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Description of a new species of the *Agauopsis ornata* group (Acari: Halacaridae) from Zanzibar, Tanzania including a key to species of the *ornata* group *sensu stricto*

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Abstract: A new halacarid species *Agauopsis zanzibari* sp. nov. belonging to the *ornata* group (*Agauopsis*, Halacaridae, Acari), collected from Zanzibar, Tanzania is described, using light and scanning electron microscopy images. Differences from closely related species are discussed and a key to species of the *ornata* group *sensu stricto* is presented.

Résumé : *Description d'une nouvelle espèce du groupe* Agauopsis ornata *(Acari : Halacaridae) de Zanzibar, Tanzanie incluant une clé d'identification des espèces du groupe* Ornata sensu stricto*.* Une nouvelle espèce *Agauopsis zanzibari* sp. nov. du groupe *ornata* (*Agauopsis*, Halacaridae, Acari) récoltée sur l'île de Zanzibar, Tanzanie est décrite. Les disparités avec les espèces du même groupe sont discutées et une clé des espèces du groupe *ornata sensu stricto* est proposée.

Keywords: Marine Halacaridae ● New species ● *Agauopsis* ● Zanzibar ● Tanzania ● Key

Introduction

Halacarid species of the genus *Agauopsis* are known from intertidal to bathyal environments worldwide. The majority of the *Agauopsis* species have been attributed to species groups (Bartsch, 1986, 1996, 1999 & 2005; Otto, 1999; Bartsch & Chatterjee, 2001; Pepato & Tiago, 2003 & 2005; Chatterjee & Chang, 2007). One of these groups is the *ornata* group named after *Agauopsis ornata* (Lohmann, 1893). The most conspicuous characteristic of this group is the presence of garland-like arranged porose polygons (garland-like areolae) on AE. In the present paper, a new species namely *A. zanzibari,* a member of the *ornata* group is described based on specimens collected from Zanzibar, Tanzania (western Indian Ocean). A key to species of the *ornata* group *s. str.* is also included.

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Materials and methods

Materials were collected from Matemwe (05°52'S, 39°21'E) and Pingwe (6°9'S, 39°31E), the east coast of Unguja, Zanzibar, Tanzania among coral rubble of *Fungia* (Anthozoa, Scleractinia). Meiofauna samples were washed over a 38 µm sieve after anaesthetizing the halacarid mites with a 7% $MgCl_2$ solution for about 30 minutes, rinsed with freshwater, and then fixed and stored in 80% ethanol. Halacarids were hand-sorted, cleared in lactic acid and mounted in glycerine jelly. Some specimens were left unmounted and were stored in 80% ethanol. Drawings were prepared using a camera lucida. The positions of setae on dorsal and ventral plates are given in a decimal system, with reference to the length of a plate, from the anterior to the posterior margin. Type specimens will be deposited in the museum of the Biological Oceanography Division, National Institute of Oceanography, Goa, India.

Material for scanning electron microscopy was fixed in 2.5% glutaraldehyde, and followed by post fixation in 2% cold osmium tetraoxide. After dehydration through a graded series of ethanol (50-100% at 10% interval) for 30 minutes each, the material was dried at the critical point dryer, and coated with gold-palladium in a high evaporator, and then examined with a scanning electron microscope.

The following abbreviations are used in the text and figure legends: AD, anterior dorsal plate; AE, anterior epimeral plate; ds_{1-6}, dorsal setae 1-6 on idiosoma; GA, genitoanal plate; GO, genital opening; OC, ocular plate(s); PAS, parambulacral seta(e); PD, posterior dorsal plate; PE, posterior epimeral plate(s); PGS, perigenital setae; P_{1-4}, first to fourth palpal segment; SGS, subgenital setae.

Systematics

Family Halacaridae Murray, 1877
Subfamily Halacarinae Viets, 1927
Genus *Agauopsis* Viets, 1927

Diagnosis

Palps 4-segmented attached laterally to basis gnathosoma. P_2 with 1 (rarely 2) distodorsal seta. P_3 short, with median bristle- or spiniform seta, in few species with denticulate divaricated spine. First pair of maxillary setae (basirostral setae) either on gnathosomal base or on rostrum. Females usually with 3 pairs (rarely 2 to 6/7 pairs) PGS, each genital sclerite with 0-4 SGS. Males with approximately 8-100 PGS close to GO and 0-2 outlying PGS, 3-5 pairs SGS. Leg I wider and longer than following legs and with conspicuous spines. Genua (Patella) shorter than tibiae and telofemora. Paired claws of tarsus I smaller than those of succeeding tarsi. One larval and 2 nymphal stages present.

Agauopsis zanzibari sp. nov.
(Figs 1-6)

Material examined

Holotype: ♂, Matemwe (5°52'S, 39°21'E), east coast of Unguja, Zanzibar, among coral rubble of *Fungia*, 0.5 m depth, August, 17th, 2004 (*leg.* M. Raes & H. Gheerardyn). Paratypes: 1 ♀, 1 ♂ (collection data same as for holotype). Additional materials: 6 ♂♂, 5 ♀♀, collection data same as for holotype; 2 ♂♂, 2 ♀♀, Pingwe (6°9' S, 39°31' E), the east coast of Unguja, Zanzibar, Tanzania among coral rubble, August, 17th, 2004 (*leg.* M. Raes & H. Gheerardyn); from additional materials 3 ♀♀ and 4 ♂♂ were used for SEM.

