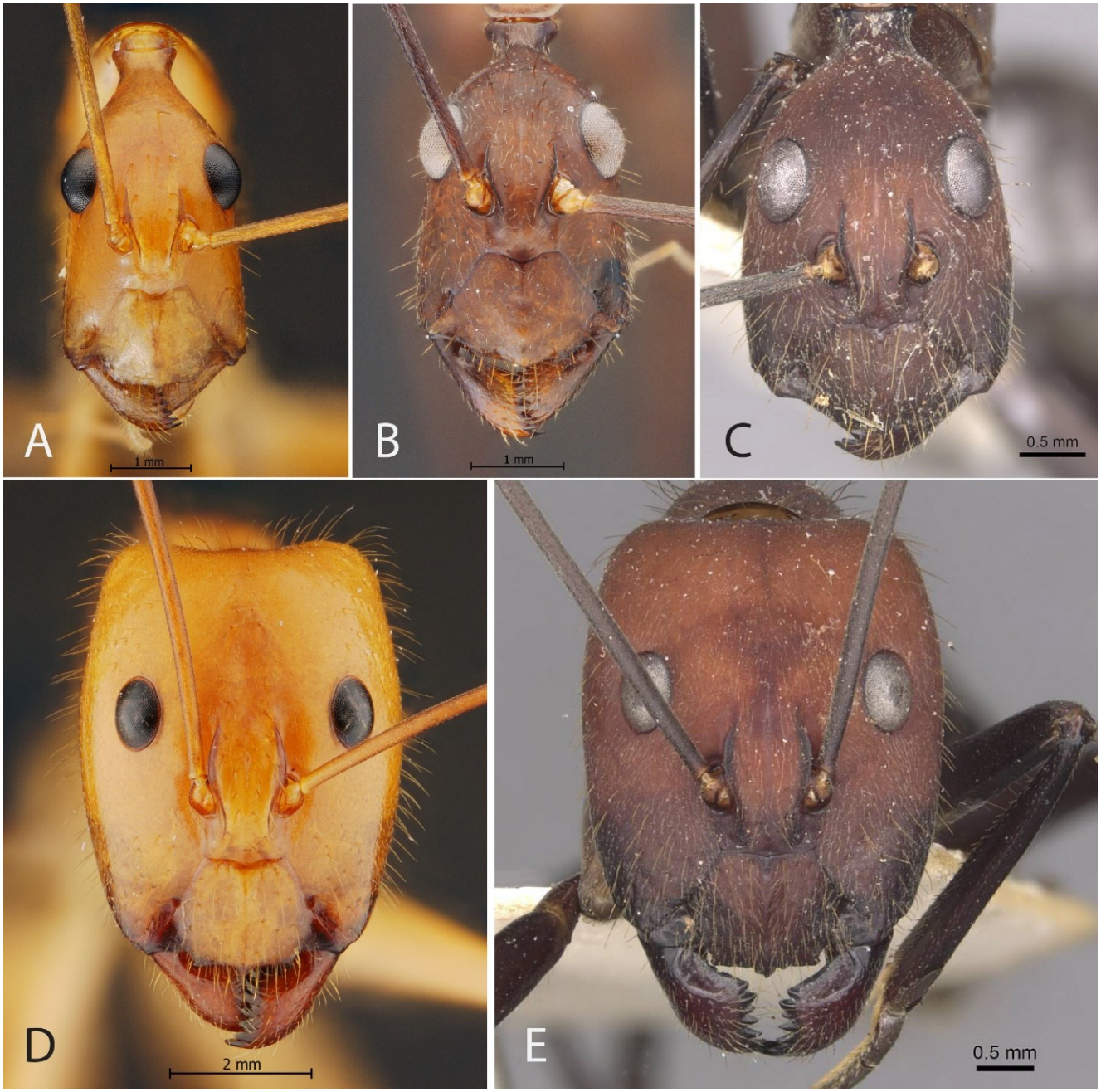

FIGURE 5. Head in full-face view of *Camponotus* spp. **A.** minor worker of *Camponotus sirindhornae* sp. nov., holotype, THNHM-I-00024278. **B.** minor worker of *Camponotus angusticollis* (Jordon, 1851), non-type. **C.** minor worker of *Camponotus angusticollis sanguinolentus* Forel, 1895, syntype, CASENT0910082. **D.** major worker of *Camponotus sirindhornae* sp. nov., paratype, THNHM-I-00030101. **E.** major worker of *Camponotus angusticollis sanguinolentus*, syntype, CASENT0910082.

