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Revision of the African Ants of the *Bothroponera pumicosa* Species Complex (Hymenoptera: Formicidae: Ponerinae)

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Abstract

African ants are poorly known, especially Afrotropical ants of the subfamily Ponerinae, despite recent advances. The genus *Bothroponera* (Ponerinae) includes the *pumicosa*, *talpa* and *sulcata* species complexes. We here present a revision of members of the *pumicosa* species complex. These ants can be characterized by having coarsely foveolate sculpture and by having either a raised a "v" or "u" shaped anterior medial border of the clypeus (anteclypeus), with or without a carina. Members of this complex lack the metatibial gland on the anterior side of the lower metatibia. Species in the *Bothroponera pumicosa* species complex are mainly distributed in the southern part of Africa. They include: *Bothroponera aspera* Arnold, 1962 (**stat. nov.)**, *B. berthoudi* (Forel, 1901) (= *variolosa* **syn. nov.)**, *B. cariosa* Emery, 1895, *B. cavernosa* (Roger, 1860), *B. granosa* (Roger, 1860), *B. laevissima* (Arnold, 1915), *B. montivaga* Arnold, 1947 (**stat. nov.)**, *B. pumicosa* (Roger, 1860), *B. strigulosa* Emery, 1895, and *B. umgodikulula* Joma and Mackay, 2013. A key to the workers with diagnoses and comparisons is provided, together with illustrations of each species and colored photographs of the species, as well as maps and the distributions of each species.

Introduction

The Afrotropical ants of the genus *Bothroponera* are a highly diverse group of Formicidae that belongs to the subfamily Ponerinae, tribe Ponerini. Little information is known about their behavior, biodiversity, richness, biology, ecology, biosystematics and evolution. The most common species in the Afrotropics are *B. talpa* and *B. pachyderma* of *talpa* species complex and *B. crassior*, *B. silvestrii* and *B. soror* of the *sulcata* species complex among 43 taxa of *Bothroponera* that are distributed in the Afrotropics and Southern Asia. The species of *pumicosa* species complex are mostly restricted to South Africa with the exception of *B. cariosa* that was collected in Mozambique (Emery, 1895), Tanzania and Gabon (Ant web, 2013), *B. granosa* that was collected in Zimbabwe (Arnold, 1926) and *B. pumicosa* that was collected in Cameroon (Wheeler, 1922; Stitz, 1910).

In this paper, we focus on the members of the *Bothroponera pumicosa* species complex from Africa to reorganize their taxonomy, which is part of a revision of this conspicuous and ecologically important group of ants, in order to improve the knowledge of African *Bothroponera* and provide keys for the identification of species.

Materials and Methods

Museums and Collections:

The specimens of the African *Bothroponera* species complexes were obtained from the following museums. :

Naturhistorisches Museum, Basel, Switzerland (NHMB).

Muséum d'Histoire Naturelle, Geneva, Switzerland (MHNG).

Iziko South African Museum, South Africa (Iziko).

The Mackay collection, the University of Texas at El Paso, USA (CWEM).

British Natural History Museum, London, UK (BMNH).

Museum für Naturkunde, Berlin, Germany (MfN).

Museum Nationale d'Histoire Naturelle, Paris, France (MNHN).

Museo Civico di Storia Naturale, Genova, Italy (MCSN).

American Museum of Natural History, New York, USA (AMNH).

Los Angeles County Museum of Natural History, California, USA (LACM).

Museum of Comparative Zoology, Cambridge, Massachusetts, USA (MCZC).

Measurements and Abbreviations used:

The specimens were examined with a Zeiss binocular microscope with an ocular micrometer. All measurements are in millimeters.

Head Length (HL), in full face view, the maximum length of the head excluding the mandibles, from the mid-point of the anterior clypeal margin to the mid-point of the posterior margin of the head.

Head Width (HW), in full face view, the maximum width of the head from the extreme side of head to the other extreme side excluding the eyes.

Mandible length (ML), the distance from the mandible's base to the apex of the apical tooth.

Eye Length (EL), the maximum diameter of the eye as seen from the side.

Eye Width (EW), the maximum distance of the eye from the anterior edge to the posterior edge as seen from the side.

Scape Length (SL), the maximum length of the scape from the proximal to the distal extremes, excluding the basal constriction.

Funiculus Length (FL), the measurement of the distal 11 segments of the antenna including the club and all of the funicular segments.

Weber Length (WL), the length in lateral view, from the anterior edge of the pronotum to the end of posterior margin of the propodeal lobes.

Petiole Length (PL), in lateral view, the maximum distance of the petiole from the anterior face to the posterior edge, excluding the helcium.

Petiole Width (PW), in dorsal view, the maximum side to side thickness of the petiole, generally at the posterior edge since it has the largest width.

Petiole Height (PH), in lateral view, the maximum length from the lower point of the sternopetiolar process excluding the petiolar teeth, to the highest point at the apex of the petiolar node.

Cephalic Index (CI), HW/HL x 100.

Ocular Index (OI), EL/HW x 100.

Mandibular Index (MandI), ML/HL x 100.

Scape Index (SI), SL/HW x 100.

Petiolar Index (PetI), PW/PL x 100.

In each specimen we measured the hair length, the total body length, the malar space length (from lower edge of the eye to the base of the mandible) and the length of the side of the head from the upper margin of the eye to the highest point of the posterior lateral corner of the head (side view). In some cases, we measured the frontal lobe width and the gaster length. There are other characters that were taken into account including the shape of the head, size of the eyes (large or small), characteristics of the pronotum, mesopleuron, propodeum, petiole and postpetiole. The shape of the pronotal shoulder, lower margin of the pronotum, basalar sclerite, and propodeal spiracle are also important. The entire body color including the antennae, clypeus, mandibles and legs were included as well. Figures 1 and 2 show the various details and morphological characters of genus *Bothroponera* that were used to identify taxa in this genus. The morphological terms are from Serna and Mackay (2010) and Keller (2011). Illustrations were completed using the typical methods such as a compound microscope, microscopic grids and a micrometer.

Photos were taken in the Museum of Comparative Zoology (MCZC) using an automontage photosystem provided with computer software (LEICA MZ 7.5 stereomicroscope, Canon Camera EOS 7D 18 megapixel digital SLR, Helicon focus software and Photoshop). The Ant website was the alternative source to obtain ant photos.

Maps of the distribution of African *Bothroponera* were completed using Golden Software MapViewer version 3.0. The terrestrial ecoregions map (Map 1) was used to display information about ecological and biological nature of the plant community distribution in Africa. Google Earth was also used to characterize the ant localities. The longitudes and latitudes of the specimen localities were determined using fuzzy gazetteer (isodp.hof-university.de/fuzzyg/query/).

Lectotypes and paralectotypes were named in order to establish the identity of the specimens.

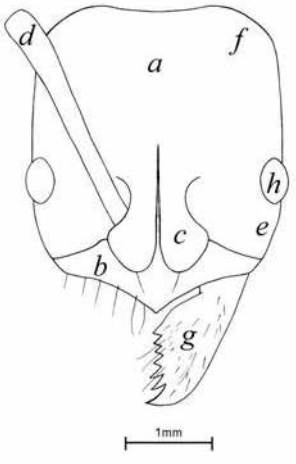


Fig 1. The full view of the head of an African *Bothroponera*. ***a***, frons; ***b***, clypeus; ***c***, frontal lobe; ***d***, scape; ***e***, malar space; ***f***, posterior lateral corner of the head; ***g***, mandible; ***h***, eye.

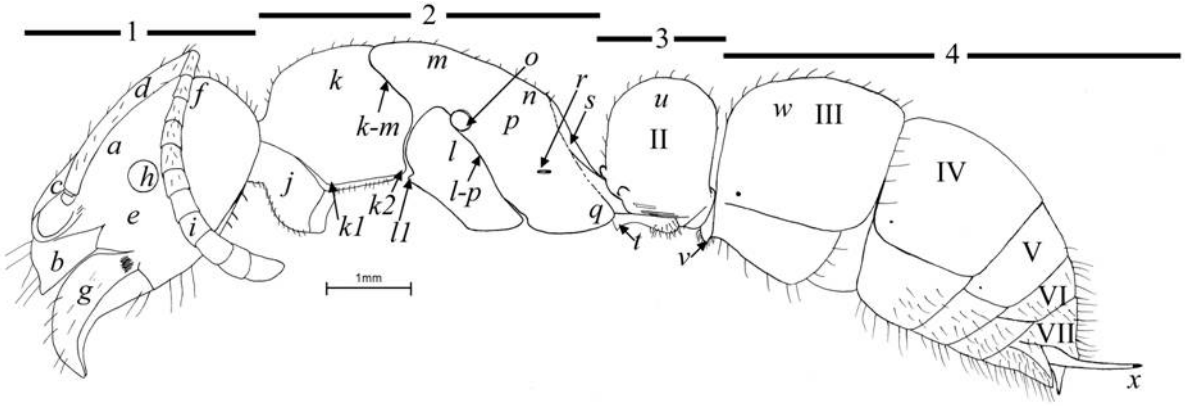


Fig 2. The lateral view of an African *Bothroponera*. **1**, head; **2**, mesosoma; **3**, petiole; **4**, gaster; ***a***, frons; ***b***, clypeus; ***c***, frontal lobe; ***d***, scape; ***e***, malar space; ***f***, posterior lateral corner of the head; ***g***, mandible; ***h***, eye; ***i***, funicular segment; ***j***, propleuron; ***k***, pronotum; ***k1***, anteroinferior pronotal process; ***k2***, inferior pronotal process; ***k-m***, promesonotal suture; ***l***, mesopleuron; ***l1***, epicnemial process; ***l-p***, mesometapleural suture; ***m***, mesonotum; ***n***, propodeum; ***o***, basalar sclerite; ***p***, lateropropodeum; ***q***, metapleural gland; ***r***, propodeal spiracle; ***s***, posteropropodeum; ***t***, sternopetiolar process; ***u***, petiole; ***v***, sternopostpetiolar process; ***w***, postpetiole; ***x***, sting; (**II** second, **III** third, **IV** fourth, **V** fifth, **VI** sixth and **VII** seventh abdominal segments).

Results

Family Formicidae
Genus *Bothroponera* Mayr, 1862

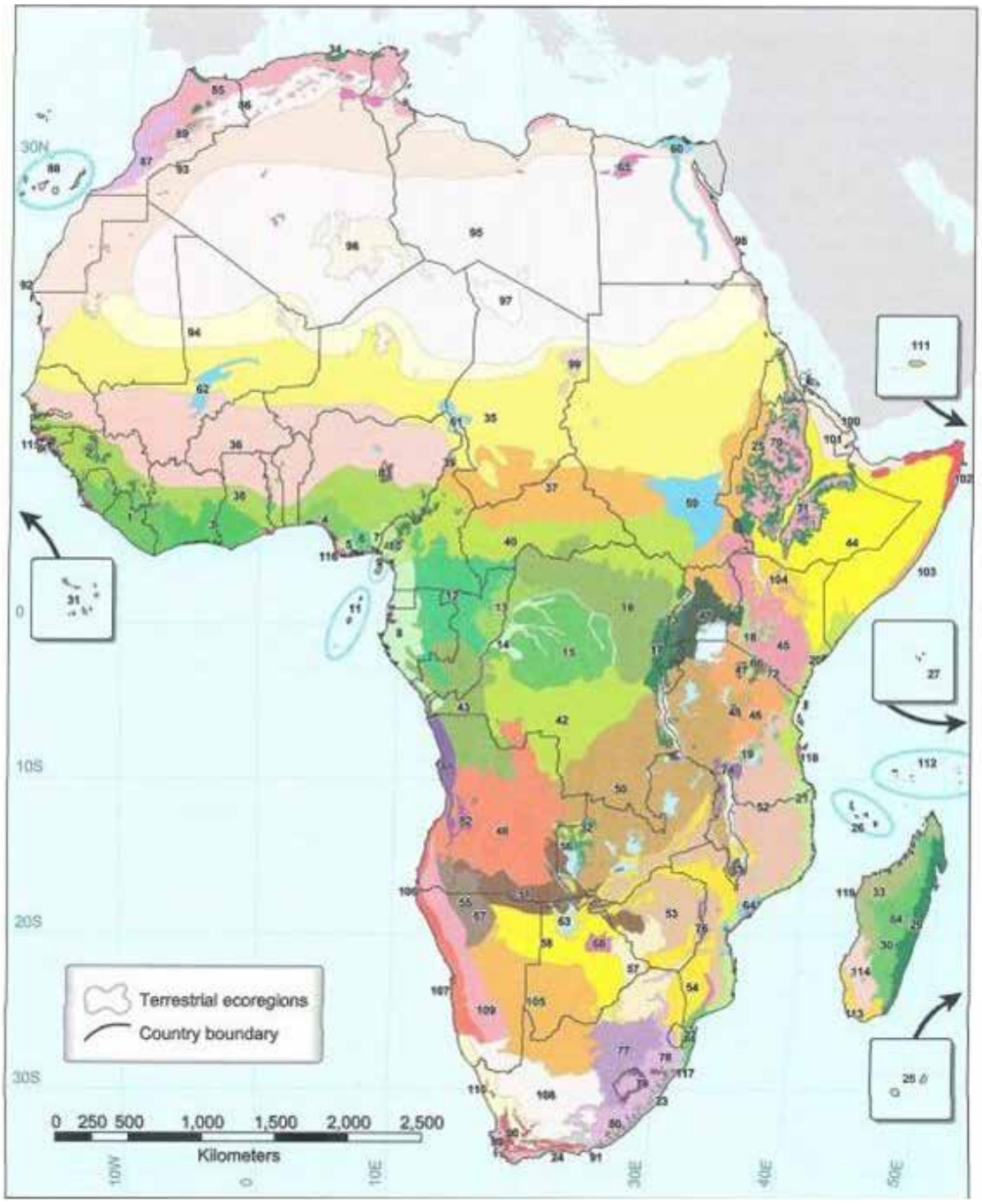
Worker: Large ants, with maximum total length of 5 - 16 mm; head subquadrate in most species (excluding mandibles), suborbicular in some species, posterior border generally concave; mandibles narrowed or triangular-shaped in most species, shorter than head length with teeth number ranging from 6 to 9; anterior medial margin of clypeus convex, often sharply angled or straight to slightly concave with medial raised area; frontal lobes divided by well-developed frontal furrow; scape shorter, nearly reaches or extends slightly past posterior border of head; compound eyes vary from relatively small to large; sculpture smooth or slightly rough to punctate or foveolate; pronotal shoulder squared or rounded, but without lateral margin or carina in all species of *Bothroponera*; mesonotum and propodeum poorly separated by notopropodeal groove; mesometapleural suture well developed; propodeum rounded between faces, mesonotal basalar sclerite rounded or oval-shaped, propodeal spiracle elongate or slightly oval-elongate; petiole subquadrate, rounded antero-posteriorly, usually wide with definite dorsal face; stridulatory file present on second acrotergite of gaster; hairs scarce on body and usually short; color mostly dark brown or black.

