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Ant fauna (Hymenoptera: Formicidae) of the Socotra Archipelago (Yemen): zoogeography, distribution and description of a new species

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ABSTRACT

The animal fauna of the Socotra Archipelago is influenced by three biogeographical regions, the Afrotropical, the Oriental and the Palaearctic. Consequently, the Archipelago shares faunal elements of these three regions in addition to unique endemic taxa. The ant fauna of Socotra Island was studied and is reviewed based on literature and newly collected material. In total, 28 species, belonging to 10 genera and four subfamilies, were collected from the main island. Eighteen of these (64%) are successful invasive species, seven are native (25%), and three are considered endemic (11%), *Cardiocondyla longiceps* Seifert, *Monomorium elghazalyi* sp. nov. and *Monomorium nimihil* Collingwood et al. Two genera are recorded for the first time from the island, *Hypoponera* Santschi, and *Syllophopsis* Santschi. Ten species are recorded for the first time, *Cardiocondyla mauritanica* Forel, *Cardiocondyla minutior* Forel, *Monomorium atomum* Forel, *Monomorium dichroum* Forel, *Monomorium exiguum* Forel, *Pheidole pallidula* (Nylander), *Syllophopsis cryptobia* (Santschi), *Tetramorium pauper* Forel, *Tetramorium transformans* Santschi and *Hypoponera punctatissima* (Roger). Ten invasive species are recorded from Socotra, reflecting human impacts on the Archipelago. These species are *Tapinoma melanocephalum* (Fabricius), *Cardiocondyla emeryi* Forel, *Monomorium exiguum* Forel, *Pheidole indica* Mayr, *Syllophopsis cryptobia* (Santschi), *Tetramorium lanuginosum* Mayr, *Tetramorium simillimum* (Smith), *Tetramorium caldarium* (Roger), *Trichomyrmex destructor* (Jerdon) and *Trichomyrmex mayri* (Forel). Our survey indicated a mixture of Afrotropical faunal elements (10 species, 36%), followed by cosmopolitan (nine species, 32%), Palaearctic (five species, 18%) and Oriental (four species, 14%) taxa. Two new synonyms of *Monomorium exiguum* Forel are proposed: *Monomorium exiguum* Forel = *Monomorium baushare* Collingwood & Agosti syn. nov. = *Monomorium qarahe* Collingwood & Agosti syn. nov. *Tetramorium transformans* Santschi is removed from synonymy with *Tetramorium caldarium* (Roger) and elevated to species

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[†]This work is dedicated to one of the authors, Cedric A. Collingwood (1919-2016) who passed after completion of the paper. We will never forget you Cedric!

rank. Ecological and biological notes for each species are given. Distribution maps for all species known from the Socotra Archipelago are provided.

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Introduction

Islands cover about 5% of the total global land surface (Da Fonseca et al. 2006). The biodiversity of islands is a subject of great interest due to their high levels of endemism, extinction, biological invasions and species radiation (Fisher 2009). Studies of island biodiversity also help to unveil histories of colonization and speciation processes (Batelka 2012). Island faunas are also more vulnerable to invasions and extinctions than similar continental faunas (Elton 1958; Pimm 1991) because of their small populations and vulnerability to ecological and biological changes (Lonsdale 1999). Biological invasions pose a major threat to island ecosystems (Fisher 2009). Invasive species are

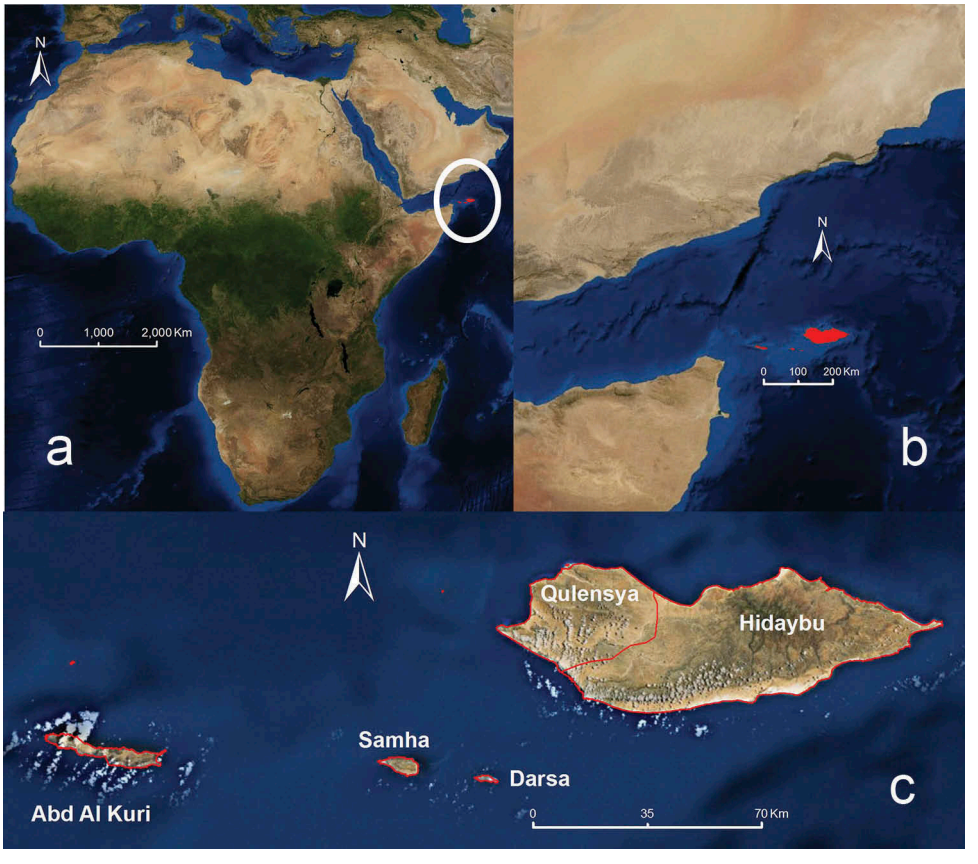

Figure 1. (a,b) Socotra Archipelago and adjacent continental land masses. (c) Islands of Socotra Archipelago.

frequently introduced by human trade (Towns et al. 2006), with immense, insidious, irreversible effects (IUCN 2000) that negatively impact the native fauna (Goodenough 2010; Bertelsmeier et al. 2015) and often lead to the extinction of endemic faunal elements (Clavero and Garcia-Berthou 2005).

The Socotra Archipelago is located south of the Arabian Peninsula (Figure 1(a–c)) with a total area of approximately 3700 km^2 (Culek 2013). The Archipelago consists of the main island of Socotra (3625 km^2) and three smaller islands, Abd al Kuri (133 km^2), Samha (41 km^2) and Darsa (10 km^2). Situated 380 km southeast of the Yemeni coast, Socotra is about 130 km long and 40 km wide. Abd al Kuri is located nearest to the African mainland, being separated from the Somalian coast by only 90 km (Van Damme and Benfield 2011; Batelka 2012).

In terms of biological diversity, the Socotra Archipelago enjoys substantial international importance due to the high degree of endemism of its flora and fauna (Di Micco De Santo and Zandri 2004), having nearly 700 endemic species. Only the Galápagos Islands, Hawaii and New Caledonia have higher numbers (Burdick 2007). Socotra is home to about 300 endemic flowering plants, more than 30 endemic vertebrate animals, and over 800 endemic invertebrate species [http://whc.unesco.org/(Accessed April 20, 2016)] (Miller and Morris 2001; Cheung and De Vantier 2004). The Archipelago has seven endemic species of birds, more than 600 endemic insect species, approximately 73% endemic terrestrial Isopoda (Taiti and Ferrara 2004), and a reptile fauna that is more than 90% endemic (Culek 2013). This high level of endemism is the primary reason that UNESCO designated the Archipelago a World Heritage site (UNEP/WCMC 2008).

Biogeographically, the Socotra Archipelago is situated at the interchange of three major zoogeographical regions, the Afrotropical, Palaearctic and Oriental. Therefore, its faunal elements are a combination of these three realms. Afrotropical faunal elements dominate many of the Archipelago's studied groups (Udvardy 1975; Takhtajan et al. 1986; Olson et al. 2001; Mendes 2004; Rheims et al. 2004; Fikáček et al. 2012; Culek 2013; Holt et al. 2013).

The history of the myrmecological studies of Socotra is limited and literature records are scattered. The first ant to be recorded from the Archipelago was from the subfamily Formicinae, *Camponotus maculatus* (Fabricius, 1782) (Kohl 1907). The first published work on the ants of the Kingdom of Saudi Arabia (KSA) (Collingwood 1985) included five species for the Archipelago: *Brachyponera sennaarensis* (Mayr, 1862), *Pheidole lamellinoda* Forel, 1902a, *Lepisiota spinisquama* (Kuznetsov-Ugamsky, 1929), *Camponotus acvapimensis* Mayr, 1862 and *Camponotus hova* Forel, 1891. In his world revision of the genus *Cardiocondyla* Forel, Seifert (2003) described *Cardiocondyla longiceps* from Ta'iz, Yemen and Socotra. The sole faunistic ant study of the Socotra Archipelago by Collingwood et al. (2004) listed and keyed 18 species and described *Monomorium nimihil* as a new species based on the worker caste. Collingwood et al. (2004) indicated that at least eight species are considered to be invasive and were introduced to the island by human commerce.

The main objectives of our study are to:

(1) Present a list of the ant species known from the Socotra Archipelago based on all available published data, in addition to new, recent collections;
(2) Provide new information about species habitats and distribution;
(3) Describe new species collected during the present survey;

(4) Consider zoogeographical affinities, degree of endemism and biological invasions.

Materials and methods

Field work was conducted on Socotra main island by the senior author from 19 April to 27 April 2014 visiting 27 sites covering different types of habitats, including agricultural and native undisturbed, disturbed, terrestrial and arboreal ecosystems. The main collecting methods were sifting trays used for soil and litter sampling, a beating sheet for arboreal sampling, and hand collecting. Extensive searches for ant nests under rocks, in rotting logs, tree falls, leaf litter, inside fallen fruits and under the bark of living trees were conducted. Specimens were collected by aspirator and preserved in absolute alcohol, mounted and sorted to morphospecies. Identification of the materials was accomplished by comparing specimens with type material available on www.AntWeb.org and also by using taxonomic keys, including those by Bolton (1980, 1987, 1994), Collingwood (1985), Collingwood and Agosti (1996) and Collingwood et al. (2004). The ant collections of the World Museum Liverpool, UK (WMLC), and the Naturhistorisches Museum, Basel, Switzerland (NHMB) were examined for records. All collected specimens were deposited at King Saud University Museum of Arthropods, King Saud University, Riyadh, Kingdom of Saudi Arabia (KSMA) and voucher specimens were also deposited at the California Academy of Sciences Collection, San Francisco, CA, USA (CASC) and the C. P. Gillette Museum of Arthropod Diversity, Colorado State University, Fort Collins, CO, USA (CSUC). 'Socotra Island' in the material examined of the present study refers to the main island.

When a species occurred in undisturbed native localities and also apparently had a limited distribution on Socotra, these were considered native taxa, whereas species found in disturbed or urban localities with a broad distribution were considered invasive (Wetterer et al. 2007). Endemic species are taxa only known from Socotra. Specimens were photographed by Christiana Klingenberg, Erin Prado, Estella Ortega, Michele Esposito, Will Ericson and Zach Lieberman (California Academy of Sciences). Digital colour images of lateral and dorsal views of the entire body and full-face views of the head of each species were created using a Leica DFC450 digital camera with a Leica Z16 APO microscope and LAS (v3.8) software. These images are also available online on AntWeb (www.AntWeb.org) and are accessible using the unique identifying specimen code.

Information on species distribution and ecology was based on field observations and data compiled from literature and some ant websites, including www.AntWeb.org and www.antwiki.org. From the previous two websites, information about treated species including taxonomic history, references, distribution, habitats and biology were used. The species names follow the online catalogue of ants of the world (Bolton 2014) available on www.AntCat.org. GPS data for all recorded distribution localities in Collingwood et al. (2004) and those mentioned only by names were obtained from Bezděk et al. (2012). Distribution maps were made using DIVA-GIS (version 7.5.0.0). All measurements and indices were given in millimetres and follow the standard measurements of Bolton (1987).

Measurements

EL, eye length; maximum diameter of eye; HL, head length; maximum length of head, excluding mandibles; HW, head width; maximum width of head behind eyes in full-face view; ML, mesosoma length; length of mesosoma in lateral view, from the point at which pronotum meets cervical shield to posterior base of propodeal lobes or teeth; PH, petiolar node height; maximum height of petiolar node measured in lateral view from highest (median) point of node to ventral outline – the measuring line is placed at an orthogonal angle to ventral outline of node; PPH, postpetiole height; maximum height of postpetiole measured in lateral view from highest (median) point of node to the ventral outline – the measuring line is placed at an orthogonal angle to ventral outline of the node; PL, petiole length; maximum length measured in dorsal view, from anterior margin to posterior margin; PPL, postpetiole length; maximum length measured in dorsal view; PPW, postpetiole width; maximum width measured in dorsal view; PRW, pronotal width, maximum width in dorsal view; PW, petiole width; maximum width measured in dorsal view; SL, scape length, excluding basal neck; TL, total length; out-stretched length of ant from mandibular apex to gastral apex.

Indices

CI, Cephalic Index (HW × 100/HL); SI, Scape Index (SL × 100/HW).

Museum abbreviations

BMNH, The Natural History Museum, London, UK; CASC, California Academy of Sciences Collection, San Francisco, CA, USA; HLMD, Hessisches Landesmuseum Darmstadt, Germany; KSMA, King Saud University Museum of Arthropods, King Saud University, Riyadh, Kingdom of Saudi Arabia (holotype depository); MHNG, Muséum d' Histoire Naturelle, Geneva, Switzerland; NHMB, Naturhistorisches Museum, Basel, Switzerland; WMLC, World Museum Liverpool, Liverpool, UK.

Results

Subfamily **DOLICHODERINAE**
Tapinoma Foerster
Tapinoma melanocephalum (Fabricius, 1793)
(Figure 2(a–c))

Formica melanocephala Fabricius, 1793: 353 (w.) French Guiana. Neotropical.

Diagnosis

Worker. An easily distinguished species by its small size (1.20–1.90 mm) and bicoloured body. Head and mesosoma brown or dark brown, antennae, maxillary palps and mandibles pale brown to yellow, gaster and legs pale yellow; mesosoma without erect hairs.

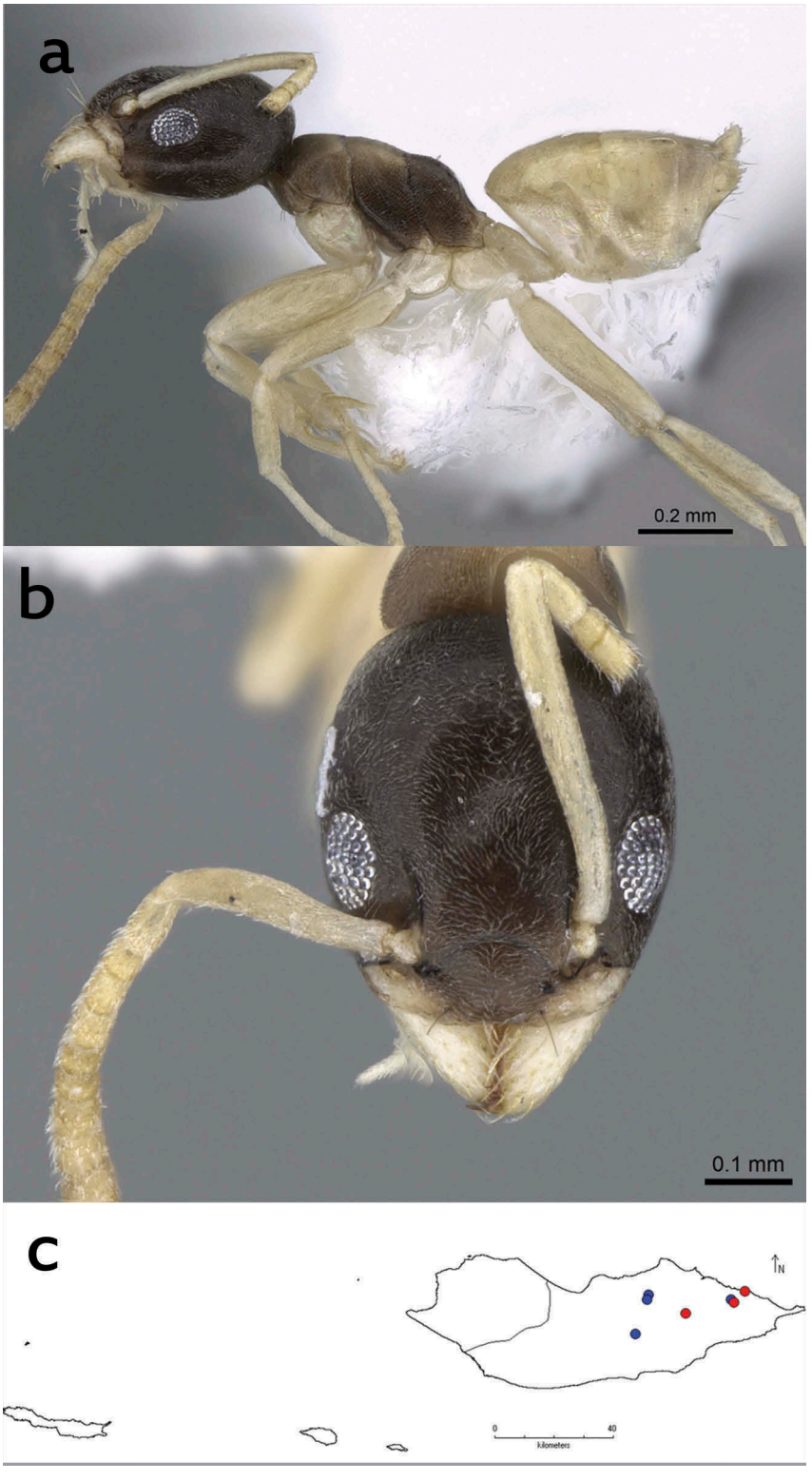

Figure 2. *Tapinoma melanocephalum*. (a) Body in profile. (b) Head in full-face view, CASENT0746621, AntWeb.org, (Zach Lieberman). (c) Distribution map, blue circles from recent records, red circles from Collingwood et al. (2004).

Material examined

Yemen, Socotra Island, Dehejamo, 22 April 2014, 563 m, (M.R. Sharaf leg.), 12.59049°N, 54.05205°E (9 w, KSMA); Yemen, Socotra Island, Himihil Protectorate, 23 April 2014, 372 m, (M.R. Sharaf leg.), 12.57615°N, 54.30651°E (3 w, KSMA); Yemen, Socotra Island, Dixam (W. Zereg), 24 April 2014, 279 m, (M.R. Sharaf leg.), 12.46868°N, 54.01091°E (6 w, KSMA); Yemen, Socotra Island, Lehanoh, 22 April 2014, 931 m, (M.R. Sharaf leg.), 12.57583°N, 54.04836°E (2 w, KSMA, 1 w, CASC).

Geographic range

An invasive species with a worldwide distribution (Wetterer 2009a). It was recorded from KSA and Oman (Collingwood 1985), Yemen (Collingwood and Agosti 1996), and the United Arab Emirates (UAE) (Collingwood et al. 1997).

Ecological and biological notes

The nesting and foraging habitats of this species are diverse. Several specimens were found foraging on a tree located on a mountainside with nearby stream drainage. The area had moist soils with high plant diversity, especially *Adiantum capillus-veneris* L. (Pteridaceae), which was abundant. The area was dominated by the ponerine ant, *Brachyponera sennaarensis* (Mayr, 1862). A nest series was collected from an area with moist soil and dense grasses. The area was rich in decayed animal faeces. Another nest was collected by sifting the leaf litter next to a stream and small pool with many scattered date palm (*Phoenix dactylifera* L.) trees. Another nest series was found under the bark of a recently cut dragon blood tree, *Dracaena cinnabari* Balf.f. (Asparagaceae) and associated with curculionid beetles. This invasive species has a broad range of habitat preference worldwide (Wetterer 2009a), including pre-existing cavities made of plant materials, and in larders and pantries, and nesting in walls and potted plants indoors (Ellison et al. 2012).

Subfamily **FORMICINAE**
Camponotus Mayr
Camponotus acvapimensis Mayr, 1862
(Figure 3(a–c))

Camponotus acvapimensis Mayr, 1862: 664 (w.) Ghana. Afrotropical.

Diagnosis

The soldier of this species is readily distinguished from other species of the genus by the densely shagreened brown body; posterior corners of head each with four stout hairs, clypeus with several pairs of long pale hairs, pronotum with four pairs, mesonotum, propodeum and petiole each with a single pair of hairs, gaster with abundant, long, yellow hairs.

Material examined

Yemen, Socotra Island, Lehanoh, 22 April 2014, 931 m, (M.R. Sharaf leg.), 12.57583°N, 54.04836°E (18 w, KSMA, 1 w, CASC).

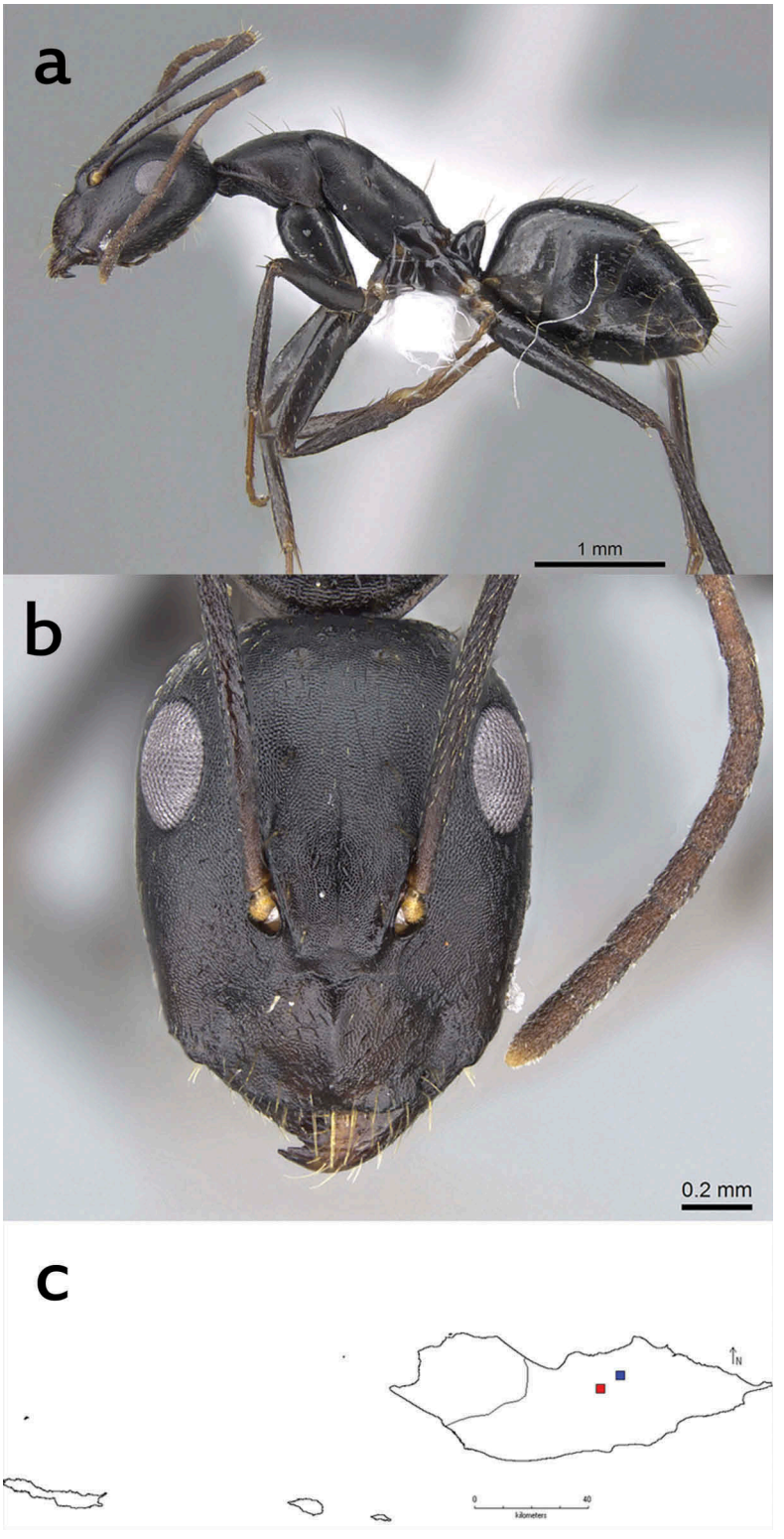

Figure 3. *Camponotus acvapimensis*. (a) Body in profile. (b) Head in full-face view, CASENT0746632, AntWeb.org, (Zach Lieberman). (c) Distribution map, blue square from recent records, red square from Collingwood et al. (2004).

