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Notes on Ants of the genus *Strumigenys* F. Smith, 1860 (Hymenoptera: Formicidae) in the Arabian Peninsula, with a key to species

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Abstract
The ant genus *Strumigenys* in the Arabian Peninsula is treated. Three species are recognized, *S. arnoldi* Forel, *S. emmae* (Emery) and *S. membranifera* Emery. The invasive species *S. membranifera* and the Afrotropical species *S. arnoldi* are recorded for the first time from Saudi Arabia and the Arabian Peninsula. A key to the Arabian species based on the worker caste is presented. Biological, ecological and distribution notes for each species are given, as well as a regional distribution map for the three species.

Introduction

The ant genus *Strumigenys* F. Smith, 1860 is one of the largest and most conspicuous genera in the subfamily Myrmicinae (Bolton 2000). The genus is classified in the tribe Dacetini, with 836 valid extant species currently recognized (Bolton 2013), and are distributed worldwide in the tropics, subtropics and warm temperate regions (Bolton 2000, Brown 2000). The majority of species are cryptic soil inhabitants, nesting and foraging in leaf litter, topsoil layers, or wood pieces or stumps embedded in litter and topsoil layers (Brown 1953, Bolton 1983, Dejean 1991), with only a very few exceptional arboreal species (Bolton 1983, 2000). The majority of species with known biology are specialized predators on a broad range of smaller arthopods including: Diplura, Symplyla, Entomobryomorpha, Chilopoda, Pseudoscorpiones, Acarina, Araneae, Isopoda and larvae of many other orders os small Insecta (Wilson 1953, Masuko 1985, Brown 1971, Dejean 1987a, b).

The taxonomic history of the genus is long with numerous contributions including Arnold (1917), Wheeler (1922), Brown (1948, 1949 a, b, c, d, 1953, 1954 a, b), Terayama & Kubota (1989), Baroni Urbani & De Andrade (1994, 2007), Deyrup (1997), Bolton (1983, 1999) and the milestone work (Bolton 2000). More recently, the Indian fauna of the genus was treated by Bharti & Akbar (2013), recognizing 24 species, two of which were newly described and five species recorded for the first time from the country.

Several *Strumigenys* species have spread throughout the world by human commerce (Deyrup & Cover 2009, Wetterer 2011), a phenomenon well documented for many other ant species including *Tapinoma melanocephalum* (Fabricius, 1793) (Williams 1994); *Hypoponera punctatissima* (Roger, 1859), *Linepithema humile* Mayr, 1868, *Paratrechina longicornis* (Latreille, 1802), *Nylanderia vividula* (Nylander, 1846), *N. jaegerskioeldi* (Mayr, 1904), *Monomorium exiguum* Forel, 1894, *Pheidole teneriffana* Forel, 1893, and *Tetramorium caldarium* (Roger, 1857) (Gómez & Espadaler 2006).

Strumigenys membranifera Emery, 1869 and *S. emmae* (Emery 1890) are successful invasive species, with broad distributions (Wetterer 2011). These two species with a third one, *S. rogeri* Emery, 1890, are the most successful invasive *Strumigenys* ants known worldwide. It is thought that all three are of Old World origin but only *membranifera* reaches more temperate areas. *Strumigenys membranifera* is thought to be of African origin and has been reported in a wide range of habitats including cultivated areas, gardens, forest and urban parks (Brown & Wilson 1959, Bolton 1983, 2000). *Strumigenys emmae* is thought to be of Australian origin (Bolton 2000).

For a full diagnosis of the genus *Strumigenys*, see Bolton (1983, 2000) and Baroni Urbani & De Andrade (2007). A brief diagnosis of the genus includes mandibles extended into elongate narrow linear blades that terminate in two preapical teeth, the proximal tooth longer than the distal; in some species mandibles are short, triangular, serially dentate and lack an apical fork of spiniform teeth; lack of apicoscrobal hair; eyes ventrolateral, below the antennal scrobes; petiole node not bidentate dorsally; postpetiole with spongiform appendages present; absence of a basal spongiform pad on the first gastral sternite; specialized body pilosity frequently present.