Description

Adult: Idiosoma of males 340-380 µm long, that of females 330-350 µm long. Costae on AD and PD with polygons, each polygon with alveolus, about 2-3 µm wide and 4-10 canaliculi. Remainder of plates with numerous shallow small pits, unequal in size. AD 132-150 µm long, 90-100 µm wide (length to width ratio about 1.45-1.50), with a frontal spine, eye spot (marked by brownish pigment) lying beneath frontal spine. AD with 2 longitudinal costae 1 alveolus wide, in a few places 2 alveoli wide (in some specimens costae on AD 2 alveoli wide throughout); a small inverted V-shaped to (almost) dome-shaped anterior areola posterior to frontal spine. Posterior margin of AD almost truncate or very slightly arched. Paired ds_1 located at anterior edge of costae on AD. OC 78-80 µm long, 44-46 µm wide (length to width ratio about 1.70-1.80); each with 2 corneae and eye spot (marked by brownish pigment) near corneae, posterior portion with small cauda. Setae ds_2 situated on small sclerite (platelet) in membranous cuticle anterior to OC; ds_3 not distinct. PD 180-187 µm long, 135-138 µm wide (length to width ratio about 1.35); anterior margin of PD almost truncate or very slightly arched; paired costae 2 alveoli wide, divergent anteriorly, near anterior end in some specimens 1 alveolus wide; in a few specimens in the middle of the costa 3 alveoli wide. Pair of gland pores posteriorly on PD lateral to costae. Seate ds_4 near anterolateral margin on PD at about 0.16 level of PD; ds_5 at about 0.51 level of PD lateral to costae; ds_6 inserted on small sclerite at base of anal cone.

All ventral plates separate. Areolae on ventral plates with porose polygons, each polygon 4-8 µm wide, with about 7-11 canaliculi. Remainder of plates with shallow pits arranged within polygon, border of polygons contain epicuticular droplets (seen under SEM). AE with 3 pairs of ventral setae; pair of garland-like areolae, 1-3 polygons wide; marginal areola on epimera I; small dorsal areola

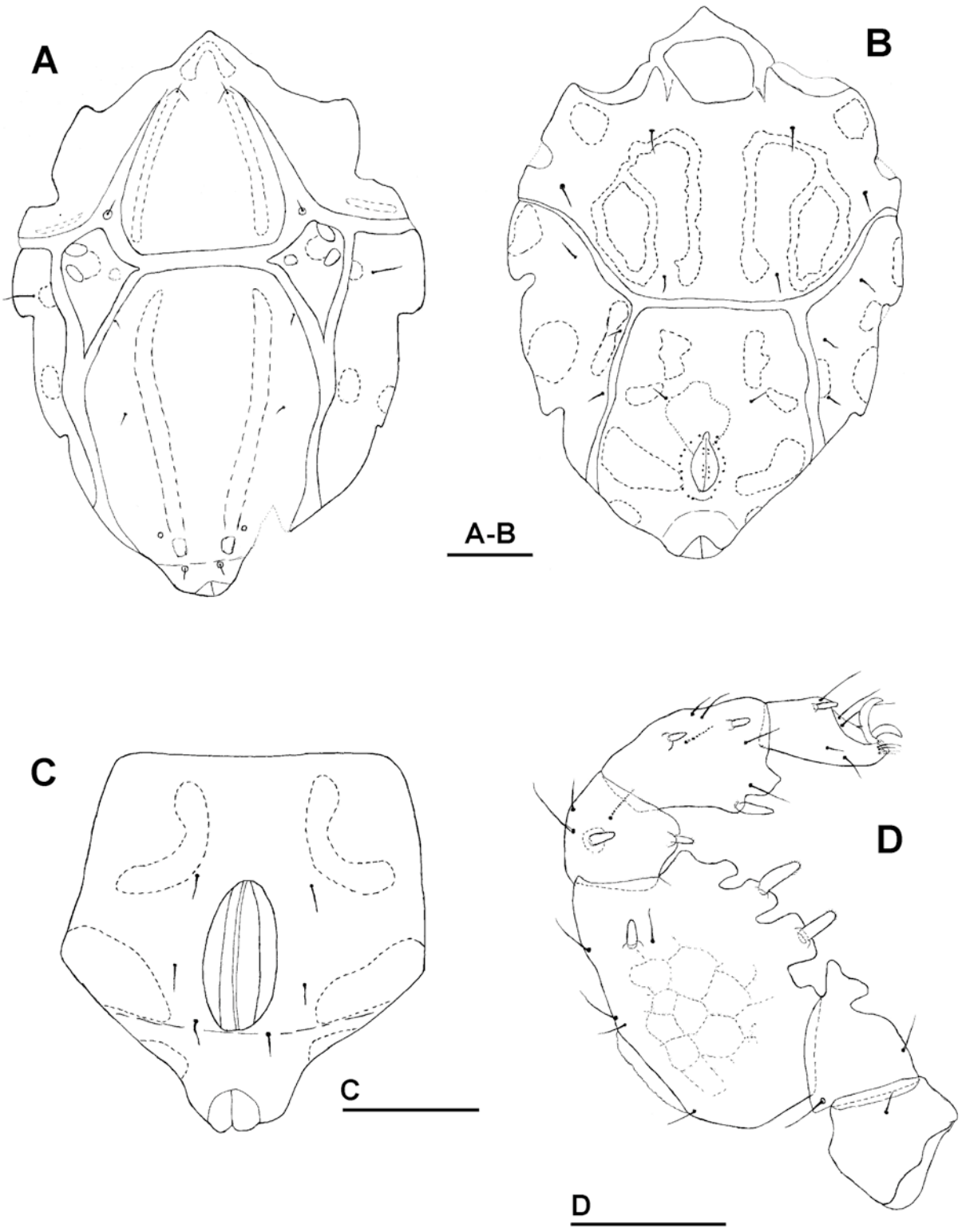

Figure 1. *Agauopsis zanzibari* sp. nov. A, B, D: male; C: female. **A.** Idiosoma, dorsal. **B.** Idiosoma, ventral. **C.** GA. **D.** Leg I. Scale bars: 50 µm.

