

II NOTES ON THE INDIAN GLOW-WORM [*LAMPORPHORUS TENEBROSUS* (Wlk.)]

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(With Plate VIII.)

The present paper is based on personal observations made during the months of August, September and October, 1917. Although the Indian glow-worm is quite common in most parts, especially during the rainy season, when snails, which form its natural food, abound, and although a good deal is known of the structure of larvae of the family and also something about their habits, no detailed account of the natural history of any particular species of Indian glow-worm seems to have been recorded. As is well known, these creatures are entirely nocturnal in their habits and spend the entire day in a state of rest or sleep from which it is almost impossible to awaken them. As soon as the light begins to fade they wake up from their slumber and wander forth in search of food. In their natural surroundings they are probably obliged to search a good deal before they find their food, as those, which I have had under observation, although supplied with a number of snails, always took some time before they secured a snail each. They can walk rather fast and when in quest of food the head is protruded as far as possible with the antennae, which are retractile, extended to their fullest extent.

My specimens were kept in breeding cages 12" × 10" × 8" made of wood with perforated zinc sheeting and glass sides and door. Snails were constantly supplied to them.

Description of full-grown larva.

Length 60 to 65 mm. greatest breadth 19 mm.

Shining black, a rather broad yellowish ochraceous margin on the lateral areas of the thoracic and abdominal segments. The dorsal segments of the thorax and abdomen are composed of chitinous, somewhat flattened plates, partially overlapping each other, that of the pronotum concealing the head. Head protrusible, shining black, flat above, with a deep, central, V-shaped emargination bordered with light brown on anterior margin; mandibles dark red, their inner areas black, very robust, curved, rather bluntly pointed, not overlapping each other, but in the earlier stages these overlap each other to a great extent and are acutely pointed apically, base of mandibles broad with a strong blunt

tooth on inner margin, just below this tooth on the upper, flattened part of the mandible there is a patch of dense, silky, recumbent, light brown hairs, a shallow groove on the inner margin of each mandible along its attenuated portion, mouth light brown with two brushes of silky hairs interspersed with a few spinose hairs, visible only from above. Antennae three-jointed, basal joint whitish, very stout, a little shorter than second which is longest, second joint whitish with a dark line on its inner area, third joint very short, light brown, a few stiff, brown hairs at the apex of the second and on the third joint. Eyes very small, situated a little within the lateral margins of the head, almost immediately behind the bases of the antennae. Pronotum black, with two longitudinally oblique, discal fasciae, broadened anteriorly and narrowed posteriorly, extending from the anterior margin to a little before the middle of the disk and the lateral margins broadly yellowish ochraceous, lateral and posterior areas of disk rugose, anterior margin rounded, lateral margins oblique, the sides slightly recurved, posterior lateral angles rounded, the posterior margin slightly concavely sinuate near middle, a narrow longitudinal sulcation on middle of disk which extends nearly throughout the dorsal segments, a rather deep, oblique depression on each side of central area of disk; meso- and metanotum broader than pronotum, discally black and strongly rugose, with some pits or depressions, lateral areas similar in colour to those of pronotum, lateral margins almost straight, posterior margins very slightly concavely sinuate. Abdomen with the first seven segments black, the greater part of their posterior lateral areas broadly yellowish ochraceous and their lateral and posterior areas faintly rugose, the posterior margins of the sixth and seventh segments are broadly concavely sinuate, their posterior lateral angles being obtusely rounded, eighth segment much smaller than preceding segments, black with a whitish patch on each antero-lateral area, ninth segment almost entirely black with a very fine pale yellow line bordering its posterior margin, which is almost semicircular, its lateral margins rounded. Underside black with the head beneath light brown, margined with black. Membrane connecting sternal segments milky white. The ventral surface of each of the second abdominal segments to the ninth bears four longitudinal ridges, each ridge being furnished with a brush of short, stiff brownish hairs or bristles, which are easily broken off. A cluster of soft filamentous processes, which can be protruded at will, situated at the apex of the abdomen. The use of this appendage is explained on p. 22.

The first larva that attracted my attention was one brought by Dr. N. Annandale from Rambha, in the Ganjam district of the Madras Presidency in August, 1917. As soon as it woke up from its day's sleep it protruded its head about a quarter of an inch beyond the pronotum and commenced walking quickly about the floor of the cage in search of a snail. On finding a snail it examined it carefully and if it found that the snail had retracted

itself into its shell it sat on the shell with its head towards the opening and waited till the animal emerged in order to find out what was on top of it. The moment the snail appeared the larva made a sudden grab at its body and if it succeeded in obtaining a firm grip it allowed its head to be dragged in by the snail until it could go no further, then it commenced its meal, at first coiling itself round the shell and then lying on one side with the shell between its legs. It moved its mandibles sideways continuously while it fed. This operation lasted till there was nothing left of the snail and sometimes occupied a couple of hours. Often when a snail was on the move it was attacked by the larva, but either out of self-defence or from the result of a bite withdrew itself into its shell and secreted a quantity of frothy matter, which the larva invariably sucked up. This, however, did not prevent the larva from continuing its attack, for as soon as it cleared this frothy secretion it inserted its head into the shell, seized the snail, and gradually devoured it. Occasionally it threw out some part of the snail's body, and in one instance I saw it come back to the spot where it had thrown out some refuse, as it were, and eat up what it had a moment ago apparently rejected.

The number of small snails (*Macrochlamys indica*) usually devoured in one night was about four, but on one or two occasions I found two empty shells of a small-sized *Achatina fulica* besides four smaller shells. It is doubtless the case that these creatures spend the whole night either eating or searching for food, for at half past four one morning I saw the larva walking about the cage with its luminous organ glowing very brightly as if it were looking for food. It may also have been possible that it was looking for a place of repose for the day.

On the 17th August at about 8.30 P.M. after I had put out all the lights I approached the cage stealthily, with a candle which I lit quickly. I found the larva standing with its fore-legs resting on the side of a watch-glass containing water. Its head was extended up to the water's edge and its mandibles and palps were being moved rapidly to and fro in the water. This went on for some time and though I placed the lighted candle inside the cage in order to watch it more closely, the larva did not seem to be affected. It occasionally thrust its head further into the water, moving it from side to side all the time. The manner in which the larva cleaned itself was very interesting. It usually rested its fore-legs on the receptacle containing water and protruded its head to its fullest extent into the water and moved its mandibles and palps rapidly to and fro. After some time it left the water and walked away a short distance where it lay on its side and rolled itself up. It appeared as if it were preparing to sleep after having had a drink of water. But this was not the case. It had been busy with its toilet. Having completed washing its mouth-parts in the water it now laid down to clean its body. It extended the filamentous appendage at the posterior end of its body, consisting of a number of soft, slender, retractile, sticky-looking objects which form

