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Note on a nest of Saunders' Embiid *Oligotoma saundersii* (Westwood) (Insecta: Embioptera: Oligotomidae) from Kolkata, India

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Embioptera is one of the less worked out ancient insect orders in India. This group is mainly distributed in the warmer tropical region, having 31 species representatives from India (Chandra 2011). The life history, social structure and behavioural biology are known for a very limited number of species, such as the biology of *Embia major* Imms by Imms (1913), study on *Oligotoma humbertiana* (Saussure) by Ananthasubramanian (1956), biology of *Embia minor* Mukerji by Mukerji (1927) and a study on nymphs and adults of *Oligotoma saundersii* (Westwood) by Ling (1934). This present work is an attempt to study further the biology, early life stages and reproductive structures of the species.

Materials and Methods: The nest containing living insects was collected from a garbage hip (mostly Coconut husk) inside home. An attempt was made to serve the colony with food, but after two days as a few insects died, the individuals were taken out by making a dissection in the nest and collected in 70% ethanol. In the mean time, a few behavioural statements were noted. The specimens were first examined under a stereoscopic binocular and the body form, dimensions, colour, number and other characteristics studied. For the detailed study some specimens were treated with 10% KOH (cold) for varying lengths of time according to the sclerotization, and then cleared in distilled water. After the usual process of neutralisation and dehydration, they were cleared in clove oil and temporary slides were made using clove oil and studied in detail under a microscope. The species was identified following the keys by Kapur & Kripalani (1957). An attempt was made to dissect out the reproductive structures of a male and a female adult specimen. The number of specimens was limited thus, it was a bit uncertain to get results as the insects were very soft. Still a very coarse idea about the reproductive structures we have got from the insects. The specimens were kept in clove oil for a few weeks; the body becomes transparent enough to see the reproductive structures from outside. The abdominal parts of these specimens were separated and treated with 10% KOH to make the sclerites loose and then the reproductive structures were dissected out with very fine needles. After dissection, photographs

Oligotoma saundersii
Saunders' Embiid

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were taken with a Leica Stereo Zoom Microscope (Leica M205A) using the software Leica Application Suit (LAS V3.8) and the necessary editing was done using Adobe Photoshop 7.0 software. The specimens were deposited at the National Zoological Collections, Zoological Survey of India, Kolkata.

Result and Discussion: The nest: The nest was collected by the third author from his house [Dover Lane, Ballygunge, Kolkata]. Generally the representatives of Embioptera make their nest under bark or sometime in leaf-litter, forming silk-webs around some hard scaffold material, but in this case the nests were made by spinning silk around rice and coconut hay, dry flowers and leaves inside the house. The nest was irregular in shape but to some extent roundish, with a length of 7–8 cm and a width of 5–6 cm and it was about 1cm thick (Image 3A). The nest was kept under observation for a few days inside a plastic cover. At night the male specimens came out of the nest and two of them died outside the nest (Image 3B). An attempt was made to feed the insects with a rotten flower (a *Hibiscus* flower was there in the nest, that's why the attempt was made with only the *Hibiscus*) but failed. Then the nest was dissected and the insects taken out. The nest consisted of long slender tubes made of fine white silk secreted from the silk gland in the enlarged first tarsal segment of the front legs of the insects. All individuals both young and adults are capable of producing the silk but most of the construction work is done by the adult females and the few last life stages (Ling 1934). The silk tubes are transparent enough to see the larvae and female adults from outside. The nest was built by making several tunnels through *Hibiscus* flower, straw, coconut husk and a bunch of hair.

The immature stages: As we were unable to rear the insects, it was difficult to designate the life stages as proper instars. From the nest we have got three different immature stages of the insect with different body lengths and different body structures. The immature stages of insects with incomplete metamorphosis are generally termed as nymphs, but according to some workers, use of the word nymph should be restricted only to the stages where wing buds or wing rudiments have developed (Ananthasubramanian 1956). So, here stages with wing pads are mentioned as nymph and all other earlier stages are mentioned as larvae. Though the female does not develop wing pads, individuals similar to male nymphs in size and shape but lacking wing pads are considered as female nymphs here.

