

**Life-histories of Indian insects. II. Some aquatic Rhynchota and Coleoptera
/ by D. Nowrojee.**

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LIFE-HISTORIES OF INDIAN INSECTS—II

SOME AQUATIC RHYNCHOTA AND COLEOPTERA

BY

D. NOWROJEE, B.A.

Assistant to the Imperial Entomologist



AGRICULTURAL RESEARCH INSTITUTE, PUSA

PUBLISHED FOR

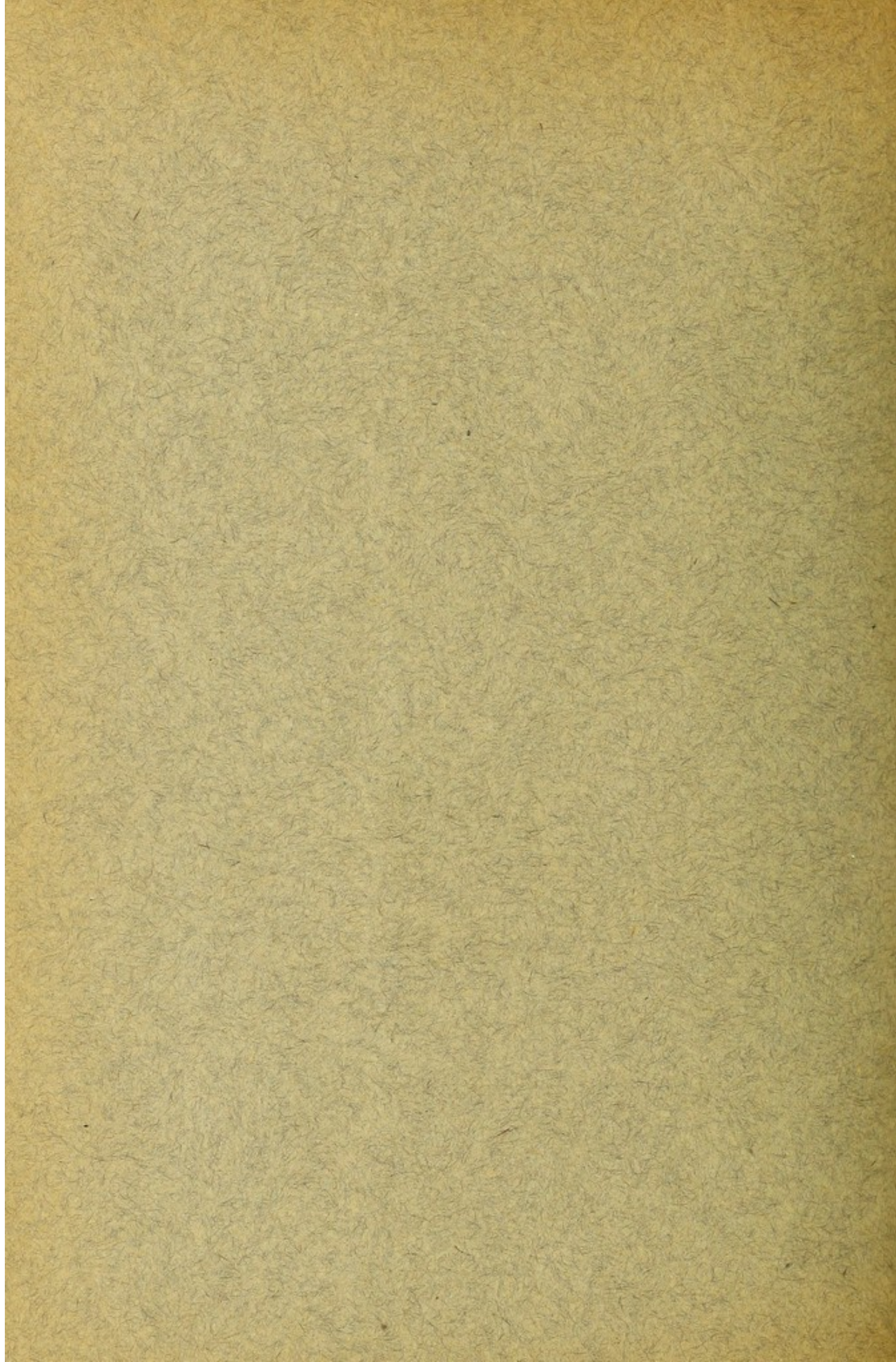
THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA

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PREFACE.

THE present Memoir contains descriptions of the early stages and habits of ten aquatic insects (two Rhynchota and eight Coleoptera) whose life-histories have been worked out at Pusa by Mr. D. Nowrojee. Those who have experienced the many difficulties and disappointments inseparable from the rearing of insects will best appreciate the careful work entailed in the preparation of this Memoir.

The present volume will probably be concluded by a Memoir, now in active preparation by Mr. C. C. Ghosh, on the Rhinoceros Beetle and the Palm Weevil, two beetles which are very destructive to palm trees, especially in the southern parts of India.

Volume III of the Entomological Series will consist wholly of a Memoir by Mr. C. W. Mason on the Food of Birds in India.

A lengthy Memoir on Eri Silk has been completed and will shortly be placed in the printers' hands, and several other Memoirs on life-histories of Indian Insects are in active preparation and will be issued this year if possible.

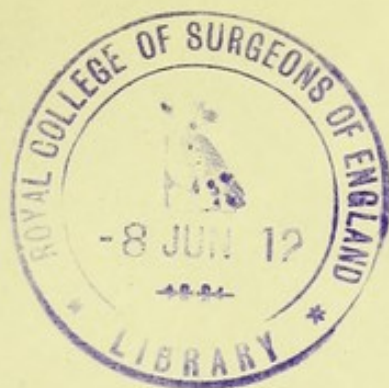
T. BAINBRIGGE FLETCHER,
Offg. Imperial Entomologist.

PUSA,
1st May, 1911.



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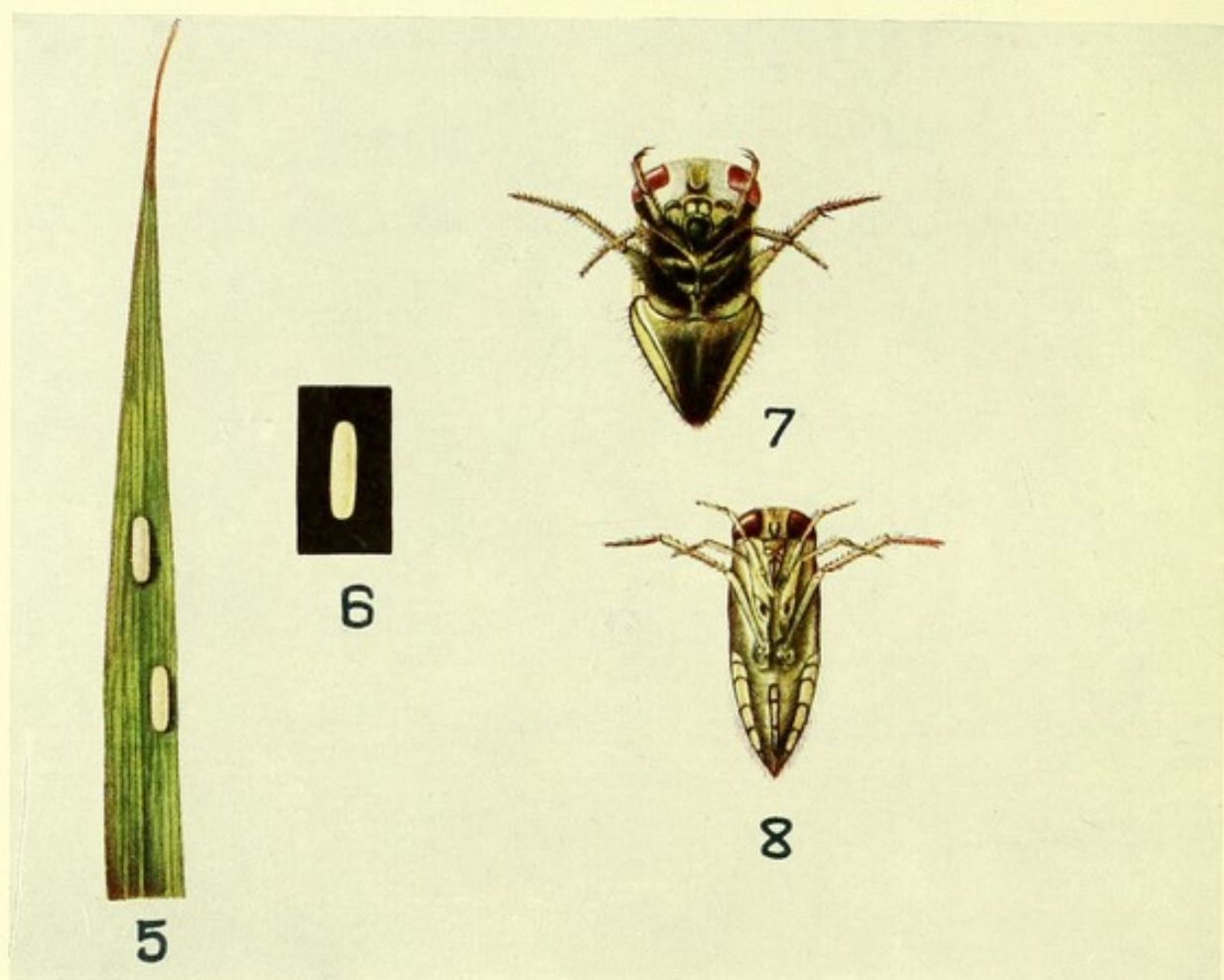
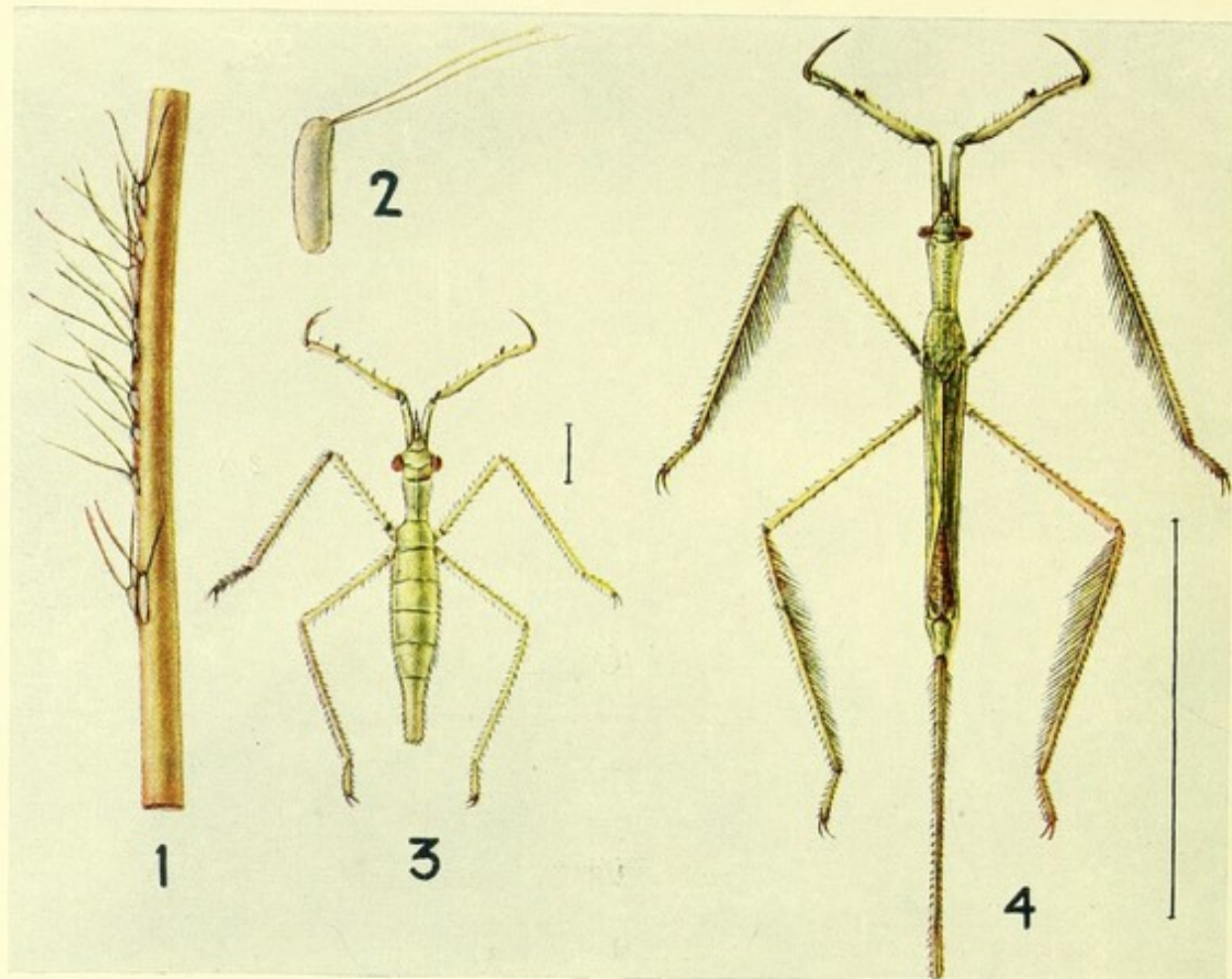
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LIFE HISTORIES OF INDIAN INSECTS—II.

SOME AQUATIC RHYNCHOTA AND COLEOPTERA.

BY

EXPLANATION OF PLATE XX.

Assistant to the Imperial Entomologist.

RANATRA FILIFORMIS, F.

Ranatra filiformis.

The genus *Ranatra* belongs to the family *Scapho*, character-

ised by the long, slender, cylindrical body, and the long, thin, filamentous antennae. The form of the antennae is much the shorter, about half the size of the latter, is the commoner one found throughout the year.

(1). Part of a stem with the eggs in the natural position.

(2). Single egg.

(3). Nymph.

(4). Imago.

The Egg.—The eggs of *R. filiformis*, F., are whitish, smooth,

elongate, cylindrical with rounded ends, and slightly curved at the anterior end. They are about $2\frac{1}{2}$ mm. long and 1 mm. broad.

Enithares indica.

(5). Portion of a blade of grass with the eggs in the natural position.

(6). Single egg.

(7). Nymph.

(8). Imago.

From the long three-segmented antennae about 4 mm. long. The eggs are laid in oblique rows in the stems of aquatic weeds (Plate XX, Fig. 1); in some cases the whole of the egg lies buried in the tissue of the stem, only the filaments projecting out; in others only a portion of the egg is embedded in the tissue, the remainder with the filaments lying free out of the slit. The eggs are laid irregularly along the stem which lies submerged under water. Eggs found on the 13th March hatched on the 17th and the 19th. The nymph escapes through a small crescent-shaped opening which it makes at the upper end of the egg just below the base of the filaments.

Nymph.—The nymph, when just hatched, is dark brown coloured, the body elongate and narrow, about $5\frac{1}{2}$ mm. long and

EXPLANATION OF PLATE XX

Maratta filiformis

- (1). Part of a stem with the eggs in the natural position.
- (2). Single egg.
- (3). Nymph.
- (4). Imago.

Phanocarpa indicus

- (5). Portion of a blade of grass with the eggs in the natural position.
- (6). Single egg.
- (7). Nymph.
- (8). Imago.



LIFE-HISTORIES OF INDIAN INSECTS—II.

SOME AQUATIC RHYNCHOTA AND COLEOPTERA.

BY

D. NOWROJEE, B.A.,

Assistant to the Imperial Entomologist.

RANATRA FILIFORMIS, Fab.

THE genus *Ranatra* belongs to the family *Nepidae*, characterised by the long apical filiform appendages. Two species of *Ranatra* are found in Pusa, *R. filiformis*, F., and *R. elongata*, F. The former, which is much the shorter, about half the size of the latter, is also the commoner one found throughout the year.

The Egg:—The eggs of *R. filiformis*, F., are whitish, smooth, elongate, cylindrical with rounded ends, and slightly curved at the anterior end. They are about $2\frac{1}{4}$ mm. long and $\frac{3}{4}$ mm. broad. From the anterior end a little below the apex is given off a pair of long thread-like filaments about 4 mm. long. The eggs are laid in oblique slits made in the stems of aquatic weeds (Plate XX, Fig. 1); in some cases the whole of the egg lies buried in the tissue of the stem, only the filaments projecting out; in others only a portion of the egg is embedded in the tissue, the remainder with the filaments lying free out of the slit. The eggs are laid irregularly along the stem which lies submerged under water. Eggs found on the 13th March hatched on the 17th and the 19th. The nymph escapes through a small crescent-shaped opening which it makes at the upper end of the egg just below the base of the filaments.

Nymph:—The nymph, when just hatched, is dark brown coloured, the body elongate and narrow, about $5\frac{1}{2}$ mm. long and

two-thirds of a mm. broad. The head is triangular, produced anteriorly into a short sharply-pointed beak. The eyes are large, round and prominent. Three pairs of legs are present; the anterior pair slightly thickened, the posterior two pairs long and slender, about $1\frac{1}{2}$ times as long as the anterior. The last abdominal segment is produced at the apex into a short tube-like process open at the tip which serves the purpose of respiration. The nymphs were fed on the larvæ of *Anopheles*. The prey is seized by the anterior pair of legs for which purpose they are very well adapted; the anterior third of the femora is curved outwardly, the tibia is curved inwardly as shown in the accompanying diagram (Fig. 1),

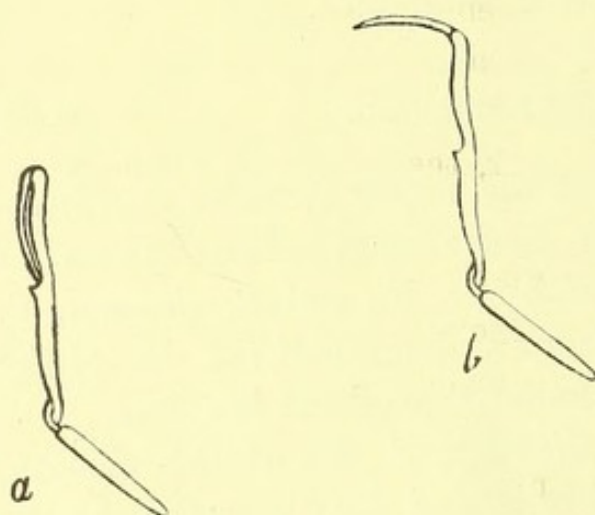


Fig. 1 : anterior leg of *R. filiformis* a. closed,
b. opened.

so that when the latter is folded on the former, they form a pair of strong claspers capable of holding a struggling prey in a firm grip. When an *Anopheles* larva comes within reach, one of the anterior pair of legs is quickly shot out and the victim seized and slowly transferred to the mouth where it is transfixed on the

beak; the forearm is then dropped and the juices slowly sucked out of the victim; if, however, the larva keeps wriggling, the arm is brought up again to hold it until enough has been sucked out and the larva becomes flabby and ceases to make any efforts to escape. The forearm is then quietly dropped so that it is free to grasp another larva, should it come within reach. A *Ranatra* can thus often be observed with one larva transfixed on the beak and another grasped in either forearm.

Life-history :—The nymph, as it grows, moults. Just before a moult the skin splits along the mid-dorsal line from the base of the head to the last thoracic or the first abdominal segment and is shed by the nymph.

The accompanying tables show the duration of the life-history :—

EGGS FOUND ON 13th March.

Egg hatched	First Moul.	Second Moul.	Third Moul.	Fourth Moul.	Fifth Moul.
17-III. Length of the body 5½ mm. Length of Respira- tory tube 1 mm.	23-III. Length of the body 7 mm. Length of Res- piratory tube 2 mm.	28-III. Length of the body 11 mm. Length of Res- piratory tube 4 mm.	3-IV. Length of the body 16 mm. Length of Res- piratory tube 6 mm.	9-IV. Length of the body 21 mm. Length of Res- piratory tube 9 mm.	20-IV. Length of the body 26 mm. Length of Res- piratory tube 23 mm.
19-III.	27-III.	1-IV.	6-IV.	13-IV.	22-IV.

The complete life-history from egg to imago thus occupies about 34 days. Each of the first four instars lasts on an average for about 5 days, while the interval between the fourth and the fifth or the last moult is about 10 days. The growth in the respiratory tube is fairly equal for the first four moults, being from about 2 to 3 mm. ; in the last moult, however, the respiratory tube more than doubles itself in length.

The Imago :—R. filiformis, F. (Plate XX, Fig. 4), when full-grown, is about 25 mm. long excluding the abdominal appendage, and about 2 mm. broad ; the abdominal appendage is about 23 mm. long. The body is narrow and elongate, of a dull brown ochraceous colour. *R. filiformis*, F., is abundant during the cold weather in the river where it lives near the banks lurking among aquatic weeds. Eggs and nymphs are abundant during March and April. Nymphs have also been found, though rarely, in ponds during the rains, and it is probable that breeding is continuous throughout the hot weather and the rains.

R. filiformis is a poor swimmer, usually remaining under water, crawling amongst the weeds except when it creeps to the surface from time to time to breathe. Respiration is carried on by means of the long abdominal appendage. It consists of a pair of long processes, each grooved on its inner side ; by bringing the two halves together, a complete tube is formed which is open at the apical end ; the tube leads to the terminal pair of spiracles situated at the apex of the abdomen on the ventral surface. When *Ranatra* wants to breathe, it creeps backwards along the sub-

merged weeds until the tip of the abdominal appendage rests above the surface of water, and air is then carried along the respiratory tube to the spiracles.

ENITHARES INDICA, Fab.

The genus *Enithares* is placed by W. L. Distant in the sub-family *Notonectinæ* of the family *Notonectidæ*. It is common during the rains in ponds and pits filled with more or less stagnant water. The insects belonging to this family can easily be distinguished in their natural habitat by their characteristic habit of swimming on their backs.

The Egg:—*Enithares indica*, Fab., lays its eggs on the stems and leaves of aquatic plants, either floating on the surface or submerged below water. The eggs are laid openly on the surface of the stem or leaf and not inserted within the tissue (Plate XX, Fig. 5). They are laid lengthwise on their sides and glued to the surface by some secretion which the female doubtless exudes. One female kept in an aquarium laid in all 8 eggs, but it is probable that the number of eggs laid by a single female varies much. The eggs are smooth, whitish, elongate, and cylindrical with rounded ends, about $1\frac{1}{2}$ mm. long and $\frac{1}{2}$ mm. broad. The eggs take from about 9 to 11 days in hatching:

Eggs laid on the night of the 10th September.

One egg hatched on the 19th September.

Two eggs " " 20th "

Three " " " 21st "

The colour of the egg gradually changes from whitish to brownish-black. Just before the nymph emerges, two crimson spots which mark the position of the eyes of the nymph appear at the upper end of the egg and the segments of the thorax and abdomen can be indistinctly seen through the egg-shell.

Nymph:—The nymph (Plate XX, Fig. 7) is broadly oval with the upper surface convex and the lower one more or less flattened, and just after emergence is about 2 mm. long and 1 mm.

broad. The eyes are large, crimson coloured; three pairs of thoracic legs are present, the anterior two pairs comparatively short, the posterior pair very long and fringed with hairs. The nymphs were fed on small insects which were grasped by the anterior pair of legs, the beak inserted into the tissues and the juices slowly sucked out. The nymphs, as they grow, moult; the skin splits mid-dorsally along the thoracic segments and is shed by the newly formed nymph.

The table below gives the duration of the life-history—

Egg laid.	Egg hatched.	1st Moul.	2nd Moul.	3rd Moul.	4th Moul.	5th Moul.
10th Sep.	20th Sep.	26th Sep.	1st Oct.	7th Oct.	14th Oct.	23rd Oct.
" "	21st Sep.	27th Sep.	3rd Oct.	10th Oct.	16th Oct.	27th Oct.
" "	" "	29th Sep.	5th Oct.	11th Oct.	17th Oct.	29th Oct.

The life-history thus occupies from the egg stage to imago from about 30 to 38 days. Each of the first four instars lasts on an average for about 6 days, but between the fourth and the fifth or the last moult there is an interval of from 10 to 12 days.

The Imago :—*E. indica*, Fab. (Plate XX, Fig. 8), when fully developed, is about 9 mm. long and about one-third as broad as long. As has been said above, the characteristic feature of the family is their habit of swimming on their backs. The posterior pair of legs are long and have the tibia and tarsus fringed with long hairs and form efficient organs of locomotion by means of which the insect is enabled to swim swiftly through the water and also make sudden leaps when disturbed. When remaining below the surface, it clings by the anterior pair of legs to submerged weeds; as it is lighter than water and very buoyant, it cannot remain for any length of time under water without clinging to some object but rises quickly to the surface as soon as it lets go its hold; occasionally it can be observed to remain suspended in midwater without any support, retaining its position by rapid vibrations of the hind legs. *E. indica* is predaceous on small aquatic insects; it also feeds on other dead or living insects which are blown into the water and keep floating on the surface. It is common in the

khajanas or masonry water tanks in indigo factories; it has a curious habit of resting a little distance below the surface, getting its air-supply in sudden quick jerks to the surface and then descending; the habit suggests danger from the surface but safety at a little distance down, but what enemy there is at the surface, unless it be *Hydrometridae*, is not known.