a sort of brush when extended; this was pressed closely first against each ventral segment, being drawn in its expanded state across the segment. After each segment had been cleaned this organ was retracted only to be placed on the next and succeeding segments, until all, but the one bearing the organ, were cleaned. This process of cleaning was applied to every part of the body in turn, always beginning from the anterior part. First the centre of the ventral segments was cleaned, then the right and left lateral areas. Having cleaned the underside it moved off to another spot where it remained in a standing position and cleaned the dorsal segments. The only segment it could not clean was the apical one of the abdomen as it could not be reached. After having finished cleaning its body thoroughly it went back to the water and appeared to drink, as its jaws and palps were almost stationary. I left the cage in perfect darkness for a quarter of an hour. When I returned I found the larva perched on top of a small stone, which was lying at the bottom of the cage, apparently asleep. I left it thus for the rest of the night. By the morning of the 21st the larva had dug a round hole about an inch and a half in diameter in the soft earth at the bottom of the cage, adjoining a small stone on which I had seen it perched the night before. In this hole it coiled itself up and remained so for the rest of the day. During the night of the 21st it began to enlarge this hole and by the morning of the 22nd it had gone well under the earth. Through a small hole the larva could be seen. It was still in its larval state. All the snails in the cage were thrown away. At 7.15 P.M. the same day the larva commenced to close up the opening through which it could be seen and which had been used for the purpose of throwing out mud excavated from the interior of the hole. Small quantities of earth were held between the mandibles and carried towards the opening. The earth was gently stuck into the side at the bottom of the hole; gradually it was carried to the top of the hole; on reaching the opening it was thrust with some force against the side, which caused the earth at the top to fall inwards, but just sufficiently to diminish the size of the opening. Continuing in this manner the larva succeeded in closing the opening entirely. It was now completely enclosed in its "dug-out." By the morning of the 23rd it had gone further under the earth and could be seen asleep through a large opening a little distance away from the one which it had closed up the night before. Apparently it had spent the night either in increasing the size of its "dug-out" or in going further underground, the large opening having been made for the purpose of placing the excavated earth outside. At 7 P.M. on the 23rd it was still asleep. The light of a candle made it glow faintly, but it did not move. On the morning of the 24th it was in the same position as on the night before. At about 4 P.M. on the 24th it glowed for a short time. On the windows being opened it ceased to glow. By dusk it commenced to close up the opening, which was accomplished in the same manner as explained before. On

the 25th it could not be seen at all. On the 26th some earth was removed by me causing an opening through which it could be seen lying perfectly still on its side. In order not to disturb it I placed a small stone on top of the opening. On the 27th I touched the larva with a match stick, which it seemed to resent as it moved and glowed. The opening was left uncovered from 5 to 8.30 P.M. during which time it glowed continuously. Nothing took place on the 28th and 29th. On the morning of the 30th the doors of the room were all closed and the room was in perfect darkness. I removed the stone which covered the opening and a faint glow was visible, which gradually died away. Noise of any kind, even talking, caused it to glow, though very slightly. In the evening I introduced another similar larva into the cage. This larva was sent by the Deputy Commissioner of Angul, Orissa. It appeared much larger than the other which had hidden itself in a "dug-out." The Angul larva behaved in exactly the same manner as the one from Rambha, devouring snails every night, having no regard to size or species. Nothing of special interest happened till the 5th September, when I noticed an empty shell of *Macrochlamys* stuck at the entrance of the "dug-out" in which the Rambha larva was. I removed the shell and found that the larva had changed its position and appeared to occupy more room than it had done during the past week or two inside its "dug-out." It also appeared as if it had eaten the snail, the shell of which was at the opening. Up to 6th September the two larvae were in one cage. On this day after dusk the larva from Angul walked about the cage and in its wanderings it came across the entrance to the "dug-out" of the other larva. It stopped a while at the entrance, peered into the "dug-out" and on seeing a light inside, it remained quite still with the anterior portion of its body almost covering the opening. The larva in the "dug-out" glowed all the time, sometimes more brightly than at others. This, however, did not scare away the Angul larva, which, after a while, began to make its way into the "dug-out." Presuming that this would terminate in one larva eating the other, I pulled the Angul larva away. The other larva had in the meantime protected itself from attack by turning its dorsal surface towards the opening of the "dug-out," thus offering a hard surface to the Angul larva in case of attack, and also barring the entrance to the "dug-out." Once pulled away the Angul larva did not further attempt to enter the abode of the other larva although the opening was left open all night. As an alternative it seized a medium-sized *Achatina fulica*, this being the second specimen of that species which it had eaten during the 6th. On the 7th September the Angul larva was placed in a separate cage. On the evening of the 8th I found the hole, in which the Rambha larva had been, empty. It (the larva) had changed its skin, which I afterwards discovered, was its last but one moult, and now appeared much larger. On leaving its "dug-out" it went forth in search of food. I had left a medium-sized *Achatina* in the

cage and it was not long before it commenced devouring it. Inside the "dug-out" were pieces of its cast skin, and on the side, at the furthest end, two of the largest dorsal plates were stuck hard up against it. On the 9th there were no snails left from the supply put into the cages on the 6th. On the 10th some large specimens of *Achatina* were put into the cages. These larvae seemed to prefer the larger snails, but if they were unable to overcome these, they readily devoured the smaller ones. At about 9 P.M. on the 10th the Angul larva was observed digging a hole in the soft earth at the bottom of its cage. This was accomplished by small quantities of earth being carried between the mandibles and deposited some distance away from the hole. On the first night the hole was not completed, only a slight depression having been made in which the larva passed the night and where I found it on the morning of the 11th. After sunset on the 11th both larvae walked about their cages, presumably looking for food. The Angul larva did not devour any snails, but tried either to get under a very large *Achatina* or to get hold of its body but the snail was too tough to allow the larva to fix its jaws in its body. The earth at the bottom of the cages appeared very dry, so I poured some water on it and as soon as the larvae found everything around them in a moist condition, they each left off what it was doing. The Angul larva's attempts having proved unsuccessful, it gave up attacking the large *Achatina* and betook itself to its pit or depression where, after cleaning its body, it retired for the night by 9.30 P.M. The Rambha larva took advantage of the water in its cage and began to clean itself. On the 12th this latter larva had managed to overcome a large *Achatina*, which it devoured. During the night the Angul larva had dug itself well under the soft earth. This was done in precisely the same manner in which the Rambha larva had done preparatory to moulting. Nothing worthy of note took place from the 13th to the 20th, the Rambha larva continued to eat and the Angul larva remained hidden underground. On the 21st morning I made a small opening on the top of the "dug-out" in which the Angul larva was, and I saw it still in its larval state. I covered up this opening with a tin cover so as to shut out all light. At 7.30 P.M. I uncovered the opening and found that the Angul larva had cast its larval skin and the creature now appeared almost milk white, the only visible black spots being the stigmata situated on the segment containing the luminous organs. The insect was now very sluggish and though handled a good deal with a tea-spoon, in order to secure the cast skin intact, it did not attempt to protrude its head or even move its legs. It glowed very brightly when touched. This was the pupal stage. On the 22nd the pupa was in the same state and its glow was now continuous. It remained so till the 27th when it cast its pupal skin between 3 and 4 P.M. The pupal skin is quite different to the last larval skin. The last larval skin resembles the larva exactly, both in texture

and appearance, while the pupal skin is quite flimsy and transparent throughout. Both these skins were carefully removed and are preserved in the collection of the Zoological Survey of India.

After casting its pupal skin the insect became quite sluggish and did not seem affected by being handled. It did not attempt to walk. It lay quietly on its side and glowed only when touched or when any loud noise was made. Its glow, however, did not last long. The Rambha larva continued to eat snails from the 23rd to the 27th, until it gradually decreased its food to a single snail a night. It now refused to touch even the smallest snail. At about 6-15 P.M. on the 28th the insect from Angul, which had now been transformed into an adult female *Lampraphorus* emerged from its "dug-out" and took up its position near one of the sides of the cage. Here it lay slightly on one side and turned up the posterior end of its body and glowed very brightly. On a light being shone on its cage the glow of the insect gradually died out and it commenced to walk round the cage. It made several attempts to get out of the cage, but finding no exit, it tried to get under a stone in the vain hope of finding an opening there. Seeing it so restless I placed the cage on an exposed window sill. Had there been any males of its species flying in the neighbourhood they would certainly have been attracted to the cage by its bright glow, although the moon was shining brightly and the skies were clear. On the morning of the 29th the female had got under a tin cover which was placed in the cage, and remained there for the rest of the day. Its milky colour had now changed to a very pale ochraceous on the middle of the first nine dorsal segments, the margins of which were pale yellow. The dorsal plates now appeared more flat than rounded. The ventral surface remained creamy white. The adult female cleans itself in the same manner as does the larva. Up to the 12th October the female had walked about the cage every night exhibiting its light at intervals in different parts of the cage. On one occasion I opened the door of the cage and it immediately walked out. After going a short distance it stopped, turned up the posterior end of its body and began to glow very brightly. Having glowed for a few minutes it attempted to go further off, but I put it back into its cage and it kept on glowing at various parts of the cage. It ate nothing, although a number of snails were placed in the cage. A little water was put in the tin cover in the cage for the snails to drink. The next morning the female was found inside the water, apparently drowned. I rescued it and placed it under the tin cover, leaving no water in the cage. It remained very quiet and listless during the day, but by evening it had revived and was walking about the cage as usual. During the night, that is the night it strayed into the water, it had laid four globular, pale yellowish eggs measuring about 3 mm. in diameter. It continued to lay eggs every night up to the 14th. In all it laid fifteen eggs. These eggs were luminous and could with ease be counted at the bottom of the cage in pitchy darkness. The luminosity of the eggs