Female: Head subquadrate or suborbiculate; pronotum rounded anteriorly, pronotal shoulder lacking carina or lateral margins; scutum wide anteriorly, reaches same width as pronotum, narrowed posteriorly to same width as scutellum; metanotum slightly elevated, narrowed, well separated from propodeum and scutellum; mesopleuron divided by anapleural sulcus to form ventral katepisternum and dorsal anepisternum; mesometapleural suture well defined; mesonotal basalar sclerite oval or round shaped, propodeal spiracles elongate or subrectangular in some species; petiole rounded anteriorly, vertical with slightly concave posterior face in some species; postpetiole rounded or subquadrate anteriorly; postpetiole and remainder of gaster larger than mesosoma; short to moderately long (up to 0.40 mm) erect golden hairs scattered on dorsum of pronotum, scutum, scutellum, metanotum, propodeum, petiole and postpetiole; short (up to 0.15 mm) erect golden hairs on head; surfaces mostly brown, dark brown or black.

Male: Head excluding mandibles rounded or elongated; eyes large, cover most of side of head; scape shorter and thicker than second segment of funiculus; pronotum triangular, scutum usually with notauli; scutellum elevated, triangular in dorsal view, metanotum slightly raised between scutellum and propodeum, mesopleuron divided by anapleural sulcus into ventral katepisternum and dorsal anepisternum; dorsopropodeum gradually sloping downward posteriorly to reach insertion of petiole; petiole small, apex rounded, width and height less than those of propodeum and postpetiole; postpetiole rounded or squared anteriorly; color mostly black or dark brownish.

Bothroponera pumicosa species complex description

Worker: The workers of the *B. pumicosa* species complex are very similar to each other. Workers large, head shape excluding mandibles subquadrate or suborbiculate, slightly narrowed anteriorly; posterior border concave; mandibles triangular, shorter than head length, with 7 - 8 teeth, smooth, coarsely punctate or covered with fine striae in some species; anterior medial margin of clypeus convex, with single medial longitudinal carina (clypeal carina) in some species, "v" or "u" shaped margin anteriorly, sharp or blunt; carinal disc rounded, often divided by longitudinal furrow; lower margins of frontal lobes smooth and shiny; scape barely reaches or slightly passes posterior lateral corner of head; compound eyes relatively large; pronotal shoulder rounded anteriorly; basalar sclerite oval or rounded; mesonotum and propodeum fused (dorsal view); mesometapleural suture well developed; propodeum



Map 1: The terrestrial ecoregions of Africa (Burgess et al., 2004) used with permission from Island Press, Washington, D.C.

angulate, quadrate or rounded posteriorly, propodeal spiracle elongated; petiole well developed with petiolar spiracles and developed sternopetiolar process; sternopostpetiolar process well developed; metatibial gland absent; generally head punctate or coarsely foveolate; edges and bottom of frontal lobes shiny; head, body, legs, antennae, mandibles shiny or weakly striated; dorsum of pronotum, mesonotum, propodeum, petiole, postpetiole usually more coarsely sculptured than sides; entire body covered with scattered or moderately abundant short or long erect golden hairs, denser on dorsum than on sides and longer on mesosoma than on head; frontal lobes covered with fine hairs; color mostly black or dark brown.

The females and males are unknown.

Key to the Afrotropical *Bothroponera* species complexes

1. Metatibial gland present (Fig 3); scape extends at least length of first funicular segment past posterior lateral corner of head; lower margin of anterior medial area of clypeus convex; frontal lobes subquadrate .... *B. sulcata* species complex

- Metatibial gland absent; scape shorter, barely reaches posterior lateral corner of head or extends past less than length of first funicular segment; lower margin of anterior medial area of clypeus convex, straight or slightly concave; frontal lobes rounded .....……. 2

The legend for Map 1 (the terrestrial ecoregions of Africa, Burgess et al., 2004), used with permission from Island Press, Washington, D.C.

2(1). Anterior medial margin of clypeus convex, "u" or "v" shaped; eyes relatively large (eye width 0.30 – 0.45 mm, eye length 0.30 – 0.50 mm and malar space area length 0.38 – 0.75 mm) .....…… *B. pumicosa* species complex

- Anterior margin of clypeus straight or slightly concave or convex but not "v" or "u" shaped; eyes relatively small (eye width 0.10 – 0.35 mm, eye length 0.11 – 0.45 mm and malar space area length 0.12 – 0.51 mm).....*B. talpa* species complex.

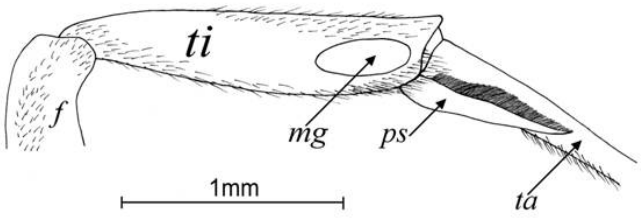


Fig 3. The Metatibial Ggland on the posterior leg of *Bothroponera crassior*. ***f*,** femur; ***ti*,** tibia; ***mg*,** metatibial gland; ***ps*,** pectinate spur; ***ta*,** basitarsus.

Key to the *Bothroponera pumicosa* species complex based on the workers

1. Hairs on entire mesosoma and gaster long (up to 0.55 mm) curly, anterior medial raised area of clypeus "u" shaped without carina ……..... *pumicosa*
- Hairs on entire surface relatively short (0.10 – 0.25 mm) erect moderately long, straight (not curly); anterior medial raised area of clypeus "u" or "v" shaped with or without carina ……..... 2

2(1). Anterior border of clypeus "u" shaped, broadly rounded ……..... 3
- Anterior border of clypeus "v" shaped with sharp anterior medial point …….....…..... 6

3(2). Anterior medial area of clypeus raised from surface (best seen in side view) to form sharp carina, which extends from between frontal lobes to anterior border of clypeus 4
- Anterior medial area raised but does not form sharp carina, if carina partially present, not complete as described above or not sharp ……..……..……..…….……..…. 5

4(3). Posterior border of petiolar node (seen from above) with deep medial depression; mandibles with several deep coarse grooves .....……..……*cariosa*
- Posterior border of petiolar node with little evidence of impression; with smooth shiny mandibles .....……. *strigulosa*

5(3). Body smooth, shiny, black, fourth abdominal segment smooth, shiny ……..…… *laevissima*
- Body strongly sculptured by dense foveolae, fourth abdominal segment foveolate .....……...……. *berthoudi*

6(2). Anterior medial area of clypeus raised to form sharp carina ……..…….. *granosa*
- Anterior medial area raised but does not form carina..…....7

7(6). Propodeal spiracle nearly horizontal; fourth abdominal segment smooth, partially glossy..... *umgodikulula*
- Propodeal spiracle nearly vertical, usually nearly parallel with posteropropodeum; fourth abdominal segment smooth to slightly rough or sculptured …….....…. 8

8(7). Head and mesosoma with sparse punctures, moderately shiny, black ……..... *aspera*
- Head and mesosoma sculptured with dense foveolae ……. 9

9(8). Scapes longer, extending slightly past posterior lateral corner of head (SI 78), short (0.10 up to 0.20 mm) erect golden hairs cover entire surface ……..…….. *cavernosa*
- Scapes barely reaching posterior lateral corner of head (SI 79.59 – 81.25), short (0.10 – 0.15 mm) erect silver hairs cover entire surface .....…….…. *montivaga*

List of species of the *Bothroponera pumicosa* species complex

Bothroponera aspera Arnold 1962 (**stat. nov.)**,
B. berthoudi Forel, 1901 (= *variolosa* **syn. nov.)**,
B. cariosa Emery, 1895
B. cavernosa Roger, 1860
B. granosa Roger, 1860
B. laevissima Arnold, 1915
B. montivaga Arnold, 1947 (**stat. nov.)**,
B. pumicosa Roger, 1860
B. strigulosa Emery, 1895
B. umgodikulula Joma and Mackay 2013

Species accounts of members of the Afrotropical *Bothroponera pumicosa* species complex

***Bothroponera aspera* Arnold, stat. nov.**
Figures 4, 5 and Plate 1; Map 2.

Bothroponera laevissima var. *aspera* Arnold, 1962: 844 (w) South Africa, Saldanha Bay; Joma and Mackay, 2013: 3; Schmidt and Shattuck: 2014: 76; *Pachycondyla laevissima* var. *aspera*: Brown, in Bolton, 1995: 303.

Diagnosis: The worker of *Bothroponera aspera* is large (total length 12 - 13 mm). The mandibles are triangular, shorter than the head length, and smooth. The anterior medial margin of the clypeus is convex, with a single raised medial carina, the anterior margin of the clypeus is "v" shaped. The scape reaches the posterior lateral corner of head or surpasses it by a short distance.

The lower margin of the pronotum is straight, rounded anteriorly (anteroinferior pronotal process) and posteriorly (inferior pronotal process).

In general, the head is shiny, but rough with dense, shallow punctures. The pronotum, mesonotum, propodeum, mesopleuron, petiole, and postpetiole are shiny, but rough with dense, shallow punctures. The terga of the fourth - seventh abdominal segments are mostly smooth and glossy while the entire remainder of the body is sculptured.

Worker Description: (n=2 for measurements), HL 2.55 - 2.75, HW 2.30 - 2.50, ML 1.35 - 1.65, EW 0.35 - 0.40, EL 0.40 - 0.45, SL 1.90 - 2.00, FL 2.35 - 2.80, WL 3.50 - 3.75, WPL 4.35 - 4.70, PL 1.10, PW 1.15 - 1.30, PH 1.40 - 1.45, CI 90.19 - 90.90, OI 17.39 - 18.00, MandI 52.94 - 60.00, SI 80.00 - 82.60, PetI 104.54 - 118.18. Head suborbiculate; mandibles with 7 teeth; maximum clypeal length 2.15 mm; maximum frontal lobe width in full face view 1.00 mm; malar space from side 0.55 mm, length from upper margin of eye to upper margin of occipital lobe 1.25 - 1.30 mm; basalar sclerite oval shaped; propodeum rounded posteriorly; propodeal spiracle elongated, obliquely vertical; petiole rounded anteriorly, posterior face vertical, slightly concave posteriorly; pronotum, mesonotum, propodeum, mesopleuron, petiole, postpetiole shiny, densely punctulate; tergum of second gastral segment mostly smooth, glossy, entire remainder of body sculptured;

entire body and head covered with scattered or moderately abundant short erect silver hairs (0.07 - 0.10 mm), erect hairs on petiole and postpetiole range from 0.10 - 0.15 mm, denser on dorsum than on sides, longer than on head, scape covered with short erect silver hairs (up to 0.07 mm); body black; legs, antennae, mandibles brownish.

Comparison: The worker of *B. aspera* is similar to the worker of *B. laevissima*; however, there are two main differences between them. The first difference is the body sculpturing, which is partially sculptured in *B. aspera* while it is less sculptured and glossy in *B. laevissima*. The head of *B. aspera* is shiny with dense punctures whereas it is shiny with few scattered shallow punctures in *B. laevissima*. The pronotum, mesonotum, propodeum, mesopleuron, petiole and postpetiole are shiny and densely punctulate in *B. aspera*. On the other hand, in *B. laevissima*, the pronotum, mesonotum, propodeum, mesopleuron, and petiole are rough and shiny with a few scattered punctures, but the postpetiole and the 4th abdominal segment along with 5th to 7th abdominal segments are smooth and glossy. The tergum of the second gastral segment is mostly smooth and glossy in *B. aspera* as well. Secondly, the clypeal structure is different in the two species. The clypeus is "v" shaped in *B. aspera* and does not form a carina on the medial raised area, which is sculptured on the sides and without a grooved beak on the lower medial margin of the posteroclypeus whereas the clypeus in *B. laevissima* is "u" shaped. The lower margin of the medial raised area of the clypeus of *B. laevissima* does not form a carina, but the grooved beak on the lower margin of the clypeus is present. Other than that, it is easy to distinguish both *B. aspera* and *B. laevissima* from the rest of the *B. pumicosa* species complex members. The black, smooth, and shiny surface with punctures is found only in *B. aspera* and *B. laevissima*. The other *B. cavernosa* species are characterized by having coarse foveolae on the body surface; however, the 4th abdominal segment is similar in some species to that of *B. aspera* and *B. laevissima*, such as *B. umgodikulula*, *B. cavernosa* and *B. montivaga*.

Plate 1: *Bothroponera aspera*, paratype worker.

There is a specimen from the South Africa Museum that was identified as *Bothroponera aspera* which is quite similar to the paratype specimen of *B. aspera*. This specimen and the paratype of *B. aspera* are from the same locality (Ysterfontein area), but the labels do not indicate if they are from the same nest. We distinguished it from the paratype specimen of *B. aspera* because it does not have the typical clypeal shape. This excluded specimen is possibly a new species of *Bothroponera* that belongs to *B. pumicosa* species complex. It has broad and slightly convex lower margin of the clypeus. The anterior medial area of the clypeus is completely lacking the "V" and "U" shapes of the anterior medial area of the clypeus that were obvious in all of the other *B. pumicosa* complex members. However, further specimens are needed to evaluate this taxon.

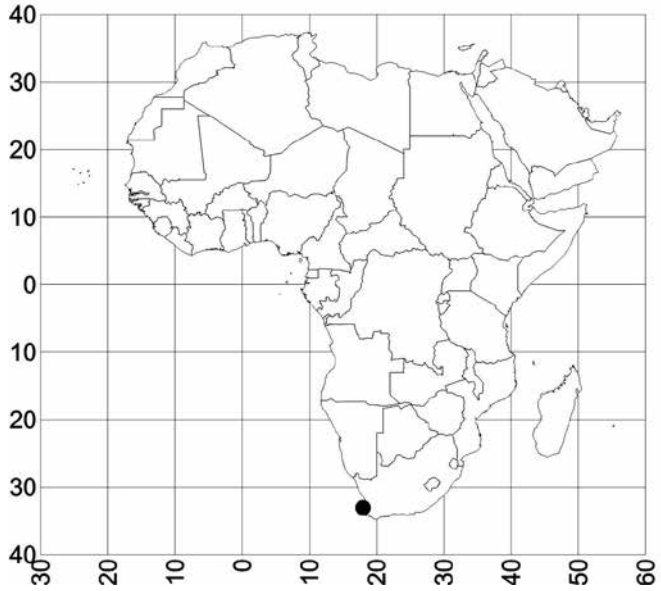
Material examined

Type material: SOUTH AFRICA: Western Cape Province, Ysterfontein, farmstead, 33°1'0'' S; 18°9'0'' E, Dr. A. J. Hesse and Mr. Thom; *Bothroponera laevissima* var. *aspera*, Det. G. Arnold, South Africa museum ex. national museum Bulawayo 1981; SAM-ENT, 9:60 (1 w #11519, Paratype [designator not specified] Iziko).

Non-type material: SOUTH AFRICA: Western Cape Province, Ysterfontein, 33°1'0'' S; 18°9'0'' E; *Bothroponera laevissima* var. *aspera*, Det. G. Arnold; S. A. M. 9:60, possible new species (1 w #COO11519, Iziko).

Distribution: *Bothroponera aspera* is known only from Saldanha Bay, South Africa.

Biology and habitat: *Bothroponera aspera* has been collected from Saldanha Bay area, Western Cape Province. The individuals were living in holes in the ground at Ysterfontein (Yzerfontein), in the southern part of the Saldanha Bay area (Arnold, 1962). The habitat is characterized by Fynbos biome vegetation. The Bay is one of the richest areas in biodiversity in the Western Cape Province. There are assemblages of several groups of organisms including benthic, intertidal, marine and plant species (Anchor Environmental Consultants, 2006, 2012). This habitat has unique distinct flora and fauna that are identified as endemic species to the area, as well as organisms in need of conservation (Schils et al., 2001; Anchor Environmental Consultants, 2006, 2012). The other members of the *B. pumicosa* species complex that can be found in this province include *B. laevissima*, *B. cavernosa*, *B. granosa* and *B. montivaga*.