EUNETES (ERETES) STICTICUS, L.

The genus *Eunectes* is represented in India by only one species, *E. sticticus*, L., which can be distinguished by the peculiar serration of the edges of the elytra from the middle to the apex. The Pusa collection contains specimens from Bengal: Pusa, Chapra; Bombay: Karachi, Igatpuri (2,000 ft.); Burma: Monywa; and the species is probably found throughout India, being one of the commonest of the *Dytiscidæ*.

Larva:—The larvæ were found in the drains around the Pusa College, in the jute pits and ponds. They were first observed at the beginning of the hot weather and were present throughout the hot weather and the rains up to about the end of October. The larva (Plate XXI, Fig.1) is elongate, spindle-shaped, being broadest a little below the middle and gradually narrowing towards either end, and is, when full-grown, about 26 mm. long and 3 mm. broad. The head is pale brown coloured, large, longer than broad and flattened above; it is narrowed posteriorly and joins with the prothorax by means of small but distinct neck. The mandibles are long, slender, curved and finely pointed at the apex. Near the base of the mandibles is given off a pair of short three-jointed antennæ. A pair of eyes is present, each formed of a number of ocelli. The prothorax is long with the sides narrowed anteriorly, the meso- and meta-thorax are comparatively shorter and broader than the prothorax. The penultimate abdominal segment is elongate and narrow, the last much more so and tapering apically to a blunt point. The integument is hardened on the dorsal surface and forms a series of hard plates, one on each segment, which protect the body above and at the sides; the under-surface of the body



1



2

EXPLANATION OF PLATE XXI

Amphipoda (Isopoda) stickleback.

- (1) Full-grown larva, dorsal view.
(2) Imago.
(3) Pupa, ventral view.



3

khajanas or masonry water tanks in indigo factories; it has a curious habit of resting a little distance below the surface, getting its air-supply in sudden quick jerks to the surface and then descending; the habit suggests danger from the surface but safety at a little distance down, but what enemy there is at the surface, unless it be *Hydrometridae*, is not known.

EUNECTES (ERETES) STICTICUS, L.

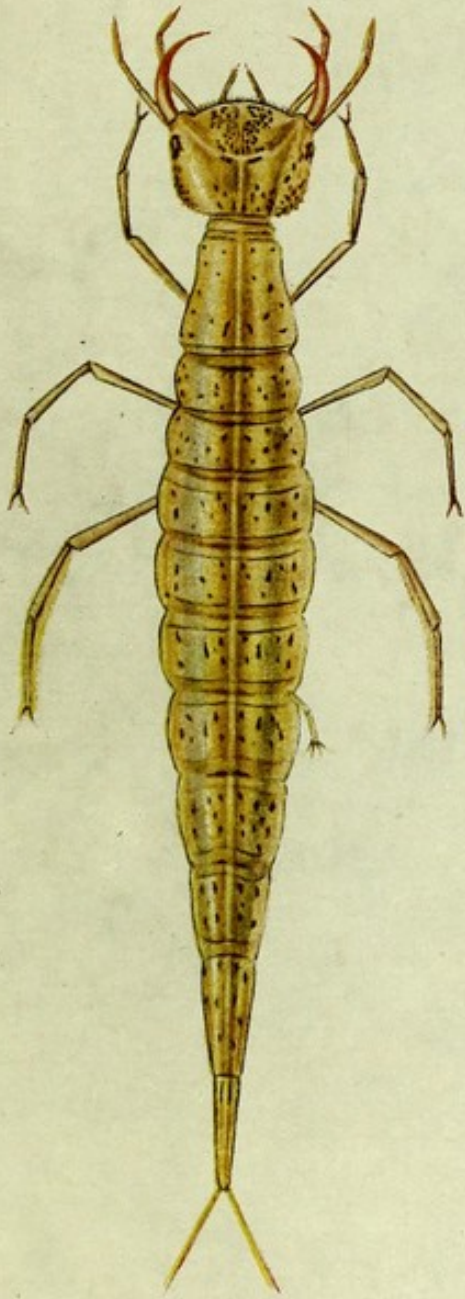
The genus *Eunectes* is represented in India by only one species, *E. sticticus*, L., which can be distinguished by the peculiar serration of the edges of the elytra from the middle to the apex. The Pusa collection contains specimens from Bengal: Pusa, Chapra; Bombay: Karachi, Igatpuri (2,000 ft.); Burma, Mawya, and the species is probably found throughout India, being one of the commonest of the *Dytiscidae*.

EXPLANATION OF PLATE XXI.

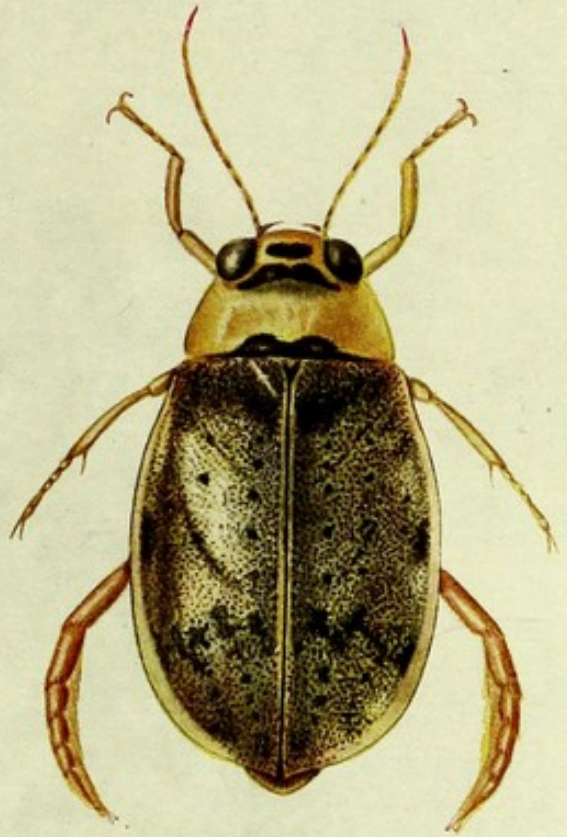
Larva.—The larvae were found in the drains around the Pusa College, in the jute pits and ponds. They were first observed at the beginning of the hot weather and were present throughout the hot

Eunectes (Eretes) sticticus.

- (1). Full-grown larva, dorsal view.
- (2). Imago. (Fig. 1) is elongate, spindle-shaped, being broadest a little below the middle and gradually narrowing towards either end, and is, when full-grown, about 26 mm. long and 3 mm. broad. The head is pale brown coloured, large, longer than broad and flattened above; it is narrowed posteriorly and joins with the prothorax by means of small but distinct neck. The mandibles are long, slender, curved and finely pointed at the apex. Near the base of the mandibles is given off a pair of short three-jointed antennae. A pair of eyes is present, each formed of a number of ocelli. The prothorax is long with the sides narrowed anteriorly, the meso- and meta-thorax are comparatively shorter and broader than the prothorax. The penultimate abdominal segment is elongate and narrow, the last much more so and tapering apically to a blunt point. The integument is hardened on the dorsal surface and forms a series of hard plates, one on each segment, which protect the body above and at the sides; the under-surface of the body
- (3). Pupa, ventral view.



1



2



3

remains soft except for the last two segments which are completely enclosed in a hard sheath. From near the apex on the ventral surface is given off a pair of stiff processes. The usual three pairs of jointed thoracic legs are present, each ending in a pair of claws and thickly fringed with hairs. The last two segments are provided at the sides with a broad fringe of hairs. The larva is grey-coloured above and whitish below except for the last two segments which are entirely grey.

The larva can swim well; its usual pace is a slow and leisurely one and is effected solely by the movements of the three pairs of thoracic legs, but it also makes sudden darts particularly when annoyed or disturbed. The movement is so quick that the eye can scarcely follow it and is carried out by a jerking movement of the body, the larva bending it and suddenly straightening it out again.

Seven pairs of spiracles are present, the first pair at the base of the prothorax and the remaining six pairs, one pair on each of the first six abdominal segments; but these spiracles are not functional. Respiration is carried on by means of the terminal pair of spiracles situated at the tip of the body; the larva, when it wants to take in air, slowly rises to the surface, tail-end upwards, its body thrown into a gentle curve till its tip is on a level with the surface of the water and the spiracles exposed to the air; these spiracles lead to the main pair of longitudinal air tubes which appear through the integument when the larva is observed from the dorsal surface as a pair of indistinct dark longitudinal stripes one on either side; when a sufficient supply of air has been taken in, the larva slowly sinks below, repeating the same process again at varying intervals.

The larvæ are predaceous, feeding on live prey; in the aquarium in the laboratory they were fed on larvæ of dragonflies and other small insects; when its prey comes within reach, the larva with a quick turn seizes it in its mandibles. I have not observed the legs being used in seizing the prey. The larva feeds by thrusting the points of the mandibles into the tissues and slowly sucking the juices out of the victim. From an examination, however, of

the insects which had been sucked out, it is probable that the larva not only sucks the juices but also devours a portion of the solid tissues; these were seen to have been eaten in some cases, leaving only the hard outer integument. In the case of *Cybister tripunctatus*, Ol, a larva of which was fed on small shrimps, shortly after the larva had seized a shrimp, it was observed to inject a dark-coloured fluid into its body; the fluid was injected two or three times and probably served to dissolve the tissues of the shrimp.

The larvæ are very ferocious, constantly attacking and preying on one another. A larva, when seizing another, usually grasps it just below the head, its weakest point, as the latter is then at a disadvantage, not being able to use its mandibles and can only wriggle about helplessly in the jaw of its enemy.

Pupa:—When full-grown the larva leaves the water and burrows into the mud where it makes a round hole smooth in the inside within which it lies; it remains in the larval stage for about a couple of days when the skin splits along the mid-dorsal line from the base of the head to the third or fourth abdominal segment and lies at the apical end of the pupa. The pupa (Plate XXI, Fig. 3) is whitish, oval-shaped, shorter and broader than the larva, about 13 mm. long and 5 mm. broad. The head is large, smooth, round, and with the mouth parts is bent down on the thorax. The prothorax is large, broad, with the sides slightly rounded; the anterior margin concave, the posterior nearly straight. The disc is strongly convex and furnished with a number of spines placed as follows: a row of spines along the anterior margin, a pair on the middle of the disc and a few closely placed at either posterior angle and at the middle of the posterior margin. The meso- and meta-thorax are shorter than the prothorax and furnished each on the mid-dorsal line with a row of short spines. The abdomen gradually narrows posteriorly; the last segment is small and is produced at the apex into a pair of short stout processes, each tipped with a number of minute spines. The pupa bears in addition a few small spines on the dorsal surface of the abdomen. The rudiments of the wings, elytra and legs of the future imago lie folded

on the ventral surface and at the sides. The pupal period is very short, lasting for about six days; larvæ which entered the soil to pupate on 18th May, pupated on 20th May and emerged as imagines on 26th May. The imago, when just emerged, has the body pale-coloured and the elytra soft; the latter gradually harden and the colour takes on a deeper shade.

Eunectes sticticus, L. (Plate XXI, Fig. 2) is olive brown-coloured, oval-shaped, about 15 mm. long and half as broad. The elytra are closely and deeply punctured with small black punctures and marked in addition with a number of large blackish impressions which vary in different specimens.

The hind pair of legs as in the other *Dytiscidæ* are long, and have the joints broadly flattened dorso-ventrally and form powerful organs of locomotion. The two anterior pairs of legs are of the normal size. The first three tarsal joints of the anterior pair of legs are in the male flattened out and together form a more or less circular disc, the under-surface of which forms a sucker by means of which the male is able to retain its hold on the female. The beetle, like the larva, is predaceous, but unlike the larva it devours the prey entire by grasping it by the two anterior pairs of legs and tearing it to pieces. As a rule, *Dytiscidæ* live on live prey, but it is probable that when food is scarce, they are not averse to even dead insects.

Sandracottus dejeani, Aube, has been observed to feed on dead caterpillars of *Euxoa segetis* and *E. spinifera*, numbers of which had fallen into the drains around the college buildings and had got drowned; every now and again a beetle could be observed rising to the surface with a caterpillar grasped by the anterior pairs of legs. The skin is ripped along the mid-ventral line and after the soft tissues have been eaten, the hard integument is thrown away.

The beetle, like the larva, cannot remain under water without coming occasionally to the surface to breathe. It is lighter than water and can only remain below by holding on to some object by the two anterior pairs of legs. When obliged to come to the surface, it merely lets go its hold and rises without any effort usually

with the hind end uppermost and hangs from the surface in an oblique attitude with the head downwards and the tip of the body at the surface. The tip of the abdomen is then curved inwards, leaving a narrow space between it and the elytra, and air passes into the space lying between the elytra and the dorsal surface of the abdomen from whence it is taken into the body through the abdominal spiracles. The period during which the beetle remains on the surface taking in air, varies considerably; when alarmed and fearing danger, it barely remains for a couple of seconds on the surface before it dives again below; on other occasions it may remain hanging from the surface for minutes together.

HYPHYDRUS RENARDI, Sev.

Hyphydrus renardi, Sev., is one of the smaller *Dytiscidæ*, belonging to the sub-family *Hyphydrini*; it is a small, oval-shaped thick-set beetle, about 3 mm. long and $2\frac{1}{2}$ mm. broad, brown-coloured with black markings on the thorax and elytra (Plate XXII, Fig. 2).

Larva:—Larvæ were observed at Pusa during the hot weather in the drains around the college buildings and the jute pits. The larva (Plate XXII, Fig. 1) is small, elongate, broad in the middle and narrowed towards either end, but much more towards the posterior than the anterior end; it is convex above and more or less flattened beneath. It is about $5\frac{1}{2}$ mm. long and $1\frac{1}{2}$ mm. broad. The head is small, with the sides rounded and narrowed anteriorly; the clypeus is produced forwards into a curious beak-like process, which is about $\frac{1}{2}$ mm. long, flattened from above downwards and rounded at the apex. The mandibles are long, slender, curved and sharply-pointed; they curve around the beak on either side with the tips touching it just below the apex. The antennæ are short, three-jointed. A pair of eyes is present, each composed of a number of closely placed ocelli. The prothorax is large, with the sides strongly rounded and slightly narrowed anteriorly; the meso- and meta-thorax together are as long as the prothorax, the body tapers posteriorly, the last segment but one is

EXPLANATION OF PLATE XXII

Hydrophilus fuscus

- (1) Full-grown larva, dorsal view.
(2) Imago.

Hydrophilus obscurus

- (3) Full-grown larva, dorsal view.
(4) Imago.



with the hind end uppermost and hangs from the surface in an oblique attitude with the head downwards and the tip of the body at the surface. The tip of the abdomen is then curved inwards, leaving a narrow space between it and the elytra, and air passes into the space lying between the elytra and the dorsal surface of the abdomen from whence it is taken into the body through the abdominal spiracles. The period during which the beetle remains on the surface taking in air, varies considerably; when alarmed and fearing danger, it barely remains for a couple of seconds on the surface before it dives again below; on other occasions it may remain hanging from the surface for minutes together.

EXPLANATION OF PLATE XXII.

Hyphydrus renardi, Sev., is one of the smaller *Dytiscidae*, belonging to the sub-family *Hyphydrini*; it is a small, oval-shaped thick-set beetle, about 3 mm. long and $2\frac{1}{2}$ mm. broad, brown-coloured with black *Hyphydrus renardi*. thorax and elytra (Plate XXII, Fig. 2).

(1). Full-grown larva, dorsal view.

(2). Imago.

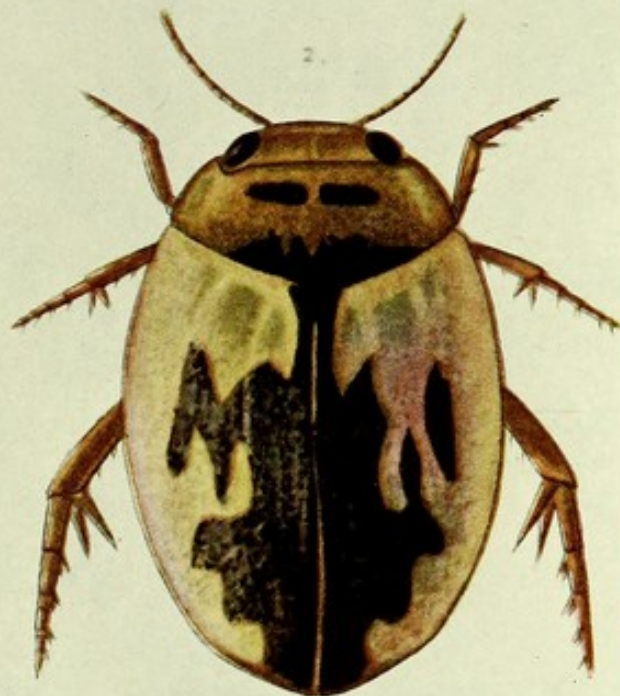
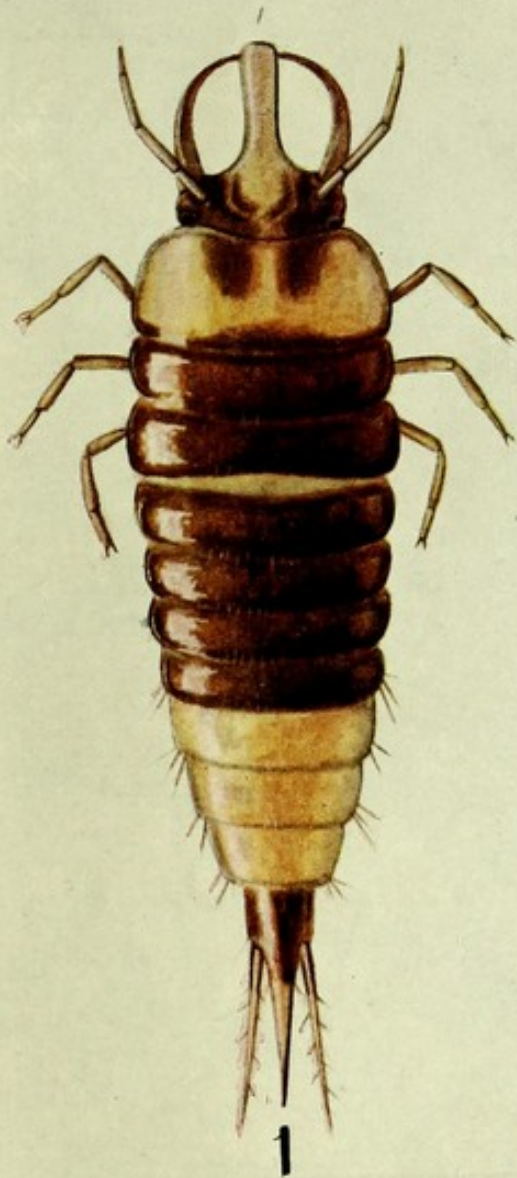
Larvae were observed at Pusa during the hot weather in the drains around the college buildings and the jute pits. The larva (Plate XXII, Fig. 1) is small, elongate, broad in the middle and narrowed towards the head and tail, but much more towards the posterior than the anterior end; it is convex above and more or

Hypophorus aper.

(3). Full-grown larva, dorsal view.

(4). Imago.

The head is small, with the sides rounded and narrowed anteriorly; the clypeus is produced forwards into a curious beak-like process, which is about $\frac{1}{2}$ mm. long, flattened from above downwards and rounded at the apex. The mandibles are long, slender, curved and sharply-pointed; they curve around the beak on either side with the tips touching it just below the apex. The antennae are short, three-jointed. A pair of eyes is present, each composed of a number of closely placed ocelli. The prothorax is large, with the sides strongly rounded and slightly narrowed anteriorly; the meso- and meta-thorax together are as long as the prothorax, the body tapers posteriorly, the last segment but one is



narrow and short, the last much longer, slender and tapering to a point. From the apex of the last segment but one is given off a pair of long stiff spines which project a little beyond the tip of the body. The head is pale yellow with a large irregularly-shaped dark brown patch near each eye. The prothorax is yellow except for a long transverse dark brown patch at the base. The meso- and meta-thorax, and the first four abdominal segments are dark brown, segments 7-9 pale yellow, the remaining segments dark brown except the lower half of the last segment which is pale brown. The under-surface is yellowish. The thorax and the abdomen of the larva are pubescent above.

The larva remains clinging to the sides or the bottom of its habitat. It breathes by means of the terminal pair of spiracles at the tip of the body. When about to breathe, the larva runs up the sides of the drains and when close to the surface turns upside down and exposes the tip of the body to the air. The larvæ are predaceous, but were themselves in turn attacked and devoured by the larva of *Sternolophus unicolor*, Cast.

Pupa.—The larvæ, like those of the other Dytiscidæ, leave the water when full grown and burrow down into the mud, to pupate.

The pupa is broadly oval, pale yellow, $3\frac{1}{4}$ mm. long and 2 mm. broad. The head is large, broad, and marked with a number of spines on the vertex, and is bent down on the thorax. The prothorax is very large, with the disc convex and bearing a number of irregularly placed spines. The abdomen is gradually narrowed behind. The last segment is small and furnished apically with a pair of long spines; the rudiments of the elytra, wings, and legs of the imago lie, as usual, folded on the ventral surface and at the sides; the dorsal surface of the abdomen is marked with a number of irregularly scattered spines.

The pupal period is short, lasting from 6 to 8 days.

HYPHOPORUS APER, Shp.

The genus *Hyphoporus* belongs to the sub-family *Hydroporini* of the Dytiscidæ. *Hyphoporus aper*, Shp. (Plate XXII, Fig. 4) is

a small oval-shaped thick-set beetle, 5 mm. long and 3 mm. broad, reddish brown with the thorax and elytra closely and coarsely punctured. *Hyphoporus aper* is common in Pusa in the river during the cold weather. The beetle breeds apparently only in the cold weather, larvæ and pupæ being fairly common during December, January and February along the river banks. They are found at a depth of from 1—2 inches below the soil, each in a separate small round hole which is smooth in the inside.

Larva :—The larva (Plate XXII, Fig. 3) is elongate, spindle-shaped, broad in the middle and gradually narrowed at either end, pale brown-coloured, flattened from above downwards, about 6 mm. long and $1\frac{1}{2}$ mm. broad. The head is large, with the sides rounded and narrowing anteriorly and produced forwards into a short triangular-shaped process, rounded at the apex, which is shorter and less pronounced than that of *Hyphydrus renardi*; the mandibles are of the type described already, long, slender, curved and finely pointed. Eyes are present in the shape of a pair of black patches, each composed of a number of ocelli. The prothorax is large with the sides rounded, the meso- and meta- thorax are comparatively short, both together being as long as the prothorax. The body from about the middle gradually tapers behind, the last two segments are narrow, cylindrical shaped, and from the tip of the last segment is given off a pair of long slender processes half as long as the body. The integument is hardened on the dorsal surface, but remains soft beneath except for the last two segments which are completely enclosed in a hard sheath. The usual three pairs of legs are present, each ending in a pair of long claws and provided with fringes of long hairs.

Pupa :—The pupa is oval-shaped, whitish or pale yellow, 4 mm. long and about half as broad, the head is large, broad, smooth, and with the mouth parts is bent down on the thorax, the prothorax is about twice as broad as long, the anterior margin nearly straight, the posterior bisinuate, the sides rounded; the meso- and meta-thorax are comparatively short. The abdomen is gradually narrowed behind, the last segment is produced laterally into a short

process and furnished at the apex with a pair of strong spines. The rudiments of the wings, legs and elytra of the future imago lie folded as usual along the ventral surface and at the sides, the pupa is provided on the dorsal surface with a number of irregularly scattered small stiff spines.

The pupal period is short, lasting for about a week ; larvæ which entered the mud to pupate on the 8th February, pupated on the 9th February and emerged on the 15th February.

DINEUTES UNIDENTATUS, Aube.

The genus *Dineutes* is placed by M. Regimbart in the sub-family Enhydrini of the family Gyrinidæ in his monograph on the family in "Genera Insectorum."

Dineutes unidentatus (Plate XXVI, Fig. 7) is common in Pusa during the hot weather in the river and during the monsoons in ponds and pits filled in by the rains. It is usually found in company with another species, *D. spinosus*, which superficially resembles it, but which can be distinguished from the former by its having the apex of the elytra produced at either angle into a sharp spine ; in *D. unidentatus* the sutural spines are absent, only the outer angles being spined.

The Larva :—The larva (Plate XXVI, Fig. 5.) is elongate, flattened, pale yellow, about 13 mm. long and about 2 mm. wide. The head is small, hard, pale brown-coloured, slightly longer than broad, a pair of eyes is present, each composed of a number of ocelli. The mandibles are long, slender, curved and sharply pointed. Near the base of the mandibles is given off a pair of short four-jointed antennæ with the basal joint very short and the three following joints relatively long. The prothorax is covered dorsally with a hard semi-circular plate which protects the whole segment except a narrow margin on either side. The meso- and meta-thorax are, like the abdominal segments, unprotected, the segments of the body are well marked and distinct. From each abdominal segment is given off at the base on either side a long tapering process fringed with hairs, the 9th abdominal segment

bearing in addition another pair of similar processes; a small slender 10th abdominal segment is present which is not furnished with the processes, but is provided at the tip with a pair of short curved hooks. The usual three pairs of thoracic legs are present, each provided at the tip with a pair of short claws.

The larvæ lead a concealed life, never leaving the bottom of the pond, but hiding among stones and submerged weeds and are consequently difficult to discover. Though a number of Gyrinid moults were found in 1910 in the month of October floating on the surface, a close search, after scraping the bottom and the sides of the pond with a dredging net, revealed only one larva. The larvæ feed on small insects; the one kept in the aquarium was fed on Chironomid larvæ and small aquatic bugs. The method of feeding is the same as that of the Dytiscid larva; the prey is grasped between the mandibles, the sharp points inserted into the tissues and the juices sucked out. The larva swims along the bottom by rapid serpentine motions of the body.

Unlike the Dytiscid or the Hydrophilid larva, the larva of *D. unidentatus* never comes to the surface for breathing. Respiration is carried on by means of the abdominal processes which function as gills. The main pair of air tubes run longitudinally along the body one on either side and appear in the living larva when it is seen from the dorsal surface as a pair of greenish black streaks, these give off branches one to each process which in their turn give off short lateral branches on either side.

Pupa :—The larvæ when about to pupate crawl out of the water and construct cocoons which are attached to the under-surface of blades of long grass fringing the margin of the ponds (Plate XXVI, Fig. 4). The cocoons are well above the surface, the distance above the water level varying from a few inches in some cases to as much as three feet in others. The cocoons are mud-coloured, oval, strongly convex above, and flattened below, about 8 mm. long and half as broad. They are of two kinds: either (1) composed of small bits of dry twigs and other vegetable débris found floating on the surface of water, or (2) they are formed

entirely of mud which is cemented by some secretion from the larva and forms into a hard crust. The larvæ lie coiled within the cocoon in a semi-circle with the head and the posterior end bent inwards.

The pupa (Plate XXVI, Fig. 6) is yellowish, oval-shaped with the anterior end broad, about 6 mm. long and $2\frac{1}{2}$ mm. across. The head with the mouth parts is bent downwards on the thorax. The prothorax is transverse, about twice as broad as long and provided at the anterior margin with a number of small stiff hairs or setæ. The abdomen is gradually narrowed behind with the last segment broadly rounded at the apex. The rudiments of the legs, wings and elytra of the future imago lie folded on the ventral surface and at the sides. The spines which are so characteristic of the Dytiscid and Hydrophilid pupa are absent. The pupal period is very short and lasts for about 7 days.

Imago :—The beetle is oval-shaped, strongly convex shiny black above, flattened and opaque below. It is 7 mm. long and 5 mm. broad. From their habit of living on the surface of water the *Gyrinidæ* are, perhaps with the *Hydrometridæ* which have a similar habit, the most commonly observed of aquatic insects. They move on the surface in short rapid circles occasionally resting on floating weeds by clinging to them with their anterior legs. Swimming is effected by the two posterior pairs of legs which are short and have the femora, tibia and tarsus broadly flattened from above downwards. When disturbed, they either dart away quickly or dive below the surface, where they remain clinging by the anterior pair of legs to submerged weeds. They, however, soon let go their hold and rise to the surface to begin again their gyrations. The *Gyrinidæ* are gregarious in habits, being usually found in numbers together. Respiration unlike that in the larva is aerial, and when the beetle dives below the surface it carries a bubble of air with it and this clings to the apex of the body which is pubescent.

Dineutes first appears during the early hot weather, breeds during the rains, and is found until cold weather sets in, hibernating in the imago state as probably all the *Gyrinidæ* do. In the first week of February 1910, numbers of *Orectochilus gangeticus*

and *O. aeneipennis* were observed swimming about on the surface of water. In a couple of days they disappeared and were not observed again until the beginning of March. A spell of warm weather had perhaps drawn them out of their winter burrows. The beetle flies in search of fresh habitats, and as soon as the ponds, which have been dry during the hot weather, are filled by the rains, they are found to be inhabited by them.

Oreochilus, the other common genus of *Gyrinidæ* found in Pusa, confines itself to the river and has not been found in ponds, probably preferring flowing water.

HYDROPHILUS, Sp.

The Eggs :—Eggs are laid in whitish fibrous cocoons (Plate XXIII, Figs. 1 & 2), oval or rounded, from 15 to 20 mm. long and about 10 mm. broad. On one side the cocoon is flattened and depressed, the margin around the depression raised into a rim, from the middle of the rim on the dorsal surface there springs a long tapering process which is darker in colour than the rest of the cocoon and measures about 10 mm. from base to tip. The cocoons are always attached by their upper surface to any floating object, a piece of weed or a leaf, and float freely with the spike directed upwards. The upper surface with the entire spike lies out of water. The rest of the cocoon remains under.

The eggs are laid within the cocoon; they are glued to the bottom on end close together and enveloped in a loose tissue of fine silky fibres. The eggs occupy only a part of the cavity, the rest being filled with a network of the same fibres with which the eggs are covered. (Plate XXIII, Fig. 3.)

It is not clear what useful purpose is served by the spike. In the natural position the spike is always directed upwards, and this end is secured partly by laying the relatively heavy eggs on the bottom of the cocoon and partly by attaching the cocoon to some floating object which further serves to keep it in an upright position. The spike is supposed to serve the purpose of supplying air to the eggs within the cocoon, but in all the cocoons examined the

EXPLANATION OF PLATE XXIII.

Hydrophilus sp.

- (1). Egg Cocoon, dorsal view.
 (2). " " side view.
 (3). Egg Cocoon with the upper surface removed showing the eggs in the natural position within the cocoon.

- (4). Single egg.
 (5). Full-grown larva, dorsal view.
 (6). Pupa, ventral view.
 (7). Imago.



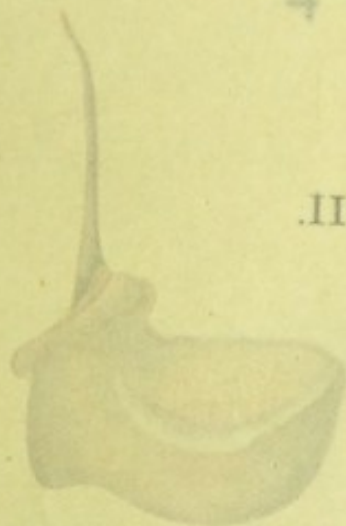
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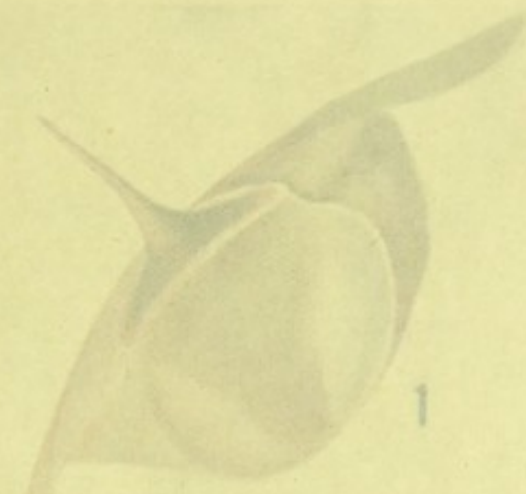
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4

and *O. aeneipennis* were observed swimming about on the surface of water. In a couple of days they disappeared and were not observed again until the beginning of March. A spell of warm weather had perhaps drawn them out of their winter burrows. The beetle flies in search of fresh habitats, and as soon as the ponds, which have been dry during the hot weather, are filled by the rains, they are found to be inhabited by them.

Oreochilus, the other common genus of *Gyrinidae* found in Puss, confines itself to the river and has not been found in ponds, probably preferring flowing water.

EXPLANATION OF PLATE XXIII.

Hydrophilus, Sp.

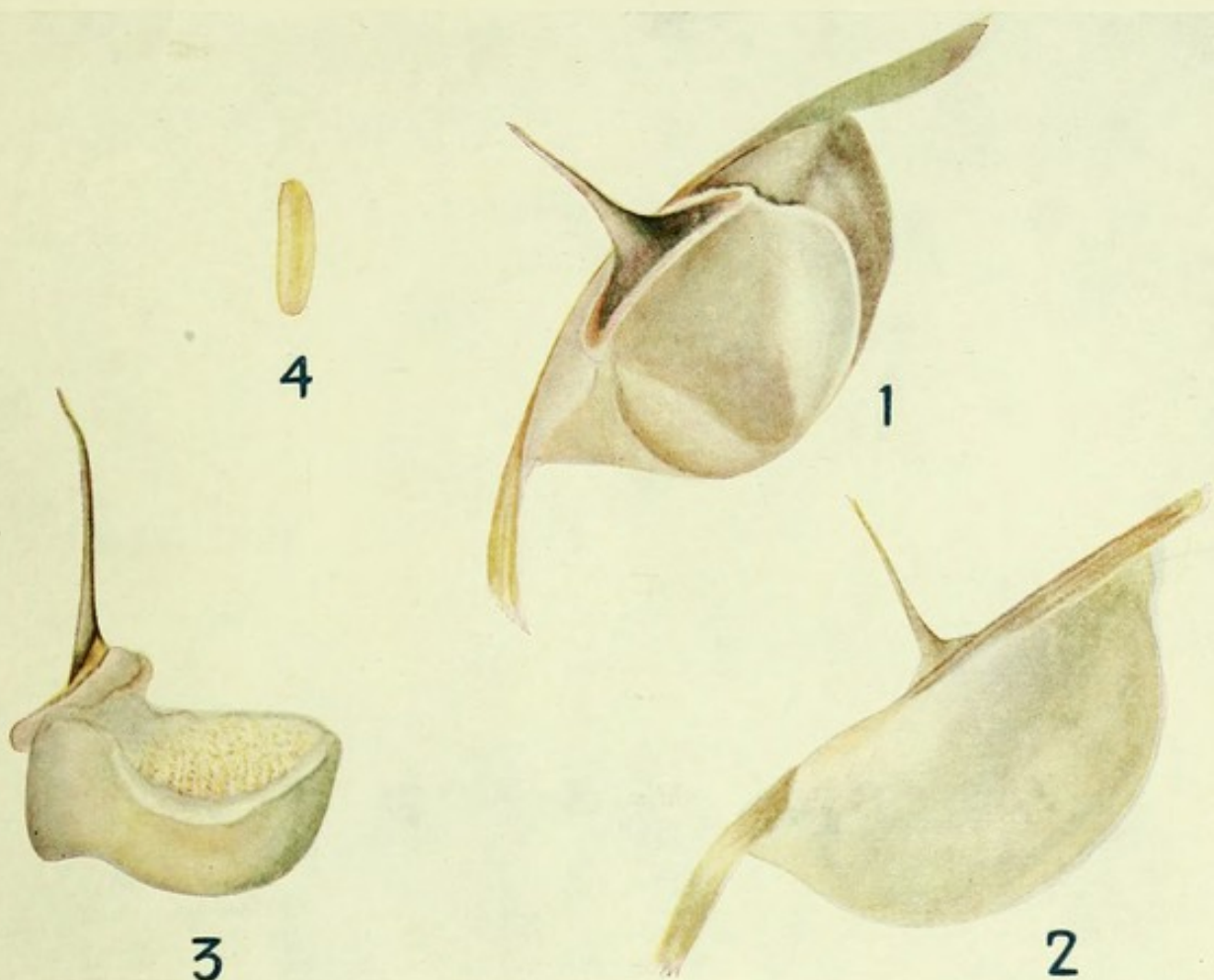
The Eggs:—Eggs ——— laid in whitish fibrous cocoons (Plate XXIII, Figs. 1 & 2), oval or rounded, from 15 to 20 mm. long and about 10 mm. broad. *Hydrophilus* sp. side the cocoon is flattened and

- (1). Egg Cocoon, dorsal view.
- (2). " " side view.
- (3). Egg Cocoon with the upper surface removed showing the eggs in the natural position within the cocoon.
- (4). Single egg.
- (5). Full-grown larva, dorsal view.
- (6). Pupa, ventral view.
- (7). Imago.

The eggs are laid within the cocoon; they are glued to the bottom on end close together and enveloped in a loose tissue of fine silky fibres. The eggs occupy only a part of the cavity, the rest being filled with a network of the same fibres with which the eggs are covered. (Plate XXIII, Fig. 3.)

It is not clear what useful purpose is served by the spike. In the natural position the spike is always directed upwards, and this end is secured partly by laying the relatively heavy eggs on the bottom of the cocoon and partly by attaching the cocoon to some floating object which further serves to keep it in an upright position. The spike is supposed to serve the purpose of supplying air to the eggs within the cocoon, but in all the cocoons examined the

PLATE XXIII.



5

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7

THESE PAPERS



apical end of the spike was not open but closed. The removal of the spike has no effect on the eggs; the spike of one of the cocoons was cut off up to the base and from another the entire upper surface with the spike removed and both floated in a dish of water. The eggs from both hatched in the same manner as from cocoons with the spike entire. Eggs which have become wet do not hatch, as was observed in the case of some which were removed from the cocoon and placed in water; these gradually sank to the bottom. A cocoon with the entire spike was submerged under water; in this case also the eggs did not hatch, as they had become wet by the water permeating through the egg case. A cocoon contains on an average from about 40 to 60 eggs.

The egg is soft, smooth, pale yellow, cylindrical with rounded ends and slightly curved; it is $3\frac{1}{2}$ mm. long and $\frac{3}{4}$ mm. broad. The egg-shell is thin and transparent. The eggs take four or five days to hatch. As the embryo develops, the colour of the egg turns from pale yellow to grayish. The gray colour starts at the upper end of the egg and gradually spreads downwards until the whole of the egg except the lower end turns grayish. The larva lies within the egg with its head at the lower end and its tail at the upper end of the egg. The eyes of the larva can be distinguished as a pair of black spots at the lower end of the egg.

Larva.—The larvæ soon after hatching remain within the cocoon for about 12 hours when they escape into the water through apertures which they make towards the lower end of the flattened surface of the cocoon. The larva, when just hatched, is ash coloured, elongate, flattened from above downwards, about 11 to 12 mm. long; the head is large, flattened, with a pair of short antennæ; the palpi are long, the mandibles are stout and short with a broad inner edge; a pair of eyes is present each composed of a number of ocelli. The body gradually tapers behind, and is furnished at the apex with a pair of short thick processes. The usual three pairs of legs are present.

The larvæ feed on snails; the snail is grasped between the mandibles, the head sharply bent backwards and the snail pressed

against the thorax which is bent into a curve. The larva does not crush the shell in order to get at the flesh but removes it by neatly cutting a narrow slit along the circumference of the shell, by chipping it off bit by bit. Unlike the larva of a Dytiscid or a Gyrinid, the larva of *Hydrophilus* devours the whole of the prey and there is thus a corresponding change in the shape of the mandibles, the long curved slender and perforated mandibles of the former giving place to the short but stout and broadly edged ones of the latter.

As the larvæ grow, they moult. When about to moult, the larva stops feeding and lies at or near the surface. The thorax is bent into a hump causing the integument to stretch out until a slit is formed along the mid-dorsal line extending from the base of the head to the first or second abdominal segment. The head with the mouth parts is first slowly drawn out of the old skin, which is gradually slipped back towards the hind end of the body from which it is ultimately cast off; just after the moult the head, mouth parts and legs of the newly moulted larva are milky white, the upper part and the sides of the body pale coloured. In about a couple of hours the body acquires the normal grayish colour.

The larva (Plate XXIII, Fig. 5), when fully developed, measures $2\frac{1}{2}$ inches in length and 9 mm. in breadth. It is elongate, flattened dorso-ventrally, gray above, dirty white below. The head is large, semi-circular shaped and more or less flattened above, about 5 mm. long and as broad. Antennæ are four-jointed, the basal joint stout and long, the three remaining joints short and slender, the basal joint slightly longer than the three remaining joints put together. The eyes are present in the shape of a pair of black irregular patches each composed of a number of ocelli; they are best seen just after a moult where they are conspicuous on the white background but they become less distinct when the larva acquires its normal gray colour. The mandibles are stout and bluntly pointed at the apex. The palpi are long and five-jointed, the basal joint stout and long equal in length to the remaining four joints which are also much more slender. The colour of the head is pale brown with indistinct darker longitudinal streaks.

The prothorax is large, rectangular shaped, with the integument chitinized and forming a hard plate above and below. The body is broadest at the middle from which point it gently tapers at either end but more towards the posterior than the anterior end ; from the apex of the body are given off a pair of short, thick, fleshy processes. The anus opens ventrally just above the base of the processes.

Respiration is aerial and is carried on by means of the pair of terminal spiracles which are situated at the base of a shallow pouch-shaped cavity at the apex of the body. The cavity can be opened or closed at will. The spiracles open into the pair of main longitudinal air tubes which run along the body one on either side and give off branches. When the larva wants to breathe, the hind end is raised up until the tip of the body is on a level with the surface of water ; the cavity is opened and air drawn in by slow alternate contractions and expansions of the hind segments of the body, when a sufficient supply of air has been taken in, the cavity is closed and the tail-end withdrawn below the surface ; the same process is repeated from time to time at varying intervals, each time the larva wants to take in a fresh supply of air.

The larvæ make a sharp squeaking noise when annoyed and squirt a quantity of dirty coloured sticky fluid from the hind end of the abdomen ; these devices are obviously protective as the larvæ have never been observed to take to this unless annoyed or attacked. Living as they do in shallow water and even when in deeper water lying close to the banks, they must be subject to constant attacks from enemies particularly wading birds. A small bird which had inadvertently seized a larva would probably be startled by the sudden squeak and the spurting of the fluid and drop the prey quickly.

When full-grown, the larva crawls out of the water, burrows into the earth where it makes a round hole about an inch and a half in diameter within which it pupates. The table below gives the duration of the life-history :—

Egg case found.	Eggs hatched.	1st Molt.	2nd Molt.	Full-grown.	Pupated.	Emerged.
9-VIII.	On the night of the 13th.	17-VIII.	21-VIII. 22-VIII.	24-VIII. 27-VIII.	25-VIII. 29-VIII.	9-IX. { 10-IX. 11-IX.

It rests in the larval stage for about a couple of days before pupating. It lies in the cell on the ventral surface with the body bent into a gentle curve.

Pupa.—The pupa (Plate XXIII, Fig. 6) is broader and shorter than the larva, whitish, oval-shaped, about 33 mm. long and 13 mm. wide. The head is as long as broad and with the mouth parts is bent on the thorax. The prothorax is large, much broader than long with the sides rounded, the disc convex and provided at either anterior angle with three long strongly curved spines. The meso- and meta-thorax are narrower than the prothorax, the former with a triangular shaped raised space in the middle and a broad depression on either side of it; both the meso- and meta-thorax bear each on the disc a pair of widely separated spines. The abdomen gradually narrows behind, the last segment is short and bears at the apex a pair of long stiff processes spirally ridged and each tipped at the apex with a pair of minute spines. Each abdominal segment (except the last two) is provided on either side with a pair of long spines. The rudiments of the legs, elytra and wings of the future imago lie folded on the ventral surface and at the sides. The pupa lies in its cell in a characteristic attitude, it lies on its ventral surface with the dorsal surface turned upwards and arched but the body does not come into contact with the walls of the cell but rests on the thoracic and apical spines as on a tripod as shown in the accompanying diagram (Fig. 2).

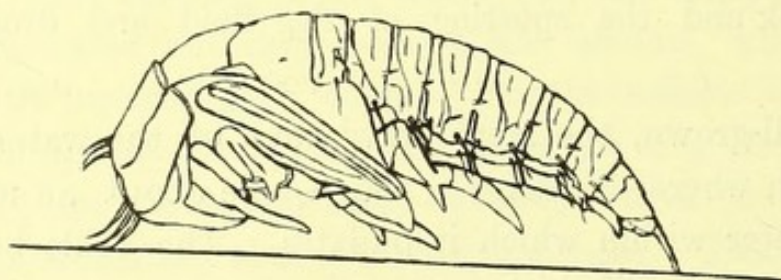


Fig. 2.

After transforming into an imago, the beetle remains in the cell for 2 to 3 days before it emerges out of it.

The table given below shows the changes, with the dates, undergone by the larva after entering the soil to pupate :—

Entered the earth.	Pupated.	Transformed to imago.	Emerged out of the cell.
29-VIII.	1-IX.	6-IX.	9-IX.
29-VIII.	2-IX.	8-IX.	10-IX.

The beetle is 27 mm. long and 13 mm. broad, oval shaped, strongly convex and shiny black above, and opaque below. (Plate XXIII, Fig. 7.) The metasternum is produced backwards into a long sharply pointed spine which reaches to the middle of third abdominal segment. The beetle swims quickly but its movements are less graceful than that of a Dytiscid. This is due to the fact that in the former the hind pair of legs strike the water simultaneously, in the latter the two posterior pairs of legs which are the organs of locomotion and which have the joints flattened, move alternately as in walking, consequently it gives the beetle an awkward gait.

The under-surface of *Hydrophilus* when seen from below through the water appears glistening white and is due to the film of air which clings to the sides of the thorax and the abdomen. When *Hydrophilus* wants to breathe, it rises to the surface head foremost. The head is pushed out of the water and by turning it on one side a cleft is formed between the head and the angle of the prothorax and the club of the antenna is brought to lie in the cleft. The abdominal segments during the act of respiration keep moving up and down. When a sufficient supply of air has been taken the head is withdrawn under water.

Hydrophilus first appears during the hot weather and breeds apparently only during the rains, as no cocoons have been observed during the hot weather. It probably hibernates as imago.

HELOCHARES Sp. (Plate XXIV, Fig. 5.)

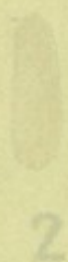
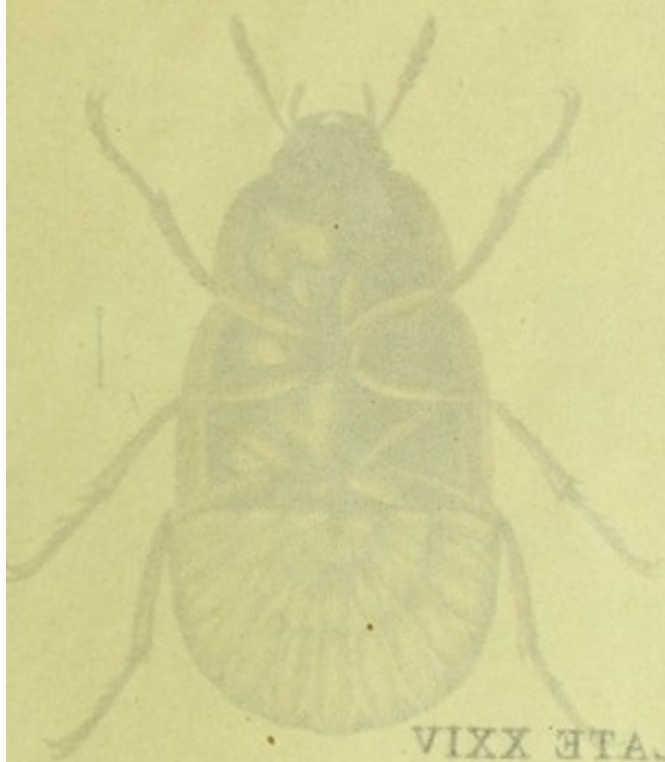
Helochares is common in Pusa during the cold weather and the early part of the hot weather in the river where it usually lives

in shallow water close to the banks hiding amongst the algæ and other weeds which grow there.

The female carries the eggs with it in a cocoon attached to its abdomen (Plate XXIV, Fig. 1). The cocoon is in the shape of a small bag, dirty white coloured, with thin paper-like walls; it measures 3 mm. by 2 mm. and is attached to the abdomen just below the hind coxæ and projects considerably beyond the apex of the body. *Helochaeres* affords an example of maternal instinct, which is rare as a rule among insects, and it is displayed at the cost of considerable inconvenience to the beetle; for it is a poor swimmer and burdened as it is with the egg case, it is considerably hampered in its movements being only able to slowly drag itself along submerged weeds.