The first two extensive faunal works on the ant fauna of Kingdom of Saudi Arabia (KSA) (Collingwood 1985) and the Arabian Peninsula (Collingwood & Agosti 1996) recorded no *Strumigenys*. Despite the absence of any record of this cryptic group, these authors predicted *Strumigenys* would be found in the Arabian Peninsula. The first record of a *Strumigeny*s from the Arabian Peninsula was by Collingwood & Van Harten (2005) from Al Mukalla, Republic of Yemen, who reported three workers of the tramp species *S. emmae*, collected in Malaise traps. More recently, two workers of *S. arnoldi* Forel, 1913 were collected by one of the authors (BLF) from a forested mountainous area in Al Sarawat Mountains (southwestern region of KSA). These specimens were found nesting in moist soil under a stone. This record was included in El-Hawagryi et al. (2013) treatment of the insect fauna of Al Baha Region, KSA.

In the present study, recent materials of the genus *Strumigenys* from Saudi Arabia and Yemen are studied. Three species, *S. arnoldi*, *S. emmae* and *S. membranifera*, are discussed. An identification key to species is presented based on worker caste to facilitate species recognition. Some notes on ecology, biology and distribution are provided as well as a regional distribution map for the three species.

Materials and Methods

All materials, except a single specimen of *S. arnoldi* which is in the California Academy of Sciences (CASC), are deposited in King Saud University Museum of Arthropods (KSMA), Plant Protection Department, College of Food and Agriculture Sciences, Riyadh, Kingdom of Saudi Arabia. Most specimens were collected by sifting soil and leaf litter using sifting trays. The two dealated gynes of *S. emmae* were collected using Malaise traps. The distribution range in the Arabian Peninsula was documented based on the new materials, along with previously published data (Yemen specimens) (Collingwood & Van Harten 2005) whose coordinates were not mentioned in the publication, but were obtained from the Google Earth website (www.earth.google.com). The map was created using the ArcGIS 9.2 program, with the help of Prof. Mahmoud S. Abdel-Dayem (King Saud University). Digital colour images were created using a Leica DFC450 digital camera and Leica Application Suite software (ver. 3.8). All images presented herein are available online and can be seen on AntWeb (http://www.antweb.org).

Results

Key to Arabian *Strumigenys*

1 Antenna with 4 segments, the first funicular segment followed directly by the 2-segmented club (pantropical tramp species)…….....***emmae*** **(Emery)**

- Antenna with 6 segments, the first funicular segment separated from the 2-segmented club by two much smaller segments…….....2

2 Mandibles in full-face view broadest near base and gradually tapering towards the apex; apical fork of mandibles with 2 spiniform teeth; cephalic dorsum pilosity dense, hairs anteriorly curved and scale-like in full-face view (Kenya, Tanzania, Zimbabwe, Saudi Arabia and Yemen)…..…….***arnoldi*** **Forel**

- Mandibles in full-face view with 12 teeth, arranged in a series of 7 larger teeth basally followed by a series of 4 denticles and a small apical teeth; cephalic dorsum pilosity restricted to a single pair of hairs at the highest point of vertex, minute and sparse appressed pubescence present (Cosmopolitan tramp species)……...….....….***membranifera*** **Emery**

Taxonomic Treatment

Strumigenys arnoldi **Forel, 1913**
(Figures 1-3)

Strumigenys arnoldi Forel, 1913: 114 (w.) ZIMBABWE. Afrotropic.
See also: Brown, 1954a: 26; Bolton, 1983: 365; Bolton, 2000: 591.