Map 2. The distribution of *B. aspera*.

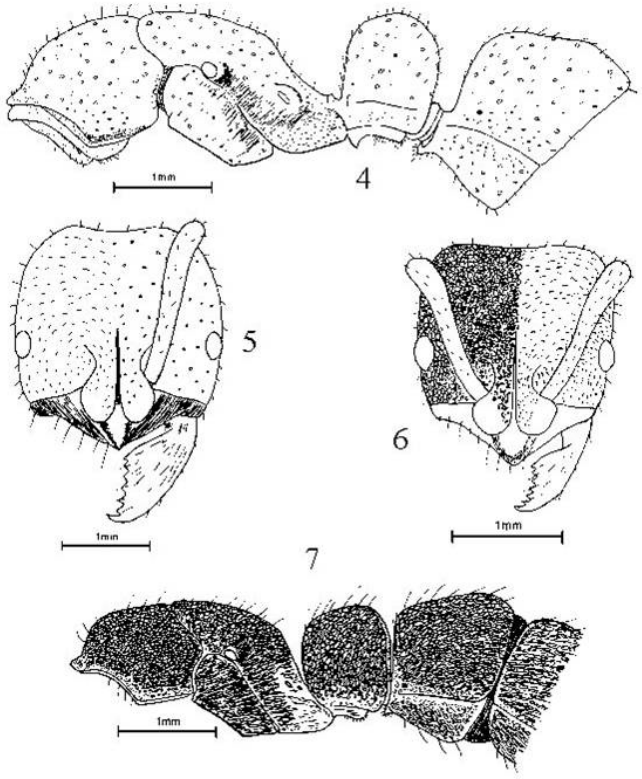


Fig 4. The lateral view of a paratype worker of *Bothroponera aspera* (Iziko). **Fig 5**. The head of the paratype worker of *B. aspera* (Iziko). **Fig 6**. The head of the worker of *B. berthoudi* from South Africa, Eastern Cape Province, Algoa-Bay (MfN). **Fig 7**. The lateral view of a worker of *B. berthoudi* from South Africa, Eastern Cape Province (MfN).

The sculpturing of the head is shown only on the right or left side, to allow the illustration of the hairs on the other side of the head.

***Bothroponera berthoudi* (Forel)**

Figures 6, 7 and Plate 2; Map 3

Pachycondyla (*Bothroponera*) *berthoudi* Forel, 1901: 344 (w), South Africa, Valdezia, Transvaal; Emery, 1911: 76; Forel, 1913a: 306 (m), Willwomore, colonie du Cap; *Pachycondyla* (*Bothroponera*) *pumicosa berthoudi*: Forel, 1913b: 109 (w), Willowmore [Willwomore], Cap; *Bothroponera pumicosa* race *berthoudi*: Arnold, 1952: 460, considered *berthoudi* to be a junior synonym of *strigulosa*; *Pachycondyla berthoudi*: Brown in Bolton, 1995: 303; *Bothroponera berthoudi*: Joma and Mackay, 2013: 3.

Bothroponera variolosa Arnold, 1947: 131 (w), South Africa, Mariepskop, Transvaal; *Bothroponera cariosa variolosa*: Arnold, 1960: 452; *Bothroponera variolosa*: Joma and Mackay, 2013: 3; Schmidt and Shattuck, 2014: 77; *Pachycondyla variolosa*: Brown, in Bolton, 1995: 311 (**syn. nov.**).

Diagnosis: The worker of *Bothroponera berthoudi* is a relatively large ant (total length 9.60 – 12.00 mm). The mandibles are hairy and coarsely covered with punctures. The anterior medial margin of the clypeus is "u" shaped and slightly bent ventrally, with the disc has a raised smooth area with striae. The upper part of the raised area, between the frontal lobes is rough with a few punctulae, and with a small clypeal carinae. The clypeal wings are punctulate and obliquely striate. The scape barely reaches the posterior lateral corner of the head.

Worker Description: (n=8 for measurements), HL 2.00 - 2.61, HW 1.75 - 2.25, ML 1.15 - 1.45, EW 0.30 - 0.35, EL 0.30 - 0.45, SL 1.40 - 1.85, FL 2.10 - 2.60, WL 2.75 - 3.85, WPL 3.60 - 4.90, PL 0.90 - 1.30, PW 0.95 - 1.35, PH 1.30 - 1.60, CI 86.20 - 87.50, OI 17.14 - 20.00, MandI 57.50 - 55.56, SI 80.00 - 82.22, PetI 103.84 - 105.56. Mandibles smooth with about 7 teeth; head subquadrate; maximum transversal clypeal length 1.60 mm; compound eyes relatively large; length of malar space 0.40 mm; length from upper edge of eye to edge of posterior lobe 1.00 mm; maximum frontal lobes width 0.75 mm; surface of head, pronotum, mesonotum, mesopleuron, propodeum, lateropropodeum, metapleuron, densely foveolate, moderately shiny; petiolar and postpetiolar surfaces densely covered with larger foveolae than those of mesosoma, moderately shiny; cheek, sides of head, area posterior to eyes, frons covered with weakly defined striae; dorsum of fourth abdominal segment covered with shallow foveolae and striae; fifth-seventh abdominal segments smooth, shiny; basalar sclerite oval in depressed surrounding area; pronotal shoulder rounded, lower margin straight (lateral view), anteroinferior pronotal process angled, inferior pronotal process rounded; mesometapleural suture developed; mesopleural-coxal excavation developed and continued with mesometapleural suture; antennae, legs, lower edges of frontal lobes, mandibles shiny; anterior face of petiolar node from dorsal view rounded, slightly narrowed anteriorly, posterior face vertical in side view, slightly concave with slight depression on medial upper margin; metapleuron rough, covered with

striae, foveolae; posteropropodeum rough, slightly concave; dorsum of postpetiole densely covered with large foveolae and striae; surface of 4th abdominal segment rough, covered with large foveolae; 5th to 7th abdominal segments moderately shiny, covered with fine striae; head, dorsum of pronotum, mesonotum, propodeum covered with fine moderately long golden erect hairs; hairs moderately long (0.12 mm up to 0.25 mm) hairs on mandibles, legs, scapes; length of hairs on pronotum, mesonotum, propodeum slightly longer (0.20 - 0.25 mm); dorsum of petiole, dorsal and ventral surfaces of postpetiole, and 4th to 7th abdominal segments covered with longer erect golden hairs (0.30 - 0.35 mm); head, pronotum, mesonotum, mesopleuron, propodeum, petiole, postpetiole, entire gaster black; legs and antennae brownish black; mandibles reddish brown.

Comparison: Arnold (1952) considered *B. berthoudi* to be a race of *B. pumicosa*, but it is clear that this species is different from *B. pumicosa* in that *B. pumicosa* has long hairs that cover the entire body, which is not the case in *B. berthoudi*. There are other slight differences between the two species. The anterior medial raised area of the clypeus of *B. pumicosa* forms a partial carina on the posterior part and a smooth narrowed area on the grooved anterior part. The same character is found in *B. berthoudi*, but the upper part forms striae instead of a partial carina, the lower part is smooth but wider than that of *B. pumicosa*. The mandibles have 7 teeth in *B. berthoudi*, similar to the other *B. pumicosa* species complex members, whereas *B. pumicosa* has 8 teeth.

Bothroponera laevissima has the same "u" shaped clypeus as does *B. berthoudi*, but is easily recognized by the unique sculpture: shiny with scattered punctures. The mandibles have 7 teeth in *B. berthoudi* and *B. laevissima*, similar to the other *B. pumicosa* species complex members.

The body surface of *B. berthoudi* is densely foveolate, and the fourth abdominal segment is densely covered with foveolae and striae. Basically, the members of the type series consistently differ from the rest of *B. pumicosa* species complex species in having long erect hairs on most surfaces (except the head) and in lacking a well-defined medial clypeal carina.

The specific epithet "*berthoudi*" was first used by Forel (1890) as a name for *Ophthalmopone berthoudi* from South Africa. Later, he used it again to identify and describe the male of *Ophthalmopone berthoudi*. Wheeler and Wheeler (1971) used the same name to identify larvae of *O. berthoudi*. In 1901 Forel used the same specific epithet to describe *Pachycondyla* (*Bothroponera*) *berthoudi*. *Pachycondyla* (*Bothroponera*) *berthoudi* has been considered to be a secondary homonym of *Pachycondyla (Ophthalmopone) berthoudi*, as they were both placed in the same genus (Bolton, 1995), which has caused considerable confusion. In this project, we clearly distinguish between *O. berthoudi* and *B. berthoudi* as these now belong to two different genera (Schmidt & Shattuck, 2014).

The worker of *B. berthoudi* is identical to the worker of *B. variolosa*, which is considered a synonym. They have the lower medial margin of the clypeus "u" shaped with a medial raised area and lack the sharp carinae.

Bothroponera cariosa and *B. strigulosa* have the same "u" shaped lower medial anterior margin of the clypeus, but this area forms a sharp clypeal carinae in both species, which is lacking in *B. berthoudi*.

Plate 2: *Bothroponera berthoudi* worker.

Material examined

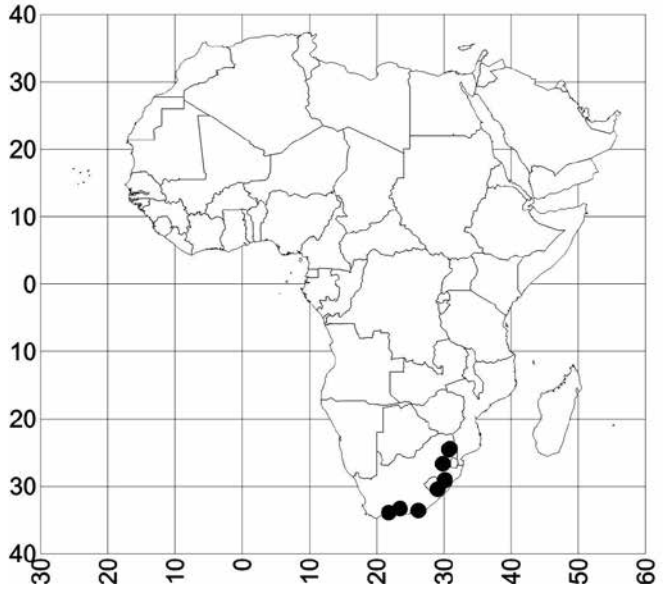
Type material: SOUTH AFRICA: Mpumalanga Province, Salique, A. R. I. Pretoria A. C. U. P. 314 (forests), 24°36'0'' S; 30°54'0'' E, vii-1944, Donated by Univ. Pretoria, 14 Mar 1995, *Bothroponera variolosa* (Arnold, 1947) (1w paratype # C008009, SAM-HYM [Iziko]); **Limpopo Province,** Marieps, A.R.I. Pretoria A. C. U.P. 367 (farmstead and forests), 24°35'0'' S; 30°52'0'' E, vii-1944, *Bothroponera variolosa n. sp.* (Arnold, 1947), (1w paratype, SAM-ENT [Iziko # 0011524]); **Mariepskop** Transvaal, (farmstead), 24°35'0'' S; 30°52'0'' E, vii-1945, J. C. Faure, *Bothroponera variolosa*

(Arnold, 1947), (2w # 0011524 paratypes, SAM-ENT [Iziko], British Museum 1947-250, BMNH (E) 1015515), Antweb Casent 0902470 (2w paratypes, BMNH).

Non-type material: SOUTH AFRICA: Eastern Cape Province, Algoa-Bay, Capland, 33°50'0'' S; 25°50'0'' E, Dr. H. Brauns, Forel det. 1922, that deposited in the Berlin Museum was designated by Forel, (labeled *Pachycondyla* (*Bothroponera*) *berthoudi* Forel, 1w # 6692, MfN), but this specimen is broken into two parts (head with the pronotum is one part and the second part includes the mesonotum, mesopleuron, propodeum, petiole, postpetiole and the 2nd to 5th gastral segments). It is not clear if this specimen is the type or not. **Limpopo Province,** Mariepskop, 4000 Transvaal (farm), 26°42'0'' S; 29°53'0'' E, vii-1944; South Africa Museum ex. National Museum Bulawayo 1981, (labeled *Bothroponera variolosa*, 1w # 11524 SAM-ENT); Some of the *B. berthoudi* specimens that were collected by H. Brauns, Paul Berthoud and G. Arnold were considered to be subspecies of *B. strigulosa*.

Distribution: The species is known from Salique in The Mpumalanga Province, Mariepskop and Valdezia in The Limpopo Province and from Algoa-Bay in The Eastern Cape Province of South Africa. *Bothroponera berthoudi* specimens were collected from other localities in South Africa such as Valdezia (locality of the type specimen), Cape Willowmore (Forel, 1913a, 1913b), Cape Nordhoek and East Griqualand (Arnold, 1952).

Biology and habitat: The type specimen was collected from Valdezia, Limpopo Province, which is far from the Eastern Cape Province where the other material was located. The habitat in Limpopo province is mainly covered with savanna biome (Mucina & Rutherford, 2008; Dubel Integrated Environmental Services, 2009). The additional material examined of *B. berthoudi* was collected from Algoa Bay, which is located at the east of the Cape of Good Hope, on the southeastern coast of South Africa. The Bay area is characterized by two seasons of rain, winter and summer (Goschen & Schumann, 1988). The fynbos and thicket biomes are the major vegetation types that cover the Algoa Bay area. The collection site is in Mpumalanga Province close to the Limpopo Province that are both covered mainly with savanna. The Mariepskop, Limpopo Province includes two continuous nature reserves: Blyde River and Motlatse Canyon Provincial Nature Reserves. They are covered with grassland and savanna biomes in both provinces, close to the Kruger National Park, the vast area that shared between South Africa and Mozambique. Savanna is the major biome of Limpopo Province where the type specimens were collected (Goschen and Schumann, 1988; Mucina and Rutherford, 2008; Dubel Integrated Environmental Services, 2009). These specimens were mainly collected from farms, farmsteads and forest habitats (information from labels and from Google maps).



Map 3. The distribution of *B. berthoudi*.