(i) Larvae: Size smaller, body length is from 4.034–5.008 mm and width is from 0.608–0.643 mm (mesothorax). The body colour of this stage larva is very pale, only the mouthparts are brownish-black due to chitinization. The gut has black spots that are the remnants of food materials (Image 1E & F).

Head: Head is ovoid, larger in comparison with the body. Head length is from 0.667–0.708 mm and width, which is most in the eye region is from 0.516–0.542 mm. The eyes are small.

Mouthparts: Mandibles short, well built with numerous denticles, bases with strong articulation. The dark colour of the apical teeth and the cutting edge represents chitinization and a biting and chewing type of feeding habit very well. Labrum fully covers the mandibles. Maxillary palps well developed and well visible from the dorsal side. The tip of the lacinia is partly chitinized.

Antennae: Stout, short, with 15 segments. The third and the last segments are a little elongated; other segments are ovoid and encircled by small hairs.

Thorax: Thoracic segments are well developed; prothorax smaller; meso- and metathorax broader than the first one as well as their length. Legs are elongated, very similar to the legs of adults. Fore tarsi are swollen and modified for silk production. Middle legs are feeble.

Abdomen: Ten abdominal segments visible, of which the first one continued with the metathorax. Tenth abdominal segment is triangular, not modified into any abdominal appendages. The end of the abdomen is very simple, symmetrical, two anal cerci present.

(ii) Male Nymph: Five male nymphs were collected from the nest. Body whitish, only except the chitinized part of the mouthparts which was dark brown to black. Body size was slightly bigger than the adult male, length 7.183mm; width 0.9mm. Gut is externally visible due to presence of remnants of food materials in the alimentary canal (Image 1G).

Head: Head ovoid, length 0.948mm and width 0.741mm. A slight increase in the length of the head is visible than the previous larvae. Eyes small. Antennae short, with 19 segments of which the 3rd segment is distinctly bigger than the others. Broad mandibles with numerous well chitinized denticles remains covered dorsally with the labrum.

Thorax: Thorax distinctly divided into three parts. Prothorax small, having a pair of fore legs on the ventral side. Fore tibiae are developed for silk production. Meso- and metathorax well built each with a pair of legs on the ventral side and a pair of wing buds on the dorsal side. The middle legs are very weak, but the hind legs are well built with musculature. A pointed claw is present at the end of all the legs. The wing bud

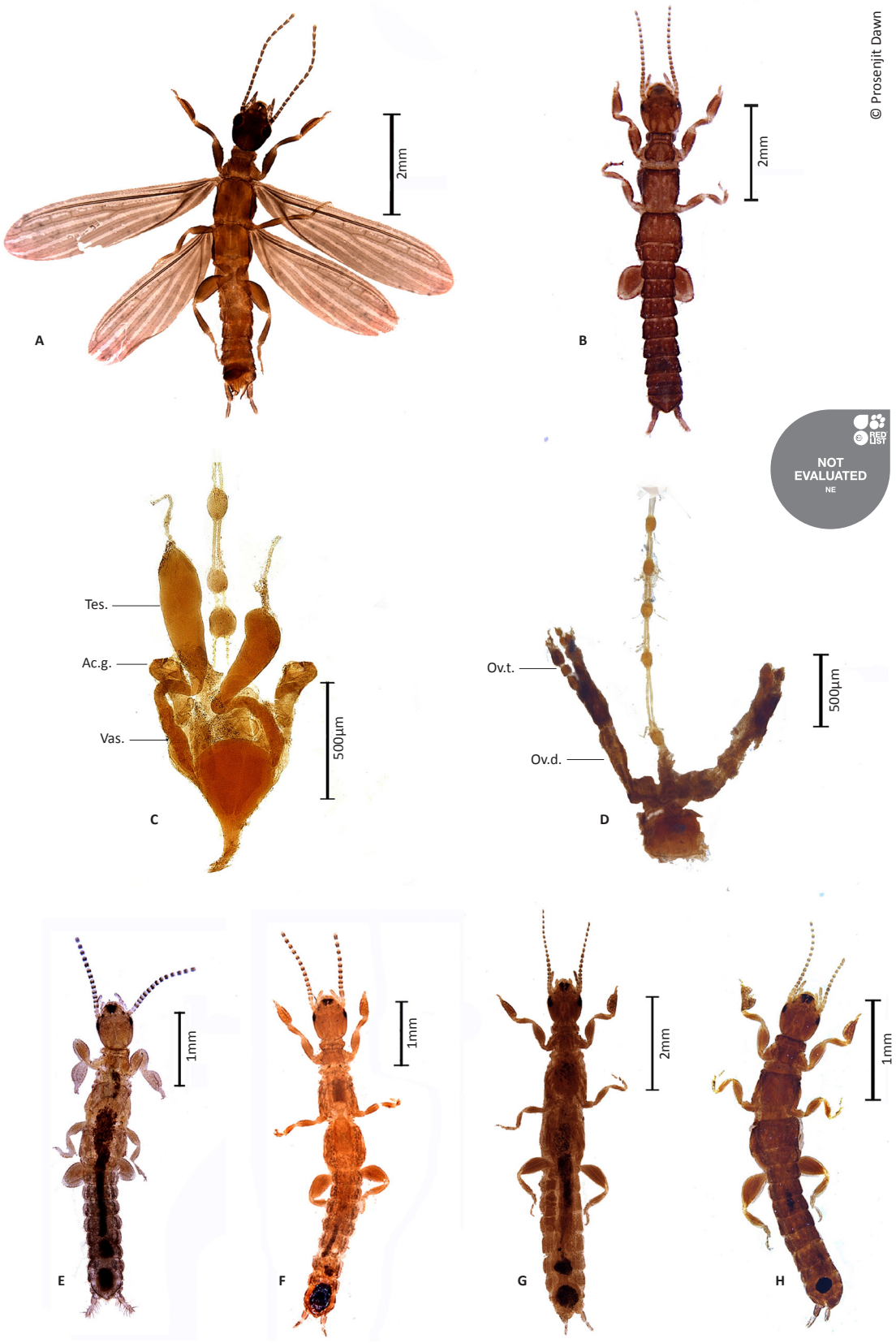

Image 1. (A–H) *Oligotoma saundersii* (Westwood).
A - Adult male; B - Adult female; C - Male reproductive system, Tes. - Testis, Ac.g. - Accessory gland, Vas - Vas deferens; D - Female reproductive system, Ov.t. - Ovarian tubule, Ov.d. - Oviduct; E&F - Larvae; G - Male nymph; H - Female nymph.
*Colour of the specimen in the photograph is yellowish because of clove oil