Figure 1. *Agauopsis zanzibari* sp. nov. A, B, D: mâle ; C: femelle. **A.** Vue dorsale de l'idiosome. **B.** Vue ventrale de l'idiosome. **C.** GA. **D.** Patte I. Échelles : 50 µm

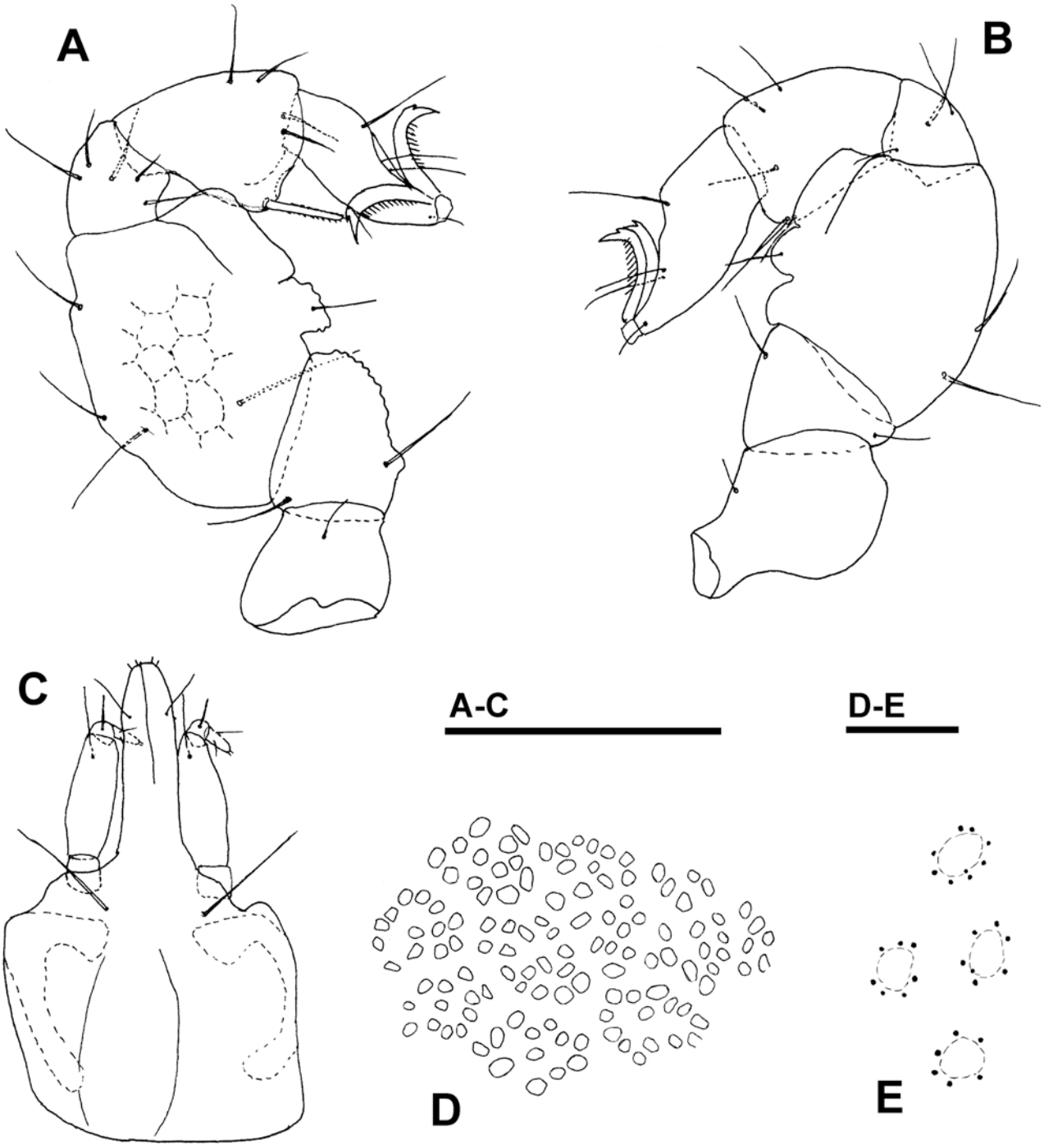

Figure 2. *Agauopsis zanzibari* sp. nov. A-D: male; E: female. **A.** Leg II. **B.** Leg III. **C.** Gnathosoma. **D.** Pits on AD between two costae. **E.** Part of costae on PD. Scale bars: A-C = 50 µm, D = 10 µm, E = 5 µm.

Figure 2. *Agauopsis zanzibari* sp. nov. A-D : mâle; E : femelle. **A.** Patte II. **B.** Patte III. **C.** Gnathosome. **D.** Cavités sur AD entre les deux côtes. **E.** Partie des côtes sur PD. Échelles : A-C = 50 µm, D = 10 µm, E = 5 µm.

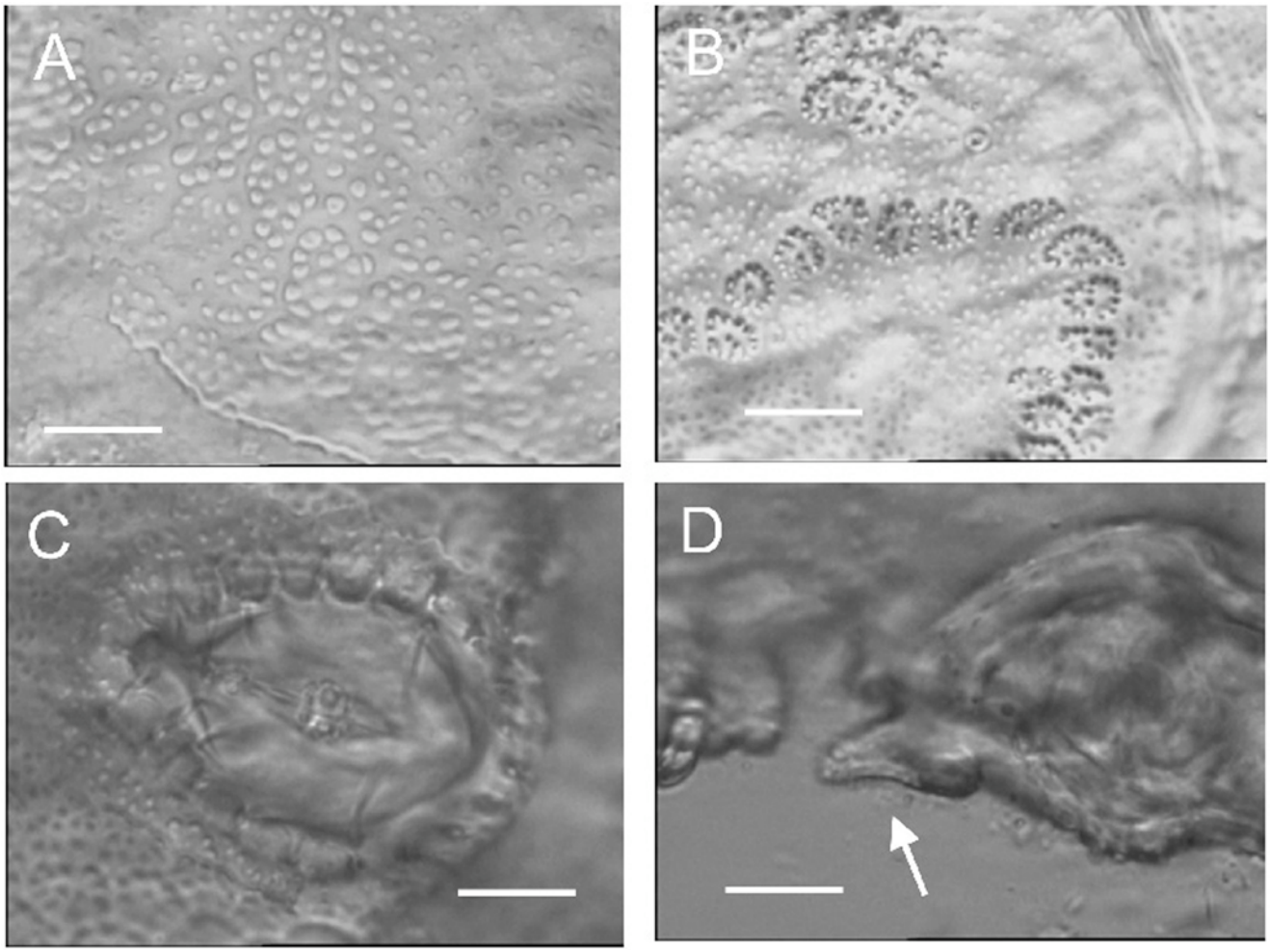

Figure 3. *Agauopsis zanzibari* sp. nov. Male. Compound microscope figures. **A.** Pits on AD between two costae. **B.** Part of areolae on AE. **C.** GO. **D.** Distoventral lamella (indicated by arrow) on basifemur I. Scale bars: 10 µm

Figure 3. *Agauopsis zanzibari* sp. nov. Mâle, Photos microscopiques. **A.** Cavités sur AD entre les deux côtes. **B.** Partie des aréoles sur AE. **C.** GO. **D.** Lamelle distoventrale (indiquée par la flèche) du basifemur I. Echelles : 10 µm.

near 1st coxal region. Among the examined materials (9 males and 6 females), 6 males and 4 females with a small porose median areola (with 1-5 polygons) near posterior margin on AE, while 3 males and 2 females devoid of such areola. Each PE with 3 ventral setae, 1 dorsal seta. In male, GA 143-148 µm long, truncate anteriorly; GO 33-35 µm long; distance between anterior margin of GO and that of GA, about 2.10-2.20 times of GO length; spermatopositor extending beyond outlying PGS, distance between anterior end of spermatopositor and that of GA 44 µm; about 20 PGS present in ring close to GO, pair of outlying PGS at about 0.37 level of GA; genital sclerites with 2 anterior and 3 posterior pairs of SGS, the middle pair of posterior group larger than others. In female, GA 135-144 µm long, truncate anteriorly, with 3 pairs of PGS, the most anterior pair on the level with anterior margin of GO; GO 54-58 µm long, 27-29 µm wide; distance from anterior margin of GO to that of GA, about 0.81 times of GO length; SGS absent.

Gnathosoma 85-105 µm long, the length to width ratio about 1.50. Gnathosomal base with ventrolateral porose panels, remainder of ventral gnathosomal base pitted. Rostrum 0.80 to subequal with length of gnathosomal base. Palp consisting of 4 segments. P_1 without seta; P_2 with 1 dorsal seta distally; P_3 with a spine medially longer than the segment; P_4 with 2 proximal setae, 1 minute seta distally. Proto- and deutorostral setae situated at tip of rostrum; tritorostral setae (maxillary setae of rostrum) in distal third of rostrum, basal pair of maxillary setae (basirostral setae) on base of gnathosoma. Rostral sulcus extending beyond tritorostral setae. Pharyngeal plate long, extending to basal margin of gnathosoma.