Diagnosis:

Apical fork of mandibles with 2 spiniform teeth; eyes small, maximum diameter less than maximum width of scape; metanotal groove absent; propodeal teeth broadly triangular; spongiform appendages of petiole and postpetiole well developed; cephalic dorsum, in full-face view, with scale-like, dense anteriorly curved hairs; pronotal humeri without flagellate hairs; mesonotum with a single pair of stout standing hairs; ground-pilosity of dorsal mesosoma similar to that of cephalic

dorsum but hairs smaller and sparser; petiole, postpetiole and first gastral tergite with stout standing hairs which are swollen and clavate apically; cephalic dorsum finely and densely reticulate-punctate; entire dorsum of mesosoma finely reticulate-punctate, on pronotum this sculpture overlaid by some fine longitudinal rugulation. Color dull yellow to light brown.

Material Examined:

Saudi Arabia, (Al Sarawat Mountains), Al Bahah, Dhi Ain Archaeological Village, 19.9296 ˚N, 41.44285 ˚E, 750 m, 20.ix.2011, (B. L. Fisher, leg.), (BLF27515) (2 workers, CASENT0260163, CASENT0260165).

Ecological and Biological notes:

This species was collected from Dhi Ain Archaeological Village (Fig. 4), a cultivated area surrounded by mountains. The field locality includes a mix of native vegetation and cultivated plants including banana (*Musa paradisiaca* L., Family Musaceae), date palm (*Phoenix dactylifera* L., Family, Arecaceae), *Pandanus tectorius* Parkinson (Family Pandanaceae), *Ricinus communis* L. (Family Euphorbiaceae), *Ficus vasta* Forssk. (Family Moraceae), *Acacia* spp. (Family Fabaceae), *Prunus dulcis* (Mill.) D.A.Webb (Family Rosaceae), *Ziziphus spina-christi* (L.) Desf. (Family Rhamnaceae) and lemon orchards (*Citrus limon* (L.) Burm.f., Family Rutaceae). Two specimens were collected by the second author (BLF), found nesting in humid soil under a stone next to a small water stream which was used for irrigation of cultivated plants. The specimens were collected by sifting the soil. Five trips to the same territory were made in an attempt to find additional specimens but no more were collected, indicating the scarcity of the species and the low population in the region.

Distribution:

This is the first record of this species for Saudi Arabia and the Arabian Peninsula. This species is known only from the Afrotropical region, originally described from Zimbabwe (Forel 1913) and recorded from Kenya (Bolton 1983) and Tanzania (Bolton 2000).

***Strumigenys emmae* (Emery, 1890)**
(Figures 5-7)

Epitritus emmae Emery, 1890: 70, pl. 8, fig. 6 (w.) ANTILLES. Neotropic.

Wheeler, 1908: 149 (gyne). Combination in *Quadristruma*: Brown, 1949b: 48; in *Strumigenys*: Bolton, 1999: 1674. Senior synonym of *Strumigenys clypeatus*, *Strumigenys malesiana*, *Strumigenys wheeleri*: Brown, 1949b: 48. See also: Bolton, 1983: 400; Bolton, 2000: 950.

Diagnosis:

Mandibles are a pair of narrow linear outcurved blades, armed with a fork of 2 spiniform teeth; anterior clypeal margin broad, with a feeble median impression; antennae four-segmented; eyes very small with a single ommatidium, situated just above ventral scrobe margin; pronotum slightly flat dorsally; metanotal groove absent; petiole and postpetiole in profile each with moderately developed spongiform appendages; lateral margins of clypeus short and with 2–3 anteriorly curved small spoon-shaped hairs; pronotal humeri each with a straight clavate hair and mesonotum with a similar but shorter pair of hairs; ground-pilosity of mesosomal dorsum in form of numerous scale-like to broadly spoon-shaped hairs; petiole, postpetiole, and gaster with short straight narrowly clavate hairs; dorsum of head behind clypeus reticulate-punctate; dorsal surface of petiole finely punctate to reticulate; postpetiole superficially reticulate to smooth. Color dull yellow to pale brown.

