Scanning electron microscopic observation of *Acarothrix grandocularis* (Acari, Halacaridae) and notes on the species of the genus *Acarothrix*

**TAPAS CHATTERJEE**

Crescent International School, Bario, Govindpur, Dhanbad 828109, Jharkhand, India

Corresponding author, e-mail: drtchatterjee@yahoo.co.in

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**Abstract** Scanning electron microscopic observations of some characters of *Acarothrix grandocularis* Chatterjee, Marshall, Guru, Ingole, Pešić 2012 is presented. Distribution and characters of species belonging to the genus *Acarothrix* are also discussed.

Cechy *Acarothrix grandocularis* (Acari, Halacaridae) widoczne dzięki zastosowaniu mikroskopu skaningowego na tle rodzaju Acarothrix

Słowa kluczowe *Acarothrix grandocularis*, SEM, rozmieszczenie

Streszczenie Artykuł prezentuje cechy *Acarothrix grandocularis* Chatterjee, Marshall, Guru, Ingole, Pešić 2012 – widoczne dzięki zastosowaniu mikroskopu skaningowego. Dyskutowane są również cechy i rozmieszczenie gatunków należących do rodzaju Acarothrix.

**Introduction**

*Acarothrix grandocularis* Chatterjee, Marshall, Guru, Ingole and Pešić (2012) was first described from India and Brunei Darussalam among algal turf growing on pneumatophores of mangroves in estuarine habitats (Chatterjee et al., 2012). Bartsch (2015) reported this species from Kranji, Singapore among green and red algae on trunks of mangrove trees. In the present paper some morphological characters of *A. grandocularis* is studied in detail, based on scanning electron microscopic observation of specimens from Goa, India. Distribution and characters of species belonging to the genus *Acarothrix* are also provided.
Material and Methods

Specimens were collected from Chorao Island (North Goa), Virnoda Pernem (North Goa), Chicalim Vasco (South Goa) and Chinchinim (South Goa) among algal turf growing on pneumatophores of mangroves or in mud flat associated with mangroves.

Specimens for scanning electron microscopy (SEM) were prefixed overnight at 4°C in 2.5% glutaraldehyde, followed by post fixation in 2% cold osmium tetroxide. After dehydration through a graded series of ethanol (50–100% at 10% interval) for 30 minutes each, the material was critical-point dried, and coated with a platinum-palladium mix 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; ds1-5, dorsal setae 1–5 on the idiosoma; GA, genitoanal plate; GO, genital opening; OC, ocular plate(s); PAS, parambulacral seta(e); PD, posterior dorsal plate; PGS, perigenital setae; PI-4, first to fourth palpal segment; SGS, subgenital setae.

Study area: Chorao Island (North Goa), west coast of India: Latitude 15° 30' 45.74" N, Longitude 73° 52' 11.25" E. The Chorao Island is situated 5 kms from Panaji. Island present in Mandovi river, water is brackish in nature and salinity from 3–7‰. Samples collected from algal turf associated with pneumatophores of Avicennia sp, Rhizophora sp.

Chicalim Vasco (South Goa), west coast of India: Latitude 15° 24' 20.49" N, Longitude 73° 53' 18.97" E. Samples collected from algal turf associated with pneumatophores of Avicennia and Rhizophora sp. Samples also collected from mud flat associated with mangroves.

Virnoda Pernem (North Goa), west coast of India: Latitude 15° 40' 13.85" N, Longitude 73° 43' 22.19". Samples collected from algal turf associated with pneumatophores of Rhizophora sp.

Chinchinim (South Goa), west coast of India: Chinchinim is located between Lat: 15° 12' N. Long: 73° 58' E and 15.20° N 73.97° E. Samples collected from mud flat in mangrove area. Avicennia sp dominated.

