THE BIOLOGY OF THE SHORE-FLY *SARCOPHILA CINEREA* FABRICIUS. (DIPTERA: METOPIIDAE).

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(*From the University Zoological Research Laboratory, Madras.*)

(Plate XIII.)

INTRODUCTION.

The sub-family Sarcophaginae of Metopiidae has a very interesting life-history. The majority of those forms whose life-history is known are saprophytic, though a certain number of parasitic species occur, and of late it has also been found that some are able to adapt themselves to either mode of living. The following account concerns the biology of a species belonging to the tropical genus *Sarcophila* recorded from India by Senior-White (1924). Except for this record nothing has been published about its habits or biology. The immature stages of this form are scavengers and although they develop as such they may become true parasites in course of time. As Hallock (1929) remarks, " it may be that what we observe is the parasite habit in the process of development"

During the beginning of December 1934, numerous females of a large grey Sarcophagid were collected on the beach at Madras, S. India. Specimens were identified as *Sarcophila cinerea* Fabr. The species was known previously from Puri (Orissa), Varkala (Travancore), Colombo and Barberyn Island. Mr. Senior-White[1] thinks that it occurs all along the Indian Coastal Region, at least the East Coast, as it is very common at Waltair. The flies were attracted to decaying fish and crabs left on the beach by low tide and numerous gravid females were collected upon or near this material.

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REARING METHODS.

Larvae are deposited by adult flies instead of eggs, the latter having hatched within the body of the parent fly. Several gravid females were captured and left in a jar containing decomposing fish or crabs. The females begin to deposit larvae on the material and within a few hours after deposition most of them could be found burrowing into the decaying

[1] In a private communication to the Director, Zoological Survey of India.

flesh. The larvae were carefully removed to specially constructed mud cages, as recommended by Patton and Cragg (1913), and allowed to develop under laboratory conditions. The fish or crab containing the larvae was placed on damp sand at the bottom of the enclosure. If the larvae are kept in a jar they crawl out of it when they migrate to pupate. But they never leave the mud enclosure, which has the further advantage of minimising the smell of decaying material. For more accurate determination of the larval instars, moulting etc., individuals were isolated and kept in separate tubes. As far as possible the progeny of a single individual was kept separate within the cage.

IMMATURE STAGES.

The larva, as soon as it is laid, is pale white in colour with eleven segments in addition to the head, all nearly of equal length. It is flattened dorso-ventrally. The bucco-pharyngeal apparatus is very weakly chitinised, consisting of an arched basal piece and the hooks. There are minute spines along the segmental lines, more numerous on the ventral side (Pl. XIII, fig. 1).

First-instar Larva, two hours old.—It is slightly yellowish in colour and the segments are distinct (Pl. XIII, fig. 2). The spines along the segmental lines are more numerous and are lightly chitinised towards the ventral side. The mouth is triangular with two lateral oral papillae. The oral groove is distinct. The antennae are minute, two jointed and the basal joint is very much broader (Pl. XIII, fig. 3). The bucco-pharyngeal apparatus is heavily chitinised, consisting of two large mandibular hooks articulated by a slender rod and attached as stated above to a weakly chitinised basal piece. The latter is drawn out on each side into paired processes. The larva is metapneustic. The posterior spiracles are yellowish in colour and are situated wide apart. The anal tubercles are two in number and are situated on either side of the minute anus (Pl. XIII, fig. 4). Length 5·4 mm., diameter 0·9 mm.

Second-instar Larva.—It is yellowish brown with well developed oral papillae. The cuticular spines along the segmental lines are more numerous on the posterior segments. The grooves of the stomal disc unite to form larger channels which enter the mouth near the lateral angles. The bucco-pharyngeal apparatus is very heavily chitinised and articulated with a pair of strong hooks and attached together by means of a median sclerite. The dorsal cornua is drawn out anteriorly and is provided with a ridge behind (Pl. XIII, fig. 5). The larva is now amphipneustic, the spiracles appearing in front of the first thoracic segment. The anterior spiracles are brownish with eight to nine lobes. The posterior spiracular cavity is shallow with a pair of brownish tubercles on either side and three above (Pl. XIII, fig. 6). The posterior spiracles are yellowish brown with slits of equal length. The anal opening is below the posterior cavity, with conical yellowish anal papillae on either side. Length 7·5 mm., diameter 1·1 mm.

Third-instar Larva.—It is pale ochreous in colour, tapering towards the anterior end (Pl. XIII, fig. 7). The first two segments are narrow

and the rest are of almost equal length. The cuticular spines are bigger and more numerous (Pl. XIII, fig. 8). There are a few conical spines on the sides, mostly on the anterior segments. The head is conical followed by the collar. The latter is provided with numerous curved spines (Pl. XIII, fig. 9). The buccal groove is deep, and on either side each oral lobe is occupied by a hemispherical area. This area is covered by a series of fine grooves which converge towards the mouth. The bucco-pharyngeal apparatus is provided with a strongly chitinised and well developed basal piece. The hooks are strong, curved, and articulate with the basal piece by the median sclerite. The dorsal cornua carries an accessory piece on the inner side, which is heavily chitinised. The ventral cornua shows a longitudinal ridge (Pl. XIII, fig. 10). The posterior spiracular cavity is fairly deep, more or less transversely elliptical. The edges of the cavity are provided with nine conical brownish tubercles, three on each side and three above the cavity. Each spiracular plate is located wide apart, the space between them is equal to about the breadth of the plate. The spiracular slits are yellowish, shining, each with a chitinised narrow ridge all round the edge. The anal opening has prominent dark brown tubercles on either side. There are numerous curved and bifid spines on the anal segment (Pl. XIII, fig. 11). The anterior spiracles are reddish with eight to nine lobes. Length 10·9 mm., diameter 2·5 mm.

Pupa.—The pupa is dark yellowish red in colour and shining; the segments are fairly distinct (Pl. XIII, fig. 12). The anterior end is pointed and heavily chitinised. The anterior spiracles are reduced and situated at the apex of the head (Pl. XIII, fig. 13). The cuticular spines along the segmental area are reddish and blunt. Starting from the anterior end, on either side a ridge runs to about two-thirds the length of the body. The posterior spiracular cavity is located mostly above the horizontal axis. The tubercles on the edges of the cavity are heavily chitinised (Pl. XIII, fig. 14). The spiracular plates are reddish in colour with three yellow shining slits. The first and the last slits are slightly curved (Pl. XIII, fig. 15). The spiracular plates are separated by a space equal to about half the width of a plate. The chitinous edge of the inner angle of the plate is produced into a ridge. The ridges on either side meet in the middle. The anal opening is 0·5 mm. below the cavity; the anal tubercles are conical, reddish and highly chitinised. Length 8·5 mm., diameter 2·8 mm.

Puparium.—It is dark red and consists of twelve segments with dark minute spines along the segmental lines (Pl. XIII. fig. 18).

Adult.—Pl. XIII, fig. 19 is the dorsal view of the male fly and shows clearly the characters of the adult which has been fully described by Senior-White (1924). Pl. XIII, fig. 20 is of the head of the female fly, front view, and shows the antennae and the chaetotaxy of the head. Pl. XIII, fig. 21 represents the terminal segments of the male, from below, showing the genitalia and the modified sixth sternite (accessory forceps). Pl. XIII. fig. 22 is of the aedeagus of the male and shows the arrangement of the basal piece, the accessory claspers, the posterior claspers, the accessory plate and the shaft. Pl. XIII, fig. 23 represents the mid-femora of the male.

HABITS AND LIFE-HISTORY.

The males, more numerous than the females, are very active and rather difficult to obtain. They are very wary and when disturbed fly away very quickly. When, however, a fly has settled for larvipositing, nothing will scare it and it will not move until the last larva is laid. The flies are abundant during the months of October, November and December and very scarce during April and May. They occur all along the coast of Madras. They are found collecting together in large numbers around places where the catamarans are landed to unload their catches. Usually they abound in the high tidal zone, although a few specimens were collected from moist places away from the shore. Owing to their grey protective colouration they generally escape notice.

Copulation was observed in nature in the morning, the pair remaining in the act from two to five minutes. Pairing in captivity was a rare phenomenon. Copulation often took place within a few hours after the emergence of the females, but no larvae were obtained from them. The adult flies were usually seen feeding on decaying fruits and vegetable matter. Occasionally they were found larvipositing on such material. But the larvae never seem to develop on decaying vegetable material. Adult male and female, fed on sugar and honey, lived for more than a month in the laboratory. The average number of larvae obtained from a single female at one time was found to be 20.