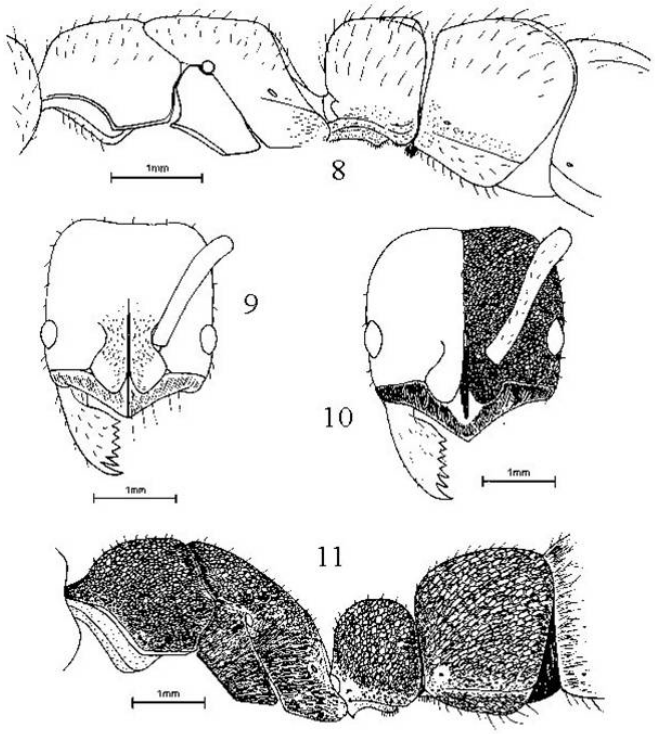


Fig 8. The lateral view of the holotype worker of *B. cariosa* (MCSN).
Fig 9. The head of the holotype worker of *B. cariosa* (MCSN).
Fig 10. The head of the holotype worker *B. cavernosa* showing sculpture on the left side of the head (MfN).
Fig 11. The lateral view of the holotype worker of *B. cavernosa* (MfN).

Bothroponera cariosa Emery

Figures 8, 9 and Plate 3; Map 4

Bothroponera cariosa Emery, 1895: 20 (w), Mozambique, Delagoa-Bay; Wheeler, W.M. 1922: 769; Wheeler, G. C. and Wheeler, J. 1971: 389 (l, semipupa); Joma and Mackay: 2013: 3; Schmidt and Shattuck, 2014: 76; *Pachycondyla* (*Bothroponera*) *cariosa*, Emery, 1901: 45 list; Arnold, 1915: 59 (w); *Pachycondyla cariosa*: Brown in Bolton, 1995: 303.

Diagnosis: The total length of the worker *B. cariosa* is 10.15 - 11.50 mm. The head is subquadrate. The anterior medial border of the clypeus is "u" shaped with the medial longitudinal clypeal area raised to form a sharp carina. The mandibles are partially covered by weakly defined striae with scattered coarse punctures. The scape does not reach the posterior lateral border of the head.

Worker Description: (n=2 for measurements), HL 2.25 - 2.50, HW 1.95 - 2.15, ML 1.25 - 1.40, EW 0.30, EL 0.35 - 0.40, SL 1.45 - 1.60, FL 2.45 - 2.75, WL 2.90 - 3.35, WPL 3.80 - 4.40, PL 1.15 - 1.25, PW 1.20 - 1.45, PH 1.25 - 1.50, CI 86 - 87, OI 17.94 - 18.60, MandI 55.56 – 56.00, SI 74, PetI 104 – 116. Maximum clypeal width 1.90 mm; mandibles with 7 teeth, partially covered by weakly defined striae with scattered coarse punctures; maximum frontal lobe width 0.95 mm; length of malar space 0.40 - 0.60 mm, length from upper edge of eye to edge of posterior lobe 1.20 - 1.55 mm; compound eyes relatively large; head coarsely foveolate; lower margin of pronotum straight with rounded inferior and anteroinferior pronotal processes; basalar sclerite oval-shaped; antennae, legs, mandibles shiny; petiole thick, anterior face and apex rounded, seen from above slightly narrowed anteriorly with depression on upper medial margin between two edges posteriorly (seen from above), posterior face vertical (side view), slightly concave; sternopetiolar process developed with one tooth pointed ventrally; entire surface covered with fine scattered suberect to erect hairs, including mandibles, scapes; head covered with short (0.05 - 0.10 mm) erect golden hairs, pronotum, mesonotum, propodeum covered with short (0.05 - 0.15 mm) erect golden hairs, petiole, postpetiole, entire gaster covered with longer (0.15 - 0.25 mm) erect golden hairs; head, entire mesosoma (pronotum, mesonotum, mesopleuron, propodeum), petiole, postpetiole, entire gastral segments black; appendages (legs, antennae, mandibles) reddish brown; clypeus dark-brown; funiculus brown.

Comparison: *Bothroponera cariosa* is similar to many other species of the *B. pumicosa* species complex with a "u" shaped anterior medial margin of the clypeus (e.g. *B. berthoudi*, *B. strigulosa*, *B. pumicosa*, and *B. laevissima*), but the anterior medial area of the clypeus is developed into a sharp longitudinal carina, which is similar to that of *B. strigulosa*. The sharp carina is partially present in *B. pumicosa* while it is absent in *B. berthoudi* and *B. laevissima*.

Bothroponera granosa is the other species in the *B. pumicosa* species complex that has the clypeus raised to form a sharp carina, but the anterior medial margin of the clypeus is "v" shaped. The "v" shaped clypeus is also present in *B. aspera* and *B. umgodikulula,* but both *B. aspera* and *B. umgodikulula* lack the carina and the surface of the disc is smooth and rounded. This area is formed into partial carinae in *B. montivaga* and *B. cavernosa*. The petiole viewed from above is similar to that of *B. berthoudi*, but is definitely indented posteriorly in *B. cariosa*, but nearly straight and not indented in *B. berthoudi*. *Bothroponera cariosa* has total length about 11.50 mm, which is longer than that of *B. berthoudi* (9.60 - 12 mm) while it is smaller than that of *B. cavernosa* (12 mm), *B. montivaga* (12.20 - 12.65 mm), *B. granosa* (13.75 - 14.50 mm), *B. strigulosa* (12.20 mm), *B. umgodikulula* (14.80 - 15.65 mm), *B. laevissima* (12 - 13.00 mm), and *B. aspera* (12 - 13 mm). The total length of *Bothroponera pumicosa* ranges from 11.00 - 11.65, which overlaps the total length of *B. cariosa*.

Material examined

Type material: MOZAMBIQUE: Delagoa Bay, mountains, 25°59'0'' S; 32°42'0'' E, type, *Bothroponera cariosa* Emery, Holotypus *Pachycondyla cariosa* Emery 1895, Museo Geneva coll. C. Emery (1w holotype, MCSN).

Non-type material: SOUTH AFRICA: Eastern Cape Province, Grahamstown**,** 33°18'0'' S; 26°32'0'' E, F. Jacot-Guillarmod, Highlands Rd, W. Grahamstown grassy grove, *B. cariosa* Em. WLB 1973, compared with type (1w, BMNH).

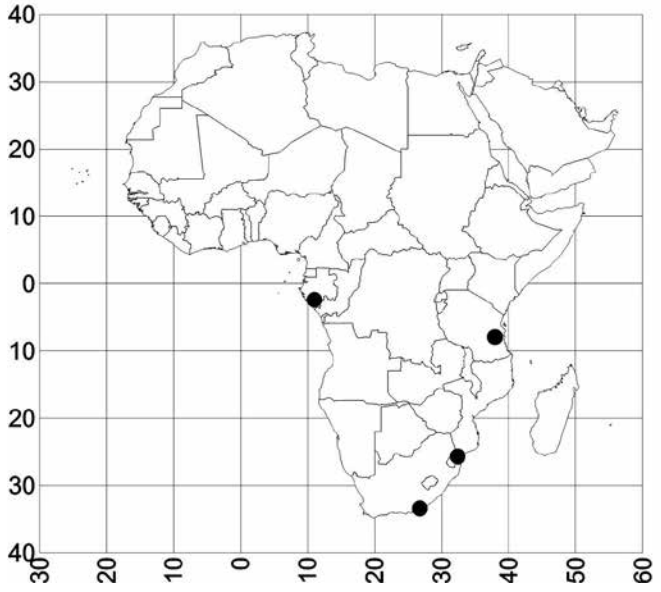
Distribution: *Bothroponera cariosa* is distributed in South Africa, Tanzania, Gabon (Ant web, accessed May 2013) and Mozambique (Emery, 1895). Workers were collected from the Cape Province; Transvaal area, South Africa by G. Arnold (Arnold, 1915).

Biology and habitat: The *Bothroponera cariosa* holotype was collected from Delagoa Bay, Mozambique. This area is located at the southeast coast of Mozambique, near the South African border, on the coast of the Indian Ocean, East Africa.

Plate 3: Holotype worker of *B. cariosa*.

Delagoa Bay is the former name of Maputo Bay. The climate in the south of Mozambique is semi-arid and subtropical while it is tropical in the north; the southern areas of the country are generally drier than the northern areas and have fluctuations in temperature and rainfall (Country Briefs web page, accessed May 2013). The country has one rainy and one dry season per year. The habitat in Mozambique is characterized by forest ecosystems that increase in elevation, especially close to Zimbabwe border and are also characterized by grassland ecosystems. The mangroves grow in the swamps and there are palm trees on the coast. These types of ecosystems most likely hold various species of ants, including *Bothroponera* (based on Bolton, 1994, 1995, 2012; Ant web, accessed January 2012; Ant wiki, accessed May 2013). Mainly, this species can be found in habitats that are characterized by high humidities and wet soils, which is the typical environment of the tropical and subtropical areas. It builds nests underground or under stones to form colonies with a small number of individuals (Wheeler, 1922; Wheeler & Wheeler, 1971).

The ant biodiversity in Mozambique is high where we can find the following species: *Megaponera crassicornis*, *Paltothyreus tarsatus delagoensis*, *Bothroponera strigulosa*, *B. kruegeri*, *B. talpa* besides *B. cariosa* (Bolton, 1994, 1995, 2012; Ant web, accessed January 2012). The recent ants collected from Mozambique, by Dr. Gary Alpert, are deposited in the MCZC. This collection includes variable species that belong to several genera of subfamily Ponerinae such as *Bothroponera*, *Hypoponera*, *Leptogenys*, *Megaponera*, *Mesoponera*, *Odontomachus*, *Platythyrea*, *Paltothyreus* and *Plectroctena* (based on a personal visit to the MCZC in 2013). *Bothroponera cariosa* is also found in Cape Province, Transvaal. The Transvaal area is located at the north of Vaal River and extends to the borders of Botswana, Zimbabwe, Mozambique and Swaziland.



Map 4. The distribution of *B. cariosa*.

***Bothroponera cavernosa* (Roger)**
Figures 10, 11 and Plate 4; Map 5

Paraponera cavernosa Roger, 1860: 288 (w) South Africa, Kaffernlande; *Pachycondyla* (*Bothroponera*) *cavernosa*: Emery, 1901: 45 (list); Arnold, 1915: 60 (w) Cape; *Bothroponera cavernosa*: Mayr, 1862: 717; Wheeler, 1922: 769, South Africa, Caffraria, Cape Province (w); Joma and Mackay: 2013: 3; Schmidt and Shattuck, 2014: 76; *Pachycondyla cavernosa*: Brown, in Bolton, 1995: 304.

Diagnosis: The main distinguishing character of the worker *B. cavernosa* is the lack of foveolae on the second tergum of the gaster, which is rough and covered with short hairs. The worker is large (total length 12 mm). The anterior margin of the clypeus is "v" shaped and covered with fine striae. The anterior medial area of the clypeus is raised, covered with longitudinal striae and coarsely punctate on the sides with an incomplete clypeal carina. The mandibles are rough, moderately shiny and covered with striae. The scape extends slightly past the posterior lateral border of the head. The frontal lobes are sculptured and covered with striae. The frons is weakly striated. The propodeal spiracle is parallel to the posteropropodeal margin. The petiole is rounded and slightly narrowed anteriorly while it is vertical, slightly concave posteriorly (seen from above).

Worker Description: (n=1)**,** HL 3.00, HW 2.70, ML 1.45, EW 0.40, EL 0.45, SL 2.10, FL 3.60, WL 4.15, WPL 4.70, PL 1.15, PW 1.45, PH 1.75, CI 90, OI 17, MI 48.33, SI 78, PI 126.08. Head suborbiculate; mandibles covered with fine striae, with 7 teeth; clypeus covered with striae, anterior medial area raised to form discontinuous carina, coarsely punctate and rough on sides, clypeal length 2.35 mm; scape extends slightly past posterior border of head; maximum frontal lobe width 1.10 mm; length of malar space 0.55 mm; length from upper edge of eye to edge of posterior lobe 1.40 mm; pronotal shoulder rounded anteriorly, lower margin of pronotum straight with rounded anteroinferior pronotal process, pointed inferior pronotal process; basalar sclerite oval shaped; head mostly foveolate; antennae rough, scape covered with tiny shallow punctures, legs shiny; entire dorsum of mesosoma foveolate and rough; mesopleuron, lateropropodeum foveolate; metapleuron, lateropropodeum covered with coarse striae and grooves orientated perpendicular to posteropropodeal margin; dorsum of petiole and postpetiole coarsely foveolate and more punctate than other body parts; metapleuron and lateropropodeum covered with striae that have perpendicular orientation with posteropropodeal lateral margin; entire head, pronotum, mesonotum, propodeum, petiole, postpetiole covered with short erect golden hairs (up to 0.20 mm), on head, antennae, mandibles (0.03 - 0.08 mm in length), on pronotum, mesonotum, propodeum (up to 0.10 mm length), on petiole, postpetiole (0.13 - 0.15 mm in length); sternopostpetiolar process and 4th to 7th abdominal segments covered with relatively short (0.20 mm) erect golden hairs; head, mesosoma, petiole, 3rd - 7th abdominal segments black; mandibles, clypeus, appendages brownish red.

Plate 4: *Bothroponera cavernosa*, holotype worker.

Comparison: *Bothroponera cavernosa* is very easy to recognize as it is one of the five species in the *B. pumicosa* species complex with a specific form of the tergum of the 4th segment of the abdomen (2nd gastral tergite), that is rough and covered with short hairs. The other species are *Bothroponera laevissima, B. aspera*, *B. umgodikulula* and *B. montivaga*. The 2nd gastral segment of *B. umgodikulula* is mostly smooth and glossy, similar to that of *B. aspera* and *B. laevissima*, while in *B. montivaga* it is smooth with few shallow scattered punctures and is moderately shiny. The head shape of *B. cavernosa*, *B. aspera*, and *B. laevissima* is suborbicular while it is subquadrate in *B. umgodikulula* and *B. montivaga*. The other important differences between *B. cavernosa*, *B. umgodikulula* and *B. montivaga* compared to *B. laevissima* and *B. aspera* is that the body surface is heavily sculptured with foveolae in *B. cavernosa*, *B. umgodikulula* and *B. montivaga* while it is black, nearly smooth and shiny in *B. laevissima* and *B. aspera* with a few scattered punctures in *B. aspera*. *Bothroponera cavernosa* and *B. umgodikulula* both share all of the characteristics of *B. montivaga* except for the propodeal spiracle, which is obliquely vertical in *B. montivaga* and *B. cavernosa* while it is horizontal in *B. umgodikulula.* The anterior medial area of the clypeus is raised and does not form a complete clypeal carina in *B. cavernosa* (it is partially carinated). On the other hand, the anterior medial area of the clypeus of *B. umgodikulula* and *B. montivaga* is mostly smooth, and does not form carinae and in some specimens of *B. montivaga* the carina is only on the upper part of the anterior medial raised area of the clypeus while the lower part is smooth.