Material Examined:

Yemen, Al Mukalla, 14.533°N, 49.133°E, 11m, 1.ii.2003, (A. V. Harten, leg.), light trap (n=2 dealated gynes, CASENT0906377).

Previous Records:

(Collingwood &Van Harten 2005)**:** Yemen: Ghail Ba Wazir, 14.776111°N, 49.366111°E, xii.2002 (A. V. Harten & M. Hubaishan leg.), Malaise trap (3 workers)

Biology and Habitats:

The Yemeni specimens were collected from Al Mukalla, a coastal city of the Arabian Sea. *Strumigenys emmae* forms small colonies with less than 50 workers and is considered to prefer disturbed habitats such as beach margins (Deyrup & Deyrup 1999).

Distribution:

Strumigenys emmae is a very successful tramp species (Bolton 2000) with a broad distribution including the tropics and subtropics in scattered localities (Brown 1949c), and has spread to at least 28 countries including non-tropical regions (Deyrup & Deyrup 1999). The origin of this species remains uncertain but is thought to be Australian (Bolton 2000). The first reported record from the Peninsula was from Yemen (Collingwood &Van Harten 2005).

***Strumigenys membranifera* Emery, 1869**
(Figures 8-10)

Strumigenys (*Trichoscapa*) *membranifera* Emery, 1869: 24, fig. 11 (w.) ITALY. Palearctic.

Emery, 1916: 205 (gyne); Wheeler & Wheeler, 1991: 93. Combination in *Strumigenys* (*Cephaloxys*): Emery, 1916: 205; in *Trichoscapa*: Brown, 1948: 113; in *Pyramica*: Bolton, 1999: 1673; in *Strumigenys*: Baroni Urbani & De Andrade, 2007: 123. Senior synonym of *S. foochowensis*, *S. marioni*, *S. santschii*, *S. silvestriana*, *S. simillima*, *S. vitiensis*, *S. williamsi*: Brown, 1948: 114. See also Brown, 1949 a: 6; Wilson, 1953: 483; Bolton, 1983: 319; Bolton, 2000: 322.

Diagnosis:

Mandibles with 12 teeth, arranged in a series of 7 larger teeth basally followed by a series of 4 denticles and a small apical teeth; anterior clypeal margin transverse to broadly feebly convex; eyes small, with only a few ommatidia, situated at ventral scrobe margin; metanotal groove absent; spongiform appendages of pedicel segments massively developed in profile; lateral spongiform appendages of petiolar node large and strongly prominent; lateral and ventral spongiform lobes of postpetiole massive, much larger than exposed area of disc; cephalic dorsum having only minute, sparse appressed pubescence; clypeal margins both anteriorly and laterally lacking projecting hairs; clypeus and lateral margins of head hairless; humeral angles of pronotum without hairs; dorsum of mesosoma bare, with only scattered sparse minute appressed pubescence present; dorsal surfaces of petiole, postpetiole and gaster without hairs but with minute appressed very sparse pubescence; cephalic dorsum reticulate-punctate and dull; sides of mesosoma smooth; propodeal dorsum and declivity smooth; in dorsal view both petiole and postpetiole smooth. Color dull yellow to yellowish brown.

Material Examined:

Saudi Arabia, Qassim, Buraydah, 26.36802˚N, 44.03905˚E, 653m, 19.x.2013, (Salman S., leg.), (2 workers CASENT0914337, CASENT0914338).

Biology and Habitats:

This species was collected by sifting soil in a date palm orchard at Buraydah (Qassim, central Region, KSA) (Fig.11). Specimens of *S. membranifera* were found inhabiting litter under a date palm tree among fallen decayed and dry dates. The soil was sandy and moist. In 1999, one of the authors (MS) collected a single worker from Abu Swelam Village, 3 km north of El Menia City (Egypt) (unpublished data). The specimen was found nesting under a small stone on a farm, in very compact and humid clay soil. Several Collembola were found in the same habitat and it is possible that *S. membranifera* preys on them as documented by Carlin (1981).