Results and Discussion

Acarothrix grandocularis Chatterjee et al. 2012

Acarothrix grandocularis Chatterjee et al. (2012, pp. 542–546, figs. 1A-D, 2A-F, 3A-D); Bartsch (2015, 100–102, figs. 2H-O).

Description: The original description of this species is given in Chatterjee et al. (2012) based on the specimens collected from Goa, India and Brunei Darussalam. Some characters referred in that paper are described in more details according to present SEM study based on the specimens collected from Goa, India.

AD, OC and PD are separate (Figure 1A). Areolae and costae on dorsal plates slightly raised with porose panel (Figures 1F, 2A); remainder of plates panelled (2B). AD with one anterior and two posterior areolae; 1st pair of gland pores inserted near anterolateral edge of posterior areolae; posterior margin of AD triangular. OC elongate, setae ds2 on OC (Figure 1D, E). PD with a pair of longitudinal porose costae, 2 porose panels wide (Figures 1F, 2A); setae ds5–ds6 on PD (2C, D). AE, PE and GA separate (Figure 1B, C). AE almost smooth (Figure 2E) with 3 pairs of ventral setae and a pair of epimeral pores, epimeral pore shown in Figure 2F. Three pairs of PGS present. Pair of SGS located at the anterior end of genital sclerites (Figure 3A).
Figure 1. *Acarothrix grandocularis* Chatterjee et al. 2012, SEM figures, female. A. Idiosoma dorsal; B, C. Idiosoma ventral; D. Magnified view of parts of AD, OC and PD; E. OC and PD; F. Part of costa and panels on PD.
Figure 2. *Acarothrix grandocularis* Chatterjee et al. 2012, SEM figures, female. A. Part of costa on PD; B. Panels between two costae on PD; C. seta ds3 on PD; D. Seta ds4 on PD; E. Part of AE; F. Epimeral pore on AE.
Figure 3. Acarothrix grandocularis Chatterjee et al. 2012, SEM figures, female. A. GO of female; B. Gnathosoma ventral view; C. Gnathosoma ventrolateral view; D. Anterior part of gnathosoma and palp; E. Part of tibia I and tarsus I; F. Part of tibia II and tarsus II (arrow indicating pectinate seta on tibia).
Figure 4. *Acarothrix grandocularis* Chatterjee et al. 2012, SEM figures, female. A, Part of tibia II and tarsus II (arrow indicating pectinate seta on tibia); B. Anterior part of tarsus II (arrow indicating 1., 2: PAS; 3: solenidion); C. Anterior part of tarsus II (arrow indicating PAS); D, E. Part of tibia and tarsus III (arrow indicating pectinate seta on tibia); D. Tip of tarsus III.
Rostrum triangular, tip of rostrum not surpassing the anterior end of $P_2$. $P_1$ and $P_3$ without any setae; $P_2$ with 1 dorsal seta; $P_4$ with 3 long proximal setae and 1 minute distal seta. Proto and deuto- rostral setae situated at the tip of rostrum, long maxillary setae of rostrum anterior to middle of rostrum, gnathosomal base with a pair of setae (3B, C). Rostral sulcus is extending posteriorly to just beyond the tritorostral setae (Figure 3B, D).

Tibiae I–IV with 1-1-1-0 bipectinate ventromedial setae. Pectinate seta shown in figures 3E, F, 4A, D, E. Tarsus I with 3 dorsal setae, 1 solenidion, 2 ventral setae, 2 doublet eupathid PAS (Figure 3E). Tarsus II with 3 dorsal setae, 1 solenidion, 2 single eupathid PAS (4B, C). Tarsus III with 4 dorsal setae and 2 PAS (4F). All tarsi with 2 lateral claws, a small bidentate medial claw, and a carpite; lateral claws smooth ventrally.

**Remarks.** In India, *A. granocularis* is found from both pneumatophores turf and mud flat also. The salinity of mangrove area ranges from 3–7‰. A detailed study based on SEM and molecular analysis for specimens from different localities is necessary to reveal variations in this species between the localities.

