The morphological and taxonomic identity of Aphaenogaster Beesoni Donisthorpe, 1933 (Stenammini: Myrmicinae: Formicidae) from Hilly Areas of Punjab and Khyber Pukhtoon Khwa

Ghulam Mujtaba Lakho[1](Corresponding Author), Imran Khatri[2], Zubair Ahmed[3], Abdul Hafeez Soomro[4]

[1,] Deputy Director, Agriculture Extension, Mirpurkhas, Pakistan. Email: lakhogmujtaba@gmail.com
[2,] Professor, Department of Entomology, Sindh Agriculture University Tandojam, Pakistan. ORIC ID: 0000-0003-2646-4156, Email: ikhatri@sau.edu.pk
[3,] Associate Professor, Department of Zoology, Federal Urdu University of Arts, Science & Technology, Karachi Pakistan, Email: zbrahmed36@gmail.com
[4] Post Graduate Scholar, State Environmental Protection Key Laboratory of Wetland Ecology and Vegetation Restoration, School of Environment, Northeast Normal University, Changchun, 130117, China. Email: hafei@nenu.edu.cn

Abstract

This study focuses on the morphology and taxonomy of a Stenammini species, Aphaenogaster beesoni Donisthorpe, 1933, of the Myrmicinae subfamily. Ant specimens were collected using pitfall traps, baiting, and leaf litter sifting in diverse habitats including forests, deserts and agricultural fields, from provinces of Pakistan. Samples were collected and preserved in ethanol, and identified by different taxonomic keys. The worker ants are less than 5 mm in length and are light brown colored with a two-toned body. Petiolar nodes were specialized; morphological analysis showed 12-segmented antenna with a club segment for four, complex elongated mesosoma and morphological features were shown. The study also looks at ecological adaptations and divergence among the species, through A. beesoni. The results provide important insight into the taxonomic diversity and functional role of the genus, including that of mutualistic seed dispersal. The regional biodiversity studies of Aphaenogaster are ideally suited to build on this foundation in the future.

Keywords: *Aphaenogaster Beesoni, Morphology, taxonomy, Ant diversity, Myrmicinae*

DOI:	https://zenodo.org/records/14605230
Journal Link:	https://jai.bwo-researches.com/index.php/jwr/index
Paper Link:	https://jai.bwo-researches.com/index.php/jwr/article/view/79
Publication Process	Received: 7 Dec 2024/ Revised: 29 Dec 2024/ Accepted: 02 Jan 2025/ Published: 06 Jan 2025
ISSN:	Online [3007-0929], Print [3007-0910]
Copyright:	© 2024 by the first author. This open-access article is distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).
Indexing:	
Publisher:	BWO Research International (15162394 Canada Inc.) https://www.bwo-researches.com

Introduction

The genus *Aphaenogaster* Mayr, 1853 belongs to the Stenammini, a tribe primarily of northern hemisphere temperate distribution, of which five of its seven genera are specialized as granivores adapted to arid and semiarid landscapes, and they harvest seeds (Bernard, 1967, 1974; Arnoldi, 1976; Collingwood, 1978; DeMarco & Cognato, 2015; Johnson et al., 2022). Others, such as *Goniomma* and *Oxyopomyrmex* are Palaearctic endemics, while the genera *Novomessor* and *Veromessor* are Nearctic. *Messor* also occurs, however, in arid parts of the Afrotropics, Arabian Peninsula, Pakistan, and India, as does *Stenamma* and *Aphaenogaster*, which inhabit many habitats, including forests and open semiarid landscapes.

The genus Aphaenogaster is particularly noted for mutualism with myrmecochores and plants that depend on ants for seed dispersal. These interactions rely on species of the *Aphaenogaster* such as *A. rudis* and *A. pica* where *Aphaenogaster* species facilitate seed dispersal in temperate forests across North America and Europe (Zettler et al., 2002; Gove et al., 2007; Prior et al., 2020). When the seeds are collected by the ants, transported to the nests of the ants and offered so that seeds can germinate and seedlings can establish in this way (Zettler et al., 2002; Prior et al., 2020).

The ecological roles of *Aphaenogaster* ants are beyond seed dispersal in an assemblage of seed dispersers or sowning ants (Prior et al. 2020; Prior et al. 2013; Caut et al. 2013). Recent studies have attempted to understand the conditions under which *A. beesoni* underwent larval development stages (Bharti, 2023), instar estimation and structural analysis.

The genus was first described by Mayr in 1853 and currently has about 200 species in the world. The major and minor worker castes have led these ants to frequently being mistaken for *Pheidole*. *Aphaenogaster* ants, however, are distinguished by the presence of only one worker caste, 12 segmented antennae with a three segmented club and larger body size. Mostly feeding on aphids on plant roots, their nests are at most 4 cm long and may have 'funnel-shaped' entrances that trap arthropods.

Materials and Methods

Specimens of ants were obtained from different geographical localities of Pakistan from agricultural fields, orchards, forests, deserts, riverines and human houses. Various sampling techniques were used, including sugar and honey baiting, pitfall traps, leaf litter sifting with Winkler bags, hand collecting, subterranean sampling and light traps for reproductive castes. Specimens were preserved in 75%–95% ethanol; cleaned; and point-mounted on entomological pins for detailed morphological studies. Precise data on locality, date, collector, and habitat details were prepared in labels.

Photography and body measurements

Measurements and analysis were performed using stack imaging (40–50 images per specimen) through combined ZP staking software, where imaging was performed using a Leica DFC450 camera. The presence of specimen identification based on regional taxonomic keys using Bingham (1897), Bolton (2003), and AntWiki was taken into consideration. The morphological and taxonomic study of ants was done in laboratory work by Sindh Agriculture University, Tandojam and University of Hong Kong.

Results

Genus ***Aphaenogaster*** Mayr, 1853: *Aphaenogaster* Mayr, 1853b: 107. Type-species: *Aphaenogaster sardous* Mayr, 1853b:107, by subsequent designation of

Bingham, 1903: ***Aphaenogaster beesoni*** Donisthorpe, 1933

Morphological characters of worker

The worker ants are less than 5 mm in length and are light brown colored with a two-toned body. The head and alitrunk are monomorphic, that is the two are the same color. The smooth, shiny head is ovoid with flat, anterior and posterior margins, weakly convex margins, and the head slightly longer than wide. They have long, fine stubby cephalic hairs. Antennae 12 segmented, yellow, with distinct, lengthened, four segmented club and long scapes extending beyond posterior margin of head bearing erect hairs. The clypeus is subpentagonal, flat, reduced in size and placed low, the median notch on the anterior margin. Medium sized, black, convex, and located at the midline of the head.

The gaster is brownish yellow, oval, smooth and stinging. The mesosoma is elongate, sculptured and possesses three convexities, erect hairs, and short propodeal spines. The petiole and postpetiole are distinct, the petiole conical and the postpetiole conical to oval, sculpture absent. Simple pretarsal claws and hind tibial spurs bearing one pectinate spur and the legs are differently colored. There is subtriangular, yellow mandibles and ocelli are absent. Body globular, propodeum with rounded spiracles, pygidium unarmed. The stridulatory system is absent, the palp formula is 4,3 or 5,3.

Material examined

Punjab Province, Sindh House Murry, 33.912,73.383, 5.VII.17,8☿. Ayubia road from Murry, 34. 133, 73.243, 5.VII.17, ,12☿. Sindh House Murry, 33.912,73.383 8.VII.17, 13☿. Khyber Pakhtunkhwa Ayubia road from Murry, 34. 133,73.235, 5.VII.17, , 13☿. Ayubia 34.029,73.405, 5.VII.17, 9☿. Ayubia road from Murry, 34. 127,73.235, 5.VII.17, 7☿. Ghora Galli Murry road, 33.907,73.277, 5.VII.17, 12☿. Murry road near tool plaza33. 699,73.110, 5.VII.17, , 8☿. Ghora Galli Murry road, 33.907,73.277, 5.VII.17, 7☿. Sindh House Murry, 33.912,73.383, 5.VII.17, 9☿. Ayubia road from Murry, 33.564,73.235, 5.VII.17, 7☿. Khyber Pakhtunkhwa Ghora Galli Murry road, 33.907,73.277, 5.VII.17, 8☿. Murry road tool plaza, 33.699,73.110, 5.VII.17, 6☿. Pindi Point Murry, 33.89073.375, 5.VII.17, 10☿. Pindi Point Murry, 33.533,73.224, 5.VII.17, 12☿. Sarwarabad Mansehra, 34.234,73.240, 6.VII.17, 14☿. Nathia Galli, 34.025, 73.386, 6.VII.17, 14☿.

Note:- Material is collected by the first author unless it is mentioned

Discussion

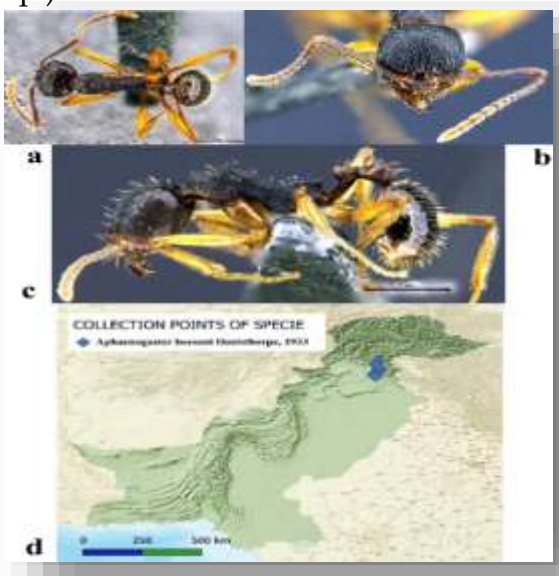
Aphaenogaster beesoni is separated from related species in the genus by its unique morphological and taxonomic analysis. *A. beesoni* is more adapted for survival in semiarid habitats than well adapted temperate forest equivalent *A. picea* and *A. rudis* (Zettler et al., 2002; Prior et al., 2020). Ecological adaptations to open landscapes and arid conditions, such as long elongated mesosoma, robust petiolar nodes and well-developed propodeal spines, are more apparent than in forest species. This is similar to *A. cristata* and *A. pachei*, which lack extensive mesosoma sculpturing (Bharti, 2023) as seen in studies published from the Himalayan region. Aphaenogaster is characterized by a 12 segmented antenna (sometimes with the club segmented into 4) that varies in proportions for the species. A. cristata has slightly shorter antennal scapes, adapted for close vegetation foraging, which contrasts with *A. beesoni* with longer scapes, favored for open foraging (Bharti, 2023). Ecological roles including dispersing seeds,