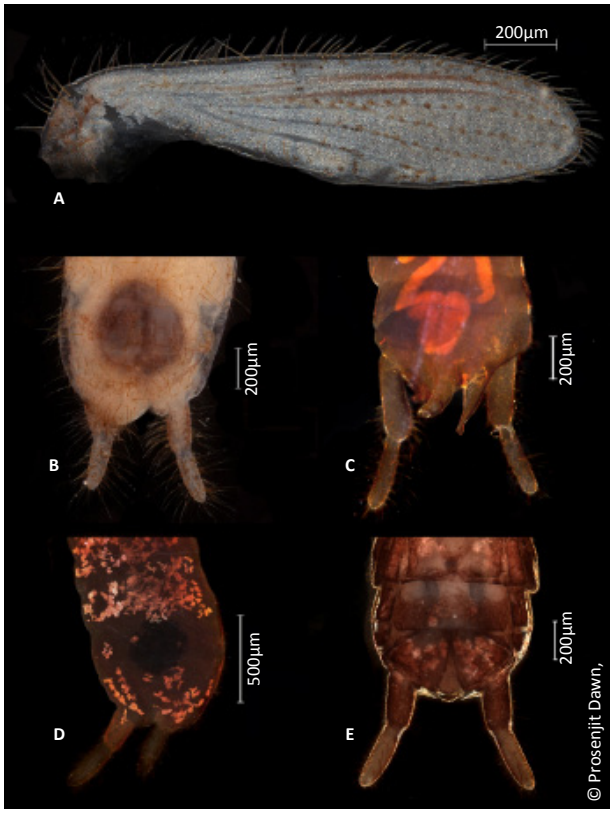

Image 2. (A–E) *Oligotoma saundersii* (Westwood).
A - Wing pad of male nymph (forewing); B - Abdominal terminalia of male nymph (dorsal); C - Abdominal terminalia of male adult (dorsal); D - Abdominal terminalia of female nymph (dorsal); E - Abdominal terminalia of female adult (ventral).

Image 3. (A–B) *Oligotoma saundersii* (Westwood).
A - The web-spinner nest; B - One live male insect came out from the nest at night.

is dumbbell-shaped, whitish in colour, about 1.4mm in length, and remains covered in wing sac (Image 2A). The line of hairs and their follicles present on the wing bud appears as a brownish line on it. In the earlier stages wing venation is not clear, but in older nymph venation and tracheation are quite clear, future vein formation can be assumed from the bud.

Abdominal appendages: The tip of the abdomen is simple, very minute modifications towards differentiation of the abdominal appendages are visible. The tenth tergum is not clearly divided, but the 10th sternum is divided into two lateral plates (Image 2B).

(iii) Female Nymph: The female nymph is very similar to the adult female in appearance, except the lighter colour due to less sclerotization and the smaller size (Image 1H).

Head: Similar to the male nymph, but the mandibles are a little elongated and the antennae have about 16 segments.

Thorax: Prothorax smaller, but fore tibiae a little more developed than in the male nymph, seems to be more active. The rest of the thorax is almost the same but a little wider than in the male, except the presence of two pairs of wing buds in the male.

Abdominal appendages: Abdominal appendages in the female nymph to some extent resemble the adult female. The 10th tergum is triangular, undivided but the 10th sternum is divided longitudinally into two equal lateral plates (Image 2D).

Adult Male: From the nest a few adult males escaped, and six adult male specimens were collected. The adult males are slightly smaller than the male nymphs, with a length from 5.96–6.5 mm and width from 0.83–0.9 mm. The general body colour is brown; head, mouthparts and abdominal appendages are very dark due to chitinization (Image 1A).

Abdominal terminalia, i.e., 10th abdominal tergum and sternum, modified into species specific pattern. Process of right hemitergite (10RP$_1$) without a subapical spine. Process of left hemitergite (10LP) broad spatulate, with curved sides. Left circus basipodite (LCB) well developed, curved outwards, ending obtusely Spine of the left paraproct (LPPT) broad, sickle-shaped. A slender, heavily chitinized spine arises subterminally from the margin of the ninth sternite, with two minute teeth at its base and the spine curves to the right under the end of the sternite projecting upwards and backwards terminally (Image 2C).

Reproductive structure: It is situated from the 5th to the last segment of the abdomen. A pair of lobular testes is suspended in the body cavity with a fine threadlike muscle. The lower parts of the testes are narrower and connected with thick vasa deferentia which further

downwards meets the vesicular ejaculatory duct. The ejaculatory duct opens outside in a narrow duct through the process of hypandrium (HP). Accessory glands are present on each side of the main reproductive structure, though their number and proper shape and size could not be judged from the dissected specimen (Image 1C).

