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First record of *Rhaphidosoma atkinsoni* (Heteroptera: Reduviidae: Harpactorinae) from Maharashtra, India, with redescription and observations on its bionomics

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Abstract

A relatively less known assassin bug, *Rhaphidosoma atkinsoni* Bergroth, 1893 (Hemiptera: Heteroptera: Reduviidae: Harpactorinae) is recorded from Maharashtra State, India, for the first time. Redescription and illustrations of the species, along with the notes on morphology and natural history, are provided.

Key words: Heteroptera, Reduviidae, Rhaphidosomatini, Pune, semi-arid region, bionomics, egg structure and first instar

Introduction

Varvand is a small village in Daund Taluka, situated in the eastern part of Pune District, Maharashtra State, India, at about 70 km east of Pune City. Daund receives monsoon rain fall of about 300–400 mm per year and the vegetation in this area is mainly small wild shrubs along with some cultivated crops. This village is situated in the semi-arid part of Maharashtra State as it is located in a rain shadow area. During the survey of true bugs (Hemiptera: Heteroptera) of this region we observed an interesting reduviid which was identified as *Rhaphidosoma atkinsoni* Bergroth, 1893 using the original description by Bergroth (1893) and the redescription by Distant (1904).

The species was placed in ‘Rhaphidosomaria’ by Distant (1904), which is currently treated as tribe Rhaphidosomini of Harpactorinae (Schuh & Slater 1995, Forero 2011). The grammatically correct stem formed from the generic name *Rhaphidosoma* is *Rhaphidosomat-*, therefore the correct tribal name would be Rhaphidosomatini (Kerzhner 1992), as has been used by the Fauna Europaea website (urn:lsid:faunaeur.org:taxname:452749). Both the spelling Rhaphidosomini (e.g. Villiers 1948, Maldonado Capriles 1990, Schuh & Slater 1995, Weirauch 2008, Weirauch & Munro 2009, Forero 2011, Zhang *et al.* 2015) and the grammatically correct form Rhaphidosomatini (e.g. Haridass 1988, Gessé & Goula 2006, Goula *et al.* 2010, Ghahari *et al.* 2013) were used by a significant number of authors, but the tribal name is generally rarely used, and therefore no prevailing usage can obviously be recognized. We suggest to discontinue use of the spelling Rhaphidosomini and treat Rhaphidosomatini Distant, 1904 as the valid name for this tribe.

The genus *Rhaphidosoma* Amyot & Serville, 1843 contains about 40 described species in Africa, four species in the Middle East (Maldonado Capriles, 1990), and three species in India (Ambrose 2006). The species reported from India are *Rh. atkinsoni* Bergroth, 1893, *Rh. tuberculatum* Distant, 1904 (type locality: Baluchistan, Pakistan) and *Rh. madukaraiensis* Ravichandran & Livingstone, 1994 (type locality: Madukkarai, Tamil Nadu, India). In an online checklist of Reduviidae of India Biswas & Mitra (2014) also listed these three species, misspelling the generic name as *Raphidosoma*. Distant (1904) provided a dorsal habitus drawing of *Rh. atkinsoni*; *Rh. tuberculatum* has never been illustrated. The third species, *Rh. madukaraiensis* was described briefly and illustrated with a line drawing of the dorsal habitus only (requests for images of the type have remained unanswered). *Rh. greeni* Distant, 1906 is another species known from Sri Lanka (Distant 1906), and not unlikely to be found in India, but so far it has never been reported again since its original description. So far none of these

species have been adequately described or illustrated. The bionomics of all species of *Rhaphidosoma* has remained poorly known, and no published information is available on their prey, oviposition and egg structure except that of *Rh. atkinsoni* by Haridass (1985, 1988) and some observations on the African congeners by Miller (1953, 1956).

The genus *Rhaphidosoma* has never been reported from this part of India, and no detailed description or adequate illustrations of this species are available. Therefore in this paper we provide detailed observations on the morphology and natural history of *Rh. atkinsoni*.

Material and methods

Varvand, a semi-arid area in Daund Taluka, with shrub vegetation (Figs. 1, 2), was visited several times during March to May, 2016 and recently in March and April 2017. The habitat and habitus of these insects and the plant on which they were found were photographed using a Canon Ixus 105 digital camera. Two males and two females were collected and preserved in absolute alcohol for further study. Methods for measurement and photography of preserved specimens follow Kulkarni & Ghate (2016), while SEM methods follow Sheth & Ghate (2014). Eggs deposited in a glass jar under laboratory conditions and those deposited in the natural environment were also studied and observed until hatching.

Observations on natural history. During March to May 2016, we found several individuals of *Rh. atkinsoni* on a leafless plant *Capparis decidua* (Forsk.) Edgew. (Capparaceae) (Fig. 3). The insects were observed basking in full sunshine on the stems of the plant (Figs. 4, 5). Both male and female bugs as well as nymphs were observed on the same plant. One collected female deposited 4 fertilized eggs in the glass jar in which it was kept; these eggs were glued to the glass in a linear row. Each egg was about 2.2 mm long, pale brown, semicylindrical or bottle-shaped, with a few dark spots in the form of a lateral patch and a white ring beneath operculum. The eggs hatched in ten to eleven days. The two days old first instar nymphs were about 3.4 mm long. A few nymphs were also seen in the field during May 2016, suggesting that the breeding season of this bug is April–May. A recent visit on April 16, 2017 to the area disclosed 18 eggs attached in a zigzag row to a small grass stem very close to a large stone. Each egg was attached to the plant with its ventral (convex) surface, with its opercular side directed obliquely upwards; the entire row was about 19 mm long (Fig. 6); a close-up of the egg batch with a freshly hatched nymph is seen in Fig. 7. The presence of eggs in April again indicates a breeding season in April–May. Under SEM the eggs appear bottle-shaped with a broadly rounded posterior pole and slightly narrowed opercular or anterior pole; the chorion shows uniform pattern of hexagonal or polygonal cells with elevated boundaries all over its surface except near operculum (collar) where it forms smooth hexagons; the operculum itself has a median projection having a different microsculpture (Figs. 8–12).

Redescription

Tribe Rhaphidosomatini Distant, 1904

Rhaphidosoma Amyot & Serville, 1843

Rhaphidosoma atkinsoni Bergroth, 1893

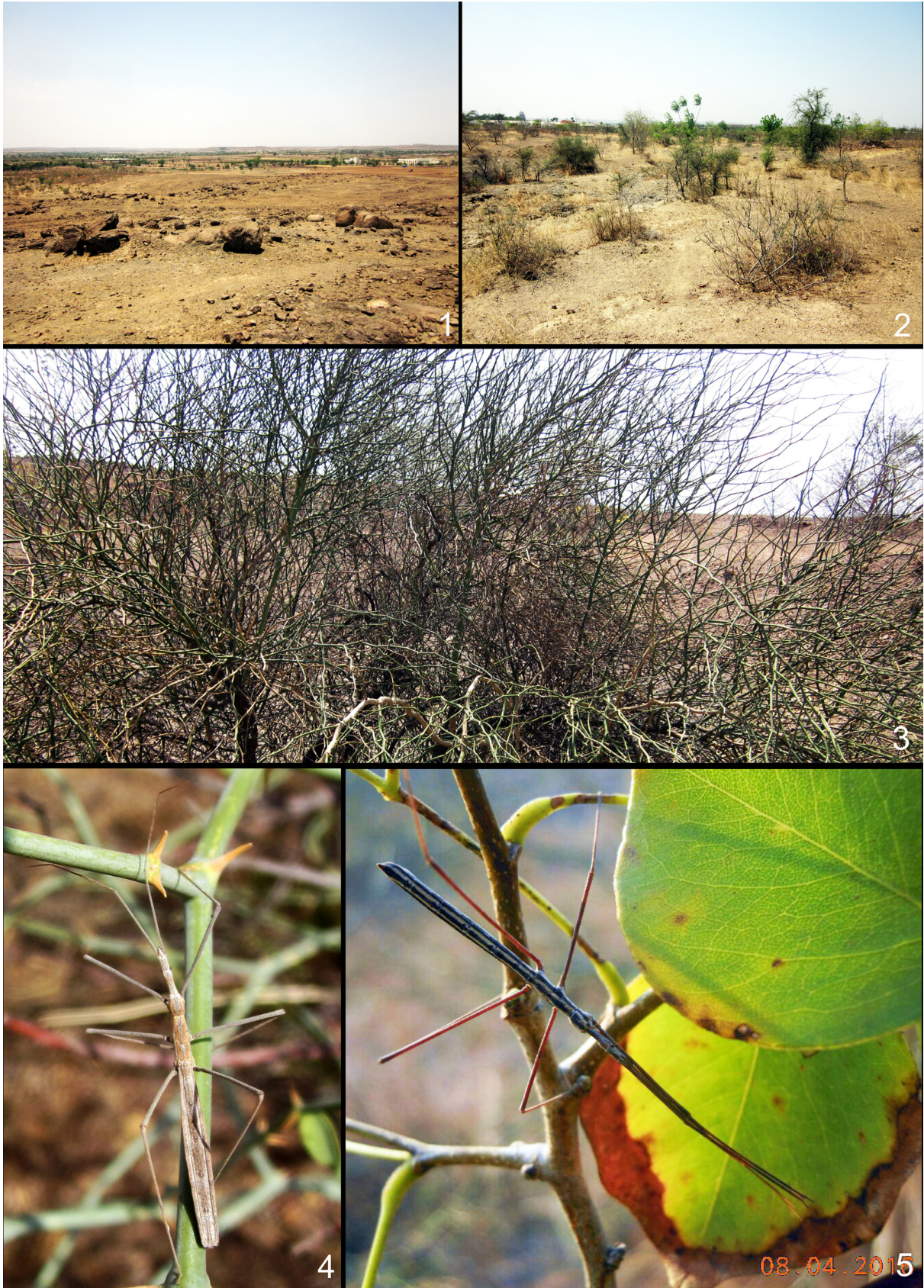
(Figs. 4–40)

Rhaphidosoma atkinsoni Bergroth, 1903: 63 (original description)

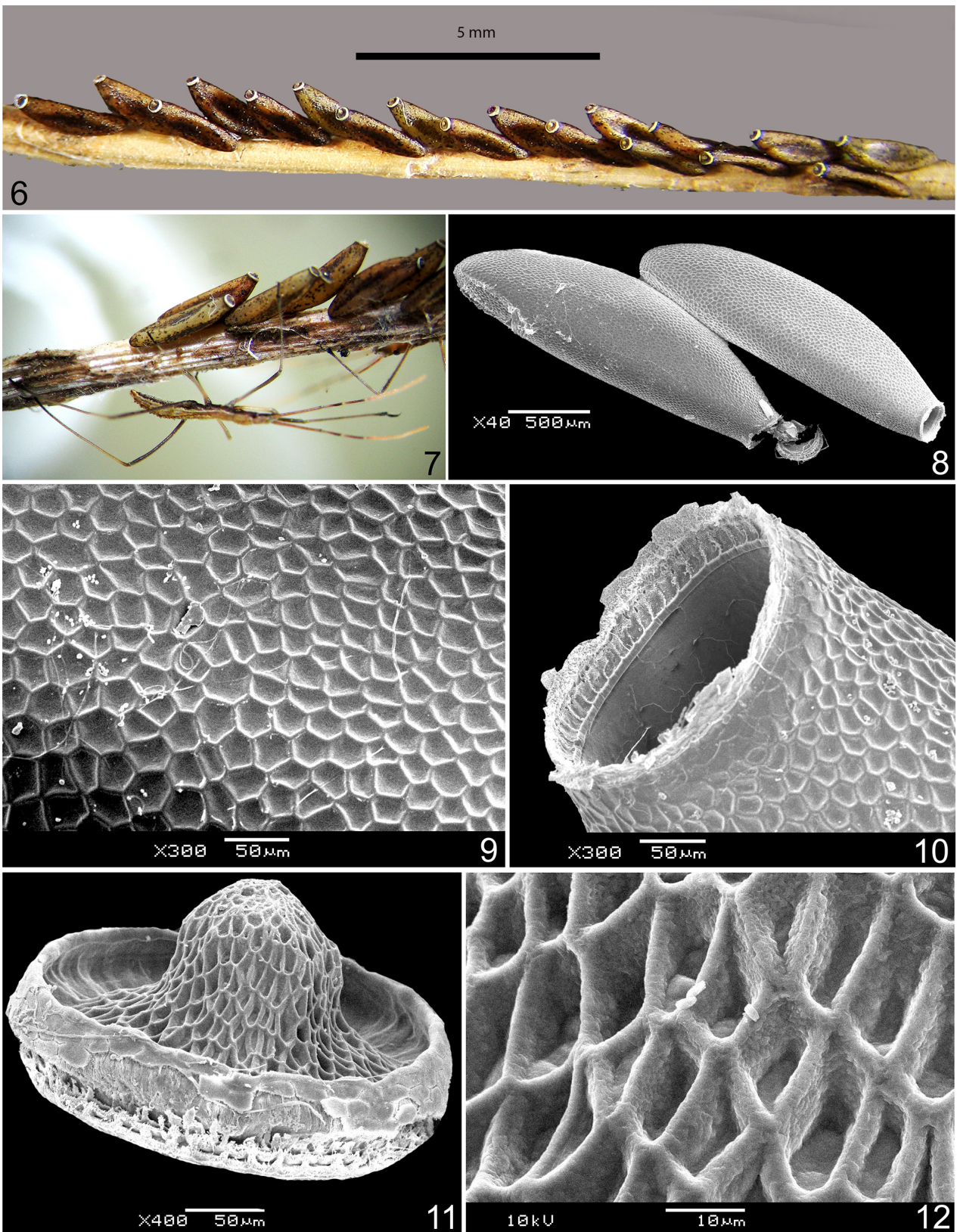
Rhaphidosoma atkinsoni: Distant (1904: 330) (diagnosis, illustrations), Haridass (1985: 245) (feeding, oviposition), Haridass (1988: 49) (ultrastructure of egg), Maldonado Capriles (1990: 271) (catalogue, distribution), Ambrose (2006: 2399) (listed).

Raphidosoma [inadvertent error] *atkinsoni*: Biswas & Mitra (2014: 15) (listed).

Rhaphidosoma atkinsoni: Mukherjee & Hassan (2016: 593) (diagnosis, image).



FIGURES 1–5. Habitat, ‘host’ plant and habitus of *Rhaphidosoma atkinsoni* Bergroth, 1893. Figs. 1–2, habitat near Varvand, Daund; Fig. 3, *Capparis* bush where the insects were seen; Fig. 4, female basking in sunshine on *Capparis*; Fig. 5, living male with forelegs held in unison in front.



FIGURES 6–12. Eggs and a nymph of *Rhapsodosoma atkinsoni* Bergroth, 1893. Fig. 6, eggs deposited in a single zig-zag row; Fig. 7, close up showing attachment of eggs and a live first instar nymph; Fig. 8, an egg; Fig. 9, surface details of chorion; Fig. 10, details of opercular region of an ecloded egg; Fig. 11, operculum; Fig. 12, details of chorion at median projection.