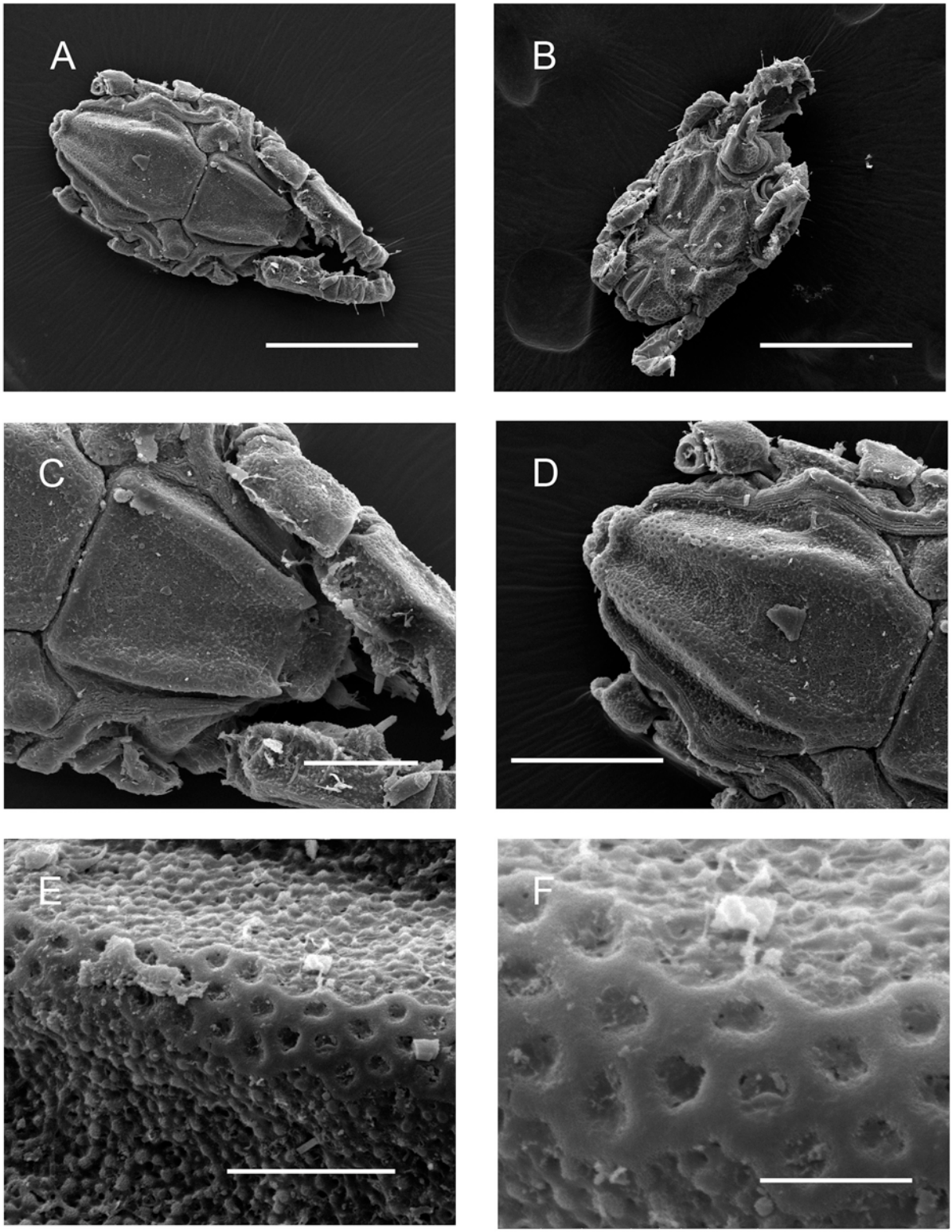

Figure 4. *Agauopsis zanzibari* sp. nov. SEM figures. A, C-F: male; B: female. **A.** Idiosoma, dorsal. **B.** Idiosoma, ventral. **C.** AD. **D.** PD. **E, F.** Magnified view of part of costa on PD. Scale bars: A & B = 200 µm, C = 50 µm, D = 100 µm, E = 20 µm, F = 10 µm.

Figure 4. *Agauopsis zanzibari* sp. nov. Photographies au MEB. A, C - F: mâle ; B: femelle. **A.** Idiosome, vue dorsale. **B.** Idiosome, vue ventrale. **C.** AD. **D.** PD. **E, F.** Photo d'un détail d'une partie des côtes sur PD. Échelles : A & B = 200 µm, C = 50 µm, D = 100 µm, E = 20 µm, F = 10 µm.

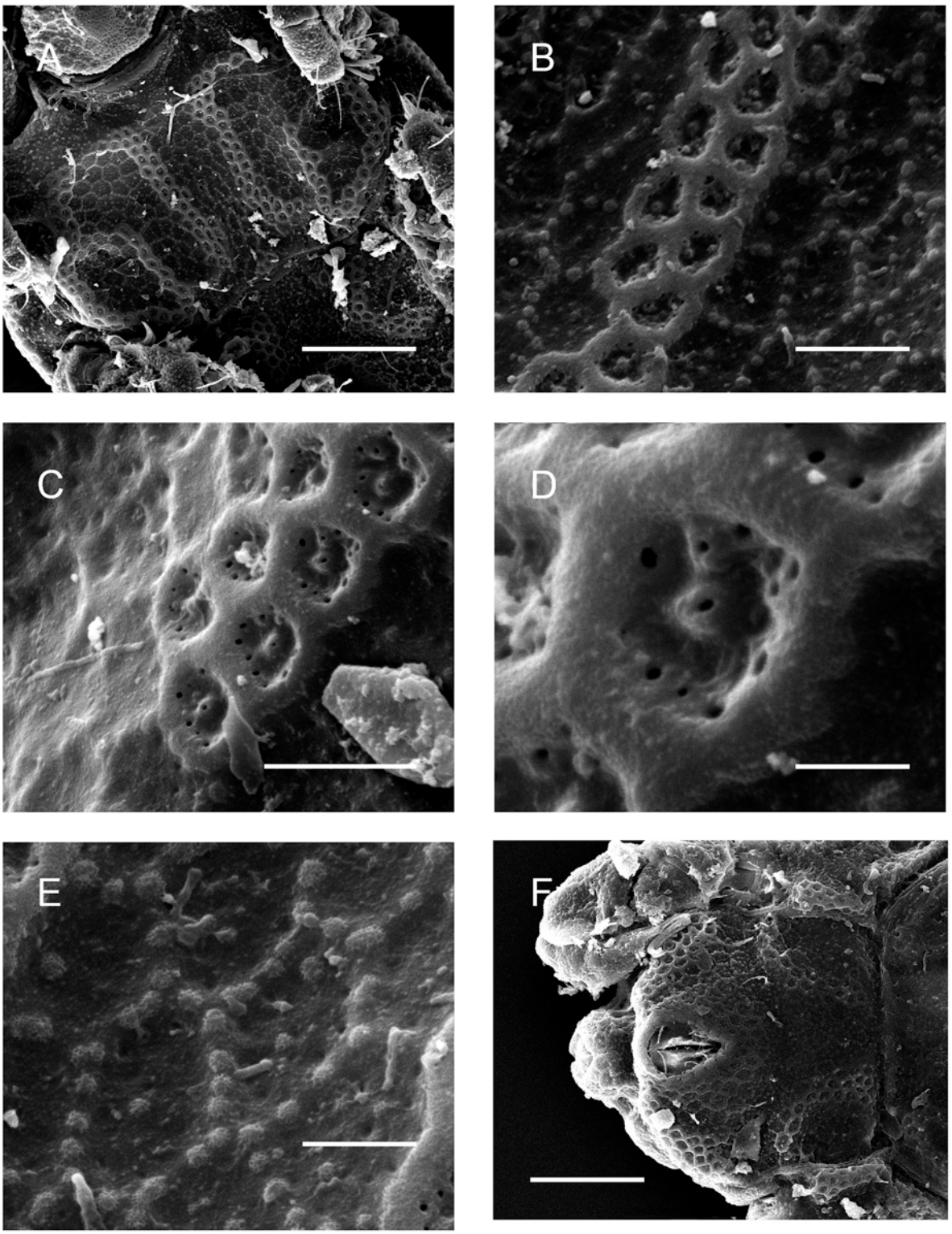

Figure 5. *Agauopsis zanzibari* sp. nov. SEM figures. A-E: female; F: male. **A.** AE. **B, C.** Magnified view of part of areola on AE. **D.** Magnified view of polygon on areola of AE. **E.** Area between two areolae on AE. **F.** GA of male. Scale bars: A & F = 50 µm, B & C = 10 µm, D = 2 µm, E = 5 µm.

Figure 5. *Agauopsis zanzibari* sp. nov. Photographies au MEB. A-E : femelle; F : mâle. **A.** AE. **B, C.** Photo d'un détail d'une partie de l'aréole sur AE. **D.** Photo d'un détail d'une partie du polygone sur l'aréole de AE. **E.** Zone entre deux aréoles sur AE. **F.** GA du mâle. Échelles: A & F = 50 µm, B & C = 10 µm, D = 2 µm, E = 5 µm.

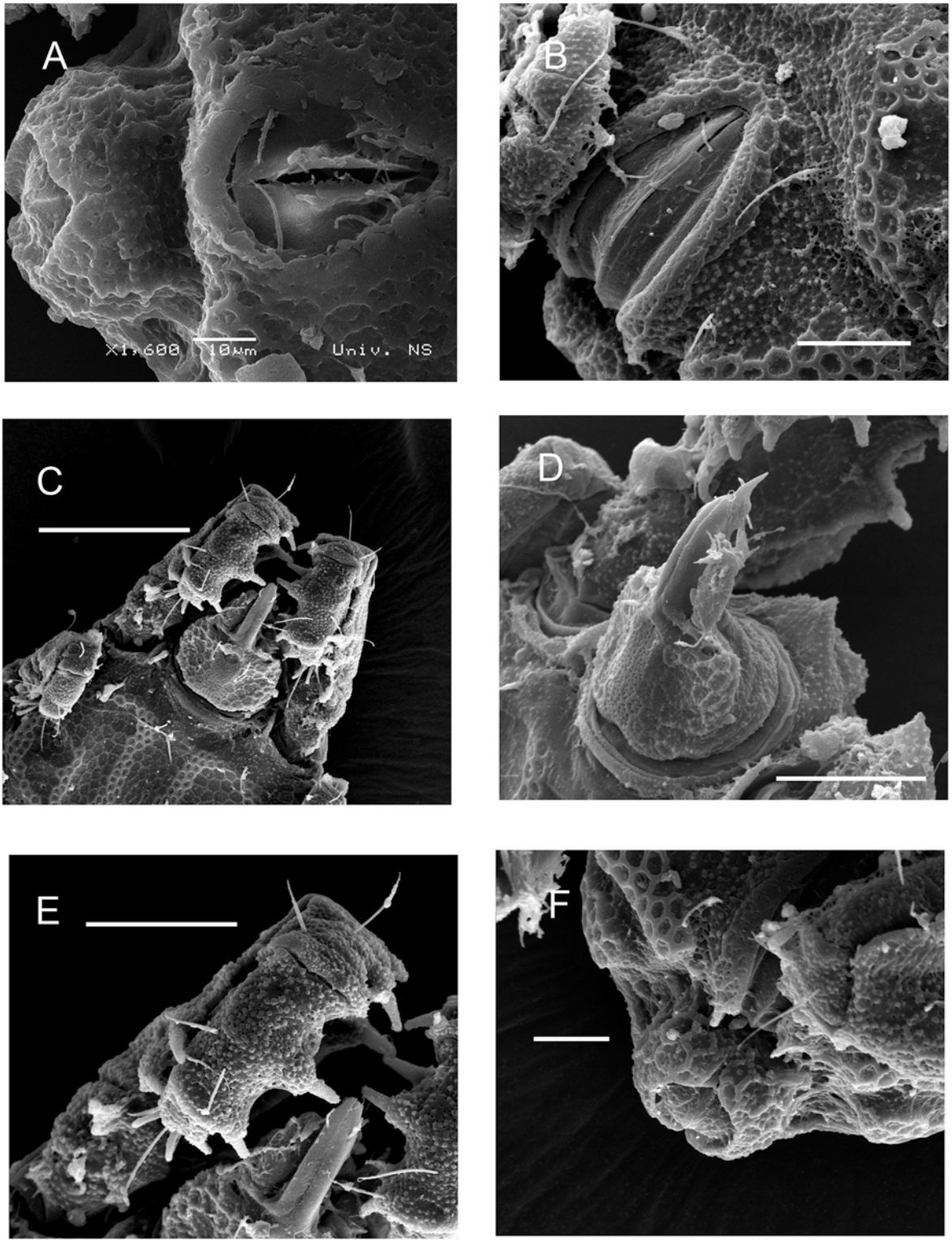

Figure 6. *Agauopsis zanzibari* sp. nov. SEM figures. A: male; B-F: female. **A.** GO area of male. **B.** GO of female. **C.** Gnathosoma, 1st leg, part of AE. **D.** Gnathosoma. **E.** 1st leg. **F.** Anal area. Scale bars: A = 10 µm; B & F = 20 µm; C = 100 µm; D & E = 50 µm.

Figure 6. *Agauopsis zanzibari* sp. nov. Photographies au MEB. A : mâle; B-F : femelle. **A.** GO zone du mâle. **B.** GO zone de la femelle. **C.** Gnathosome, 1ère patte, partie de AE. **D.** Gnathosome. **E.** 1ère patte. **F.** Zone anale. Échelles : A = 10 µm, B & F = 20 µm, C = 100 µm, D & E = 50 µm.

All leg segments with tiny granules (epicuticular droplets) and scattered canaliculi in deeper layer. Leg I stout and longer than following legs. Chaetotaxy of legs: trochanters I-IV, 1-1-1-0; basifemora I-IV, 2-2-2-2; telofemora I-IV, 8-5-3-3; genua I-IV, 5-5-3-3; tibiae I-IV, 8-5-5-5; tarsi (solenidion excluded) I-IV, 10-5-4-4. Telofemur I with 2 ventral spines and 1 ventromedial spine; genu I with 2 spines; tibia I with 1 ventral and 2 ventromedial spines. All spines on telofemur I to tarsus I apically blunt with minute denticles at tip. Tibia II with 1 spiniform pectinate ventral seta. Basifemur I with prominent distoventral lamella. Telofemur I ventrally with proximal and middle lamellar protuberances equipped with spine, distal to these prominent lateral lamellar lobe (bilobed lamella); a thin cuticular lamella dorsolaterally. Telofemur II with a ventral lamellar protuberance proximally and distal to this a wide lateral lamella, seta on protuberance. Telofemora III and IV with 2 proximoventral lamellar protuberances, distal to these a wide ventrolateral lamella; seta on middle protuberance. Tarsus I with 3 dorsal setae, 1 solenidion, 1 medial thick spine, 2 ventral setae and 2 doublets eupathid PAS. Tarsus II with 3 dorsal setae, 1 ventral seta and 1 single eupathid lateral PAS. Tarsi III and IV each with 3 dorsal setae, 1 setiform medial PAS and without ventral seta. Paired claws on tarsus I shorter than those on succeeding tarsi, smooth ventrally, devoid of accessory process; claws on tarsi II-IV with accessory process; pectines present ventrally. Tarsus I with bidentate median claw; median claw absent on tarsi II-IV.

Etymology

The specific name, *zanzibari*, alludes to the type locality of this new species, Zanzibar.

Differential diagnosis

Agauopsis zanzibari sp. nov. belongs to the *ornata* group *s. str.* (Bartsch, 1986, 1996 & 1999). The most important characteristic of this group is the garland-like arranged porose polygons (garland-like areolae) on AE. Other characteristics of this group are: Costae on AD and PD with distinct alveoli and canaliculi, P_3 with tapering bristle-like spine or anteriorly blunt spine, P_4 with 2 basal setae, telofemur I with 1 ventromedial spine and 2-3 ventrolateral spines, tibia I with 2 ventromedial spines and 1 ventral spine (ventromedial spines are apart from each other), all tarsi with 3 dorsal setae, tarsus II with 1 lateral PAS and 1 ventral seta, tarsi III and IV each with 1 medial PAS and devoid of ventral seta. Ten species of the *ornata* group s. str. are recognized viz. *A. bacescui* Konnerth-Ionescu, 1977, *A. bermudensis* Bartsch & Iliffe, 1985, *A. calidictyota* Bartsch, 2007, *A. decorata* Otto, 1999, *A. fenneri* Otto, 1999, *A. inflata* Newell, 1984, *A. nonornata* Bartsch, 1999, *A. ornata* (Lohmann, 1893), *A. ornatella* Bartsch, 1996 and *A. pseudoornata* Bartsch, 1985 (Lohmann, 1893; Konnerth-Ionescu, 1977; Newell, 1984; Bartsch, 1985, 1996, 1999, 2005 & 2007; Bartsch & Iliffe, 1985; Otto, 1999). Bartsch (1999 & 2005) indicated 5 species viz. *A. aequilivestita* Bartsch, 1996, *A. arenaria* Bartsch, 1992, *A. exornata* (Trouessart, 1899), *A. hamata* Newell, 1984, and *A. punctata* Bartsch, 1981 are closely related to the *ornata* group. However, all these 5 species lack garland-like porose areolae on AE.

Among the species of the group, *Agauopsis zanzibari* sp. nov. is similar to *A. pseudoornata* Bartsch from the Philippines and *A. calidictyota* Bartsch from Australia in having only 1 thick pectinate seta on tibia II. Two small separate roundish areolae are present posterior to frontal spine on AD in *A. pseudoornata* and 1 small roundish porose areola in *A. calidictyota*, while an inverted V-shaped to dome-shaped areola is present in *A. zanzibari*. Setae ds_2 are inserted on small sclerites in *A. zanzibari*, while such sclerites are absent in *A. pseudoornata*. PGS (around GO) of male in *A. pseudoornata* are plumose, while smooth in the new species. *A. pseudoornata* has wider costae (3 alveoli wide) on PD and transverse bar (made of alveoli) posteriorly on PD, while in the new species costae on PD are usually 2 alveoli wide (in some specimens in the middle 3 alveoli wide) and transverse bar is not found posteriorly. Telofemora III and IV each have 2 proximoventral lamellar protuberances, distal to these a wide ventrolateral lamella in the new species, while such lamellar arrangement are not observed in *A. calidictyota*. Telofemur I of *A. zanzibari* ventrally has proximal and middle lamellar protuberances equipped with spine, distal to these prominent lateral lamellar lobe, while telofemur I of *A. calidictyota* has two protuberances with spines and devoid of such lateral lamellar lobe distal to these.

A. ornata (Lohmann) from Bermuda and *A. nonornata* Bartsch from the Galapagos Islands have a small dome-shaped anterior areola posterior to frontal spine on AD. The new species differs from the above species in the following aspects. Only 1 pectinate seta is present ventrally on tibia II in *A. zanzibari*, while 1 ventral and 1 ventromedial setae on that segment are pectinate in the latter two species. Moreover, *A. ornata* bears 2 small porose areolae near posterior margin on AE (1 or no areola in *A. zanzibari*), 1 proximoventral lamellar protuberance on telofemora III-IV (2 lamellar protuberances in *A. zanzibari*) and basifemur I is devoid of distoventral lamella.

