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# BIOLOGY AND ECOLOGY OF *OSCINELLA FUSIDENTATA* CHERIAN (DIPTERA : CHLOROPIDAE) WITH NOTES ON THE EXTERNAL MORPHOLOGY OF THE IMMATURE STAGES

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(With 5 Text-figures, 1 Plate and 15 Tables)

## INTRODUCTION

*Oscinella fusidentata* Cherian is a very common chloropid seen on *Cynadon dactylon* Linn. It enjoys a wide distribution in India. Though it is very common nothing is known of its life history so far. An attempt is made here to study its biology besides adding some ecological notes.

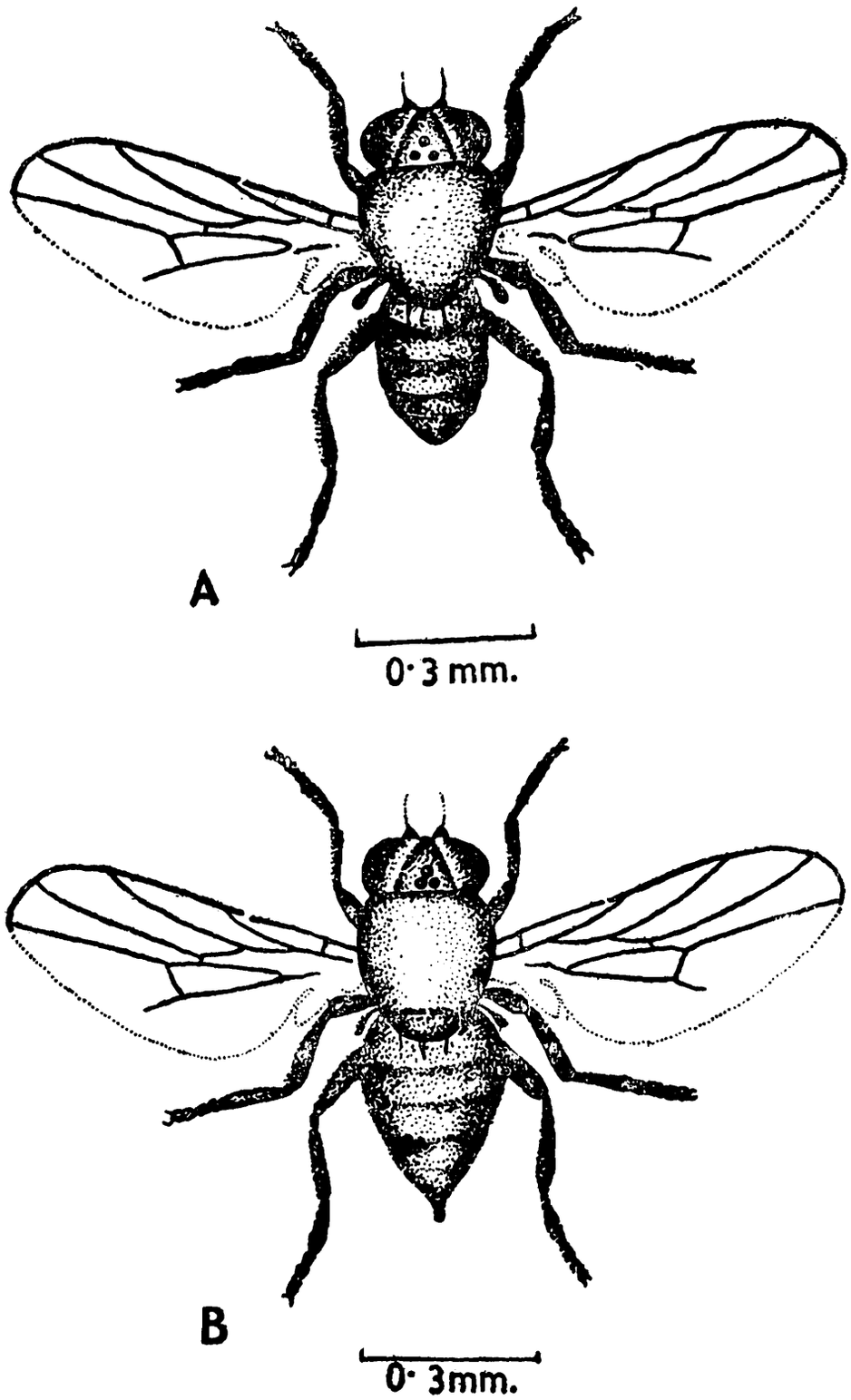
This species is fairly common in Agra during February—May and July-November. For studying the life history grass infested by the larvae were uprooted from field and planted in glass tubes inside glass jars. The adults which emerged were separated into pairs. Each pair was released into an inverted glass (25 cm. × 20 cm.). In this glass cotton wool soaked in sugar solution, changed every day, provided food and *C. dactylon*, potted in glass tubes (7.5 cm. × 2.5 cm.) served as sites for sitting and egg laying. The grass was examined for eggs at regular intervals and those on which eggs were found were replaced by fresh potted plants. The former were transferred to the constant temperature room where required temperature and high humidity were maintained.

## HABITAT AND HABIT

*O. fusidentata* can easily be collected from the fields by sweeping the grasses with an insect net. The adult is positively heliotropic. When kept in a breeding jar it moves from the dark to the light side of the jar, regardless of the light being whether natural or artificial. This habit makes handling them in the laboratory easy. The same habit is described by Hall (1932) in *Hippelates pusio* Loew. The flies, when kept in a jar provided with food and plants, were found to select the highest places along the wall of the jar for resting, facing the rays of the light.

The adult males (Text-fig. 1 A) are slightly active and have restricted flight movements whereas the females (Text-fig. 1B) are not so active.

They are found resting under the shade on leaves in the morning, flying about during day time and resting after sunset.




Text-fig. 1—*Oscinella fusidentata*, A—♂ ; B—♀.

*Distribution of the fly in India*

The range of distribution of the fly in India, based on the present investigation, is given in Table 1 from which it is evident that the fly is available in the plains almost all round the year. They were caught from places like Quilon (25 metres) and Moirang (1,000 metres).

TABLE 1.—The distribution of *O. fusidentata* in India.

| Locality | State | Occurrence |
|---|---|---|
| Agra | (U. P.) | February-May and July to middle of November |
| Aligarh | (U. P.) | July, August |
| Band Baretha | (Rajasthan) | September |
| Bangalore | (Karnataka) | January |
| Bharatpur | (Rajasthan) | November |
| Coimbatore | (Tamil Nadu) | December |
| Delhi | (Delhi) | August, September |
| Garampani | (Assam) | May |
| Gorakhpur | (U. P.) | October |
| Gwalior | (M. P.) | February |
| Haflong | (Assam) | April |
| Kanpur | (U. P.) | August, September |
| Kohima | (Naga Land) | May |
| Kottarakara | (Kerala) | January |
| