OBSERVATIONS ON THE BIONOMICS OF THE MIDGE *CHIRONOMUS* (*LIMNOCHIRONOMUS*) *TENUIFORCEPS* (KIEFF.) OCCURRING ON THE FILTER-BEDS OF THE CALCUTTA CORPORATION WATER WORKS AT PULTA, NEAR CALCUTTA (CHIRONOMIDAE: DIPTERA).

By H. A. HAFIZ, *Ph.D.* (*London*), *D.I.C.* (*London*), *Assistant Superintendent, Zoological Survey of India, Calcutta.*

INTRODUCTION.

Chironomus (*Limnochironomus*) *tenuiforceps* (Kieff.)[1] is by far the most abundant of the several species of Chironomidae occurring in the slow sand filter-beds in the water works of the Calcutta Corporation at Pulta. The "mound-shaped" larval and pupal cases of this species, which are found spread almost uniformly over the surface layer of the filter-beds, appear to interfere, to some extent, with the process of filtration, and it was, therefore, considered desirable to study the bionomics of this Chironomid in connection with the investigations on the biology of the slow-sand filter-beds at Pulta which are being carried out by the Zoological Survey of India. Unfortunately, very few observations have been made on the bionomics of any species of Chironomidae in India; the only reference being that of *C. cubiculorum* Dolesch[2] Rempel's[3] account of the life-history of the North American species, *C. hyperboreus* Staeger, is unfortunately too brief for comparative purposes. In this species eggs, which are said to be deposited over the lake surface, sink to the bottom. Four larval instars and a two-year life-cycle were observed.

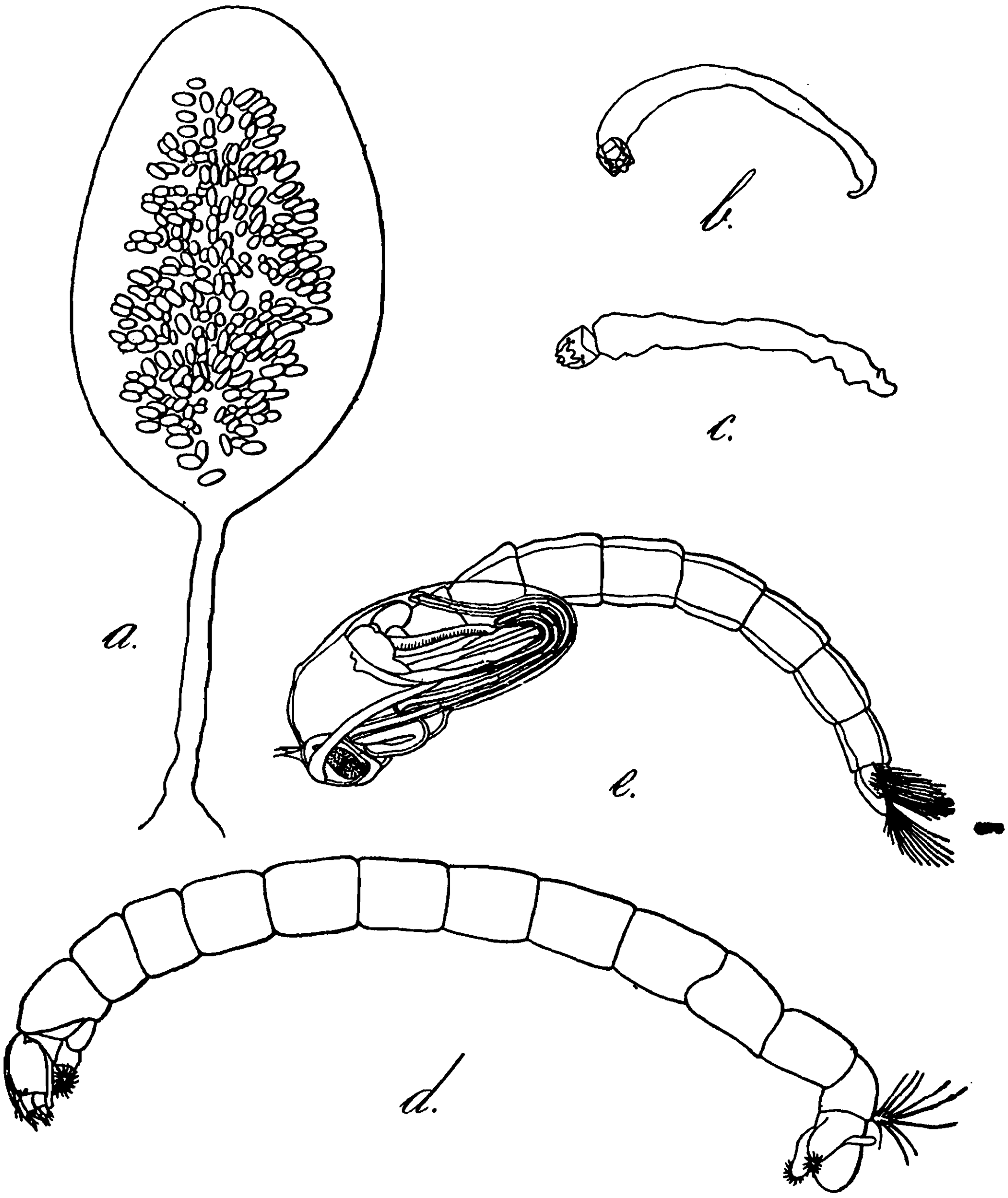
I am grateful to Mr. F. W. Edwards, British Museum, London, for kindly identifying the adult midges and to Dr. B. Prashad, Director, Zoological Survey of India, for helping me in preparing this paper for the press. The text-figures illustrating this paper were prepared under my supervision by Babu S. C. Mondul, one of the artists of the Zoological Survey of India.

OBSERVATIONS.

Eggs of this species are laid in water embedded in pear-shaped gelatinous masses which are moored to the surface layer of the filter-beds by short stalks (text-fig. *a*). Each mass consists of several hundred eggs, narrowly elliptical in shape and of a milky-white colour, which are collected together in the middle in an irregular manner. The colour of the eggs changes to pale-brownish after about two days. Each egg is, on an average, 0·2 mm. long. Thread-like colourless larvae hatch out, in the laboratory, about four days after oviposition. It is not

[1] Kieffer, J. J., *Ann. Soc. Sci. Bruxelles*, p. 166, (1919).
[2] *Ind. Mus. Notes* V, p. 189, (1903).
[3] Rempel, J. G., *Journ. Biol. Board of Canada* II, p. 209, (1936).

possible to make out the segments of the larva at this stage. A two-days old larva is 0·88 mm. long (text-fig. *b*). A figure of a first larval



Chironomus (*Limnochironomus*) *tenuiforceps* (Kieff.).

a. Egg-mass, drawn from a photograph, × 11 ; *b*. A two-days old larva, drawn from slide, × 36 ; *c*. Cast skin of first instar, drawn from slide, × 36 ; *d*. Lateral view of full-grown larva, × 14·5 ; *e*. Lateral view of pupa, × 14·5.

cast skin is also given (text-fig. *c*). After about a week the larvae turn light greenish and later become red (text-fig. *d*) ; by this time they grow to a length of 8 mm.

So far it has not been possible to make a detailed study of the life-history of these midges with regard to the number of instars, as it was not found possible to keep very young segregated larvae alive, under laboratory conditions, beyond a few days. From observations made in the field, however, it appears that full grown larvae when ready to pupate are about 8 mm. in length. The period of pupation appears to last for three to four days and the number of days taken for the life-cycle to be completed does not appear to exceed about twenty days.

Soon after hatching out of the eggs, the Chironomid larvae surround themselves with very thin tubes which are of the same length as the larvae. The body of the larvae lies entirely in these tubes but the head is constantly pushed out in search of food and more material for enlarging the tubes. The tube is formed of minute grains of sand, bits of dead algae, silt, etc., which are cemented together by the silk-like secretion of the salivary glands of the larvae.

With the increase of thickness of the tube, the length of the tube is also increased by the addition of more material to the open end of the tube by the larva. From time to time the larva completely withdraws itself inside the tube, where it sets up characteristic lashing movements of the body. It was also noticed that as the length of the tube increases, the tubes sometimes become rather curved in outline. This condition was observed on several occasions on the surface of an affected filter-bed when the water had been drained off for scraping and cleaning.

It is not unusual for the larva to pierce the roof of its tube at various points to pick up more bits of material for increasing the thickness of the wall of the tube. Sometimes the larva abandons its tube and swims about freely for a while in the water, but before long it builds a fresh tube or enters one abandoned by another larva. Larvae that are accidentally buried in sand to a depth of an inch or more are unable to crawl through to the surface, and ultimately perish.

As the time for pupation approaches, the larva gradually closes the open end of the tube, and lies fully stretched, but the undulating movements of the body, referred to above, are continuously maintained. To all intents and purposes, the tube now becomes a temporary grave for the pupating larva.

The pupa is usually devoid of all colour in the region immediately behind the thorax, but the anterior and posterior ends still retain the reddish brown colour. The pupa is about 5·6 mm. in length, and has a considerably broader and more rounded head than the larva (text-fig. *e*). It is doubled up in the form of a broad U. The body movements are very rapid, the head and the tail ends moving at the same time.

The amount of space needed for the pupa in the original narrow larval tube is possibly attained by stretching the elastic walls of the tube with what appears to be the powerful pounding action of the head and the tail ends of the pupa against the wall of the tubes. The pupae are unable to repair any damage or to re-enter the tubes when dislodged or build new pupal tubes. The pupa finally comes out of its tube by making a neat hole by its head near the anterior end of the pupal tube. It then lies on the sand still keeping up its body movement. When it is more or less ready for the emergence of the adult, it comes up to the surface of water and remains there with its head at the surface, and the rest of the body hanging down into the water in almost a straight line. From time to time, however, it dives down into mid-water. When the pupa is finally ready for passing into the adult stage it rises again to the surface of water, remains there for a few seconds with its bent head-end protruding slightly above the surface, and after what appears to be a desperate struggle, the head emerges first and the body later and the adult fly then rests on the thin empty floating pupal skin, till the wings are unfolded and dried when it flies off.

Besides the " mound-shaped " type of larval and pupal tubes made by the species of Chironomidae dealt with in this paper, a " cylindrical " type of tubes of the larvae and pupae of *Chironomus* (*s. str.*) *barbatitarsis* (Kieff.) and *Chironomus* (*Cryptochironomus*) *orissae* (Kieff.)[1] also occurs on the filter-beds. The former type of tubes is, however, the most important in so far as the filter-beds are concerned in that it occurs in enormous numbers uniformly spread over almost the entire surface of the bed; sometimes as many as 800 larvae occur in an area of one square foot. The " cylindrical " tubes on the other hand are less numerous than the " mound-shaped " tubes and they do not completely cover up the surface layer. The majority of these tubes lie loosely on the surface of the filter-beds and are very rarely attached to each other in any numbers. Further, their tubes appear to be rather thinner and probably more porous.

From the following table it will be seen that the Chironomid larvae and pupae which make the " mound-shaped " tubes generally occur during the months of December, January, February and the early part of March. During the remaining months of the year, the " cylindrical " type of larval and pupal tubes occurs in great abundance. Sometimes a few of these also occur along with the " mound-shaped " tubes but, as remarked above, they are never so abundant as the " mound-shaped " tubes.

Years and months.	Types of Chironomid larval and pupal tubes.
1937.	
January	" Mound-shaped " tubes and a few " cylindrical " tubes.
February (early)	" Mound-shaped " tubes and a few " cylindrical " tubes.
March (early) ..	" Mound-shaped " tubes and a few " cylindrical " tubes.
March (late)	" Cylindrical " tubes.
April	" Cylindrical " tubes.
May	" Cylindrical " tubes (a few).
June	" Cylindrical " tubes.
July	" Cylindrical " tubes.
August ..	" Cylindrical " tubes (a few).
September ..	" Cylindrical " tubes.
October	" Cylindrical " tubes.
November	" Cylindrical " tubes.
December ..	" Mound-shaped " and a few " cylindrical " tubes.

[1] Kieffer, J. J., *Rec. Ind. Mus.* IX, p. 131, (1913).

Years and months.	Types of Chironomid larval and pupal tubes.
1938.	
January	"Mound-shaped" tubes.
February	"Mound-shaped" tubes.
March	*
April	"Cylindrical" tubes.
May	"Cylindrical" tubes.
June	"Cylindrical" tubes.
July	"Cylindrical" tubes.
August	"Cylindrical" tubes (a few).
September	"Cylindrical" tubes (a few).
October	*
November	"Cylindrical" tubes.
December	*
1939.	
January ..	"Mound-shaped" tubes.
February ..	"Mound-shaped" tubes.
March (early)	"Mound-shaped" tubes.
March (late)	"Cylindrical" tubes.
April ..	"Cylindrical" tubes.
May	"Cylindrical" tubes.
June	"Cylindrical" tubes.
July ..	"Cylindrical" tubes.

* No observations are available for these months.

I have observed several instances of earwigs preying on female Chironomid flies near the edge of the water, but they do not occur in sufficient numbers to serve as a natural biological check on the latter.

Removal of grass and other weeds in the neighbourhood of the filter-beds among which newly emerged Chironomid flies rest during the hot part of the day before mating and laying eggs, has to a certain extent reduced the number of these flies. De Meillon and Gray[1] in a recent paper have observed that the increase of salinity of water has proved of value for controlling the number of a South African species of *Chironomus* Meig. For obvious reasons, this method cannot be applied in the case of filter-beds which supply water for human consumption.

[1] De Meillon, B. and Gray, F. C., *S. Afr. Med. J.* XI, pp. 658-660, (1937).

REFERENCES.

Hastings, A. B., 1937.—Biology of Water Supply. *Brit. Mus. (Nat. Hist.) Econ. Ser.* No. 7A.

Kirkpatrick, R., 1924.—The Biology of Waterworks. *Brit. Mus. (Nat. Hist.) Econ. Ser.* No. 7.

Miall, L. C., 1895.—*The Natural History of Aquatic Insects, London.*

Ward, H. B. and Whipple, G. C., 1918.—*Fresh-Water Biology.* New York and London.