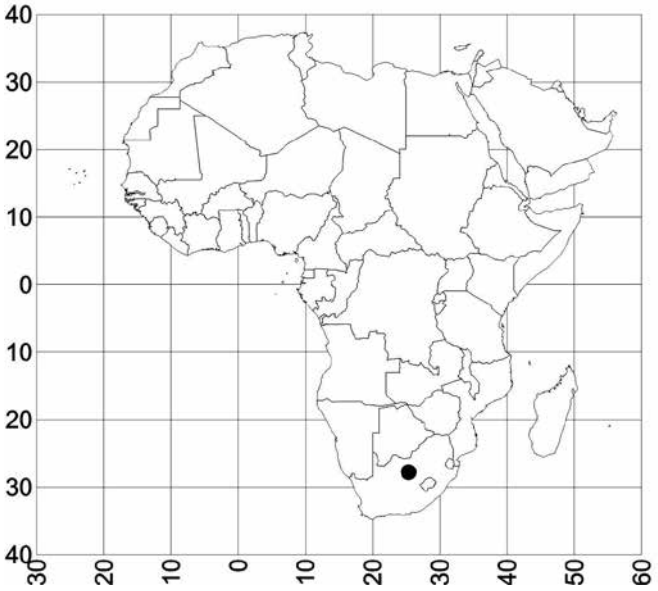
Material Examined

Type material: SOUTH AFRICA: Eastern Cape Province, Caffraria Drege, farm, 27°48’0’’ S; 25°7’0’’ E, *Bothroponera cavernosa* Roger, Mayr (1 w # 7165 GBIF-D/FoCol 0955, holotype, MfN).

Non-type material: Although we requested material from several collections, the holotype was the only specimen available for this study.

Distribution: South Africa.

Biology and habitat: The type specimen is known from Kaffernlande, South Africa. Kaffernlande is the former name of what is known today as the Transkei and Ciskei regions (Transkei District), Eastern Cape Province (Dr. Worden, personal communication). The habitat in this area is characterized by three types of biomes: Grassland, Savanna and Thicket. This indicates the high biodiversity and different habitats that are available to the organisms in the area, which could result in high speciation rates. In fact, most of the species in the *B. pumicosa* species complex species were found in South Africa. Caffraria or Kaffraria also is a descriptive name that was given to the southeast part of what is called today the Eastern Cape of South Africa. The material examined was collected in a farmland area in Caffraria. Wheeler (1922) and Wheeler and Wheeler (1971) reported that this species, as well as *B. pumicosa* and *B. cariosa*, are usually found in colonies with a small number of individuals under stones in humid habitats and wet soils.



Map 5. The distribution of *B. cavernosa*.

***Bothroponera granosa* (Roger)**
Figures 12, 13 and Plate 5; Map 6

Ponera granosa Roger, 1860: 290 (w) SOUTH AFRICA, Cape of Good Hope; *Bothroponera granosa*: Mayr, 1862: 717; Dalla Torre, 1893:36; Wheeler, W. M. 1922: 770; Joma and Mackay: 2013: 3; Schmidt and Shattuck, 2014: 76; *Pachycondyla* (*Bothroponera*) *granosa*: Emery, 1901: 45; Arnold, 1915: 61(w); *Pachycondyla granosa*: Arnold, 1926: 201 (m); Brown, in Bolton, 1995: 305; Bolton, 2013.

Diagnosis: The head of the worker is large and subquadrate. The mandibles are covered with hairs and partially by fine weakly defined striae and scattered coarse punctures. The anterior medial margin of the clypeus is "v" shaped with a raised sharp medial longitudinal carina. The scape reaches the posterior lateral corner of the head. The lower margin of the pronotum is straight with a strongly rounded angle at the anteroinferior pronotal process (lateral view), rounded inferior pronotal process and sometimes forming a sharp angle that is pointed posteroventrally. The petiole (dorsal view) is rounded and slightly narrowed anteriorly while it has a slight concavity on the upper medial margin between the two posterior angles of the petiolar apex. The posterior edge of the petiole is vertical (side or top view) and slightly concave (dorsal view). The sternopetiolar process is developed with a single tooth pointed ventrally.

Worker Description: (n= 20)**,** HL 2.90 - 3.10, HW 2.40 - 2.75, ML 1.40 - 1.75, EW 0.30 - 0.40, EL 0.40 - 0.50, SL 1.90 - 2.35, FL 2.90 - 3.50, WL 3.90 - 4.45, WPL 4.80 - 5.40, PL 1.20 - 1.30, PW 1.40 - 1.60, PH 1.50 - 1.80, CI 83 - 89, OI 17 - 18.18, MandI 48.27 - 56.45, SI 79.16 - 85.45**,** PetI 117 – 123. Total length 13.75 - 14.50 mm; mandibles with 7 teeth; clypeal length 1.70 - 2.35 mm; malar space length from lower edge of eye to base of mandible 0.40 - 0.65 mm; from upper edge of eye to edge of posterior lobe 1.35 - 1.70 mm; frontal lobe width 0.90 - 1.15 mm; metapleuron rough and weakly punctate; head covered with small dense punctures; sides of head covered with fine striae; dorsum of pronotum, mesonotum, mesopleuron, lateropropodeum and propodeum moderately punctate, moderately shiny; metapleuron rough, weakly punctate; petiole covered with deeper sparse punctures and foveolae than postpetiole; postpetiole covered with shallow sparse punctures, foveolate, with weakly defined fine striae; dorsum of second gastral segment covered with shallow foveolae and striae; remaining gastral segments shiny; lower margin of pronotum straight with strong angle at anteroinferior pronotal process, rounded inferior pronotal process; antennae, legs, lower edge of frontal lobes, mandibles shiny; entire surface of *B. granosa* worker covered with fine short (up to 0.15 mm) silver hairs, denser on second - seventh gastral segments (up to 0.20 mm); entire surface covered with scattered erect golden hairs, including mandibles, scapes; head, pronotum, mesonotum; propodeum covered with short erect golden hairs (0.10 - 0.15 mm); dorsum of petiole covered with short erect golden hairs (0.15 mm); postpetiole, entire gaster covered with longer erect golden hairs (0.15 - 0.20 mm); hairs on sternum of postpetiole, hairs on other gastral segments reach about 0.30 mm.

Plate 5: *Bothroponera granosa*, worker. (From www.antweb.org. Accessed 23 February 2015).

Head, pronotum, mesonotum, mesopleuron, propodeum, petiole, postpetiole, entire gaster black; legs, antennae, clypeus, mandibles brownish black.

Comparison: The worker of *B. granosa* can be recognized by the anterior medial raised area of the clypeus ("v" shaped anterior border) that forms a sharp longitudinal carina, which differs from most of the other *B. pumicosa* species complex members (except *B. cariosa* and *B. strigulosa*). The anterior medial area of the clypeus is also "v" shaped in *B. cavernosa*, *B. montivaga*, *B. aspera* and *B. umgodikulula*, but without a carina in *B. aspera* and *B. umgodikulula* while it is partially carinate in *B. cavernosa* and *B. montivaga*. The other species, including *B. cariosa*, *B. strigulosa*, *B. pumicosa*, *B. laevissima* and *B. berthoudi* have an anterior medial raised area of the clypeus with a "u" shaped anterior border, however *B. cariosa* and *B. strigulosa* have a sharp carinae similar to *B.*

granosa. The surface of *B. granosa* is more likely to be rough with moderately scattered punctures than that of the other *B. pumicosa* species complex taxa, which are always coarsely foveolate except for *B. aspera* and *B. laevissima*, which are shiny black with punctate sculpture. The petiolar shape of *B. granosa* is unique among the *B. pumicosa* species complex individuals even if the petiolar indices seem not to be separable. The petiole is rounded and slightly narrowed anteriorly (dorsal view) in all species of the *B. pumicosa* species complex including *B. granosa*, but the posterior face is deeply depressed from the upper edge to form two rounded apices found only in *B. granosa* (best seen from above). The petiolar indices vary among the *B. pumicosa* species complex members in that the smallest PetI recorded were for *B. aspera* (104.54 - 118.18), and *B. berthoudi* (105.55), whereas the largest PetI registered was for *B. montivaga* (130.00). The other species have intermediate PetI, *B. umgodikulula* (115 - 126), *B. granosa* (117 - 123), *B. strigulosa* (117.39), *B. laevissima* (118.18 - 121.05), *B. pumicosa* (120.00 - 125.00), *B. cariosa* (104 - 116), and *B. cavernosa* (126.08).

Material examined

Type material: The types were not found, therefore, we used specimens determined by Forel and Bolton to define this species. **SOUTH AFRICA**: **KwaZulu-Natal Province**, Natal, Broughton, (farm) 29°26'0'' S; 30°27'0'' E, Wm. M. Wheeler collection, *Pachycondyla* (*Bothroponera*) *granosa* Roger (1 worker, AMNH, one worker specimen from MfN determined by Forel in 1922. **SOUTH AFRICA**: George [cgcorge kocysica Browns], *Pachycondyla* (*Bothroponera*) *granosa* Roger, Forel det. 1922, Zool. Mus. Berlin (1w MfN and two specimens from LACM that were determined by Bolton in 1977). **Eastern Cape Province,** Highland Rd., W. Grahamstown grassy grove, 33°18'0'' S; 26°32'0'' E, 22-x-1966, F. Jacot-Guillarmod, collection of W. S. Creighton purchased by LACM 1974 (2 workers # 315919 LACM). One specimen (1 worker # 315920) from the Los Angeles County Museum determined by Forel with no further information. This specimen was in collection of W. S. Creighton, but was purchased by the Los Angeles County Museum in 1974.

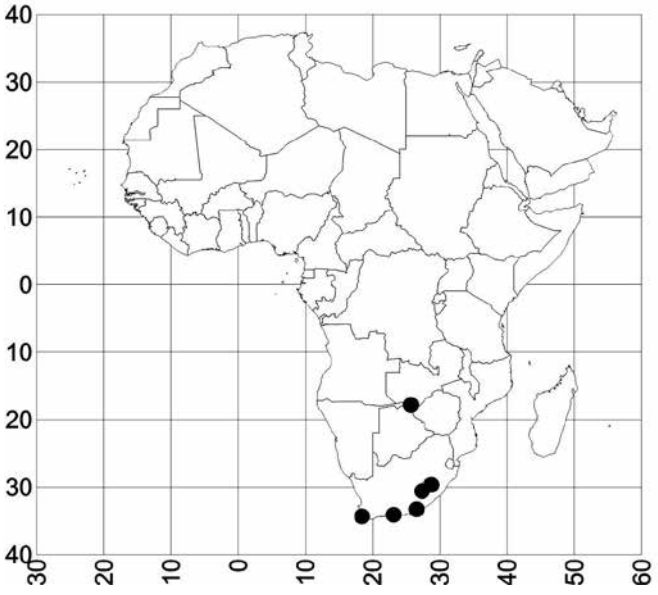
Non-type material: SOUTH AFRICA: Eastern Cape Province, Highlands Rd. W., Grahamstown grassy grove, 33°18'0'' S; 26°32'0'' E, F. Jacot Guillarmod (3w MCZC, 1w CWEM), **Coldsprings,** Grahamstown, under stone, 33°18'0'' S; 26°32'0'' E, 9-viii-1964, C. Jacot-Guillarmod (1w MCZC), Near Highlands farm SW of Grahamstown C. P., 33°18'0'' S; 26°32'0'' E, 22-x-1966, L. H. Weatherill, ANIC Ants Vial 14.164, Ent. 315917, 315918 (4w LACM), 27 km NW of Cathcart, 32°18'0'' S; 27°8'0'' E, N. G. Robertson, 16-ix-1985, C46, h. rock (2w BMNH); **KwaZulu-Natal Province**, Estcourt Natal, 29°0'0'' S; 29°53'0'' E (R.C.W.) 1914, G. Arnold, Arnold coll. B. M. 1934-354, *Pachycondyla pumicosa* Roger det. B. Bolton 1977 (1w # 315925 LACM). **Natal**, **Drakensberg**, 29°0'0'' S; 29°0'0'' E, 2200m, 1983, C. Peeters, Giant's Castle DRA (P) io (3w, BMNH).

Distribution: Most of the specimens of *Bothroponera granosa* were collected from South Africa, including the Eastern Cape and KwaZulu-Natal Provinces. They were also collected from the Cape of Good Hope (Roger, 1860), Natal area (Forel, 1901) and from Cape Knysna and Cape Majuba Nek areas (Arnold, 1926). Some specimens were collected from Victoria Falls, Zimbabwe (Arnold, 1926).

Biology and habitat: *Bothroponera granosa* inhabits the grassy grove areas of West Grahamstown in South Africa, under stones. It can also be found in rocky habitats such as the area north west of Cathcart City in South Africa (label information). The three specimens from Natal, Drakensberg and that from KwaZulu-Natal Province, Estcourt Natal, South Africa were misidentified as *B. pumicosa*.

Arnold (1926) reported that *B. granosa* was also taken at Victoria Falls located on the border between Zimbabwe and Zambia, which is far from the South Africa collection sites. The habitat at Victoria Falls is similar to that at the town of Knysna which has the Knysnarivier Stream (River) and the areas are covered with deciduous forests. The stream is connected with the Indian Ocean at the extreme southern shores of South Africa. The material examined was collected from a grassy grove and farmland habitats (information from labels and Google Earth Maps). One specimen was collected from Cape Province, South Africa by F. Jacot-Guillarmod, misidentified in the MCZC as *B. cariosa*.

The Western Province, KwaZulu-Natal Province and Eastern Province include several other species that belong to the *B. pumicosa* species complex: *B. montivaga*, *B. aspera* and *B. laevissima* found in the Western Cape Province, *B. umgodikulula*, *B. cariosa*, *B. granosa*, *B. cavernosa*, *B. berthoudi* and *B. pumicosa* found in Eastern Cape Province. *Bothroponera granosa* was also collected from Knysna, Western Cape Province and Majuba Nek, Eastern Cape Province (2 workers and one male) as material examined (Arnold, 1926).



Map 6. The distribution of *B. granosa*.

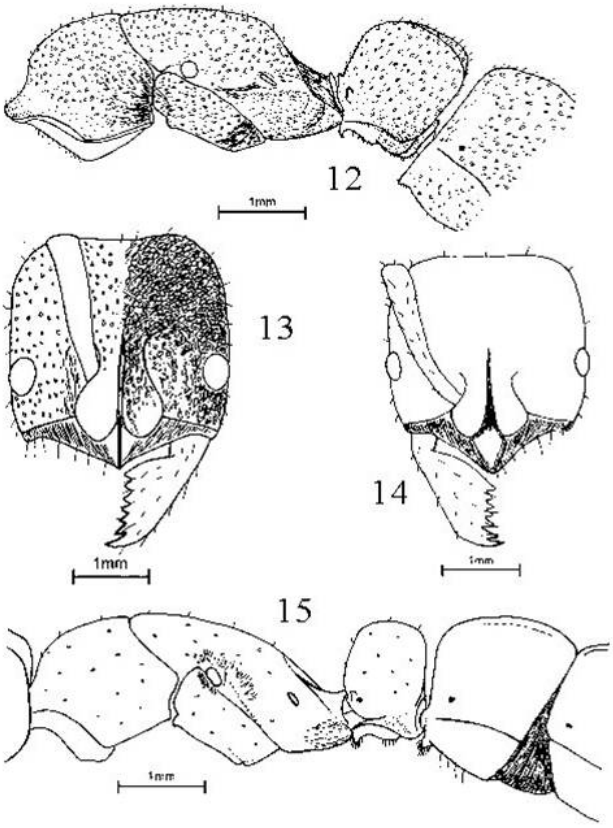


Fig 12. The lateral view of worker of *B. granosa* (AMNH). **Fig 13**. The head of worker of *B. granosa* (AMNH). **Fig 14**. The head of the lectotype worker of *B. laevissima* (Iziko). **Fig 15**. The lateral view of the lectotype worker of *B. laevissima* (Iziko).