Agauopsis zanzibari sp. nov. is the 2nd species of the *ornata* group known from Tanazania, next to *A. bacescui* Konnerth-Ionescu, 1977 that was reported from the intertidal zone of Kunduchi, Tanzania (Konnerth-Ionescu, 1977). Differences between *A. zanzibari* and *A. bacescui* are: 2 small separate roundish areolae are present posterior

to frontal spine on AD in *A. bacescui*, while an inverted V-shaped to dome-shaped areola is present in *A. zanzibari*; 2 garland- like areolae on AE of *A. bacescui* are connected to each other posteriorly, that of *A. zanzibari* are separate. Telofemur I of *A. bacescui* is equipped with 3 ventrolateral spines and 1 ventromedial spine, while 2 ventrolateral spines and 1 ventromedial spine are present in *A. zanzibari*. Further, *A. bacescui* does not have distoventral lamella on basifemur I. The description of *A. bacescui* by Konnerth-Ionescu (1977) is lacking illustrations and description of legs II-IV and therefore detailed comparisons remain impossible.

Agauopsis exornata (Trouessart, 1899), a species closely related to the species of the *ornata* group was recorded from adjacent area, Djibouti, the Red Sea (Trouessart, 1899 & 1901; André, 1938 & 1959) lacks garland-like areolae on AE.

Key to species of the *Agauopsis ornata* group s. str.

1. Telofemur I with 4 spines, 2 garland-like areolae on AE connected to each other posteriorly..... .....***bacescui*** Konnerth-Ionescu, 1977
- Telofemur I with 3 spines; 2 garland-like areolae on AE not connected to each other posteriorly **2**

2(1) Rostrum longer than gnathosomal base ....***inflata*** Newell, 1984
- Rostrum equal or shorter than gnathosomal base **3**

3(2). Tibia II with 2 pectinate setae (spines) **4**
- Tibia II with 1 pectinate seta (spine).....**9**

4(3). Telofemora III and IV without proximoventral lamellar protuberance and ventrolateral lamella ....***bermudensis*** Bartsch & Iliffe, 1985
- Telofemora III and IV with proximoventral lamellar protuberance and ventrolateral lamella **5**

5(4). Two oblong swellings (ridge-like) posterior to frontal spine on AD **6**
- One dome-shaped or roundish areola posterior to frontal spine on AD **7**

6(5). Costae on PD 2 alveoli wide, 1 small porose areola medially near posterior margin on AE..... .....***fenneri*** Otto, 1999
- Costae on PD 1 alveolus wide, 2 small porose areolae medially near posterior margin on AE..... .....***ornatella*** Bartsch, 1996

7(5). One roundish porose areola posterior to frontal spine on AD .....***decorata*** Otto, 1999
- One dome-shaped areola posterior to frontal spine on AD **8**

8(7). Basifemur I without distoventral lamella, telofemora III and IV each with 1 proximoventral lamellar protuberance, 2 small porose areolae medially near posterior margin on AE .....***ornata*** (Lohmann, 1893)
- Basifemur I with distoventral lamella, telofemora III and IV each with 2 proximoventral lamellar protuberances, 1 small porose areola medially near posterior margin on AE.....***nonornata*** Bartsch, 1999

9(3). Telofemora III and IV each with 2 proximoventral lamellar protuberances, telofemur I with prominent distoventral lamellar lobe laterally **10**
Telofemora III and IV devoid of proximoventral lamellar protuberance, telofemur I without distoventral lamellar lobe.....***calidictyota*** Bartsch, 2007

10(9). Two small roundish areloae posterior to frontal spine on AD, costae on PD usually 3 alveoli wide, sclerite absent at base of ds_2, PGS (around GO) in male plumose .....***pseudoornata*** Bartsch, 1985
- An inverted V-shaped to dome-shaped areola posterior to frontal spine on AD, costae on PD usually 2 alveoli wide, ds_2 inserted on small sclerite, PGS in male smooth .....***zanzibari*** sp. nov.

Halacarid fauna of Tanzania

Lohmann (1893) reported *Agaue hypertrophica* (Lohmann, 1893) and *A. thaleia* (Lohmann, 1893) from shallow water in the coral reef zone around Zanzibar. Gimbel (1919) reported *Copidognathus zanzibari* (Gimbel, 1919) on the basis of nymph from Zanzibar. Konnerth-Ionescu (1977) reported *Agauopsis bacescui* Konnerth-Ionescu, 1977 and *Agaue* sp. from Kunduchi, on the mainland of Tanzania. Recently Chatterjee et al. (2006 & 2008a) described new species and new records of *Copidognathus* among coral rubble from Matemwe, the east coast of Unguja, Zanzibar viz. *Copidognathus corallicolus* Chatterjee, De Troch & Chang, 2006, *C. corallorum* (Trouessart, 1899), *C. fungiae* Chatterjee, De Troch & Chang, 2006, *C. matemwensis* Chatterjee, De Troch & Chan, 2008 and *C.ungujaensis* Chatterjee, De Troch & Chang, 2006. *C.ungujaensis* was also reported from Makunduchi, the east coast of Unguja, Zanzibar (Chatterjee et al., 2008a). *Arhodeoporus tanzanicus* Chatterjee, Pešić & De Troch, 2008 was described by Chatterjee et al. (2008b) among coral rubble of *Fungia* and *Tubipora* at 0.5 m water depth from Pingwe, the east coast of Unguja, Zanzibar. *Atelopsalis zanzibari* Chatterjee, Pešić & De Troch, 2009 was collected among coral rubble from Matemwe, Zanzibar (Chatterjee et al., 2009). We have in our collections many undescribed species belonging to genera like *Arhodeoporus*, *Copidognathus* and *Scaptognathus* from Zanzibar that will be published shortly.

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