The eggs lie closely packed in the case, each case containing on an average about 60 eggs.

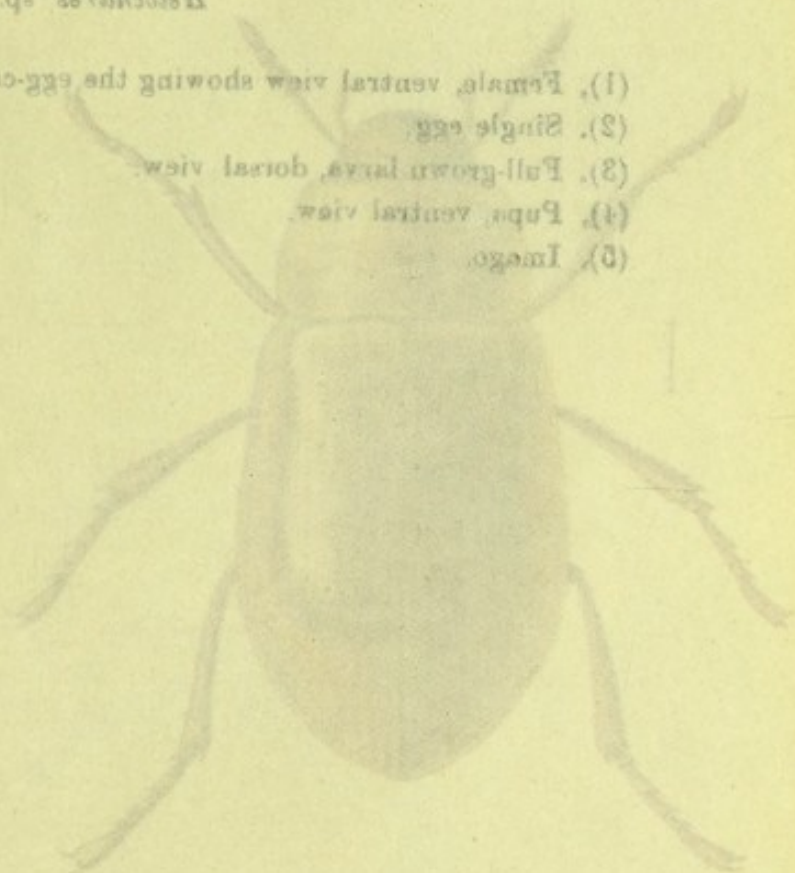
Larva.—The larva just after hatching is about 2 mm. long and $\frac{1}{2}$ mm. broad. When full-grown it is 10 mm. long and $1\frac{3}{4}$ mm. broad. (Plate XXIV, Fig. 3.) It is elongate, stout bodied, flattened from above downwards and of a pale ash colour. The head is large, slightly longer than broad; the mouth is furnished with a pair of long curved mandibles finely pointed at the tip and provided each on the inner side with a pair of sharp teeth; near the base of the mandibles is given off a pair of short antennæ; the palpi are long with the basal joint long and thick and the three following joints short and slender; eyes are present in the shape of a pair of black patches each composed of a number of ocelli. The prothorax is elongate with the sides narrowing anteriorly, much longer than broad. The meso- and meta-thorax are more transverse and shorter than the prothorax. The body is thickest about the middle from which point it narrows gradually towards either end but more towards the posterior than the anterior end; the last segment is elongate, longer and narrower than the preceding ones with the apex rounded and furnished apically with a pair of short processes. The head, pro- and meso-thorax are hard, the remaining segments remain soft but the integument is deeply



EXPLANATION OF PLATE XXIV

Helochares sp.


- (1) Female, ventral view showing the egg-case attached to the abdomen.
- (2) Single egg.
- (3) Full-grown larva, dorsal view.
- (4) Pupa, ventral view.
- (5) Imago.



in shallow water close to the banks hiding amongst the algae and other weeds which grow there.

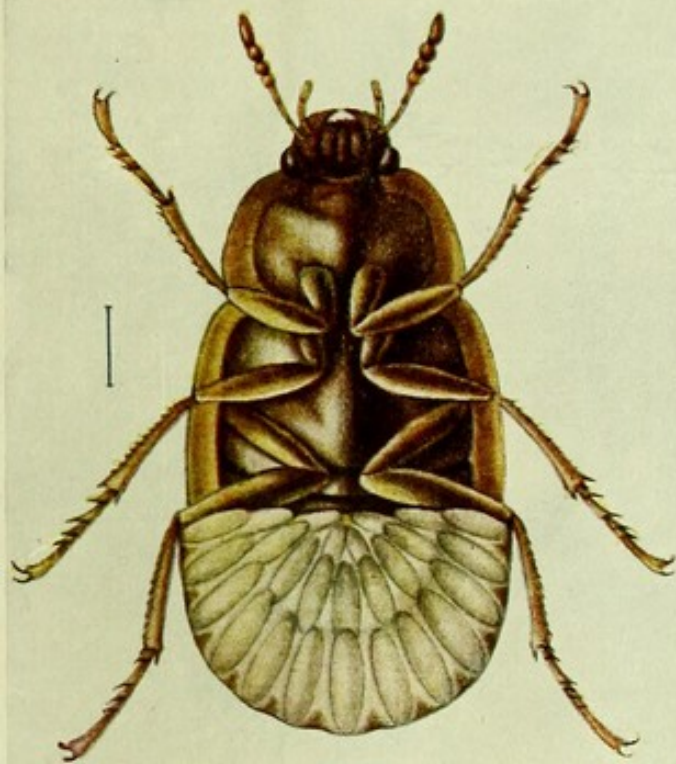
The female carries the eggs with it in a cocoon attached to its abdomen (Plate XXIV, Fig. 1). The cocoon is in the shape of a small bag, dirty white coloured, with thin paper-like walls; it measures 3 mm. by 2 mm. and is attached to the abdomen just below the hind coxæ and projects considerably beyond the apex of the body. *Helochares* affords an example of maternal instinct, which is rare as a rule among insects, and it is displayed at the cost of considerable inconvenience to the beetle; for it is a poor swimmer and burdened as it is with the egg case, it is considerably hampered in its movements being only able to slowly drag itself along.

EXPLANATION OF PLATE XXIV.

The eggs lie closely packed in the case, each case containing on an average about  25.

Larva.—The larva just after hatching is about 2 mm. long and $\frac{1}{2}$ mm. broad. When *Helochares* sp. it is 10 mm. long and $1\frac{1}{2}$ mm. broad. (Plate XXIV, Fig. 3.) It is elongate, stout bodied, flattened

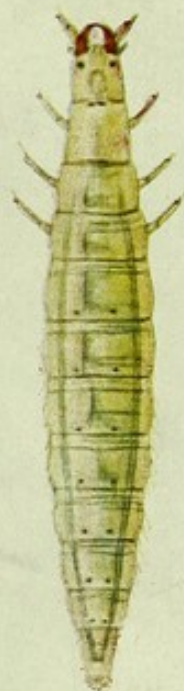
- (1). Female, ventral view showing the egg-case attached to the abdomen.
 - (2). Single egg.
 - (3). Full-grown larva, dorsal view.
 - (4). Pupa, ventral view.
 - (5). Imago.
- each on the inner side with a pair of sharp teeth; near the base of the mandibles is given off a pair of short antennæ; the palpi are long with the basal joint long and thick and the three following joints short and slender; eyes are present in the shape of a pair of black patches each composed of a number of ocelli. The prothorax is elongate with the sides narrowing anteriorly, much longer than broad. The meso- and meta-thorax are more transverse and shorter than the prothorax. The body is thickest about the middle from which point it narrows gradually towards either end but more towards the posterior than the anterior end; the last segment is elongate, longer and narrower than the preceding ones with the apex rounded and furnished apically with a pair of short processes. The head, pro- and meso-thorax are hard, the remaining segments remain soft but the integument is deeply



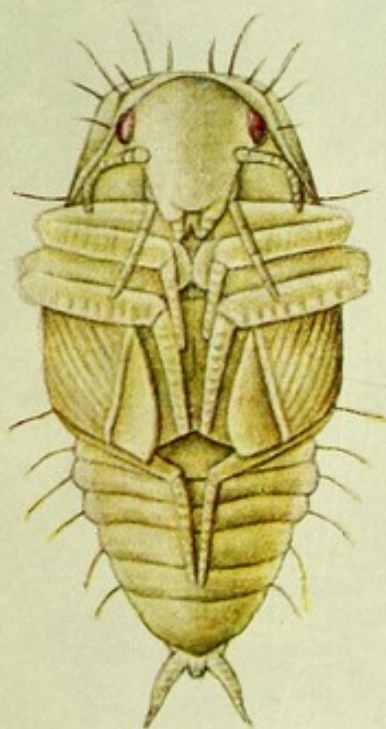
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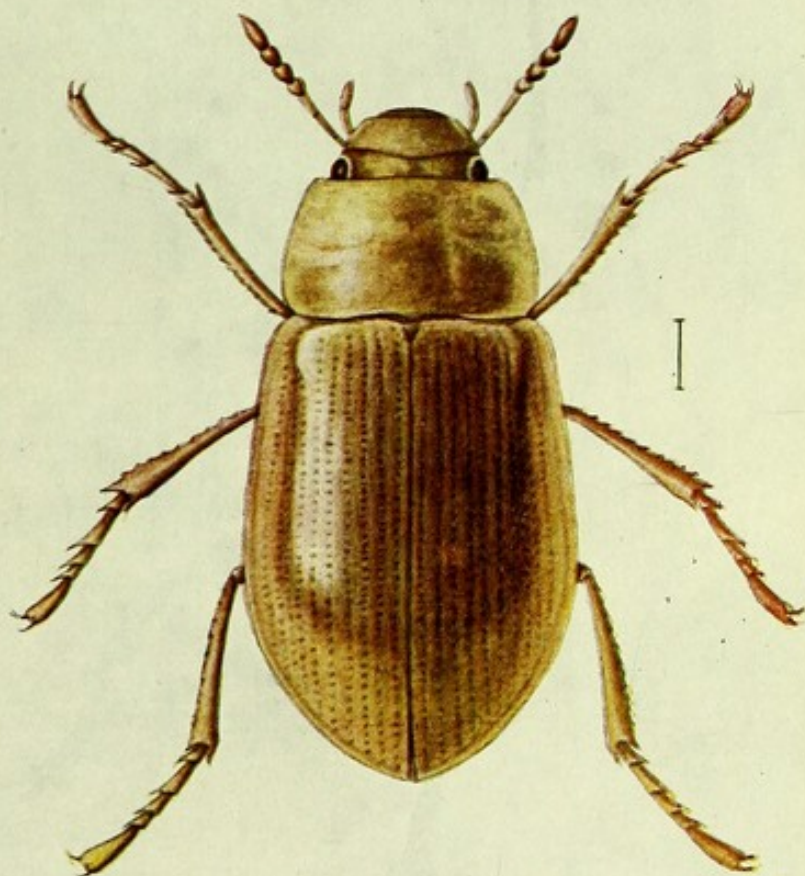
2



3



4



5



wrinkled. The usual three pairs of thoracic legs are present, each ending in a single claw. Respiration is effected by the terminal pair of spiracles which are situated in a shallow cup-shaped cavity fringed with hairs. The larva breathes in the usual way by bringing the tip of its body on a level with the surface of the water. When full-grown the larva leaves the water, crawls on to the banks, makes a small round hole within the mud and pupates in it.

Pupa.—The pupa is broadly oval, pale yellow, 5 mm. long and a little less than 3 mm. broad (Plate XXIV, Fig. 4). Head is smooth, large, with the mouth parts bent down on the thorax, prothorax very large, the sides slightly narrowed anteriorly, the disc strongly convex and marked with a number of spines; a row of 8 spines on the anterior margin, a row of similar number on the posterior margin, a pair on the middle of the disc. The meso- and meta-thorax are comparatively shorter than the prothorax and provided each with a pair of widely separated spines on the middle of the disc. The abdomen is gradually narrowed posteriorly and provided with a row of long spines on either side and a number of shorter spines scattered on the dorsal surface. The apex of the abdomen is rounded and provided with a pair of stiff divergent processes each ending at the tip in a long spine. The rudiments of the legs, wings and elytra lie folded on the ventral surface and at the sides.

The table below gives the duration of the life-history :—

Egg case found.	Egg hatched.	Larva full-grown.	Pupated.	Emerged.
6-IV.	9-IV.	26-IV.	26-IV.	2-V.