***Bothroponera laevissima* (Arnold)**
Figures 14, 15 and Plate 6; Map 7

Pachycondyla (Bothroponera) laevissima Arnold, 1915: 58 (w) South Africa, Cape Province, Saldanha Bay; *Bothroponera laevissima*: Wheeler, W.M. 1922: 73; Joma and Mackay: 2013: 3; Schmidt and Shattuck, 2014: 76; *Pachycondyla laevissima*: Brown, in Bolton, 1995: 306

Diagnosis: The workers of *Bothroponera laevissima* are large (total length 12 - 13 mm) shiny black ants. The mandibles are shorter than the head length and covered with fine striae. The anterior medial raised area of the clypeus is convex, but lacks a longitudinal carina; the anterior border is "u" shaped. The lower margin of the clypeus has a short grooved beak on the lower margin of the posteroclypeus. The metapleural area is compressed in some specimens.

The head is smooth and shiny with few punctulae scattered on the surface. The pronotum, mesonotum, mesopleuron, propodeum, petiole and postpetiole are smooth and shiny with a few scattered punctulae. The petiole is more sculptured than the other body parts. The second gastral tergite is smooth and glossy.

Worker Description: (n=9)**,** HL 2.90 - 3.10, HW 2.50 - 2.65, ML 1.55 - 1.70, EW 0.35, EL 0.35 - 0.40, SL 1.95 - 2.15, FL 2.95 - 3.10, WL 3.65 - 3.95, WPL 4.40 - 4.85, PL 0.95 - 1.10, PW 1.15 - 1.30, PH 1.35 - 1.55, CI 85.48 - 86.20, OI 14.00 - 15.09, MandI 53.44 - 54.83, SI 78.00 - 81.13, PetI 118.18 - 121.05. Head suborbiculate; mandibles with 7 teeth; clypeal length 2.15 - 2.35 mm; frontal lobe width 0.90 - 1.05 mm; scape nearly reaches posterior lateral corner of head; compound eyes relatively large; malar area length 0.60 - 0.75 mm, length from upper margin of eye to upper margin of posterior corner of head 1.25 - 1.45 mm; area around basalar sclerite depressed; basalar sclerite oval; propodeum rounded; propodeal spiracle elongated, diagonal on lateropropodeum; sternopostpetiolar process well developed; edges and anterior part of frontal lobes shiny; entire body covered with scattered or moderately abundant short erect silver hairs (0.07 - 0.10 mm), hairs on dorsum denser than those on sides, longer than those on head, similar hairs on petiole, postpetiole, range from 0.10 - 0.15 mm; entire body black; legs, antennae and mandibles brownish.

Comparison: The worker of *B. laevissima* can be recognized as a shiny black ant. The general characters of the worker of *B. laevissima* are similar to those of the worker of *B. aspera*, but the lower margin of the anterior medial raised area of the clypeus has a "u" shape in *B. laevissima* while it has "v" shape in *B. aspera*. The lower margin of the clypeus forms a grooved beak in *B. laevissima*, which is not found in *B. aspera*. Despite that they both have a shiny surface and black color, *B. laevissima* is characterized by a smooth head with few scattered punctulae, similar to the pronotum, mesonotum, mesopleuron, propodeum, petiole and postpetiole. The petiole is more sculptured than other body surfaces; the second gastral tergite is smooth. Conversely, *B. aspera* is recognized as rough with dense shallow punctulae on the body surface (head, pronotum, mesonotum, mesopleuron, propodeum, petiole and postpetiole), the tergum of the second-fifth gastral segments are mostly smooth and glossy. Due to the mostly polished sculpture, *B. laevissima* would not be confused with any other species except *B. aspera*. *Bothroponera laevissima* was collected from Saldanha Bay, Western province area of South Africa, where *B. aspera* also occurs, which further suggests they are separate species.

Material examined

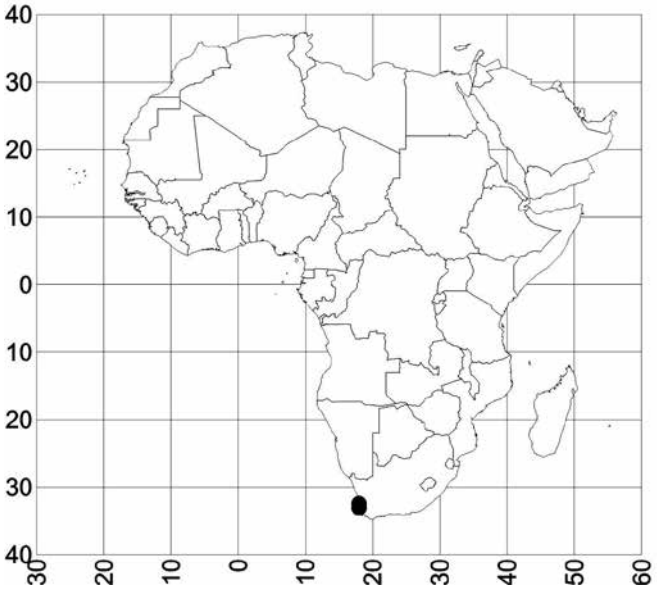
Type material: SOUTH AFRICA: Western Cape Province, Saldanha Bay, 33°1'0'' S; 17°57'0'' E, ix-1912, L. P., Rhodesian museum, South Africa museum ex. national museum Bulawayo 1981, *Pachycondyla laevissima* G. Arnold, SAM-ENT 11518, 11517, *Bothroponera laevissima* (4w, lectotype marked with red dot and 3 paralectotype worker without dot [here designated], Iziko). leg. F. Peringuey; ix 1912; *Pachycondyla laevissima*, G. Arnold; Arnold coll. B. M. 1934-354 (BMNH (E) 1015515) Antweb Casent 0902471, *Bothroponera laevissima* (2w, Syntypes, BMNH).

Non-type material: SOUTH AFRICA: Western Cape Province, Saldanha Bay, 33°1'0'' S; 17°57'0'' E, Sept. 1912, L. P., Arnold determ., *Pachycondyla laevissima* G. Arnold, SAM-ENT 0011517, *Bothroponera laevissima* (3w, Iziko).

Distribution: Known from Saldanha Bay, South Africa. A *B. laevissima* worker was collected from Jacobsbai, 32°58'0'' S; 17°53'0'' E, Cape Province by H. G. Robertson and C. Peeters (The Ants of Africa website, accessed March 2014).

Biology and habitat: The Western Cape Province includes the Cape Floristic Region (CFR), which is considered one of the global biodiversity hotspots that needs priority conservation attention. It is small area, but includes high plant species richness, especially plants considered as endemics to CFR. It also includes several endemic species of birds, amphibians, insects and a few invertebrates (Giliomee, 2003). Ants play an important role in maintaining this ecosystem and they use different habitat such as under litter, on the ground, in logs, inside dead trees and on tree branches. The nest of *B. laevissima* from Jacobsbai, Cape Province, South Africa was found in sandy soil (The Ants of Africa web, accessed May 2014). The main vegetation characterizing the Western Province are Fynbos and Succulent Karoo biomes with high floral diversity accompanied by a moderate to high biodiversity of ant species. Although these ecosystems have their own biodiversity and richness of organisms resembling similar global ecosystems, they contain less ant biodiversity and richness than rainforest habitats (Braschler et al., 2012). Both *B. laevissima* and *B. aspera*, with *B. cavernosa, B. montivaga* and *B. granosa* were collected from the Western Cape Province. The various vegetation types and biodiversity in the Western Cape Province has apparently led to high speciation in the area which may happen only in this and similar areas in South Africa. The Cape Provinces in South Africa include Eastern Cape, Western Cape, and Northern Cape and includes about half of the *B. pumicosa* species complex species. For example, *B. strigulosa* is found in the Northern Cape, *B. berthoudi* in the Eastern Cape with the previous five species in the Western Cape Province. The Cape Provinces are unique because they also hold the majority of the South Africa area and all types of biomes, including Forest, Nama Karoo, Fynbos, Thicket, Savanna and Succulent Karoo.

Plate 6: *Bothroponera laevissima*, lectotype worker.



Map 7. The distribution of *B. laevissima*.

***Bothroponera montivaga* Arnold, stat. nov.**
Figures 16, 17 and Plate 7; Map 8

Bothroponera cavernosa var. *montivaga* Arnold, 1947: 132 (w) South Africa, Steenberg Mountains, Cape Peninsula; Joma and Mackay: 2013: 3; Schmidt and Shattuck 2014: 76; *Pachycondyla cavernosa* var. *montivaga*: Brown, in Bolton, 1995: 307.

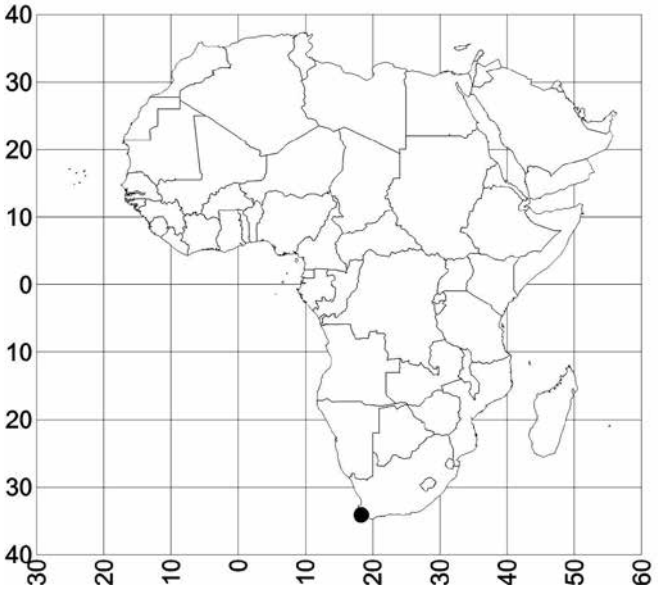
Diagnosis: The worker is large, total length 12.20 - 12.65 mm. The 2nd gastral segment of the *B. montivaga* worker is smooth and moderately shiny with a few shallow scattered punctures. The anterior border of the clypeus is convex, "v" shaped with a smooth anterior medial raised area and with a carina on the posterior half.

Worker Description: (n=2), HL 2.80 - 2.90, HW 2.40 - 2.45, ML 1.50, EW 0.35 - 0.40, EL 0.45, SL 1.95, FL 2.90, WL 3.80 - 3.75, WPL 4.50 - 4.55, PL 1.00, PW 1.30, PH 1.55 - 1.50, CI 84.48 - 85.71, OI 18.36 - 18.75, MandI 51.72 - 53.57, SI 79.59 - 81.25, PetI 130. Head subquadrate; maximum clypeal length 2.00 - 2.05 mm; mandibles weakly striate with few scattered punctures, 7 teeth; scape nearly reaching posterior border of head; anterior margins of frontal lobes smooth, posterior part punctate; maximum width of frontal

lobes 0.95 - 1.00 mm; length of malar space (0.50 mm), length from upper edge of eye to edge of posterior lobe 1.25 mm; propodeal spiracle sloping vertically; antennae, legs, mandibles shiny; petiole rounded and slightly narrowed anteriorly (top view), slightly concave posteriorly; sternopetiolar process developed with one tooth pointed ventrally; head covered with short (0.10 mm) erect silver hairs; pronotum, mesonotum, propodeum covered with short (0.10 - 0.15 mm) erect silver hairs; petiole and postpetiole covered with similar hairs (0.15 mm); head, pronotum, mesonotum, propodeum, mesopleuron, lateropropodeum, metapleuron, petiole and postpetiole coarsely foveolate. Metapleuron and lateropropodeum covered with vertical striae with upper part of posteropropodeal margin with coarse vertical nearly parallel grooves with posteropropodeal margin on lower part;second segment of the gaster smooth, slightly shiny and with tiny scattered punctures; mandibles, antennae and legs shiny; petiole rounded and slightly narrowed anteriorly, slightly concave posteriorly; head, pronotum, mesonotum, mesopleuron, propodeum, petiole, postpetiole, entire gaster black; legs, antennae, mandibles brownish black; clypeus dark-brown.

Comparison: The workers of *B. montivaga* are nearly identical to those of *B. cavernosa* and *B. umgodikulula*. They differ from *B. cavernosa* and *B. umgodikulula* in the following ways: the surface of the 4th abdominal segment is smooth, but slightly less shiny, with tiny scattered punctures in *B. montivaga* while it is somewhat rough and shiny in *B. umgodikulula* and *B. cavernosa*. The anterior medial area of the clypeus is raised, but does not form a complete clypeal carina in *B. montivaga*, *B. umgodikulula* and *B. cavernosa*. The lower medial margin of the clypeus is "v" shaped without a carina in *B. montivaga* similar to that in *B. umgodikulula*, *B. cavernosa* and *B. aspera*, but this shape is with a longitudinal sharp carina in *B. granosa*. This character separates *B. montivaga* from the other *B. pumicosa* species complex members in that all species including *B. berthoudi*, *B. cariosa*, *B. laevissima*, *B. pumicosa* and *B. strigulosa* have an "u" shaped anterior medial margin of the clypeus. The propodeal spiracle is nearly vertical, leaning slightly anteriorly in *B. montivaga* resembling that in *B. cavernosa* and the other species in this complex, but not horizontal as in *B. umgodikulula*. The scape nearly reaches the posterior lateral corner of the head in *B. montivaga* similar to that in *B. berthoudi*, *B. cariosa*, *B. granosa*, *B. laevissima*, *B. pumicosa* and *B. strigulosa*. Conversely, the scape slightly exceeds the posterior lateral border of head in *B. cavernosa* and *B. aspera*, but just reaches or slightly exceeds it in *B. umgodikulula*. The sculpture of *B. montivaga* is foveolate identical to that of *B. berthoudi*, *B. cavernosa*, *B. pumicosa*, *B. strigulosa*, *B. cariosa* and *B. umgodikulula* while it is mostly smooth in both *B. laevissima* and *B. aspera* with few punctures in *B. aspera*. The sculpture is somewhat less foveolate in *B. granosa*. The head is subrectangular of *B. montivaga*, but it is suborbicular in both *B. laevissima* and *B. aspera*.

Plate 7: *Bothroponera montivaga*, lectotype worker.



Map 8. The distribution of *B. montivaga*.

Material examined

Type material: SOUTH AFRICA: Western Cape Province, Steenberg Mountains, Cape Peninsula, 34°4'0'' S; 18°28'0'' E, ii-1946, C. Pearson *B. cavernosa* v. *montivaga* (Arnold, 1947), 1 lectotype worker [here designated, marked

with red dot] and 1 paralectotype worker without dot (# 11516), Collection South Africa museum ex. National Museum Bulawayo 1981 SAM/ENT (Iziko).

Non-type material: None.

Distribution: Only known from South Africa, Cape Province.