Adult Female: Adult females are dark brown in colour, except the joints, which are pale in colour (Image 1B). Bigger in size than the male adult, with a body length of 7.35mm and width of 0.913mm. The female adult differs from the male in many aspects. Shorter antennae (2.8 mm) with 19–20 segments, second and fourth segments longer, third one smaller unlike in the male. The mandibles are shorter with sharper teeth, dentitions more. Tibiae of fore legs well developed, indicate the maximum ability to produce silk. Abdominal appendages are very different from those in the male; the 10th tergum is triangular, undivided; 8th sternum is modified to form the subgenital plate whose posterior margin is opened for the coming out of eggs during oviposition (Ling 1934). Female genital aperture is visible through the middle of the 8th segment as a well defined dark area. The cerci are symmetrical without any modification; both basal and distal segment same in length. Tenth sternum divided in two equal lateral plates (Image 2E).

Reproductive structure: Female reproductive organ also extends from 5th to 10th segment. Ovaries are formed of 3–4 parallel filaments, i.e., ovarian tubules. The parallel filaments, each containing 6–7 follicles, are supported by hard sclerotization to stick together. Filaments are connected with a thick whitish oviduct. The ducts from each side gradually narrow and meet together to produce a common duct downwards. After dissection no proper structure of accessory glands or spermatheca was visible, but their presence is expected (Image 1D).

Behaviour: The male insects used to come out from the nest at night and they were attracted to light. As the nest was made around soft materials, the larvae and the females were well disguised inside; sometime movement was visible through the transparent web wall. The larvae were far inside, and seen only when the nest was dissected. Both the larvae and the adults were very fast in moving backward as well as forward inside the tunnels. If released in the open, they preferred to find a corner and made themselves motionless; if disturbed they ran very fast. Males do not take food; their thinner abdomen, absence of food remnants in the gut, simpler mandibles indicate that. The eyes in the males are well developed unlike in females, as females seldom leave the nest; on the other hand males sometime travel good distances on wings towards light. Sometimes females with fertilized eggs can be seen alone in the open, as they try to set a new nest.

Conclusion: These small insects are very interesting because of their typical web building ability and social behaviour. In this study it was noticed that the insects used household waste materials chiefly plant products such as wood, husks, dried flowers etc. to make their nest. It indicates the possibility for these insects to radiate globally through goods carriages, which may

Table 1. Comparative morphology of different stages of the insects

Features	Larvae	Male nymph	Female nymph	Adult male	Adult female
Head Length	0.667–0.708 mm	0.948mm	1.02mm	1.002mm	1.17mm
Head Width	0.516–0.542 mm	0.741mm	0.823mm	0.752mm	0.921mm
Mandibles	Short, denticles more	Little elongated	Little elongated	Elongated, denticles very inconspicuous	Not very elongated, denticles more
Antennae	Short (19–20 segments)	Short (19–20 segments)	Short (19–20 segments)	Very long (4mm)	Short (2.8mm)
Body Length	4.034–5.008 mm	7.183mm	7.18 mm	5.96mm	7.35mm
Body Colour	Whitish	Whitish	Palest brown	Brown	Dark brown
Width of Thorax	0.608–0.643 mm	0.9mm	1mm	0.830mm	0.913mm
Width / Length	0.128–0.151	0.125	0.139	0.139	0.124
Wings	Absent	Wing buds present	Absent	Fully developed wings	Absent
Abdominal Appendages	Not developed	Tenth segment undivided, but development towards differentiation of abdominal appendages visible	Same as the adult but paler in colour	Modified as species specific pattern	Simpler unlike the male

be the probable cause that this species is Artificially Cosmopolitan.. In the nest the females are the main web builders, males are generally less in number because they leave the nest. At a time different life stages may be easily seen in the nest. As the insect shows hemimetabolous, i.e., with incomplete metamorphosis, larvae do not show drastic changes in the morphology except the measurements, development of wings and genital structures (Table 1). It is clear that a more detailed study and rearing of the insects will reveal some more interesting information.

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