Redescription. Apterous male and female. Body strongly elongate, narrow, in male almost 14 times longer than its maximum width at metacoxae, female slightly broader than male in thoracic region and almost twice as broad in mid-abdominal region. Body of male subparallel posteriad of prothorax, with only slight dilations at meso- and metathoracic regions.

Colouration, integument and vestiture. Dark brown, covered with dense, white, scale-like setae that form complete bands laterally along entire length of body except head. Male with a median dark band covered with only sparse setae, exposing dark brown ground colour of integument; a lateral band of colourless setae and another dark band marginally (Fig. 13). Median dark band with transverse delicate wrinkles and fine tubercles at places; each abdominal tergite also with rounded depression on either side of median dark line which is devoid of white setae. Female more diffuse earth-brown, without distinct lateral bands (Fig. 14). Coloration of setae as well as relative density of setae is different in male and female. Segmental boundaries obscured by setae. Head also densely covered with white setae and many dark brown fine tubercles on its whole surface. A pair of dark lines (which are bare areas with few setae in male and relatively more setae in female) that converge posteriorly to form a 'V' is present in front of eyes and behind antenniferous tubercles. Antennae dark brown and sparsely covered with white setae, thus appearing spotted. Entire venter more densely covered with white setae, with minor difference in male and female; coxae partly dark brown, underside of head and thorax also with sparse, fine, brown granules. Granules on abdomen sparse, barely visible due to dense setae in male, more clear due to relatively sparse setae in female. A ventromedian, partly dark brown line present along all abdominal sternites. Pygophore with sparse setae hence dark brown, similarly female genital segments darker with very few setae (Figs. 15, 16). Abdominal segments III–VII each with a round dark brown patch at anterolateral angle, these patches prominent in male. Spiracles on first abdominal segment dorsal, dark brown, remaining spiracles situated on laterosternites but visible from dorsal side as minuscule protuberances on either side, except for second abdominal spiracle which is very minute. Rostrum brown with very sparse setae on first visible segment; second visible segment longest. All legs brown, relatively sparsely covered by scale-like setae; setae on legs also denser in female than in male.

Structure. *Head.* Elongate, with a deep transverse interocular sulcus close to posterior margin of eyes. Area in front of sulcus rather flat, posteriad of sulcus slightly laterally dilated, in lateral view tumescent above anteriorly, narrowed behind and slightly concave posteriorly. Eyes moderate, semiglobular, situated laterally. Antenniferous tubercles prominent, slightly divergent, exposed from above. Clypeus and mandibular plates indistinguishable from above due to setae, but clypeus is slightly raised and mandibular plates are slightly oblique. Apex of head without distinct spine (Figs. 17, 18). Antennae long, first segment longest, second slightly shorter than first, third and fourth much shorter than first. Labium long, reaching procoxae, its first visible segment almost as long as preantennal region of head, second visible segment longest (Figs. 19, 20). Ocelli completely lacking, untraceable even with SEM; few setae, especially on midline, are situated on tubercles, and some setae are slightly longer than others (Figs. 21, 22).

Thorax. Pronotum tumescent above, with anterior margin concave and posterior margin straight, and with short, median, longitudinal sulcus visible in part; subdivided into a subtrapezoid, anteriorly slightly narrowed anterior lobe and a very short, rim-like, dorsally flat posterior lobe, by a transverse sulcus very close to base. Mesonotum also with a median very shallow longitudinal sulcus, its surface partly granular. Scutellar area slightly raised above at tip; metanotum with median raised area or blunt carina along its length. Metanotum shorter than mesonotum, with posterior margin sinuate and posterolateral corners slightly produced. Granules on pro-, meso- and metanota more prominent laterally (Figs. 23, 24). Prosternum narrow, with deep median sulcus to receive labium. Ventral (pleural) parts of posterior lobe of prothorax encircling coxae posterolaterally and closely approaching but not meeting each other, with a noticeable gap in the midline ventrally. Meso- and metasterna densely clothed with setae, provided with few dark brown granules. Area between mesocoxae slightly elevated, boundary between meso- and metasterna unnoticeable. Mesosternum produced between metacoxae to meet abdominal sternite, their boundaries indistinct. Posterior part of metasternum slightly sulcate (Figs. 25, 26).

Legs. All legs long, slender, uniformly coloured. All coxae swollen. Hind legs with longest femora and tibiae. Tarsi with 3 segments and sharp claws.

Abdomen. First abdominal tergite short, medially raised, with small anteriorly directed tubercle and with lateral spiracle. Remaining segments long but segmental boundaries indistinct due to setae. Connexivum narrow, spiracles small but distinct. Median part of each tergite shining in male; third and fourth tergites with small mid-dorsal tubercle.

Pygophore with sparse setae, eighth segment completely telescoped into seventh segment and not visible

ventrally. In male posterior border of tergites III–VI medially slightly elevated as small shining tubercle. In female tergite V with a small medio-dorsal tubercle at posterior border, tergite VI with a pair of small tubercles and tergite VII with a pair of posteriorly directed blunt tubercular projections on either side of midline (Fig. 27); tergite VIII broader than long; tergite IX slightly sloping downward, not fully visible from above, while only extreme apex of tergite X exposed (Figs. 28, 29). Male abdominal tergites with median part slightly wrinkled and covered with broad setae, some of which have a globular base; and with lateral area covered with dense setae (Figs. 30, 31).