Distribution:

This is the first record of the species from KSA and the Arabian Peninsula. *Strumigenys membranifera* is a successful and widely distributed pantropical tramp species that has spread via human commerce (Wetterer, 2011) through all zoogeographical regions (Bolton 1983, Bolton 2000 & Wetterer, 2011).

Discussion

An interesting aspect of the genus *Strumigenys* in the Arabian Peninsula is its apparent scarcity, which makes the available information on the species limited, and consequently only few specimens are available in museums and collections. This is likely due to the small size and cryptic nature of the species (Bolton 1983, Bolton 1999, Bolton 2000).

The *S. membranifera* records from Buraydah (Qassim, Central Region, KSA) and El Menia (Egypt) were collected in human modified landscapes. Wilson & Hunt (1967) also noted this species in open cultivated fields in Futuna and Wallis Islands. The Buraydah record is an area of date palm trees cultivation, supporting the notion that this species was introduced probably associated with date palm shoots imported from adjacent regions. It seems likely this species could be found in other localities where extensive date palm production occurs, especially the central region and eastern region of the Arabian Peninsula.

Strumigenys arnoldi is an Afrotropical species (Bolton, 2000). The record from Al Sarawat Mountains (Al Bahah. KSA) is further evidence of the Afrotropical faunal affinities of the southwestern Mountains of KSA, supporting results of the faunal studies of the region (Eig 1938; Zohary 1973; Lehrer & Abou-Zied 2008; Doha 2009; Aldawood et al. 2011; Sharaf & Aldawood 2011, 2012; Sharaf et al. 2012a, 2012b; El-Hawagryi et al. 2013; Sharaf & Aldawood 2013).

The lack of previous studies recording *Strumigenys* (Collingwood 1985; Collingwood & Agosti 1996) may reflect their methods of collecting, which are not effective in collecting cryptic groups like dacetine ants. Methods such as sifting soil and leaf litter and using Malaise traps and Winkler bags, are much more effective in collecting these ants (Bestelmeyer et al. 2000).

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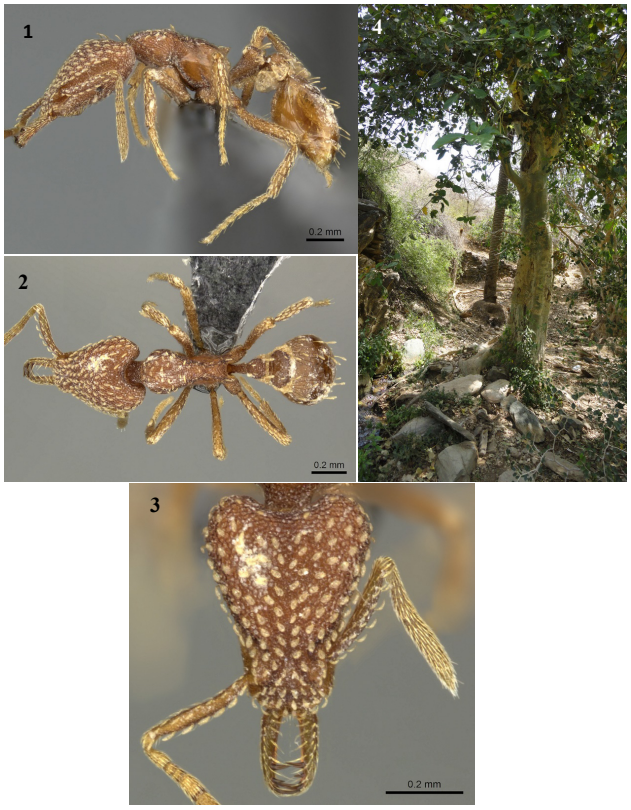
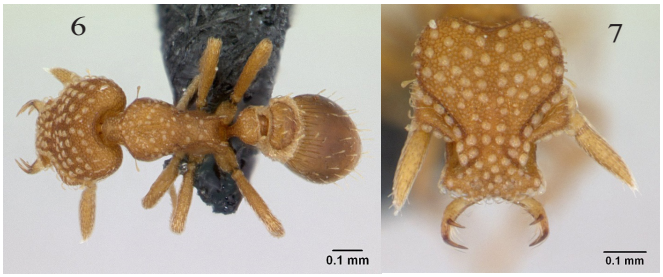
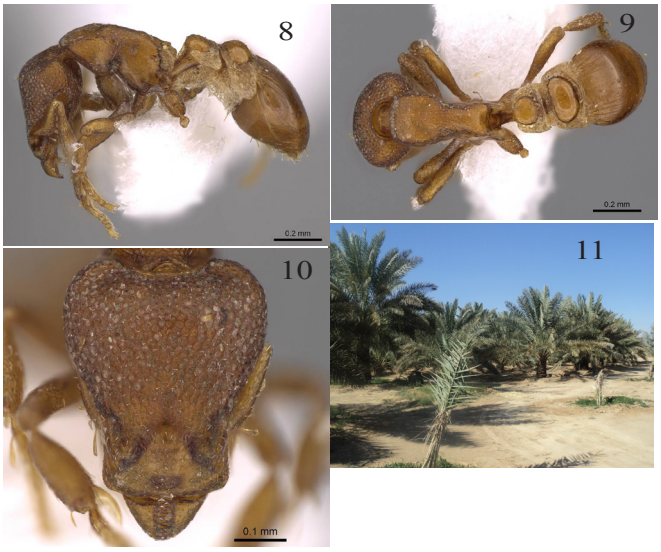