similar to other members of the genus, are shared by *A. beesoni* (Gove et al., 2007; Prior et al., 2013). But it extends the ecological range of *Aphaenogaster* known outside the semiarid zones of Pakistan. Taken together, these findings help to extend the taxonomic diversity of the genus and ecological adaptations, laying a foundation for future biodiversity research in the region.

Conclusion

The present work details the morphological and taxonomical identity of *Aphaenogaster beesoni*, from Northern Pakistan and highlights its morphological adaptations for life in semi-arid habitats. They can be diagnosed by important morphological features that includes; 12-segmented antenna with four-segmented club; elongated mesosoma. Historically recorded range may be less than the full extent of the ecological role of the species, especially as a seed disperser. This new diversity with new localities will contribute to a better understanding of *Aphaenogaster* diversity, as well as serve as a baseline for future work examining biodiversity and ecological processes in the region.

Plate: *Aphaenogaster beesoni* Donisthorpe, 1933 (a. Dorsal view b. Full-face view c. Profile view d. Distribution Map.)



References

AntWiki. *Aphaenogaster beesoni*. Available at: https://www.antwiki.org/wiki/Aphaenogaster_beesoni. Accessed [24.11.2024].

Arnoldi KV. The ants of the USSR and adjacent countries. Nauka, 1976.

Bernard F. Les fourmis (Hymenoptera Formicidae) d'Europe occidentale et septentrionale. Éditions Masson, 1967; 1974.

Bharti H. Larval instar estimation and ultra-structural analysis of *Aphaenogaster cristata* (Forel, 1902) and *Aphaenogaster pachei* (Forel, 1906) (Hymenoptera: Formicidae) from the Himalayas. Entomological Science, 2023; 26(4).

Bingham CT. The fauna of British India, Including Ceylon and Burma. Hymenoptera Vol. I: Wasps and Bees. Taylor and Francis, 1897.

Bingham CT. The fauna of British India, Including Ceylon and Burma. Hymenoptera Vol. II: Ants and Cuckoo-Wasps. Taylor and Francis, 1903.

Bolton B. Synopsis and classification of Formicidae. American Entomological Institute, 2003; 71:370.

Boulay R, Cerdá X, Fertin A, Ichinose K, Lenoir A. Brood development into sexual females depends on the presence of a queen but not on temperature in an ant dispersing by colony fission, *Aphaenogaster senilis*. Ecological Entomology, 2009; 34(5):595-602.

Caut S, Barroso Á, Cerdá X, Amor F, Boulay R. A year in an ant's life: Opportunism and seasonal variation in the foraging ecology of *Aphaenogaster senilis*. Ecoscience, 2013; 20(1):19-27.

Collingwood CA. A key to the ants of Northern Europe. Entomologist's Gazette, 1978; 29:127-136.

DeMarco B, Cognato A. A multiple-gene phylogeny reveals polyphyly among eastern North American *Aphaenogaster* species (Hymenoptera: Formicidae). Zoologica Scripta, 2015; 45(5):512-520.

Gove A, Majer J, Dunn R. A keystone ant species promotes seed dispersal in a "diffuse" mutualism. Oecologia, 2007; 153(3):687-697.

Johnson C, et al. Ecological adaptations in seed-harvesting ants. Annual Review of Ecology, Evolution, and Systematics, 2022; 53:195-212.

Prior K, Meadley-Dunphy S, Frederickson M. Interactions between seed-dispersing ant species affect plant community composition in field mesocosms. Journal of Animal Ecology, 2020; 89(11):2485-2495.

Prior K, Saxena K, Frederickson M. Seed handling behaviours of native and invasive seed-dispersing ants differentially influence seedling emergence in an introduced plant. Ecological Entomology, 2013; 39(1):66-74.

Zettler J, McInnis T, Allen C. Biodiversity of fungi in red imported fire ant (Hymenoptera: Formicidae) mounds. Annals of the Entomological Society of America, 2002; 95(4):487-491.