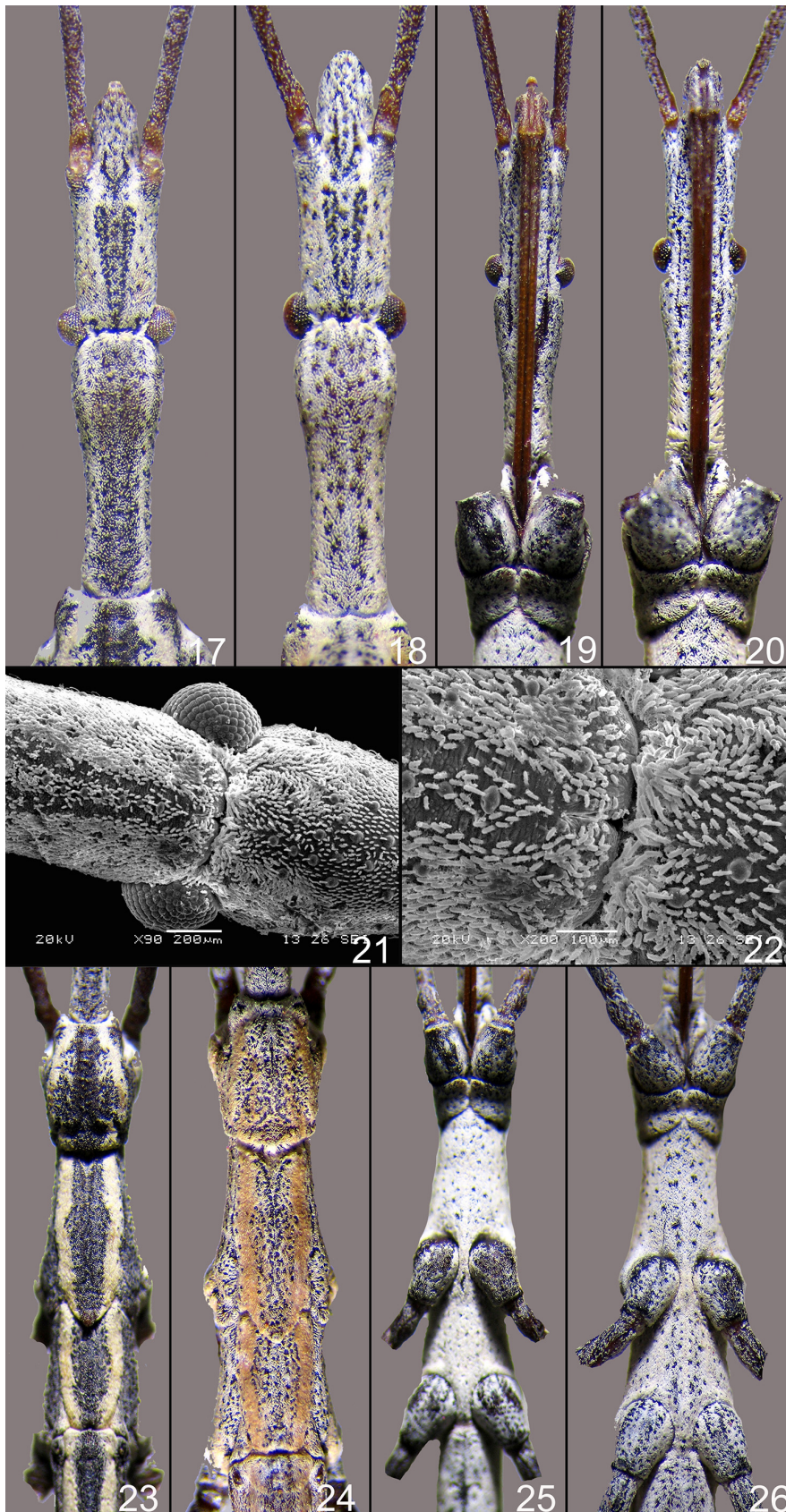
Male genitalia. Pygophore ventrally convex and sclerotized, its superior tip produced into a dark brown tubercle visible in ventral view (Fig. 32). In lateral view pygophore appears boat-shaped, the tubercle at superior tip appears bidentate (Fig. 33). Pygophore dorsally membranous and its shape resembles a ‘slipper’ in dorsal view (Fig. 34). Parameres small, symmetrical, sparsely covered with long setae, almost straight distally (Fig. 35) and projecting out slightly behind in intact pygophore. Phallus oblong oval in lateral view (Fig. 36), endosoma with three sclerotised, spiny areas (Figs. 37, 38).

Female terminalia. Boundaries between valvulae and valvifers obscure due to setae. Ninth tergite downwardly sloping, with blunt, black and shining tubercle at each corner (Fig. 39, 40).