### Notes on species of the genus Acarothrix

*Acarothrix* is a genus of halacarid mites that was proposed by Bartsch (1990) and has *A. palustris* Bartsch 1990 as the type species. There are five species viz. *A. palustris* Bartsch (1990), *A. longiunguis* Bartsch (1997), *A. umgenica* Procheş (2002), *A. ampliata* Bartsch (2004) and *A. granocularis* Chatterjee et al. (2012) so far recorded under this genus.

The genus has been recorded from Southern China, Singapore, northern Australia, south-eastern Africa, Florida and India. All species are known from tropical or warm temperate regions. Table 1 shows detail distribution of the species in *Acarothrix* along with the habitats and references.

| Table 1. Species of *Acarothrix*: Localities with habitats |
|-----------------------------------------------------------|
| **Name of the species** | **Locality** | **Oceanic provinces** | **Habitat** | **References** |
| Acarothrix ampliata | USA: Gulf of Mexico | ATW: Atlantic Ocean, tropical west | Little Manatee River, which empties into Tampa Bay | Bartsch (2004) |
| | Tampa Bay, Florida | | | |
| Acarothrix ampliameris | Singapore | PTW: Pacific Ocean, tropical west | Cladophora mat, Chlorophyta, on muddy and sandy sediments in mangrove area | Bartsch (2006) |
| | Singapore: End of Lim Chu Kang Road | | | |
| | | | Among green (Cladophorales) and red algae (*Catenella* sp., Gigartinales) on pneumatophores of *Avicennia* sp. (*Avicenniaceae*) mangroves | Bartsch (2015) |
|          | Country/Region | Location Details | Environmental Conditions | Notes                                                  |
|----------|----------------|------------------|--------------------------|--------------------------------------------------------|
| **Acarothrix grandocularis**<br>Chatterjee, Marshall, Guru, Ingole, Pešić 2012 | Brunei Darussalam: Batu Marang | PTW: Pacific Ocean, tropical west | Algal turf growing on *Rhizophora* sp. pneumatophores | Chatterjee et al. (2012) |
|          | India: Chorao Island, North Goa | ITE: Indian Ocean, tropical east | Algal turf growing on *Avicennia, Rhizophora* pneumatophores | Chatterjee et al. (2012); Present report |
|          | Singapore: Kranji | PTW: Pacific Ocean, tropical west | Algal turf growing on pneumatophores of mangroves; mud flat associated with mangroves | Bartsch (2015) |
|          | India: Chicalim Vasco (South Goa) | ITIE: Indian Ocean, tropical east | Algal turf growing on pneumatophores of mangroves; landward edge of mangrove area, green and red algae on trunk, high water edge | Present report |
|          | India: Virnoda Pernem (North Goa): | ITIE: Indian Ocean, tropical east | Algal turf growing on pneumatophores of mangroves; | Present report |
|          | India: Chinchinim (South Goa) | ITIE: Indian Ocean, tropical east | Mud flat on the mangrove area. | Present report |
| **Acarothrix longiunguis**<br>Bartsch 1997 | Australia: Sadgroves Creek, near Darwin, Northern Australia, | PTW: Pacific Ocean, tropical west | Soft mud from mangrove area | Bartsch (1997) |
| **Acarothrix palustris**<br>Bartsch 1990 | Hong Kong: southern China | PTW: Pacific Ocean, tropical west | Algal turf on salt marshes and mangrove flats | Bartsch (1990) |
|          | Singapore: Pandan River, southern coast of Singapore | PTW: Pacific Ocean, tropical west | Green algae and epibiota on *Avicennia* pneumatophores in a rockpool | Bartsch (2006) |
|          | Singapore: End of Lim Chu Kang Road, northern coast of Singapore | PTW: Pacific Ocean, tropical west | Cladophora mat on muddy and sandy sediment in mangrove area | Bartsch (2006) |
|          | India: Chorao Island, North Goa | ITIE: Indian Ocean, tropical east | From algal turf growing on *Avicennia* pneumatophores | Chatterjee et al (2013) |
| **Acarothrix umgenica**<br>Procheş 2002 | South Africa: Beachwood and Bayhead Lagoon, near Durban, KwaZulu-Natal | ITW: Indian Ocean, tropical west | Sediment on *Avicennia* pneumatophores | Procheş et al. (2001) |
|          | South Africa: Beachwood mangroves in Durban, and Richards Bay, KwaZulu-Natal | ITW: Indian Ocean, tropical west | Sediment or algae covering the pneumatophores of the *Avicennia marina* mangrove tree | Procheş (2002) |
All species live in intertidal muddy environments characterized by fluctuating salinities. Four species of *Acarothrix* are found to be associated with mangroves (Chatterjee, Pfingstl, Pešić, 2018a).