Geographic range

This species was described from Ghana and with a broad distribution in the Savannahs and forests of the Afrotropical region (Collingwood 1985). It was recorded from Socotra by Collingwood et al. (2004) with no records known from the Arabian Peninsula. In Socotra, this species has a limited distribution and is confined to a few sites at higher elevations.

Ecological and biological notes

This species appears to be uncommon, only collected from one locality during the present study. Workers were found foraging on twigs of *Croton socotranus* Balf. f. (Euphorbiaceae). It seems likely that the species may be confined to higher elevation sites above 900 m. It was recorded from Dixam Plateau 1000–1200 m (Collingwood et al. 2004).

Camponotus atlantis Forel, 1890
(Figure 4(a–c))

Camponotus rubripes r. *atlantis* Forel, 1890: lxiii (s. w. q.) Tunisia. Palaearctic.

Diagnosis

The soldier caste of this species is easily identified by the yellow blotch over the first and second gastral tergites; head, mesosoma and gaster end dark brown; minor workers are completely yellow.

Geographic range

Camponotus atlantis was described from Tunisia and has been recorded from several countries in the Arabian Peninsula including KSA (Collingwood 1985), Oman and Yemen (Collingwood and Agosti 1996), and Socotra (Collingwood et al. 2004).

Ecological and biological notes

Colonies of *Camponotus atlantis* are commonly found under rocks next to and under *Acacia* trees.

Camponotus hova Forel, 1891
(Figure 5(a–c))

Camponotus maculatus r. *hova* Forel, 1891: 35 (s. w. q.) Madagascar. Malagasy.

Diagnosis

Soldier. Anterior clypeal margin finely dentate; subcephalic hairs 2–4; body pilosity abundant, thin, and long; head, scapes blackish brown, anterior half of mesosoma, posterior half of gaster dark brown, posterior half of mesosoma, legs, petiole and first gastral tergite yellowish.

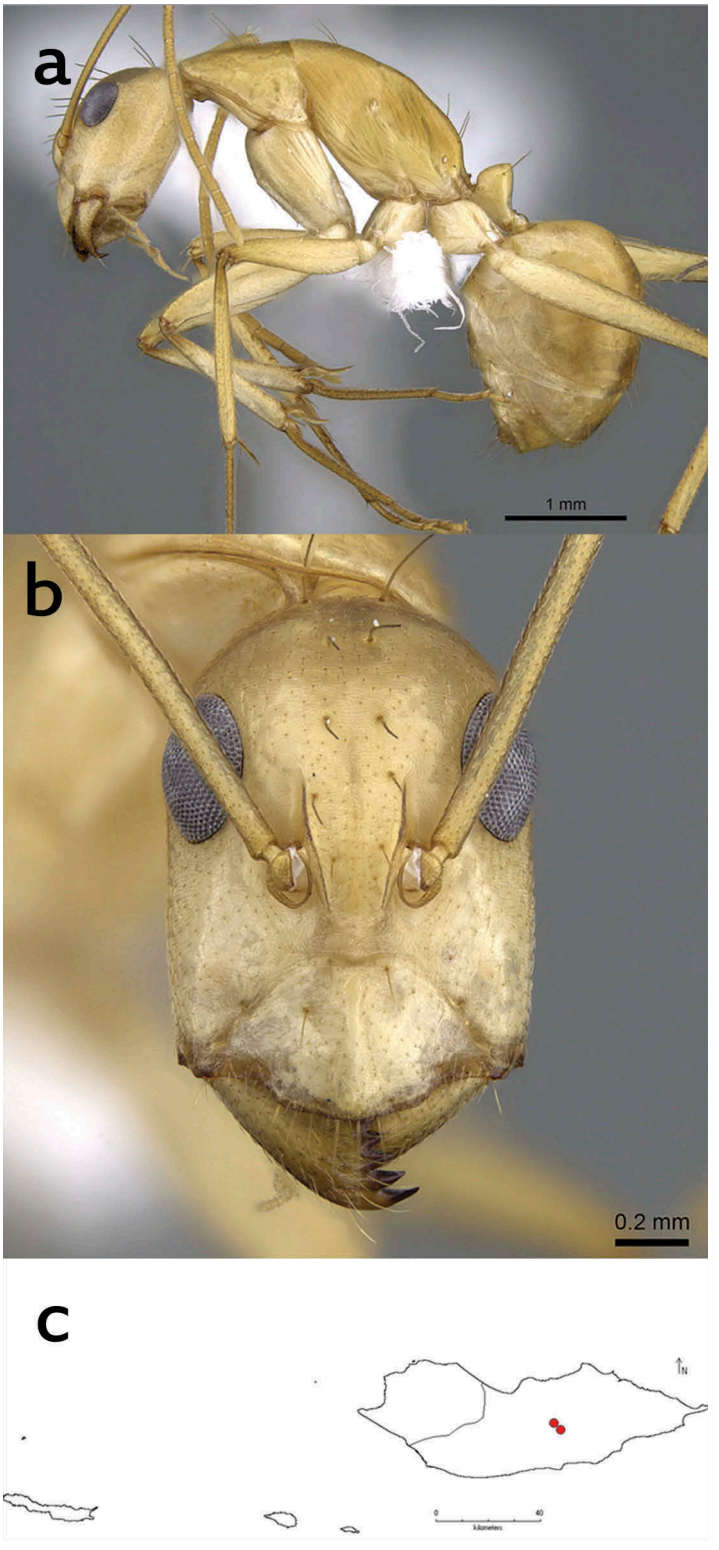

Figure 4. *Camponotus atlantis*. (a) Body in profile. (b) Head in full-face view, CASENT0746633, AntWeb.org, (Zach Lieberman). (c) distribution map, from Collingwood et al. (2004).

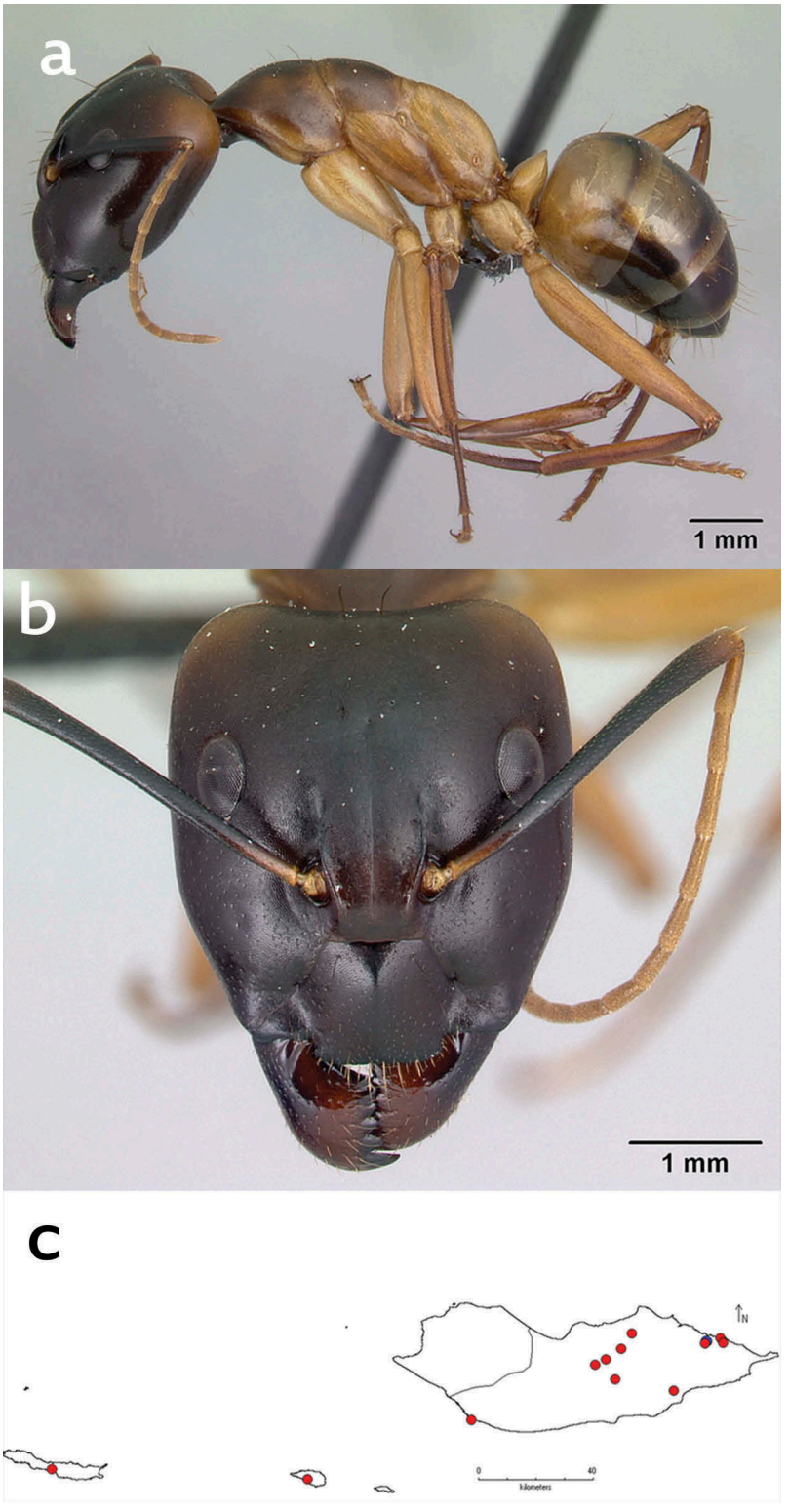

Figure 5. *Camponotus hova*. (a) Body in profile. (b) Head in full-face view, CASENT0137305, AntWeb.org, (Erin Prado). (c) Distribution map, blue circles from recent records, red circles from Collingwood et al. (2004).

Material examined

Yemen, Socotra Island, Himihil Protectorate, 23 April 2014, 355 m, (M.R. Sharaf leg.), 12.58954°N, 54.30570°E (one soldier without gaster, KSMA).

Geographic range

A species described originally from Madagascar, commonly found on islands of East Africa (Collingwood and Agosti 1996), and recorded from the Arabian Peninsula from Oman (Collingwood 1985) and Yemen (Collingwood and Agosti 1996).

Ecological and biological notes

This species was found in dry leaf litter next to a date palm tree.

Lepisiota Santschi
Lepisiota spinisquama (Kuznetsov-Ugamsky, 1929)
(Figure 6(a–c))

Acantholepis frauenfeldi subsp. *spinisquama* Kuznetsov-Ugamsky, 1929: 483, fig. 3 (w.) Kazakhstan. Palaearctic.

Diagnosis

Worker. Antennal scapes when laid back from their insertions surpassing posterior margin of head by more than half of its length; propodeal spines short, acute and curved; petiole bituberculate; pronotum with a single pair of long hairs; body smooth and shining black, antennae, tibiae and tarsi yellowish.

Material examined

Yemen, Socotra Island, Qalansyia, 25 April 2014, 26 m, (M.R. Sharaf leg.), 12.68401°N, 53.49052° E (3 w, KSMA); Yemen, Socotra Island, Dixam, 24 April 2014, 656 m, (M.R. Sharaf leg.), 12.49320° N, 53.99145°E (3 w, KSMA); Yemen, Socotra Island, Qoaher (himihil RD), 23 April 2014, 124 m, (M.R. Sharaf leg.), 12.58561°N, 54.27643°E (10 w, KSMA); Yemen, Socotra Island, Himihil Protectorate, 23 April 2014, 330 m, (M.R. Sharaf leg.), 12.58204°N, 54.29057°E (16 w KSMA); Yemen, Socotra Island, Haydibo, Erheno, 19 April 2014, 33 m, (M.R. Sharaf leg.), 12.65023°N, 54.04016°E (15 w, KSMA); Yemen, Socotra Island, W. Ayhift, 20 April 2014, 38 m, (M.R. Sharaf leg.), 12.61906°N, 53.94005°E (12 w, KSMA); Yemen, Socotra Island, Himihil Protectorate, 23 April 2014, 372 m, (M.R. Sharaf leg.), 12.57615°N, 54.30651°E (12 w, KSMA, 1 w, CASC).

Geographic range

This species has a wide distribution in central Asia but on the Arabian Peninsula it has been recorded only in Oman and Socotra (Collingwood 1985; Collingwood and Agosti 1996; Collingwood et al. 2004).

Ecological and biological notes

Lepisiota spinisquama was collected from dry soil under a date palm tree by sifting. A colony was found nesting under a stone in Dixam Plateau. A nest was collected from under a dead palm tree where the soil had a high degree of humidity and was rich in organic material. Another colony was found under a stone where exoskeletons of minor workers of a yellow

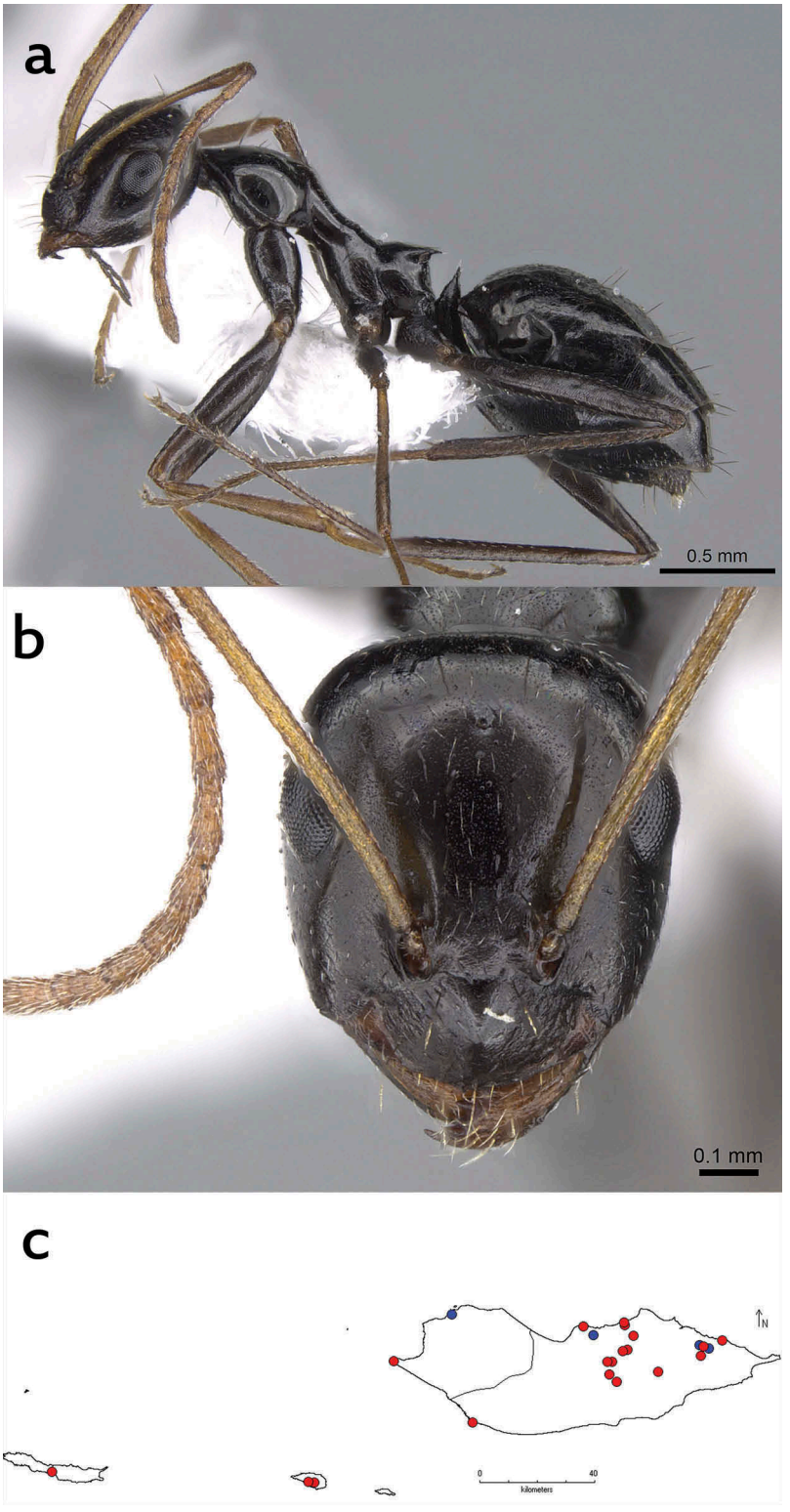

Figure 6. *Lepisiota spinisquama*. (a) Body in profile. (b) Head in full-face view, CASENT0746630, AntWeb.org, (Zach Lieberman). (c) Distribution map, blue circles from recent records, red circles from Collingwood et al. (2004).

Camponotus sp. were present. Workers were observed foraging on the trunk of *Boswellia carteri* Flueck. (Burseraceae) where many worker of *Trichomyrmex mayri* (Forel) were also found at the trunk base and the soil was dry. Several mealybugs (Hemiptera: Pseudococcidae) were observed under the bark of the tree. The species was also found nesting under a stone with several dead tenebrionid beetles and a species of the family Lygaeidae (Hemiptera). Several workers of *L. spinisquama* were foraging on ground where soil was sandy and dry. Several individuals were collected from a dry leaf litter by sifting. A nest was located in a relatively moist, compact clay soil under a stone. Previous observations indicate that this species apparently prefers dry habitats.

Paratrechina Motschoulsky
Paratrechina longicornis (Latreille, 1802)
(Figure 7(a–c))

Formica longicornis Latreille, 1802: 113 (w.) Senegal. Afrotropical

Diagnosis

Worker. A relatively small species (TL 2.30–3.00); antennae long with 12 segments; scapes exceptionally long, when laid back from their insertions surpassing posterior margin of head by at least one-half its length; eyes close to posterior margin of head; legs extraordinarily long. Colour: head, mesosoma, petiole and gaster dark brown to blackish brown; body with faint bluish iridescence. Pilosity long, stout, scattered, suberect to erect, greyish or whitish setae.

Material examined

Yemen, Socotra Island, Qalansyia, W. Taisoh, 25 April 2014, 67 m, (M.R. Sharaf leg.), 12.65880°N, 53.46988°E (7 w, KSMA); Yemen, Socotra Island, Dehejamo, 22 April 2014, 563 m, (M.R. Sharaf leg.), 12.59049°N, 54.05205°E (25 w, KSMA); Yemen, Socotra Island, Haydibo, Erheno, 19 April 2014, 33 m, (M.R. Sharaf leg.), 12.65023°N, 54.04016°E (14 w, KSMA); Yemen, Socotra Island, Himihil Protectorate, 23 April 2014, 372 m, (M.R. Sharaf leg.), 12.57615°N, 54.30651°E (5 w, KSMA); Yemen, Socotra Island, W. Jo'o, 21 April 2014, 196 m, (M.R. Sharaf leg.), 12.54038°N, 54.17186°E, (6 w, KSMA); Yemen, Socotra Island, Himihil Protectorate, 23 April 2014, 355 m, (M.R. Sharaf leg.), 12.58954°N, 54.30570°E (1 w, KSMA); Yemen, Socotra Island, W. Ayhift, 20 April 2014, 198 m, (M.R. Sharaf leg.), 12.61155°N, 53.97755°E (3 w, KSMA); Yemen, Socotra Island, Deyishil village, 21 April 2014, 180 m, (M.R. Sharaf leg.), 12.52010°N, 54.17438°E (3 w, KSMA); Yemen, Socotra Island, Dixam, 24 April 2014, 610 m, (M.R. Sharaf leg.), 12.46557°N, 54.00247°E (1 w, KSMA).

Geographic range

Among the region's most successful invasive species (Wetterer 2008), this ant is frequently distributed by human commerce and usually found in disturbed sites. In many areas of Egypt and KSA, the senior author has observed high populations of this species where garbage and human wastes were found. It was recorded from several countries of the Arabian Peninsula, KSA (Collingwood 1985), Yemen (Collingwood and Agosti 1996), UAE (Collingwood et al. 2011), Socotra (Collingwood et al. 2004).

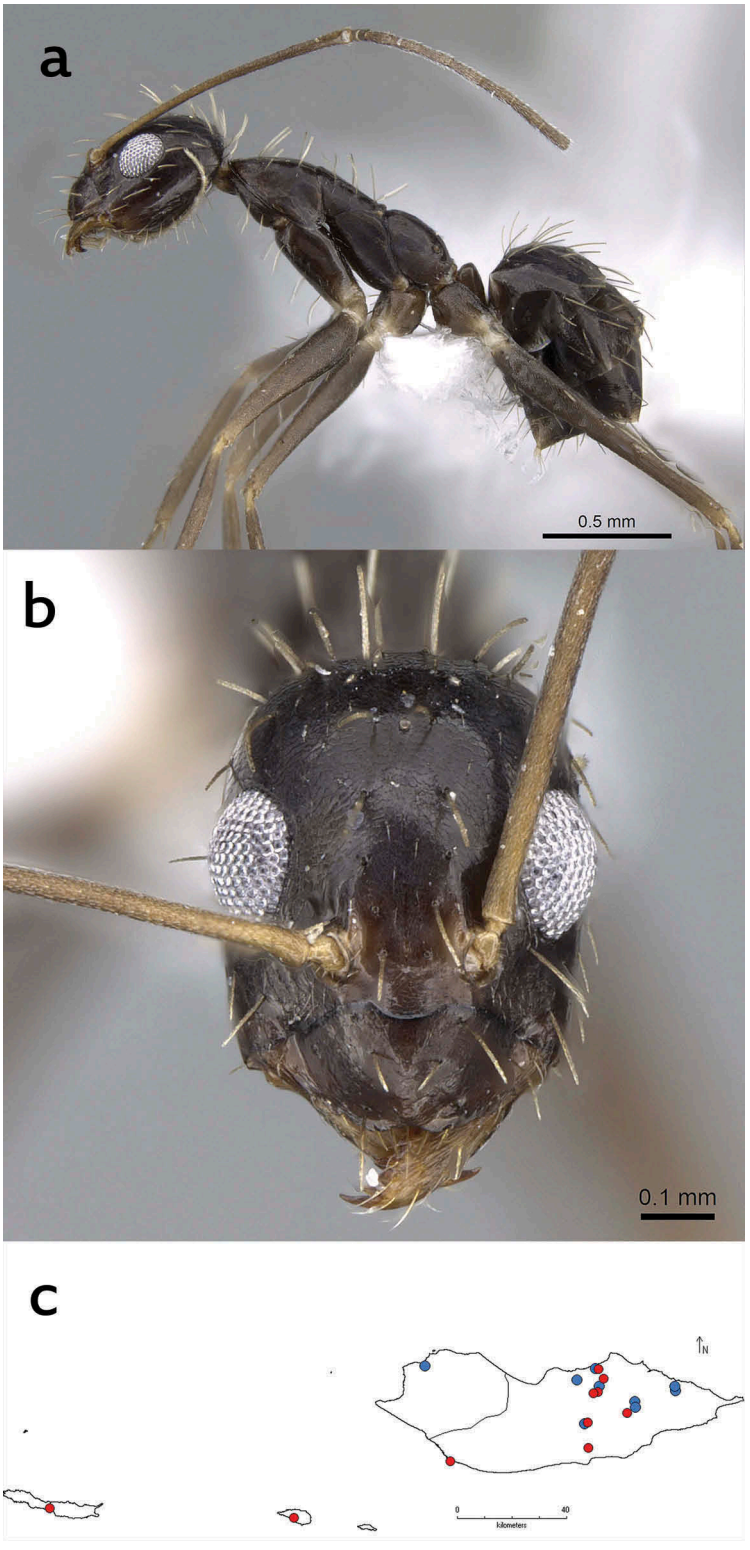

Figure 7. *Paratrechina longicornis*. (a) Body in profile. (b) Head in full-face view, CASENT0746631, AntWeb.org, (Zach Lieberman). (c) Distribution map, blue circles from recent records, red circles from Collingwood et al. (2004).

Ecological and biological notes

The known habitats of this species are diverse, no doubt enabling its wide distribution. We observed *Paratrechina longicornis* nesting in moist soil under a rock adjacent to a date palm tree. Another nest was collected from dry soil under shrub *Frangula alnus* Mill. (Rhamnaceae). Many workers were found in leaf litter under a date palm tree where the soil was moist and rich in accumulated sheep and goat faeces. Several workers were foraging in leaf litter on dry soil under an *Eragrostis tef* (Zucc.) Trotter (Poaceae) tree, where the soil was dry. A nest was observed under a rock in moist, compacted, clay soil. Hundreds of workers were foraging in moist leaf litter and on twigs of a small shrub. Several workers were nesting under a stone in humid soil and next to banana plantations. A nest was found under a rock next to a dragon blood tree, *Dracaena cinnabari* Balf.f. (Asparagaceae). This species has been reported as a pest in greenhouses in both temperate and tropical regions (Nylander 1856; Motschoulsky 1863).

Subfamily **MYRMICINAE**

Cardiocondyla Emery

Cardiocondyla emeryi Forel, 1881

(Figure 8(a–c))

Cardiocondyla emeryi Forel, 1881: 5 (w.) Virgin Is. Neotropical

Diagnosis

Worker. Head distinctly longer than broad; promesonotal outline in profile continuous and shallowly convex, not abruptly sloping into moderately deep metanotal groove; propodeal spines short and less acute; postpetiolar sternite with a conspicuous anteroventral prominence or bulge. Body yellow, gaster dark brown or blackish brown.

Material examined

Yemen, Socotra Island, Lehanoh, 22 April 2014, 931 m, (M.R. Sharaf leg.), 12.57583°N, 54.04836°E (1 w, KSMA).

Geographic range

Cardiocondyla emeryi is a successful cosmopolitan invasive species introduced by human commerce (Seifert 2003; Wetterer 2012). It has been recorded from several countries of the Arabian Peninsula including KSA (Collingwood 1985), Oman, Yemen (Collingwood and Agosti 1996), UAE (Collingwood et al. 1997) and Socotra (Collingwood et al. 2004). The occurrence of *Cardiocondyla emeryi* in Socotra is likely the result of commerce and the transport of plant material.

Ecological and biological notes

This species was found nesting under a rock on loose and sandy soil.

Cardiocondyla longiceps Seifert, 2003

Cardiocondyla longiceps Seifert, 2003: 259, fig. 45 (q.) Yemen. Afrotropical.

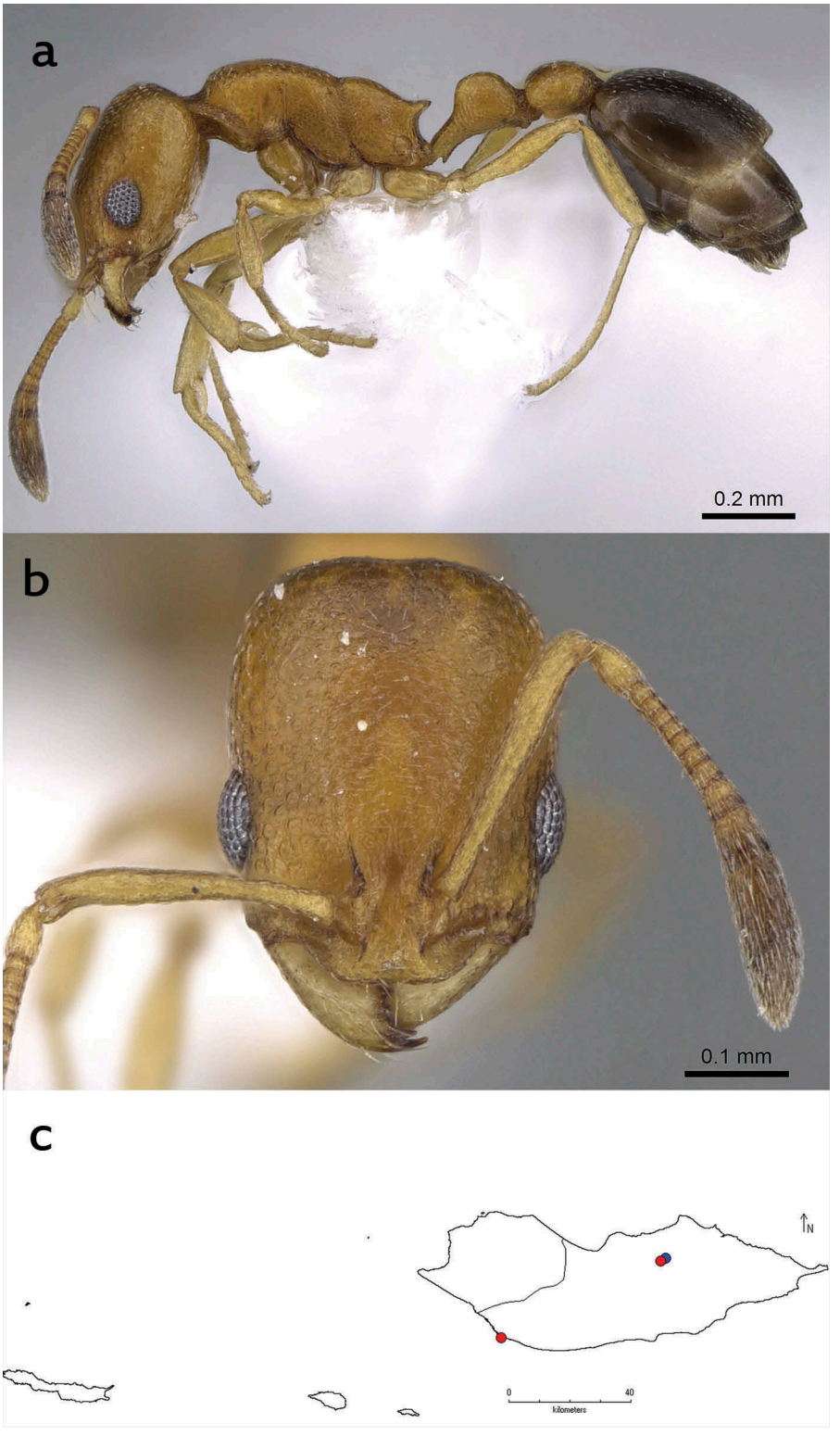

Figure 8. *Cardiocondyla emeryi*. (a) Body in profile. (b) Head in full-face view, CASENT0746616, AntWeb.org, (Zach Lieberman). (c) Distribution map, blue circles from recent records, red circles from Collingwood et al. (2004).

Diagnosis

Queen. Anterior clypeus with profuse erect pubescence, appearing bearded; mesonotum strongly longitudinally rugulose, interspaces foveolate; propodeum and postpetiolar dorsum strongly foveolate-reticulate; petiolar node in dorsal view globular, as long as or slightly longer than broad; whole body with long and profuse pubescence; lateral mesosoma, propodeum, petiole and postpetiole light-yellowish brown, dorsum of antennal funiculus, dorsum of head, gaster and mesosoma from scutellum to metanotum distinctly darker.

Geographic range

This species is endemic to Socotra Island and is also known from Ta'iz Yemen mainland area and was originally described from Hadibo City, capital of Socotra, based on the gyne caste (Seifert 2003). Workers are not known.

Ecological and biological notes

No ecological or biological information is available.

Cardiocondyla mauritanica Forel, 1890
(Figure 9(a–c))

Cardiocondyla nuda var. *mauritanica* Forel, 1890: lxxv (w.) Tunisia. Palaearctic.

Diagnosis

Worker. Clypeus with few longitudinal rugae; mesosoma usually with well-developed micro-reticulum; metanotal groove shallow; propodeal spines short and blunt; postpetiole narrow, roughly hexagonal in dorsal view, with a flat sternite, and distinctly lower than petiole in profile. Colour variable, dorsal head dark brown, mesosoma, petiole and postpetiole orange brown, gaster bark brown to blackish brown.

Material examined

Yemen, Socotra Island, W. Feriho (daitab), 21 April 2014, 93 m, (M.R. Sharaf leg.), 12.44103°N, 54.15576°E (2 w, KSMA); Yemen Island, Socotra, W. Jo'o, 21 April 2014, 196 m, (M.R. Sharaf leg.), 12.54038°N, 54.17186°E (1 w, KSMA).

Geographic range

A cosmopolitan species (Seifert 2003) and one of the most successfully distributed species of the genus. This species has been recorded from KSA (Collingwood 1985), Yemen (Collingwood and Agosti 1996) and UAE (Collingwood et al. 1997). Although this species was found in uninhabited areas of Socotra Island, it is likely to have been dispersed through the cargo and food being transported by islanders from the capital city of Haydibo into the countryside. *Cardiocondyla mauritanica* is recorded from Socotra Archipelago for the first time.

Ecological and biological notes

Workers were observed foraging in wet, sandy soil next to a small stream. Some specimens were found in leaf litter under a date palm where the soil was moist and rich in decayed goat and sheep faecal material.

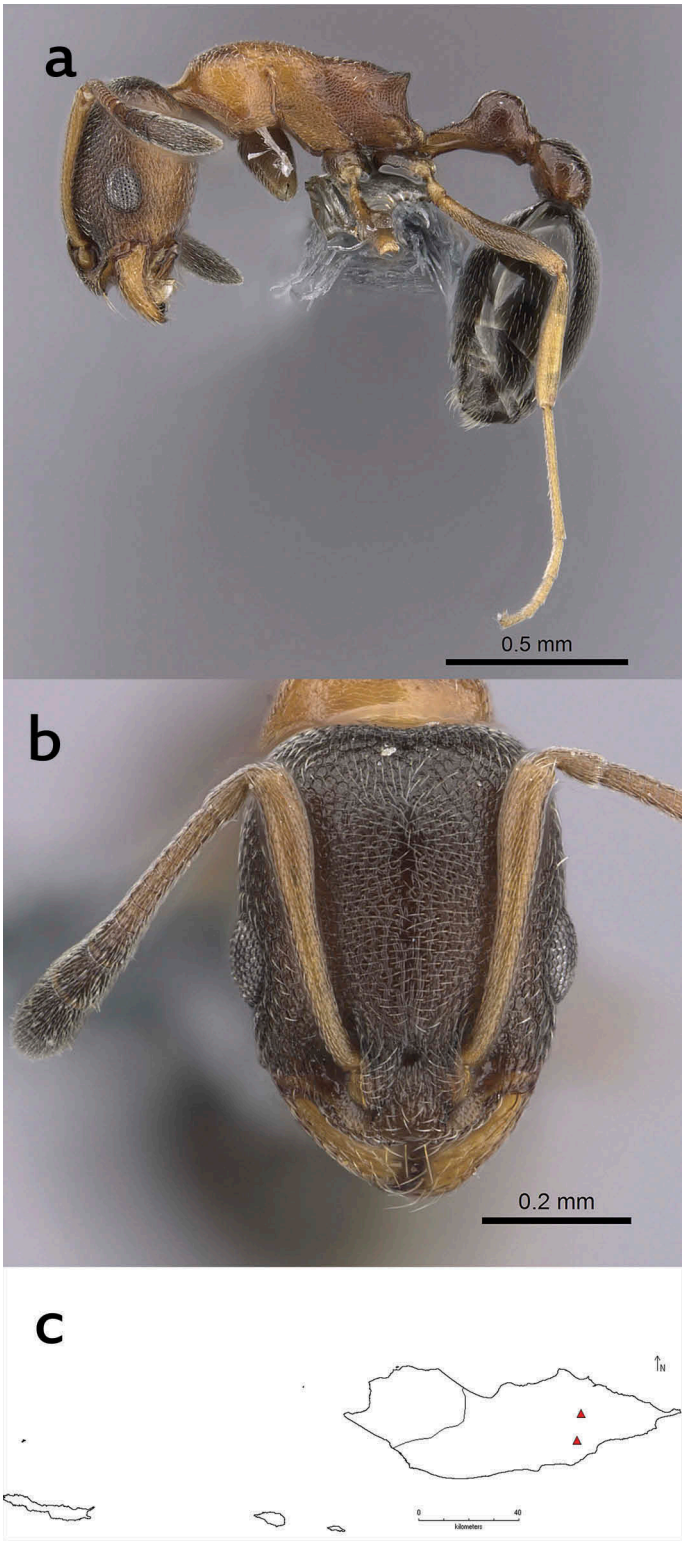

Figure 9. *Cardiocondyla mauritanica*. (a) Body in profile. (b) Head in full-face view, CASENT0263693, AntWeb.org, (Will Ericson), KSA. (c) Distribution map, from recent records.

Cardiocondyla minutior Forel, 1899
(Figure 10(a–c))

Cardiocondyla nuda var. *minutior* Forel, 1899: 120 (w.) Hawaii. Oceania.

Diagnosis
Worker. Eyes small, with distinct microsetae; posterior margin of head straight or very weakly concave; anterior clypeal margin with feeble median concavity; mesosomal outline in profile nearly straight or feebly convex; metanotal groove weakly impressed or entirely absent; propodeal spines short and acute; petiole in profile with concave anterior face and rounded node; petiolar node in dorsal view circular and as long as broad; postpetiole low, with a completely flat sternite and without anteroventral bulge. Head, mesosoma, petiole and postpetiole varying from dirty yellow to dark dirty brown, gaster brown to blackish brown.

Material examined
Yemen, Socotra Island, Dixam (W. Zereg), 24 April 2014, 279 m, (M.R. Sharaf leg.), 12.46868°N, 54.01091°E (18 w, KSMA); Yemen, Socotra Island, Himihil Protectorate, 23 April 2014, 355 m, (M.R. Sharaf leg.), 12.58954°N, 54.30570°E (12w, KSMA); Yemen, Socotra Island, W. Jo'o, 21 April 2014, 196 m, (M.R. Sharaf leg.), 12.54038°N, 54.17186°E (2 w, KSMA); Yemen, Socotra Island, W. Sakhalof, 27 April 2014, 48 m, (M.R. Sharaf leg.), 12.63311°N, 54.05632°E (5 w, KSMA); Yemen, Socotra Island, Lehanoh, 22 April 2014, 931 m, (M.R. Sharaf leg.), 12.57583°N, 54.04836°E (10 w, KSMA); Yemen, Socotra Island, Dehejamo, 22 April 2014, 563 m, (M.R. Sharaf leg.), 12.59049°N, 54.05205°E (1 w, KSMA).

Geographic range
This species was originally described from Hawaii (Forel 1899) and is a cosmopolitan tramp species (Seifert 2003). Our collections represent a new record for Socotra Archipelago.

Ecological and biological notes
The nesting and foraging behaviours of *Cardiocondyla minutior* are diverse. Workers were found in leaf litter under a date palm tree where the soil was moist and rich in accumulations of domestic livestock waste. Several specimens were observed foraging in leaf litter on a mountainside near a drainage where the soil was moist and supported diverse plant cover but was dominated by *Adiantum capillus-veneris* L. (Pteridaceae). A number of workers were found foraging in dry leaf litter under a small *Fagonia* tree (Zygophyllaceae). Several workers were found nesting in the moist basal leaves of a date palm tree trunk where hundreds of *Hypoponera punctatissima* (Roger, 1859) workers co-occurred.

Monomorium Mayr
***Monomorium atomum* Forel, 1902a**
(Figure 11(a–c))

Monomorium (Martia) atomus Forel, 1902a: 210 (w.) India. Indomalaya.

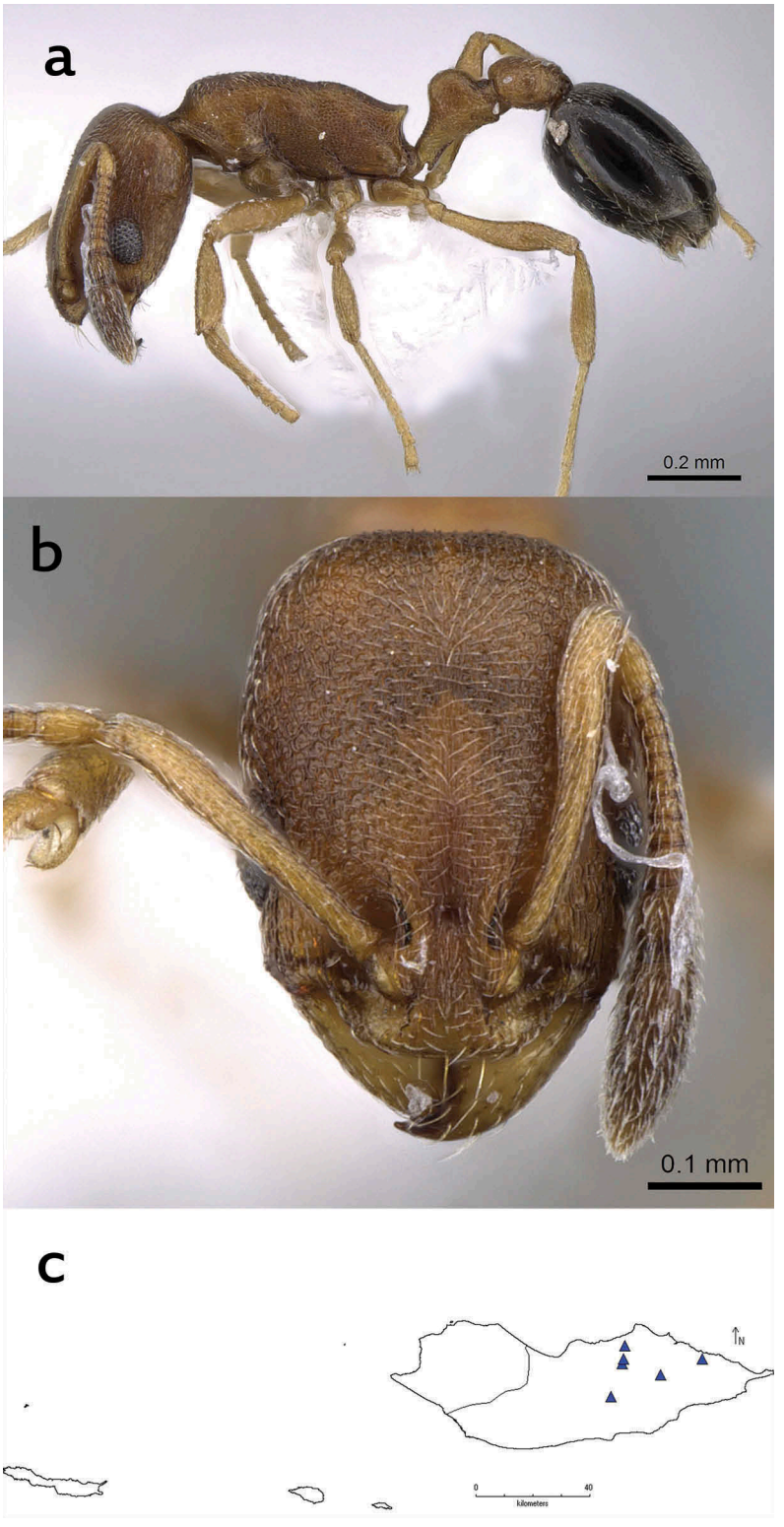

Figure 10. *Cardiocondyla minutior*. (a) Body in profile. (b) Head in full-face view, CASENT0746617, AntWeb.org, (Zach Lieberman). (c) Distribution map from recent records.

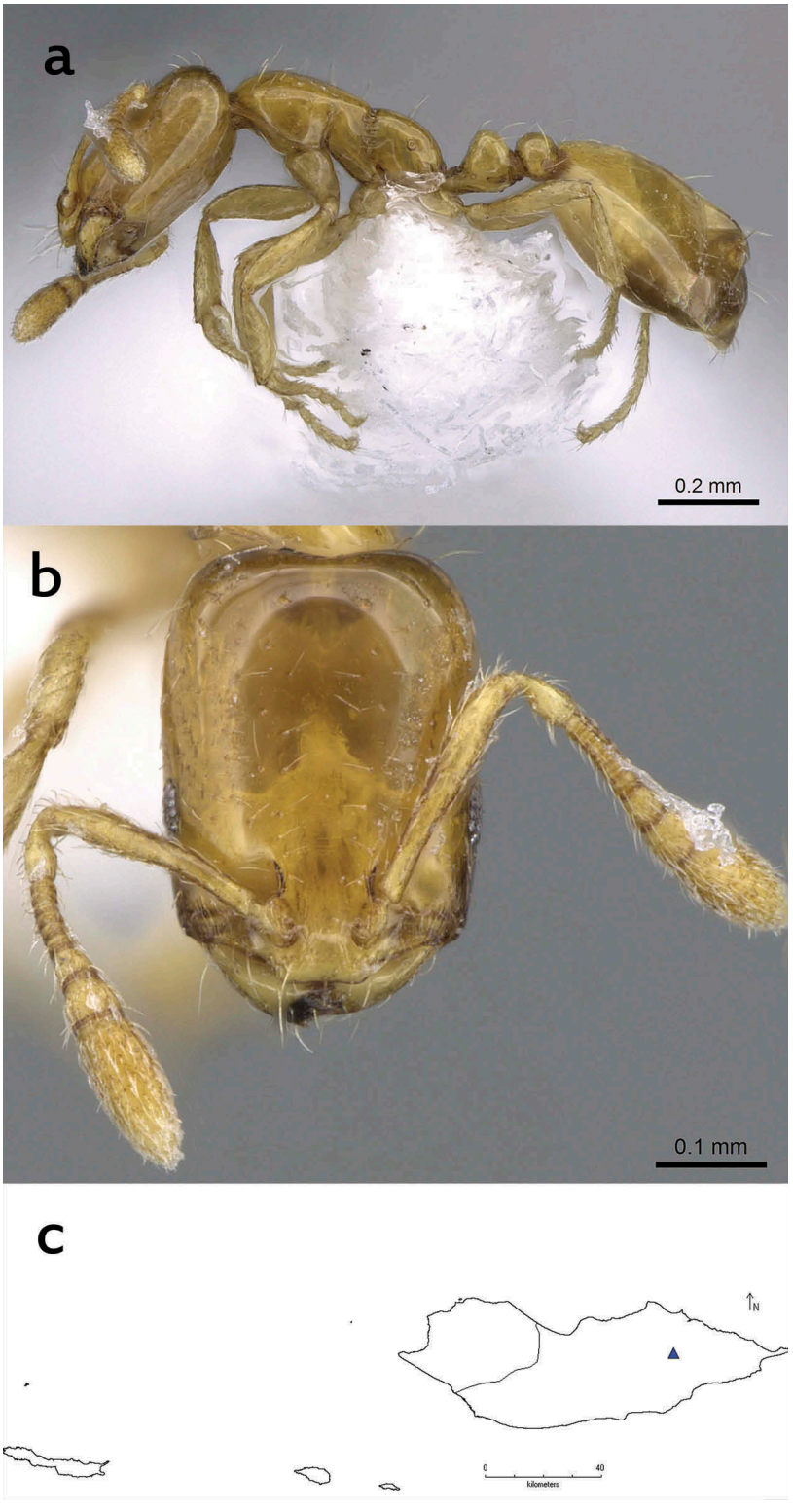

Figure 11. *Monomorium atomum*. (a) Body in profile. (b) Head in full-face view, CASENT0746615, AntWeb.org, (Zach Lieberman). (c) Distribution map from recent records.

Diagnosis

Worker. Small species (TL 1.20–1.30). Head distinctly longer than broad, feebly convex or parallel sides and feebly concave posterior margin; eyes small with four or five ommatidia in the longest row; petiole peduncle in profile short and without anteroventral process. Body smooth and shining. Colour uniform yellow.

Material examined

Yemen, Socotra Island, W. Jo'o, 21 April 2014, 196 m, (M.R. Sharaf leg.), 12.54038°N, 54.17186°E (1 w, KSMA).

Geographic range

India (Forel 1902a). This species is recorded for the first time from Socotra Archipelago Island.

Ecological and biological notes

This species was found in humid leaf litter under a date palm tree where the soil was rich in accumulations of decayed animal faeces.

Monomorium dichroum Forel, 1902a

(Figure 12(a–c))

Monomorium dichroum Forel, 1902a: 212 (w. q.) India. Indomalaya. Imai, Baroni Urbani, *et al.*

Diagnosis

Worker caste of this species can be confused with the cosmopolitan species *Monomorium pharaonis* (L., 1758) but it can be separated by the finely longitudinally striated head, the smooth first gastral tergite, and the dark patches in front of the eyes.

Material examined

Yemen, Socotra Island, Himihil Protectorate, 23 April 2014, 330 m, (M.R. Sharaf leg.), 12.58204°N, 54.29057°E (1 w, KSMA, 1 w, CASC).

Geographic range

This species was described from India (Forel 1902a) and is recorded here for the first time from the Socotra Archipelago.

Ecological and biological notes

This species was collected from a banana farm where the soil was moist and rich in decaying livestock faeces. Several pselaphine beetles were also observed in the same habitat.

Monomorium elghazalyi Sharaf & Aldawood, sp. nov.

(Figure 13(a–c))

Holotype worker

Yemen, Socotra Island, Haydibo, Erheno, 12.65023°N, 54.04016°E, 33 m, 19 April 2014, (M.R. Sharaf leg.) (CASENT0822346) (KSMA).

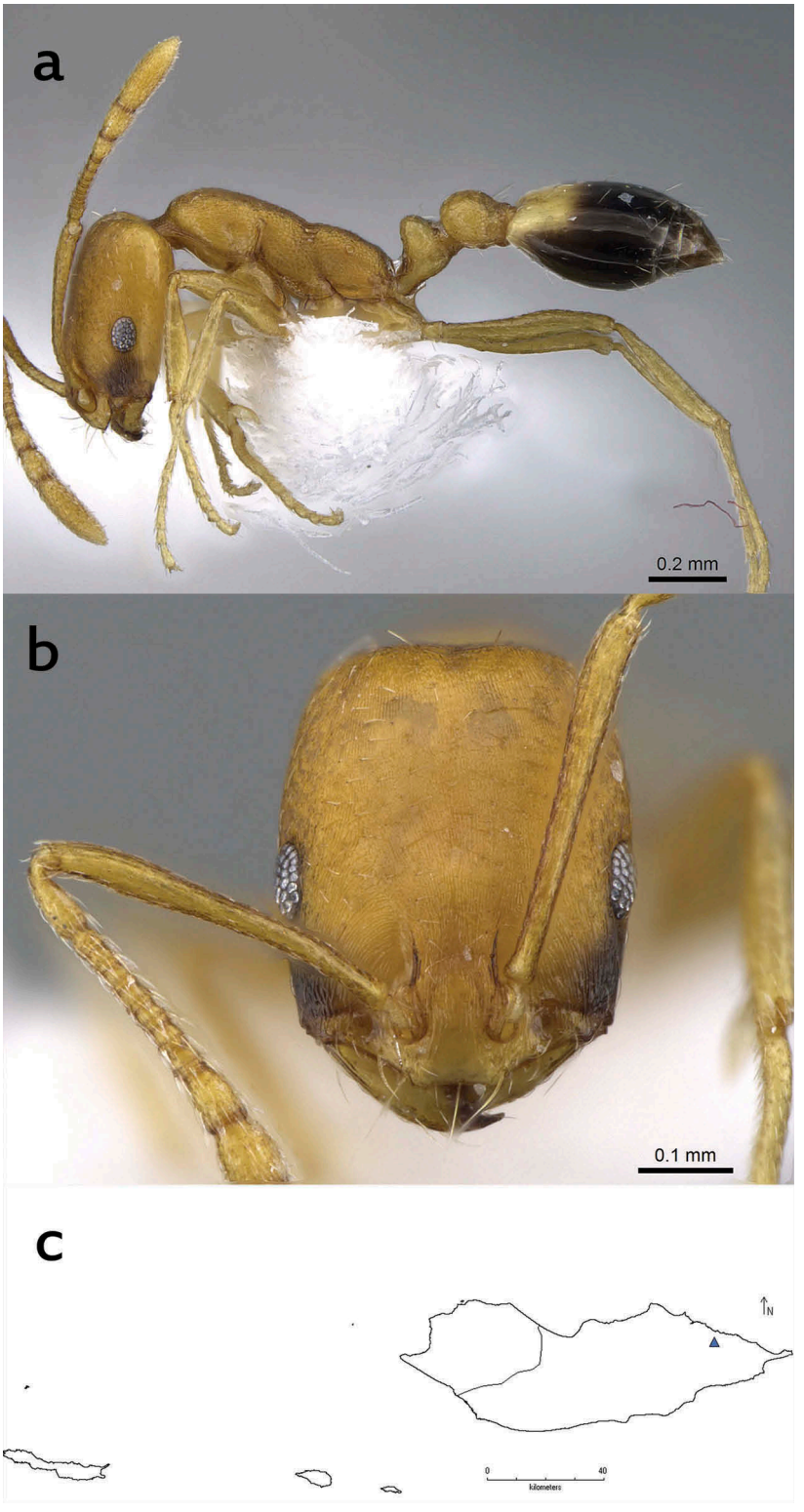

Figure 12. *Monomorium dichroum*. (a) Body in profile. (b) Head in full-face view, CASENT0746622, AntWeb.org, (Zach Lieberman). (c) Distribution map from recent records.

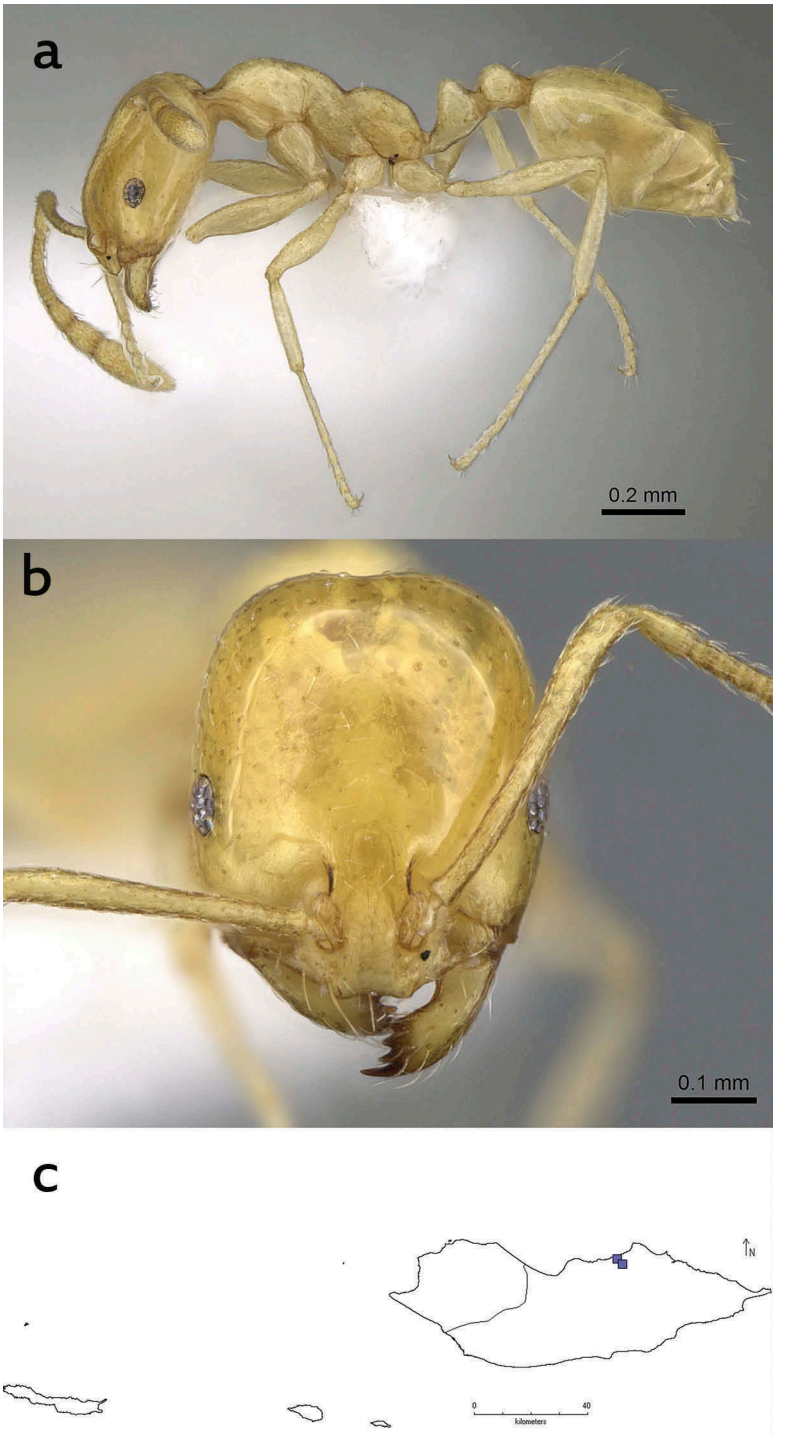

Figure 13. *Monomorium elghazalyi* sp. nov., Paratype worker. (a) body in profile. (b) Head in full-face view, CASENT0746626, AntWeb.org, (Michele Esposito). (c) Distribution map.

Paratype workers

Yemen, Socotra Island, W. Sakhalof, 12.63311°N, 54.05632°E, 48 m, 27 April 2014, (M.R. Sharaf leg.), (3 w, KSMA); Yemen, Socotra Island, W. Ayhift, 12.61155°N, 53.97755°E, 198 m, 20 April 2014, (M.R. Sharaf leg.), (CASENT 0746626) (1 w, CASC); Yemen, Socotra Island, Haydibo, Erheno, 12.65023°N, 54.04016°E, 33 m, 19 April 2014, (M.R. Sharaf leg.) (14 w, KSMA).

Description

Head. Head in full-face view longer than broad (CI 73–86) with shallowly convex sides and feebly concave posterior margin; anterior clypeal margin shallowly concave between a pair of low, broad, blunt teeth; clypeal carinae feebly developed, widely separated and subparallel; maximum diameter of eyes 0.19 × HW and with six ommatidia in the longest row; with head in full-face view the posterior margins of eyes at midlength of lateral sides; antennae 12-segmented; scapes, when laid back from their insertions, just reach posterior margin of head; masticatory margin of mandibles armed with four teeth. *Mesosoma*. Mesosoma in profile with promesonotum evenly convex and sloping abruptly posteriorly to the strongly and broadly impressed metanotal groove; propodeal dorsum in profile high and followed by long, shallow, convex curve which slopes posteriorly to propodeal declivity; propodeal spiracle small and pinhole-like, located at midline of the upper half of propodeum. *Petiole*. Petiolar node high and narrow in profile, cuneate, very narrowly rounded above; subpetiolar process absent. *Postpetiole*. Postpetiolar node lower than postpetiolar node in profile and nearly hexagonal in shape in dorsal view; postpetiolar dorsum in profile distinctly more broadly rounded than petiole. *Pilosity*. Cephalic dorsum with short scattered hair-pits; underside of head with two or three short hairs; anterior clypeal margin and mandibles with long hairs; antennae and legs with appressed pubescence; mesosoma without hairs (with no indication of abrasion in all specimens), only sparse appressed pubescence; petiole and postpetiole each with a single pair of hairs; gaster with several pairs of hairs. *Sculpture*. Overall smooth and glossy. Mesopleura, propodeum, petiole and postpetiole finely punctate. *Colour*. yellow, mesosomal dorsum, petiole, postpetiole and first gastral tergite whitish yellow.

Measurements of holotype worker

EL 0.08; HL 0.48; HW 0.41; ML 0.53; PH 0.14; PL 0.09; PPH 0.11; PPL 0.09; PPW 0.12; PRW 0.24; PW 0.09; SL 0.42; TL 1.88; CI 85; SI 102.

Measurements of paratype workers

EL 0.07–0.08; HL 0.48–0.53; HW 0.36–0.42; ML 0.46–0.59; PH 0.12–0.14; PL 0.08–0.14; PPH 0.09–0.12; PPL 0.07–0.11; PPW 0.09–0.12; PRW 0.21–0.26; PW 0.08–0.11; SL 0.38–0.44; TL 1.76–2.20; CI 73–86; SI 97–117 (n = 17).

Geographic range

Type locality: Socotra Island.

Differential diagnosis

This new species is a member of the *Monomorium salomonis*-group as defined by Bolton (1987), but will not key in Bolton's (1987) study of the Afrotropical *Monomorium*. It appears similar to *Monomorium rotundatum* Santschi, 1920 described from South Africa in colour and body size. *Monomorium elghazalyi* can be readily separated by the concave anterior clypeal margin, the longer antennal scapes (SI 97–117), the absence of erect hairs on mesosoma, the clearly convex promesonotum, the deeply and broadly impressed metanotal groove, the reticulate-punctate mesopleuron and propodeal dorsum. Whereas *Monomorium rotundatum* has a transverse, or shallowly convex anterior clypeal margin, a shorter antennal scape (SI 79–83), four or five pairs of hairs on the promesonotum, and a single pair on propodeum, a shallowly convex promesonotum profile, a weakly impressed metanotal groove, and a smooth unsculptured body.

Superficially, *Monomorium elghazalyi* also appears closest to *Monomorium tumaire* Collingwood & Agosti, 1996 from KSA but *Monomorium elghazalyi* can be recognized by the smaller eyes composed of six ommatidia in the longest row, the uniform yellow colour, and the lack of the ammochaeta psammophore. *Monomorium elghazalyi* is a distinctive member of the Arabian *Monomorium* fauna as it is the first unicolorous yellow species of the *Monomorium salomonis*-group known from the Arabian Peninsula.

Etymology

A patronymic (*Monomorium elghazalyi*) was chosen to honour the late Egyptian Islamic writer Mohammed Elghazaly (1917–1996).

Ecological and biological notes

The type series of the new species was found nesting in moist soil under a rock next to a date palm tree. The other nest series was collected from Wadi Sakhalof, where it was found foraging in very dry soil rich in decaying goat faeces under a date palm tree. It seems likely that the species may be endemic to Socotra.

Monomorium exiguum Forel, 1894
(Figure 14(a–c))

For full synonymy see Heterick (2006), pp.115–116.

Monomorium exiguum Forel, 1894: 85. (Lectotype worker) Ethiopia. Afrotropical. 'Ethiopia, Sudabessinien.' (MHNG), http://www.antweb.org/specimen/CASENT0101870 [Image of type specimen examined].

Monomorium baushare Collingwood & Agosti, 1996: 342 (w.) Oman. Palaearctic. (WMLC), http://www.antweb.org/specimen/CASENT0906343. Syntype worker [examined], Syn. nov.

Monomorium qarahe Collingwood & Agosti, 1996: 353 (w.) KSA. Afrotropical (WMLC), http://www.antweb.org/specimen/CASENT0906344. Syntype worker [examined], Syn. nov.

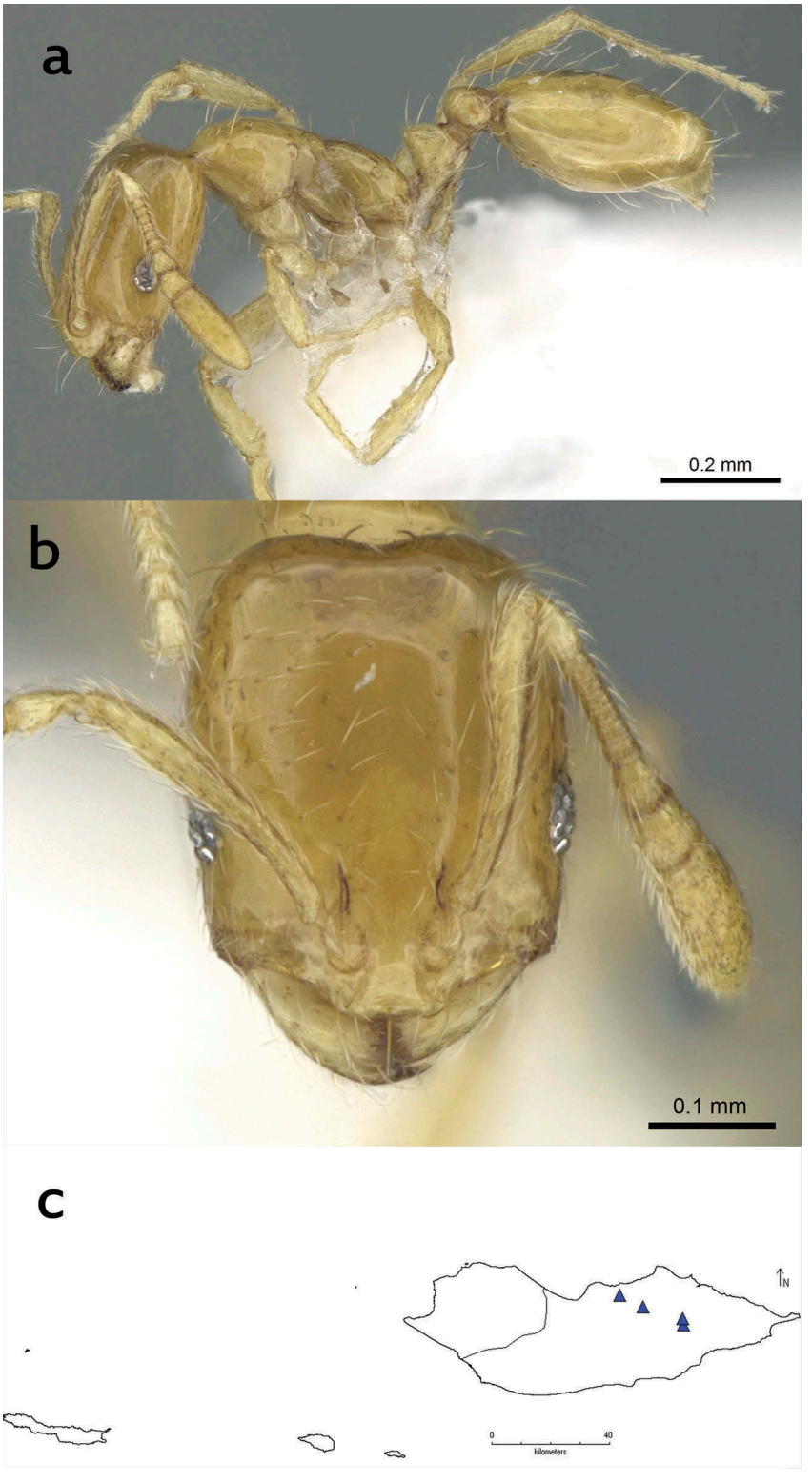

Figure 14. *Monomorium exiguum*. (a) Body in profile. (b) Head in full-face view, CASENT0906390, AntWeb.org, (Estella Ortega), KSA. (c) Distribution map from recent records.

Diagnosis

Worker. Eyes small, with six ommatidia in the longest row; promesonotum convex in profile; metanotal groove impressed; pronotum with a single pair of erect hairs at the humeri. Colour uniform yellow to pale yellowish brown; posterior margin of first gastral tergite, lateral sides and remaining tergites, usually darker than disc of first tergite.

Material examined

Yemen, Socotra Island, Deyishil village, 21 April 2014, 180 m, (M.R. Sharaf leg.), 12.52010° N, 54.17438°E (2 w, KSMA); Yemen, Socotra Island, W. Jo'o, 21 April 2014, 196 m, (M.R. Sharaf leg.), 12.54038°N, 54.17186°E (5 w, KSMA); Yemen, Socotra Island, W. Ayhift, 20 April 2014, 38 m, (M.R. Sharaf leg.), 12.61064°N, 53.97672°E (12 w, 1 q, KSMA); Yemen, Socotra Island, Lehanoh, 22 April 2014, 931 m, (M.R. Sharaf leg.), 12.57583°N, 54.04836°E (1 w, KSMA); Yemen, Socotra Island, W. Jo'o, 21 April 2014, 196 m, (M.R. Sharaf leg.), 12.54038°N, 54.17186°E (1 w, CASC).

Note

Collingwood and Agosti (1996) described *Monomorium baushare* from Oman and Yemen, and *Monomorium qarahe* from KSA based on the worker castes. Comparison of type material of both species with that of *Monomorium exiguum* indicates the above synonymy.

Geographic range

This minute species belongs to the *Monomorium monomorium*-group and has been recorded from numerous countries in the Afrotropical region including Ivory Coast, Nigeria, Cameroun, Gabon, Zaire, Ethiopia, Kenya and Zimbabwe (Bolton 1987). In the Mediterranean region it has been reported from the Balearic Islands (Gòmez and Espadaleer 2006) and Egypt (Sharaf 2006). *Monomorium exiguum* was recorded from the Asir Mountains, KSA by Aldawood and Sharaf (2009). This species is a new record for Socotra.

Ecological and biological notes

This tiny yellow species was found nesting under a stone next to a large fig tree and inside the galleries of a termite nest. The soil was dry with ample dry seeds. Another nest series was found in leaf litter next to a date palm tree where the soil was rich in decaying organic material.

Monomorium nimihil Collingwood, 2004
(Figure 15(a–c))

Monomorium nimihil Collingwood, 2004: 485, fig. 12 (w.) Yemen. Afrotropical. (Paratype examined]

Diagnosis

Worker. Head nearly square with feebly convex sides and strongly concave posterior margin; eyes large with 10–11 ommatidia in the longest row; mandibles sculptured; body pilosity abundant. Body colour uniform yellow.

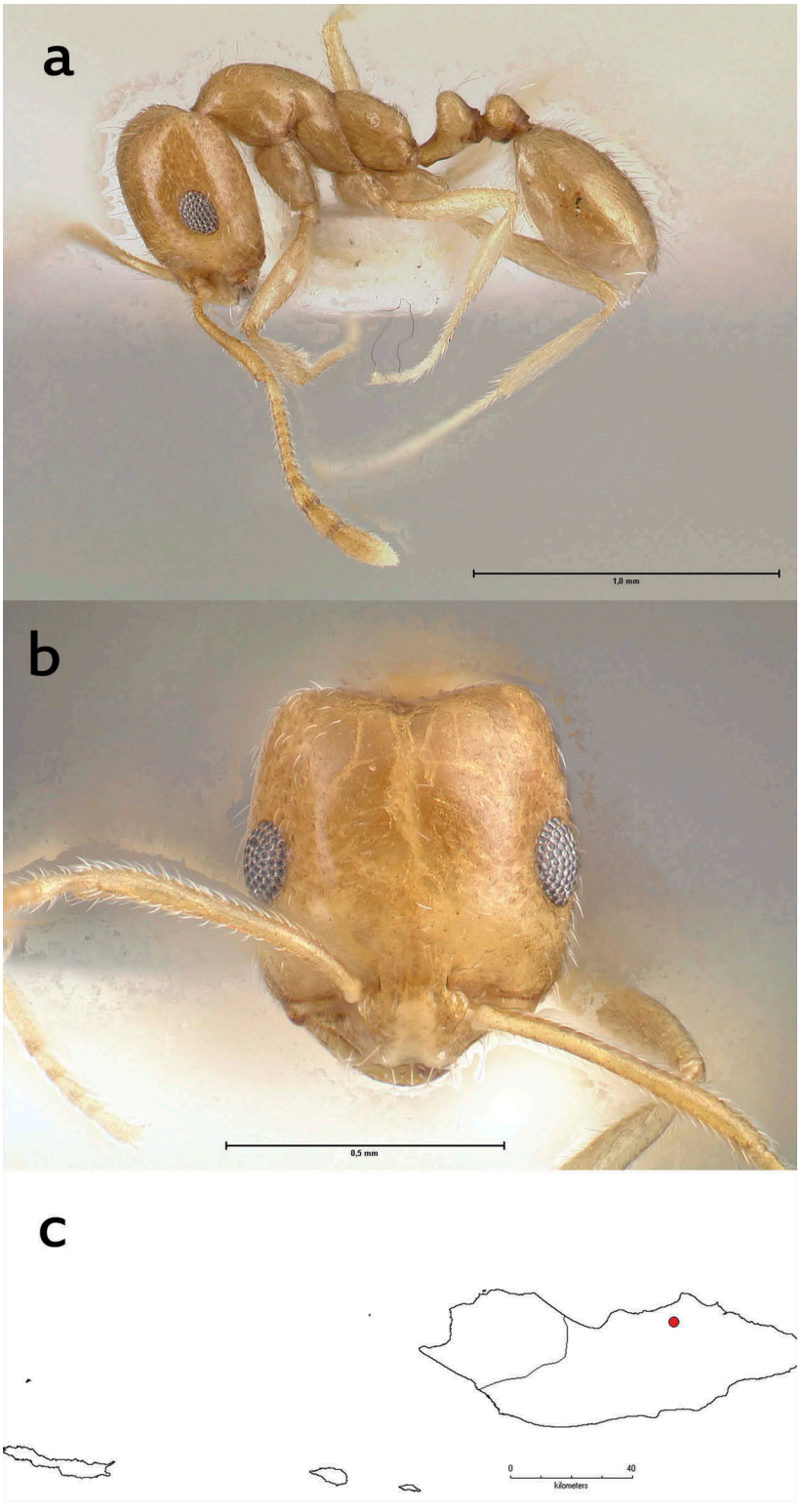

Figure 15. *Monomorium nimihil*. (a) Body in profile. (b) Head in full-face view, (Christiana Klingenberg, FoCol-Project). (c) Distribution map based on the record of Collingwood et al. (2004).

Geographic range

Monomorium nimihil is only known from the type locality, Wadi Daneghan, Socotra Island, 12.616667°N, 54.066667°E, and therefore is considered endemic. No new material was collected during the present study.

Ecological and biological notes

The species was reported from leaf litter under a fig tree, mostly *Ficus cordata* var. *salicifolia* (Vahl) next to a permanent stream (Collingwood et al. 2004).

Key to species of *Monomorium* of Socotra

(1) Dorsum of mesosoma without projecting hairs (Figure 16(a)) 2
Dorsum of mesosoma with projecting hairs (Figure 16(b))..... 3

(2) Colour yellow with the area in front of eyes and gaster except first third of first gastral tergite blackish brown (Figure 16(c)); metanotal groove shallowly impressed (Figure 16(c)); eyes larger with seven ommatidia in the longest row (EL 0.21 × HW); cephalic surface finely and distinctly longitudinally striated (Figure 16(d)); sides of head straight or feebly convex; postpetiole in dorsal view about 1.7 times broader than petiole width (India, Socotra)..... ***dichroum* Forel**
Unicolorous clear yellow; metanotal groove deeply impressed and broad (Figure 16 (e)); eyes smaller with five ommatidia in the longest row (EL 0.19 × HW); cephalic surface unsculptured smooth, and shining; lateral sides of head clearly convex; postpetiole in dorsal view about 1.2 times broader than petiole width (Socotra, Yemen)..... ***elghazalyi* sp. nov.**

(3) Pilosity abundant and clubbed; antennae with 12 segments; eyes large with 10–11 ommatidia in the longest row; mandibles sculptured (Socotra, Yemen)..... ***nimihil* Collingwood**
Pilosity few and simple; antennae with 11 segments; eyes smaller with four to six ommatidia in the longest row; mandibles unsculptured except for hair-pits, smooth and shining 4

(4) Petiole node nearly as long as broad in dorsal view; petiole peduncle in profile without anteroventral process (India, Bangladesh, Socotra)..... ***atomum* Forel**
Petiole about 1.5 times broader than long in dorsal view; petiole peduncle in profile with a small anteroventral process (Afrotropical and Mediterranean regions, Arabian Peninsula (KSA))..... ***exiguum* Forel**

Pheidole Westwood

Pheidole lamellinoda Forel, 1902a

(Figure 17(a–c))

Pheidole lamellinoda Forel, 1902a: 166 (s.), 186 (w. q. m.) India. [Also described as new by Forel, 1902b: 538.].

Diagnosis

Major worker. Anterior cephalic dorsum striated; posterior half smooth and shining; posterior margin of head strongly concave; eyes small with 10 ommatidia in the longest

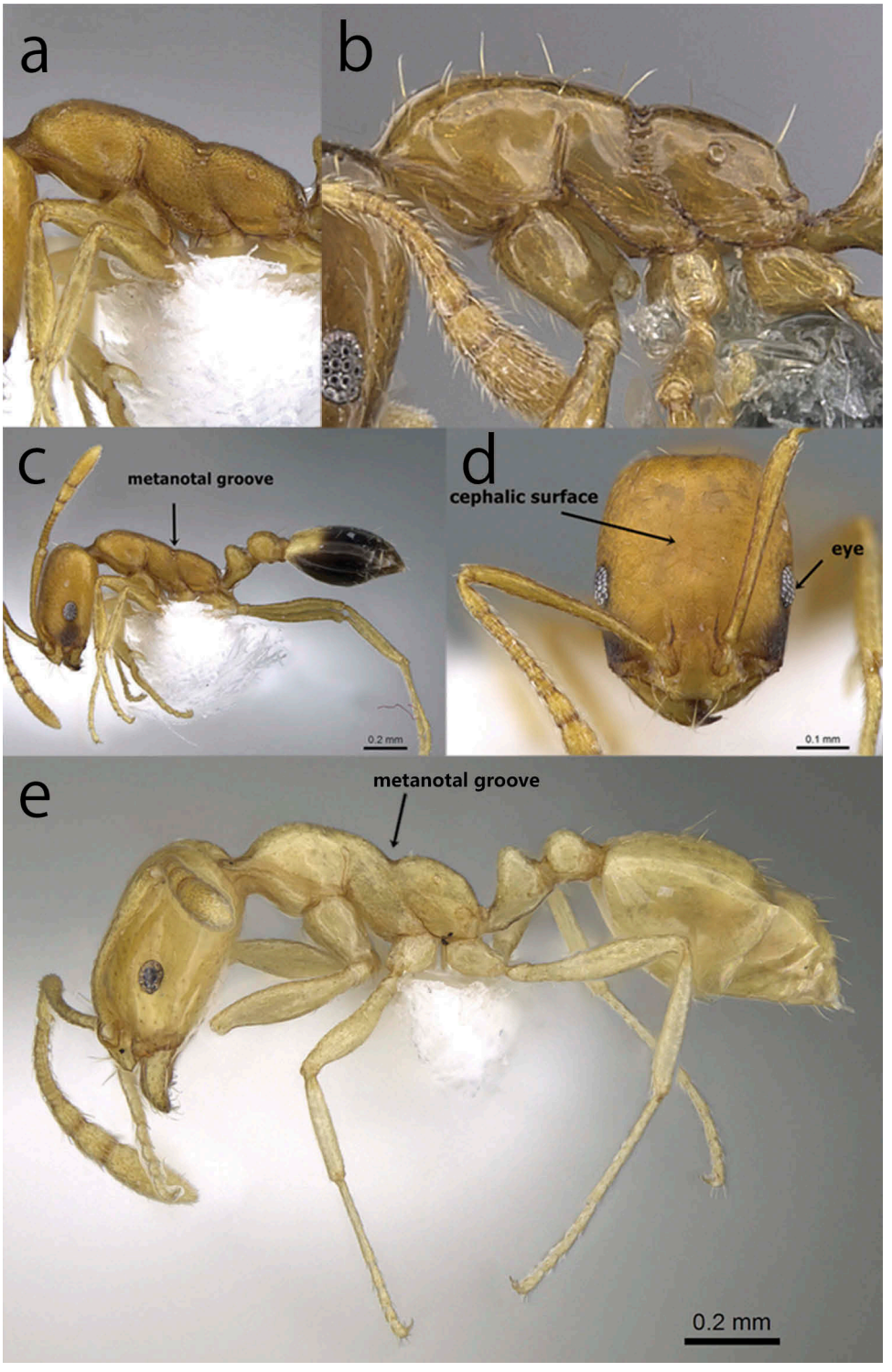

Figure 16. *Monomorium* key illustrations: (a) Mesosoma without hairs. (b) Mesosoma with hairs. (c) *M. dichroum*. (d) Head of *M. dichroum*. (e) Mesosoma of *M. elghazalyi* sp. nov. showing deeply impressed metanotal groove.

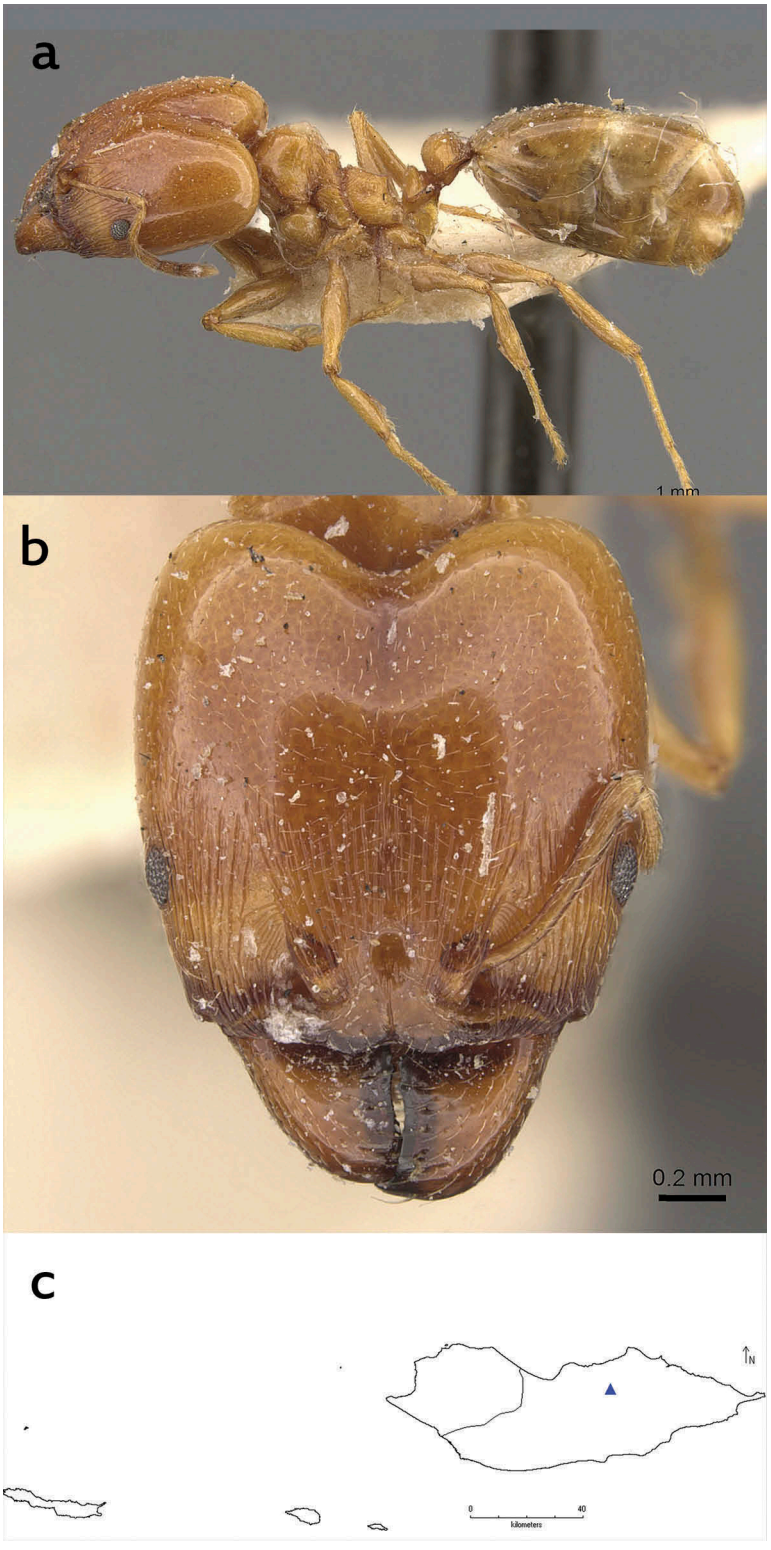

Figure 17. *Pheidole lamellinoda*. (a) Body in profile. (b) Head in full-face view, CASENT0907920, AntWeb.org, type (Will Ericson). (c) Distribution map from recent records.

row; metanotal groove a strongly depressed U-shape; propodeal spines short and acute; petiolar peduncle short; postpetiole massive and glabrous in profile and more than twice broader than long in dorsal view. Head reddish yellow, mesosoma, petiole and postpetiole yellow, gaster brownish yellow.

Geographic range

India (Forel 1902a) and Socotra (Collingwood et al. 2004).

Ecological and biological notes

No ecological or biological information is available.

Pheidole pallidula (Nylander, 1849)

Myrmica pallidula Nylander, 1849: 42 (w.) Italy (Sicily). Palaearctic.

Diagnosis

Major worker. TL 3.4–3.9; Head in full-face view subrectangular with moderately deeply impressed posterior margin; clypeus smooth and shining with weak median longitudinal carina; frontal carinae short and feebly divergent; antennae elongate; eyes small and weakly circular; hypostoma with a pair of large lateral teeth; mesosoma in profile with a slightly domed promesonotum; metanotal groove impressed; propodeal spines with small triangular teeth. In profile, petiole with a relatively short pedicel; postpetiole small and globular; gaster distinctly smaller than head; pilosity long, fine and abundant. Body shining; sculpture absent except for fine longitudinal striations on anterior one-third of head. Colour overall pale yellowish brown, mandibles dark brown.

Material examined

Socotra (no specific locality), September 1999 (W. Wranik leg.) (1 major worker, WMLC).

Geographic range

Pheidole pallidula has a broad distribution in the Mediterranean region (Bernard 1983) and has been recorded from the Iberian Peninsula (Espadaler 1986). Our collections represent a new record for Socotra Island.

Ecological and biological notes

No ecological or biological information is available.

Pheidole indica **Mayr, 1879**

(Figure 18(a–c))

Pheidole indica Mayr, 1879: 679 (s.w.q.) India. Indomalaya.

Diagnosis

Major worker. Cephalic dorsum with oblique longitudinal rugae posteriorly, curved toward posterolateral lobes; promesonotal process prominent and well-developed; metanotal groove shallow in profile; postpetiole in dorsal view trapezoidal with rounded

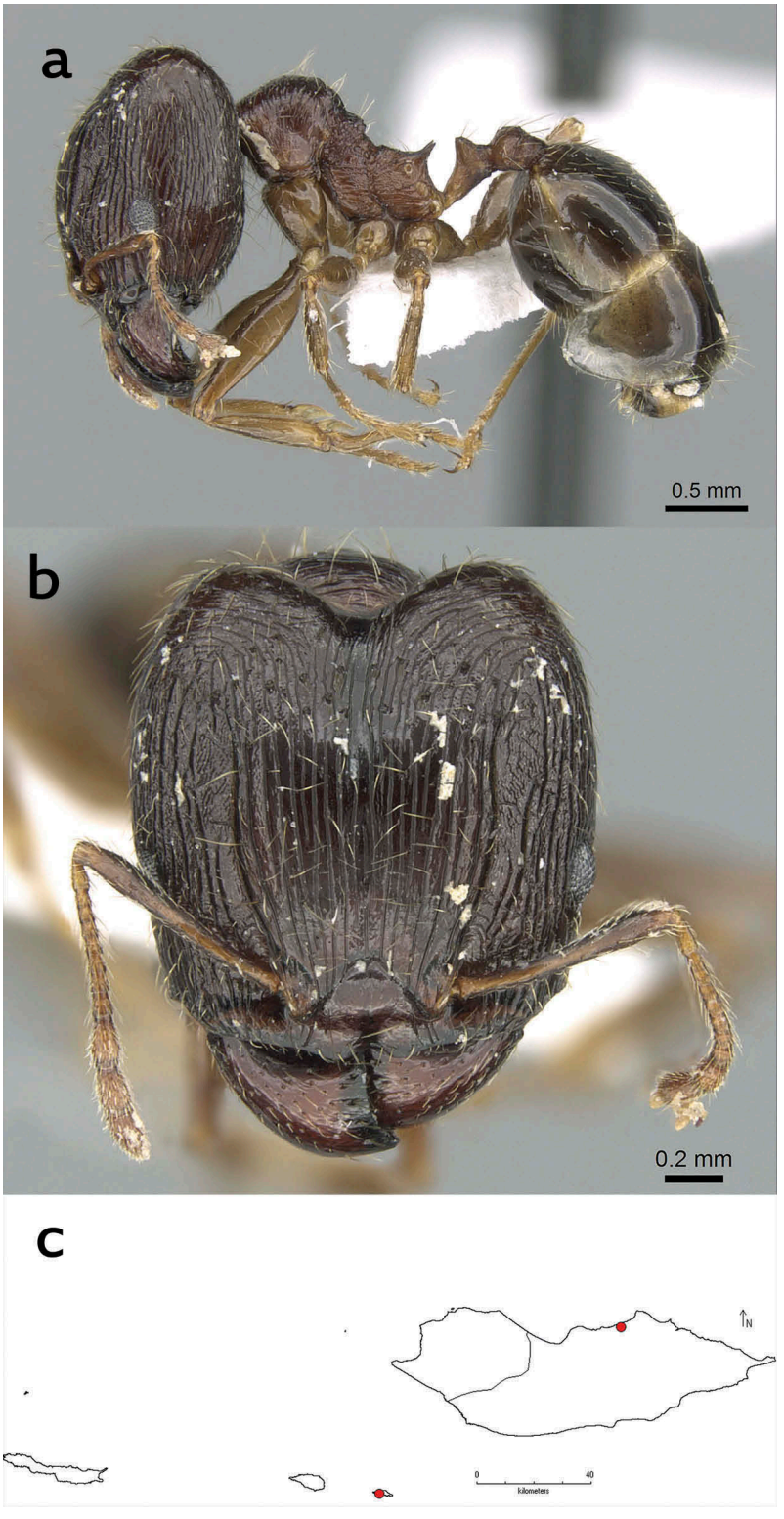

Figure 18. *Pheidole indica*. (a) Body in profile. (b) Head in full-face view, CASENT0906401, AntWeb.org, (Estella Ortega), KSA. (c) Distribution map from Collingwood et al. (2004).

lateral corners; postpetiole 1.9–2.5 times broader than petiole in dorsal view; postpetiolar ventral process reduced.

Geographic range

A successful invasive species originally described from India and recorded from the Canary Islands (Espadaler and Bernal 2003) and broadly distributed in several regions of the world, including the Arabian Peninsula (Collingwood 1985; Collingwood and Agosti 1996), the Mediterranean region, West Indian islands, the Malagasy region and the New World, with many scattered records in several continents (Fischer and Fisher 2013).

Ecological and biological notes

This species prefers drier habitats (Wetterer 2011) and urban areas (Collingwood et al. 1997; Gòmez and Espadaleer 2006). It was observed to be aggressive toward other ant species in the same habitats (Collingwood 1985) with a negative impact on local native ants, e.g. *Pheidole sinaitica* Mayr, 1862 (Collingwood, personal communication).

Syllophopsis Santschi
Syllophopsis cryptobia (Santschi, 1921)
(Figure 19(a–c))

Monomorium cryptobium Santschi, 1921: 119, fig. 2 (w.) Democratic Republic of Congo. Afrotropic.

Heterick, 2006: 162 (q.). Combination in *Monomorium*: Bolton, 1987: 421; in *Syllophopsis*: Ward, Brady, Fisher & Schultz, 2015: 13.

Diagnosis

Worker. Eyes minute and consisting of a single ommatidium, located in front of midlength of head; promesonotum in profile with its dorsal outline evenly convex, not strongly dome-shaped; metanotal groove deeply and distinctly impressed in a U-shape; highest point of propodeum immediately behind the metanotal groove, without a sharp central peak or narrow transverse crest; propodeal dorsum meeting declivity with a small dent; body smooth and shining except for cross-ribbing at mesopleural–propodeal junction; all body surfaces covered with sparse, fine hairs, cephalic and gastral pilosity denser than mesosomal pilosity; uniform clear yellow, first gastral tergite light brown, some specimens pale brown-yellow.

Measurements of workers

EL 0.02; HL 0.42–0.48; HW 0.31–0.39; ML 0.49–0.55; PH 0.12–0.14; PL 0.11–0.15; PPH 0.09–0.12; PPL 0.07–0.09; PPW 0.11–0.14; PRW 0.17–0.28; PW 0.09–0.14; SL 0.31–0.38; TL 1.64–2.14; CI 69–87; SI 89–106 (N = 16).

Material examined

Yemen, Socotra Island, Dehejamo, 12.59049°N, 54.05205°E, 563 m. 22 April 2014, (M.R. Sharaf Leg.) (16 workers, KSMA, 1 w, CASC).

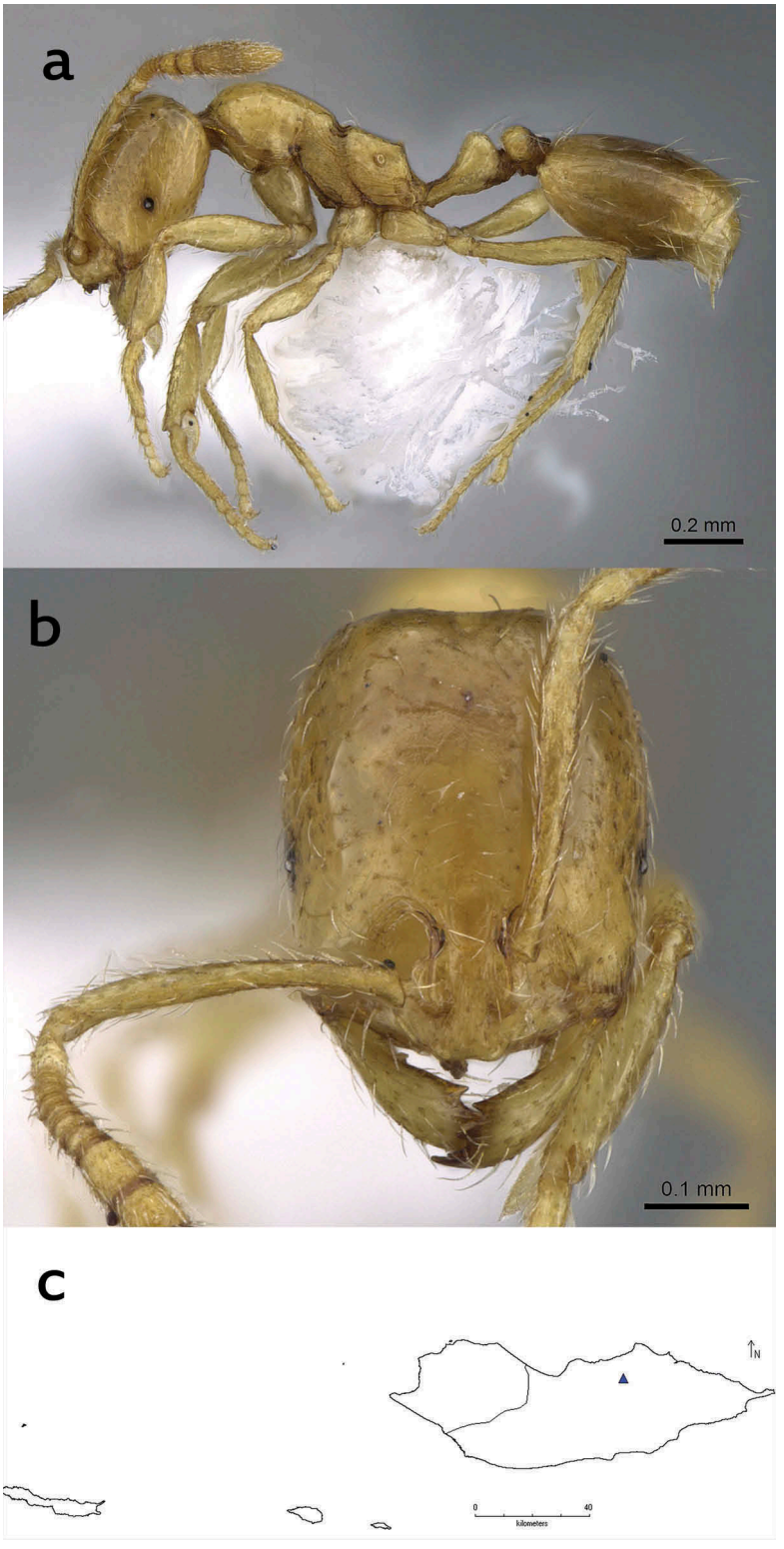

Figure 19. *Syllophopsis cryptobia*. (a) Body in profile. (b) Head in full-face view, CASENT0746603, AntWeb.org, (Zach Lieberman). (c) Distribution map.

Geographic range

This species is originally described from Democratic Republic of Congo and is widespread throughout the forests of west and central Africa (Bolton 1987). It is recorded for the first time from Socotra Archipelago.

Ecological and biological notes

Workers of *Syllophopsis cryptobia* were found on a mountainside near former drainage of the mountain crest. The area has a high plant diversity dominated by *Adiantum capillus-veneris* L. (Pteridaceae). This species was collected from leaf litter using a sifting tray where the soils were moist. This ant was found coexisting with *Brachyponera sennaarensis*. In Africa, this species has been report to be abundant in layers of topsoil and leaf litter (Bolton 1987).

Tetramorium Mayr
Tetramorium caldarium (Roger, 1857)
(Figure 20(a–c))

Tetrogmus caldarius Roger, 1857: 12 (w. q.) Poland. Palaearctic.

Diagnosis

Worker. Anterior clypeal margin entire; frontal carinae well-developed, reaching back to posterior level of eyes and more feeble behind eyes than in front; antennal scrobes less-developed or indistinct; eyes with seven or eight ommatidia in the longest row; propodeal spines small, triangular and acute; cephalic dorsum feebly and finely longitudinally rugulose. Body pilosity short, stout and blunt. Colour yellow or yellowish brown, gaster brown or blackish brown.

Geographic range

A successful invasive species with an African origin (Bolton 1980), widely distributed worldwide by human commerce (Wetterer and Hita Garcia 2015). In the Arabian Peninsula, this species has more successfully dispersed into undisturbed areas than *Tetramorium simillimum*, but is also known to become established in greenhouses. Wetterer and Hita Garcia (2015) have indicated that colonies of *Tetramorium caldarium* are successful in establishing colonies in greenhouses and heated buildings in temperate regions.

Ecological and biological notes

In India, this species is commonly found in disturbed regions with increased anthropogenic activities (Bharti and Kumar 2012), whereas in tropical and subtropical regions, populations are associated with greenhouses, zoos and heated buildings (Bolton 1980).

Tetramorium lanuginosum Mayr, 1870
(Figure 21(a–c))

Tetramorium lanuginosum Mayr, 1870: 976 (w.) Indonesia (Java). Indomalaya.

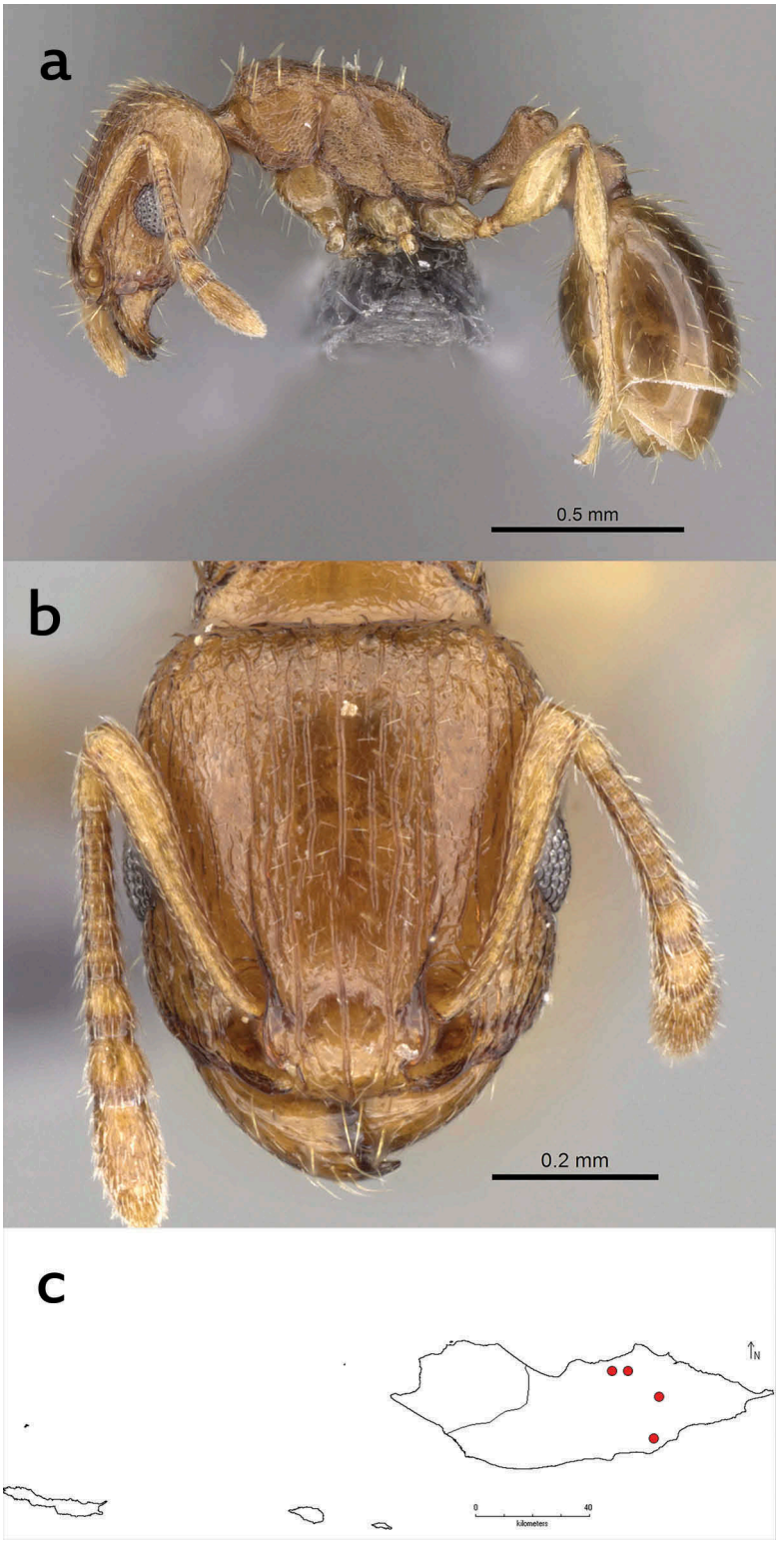

Figure 20. *Tetramorium caldarium*. (a) Body in profile. (b) Head in full-face view, CASENT0264195, AntWeb.org, (Estella Ortega), KSA. (c) Distribution map from Collingwood et al. (2004).

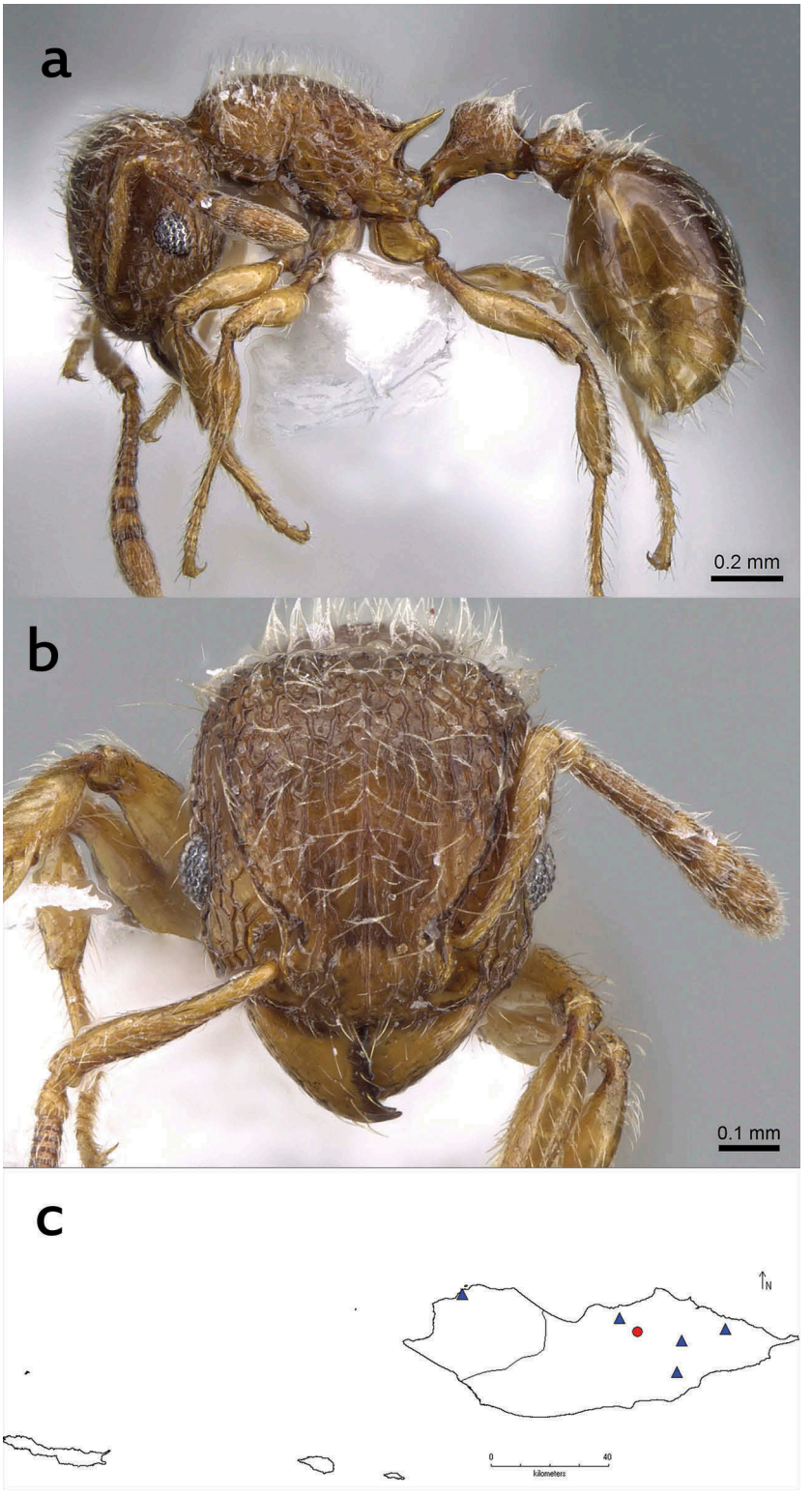

Figure 21. *Tetramorium lanuginosum*. (a) Body in profile. (b) Head in full-face view, CASENT0746619, AntWeb.org, (Zach Lieberman). (c) Distribution map, blue triangles from recent records, red circles from Collingwood et al. (2004).

Diagnosis

Worker. Head longer than broad with reticulate-rugose sculpture; anterior clypeal margin with small median impression; frontal carinae strongly developed; antennal scrobes well-developed with distinct margins; eyes of moderate size with 8–10 ommatidia in longest row; mesosoma convex in profile; metanotal groove absent; propodeal spines long and sharp; petiolar node rounded in profile; gaster smooth and shiny. Body pilosity profuse and relatively long, bifid and simple hairs. Body colour variable from pale brown to dark brown, gaster darker than body.

Material examined

Yemen, Socotra Island, Qalansyia, 25 April 2014, 26 m, (M.R. Sharaf leg.), 12.68401°N, 53.49052°E (5 w, KSMA); Yemen, Socotra Island, W. Ayhift, 20 April 2014, 214 m, (M.R. Sharaf leg.), 12.60970°N, 53.97770°E (6 w, KSMA); Yemen, Socotra Island, Himihil Protectorate, 23 April 2014, 372 m, (M.R. Sharaf leg.), 12.57615°N, 54.30651°E (9 w, KSMA); Yemen, Socotra Island, W. Jo'o, 21 April 2014, 196 m, (M.R. Sharaf leg.), 12.54038°N, 54.17186°E, (6 w, KSMA); Yemen, Socotra Island, W. Feriho (daitab), 21 April 2014, 93 m, (M.R. Sharaf leg.), 12.44103°N, 54.15576°E (13 w, KSMA).

Geographic range

A cosmopolitan species widely distributed in tropical and subtropical regions of Asia, Australia, Oceania (Wetterer 2010; Hita Garcia and Fisher 2011), KSA (Collingwood and Agosti 1996) and Socotra (Collingwood et al. 2004).

Ecological and biological notes

Tetramorium lanuginosum is one of the most successful ants occurring on the main island and has varied nesting habitats. A nest was found under the trunk of a fallen, dead palm tree where the soil was moist and rich in decaying organic material. Individuals were collected from dry soil next to a date palm tree. Several specimens were observed foraging on the ground where the soil was moist. Other workers were found foraging on the ground near a small flowing stream where the soil was sandy and moist. This species seems likely to have been introduced to Socotra through commerce.

Tetramorium pauper Forel, 1907
(Figure 22(a–c))

Tetramorium pauper Forel, 1907:14 (w.) Kenya. Afrotropical.

Diagnosis

Worker. Anterior clypeal margin lacking a median notch; frontal carinae very short, ending just behind frontal lobes; antennal scrobes absent; eyes distinctly small with four ommatidia in the longest row; propodeum armed with reduced acute tubercles; cephalic dorsum superficially sculptured; body pilosity short, stout and blunt. Colour uniform yellowish brown or pale brown.

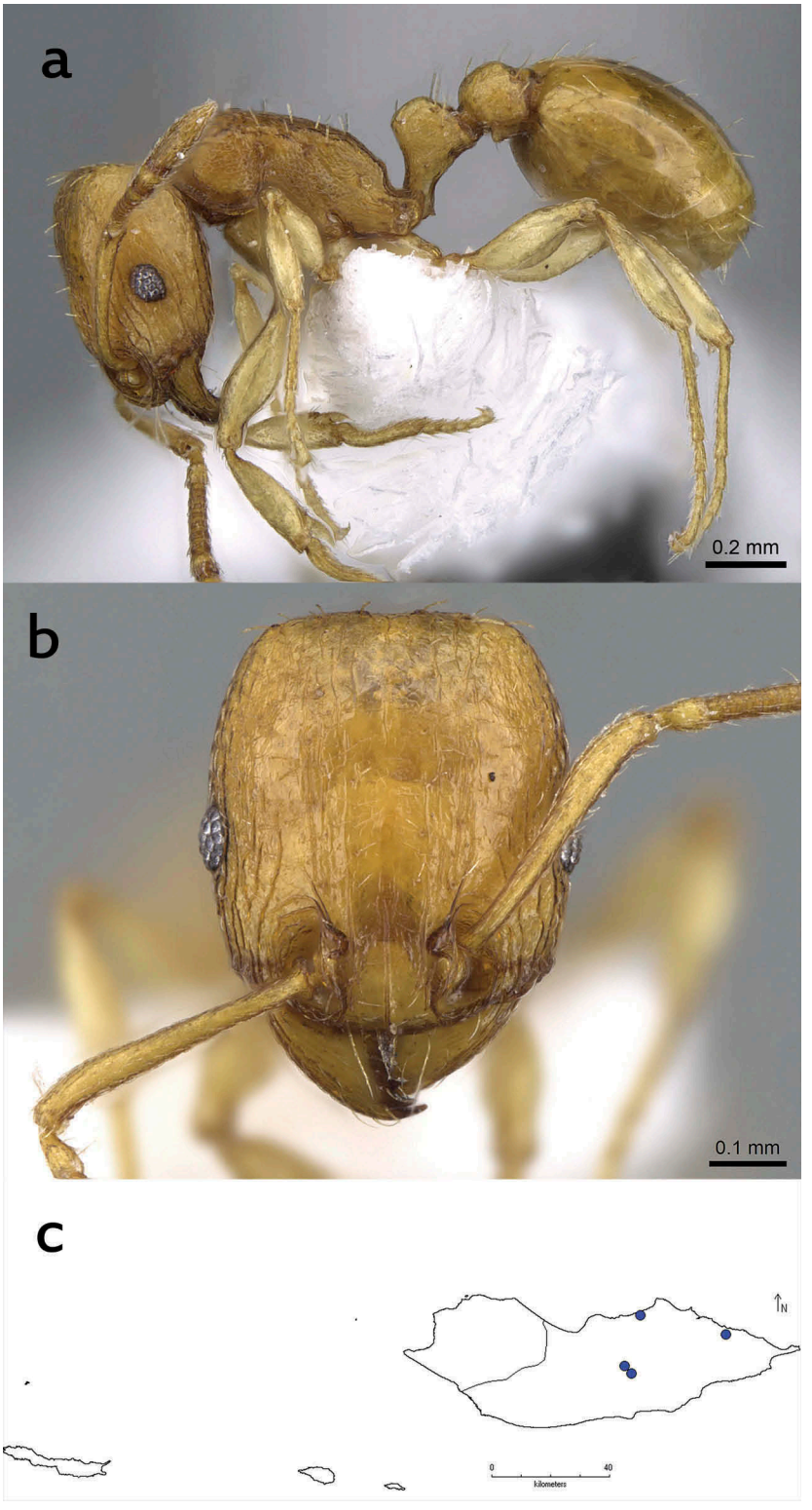

Figure 22. *Tetramorium pauper*. (a) Body in profile. (b) Head in full-face view, CASENT0746628, AntWeb.org, (Zach Lieberman). (c) Distribution map from recent records.

Material examined

Yemen, Socotra Island, Dixam (W. Zereg), 24 April 2014, 279 m, (M.R. Sharaf leg.), 12.46868°N, 54.01091°E (3 w, KSMA); Yemen, Socotra Island, Dixam, 24 April 2014, 656 m, (M.R. Sharaf leg.), 12.49320°N, 53.99145°E (3 w, KSMA); Yemen, Socotra Island, Himihil Protectorate, 23 April 2014, 355 m, (M.R. Sharaf leg.), 12.58954°N, 54.30570°E (1 w, KSMA); Yemen, Socotra Island, Haydibo, Erheno, 19 April 2014, 33 m, (M.R. Sharaf leg.), 12.65023°N, 54.04016°E (20 w, KSMA).

Geographic range

A species originally described from Kenya and recorded for the first time from Socotra Island.

Ecological and biological notes

Tetramorium pauper was found nesting inside a small decayed twig. The soil was moist due to irrigation of the date palm orchard. Several workers were nesting under a rock. A nest series was collected from a dry leaf litter next to a date palm tree using a sifting tray.

Tetramorium simillimum (Smith, 1851)
(Figure 23(a–c))

Myrmica simillima Smith, 1851: 118 (w.) Great Britain. Palaearctic.

Diagnosis

Worker. Frontal carinae long and strongly developed, running back unbroken to posterior margin of head and out curving posteriorly; antennal scrobes well-developed forming distinct concavity on each side between frontal carinae and eyes; propodeal spines, short, triangular, and acute; cephalic dorsum finely and densely irregularly longitudinally rugulose; scrobal surface densely reticulate-punctate; body pilosity short, stout and blunt. Colour yellow to yellowish brown, gaster dark brown.

Material examined

Yemen, Socotra Island, Qalansyia, w. Taisoh, 25 April 2014, 67 m, (M.R. Sharaf leg.), 12.65880°N, 53.46988°E (2 w, KSMA); Yemen, Socotra Island, Lehanoh, 22 April 2014, 931 m, (M.R. Sharaf leg.), 12.57583°N, 54.04836°E (5 w, KSMA, 1 w, CASC).

Geographic range

This species is a successful invasive and is considered cosmopolitan. *Tetramorium simillimum* is of African origin (Bolton 1977) with a broad distribution in the Oriental, Indo-Australian, Australian, Neotropical (Kempf 1972), Nearctic (Creighton 1950) and Polynesian (Wilson and Taylor 1967) regions. From the Arabian Peninsula, it has been recorded from KSA and Yemen (Collingwood and Agosti 1996).

Ecological and biological notes

Workers of this species were found foraging on the soil under thrown, dry, date palm fronds. Several workers were found foraging on the ground under grasses.

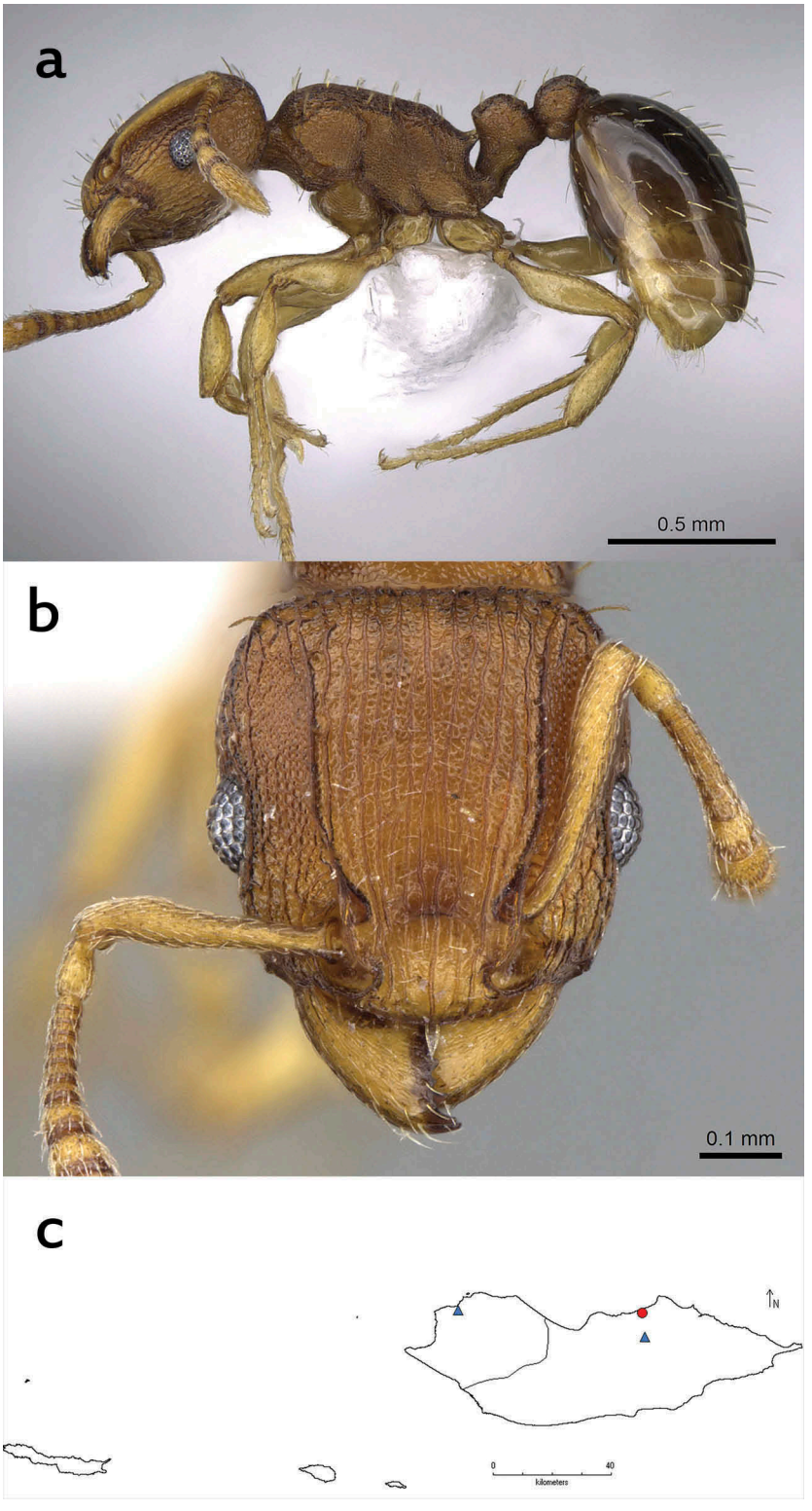

Figure 23. *Tetramorium simillimum*. (a) Body in profile. (b) Head in full-face view, CASENT0746627, AntWeb.org, (Zach Lieberman). (c) Distribution map, blue triangles from recent records, red circles from Collingwood et al. (2004).

Tetramorium transformans Santschi, 1914, stat. rev., stat. nov. (Figure 24(a–c))

Tetramorium pauper st. *transformans* Santschi, 1914: 104 (w.) Kenya. Afrotropical. Junior synonym of *Tetramorium caldarium*: Bolton, 1980: 310. (Holotype worker, NHMB) [examined].

Diagnosis

Worker. Eyes of eight ommatidia in longest row; frontal carinae running back beyond posterior level of eyes; head and gaster yellowish, first gastral tergite darker than gaster, mesosoma, petiole and postpetiole reddish distinctly contrasting rest of body.

Material examined

Yemen, Socotra Island, W. Sakhalof, 27 April 2014, 48 m, (M.R. Sharaf leg.), 12.63311°N, 54.05632°E (1 w, KSMA); Yemen, Socotra Island, Qalansyia, 25 April 2014, 26 m, (M.R. Sharaf leg.), 12.68401°N, 53.49052°E (2 w, KSMA); Yemen, Socotra Island, Dixam (W. Zereg), 24 April 2014, 279 m, (M.R. Sharaf leg.), 12.46868°N, 54.01091°E (3 KSMA); Yemen, Socotra Island, W. Ayhift, 20 April 2014, 38 m, (M.R. Sharaf leg.), 12.61906°N, 53.94005°E (12 w, KSMA); Yemen, Socotra Island, W. Jo'o, 21 April 2014, 196 m, (M.R. Sharaf leg.), 12.54038°N, 54.17186°E, (10 w KSMA); Yemen, Socotra Island, Deyishil village, 21 April 2014, 180 m, (M.R. Sharaf leg.), 12.52010°N, 54.17438°E (1 w, KSMA).

Remarks

Bolton (1980) synonymized *Tetramorium transformans* under *Tetramorium caldarium*. However, *Tetramorium transformans* can be readily separated from *Tetramorium caldarium* by the following characters: cephalic dorsum with scattered longitudinal feeble rugulae, with ground-sculpture shining and weakly imbricate. Frontal carinae less-developed, ending back at the posterior levels of eyes. Whereas *Tetramorium caldarium* has the cephalic dorsum feebly densely finely longitudinally rugulose, with ground-sculpture dull, finely, conspicuously punctulate or granulate. Frontal carinae well-developed running back beyond the posterior levels of eyes, feebly defined, and interrupted before reaching posterior margin of head.

Tetramorium transformans was originally described as a strain under *Tetramorium pauper* Forel, 1907. Comparing *Tetramorium transformans* with *Tetramorium pauper*, both are similar in body size, sculpture and pilosity, but *Tetramorium transformans* is easily diagnosed by the larger eyes, with seven ommatidia in the longest row (EI 26), whereas eyes of *Tetramorium pauper* are consistently smaller, with four ommatidia in the longest row (EI 15). In addition, the frontal carinae in *Tetramorium pauper* are shorter and just reach back to midline of eyes, whereas *Tetramorium transformans* has a longer and stronger frontal carinae running back to the posterior level of eyes. The eyes structure and size are important diagnostic characters in the genus *Tetramorium* (Francisco Hita Garcia & Barry Bolton, personal communication 2016), Therefore, *Tetramorium transformans* is removed from synonymy with *Tetramorium caldarium* and recognized as a valid species.

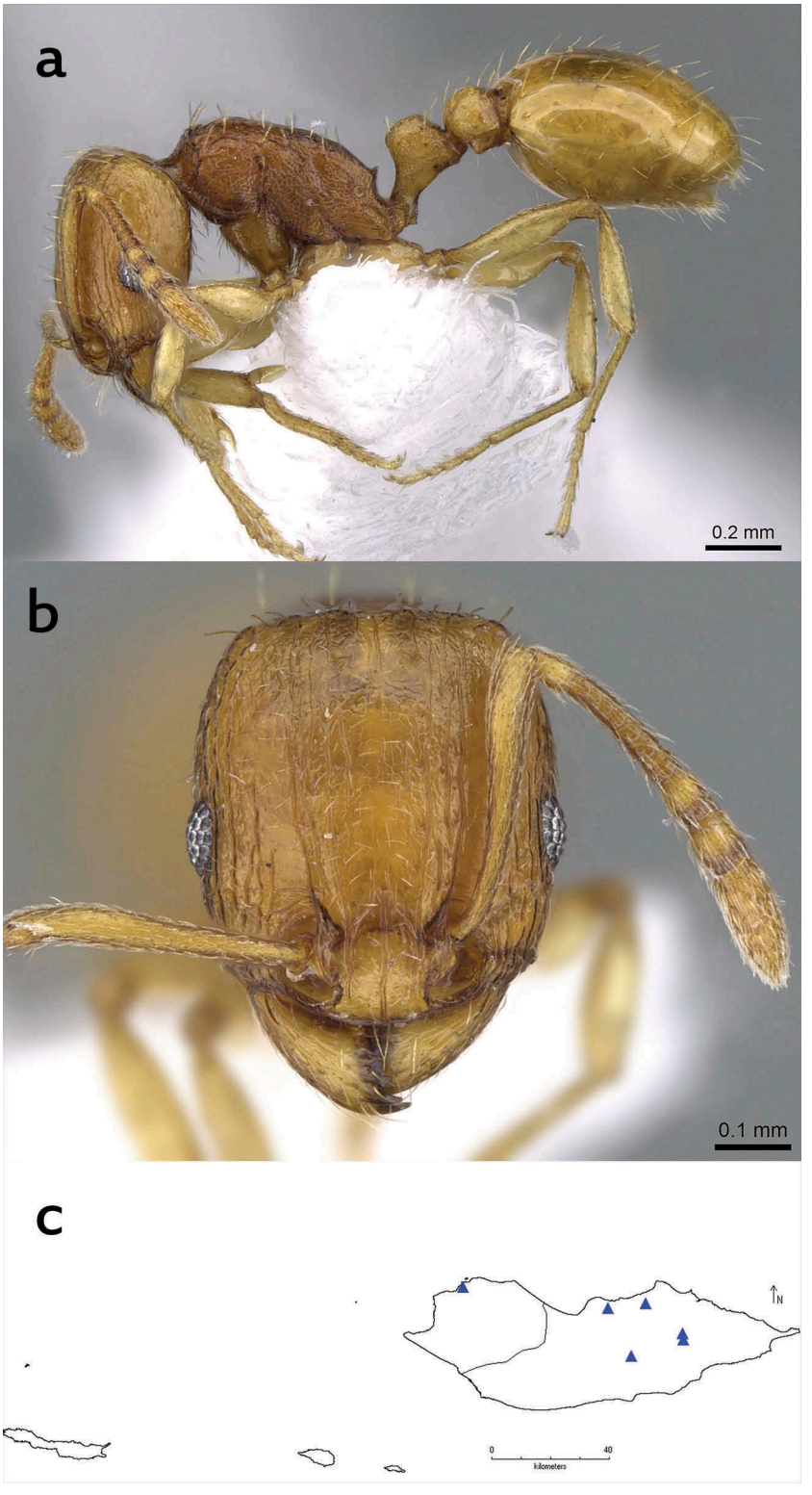

Figure 24. *Tetramorium transformans*. (a) Body in profile. (b) Head in full-face view, CASENT0746629, AntWeb.org, (Zach Lieberman). (c) Distribution map from recent records.

Geographic range

This species is originally described from Kenya (Santschi 1914) and is recorded for the first time from Socotra Archipelago.

Ecological and biological notes

This species was collected from dry leaf litter under a tree of *Ficus cordata* Thunb (Moraceae). Several workers were foraging in dry soil under a date palm tree. A nest was found in moist leaf litter rich in decaying organic materials of animal faeces and next to a stream near date palm trees. A nest was found in galleries of a termite nest under a rock and coexisting with a nest of *Monomorium exiguum*.

Trichomyrmex Mayr
Trichomyrmex destructor (Jerdon, 1851)
(Figure 25(a–c))

Atta destructor Jerdon, 1851: 105 (w.) India. Indomalaya.

Diagnosis

Worker. Mandibles with three strong teeth; eyes relatively small, with four to six ommatidia in longest row; scapes when laid straight back from their insertions reaching posterior margin of head in smallest workers but falling short of margin in larger individuals; mesosoma in profile with promesonotum convex and metanotal groove impressed; petiolar node in dorsal view globular to subglobular; propodeal dorsum finely transversely striolate. Head, mesosoma, petiole and postpetiole uniformly shining yellow or dull brownish yellow; gaster dark brown to blackish brown, with a conspicuous yellowish area mediobasally.

Material examined

Yemen, Socotra Island, W. Sakhalof, 27 April 2014, 48 m, (M.R. Sharaf leg.), 12.63311°N, 54.05632°E (15 w, KSMA); Yemen, Socotra Island, Himihil Protectorate, 23 April 2014, 330 m, (M.R. Sharaf leg.), 12.58204°N, 54.29057°E (1 w, KSMA); Yemen, Socotra Island, Haydibo, Erheno, 19 April 2014, 33 m, (M.R. Sharaf leg.), 12.65023°N, 54.04016°E (3 w, KSMA); Yemen, Socotra Island, W. Ayhift, 20 April 2014, 38 m, (M.R. Sharaf leg.), 12.61906° N, 53.94005°E (13 w, KSMA); Yemen, Socotra Island, Dehejamo, 22 April 2014, 563 m, (M. R. Sharaf leg.), 12.59049°N, 54.05205°E (5 w, KSMA); Yemen, Socotra Island, Lehanoh, 22 April 2014,931 m, (M.R. Sharaf leg.), 12.57583°N, 54.04836°E (1 w, CASC).

Geographic range

A widespread invasive species originally described from India and occurring in tropical and subtropical regions of the world (Wetterer 2009b), supposedly spread from central Asia west to north Africa (Forel 1909; Sharaf 2006), southern Europe (Ruzsky 1907) and the Arabian Peninsula (Collingwood 1985; Collingwood and Agosti 1996). In the USA it is reported from Key West and Tampa (Deyrup et al. 2000).

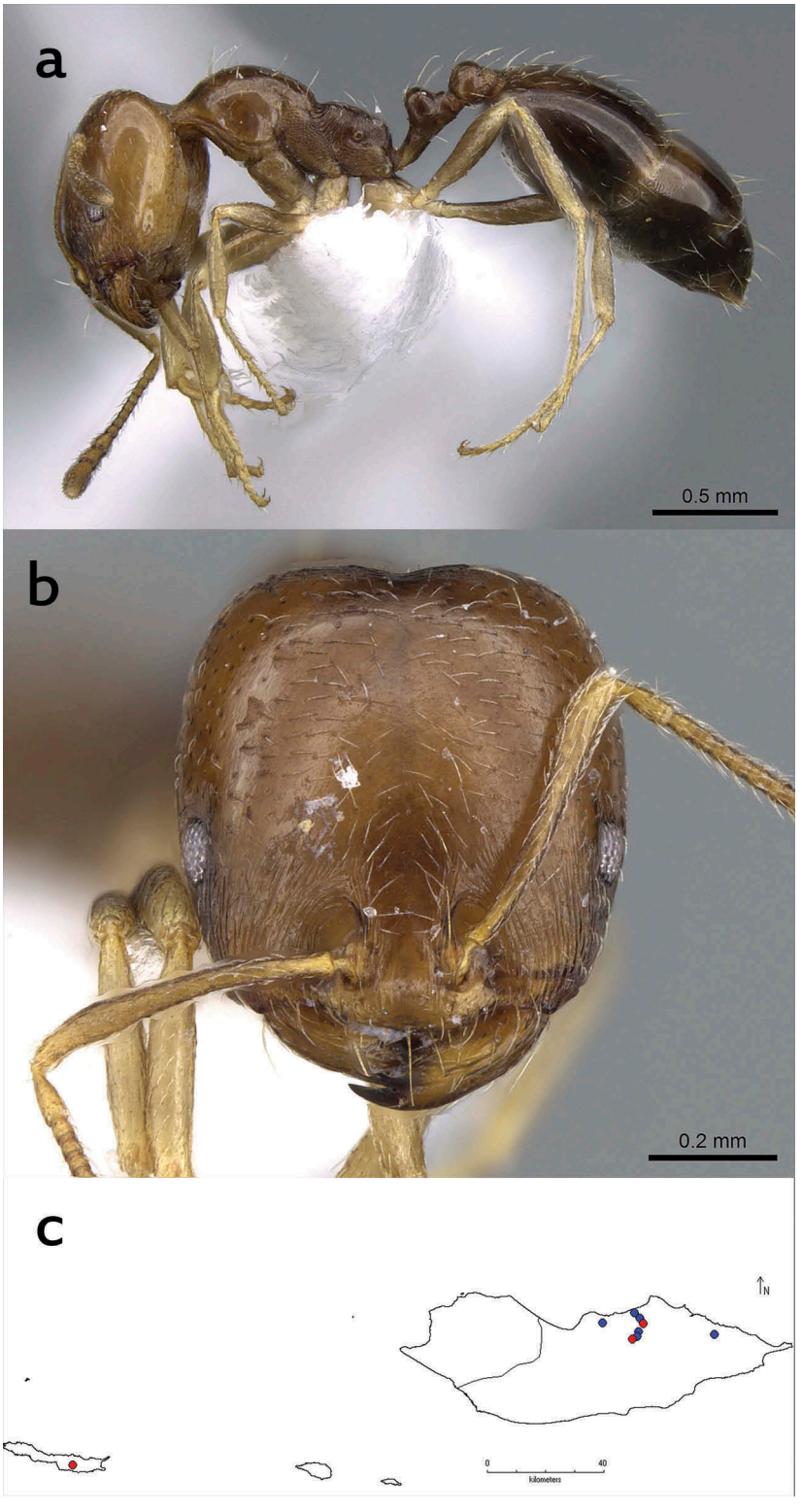

Figure 25. *Trichomyrmex destructor*. (a) Body in profile. (b) Head in full-face view, CASENT0746624, AntWeb.org, (Zach Lieberman). (c) Distribution map, blue circles from recent records, red circles from Collingwood et al. (2004).

Ecological and biological notes

Trichomyrmex destructor is one of the most successful invasive species on Socotra Island, occupying diverse habitats. It was found nesting directly in soil under a rock. Several workers were found in leaf litter under *Eragrostis eragrostis* (L.) (Poaceae), where the soil was dry and rich in organic material. Several individuals were nesting under a rock in very moist, compact, clay soil. A nest was found under the bark of a dead rotten log located on a mountainside where a small stream was draining a mountain crest surrounded by diverse plant communities. Another nest series was found in leaf litter under a tree of *Ficus cordata* Thunb (Moraceae).

Trichomyrmex mayri (Forel, 1902a)
(Figure 26(a–c))

Monomorium (Parholcomyrmex) gracillimum var. *mayri* Forel, 1902a: 209 (w.) India. Indomalaya.

Diagnosis

Worker. Matching the description of *Trichomyrmex destructor* in all respects except colour, *Trichomyrmex mayri* is a uniformly dark brown species, several individuals with a paler patch at base of the first gastral tergite.

Material examined

Yemen, Socotra Island, W. Jo'o, 21 April 2014, 196 m, (M.R. Sharaf leg.), 12.54038°N, 54.17186°E, (2 w, KSMA); Yemen, Socotra Island, Himihil Protectorate, 23 April 2014, 330 m, (M.R. Sharaf leg.), 12.58204°N, 54.29057°E (7 w, KSMA); Yemen, Socotra Island, Haydibo, Erheno, 19 April 2014, 33 m, (M.R. Sharaf leg.), 12.65023°N, 54.04016°E (4 w, KSMA); Yemen, Socotra Island, Deyishil village, 21 April 2014, 180 m, (M.R. Sharaf leg.), 12.52010°N, 54.17438°E (1 w, KSMA); Yemen, Socotra Island, Qalansyia, 25 April 2014, 26 m, (M.R. Sharaf leg.), 12.68401°N, 53.49052°E (3 w, KSMA); Yemen, Socotra Island, Lehanoh, 22 April 2014, 931 m, (M.R. Sharaf leg.), 12.57583°N, 54.04836°E (30 w, KSMA); Yemen, Socotra Island, W. Feriho (daitab), 21 April 2014, 93 m, (M.R. Sharaf leg.), 12.44103°N, 54.15576°E (10 w, KSMA); Yemen, Socotra Island, Himihil Protectorate, 23 April 2014, 330 m, (M.R. Sharaf leg.), 12.58954°N, 54.30570°E (2 w, KSMA); Yemen, Socotra Island, Dixam, 24 April 2014, 279 m, (M.R. Sharaf leg.), 12.52430°N, 53.88186°E (3 w, KSMA); Yemen, Socotra Island, Dixam (W. Zereg), 24 April 2014, 279 m, (M.R. Sharaf leg.), 12.46868°N, 54.01091°E (6 w, KSMA); Yemen, Socotra Island, Dixam, 24 April 2014, 656 m, (M.R. Sharaf leg.), 12.49320°N, 53.99145°E (9 w, KSMA); Yemen, Socotra Island, Dehejamo, 22 April 2014, 563 m, (M.R. Sharaf leg.), 12.59049°N, 54.05205°E (7 w, KSMA).

Geographic range

Trichomyrmex mayri has been successfully introduced into many regions of the tropics but compared with *Trichomyrmex destructor* apparently has a more limited invasion capability (Bolton 1987). The speculated origin of the species is the Indian subcontinent (Bolton 1987), with geographic extensions westward to the Middle East, the Arabian Peninsula (Collingwood 1985; Collingwood and Agosti 1996; Sharaf et al. 2013), North

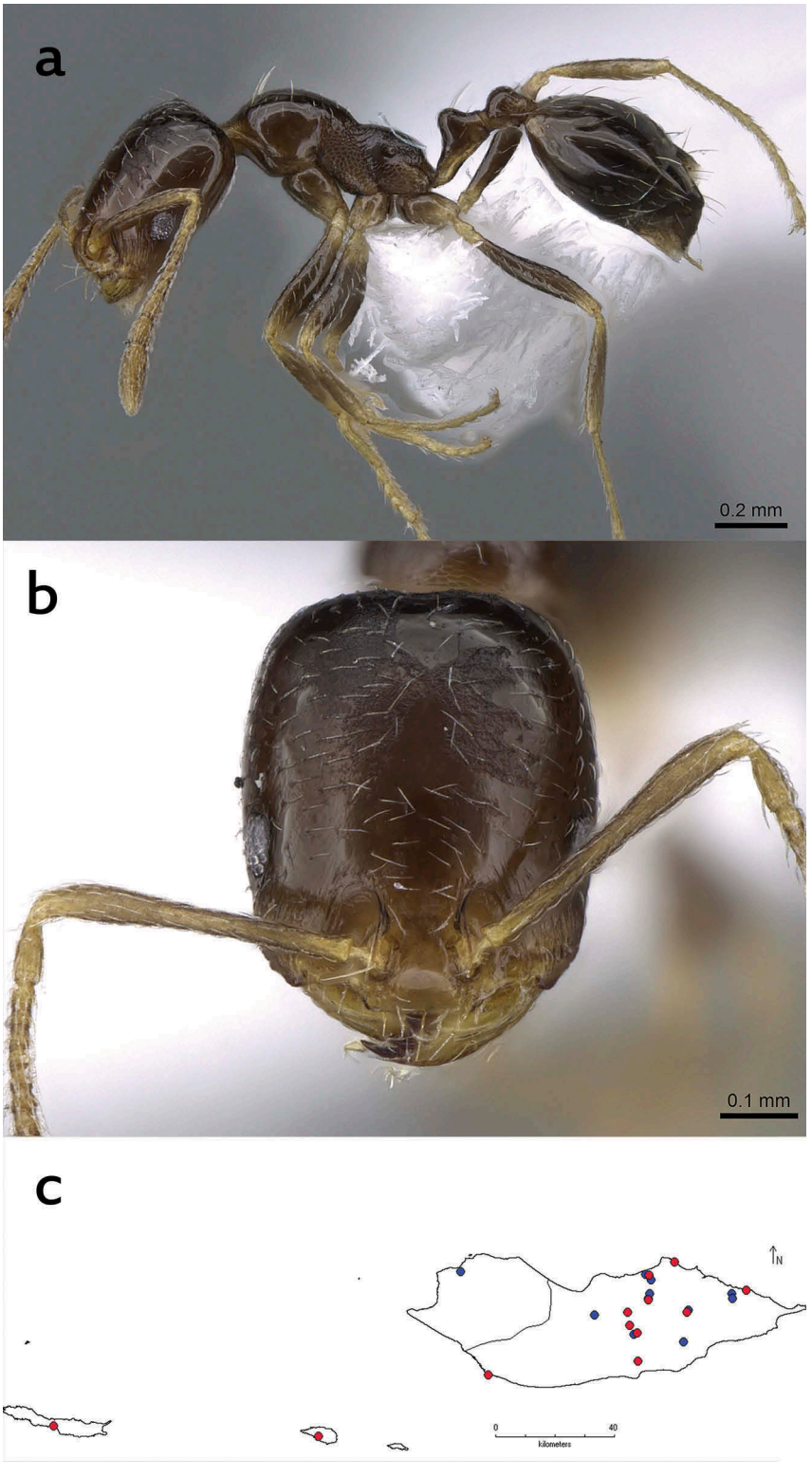

Figure 26. *Trichomyrmex mayri*. (a) Body in profile. (b) Head in full-face view, CASENT0746625, AntWeb.org, (Zach Lieberman). (c) Distribution map, blue circles from recent records, red circles from Collingwood et al. (2004).

Africa (Egypt) (Sharaf 2006) and along the coastal zones of Sub-Saharan Africa (Bolton 1987). It is also recorded from the Far East (Thailand and Malaysia) (Bolton 1987).

Ecological and biological notes

This species is one of the more widely distributed invasive species in Socotra due to its broad range of acceptable habitats. It was observed foraging on the ground next to a date palm tree. Several specimens were collected from leaf litter where the soil was moist and rich in the faecal material of sheep and goats. Another nest was found in dry soil under *Eragrostis eragrostis* (L.) (Poaceae). Several workers were foraging on sandy, moist soil next to a small running stream. Many workers were observed foraging on green twigs of a plant and coexisting with *Tapinoma melanocephalum*. Workers of a nest series were foraging on a rock next to a *Cochliasanthus caracalla* (L.) Trew (Fabaceae) plant. Several workers were nesting in loose, dry soil under a rock. Many individuals were foraging at the base of a trunk of *Boswellia scacra* Flueck. (Buseraceae). Another nest series was found in a dry leaf litter close to a date palm tree.

Subfamily **PONERINAE**
Brachyponera Emery
Brachyponera sennaarensis (Mayr, 1862)
(Figure 27(a–c))

Ponera sennaarensis Mayr, 1862: 721 (w.) Sudan. Afrotropical.

Diagnosis

Worker. Large species (TL 5–6). Head broader than mesosoma, with convex sides and emarginated posterior margin; eyes relatively large; metanotal groove deeply impressed; petiole a high and thick node with a straight anterior surface and a convex posterior surface; first and second gastral tergites separated by a distinct constriction characteristic for ponerine ants; gaster ending with a powerful sting. Dark brown to blackish brown, antennae, tibiae and tarsi reddish. All body surfaces covered with fine and dense pubescence.

Material examined

Yemen, Socotra Island, W. Sakhalof, 27 April 2014, 48 m, (M.R. Sharaf leg.), 12.63311°N, 54.05632°E (1 w, KSMA); Yemen, Socotra Island, Qalansyia, W. Taisoh, 25 April 2014, 67 m, (M.R. Sharaf leg.), 12.65880°N, 53.46988°E (2 w, KSMA); Yemen, Socotra Island, Dixam, 24 April 2014, 449 m, (M.R. Sharaf leg.), 12.52430°N, 53.88186°E (2 w, KSMA); Yemen, Socotra Island, Dixam, 24 April 2014, 656 m, (M.R. Sharaf leg.), 12.49320°N, 53.99145°E (1 w, KSMA, 1 w, CASC); Yemen, Socotra Island, Dixam, 24 April 2014, 610 m, (M.R. Sharaf leg.), 12.46557°N, 54.00247°E (1 w, KSMA); Yemen, Socotra Island, Himihil Protectorate, 23 April 2014, 355 m, (M.R. Sharaf leg.), 12.58954°N, 54.30570°E (2 w, KSMA); Yemen, Socotra Island, Himihil Protectorate, 23 April 2014, 372 m, (M.R. Sharaf leg.), 12.57615°N, 54.30651°E (1 w, KSMA); Yemen, Socotra Island, Haydibo, Erheno, 19 April 2014, 33 m, (M.R. Sharaf leg.), 12.65023°N, 54.04016°E (4 w, KSMA); Yemen, Socotra Island, W. Jo'o, 21 April 2014, 196 m, (M.R. Sharaf leg.), 12.54038°N, 54.17186°E, (4 w, KSMA); Yemen, Socotra Island, W. Feriho (daitab), 21 April 2014, 93 m, (M.R. Sharaf leg.), 12.44103°N,

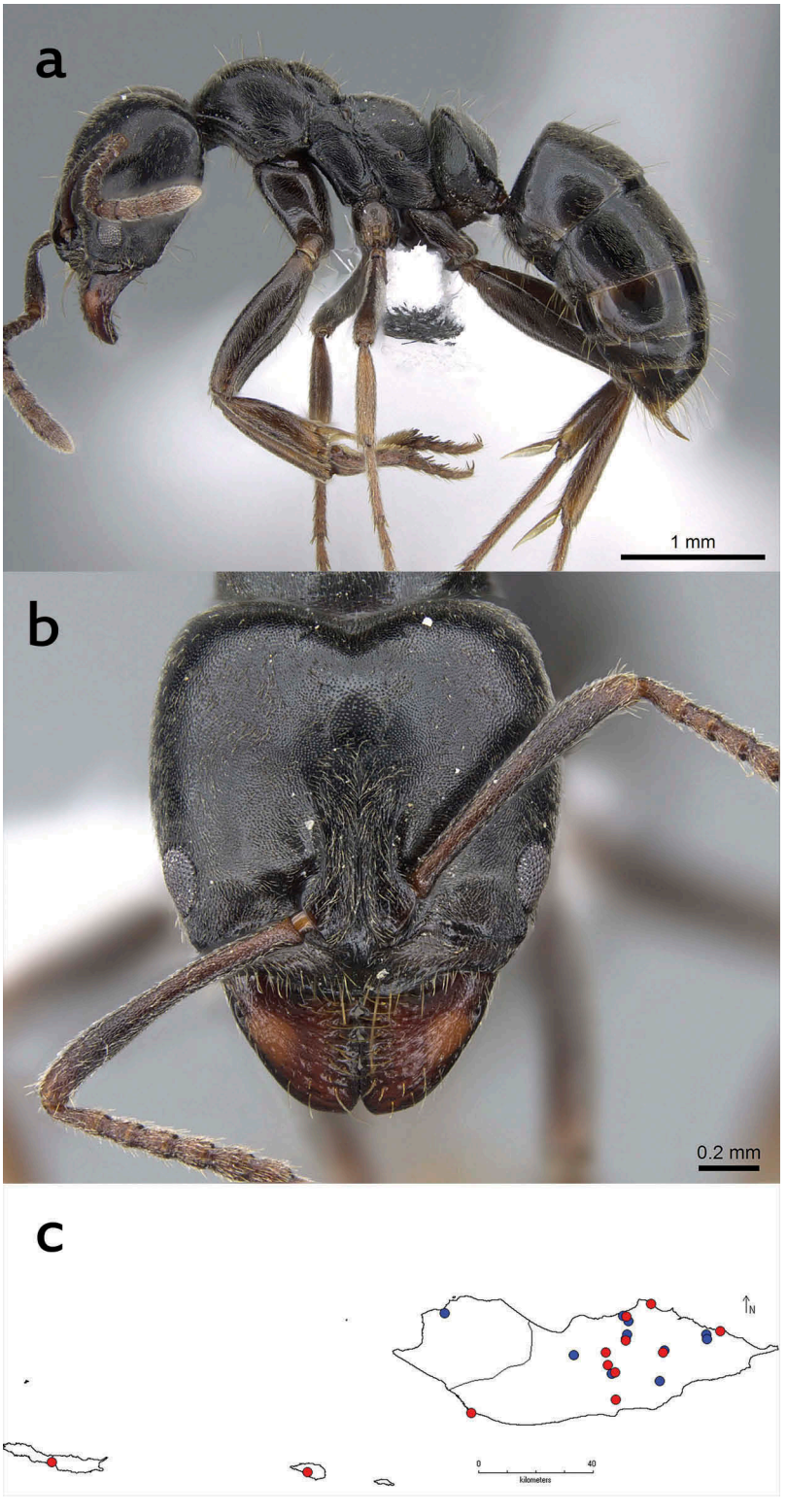

Figure 27. *Brachyponera sennaarensis*. (a) Body in profile. (b) Head in full-face view, CASENT0746634, AntWeb.org, (Zach Lieberman). (c) Distribution map, blue circles from recent records, red circles from Collingwood et al. (2004).

54.15576°E (1 w, KSMA); Yemen, Socotra Island, Lehanoh, 22 April 2014, 931 m, (M.R. Sharaf leg.), 12.57583°N, 54.04836°E (1 w, KSMA); Yemen, Socotra Island, Dehejamo, 22 April 2014, 563 m, (M.R. Sharaf leg.), 12.59049°N, 54.05205°E (4 w, KSMA).

Geographic range

Brachyponera sennaarensis is one of the more successful invasive Ponerine ants (Wetterer 2013), being broadly distributed throughout Sub-Saharan Africa, Iran (Akbarzadeh et al. 2006; Paknia 2006; Tourenq and Shuriqi 2010), and several countries of the Arabian Peninsula including KSA (Collingwood 1985), UAE, Yemen, Oman (Collingwood and Agosti 1996; Collingwood et al. 2011) and Qatar (Sharaf and Aldawood unpublished data).

Ecological and biological notes

Brachyponera sennaarensis has invaded a wide range of habitats on Socotra, especially soil that is moist covered with the leaf litter of date palm trees. This species also commonly nests under rocks and objects associated with moist soils. *Brachyponera sennaarensis* has also invaded the relatively undisturbed valleys of the island where streams and denser vegetation are found. A nest was found under a stone under a dragon blood tree.

Hypoponera Santschi

Hypoponera punctatissima (Roger, 1859)

(Figure 28(a–c))

Ponera punctatissima Roger, 1859: 246, pl. 7, Figure 7 (w. q.) Poland, Germany. Palaearctic.

Diagnosis

Worker. Eyes small but distinct, situated far forward on sides of head; impression or feeble longitudinal line running back along midline of head from frontal lobes to midlength of vertex; scapes, when laid straight back from their insertions, fail to reach or less commonly just touch midpoint of posterior margin of head in full-face view; metanotal groove deeply impressed; mesonotum with a well-defined posterior margin; mesopleuron smooth and shining; petiole in profile with anterior and posterior faces of node weakly convergent dorsally. Dark brown to yellowish brown, antennae and legs yellowish.

Material examined

Yemen, Socotra Island, W. Jo'o, 21 April 2014, 196 m, (M.R. Sharaf leg.), 12.54038°N, 54.17186°E, (5 w, KSMA, 1 w, CASC); Yemen, Socotra Island, W. Sakhalof, 27 April 2014, 48 m, (M.R. Sharaf leg.), 12.63311°N, 54.05632°E (12 w, KSMA); Yemen, Socotra Island, Qalansyia, 25 April 2014, 26 m, (M.R. Sharaf leg.), 12.68401°N, 53.49052°E (21 w, KSMA); Yemen, Socotra Island, W. Ayhift, 20 April 2014, 214 m, (M.R. Sharaf leg.), 12.60970°N, 53.97770°E (3 w, KSMA); Yemen, Socotra Island, Dixam (W. Zereg), 24 April 2014, 279 m, (M.R. Sharaf leg.), 12.46868°N, 54.01091°E (1 w, KSMA).

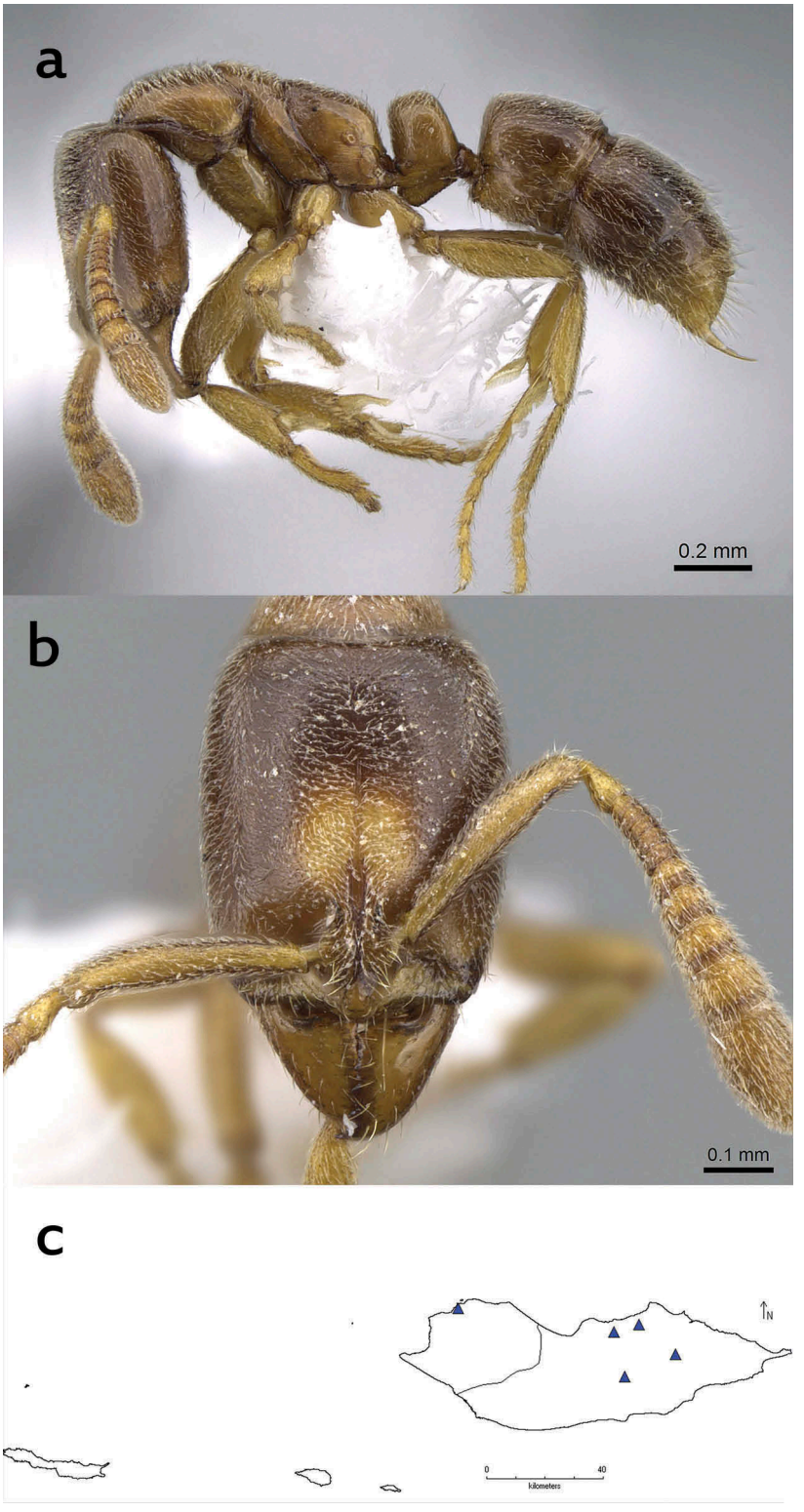

Figure 28. *Hypoponera punctatissima*. (a) Body in profile. (b) Head in full-face view, CASENT0746620, AntWeb.org, (Zach Lieberman). (c) Distribution map.

Geographic range

This species is broadly distributed throughout the Afrotropical region (Bolton and Fisher 2011) and Europe (Belgium, Britain, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Norway, Poland, Spain, Switzerland and the Balkans) (Delabie and Blard 2002). For the Arabian Peninsula, it has been recorded from KSA (Collingwood 1985), Oman and Yemen (Collingwood and Agosti 1996). This species is a new record for Socotra.

Ecological and biological notes

This genus is recorded for the first time from Socotra; based on its distribution, this species has probably been introduced. This species was collected from moist soil and leaf litter under mango and date palm trees where the soil was rich in decaying organic material. It was also observed nesting under a stone next to a dragon blood tree. This species was also nesting directly in moist soil under a dead palm tree where organic materials are found. Another nest was found among old moist leaf sheaths surrounding the trunk base of a date palm tree.

Discussion

This study, with the records available from Collingwood et al. (2004), makes at least 28 species of ants now known from the Socotra Archipelago. One species, *Monomorium elghazalyi* is described as new, whereas two genera, *Hypoponera* and *Syllophopsis*, and 10 species are recorded for the first time from the Archipelago. The newly recorded species are *Cardiocondyla mauritanica*, *Cardiocondyla minutior, Monomorium atomum, Monomorium dichroum, Monomorium exiguum, Pheidole pallidula, Syllophopsis cryptobia*, *Tetramorium pauper*, *Tetramorium transformans* and *Hypoponera punctatissima*. Due to its position at the junction of three major biogeographical regions, the Afrotropical, Oriental and Palaearctic, Socotra has an ant fauna consisting of a mixture of species from the three zoogeographic realms. At least 10 species (36%) are of Afrotropical origin followed by nine cosmopolitan species (32%). A relatively smaller number of Palaearctic (five species, 18%) and Oriental (four species, 14%) elements were also recorded. Our collections and review of previous records reflect a mixture of the Afrotropical Palaearctic and Oriental faunal elements, as well as a relatively high number of introduced species. The Socotra Afrotropical affinities we found agree with many previous studies (Udvardy 1975; Takhtajan et al. 1986; Olson et al. 2001; Mendes 2004; Rheims et al. 2004; Taiti and Ferrara 2004; Mahnert 2007; Taiti and Checcucci 2009; Fikáček et al. 2012; Culek 2013; Holt et al. 2013) of the zoogeography of the Socotra Archipelago.

The ant species introduced to Socotra are noteworthy. Eighteen (64%) of the 28 known Socotra species are apparently non-native taxa. Endemics were represented by three species (11%) whereas natives amounted to seven species (25%). The importation of plants and animals is legally prohibited in the Socotra Archipelago (Van Damme and Benfield 2011), but present records, in addition to other published works (Collingwood et al. 2004; Miller and Morris 2004), reveal the ineffectiveness and futility of quarantine policies on the island, especially regarding undetected arthropods in imported materials. As on other islands (Simberloff 1981; Hengeveld 1988; Porter and Savignano 1990), the biological invasions of the Socotra Archipelago by geographically widespread species, in

addition to the high impact of tourism and related human activities, undoubtedly have had impacts on the native biota. The serious ecological impacts of invasive species include extinctions of native taxa (Clavero and Garcia-Berthou 2005), especially of island endemics (Chown et al. 1998; McGlynn 1999; Sax et al. 2002; Sax and Gaines 2003; Blackburn et al. 2004; Steadman 2006; Fisher 2009).

For example, two colonies with large populations of the invasive species *Tapinoma melanocephalum* were found in two undisturbed mountainous sites (Lehanoh, 931 m, Dehejamo, 563 m). This species has successfully extended its range worldwide (Wetterer 2009a), frequently inhabiting disturbed habitats, buildings including, kitchens, restaurants, greenhouses and gardens. However, *Tapinoma melanocephalum* has been reported even to colonize relatively undisturbed habitats (Wetterer 2009a). Original colonists of this ant species may have been transported by locals moving domestic goats and sheep, and their belongings back and forth into the valleys for grazing from Haidibo (capital) and Qalansyia to sell their animals.

The success of several invasive species such as *Tapinoma melanocephalum* producing large colonies in relatively undisturbed valleys may indicate the existence of ideal conditions for the invaders. The ecological effect of super colonies of invasive species may result in severe impacts on native terrestrial communities (Fisher 2009). The invasive species *Anoplolepis gracilipes* (Smith), which formed super colonies on Christmas Island that tended scale insects, eliminated the red ground crab (*Gecarcoidea natalis* (Pocock)), the main litter consumer. The scale insects killed numerous trees. Ground-nesting birds were also impacted. Unfortunately, the ecological effects of invasive species on the native and endemic fauna of Socotra are poorly studied (Van Damme and Benfield 2011), with only scattered notes and observations in the literature.

Human activities in Socotra are accelerating and expanding with increased trade, new roads and uncontrolled development of the tourist industry (Van Damme and Benfield 2011). These activities have contributed to the introduction of invasive species that are impacting the island's biodiversity. Extensive litter and trash accumulations in Socotra, especially in the largest two cities, Hadibo and Qalansyia, are opportune habitats for the colonization of invasive taxa such as *Paratrechina longicornis* and *Brachyponera sennaarensis*. One report estimates that the amount of garbage being generated in Socotra (Loretz and Martin 2006) will increase from 8650 tonnes to 10,900 tonnes by 2015.

Another example of a successful invasive species in Socotra is *Tetramorium lanuginosum*, which was recorded from Socotra by Collingwood et al. (2004) from a single site (Adho Dimello, 940 m). Our collections show that this species is now found in numerous places including agricultural areas and undeveloped sites at both low and high altitudes. This species is one of the most widely distributed ant species on the island and could be impacting the local fauna (Simberloff 1981; Lawton and Brown 1986; Hengeveld 1988; Porter and Savignano 1990; Fowler et al. 1994; Goodenough 2010; Bertelsmeier et al. 2015). The biology and ecology of the invasive ants in Socotra need to be studied to determine the types of ecological effects on both native and endemic faunas.

The three endemic species of Socotra (*Cardiocondyla longiceps, Monomorium nimihil*, and the one newly described species, *Monomorium elghazalyi*) apparently have restricted distributions. This is particularly true for *Monomorium nimihil*, which is currently known only from its type locality of Wadi Daneghan. Despite extensive collecting efforts, no additional specimens of this species were collected. The other endemic ant of

Socotra, *Monomorium elghazalyi* is apparently confined to higher altitudes in the eastern portion of the island (Haggeher Mountain). Future surveys should target this area of the island.

It is noteworthy to mention the apparent lack of several common regional formicine groups. The only recorded formicine genera were *Camponotus* (three spp.), *Lepisiota* (one sp.) and *Paratrechina* (one sp.). Two *Camponotus* species (*Camponotus acvapimensis* and *Camponotus atlantis*) have a limited distribution confined to relatively undisturbed valleys at higher elevations. The formicine genera *Cataglyphis* and *Plagiolepis*, which have relatively high diversity in adjacent regions (Arabian Peninsula and Afrotropical region), are absent from the Socotra Archipelago. Also, no species of the genus *Pheidole* were collected during our study.

The present study was based on specimens collected only by hand and using sifting trays to sample soil and leaf litter. No doubt the use of other well-known collecting techniques (e.g. Malaise traps, light traps, Berlese funnels, baits) in different seasons could add additional material and species.

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