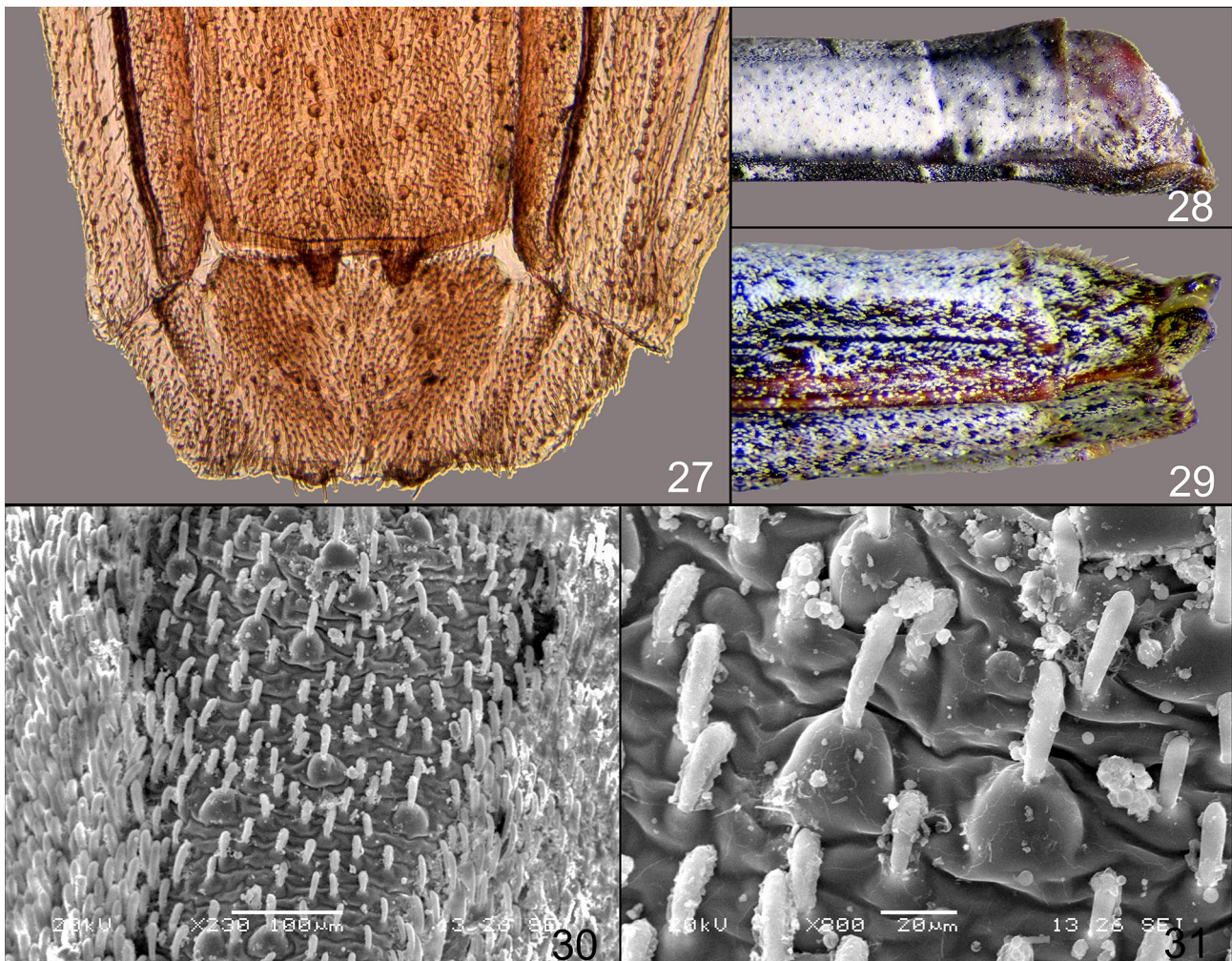
Measurements in millimetres (average of 2 ♂♂ / average of 2 ♀♀): total length 25.1 / 23.5, length of head anterior of transverse sulcus 2.2 / 1.9, length of head posterior of transverse sulcus 2.3 / 2.0, total length of head 4.5 / 3.9, width across eyes 1.0 / 1.0, length of prothorax at midline 1.0 / 1.1, width of prothorax 1.1 / 1.1, length of mesothorax 1.5 / 1.5, width of mesothorax 1.5 / 1.6, length of metathorax 0.8 / 0.8, width of metathorax 1.8 / 1.8, width of abdomen at level of first spiracle seen from above 1.1 / 1.2, length of pro coxa 0.7 / 0.7, length of pro femur 9.7 / 8.5, length of pro tibia 10.7 / 8.9, length of pro tarsus with claw 0.7 / 0.5, length of meso coxa 1.0 / 1.0, length of meso femur 9.25 / 7.8, length of meso tibia 9.1 / 7.85, length of meso tarsus with claw 0.7 / 0.5, length of meta coxa 0.8 / 1.0, length of meta femur 12.7 / 11.2, length of meta tibia 14.85 / 14.1, length of meta tarsus with claw 0.8 / 0.6, length of first segment of antenna 7.7 / 6.7, length of second segment of antenna 3.5 / 2.6, length of third segment of antenna 3.2 / 2.6, length of fourth segment of antenna 3.0 / 2.8, total length of labium 4.3 / 4.3, length of second visible segment of labium 3.3 / 3.2, length of third visible segment of labium 0.44 / 0.44



FIGURES 13–16. *Rhapsodosoma atkinsoni* Bergroth, 1893. Fig. 13, male, dorsal view; Fig. 14, female, dorsal view; Fig. 15, abdomen of male, ventral view; Fig. 16, abdomen of female, ventral view.