Sexual dimorphism is common in many groups of Arthropoda. Sexual dimorphism is also found in some species of halacarid mites (Chatterjee, Guru, 2012). A pair of external genital acetabula is present on genital sclerites in males of the genus *Acarothrix*, while the external genital acetabula on genital sclerites are absent in the female.

A comparison of important characteristics between species in the genus *Acrothrix* is compiled in Table 2.

| Table 2. Comparison of important characteristics between species in the genus *Acarothrix* |
|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Characters                      | *Acarothrix ampliata*           | *Acarothrix ampliumeris*        | *Acarothrix grandocularis*      | *Acarothrix longiunguis*        | *Acarothrix palustris*           | *Acarothrix umgenica*           |
| Idiosoma length                | Male 326–340                    | Male 314–325                    | Male 278–291                    | Male 278–286                    | Male 287–322                    | 325–385                        |
|                                | Female 340                      | Female 294–309                  | Female 291–293                  | Female 279–294                  |                                 |                                 |
| Posterior end of AD            | Triangular                      | Triangular                      | Triangular                      | Rounded                         | Rounded                         | Triangular                      |
| Cornea on OC                   | Remnants of cornea              | Absent                          | Present                         | Present                         | Present                         | Present                         |
| Position of ds1                | Anterior part on AD             | About middle on AD              | Posterior part of AD            | About middle of AD              | About middle of AD              | Posterior part of AD            |
| Position of ds2                | OC                              | Membranous cuticle              | OC                              | OC                              | OC                              | OC                              |
| Position of ds3                | OC                              | OC                              | PD                              | OC                              | OC                              | OC                              |
| Costae on PD                   | Very faint line like            | Absent                          | Present, two porose panel wide  | Absent                          | Present                         | Absent                          |
| Panels on PD                   | Reticulate panels on PD         | Median portion deliculately reticulate | Reticulate panels on PD         | Smooth area on PD               | Reticulate panels on PD         | Reticulate panels on PD         |
| Wart on membranous cuticle on idiosoma dorsal | Present | Absent | Absent | Absent | Present | Absent |
| Setae on basifemur III         | 3                               | 3                               | 2                               | 3                               | 3                               | 3                               |
| Bipectinate seta in tibiae I to IV | 1-1-1-0                        | 1-1-1-1                        | 1-1-1-0                        | 1-1-1-0                        | 1-1-1-0                        | 1-1-1-?                        |
| Distance between anterior end of GO and GA in male | 0.7 of GO length               | Slightly less than GO length    | 1.1 of GO length                | 0.7 of GO length                | Equal with GO length            | 1.8 of Go length               |

Suctorian and Peritrich ciliate epibionts have been found on several halacarid mites (Chatterjee, Dovgal, Pešić, Zawal, 2018b). Bartsch (2015) reported suctorian ciliate *Praethecacineta halacari* (Schulz, 1933) on *Acarothrix grandocularis* from Singapore.
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