The life-history from egg to imago thus takes about 23 days to complete. The beetle is oval-shaped, olive brown coloured, 5 mm. long and about 3 mm. broad.

STERNOLOPHUS UNICOLOR, Cast.

(Plate XXV, Fig. 3.)

S. unicolor, Cast., is an oval-shaped blackish beetle, with the sides of the elytra paler coloured, measuring about 9 mm. in length

and about 5 mm. in breadth. The metasternum is produced posteriorly into a spine, which is much shorter and more slender than that of *Hydrophilus*, reaching only to the first abdominal segment. It is abundant in shallow water.

Larva.—The larvæ have been found in the drains around the Pusa College and in the jute pits during the hot weather and the rains. The larva (Plate XXV, Fig. 1) is dirty white coloured, elongate and thick-bodied; it is flattened dorso-ventrally and when full-grown is about 15 mm. long and $3\frac{1}{2}$ mm. broad. Head is large, pale brown, scarcely longer than broad, flattened above. A pair of eyes is present each formed of a number of ocelli. The mandibles are long, curved, finely pointed and bear on the inner side of each at the middle a pair of sharp teeth. The antennæ are short and three-jointed, the palpi are long and four-jointed, the basal joint long, the three following joints short. The prothorax is longer than broad with the sides narrowed anteriorly, the meso- and metathorax are together as long as the prothorax. The segments behind the metathorax gradually widen up to about the middle from which point the body gently tapers posteriorly. The last segment is small and rounded at the apex; from the middle of each abdominal segment is given off on either side a short backwardly directed process furnished with scattered hairs. The head and prothorax are hard, the rest of the body soft, but deeply and transversely wrinkled. The usual three pairs of jointed thoracic legs are present each ending in a single claw.

The larvæ usually remained clinging to the sides of the drains or crawling along the bottom. Respiration is carried on by means of the pair of terminal spiracles situated in a small rounded depression at the tip of the abdomen. Every now and again a larva could be observed running up the sides of the drains and when near the surface it would turn itself upside down and bring the tip of the body on a level with the surface of water. When the larva lies, as it often does, a little below the surface, it can gain access to the air without moving from its position. The lower segments



EXPLANATION OF PLATE XXV



2

Sternolophus unicolor.

- (1) Full-grown larva, dorsal view.
- (2) Pupa, ventral view.
- (3) Imago.



3

and about 5 mm. in breadth. The metasternum is produced posteriorly into a spine, which is much shorter and more slender than that of *Hydrophilus*, reaching only to the first abdominal segment. It is abundant in shallow water.

Larva.—The larvæ have been found in the drains around the Pusa College and in the jute pits during the hot weather and the rains. The larva (Plate XXV, Fig. 1) is dirty white coloured, elongate and thick-bodied; it is flattened dorso-ventrally and when full-grown is about 15 mm. long and $3\frac{1}{2}$ mm. broad. Head is large, pale brown, scarcely longer than broad, flattened above. A pair of eyes is present each formed of a number of ocelli. The mandibles are long, curved, finely pointed and bear on the inner side of each at the middle a pair of sharp teeth. The antennæ are short and the palpi are long and four-jointed, the basal joint long, the three following joints short. The prothorax is longer than broad with the sides narrowed anteriorly, the meso- and meta-thorax are together *Sternolophus unicolor*.

EXPLANATION OF PLATE XXV

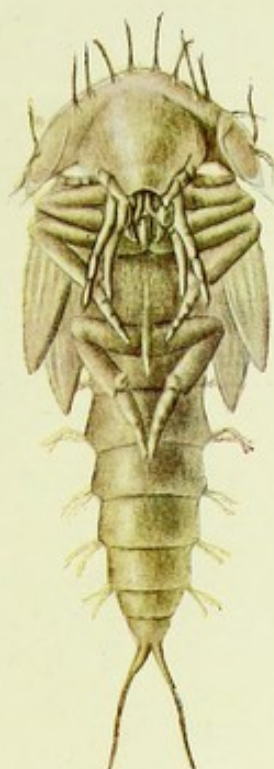
- (1). Full-grown larva, dorsal view.
 - (2). Pupa, ventral view.
 - (3). Imago.
- abdominal segment is given off on either side a short backwardly directed process furnished with scattered hairs. The head and prothorax are hard, the rest of the body soft, but deeply and transversely wrinkled. The usual three pairs of jointed thoracic legs are present each ending in a single claw.

The larvæ usually remained clinging to the sides of the drains or crawling along the bottom. Respiration is carried on by means of the pair of terminal spiracles situated in a small rounded depression at the tip of the abdomen. Every now and again a larva could be observed running up the sides of the drains and when near the surface it would turn itself upside down and bring the tip of the body on a level with the surface of water. When the larva lies, as it often does, a little below the surface, it can gain access to the air without moving from its position. The lower segments

PLATE XXV.



1



2



3



of the abdomen are elastic and they can be elongated or retracted at will. All that the larva has to do when it requires air is to lengthen out the hind end of the abdomen until the tip is above the surface and then draw it beneath again by contracting the muscles.

Pupa.—The larva when about to pupate leaves the water and burrows down into the mud where it makes a round hole smooth in the inside within which it lies. The pupa (Plate XXV, Fig. 2) is shorter than the larva, broadly oval, whitish coloured, about 9 mm. long and $2\frac{1}{2}$ mm. broad. The head is large, smooth and with the mouth parts is bent well down on the thorax. The prothorax is large with the disc strongly convex and marked with a row of spines on the anterior margin, a similar row on the posterior margin, a pair on either side near each angle and a pair on the middle of the disc. The meso- and meta-thorax are comparatively short, the abdomen gradually narrowed posteriorly and the apex is furnished with a pair of long spines. The pupal period lasts for about a week.

SCIRTES GRANDIS, Mots.

(Plate XXVI, Fig. 3.)

The larvæ of one species of *Dascillidæ* have been found in Pusa leading an aquatic life. The specimens agree with those taken in Belgaum by Mr. H. E. Andrewes and identified by Bourgeois as *Scirtes grandis*, Mots. They have been observed in the drains around the college buildings from the beginning of the hot weather to the beginning of the cold season.

Larva.—The larvæ (Plate XXVI, Fig. 1) are elongate, flattened dorso-ventrally, slightly convex above and measure when full-grown about 8 mm. in length and $2\frac{1}{2}$ mm. in breadth. The head is more or less flattened, more than twice as broad as long and partly retracted within the prothorax. The mouth parts are well developed; the labrum is large, semi-circular with the anterior margin concave; the mandibles are short and stout, triangular, curved outwardly, sinuous along the inner margin

with the apex finely pointed; the eyes are small, inconspicuous; the maxillæ are well developed with a broad inner lobe and a short four-jointed palpus. The antennæ are characteristic, being quite unlike those found in Coleopterous larvæ, which are usually short and few-jointed. They are very long and slender, reaching to the apex of the fifth abdominal segment. They are setaceous, the first two joints comparatively long and followed by a great many minute joints, the antennæ gradually narrowing towards the apex. The pro meso- and meta-thorax are broad with the sides rounded; behind the metathorax the body becomes gradually narrowed. The last abdominal segment is small and truncate at the apex. Three pairs of legs are present each ending in a single long claw. The colour is dark brown to blackish above, dirty white below except the sides and the apical end which are fuscous; the legs are pale brown. The larvæ remain clinging to the sides of the drains, particularly at the corners where it is dark and shady. They run quickly up and down the sides of the drains or the bottom, but they are much lighter than water and cannot remain under the surface without clinging to some support and when forced to let go their hold, they quickly rise to the surface. Occasionally they float passively on their backs on the surface. Respiration is aërial, the larva taking in air through the tip of its body; it runs up the sides of the drains and when close to the surface turns upside down exposing the tip of the body to the air; when going below the surface it carries a bubble of air attached to its hind end. When under water the larva protrudes from the hind end of the body a number of processes; they are slender finger-shaped, thin walled sacs, pale white in colour; their function is not clear, probably they are connected with the process of respiration. The larvæ are carnivorous feeding on small insects and not averse to them even when dead. When about to pupate the larva leaves the water and buries itself in the mud where it makes a small round hole within which it pupates.

Pupa.—The pupa (Plate XXVI, Fig. 2) is oval-shaped, pale yellow, 5 mm. long and 2 mm. broad. The head is round,

EXPLANATION OF PLATE XXVI

Scirtes graminis

- (1) Full-grown larva, dorsal view.
(2) Pupa, ventral view.
(3) Imago.

Dentaria undulata

- (4) Part of a blade of grass with the pupal case attached.
(5) Full-grown larva, dorsal view.
(6) Pupa.
(7) Imago.

with the apex finely pointed; the eyes are small, inconspicuous; the maxillæ are well developed with a broad inner lobe and a short four-jointed palpus. The antennæ are characteristic, being quite unlike those found in Coleopterous larvæ, which are usually short and few-jointed. They are very long and slender, reaching to the apex of the fifth abdominal segment. They are setaceous, the first two joints comparatively long and followed by a great many minute joints, the antennæ gradually narrowing towards the apex. The pro-meso- and meta-thorax are broad with the sides rounded; behind the thorax the abdomen is gradually narrowed.

EXPLANATION OF PLATE XXVI.

The last abdominal segment is small and truncate at the apex. Three pairs of legs are present each ending in a single long claw. The colour is dark brown to blackish above, dirty white below except the sides and *Scirtes grandis*, which are fuscous; the legs are pale brown. The larvæ remain clinging to the sides of the drains.

(1) Full-grown larva, dorsal view.

(2) Pupa, ventral view.

(3) Imago.

They quickly up and down the sides of the drains or the bottom, but they are much lighter than water and cannot remain under the surface without clinging to some support and when forced to let go their hold, they float on the surface. Occasionally they float passively on their backs on the surface. Respiration is

(4) Part of a blade of grass with the pupal case attached.

(5) Full-grown larva, dorsal view.

(6) Pupa.

(7) Imago.

Dineutes unidentatus. The larvæ of the drains and when close to the surface turns up exposing the tip of the body to the air; when going below the surface it carries a bubble of air attached to its hind end. When under water the larva protrudes from the hind end of the body a number of processes; they are slender finger-shaped, thin walled sacs, pale white in colour; their function is not clear, probably they are connected with the process of respiration. The larvæ are carnivorous feeding on small insects and not averse to them even when dead. When about to pupate the larva leaves the water and buries itself in the mud where it makes a small round hole within which it pupates.

Pupa.—The pupa (Plate XXVI, Fig. 2) is oval-shaped, pale yellow, 5 mm. long and 2 mm. broad. The head is round,

PLATE XXVI.



2



3



4



6



5



7



smooth. The vertex convex and with the mouth parts is bent down on the thorax. The prothorax is large with the posterior margin straight, the sides narrowing anteriorly, the disc convex. The anterior margin bears a pair of long sharply pointed spines, one near each angle. The meso-thorax is narrow and bears on the disc a pair of widely separated spines. The last but one abdominal segment is abruptly narrowed and truncate at the apex, the last very small, triangular and provided at the apex with a pair of long curved spines. The legs, wings and elytra lie as usual folded on the ventral surface and at the sides. The last pair of legs have the femora considerably dilated and the body is covered with closely placed erect stiff hairs. The pupal period lasts for 8 to 10 days. Larvæ which entered the mud to pupate on 17-VIII, emerged as beetles on 24-VIII and 26-VIII.

The beetle is reddish brown coloured, covered above with close short fulvous pubescence, oval-shaped, 5 mm. long and about 3 mm. broad; the posterior femora are very much dilated like that of a flea beetle and the tibia is provided at the apex with a long sharply pointed spine.

anterior. The vertex convex and with the mouth parts is bent down on the thorax. The pronotum is large with the posterior margin slightly raised. The sides ascending anteriorly, the disc convex. The anterior margin bears a pair of long sharply pointed spines. The posterior margin is narrow and bears one pair of long spines. The mesothorax is narrow and bears on the disc a pair of long sharply pointed spines. The last half of the abdominal segments is slightly flattened and bears at the apex, the last very small, rounded, and provided at the apex with a pair of long curved spines. The legs, wings and other parts are not folded in the ventral surface and at the sides. The last pair of legs have the femora considerably thickened and the body is covered with closely placed setae. The pupal period lasts for 8 to 10 days. Larvae which entered the mud to pupate on 11-VIII, emerged as beetles on 21-VIII and 22-VIII.

The beetle is reddish brown, covered above with close short hairs. The antennae are 11-segmented and about 3 mm. long. The posterior femora are very much thickened like that of a flea beetle and the tibiae are provided at the apex with a long sharply pointed spine.