did not appear to last for more than one night. On the afternoon of the 14th the female appeared very sluggish and apparently lifeless. Its colour too had changed to a dark brown.

The following is a description of the female taken immediately after death:—

Dark brown. Dorsal segments greatly arched, shining, faintly, transversely rugose, especially on the lateral areas; posterior margins of the abdominal segments narrowly ochraceous; some large irregular patches on the disk of the meso- and metanotum also pale ochraceous; lateral margins of all the dorsal segments narrowly shining black; a distinct, short, central, longitudinal carina on anterior area of pronotum which is posteriorly bifurcate, and beyond this is a narrow central longitudinal sulcation continued to about the metanotum; the lateral areas of each dorsal segment with some shallow pits or depressions. Legs and underside dark castaneous, with the central discal area of the abdomen brownish ochraceous; apical margins of all the abdominal segments clothed with a few short stiff, spinose hairs, which are very easily broken off; underside of femora and tibiae of all the legs armed with short stiff yellowish hairs; apical joint of tarsi very long, as long as or longer than the remaining joints together. Antennae composed of six joints of which the basal joint is very stout, the second joint long, longer than the remaining joints together; these are very short and subequal in length; some stiff hairs on the antennal joints, the most conspicuous of all being two rather long ones at the apex of the second joint, and a single, long, curved one at the inner side of the apical joint; the palps are also hairy; jaws large, strongly curved, overlapping each other, pointed apically, black and shining on their distal half and reddish-brown on their proximal half. Eyes small, blackish, situated at the base of the antennae.

The larva from Rambha had eaten nothing for at least ten days. The earth at the bottom of its cage was damped and some water placed in a watch-glass. It was evidently very thirsty for it immediately went to the watch-glass and drank a good deal of water. During the night of the 11th October it tried to dig itself under the damp earth, but it did not make much progress. On the evening of the 12th it dug diligently for an hour or so until it made quite a deep pit. The excavated mud was carried in small quantities and placed first a little distance away from the hole and as the hole began to get deeper and the insect was able to get inside, it began to close up the entrance in the same manner as has been explained when referring to the Angul larva. It eventually hid itself entirely from view and I left it so till the 24th October when I noticed a change had commenced to take place. The larva had begun to cast its final larval skin, but this it did in a very awkward and certainly unusual manner, for insect larvae do not, as a rule, cast their skins piece-meal. First the three dorsal plates of the thorax were cast off, then the first dorsal plate of the abdomen and so on till all the dorsal plates had been

got rid of. It seemed greatly affected when any light shone on it. On the 25th morning the ventral plates still appeared to be uncast. Something seemed to have gone wrong with this creature as it lay on its back till the 28th, glowing very gently when exposed to view, either during the day or at night, but its moult was not completed. On the 29th it had discoloured altogether and had no resemblance, as far as colouration was concerned, to the pupa of the Angul insect. Its glow even began to be very irregular and faint. It was still limp and I took it out of its "dug-out." Several pieces of its larval skin still adhered to its ventral surface, especially over the stigmata. This probably caused asphyxia and the creature eventually died. I cannot assign any other reason for its death. It had lived under the same conditions as the larva from Angul, in fact it had been so well fed that it grew to an enormous size and prior to its leaving off eating it looked almost cylindrical. From the very beginning this larva seemed to have had some difficulty in ridding itself of its skin when moulting. At its last but one moult its larval skin was cast piece-meal, whereas in the case of the Angul specimen the larval and pupal skins were cast intact.