FIGURES 17–26. *Rhapsodosoma atkinsoni* Bergroth, 1893, head and thorax. Fig. 17, dorsal view of head of male; Fig. 18, same of female; Figs. 19, ventral view of head of male; Fig. 20, same of female; Figs. 21–22, SEM details of dorsal side of head; Fig. 23, thoracic segments of male, dorsal view; Fig. 24, same of female; Fig. 25, thoracic segments of male, ventral view; Fig. 26, same of female.



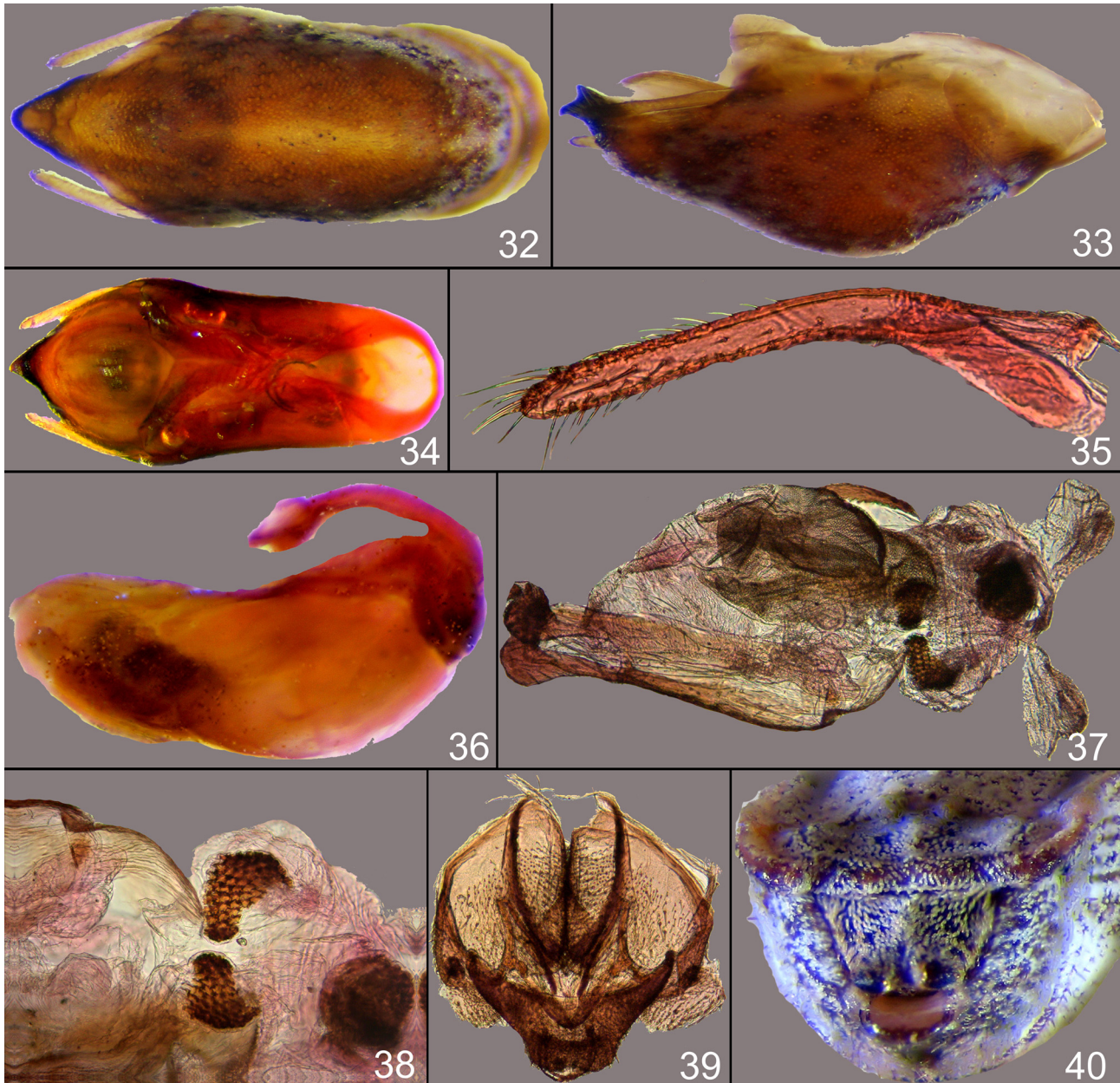
FIGURES 27–31. *Rhaphidosoma atkinsoni* Bergroth, 1893, abdomen and genital segments. Fig. 27, tergite VII of female; Fig. 28, terminalia of male, lateral view (ventral side directed upwards); Fig. 29, same of female; Figs. 30–31, SEM details of a pregenital abdominal tergite of a male.