Figures 1-4; 1-3 *Strumigenys arnoldi* worker, 1 Body in profile, 2 Body in dorsal view, 3 Head in full-face view (casent0260163, Saudi Arabia), Photographer: Estella Ortega, copyright, www.antweb.org, 4 Habitat of *S. arnoldi*, Dhi Ain archaeological village, Al Bahah.



Figures 5-7; *Strumigenys emmae* worker (casent0133445, Mayotte), 5 Body in profile, 6 Body in dorsal view, 7 Head in full-face view. Photographer: Erin Prado, copyright. www.antweb.org



Figures 8-11; 8-10 *Strumigenys membranifera* worker (casent0914338, Saudi Arabia), 8 Body in profile, 9 Body in dorsal view, 10 Head in full-face view, Photographer: Michele Esposito, copyright www.antweb.org, 11 Habitat of *S. membranifera*, Buraydah (Qassim).

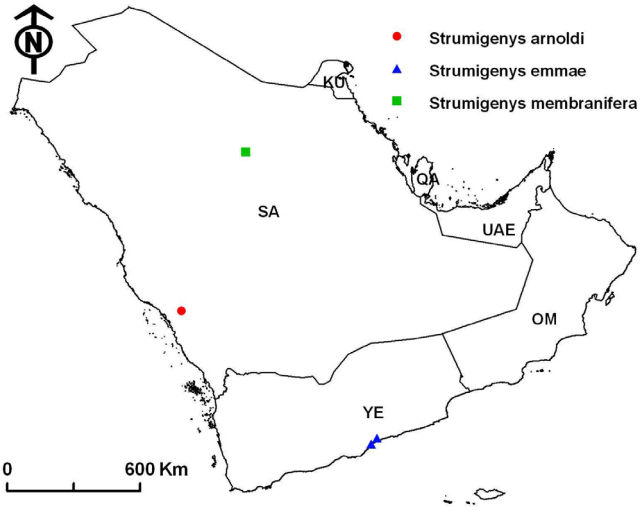


Fig. 12; Distribution map of the genus *Strumigenys* in the Arabian Peninsula. (M.S. Abdel-Dayem map). Abbreviations: (KU) Kuwait, (QA) Qatar, (OM) Oman, (SA) Saudi Arabia, (YE) Yemen, (UAE) United Arab Emirates.