Larval Habits.—The larvae are active as soon as they are deposited. They are able to stand prolonged immersion in salt water. The larval period is very short, the larva undergoing three moults before turning into pupa. The larva grows very rapidly especially after the second moult. The average length of the larval stage was 83 hours. The larva at the end of final moult ceases feeding and becomes restless. It wanders out of the food material and pupates under the damp sand, mostly along the sides of the mud enclosure.

The pupa is yellowish-brown at first, later on turning reddish in colour. The pupal period in 46 individuals reared was from 6 to 8 days. The rudiments of the wings and limbs appear at the end of the first day. The ptilinum is very prominent. Flies generally emerge out late in the afternoon. To have an idea of the proportion of sexes, larvae were divided into batches and placed in separate cages. In several cases it was found that the males very much exceed the females in number.

Although decaying fish and crabs were found to be a very good medium for the development of the larvae, they were observed to grow satisfactorily when allowed to feed on freshly killed fish. Probably in course of time they might acquire a parasitic habit and begin to feed on living tissues. In order to explain the limited littoral habitat of the species I tried to feed the larvae on decaying material of other than marine origin. A number of newly laid larvae were supplied with dead fresh-water fish and tissues of frogs. The larvae, as soon as they were placed on this material, were restless and appeared to be quite uncomfortable ; but after some time most of them had disappeared into the material and developed normally. This shows that these flies are

highly plastic in regard to some of their habits. Careful search did not reveal any flies in the vicinity of fresh-water pools and tanks. As far as I am aware they never occur beyond the limited littoral zone.

Below are given two tables, (i) to illustrate the measurements of the larval stadia and (ii) to show the duration of the various stages of the larva.

I. Table showing the measurements of the stadia of four larvae reared in the Laboratory.

No. of specimen.	Larval Stadia.					
	I		II		III	
	Length.	Diameter.	Length.	Diameter.	Length.	Diameter.
	mm.	mm.	mm.	mm.	mm.	mm.
1	5·34	0·89	7·3	1·00	9·9	2·4
2	4·95	0·80	7·0	0·98	9·15	2·1
3	5·20	0·95	7·3	1·01	10·75	2·0
4	5·15	0·89	7·4	1·10	10·75	2·0

II. Table showing the duration of the various stages of four batches of larvae reared in the Laboratory.

Batch.	Larvae laid on	Pupated on	Flies emerged on	Larval period.	Pupal period.	Total no. of days.
I	22-10-34	25-10-34	1-11-34	3½ days	7 days	10½ days
II	15-11-34	18-11-34	26-11-34	3 days	8 days	11 days
III	27-2-35	3-2-35	10-2-35	3½ days	7 days	10½ days
IV	19-7-35	23-7-35	29-7-35	4 days	6 days	10 days

Though the larval period and pupal period are slightly different, it is noticeable that the total developmental period is practically the same.

SUMMARY.

1. The life-history and habits of *Sarcophila cinerea* Fabr. are described.

2. The larva resembles very much that of Calliphorinae, but differs from larvae of this sub-family in the absence of a button on the spiracular plate.

3. The habits of this form are to a great extent plastic as in some other members of the family. The species is confined to the limited littoral zone.

BIBLIOGRAPHY.

1. Greene, C. T.—The puparia and larvae of Sarcophagid flies. *Proc. U. S. Nat. Mus.*, LXVI, pp. 1-26 (1925).
2. Hallock, H. C.—Notes on methods of rearing Sarcophaginae etc. *Ann. Ent. Soc. Amer.*, XXII, pp. 246-250 (1929).
3. Imms, A. D.—*Text Book of Entomology.* (London, 1934).
4. Patton, W S. and Cragg, F. W.—*Text Book of Medical Entomology.* (Calcutta-Madras, 1913).
5. Senior-White, R.—A revision of the sub-family Sarcophaginae, in the Oriental Region. *Rec. Ind. Mus.*, XXVI, pp. 193-283 (1924).
6. Sinton, J. A.—Some cases of Myiasis in India and Persia. *Ind. Jour Med. Research*, IX, pp. 132-162 (1921-22).