Discussion

Diagnostic characters of *Rh. atkinsoni*. All the three species of *Rhaphidosoma* recorded from India were only briefly described and therefore it is difficult to compare their diagnostic characters. The original description of *Rh. tuberculatum* states that this species has the “apex of head distinctly porrectly spinous [...] and anterior angles of pronotum spinously produced” (Distant, 1904); this is not the situation in *Rh. atkinsoni*. The original description and illustration of *Rh. madukariensis* are so inadequate that the type material of this species needs re-examination, however, it appears to be 20 mm long and so slightly smaller than *Rh. atkinsoni*.

The male and female genitalia or genital segments of *Rh. atkinsoni* show an overall similarity with some African species of *Rhaphidosoma* (cf. Villiers 1948, Ponel *et al.* 2015). Genitalia of the other Indian species of the genus have remained undocumented; the description and illustrations presented here for *Rh. atkinsoni* are aimed to facilitate identification of this species.

Sexual dimorphism, camouflage. Males and females of this species are more or less of the same body length but can be distinguished from each other on the basis of colouration, setae and breadth of the body. No author except of Villiers (1948) has commented on setae that cover the body almost entirely. It is likely that these white or off-white setae reflect sunlight and prevent overheating of this insect in bright sunshine. The narrow and elongate body of this bug makes it difficult to locate this animal on slender stems of *Capparis*, and perhaps also on grasses, where they are reported to be present (Haridass 1985). The dense covering of setae may provide additional camouflage.



FIGURES 32–40. *Rhapsodosoma atkinsoni* Bergroth, 1893, genitalia. Fig. 32, pygophore in ventral view; Fig. 33, same, lateral view; Fig. 34, same, dorsal view; Fig. 35, paramere; Fig. 36, phallus in repose; Figs. 37–38, partly everted phallus; Fig. 39, female genital segments cleared in KOH, ventral view; Fig. 40, posterior view of female genital segments.

Habitat, bionomics, behaviour. As in most other described species of *Rhapsodosoma* (cf. Villiers 1948, Miller 1953), both sexes of *Rh. atkinsoni* are completely apterous and hence flightless. During the present study individuals were always found associated with *Capparis decidua* even when the plant is fully leafless in summer; they were found moving very slowly on thin branches of the plant. This species is said to be a predator of termites (Haridass 1985). However it is intriguing that these flightless insects are restricted on a particular plant, without any small potential preys such as termites or ants around. We did not observe any individuals of *Rh. atkinsoni* actually feeding on termites or ants. Additional observations are, however, necessary to find actual food of these insects in nature. Miller (1956) observed these insects to live mostly ‘in grasses or on low bushes’ and noted that nothing definite is known about the food of the group, but speculated that their long and straight rostrum may be useful in feeding on small insects such as stem-boring lepidopteran larvae. Although earlier reports of this species are from grass patches (see below), our survey in the adjacent grass patches did not show adults of this species so far, although eggs were detected on a grass stem.

It is interesting to note that some other harpactorine bugs are similarly restricted to a single plant and at least one species has secondarily become phytophagous (Bérenger & Pluot-Sigwalt 1997). It remains to be seen if *Rh. atkinsoni* is also capable of using any plant resources as food. Schuh and Slater (1995) have mentioned that species of Rhaphidosomatini are found on grasses in arid and desert areas in Africa, frequently on the top of branches. This agrees well with our observations on *Rh. atkinsoni* on *Capparis*. Haridass (1988) also observed that the ‘bottle-shaped’ eggs of *Rh. atkinsoni* are glued obliquely in a line, in groups of 17–22 eggs, on stems of grasses (*Aristida setacea* Retz., Poaceae) in the field. The same author further observed that a female lays 4–5 egg batches in her life time (season not mentioned); the egg batches deposited on grass stems observed during the present study match exactly with that described by Haridass (1985, 1988). April–May appears to be the breeding season of this species at least in Daund area.

Faunistic remarks. *Rh. atkinsoni* was originally described from ‘Trevandrum’ (now known as Thiruvananthapuram) in South India (Bergroth 1893); Ambrose (2006) also listed it from localities in South India while Mukherjee & Hassan (2016) very recently recorded this species from Telangana. A checklist of the Reduviidae of Maharashtra (Sharma & Bano 2012) did not include *Rh. atkinsoni*; this checklist is apparently an extract from volumes of the book series “Fauna of British India” and is not based on examination of any specimens. The present report represents the first record of this species from Maharashtra. Since *Rh. atkinsoni* was so far known only from south India, its presence in Maharashtra extends its range northward; the species is probably distributed all over the Malabar subregion of India. The same Varvand area also harbours other interesting Reduviidae that need attention: these are *Ploiaria anak* Distant, 1909, *Polytoxus fuscovittatus* (Stål, 1859), *Triatoma rubrofasciata* (De Geer, 1773), *Holoptilus fasciatus* Reuter, 1881, and *Acanthaspis rugulosa* Stål, 1863 as well as a species of *Stenolemus*, as was revealed during our preliminary surveys; some of these species have already been recorded from this state (Sharma & Bano 2012). Particularly interesting is the record of an emesine bug *P. anak*, which has remained unrecorded since its original description more than a century ago, and the presence of a *Stenolemus* sp. These species will be dealt with in separate publications.

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