A point worthy of note is that I had never observed these larvae to glow during the day if undisturbed, though kept, for the most part, in a semi-dark room. The admission of strong sunlight did not even affect them, but any sound, however slight, caused them to glow immediately. After dusk the larva, when in the "dug-out," glowed continuously all night and the rays of light passing through the opening of the "dug-out" diverged to a great extent, reminding one of the rays of a search-light, for any object coming within these rays was enormously magnified. With regard to the glowing of the larva there is a difference in the use of the luminous organ when the creature is in the open and when it is in a hole. In the former condition it glows with both its luminous organs if it apprehends any danger, but in the latter state it only glows with that part which is uppermost and in a line with the opening of the "dug-out," the light being sufficiently strong to be seen at a great distance. The terminal sucker has been said to serve as an organ of locomotion, an organ of respiration, and an organ accessory to feeding. Of the first two there may be no doubt, but I have never seen a larva smear its head with any secretion preparatory to attacking a snail. Mr. C. J. Gahan says, "It is well known that Lampyrid larvae use the terminal sucker to clean their heads and limbs from the slime of the snail after having fed on the latter." This, which seems to be its chief use, I have explained fully on page 22. The luminous organ, as far as I have been able to observe, is used chiefly as a means of defence in the larva and as a means to attract the males in the adult female. These larvae belong to that group of Malacoderms in which the female is larviform and the male is winged. The light emitted by these insects, both males and females, is not intermittent, but a bright steady glow. In that

group in which the light is intermittent and subject to rapid diminutions and increase of brilliancy, the males and females are both winged and are our true "fire-flies," which are generally seen in swarms.

Another very interesting point is the manner in which these glow-worms bury themselves underground. In both the specimens I had in captivity I noticed that they began digging at the middle of the cage. As soon as the insect got well underground it closed up the hole by which it entered and which had been used to throw out the excavated mud; it then gradually enlarged the burrow and extended it towards the further end of the cage until it met with an obstacle, in this case the wooden frame of the cage, which prevented further progress in a straight line. On meeting with this obstacle, the excavation was continued for a short distance to the left along the frame-work of the cage, where a comparatively large compartment was made, large enough to hold the insect in comfort and to allow perfect freedom of movement. Once the insect enclosed itself in this "dug-out" all light was shut out as no opening was visible. For the purpose of observation I made openings in the "dug-out" of both specimens and kept the light out by covering these openings with tin covers. From the foregoing observations I am inclined to believe that these insects, being entirely nocturnal in habits, dig burrows in which they spend their lives, resting in them during the day and coming out only at dusk in search of food. In captivity, when there is no hole for them to hide in during the day, they invariably seek some dark corner of the cage and partially bury their heads either at the side of the cage or alongside some object such as a stone or even a large shell. In these burrows they must also change their larval and pupal skins; but when the time for pupation arrives these burrows must be extended for some distance, the female or even the male must find its way out by making a fresh opening. These burrows must also be used by the females for resting during the day, for the Angul specimen always went back to its shelter under the tin cover and remained there all day, only coming out after dusk.

I have compared the full-grown larva and the adult female which I have successfully bred from it, with larvae and females of various species of Malacoderms from various localities in the collection of the Zoological Survey of India and I find that my specimens agree with those of *Lamprophorus tenebrosus* (Wlk.) collected by Drs. N. Annandale and F. H. Gravely in Ceylon. This species, besides being known from Ceylon, has also been recorded from Pondicherry; Dharwar, "taken during the rains"; Madura; all recorded by Gorham. Among the unnamed Malacoderms in the collection of the Zoological Survey of India there is a male *Lamprophorus* collected by Dr. N. Annandale, at Balugaon, Puri district, Orissa (21-30-vii-1913). This specimen agrees exactly with males of *L. tenebrosus* from Ceylon in the above collection.