the head, and broadest anteriorly), an occipital carina forming distinct flange, long and slender antennae and legs, and a slender body (Fig. 1). However, the new species is most similar to *C. angusticollis* and can be distinguished by the following characteristics: 1) both worker and queen lack short appressed pubescence on the head dorsum (in contrast to dense, long appressed pubescence in *C. angusticollis*); 2) the dorsal surfaces of the head and mesosoma are superficially reticulate with smooth and shining interspaces (in *C. angusticollis*, finely punctate, and absence of reticulation); 3) the head, mesosoma, and petiole light yellow, with the anterior half of each matasomal segment yellowish-brown and the posterior half dark brown (in *C. angusticollis*, the body is entirely dark brown); 4) in the queen, the head in full-face view is clearly longer than broad, and broadened medially (in *C. angusticollis*, the head is slightly longer than broad and broadened posteriorly in the holotype).

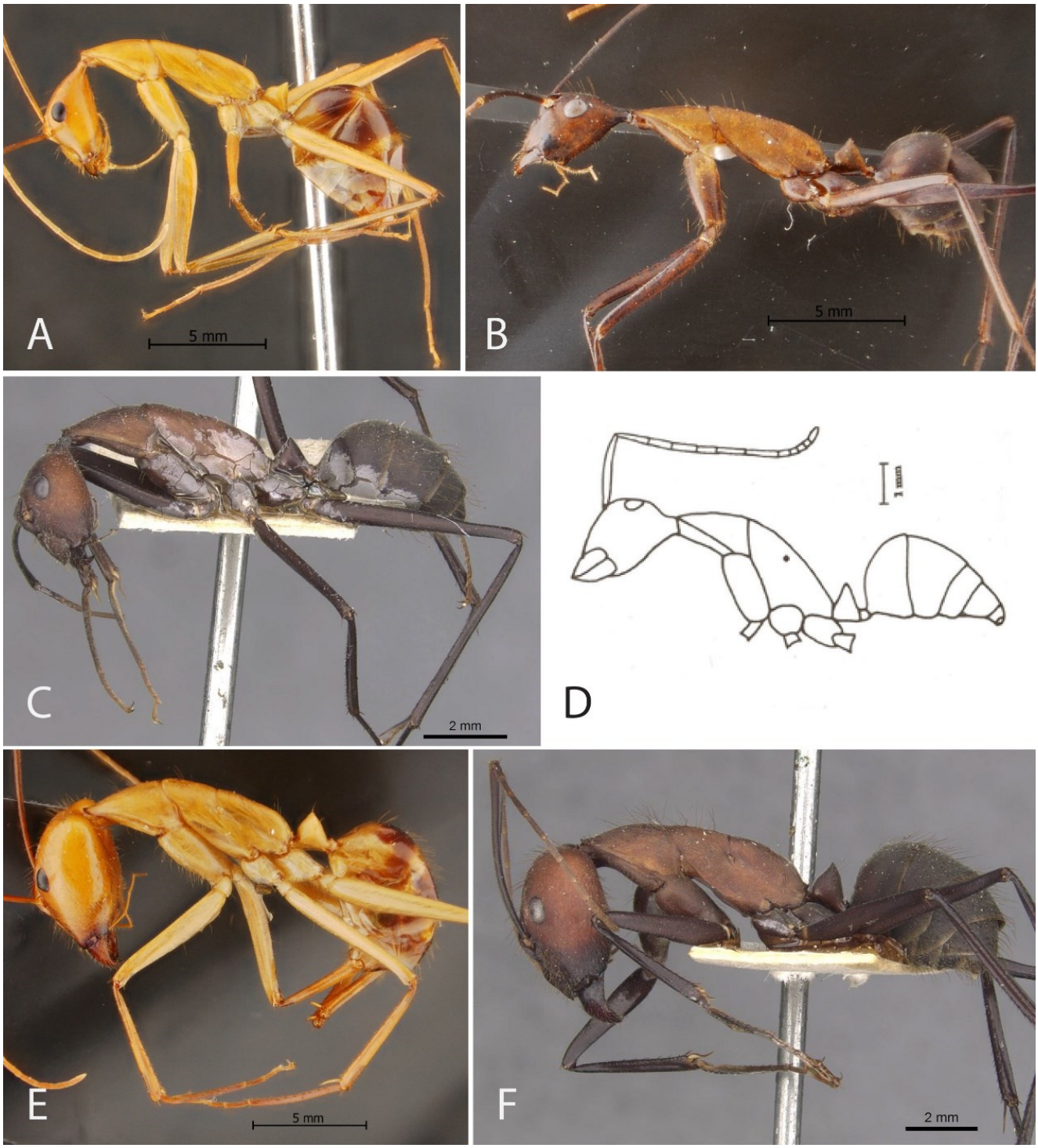

FIGURE 6. Body in profile of *Camponotus* spp. **A.** minor worker of *Camponotus sirindhornae* sp. nov., holotype, THNHM-I-00024278. **B.** minor worker of *Camponotus angusticollis* (Jordon, 1851), non-type. **C.** minor worker of *Camponotus angusticollis sanguinolentus* Forel, 1895, syntype, CASENT0910082. **D.** minor worker of *Camponotus ashokai*, from Karmaly and Narendran (2006: fig. 7). **E.** major worker of *Camponotus sirindhornae* sp. nov., paratype, THNHM-I-00030101. **F.** major worker of *Camponotus angusticollis sanguinolentus*, syntype, CASENT0910082.

The new species can be distinguished from *C. angusticollis sanguinolentus* by the following characteristics (points 2–7 refer to the major worker) 1) for the minor worker, refer to the comparative notes given above (see Figs 5A and 5C for comparison); 2) the body has short appressed pubescence (in contrast to dense, long appressed pubescence in *C. angusticollis sanguinolentus*); 3) the dorsal surfaces of the head and mesosoma are superficially reticulate with smooth and shining interspaces (whereas in *C. angusticollis*

sanguinolentus, the surface is finely punctate and lacks reticulation); 4) the head, mesosoma and petiole are light yellow (reddish brown in *C. angusticollis sanguinolentus*), with the anterior half of each matasomal segment yellowish-brown and the posterior half dark brown (in *C. angusticollis sanguinolentus,* the body is entirely dark brown); 5) the head of the major worker is relatively narrower (CI = 72–77 in the new species; CI = 87–88 in *C. angusticollis sanguinolentus*); 6) the anterior clypeal margin is sinuate (almost straight in *C. angusticollis sanguinolentus*); 7) the posterior margin of head is distinctly concave (weakly concave in *C. angusticollis sanguinolentus*) (see Fig. 5D and 5E for comparison). The subspecies *C. angusticollis sanguinolentus* is distinctly different from *Camponotus angusticollis* in that *C. angusticollis sanguinolentus* possesses a wider head and the outer margin of the eye does not extend beyond the lateral margin of the head (see Figs 5B and 5C for comparison). Therefore, the taxonomic status of *C. angusticollis sanguinolentus* should be confirmed in future studies.

Camponotus sirindhornae sp. nov. can be separated from *C. ashokai* (Fig. 6D) by the following characteristics: 1) the anterior clypeal margin is almost straight medially, with a median tooth in the new species, whereas it is roundly convex without a tooth in *C. ashokai*; 2) the coloration of gaster in the new species is yellowish-brown in the anterior half and dark brown in posterior half, while in *C. ashokai*, these segments are dark brown with a narrow whitish-yellow band along the posterior margin; 3) the sculpturing on the petiole and gaster is reticulate with smooth and shining interspaces in the new species, whereas it is rugulose and feebly granulate in *C. ashokai*; 4) the head length in the minor worker is relatively longer, with a CI of 49–51 in the new species; while it is relatively shorter, with a CI of 88 in *C. ashokai*.

Camponotus sirindhornae sp. nov. can be easily distinguished from *C. ager* by the absence of short appressed pubescence on the dorsum of the head in the minor worker (present as dense, long appressed pubescence in *C. ager*), and by the relatively longer head in the minor worker (CI = 49–51 in *C. sirindhornae* sp. nov.; CI = 65 in *C. ager*).

DISCUSSION

Cave ant studies are still limited. Pape (2016) conducted a global literature review and cave ant surveys in Arizona, resulting in a checklist of approximately 300 species from 80 genera. Among these, 33 species belong to the genus *Camponotus*, most of which were trogloxene species. Only one troglobiotic species in the genus has been reported from a cave in the Philippines (Batucan and Nuñeza, 2013). *Camponotus sirindhornae* sp. nov. is considered a troglobiotic species due to its pale coloration, elongated body, particularly the head, and very long legs and antennae (Roncin and Deharveng, 2003; Batucan and Nuñeza, 2013; Naka and Maruyama, 2018). Furthermore, this ant species was exclusively found in dark areas within caves, and was never observed outside of cave environments. A colony (the type series) was found in a man-made tunnel in a mine near Sahakorn Nikhom Village, Thong Pha Phum District, Kanchanaburi Province, western Thailand (Fig. 7A). A colony (colony no. TH19-WJT-153) occupied a cavity approximately 7 cm diameter, 15 cm deep in the tunnel wall within the dark zone, about 1.5 m above the floor and 23 m from the entrance (Fig. 7B). Three nests of this species were discovered exclusively in the twilight and dark zones of two caves within the same small, isolated limestone hill (ca. 30 ×140 meters). The two caves are located only 20 meters apart, and their network may be partially interconnected. The first cave is rather small, 33 meters in length, while the second cave is larger, 75 meters in length. In the first cave, two colonies were found: one colony (colony no. TH19-WJT-152) was located near the entrance in the twilight zone (3 meters from the entrance), about 2 meters from the ground in a rock crack on the cave ceiling with a population of approximately ±100 individuals. The second colony (colony no. TH19-WJT-151) was found nesting in the deep zone of the cave about 20 meters from the entrance, in a small hole with narrow entryway of the cave wall, about 10 cm from the floor, and had a population of around ±250 individuals (Fig. 7E). In the adjacent cave, the third colony (colony no. TH19-WJT-153) was found in the dark zone of the cave, about 20 meters from the entrance. It nested between cracks of the rock wall (1.4 meters from the cave floor) with a rather large population of around ±400 individuals. The nests were simple, with no silk observed. All colonies comprised workers, a dealate queen, and broods. Small individuals were observed roaming freely on the floor of the dark zone near the nest (Fig. 6F). Interestingly, many worker corpses, sometimes consisting only of heads, were found in the dark zone, though the cause of this remains unknown.

The habitat in which this ant species nests can be classified as an oligotrophic environment. The nests are located in the dark zone of the cave, devoid of bat guano and other organic resources, in a rather dry area with humidity ranging from 60–74%. The cave where the new ant species was found is situated at a rather high altitude of 762 meters above sea level and are covered by mixed deciduous forest. The temperature

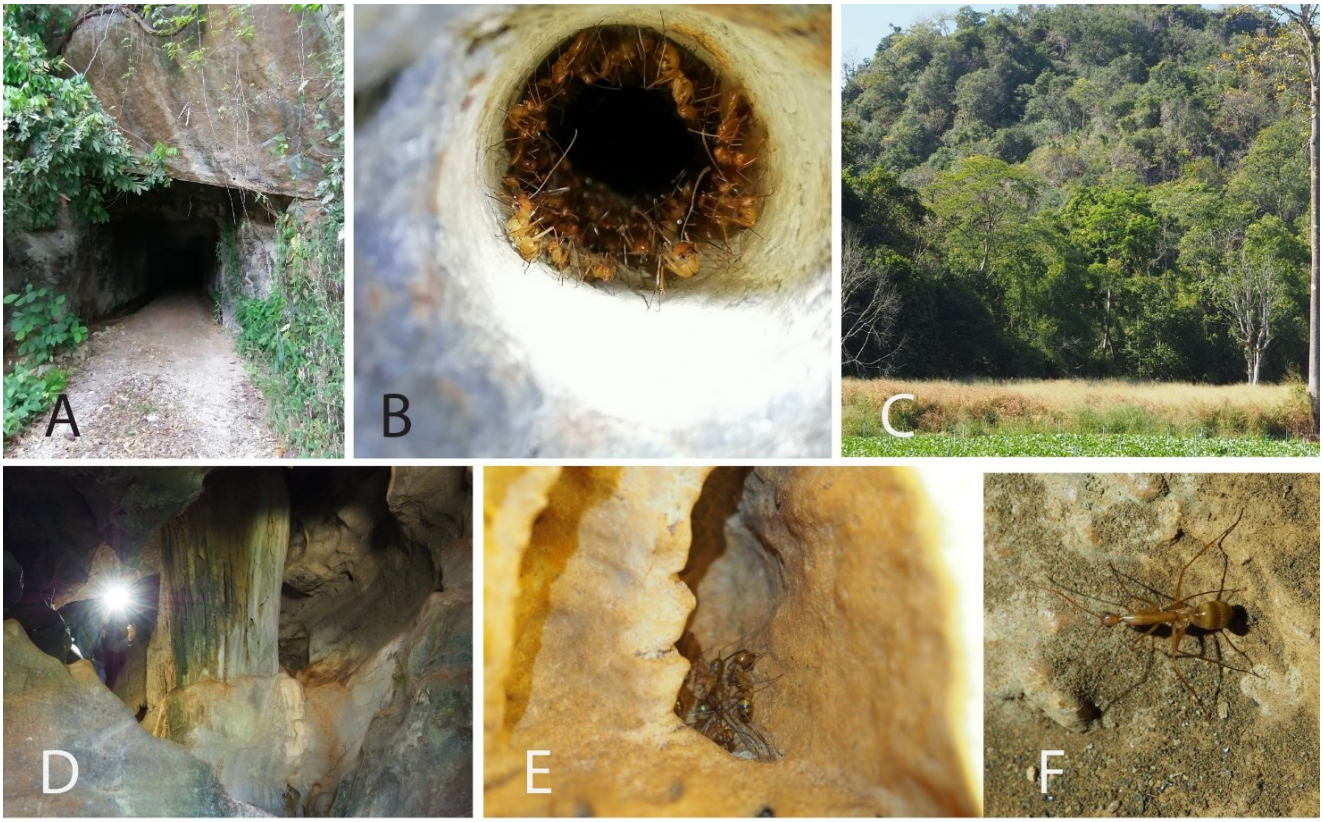

FIGURE 7. Nesting sides of *Camponotus sirindhornae* sp. nov. **A, B.** man-made underground tunnel. **D–E.** nesting sites in caves of limestone mountain. **A.** entrance of the tunnel. **B.** nest in a small hole in a tunnel wall. **C.** limestone mountain, locality of *C. sirindhornae* sp. nov. **D.** cave entrance. **E.** nest in a hole with narrow entryway of the cave wall. **F.** foraging worker on cave floor.

inside the caves present minimal fluctuation ranging from 21.1–22.2 °C in March to 24.1–25.4 °C in November. In contrast, outside temperature outside can drop below 10 °C during the short cool-dry period (November to January) at night and early morning, while daytime temperature can rise to 37 °C during the dry season.

The workers of the new species exhibit predatory behaviour toward other cave arthropods (see below). Additionally, two cave geckos (*Cyrtodactylus* sp.) were observed near the nest in the second cave, presumably predating upon this ant species. *Camponotus sirindhornae* sp. nov. is obviously associated with underground environment and is herein considered as a troglobitic species based on several characteristics. We discuss various aspects on the adaptation of this species to cave environment.

1) The repeated discoveries of nests in the twilight to dark zone of the cave, containing broods, workers, and a queen strongly suggests that the presence of this ant species within the caves is not accidental, and that this species can be classified as a strictly cave-dwelling species (Wilson, 1962; Tinaut and Lopes, 2001). Colonies of this ant species were observed on two occasions, in March and November 2019, and were found to persist for around 10 months, indicating that they represent long-term, permanently inhabiting colonies within the caves. However, observations suggest that the nesting site may shift over short distance (±2 meters).

The two caves where *C. sirindhornae* sp. nov. was discovered are located within a small limestone outcrop and are surrounded by agricultural areas, where the land is regularly used for crop cultivation, such as corn, cassava, cabbage and tomatoes in rotation (Fig. 7C). After the harvest season, the land is cleared and left to dry for a period of time. We are currently unable to determine whether agricultural areas surrounding limestone mountains have a negative impact on cave-dwelling ant populations.

We attempted to search for nests and foragers individuals outside the caves, focusing on the proper habitats such as forest floor around the caves, tree trucks, space under rocks, and small holes and cracks in limestone hill. However, neither individuals nor nests were detected in these potential habitats. This provides evidence that *C. sirindhornae* sp. nov. is a cave-dwelling restricted species. Additionally, attempts to discover *C. sirindhornae* sp. nov. inside and outside the caves of the other adjacent limestone hills (within a 20 km radius including four caves across three

limestone hills) were unsuccessful, as no individuals were found in any of these habitats.

2) Pale coloration and elongated appendages (such as antennae, legs, palpi, etc.) are observed in both the workers and queens of the new species, traits characteristics of cave-dwelling fauna (Roncin and Deharveng, 2003; Batucan and Nuñeza, 2013; Pape, 2016; Naka and Maruyama, 2018). While some non-cave *Camponotus* species (e.g., *C. ager*, *C. angusticollis*, and *C. ashokai*) share similar morphological features, they typically have darker coloration (Figs 6B, C, F). These similarities suggest that the new species may possess pre-adaptative traits for cave dwelling.

3) Troglobiotic species are typically associated with oligotrophic habitats in the dark zone of cave (Deharveng and Bedos, 2000). This is evident in the case of *Leptogenys khammouanensis* where specimens were found in the dark zone of cave between 500 and 4,500 meters from the cave entrance. In contrast, *Aphaenogaster gamagumayaa* was collected at only approximately 20 meters from the entrance in the energy-rich habitat, such as guano deposits. *Camponotus sirindhornae* sp. nov. occupies an ecological niche that bridges those of both species. This ant species was found in an oligotrophic habitat, lacking organic matter and bat guano, similar to *L. khammouanensis*, but it nested relatively close to the cave entrance (ca 20 meters), akin to *A. gamagumayaa*. This finding further suggests that troglobiotic ant can inhabit a range of distances from the entrance to a very deep interior zones in the cave, depending on the cave structure and network.

4) The presence of dimorphism in *C. sirindhornae* sp. nov. raises questions regarding its adaptation to cave life. The genus *Camponotus* is typically polymorphic, exhibiting considerable size variation within species (Shattuck, 1999). However, some species can also display complete dimorphism (Wilson, 1953). In this new species, workers clearly exhibit a dimorphic condition, with two physical worker subcastes (major and minor) showing size variation (Fig. 4). This characteristic is considered an advanced state of caste differentiation for ants (Wilson, 1953). In contrast, the other two cave-dwelling species mentioned above possess a monomorphic worker caste, characteristics in those genera. Further investigation into dimorphism and its relationship to cave life would provide valuable insights into ecomorphological adaptation.

5) The nest size of *C. sirindhornae* sp. nov. ranges widely from 100 to ≥ 400 individuals, which contrasts with the typical cave life strategy, where nest sizes are generally small due to the scarcity of energy resources in cave environments (Deharveng and Bedos, 2000; Culver and Pipan, 2009). In comparison, only seven individuals of *L. khammouanensis* and 12 individuals of *A. gamagumayaa* were collected from their respective sites, although the low number of species collected may not accurately reflect the true nest population, as the nest of these species were not located. The presence of larger individuals, including broods, in *C. sirindhornae* sp. nov. colonies likely require more energy to sustain the colony. As discussed by Wilson (1962) and Tinaut and Lopes (2001), a decrease in colony size may be favored in environments with limited food resources, such as caves and subterranean environment. *Camponotus* ants are generally considered as both scavengers and predators (Shattuck, 1999). Some species in this genus feed on sugars produced by honeydew-producing insects and from plant extrafloral nectaries (Dejean, 1988). Our observations around the nesting sites of this species indicated an abundance of prey organisms, particularly with the giant arthropod community (GAC) and meso-arthropod community (MIC) (*sensu* Deharveng and Bedos, 2000), including crickets, cockroaches, beetles and moths, which serve as potential diet for this ant. This was further confirmed when MAC and MIC specimens placed near the entrance of the nest were quickly approached by workers, who carried the carcasses back into the nest, affirming the ecological role of *C. sirindhornae* sp. nov. within the cave ecosystem.

Camponotus sirindhornae sp. nov. is considered as a strictly cave-dwelling species that exhibits several troglobiotic traits. It represents the second known cave-dwelling species within the genus *Camponotus*. As mentioned above, the isolated limestone outcrop where this new species was discovered is surrounded by agricultural areas and is currently under potential threat. Given this, it is crucial to enhance our understanding of subterranean biodiversity in the country to inform cave management and conservation efforts.

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