Biology and habitat: *Bothroponera montivaga* specimens were collected from the Steenberg Mountains of the Cape Peninsula of South Africa. This area is located in Southern Cape Town City opposite the region with *B. cavernosa*, which is the Northern Cape Town. The habitat is similar in both areas; they are covered mostly with Fynbos and Thicket biomes (Picker & Samways, 1996). The Cape Peninsula is rich with very high percentage of endemic fauna and flora, especially for species that inhabit caves and mountains. The area is considered as a distinct hotspot that provides relictual habitats for organisms. Human activities, disturbances, introduction of alien species and fragmentation increase the importance of conservation priority for species in the Cape Peninsula (Picker & Samways, 1996).

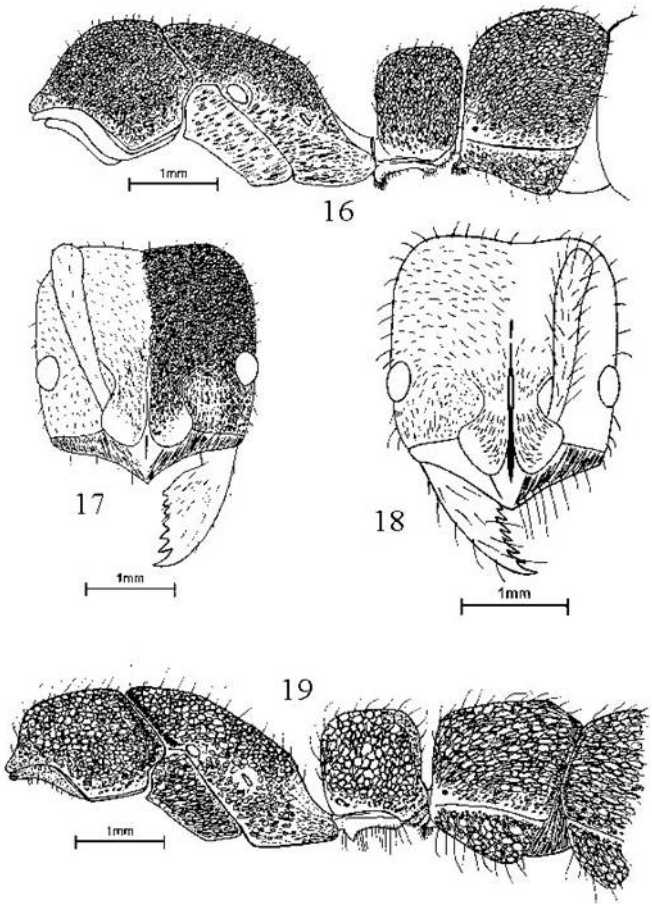


Fig 16. The lateral view of the lectotype worker of *B. montivaga* (Iziko).
Fig 17. The head of the lectotype worker of *B. montivaga* (Iziko).
Fig 18. The head of the holotype worker of *B. pumicosa* (Iziko).
Fig 19. The lateral view of the holotype worker of *B. pumicosa* (Iziko).

***Bothroponera pumicosa* (Roger)**
Figures 18, 19 and Plate 8; Map 9

Ponera pumicosa Roger, 1860: 290 (w) SOUTH AFRICA, Kaffernlande; *Bothroponera pumicosa*: Mayr, 1862: 717 (w); Joma and Mackay: 2013: 3; Schmidt and Shattuck 2014: 76; *Bothroponera pumicata*: Raffray, 1887: 21 [Misspelled name for *B. pumicosa* (Bolton, 2012)]; *Pachycondyla* (*Bothroponera*) *pumicosa*: Emery, 1901: 45; Stitz 1910: 130; Arnold, 1915: 62; Santschi, 1914: 4 *Pachycondyla pumicosa*: Forel, 1901: 344 (m); Wheeler, 1922: 771; Wheeler, G. C. and Wheeler, J. 1971: 390 (l); Brown, in Bolton, 1995: 308

Diagnosis: The worker of *Bothroponera pumicosa* is characterized by a large total length (11- 12 mm). The main distinguishing character of the *B. pumicosa* worker is the long (up to 0.50 mm or more) golden hairs that are distributed on the entire body including the mandibles, clypeus, and legs. The hairs on the scape are long, at least as long as greatest diameter of the scape. The mandibles are hairy and smooth. The anterior medial margin of the clypeus is convex, "u" shaped, with a raised smooth medial clypeal area on the lower part and is partially carinate on the upper part between the frontal lobes. The lower part of the medial raised area tends to form a groove. The scape does not reach the posterior lateral corner of the head.

Worker Description: (n=5), HL 2.50 - 2.75, HW 2.05 - 2.15, ML 1.30 - 1.40, EW 0.30 - 0.35, EL 0.40, SL 1.75 - 1.80, FL 2.35 - 2.60, WL 3.25 - 3.70, WPL 4.10 - 4.30, PL 1.00, PW 1.20 - 1.25, PH 1.00 - 1.55, CI 82.00 - 78.18, OI 19.51 - 18.60, MandI 51.00 - 52.00, SI 81.39 - 85.36, PetI 120 – 125. Head subquadrate; mandibles with about 8 teeth, covered with hair (0.20 mm in length); maximum clypeal length 1.85 - 2.00 mm; scape not reaching posterior lateral corner of head; maximum frontal lobes width 0.90 - 0.95 mm; frontal furrow well developed; length of malar space from lower edge of eye to base of mandible 0.50 mm; length from upper edge of eye to edge of posterior lobe 1.20 mm; frontal furrow well developed; lower margin of pronotum straight with anteropronotal area forming strongly curved angle, rounded inferior pronotal angle; basalar sclerite oval shaped; mesometapleural suture developed; anterior face of petiole from dorsal view rounded, slightly narrowed, posterior face vertical, slightly concave posteriorly (side view); posterior edge of petiole with slight depression (seen from above); mandibles shiny; antennae, legs, edges of frontal lobes, surface of head densely punctate; pronotum, mesonotum, propodeum, lateropropodeum, and metapleuron densely foveolate; mesopleuron rough with few scattered punctae and foveolae; petiolar and postpetiolar surfaces covered with larger foveolae than those of mesosoma; postpetiolar dorsum partially covered with striae; dorsum of second segment of gaster covered with shallower foveolae than those of petiole and postpetiole, covered with large striae; gastral segments rough, shiny; long golden hairs (up to 0.50 mm or more) distributed on entire body including mandibles,

clypeus, legs; hairs on scape long, at least as long as greatest diameter of scape; erect and suberect hairs on body surface as following: head, funiculus, mandibles with long hairs (0.20 mm), hairs on scape about 0.20 mm on far end, about 0.40 mm on near area of scape's base, hairs on legs about 0.25 - 0.30 mm, on pronotum, mesonotum, propodeum (0.40 - 0.45 mm), on petiole, postpetiole, entire gaster (0.50 - 0.55 mm); head, pronotum, mesonotum, mesopleuron, propodeum, petiole, postpetiole, entire gaster black; femora, mandibles brownish black; tibia, tarsi, antennae, edges of frontal lobes brown.

Comparison: The worker of *B. pumicosa* has a similar "u" shaped anterior margin of the clypeus as those of *B. strigulosa*, *B. cariosa*, *B. berthoudi*, and *B. laevissima*. The upper part of the raised area of the clypeus forms a partial carina while it forms a complete longitudinal sharp carina in both *B. strigulosa* and *B. cariosa*, but *B. berthoudi*, and *B. laevissima* lack the carina. The long hairs (up to 0.50 mm or more) separate *B. pumicosa* from all of the other members of the *B. pumicosa* species complex. The hair length of the other *B. pumicosa* species complex species is less than 0.20 mm for the head; less than 0.25 mm for the pronotum, mesonotum, and propodeum; and less than 0.35 mm for the petiole and postpetiole. The traits of *B. pumicosa* are very similar to those of *B. berthoudi* and *B. strigulosa*, but it can be separated by the longer hairs and the form of the anterior medial border of the clypeus. The length of the hairs on the head of *B. strigulosa* is 0.07 - 0.13 mm with a few hairs up to 0.16 mm. The length of the hairs of the head of *B. berthoudi* is 0.20 mm. The hairs on the dorsum of the pronotum, mesonotum and propodeum are 0.25 mm, and 0.07 - 0.16 mm in *B. berthoudi* and *B. strigulosa* respectively. The length of the hairs on the petiole and postpetiole in *B. strigulosa* is 0.15 - 0.18 mm, and those of *B. berthoudi* less than 0.30 mm. The hairs length comparison of these species with *B. pumicosa* shows that *B. pumicosa* has the longest hair length among those mentioned above. The hairs on the entire body of *B. berthoudi* are up to 0.35 mm in length, but the hairs of *B. pumicosa* are longer, up to 0.45 - 0.55 mm.

Among the 5 specimens of *B. pumicosa*, there is one specimen, a worker # 315926, from the LACM, that appears to be different from the others based on hair length. This specimen was collected from South Africa and determined by Forel without any further information. The hairs on the head measure from 0.07 to 0.11 mm, on the mandibles from 0.10 to 0.20 mm, on the scape from 0.14 to 0.21 mm, hairs on the legs range from 0.15 to 0.22 mm, on the anterior part of the pronotum from 0.20 to 0.22 mm, posterior part of pronotum, sides of pronotum, mesonotum and propodeum from 0.05 to 0.15 mm, on edges of posteropropodeum up to 0.22 mm, on the petiole from 0.05 to 0.13 mm, on the postpetiole up to 0.10 mm, on the sides of postpetiole up to 0.22 mm, hairs between the gastral segments (ventrally) from 0.36 to 0.44 mm, on the pygidium up to 0.22 mm and ventrally (hypopygium) up to 0.30 mm. The other characters for this specimen are quite similar to those of *B. pumicosa*. It is possible it could be a new species, but when more specimens are collected, it can be reevaluated.

Plate 8: *Bothroponera pumicosa,* holotype worker.

Material examined

Type material: SOUTH AFRICA: Kaffernlande, Transkei District, 31°30'0'' S; 29°0'0'' E, *Bothroponera pumicosa* type (Roger, 1860) (1 w holotype, #11522.) SAM-ENT (Iziko).

Non-type material: SOUTH AFRICA: Eastern Cape Province, Grahamstown, 33°18'0'' S; 26°32'0'' E, 21-iv-1986, N. G. Robertson, C154, u. stone (3w BMNH). **SOUTH AFRICA:** No further information, Forel det., collection of W. S. Creighton purchased by LACM 1974, *Pachycondyla pumicosa* Roger, det. Forel (1w # 315926 LACM).

Distribution: *Bothroponera pumicosa* is known from the Cape Province of South Africa (Wheeler 1922), the Cape of Good Hope (Roger, 1860), the Natal, Province of KwaZulu-Natal (Forel, 1901; Santschi, 1914: 4) and some other workers were collected from a nest in Burntkraal, Cape Province (The Ants of Africa website, accessed March 2014). This species collected also from Cameroon (Wheeler, 1922) and Mundame, Cameroon (Stitz, 1910).

Biology and habitat: The type specimen was collected from Kaffernlande, former name of the Transkei and Ciskei regions, both in the Transkei District (per. comm. Dr. Worden) and the Eastern Cape Province, South Africa. The type specimens of *B. cavernosa* were also collected from Kaffernlande. The habitat in Transkei District is covered with three types of biomes: Grassland, Savanna, and Thicket biomes (Map 1). These species, with *B. cariosa*, are recognized by their behavior in that they build small colonies under stones in moist clay soils. They are mainly specialized to feed on termites (Wheeler, 1922; Wheeler and Wheeler, 1971). The worker and male of *B. pumicosa* were collected from the Cape Province, Natal, South Africa (Forel, 1901: Arnold, 1915).

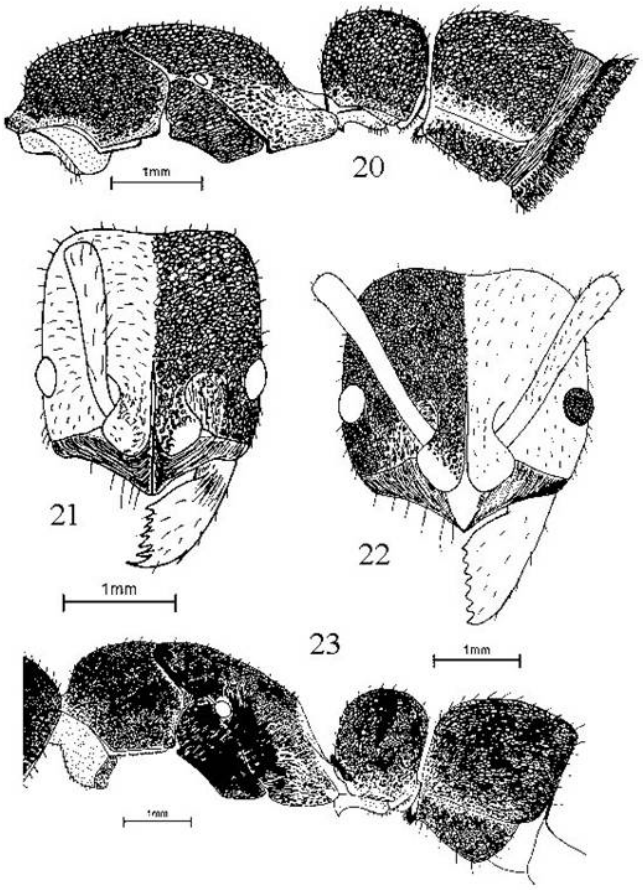
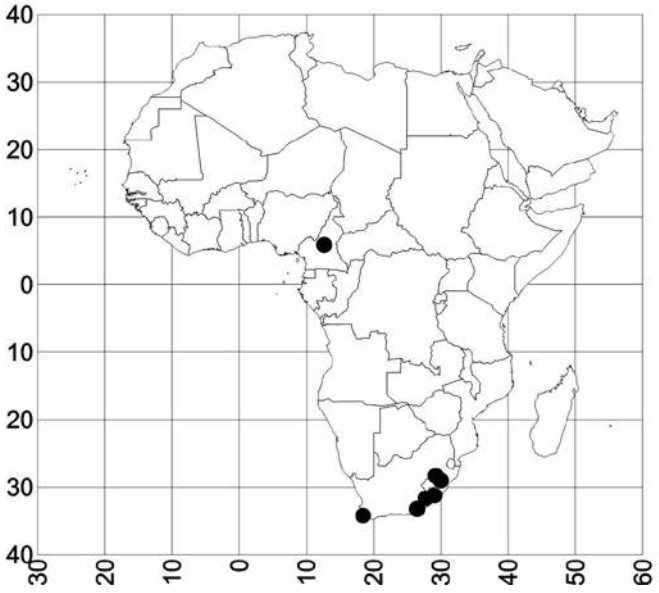


Fig 20. The lateral view of the holotype worker of *B. strigulosa* (MCSN). **Fig 21**. The head of the holotype worker of *B. strigulosa* (MCSN). **Fig 22**. The head of the holotype worker of *B. umgodikulula* (MCZC). **Fig 23**. Lateral view of the holotype worker of *B. umgodikulula* (MCZC).

Bothroponera strigulosa Emery

Figures 20, 21 and Plate 9; Map 10

Bothroponera strigulosa Emery, 1895: 19 (w) South Africa, Kimberley; Wheeler, W.M. 1922: 72 in key; Joma and Mackay: 2013: 3; Schmidt and Shattuck, 2014: 76; *Pachycondyla (Bothroponera) strigulosa*: Emery, 1901: 45 list; Arnold, 1915: 61 (w); Wheeler, W.M. 1922: 773; *Pachycondyla strigulosa*: Brown, in Bolton, 1995: 310.



Map 9. The distribution of *B. pumicosa*.

Diagnosis: The head of the worker is subquadrate and the mandibles are smooth and covered with hairs. The anterior medial margin of the clypeus is convex and forms a "u" shaped edge, and the clypeus has a raised medial sharp carina which extends from the base of the frontal furrow to the lower medial margin of the clypeus.

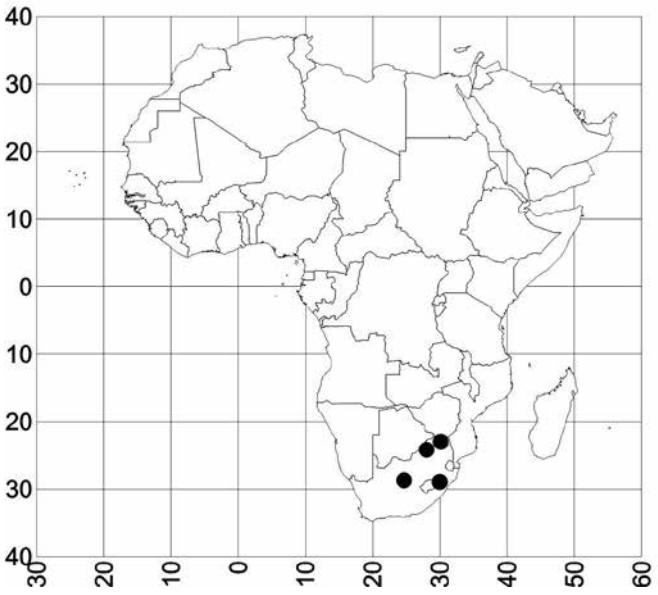
Worker Description: (n=1), HL 2.50, HW 2.10, ML 1.35, EW 0.35, EL 0.45, SL 1.65, FL 2.50, WL 3.60, WPL 4.50, PL 1.15, PW 1.35, PH 1.45, CI 84, OI 21.42, MandI 54, SI 79, PetI 117.39. Total length 12.20 mm; mandibles triangular with 7 teeth, smooth, moderately covered with hairs (0.10 - 0.20 mm long); clypeal length 1.85 mm; scape nearly reaches posterior lateral corner of head; malar space from lower edge of eye to base of mandible 0.38 mm; length from upper edge of eye to edge of posterior lobe 1.10 mm; surface of head coarsely foveolate; frontal lobes rounded, smooth, shiny with width of 0.85 mm; pronotal shoulder rounded; two sharp angles on anterior (anteroinferior pronotal process) posterior (inferior pronotal process) ends of lower margin of pronotum (lateral view); basalar sclerite rounded; lower part of mesopleural suture well developed with mesopleural-coxal excavation; petiole in dorsal view rounded, slightly narrowed anteriorly, anterior face vertical (side view), slightly concave posteriorly (side view) with slight depression on upper medial margin (top view); mesosoma 3.4 mm, gaster length 4 mm; antennae, edges of frontal lobes, mandibles and legs shiny; pronotum, mesonotum, propodeum, lateropropodeum, metapleuron densely foveolate, punctate; posteropropodeum rough, slightly concave; petiolar and postpetiolar surfaces densely covered with larger foveolae than those of mesosoma; postpetiolar dorsum partially covered with striae; second - fifth gastral segments densely covered with foveolae, punctures that become smaller, shallower posteriorly; postpetiolar dorsum partially covered with striae; dorsum of 2nd - 5th segments of gaster covered with fine striae; short (0.05 – 0.22 mm)

golden hairs distributed on entire body including mandibles, clypeus, head, scape, legs; top of the head covered with short (0.05 - 0.13 mm) golden erect hairs; dorsum of pronotum, mesonotum, propodeum covered with short golden erect hairs (0.07 - 0.13 mm, a few up to 0.18 mm); petiole (0.08 - 0.22 mm), postpetiole covered with moderately short erect hairs (0.12 - 0.18 mm); sternopetiolar and sternopostpetiolar processes and 3rd to 7th abdominal segments covered with moderately long hairs (0.11 – 0.22 mm); ventral surface of gastral segments and between segments (0.15 - 0.32 mm); pygidium and hypopygium (up to 0.30 mm); head, scape, pronotum, mesonotum, mesopleuron, propodeum, petiole, postpetiole, entire gaster, legs black or dark-brown; mandibles, funiculus, frontal lobes reddish brown.

Comparison: *Bothroponera strigulosa* is similar to *B. cariosa*, and *B. pumicosa*, as they all have a "u" shaped anterior medial margins of the clypeus. *Bothroponera strigulosa* is quite similar to *B. cariosa*, but it can be distinguished because the mandibles of *B. strigulosa* are smooth and shiny while in *B. cariosa* they are covered with fine striae. The mandibles in *B. pumicosa* are hairy and smooth. The hairs are long (from 0.20 up to 0.55 mm) in *B. pumicosa* while they are short in *B. strigulosa* (from 0.05 up to 0.32 mm) and *B. cariosa* (from 0.05 up to 0.25 mm).

The characters of *Bothroponera strigulosa* are similar to those of *B. berthoudi*. The only apparent differences between them are that the raised medial area of the clypeus of *B. berthoudi* is smooth and the clypeal carina is not present, but *B. strigulosa* has a clypeal carina (it partially forms a carina in *B. pumicosa*). The erect golden hairs on most surfaces are slightly longer in *B. berthoudi* than those of *B. strigulosa*.

Plate 9: *Bothroponera strigulosa*, holotype worker.



Map 10. The distribution of *B. strigulosa*.

Material examined

Type material: SOUTH AFRICA: Northern Cape Province, Kimberley, 1230 m [4040 ft] (Gr. W.), 28°44'0'' S; 24°46'0'', E, E. Simon 1893, *Bothroponera strigulosa* (Emery, 1895), Museo Geneva coll., Emery (dono 1925) (1w Holotype, MCSN).

Non-type material: None.

Distribution: Known from the type locality of Kimberley, South Africa. *Bothroponera strigulosa* was collected from Vaalwater, Northern Province, South Africa (The Ants of Africa website, accessed March 2014).

Biology and habitat: Kimberley, Northern Cape Province, South Africa is a large city located almost in the center of South Africa, close to the Free State Province. The summer climate is hot and wet, the annual maximum temperature is 26.05 ºC, the annual minimum temperature is 10.8 ºC (Kimberley website 1 and Kimberley website 2). It rains an average of 42.0 cm/year while the winter climate is dry to moderately dry (Kimberley website 1 and Kimberley website 2). The area is considered as a dry or semi-arid region, which is the typical environment for the Northern Cape Province. Mokala National Park, one of the 20 national parks

in South Africa, is located south-southwest of Kimberley. The main vegetation in this park is the savanna biome with Kameeldoring trees or camel thorn trees *Acacia erioloba*, one of the major tree species of the desert regions (Kimberley website 3). This park is also one of the protected areas that include several endangered species and wild animals. The Northern Cape Province is characterized by three types of biomes, succulent karoo, nama karoo, and savanna biomes.

***Bothroponera umgodikulula* Joma and Mackay**
Figures 22, 23 and Plate 10; Map 11

Bothroponera umgodikulula Joma and Mackay 2013: 1 - 8 (w) South Africa, Whittlesea; Schmidt and Shattuck: 2014: 77.

Diagnosis: The worker of *B. umgodikulula* can be diagnosed by several morphological characters, such as the lack of sculpture on the tergum of the fourth abdominal segment (second gastral segment), which is mostly smooth and glossy. The propodeal spiracle is unusual in being nearly horizontal on the lateropropodeum. The worker of *B. umgodikulula* is also characterized by the largest body size among *Bothroponera* species, which is 14.80 - 15.65 mm.

Worker Description: HL 3.00 - 3.10, HW 2.85 - 2.95, ML 1.50 - 1.70, EW 0.40 - 0.45, EL 0.45, SL 2.35 - 2.40, FL 3.65 - 3.75, WL 4.20, WPL 5.00 - 5.50, PL 1.30 - 1.35, PW 1.50 - 1.70, PH 1.75 - 1.80, CI 95.00 - 95.16, OI 15.78 - 15.25, MandI 50.00 - 54.83, SI 82.45 - 81.35, PetI 115 – 126. Head subquadrate; mandibles triangular, shorter than head length, smooth and glossy with scattered elongated coarse punctures and about 7 teeth; clypeus convex, "v" shaped, covered with striae, except medial area; anterior medial area raised, coarsely punctate on sides, smooth, glossy medially; scape reaches or extends slightly past posterior border of head; compound eyes relatively large; lower margins of frontal lobes smooth, upper part punctate; maximal frontal lobe width 1.10 - 1.20 mm; head coarsely foveolate; length of malar space on side of head (0.65 - 0.70 mm), length from upper edge of eye to edge of posterior lobe 1.35 - 1.50 mm.

Pronotal shoulder rounded; petiole rounded, slightly narrowed anteriorly, slightly concave posteriorly; pronotum, dorsum of mesonotum, dorsum of propodeum coarsely foveolate, rough; dorsum of petiole, postpetiole coarsely foveolate, punctate; mesopleuron, lateropropodeum coarsely grooved, covered with striae, foveolae, punctures; antennae, legs, posterior edge of each gastral tergite shiny.

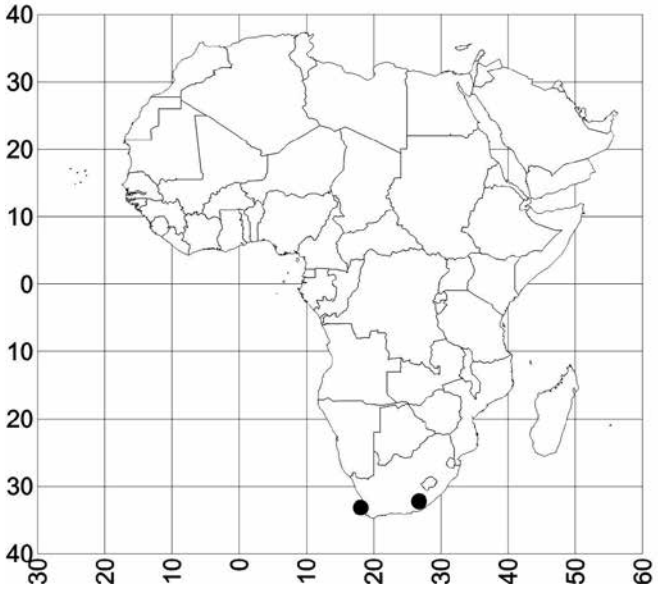
Entire head, pronotum, mesonotum, propodeum, petiole, postpetiole covered with short (0.03 - 0.10 mm) fine golden hairs; hairs on underside of head range from 0.25 - 0.50 mm in length; ventral surface of postpetiole, fourth–seventh abdominal segments covered with relatively long (0.20 - 0.25 mm) golden suberect hairs.

Head, pronotum, mesonotum, mesopleuron, propodeum, petiole, postpetiole, entire gaster black; legs, antennae, mandibles red; clypeus dark-brown.

Comparison: The worker of *Bothroponera umgodikulula* is easily recognized by the horizontal propodeal spiracle on the lateropropodeum, while it is obliquely vertical in all of the other African *Bothroponera* species. The 4th abdominal segment (second gastral segment) is smooth and glossy in *B. umgodikulula*, conversely, the 4th abdominal segment of *B. cavernosa* is rough, moderately shiny with few scattered hairs and fine poorly defined striae; this structure is moderately smooth and shiny (less than *B. umgodikulula*) with a few scattered punctures in *B. montivaga*. The other taxa that can be confused with *B. umgodikulula* are *B. laevissima* and *B. aspera*, which both have a 4th abdominal segment that is smooth and shiny, similar to *B. umgodikulula*. The unique sculpture of these three species simplifies their separation. The surface from the head to the postpetiole is smooth and shiny with few scattered punctulae in *B. laevissima* and is shiny, rough with dense, shallow punctures in *B. aspera*, but is coarsely foveolate in *B. umgodikulula*. The total length of *B. umgodikulula* is large (14.80 - 15.65 mm) compared to *B. cavernosa* (11.90 mm) and *B. montivaga* (12.20 - 12.65 mm). In fact, *B. umgodikulula* has the largest body size among

Plate 10: *Bothroponera. umgodikulula*, holotype worker. (Photo by Michele Esposito/From www.antweb.org. Accessed 23 February 2015).

the other species of the *B. pumicosa* species complex (e.g. *B. granosa* 13.75 - 14.50 mm, *B. strigulosa* 12.20 mm, *B. laevissima* 11.80 - 13.00 mm, *B. aspera* 11.70 - 12. 70 mm, *B. pumicosa* 11.00 - 11.65 mm, *B. cariosa* 11.50 mm and *B. berthoudi* 9.60 - 12.75 mm). The anterior medial margin of the clypeus is "v" shaped in *B. umgodikulula* similar to that of *B. granosa*, *B. cavernosa*, *B. montivaga* and *B. aspera*, conversely, the anterior medial margin of the clypeus is "u" shaped in *B. cariosa*, *B. strigulosa*, *B. pumicosa*, *B. laevissima* and *B. berthoudi*. The anterior medial raised area of the clypeus of *B. umgodikulula* is completely smooth (lacking a carina) shiny, but sculptured and punctate on the sides of the medial raised area. The anterior medial raised area of the clypeus of *B. granosa* has a sharp clypeal carina whereas it is partially carinate in *B. cavernosa* and *B. montivaga*.



Map 11. The distribution of *B. umgodikulula*.

Material examined

Type material: SOUTH AFRICA: **Eastern Cape Province**, Bulhoek, klaver-clanw [Whittlesea], Bulhoek at 32°10'0'' S; 26°49'0'' E, Mus. Expd. Oct. 1950, identified as *Bothroponera cavernosa* Roger, 1860, F. W. G. (1 w holotype, MCZC) and (1 w paratype, # C005835 Iziko).

Non-type material: SOUTH AFRICA: **Western Cape Province, Hopefield**, 33°03′56″S 18°21′03″E, identified as *Bothroponera cavernosa* Roger, Det. G. Arnold (1w BMNH).

Distribution: Whittlesea and Hopefield areas in South Africa.

Biology and habitat: The type specimens were collected in Whittlesea city in South Africa. This area is located in the Eastern Cape Province, but the additional material examined (one specimen) was collected in Hopefield city in the Western Cape Province. Hopefield is a small village situated 90 miles north of Cape Town and about 24.14 km [15 miles] east of Saldanha Bay (Singer, 1954). The Fynbos biome is dominant in this area (Rouget et al., 2004), and it is one of the threatened ecosystems in South Africa (Farrier et al., 2013). The ecological importance of the Hopefield area results from the soil structure, water permeability, climatic influence and vegetational cover. The area is characterized by spreading of several alien invasive plants such as the alien wattles *Acacia cyclops* (Rooikrans), *A. longifolia* (long-leaf wattle), *A. saligna* (Port Jackson), a number of *Eucalyptus* species, Manitoka (*Myoporum montanum*) and introduced prickly pear cactus (*Opuntia* sp.). Also many endemic and threatened plant taxa are present (Department of Environmental Affairs & Development Planning 2011). This type of mixed habitat is likely to include many species of insects such as tropical ants.

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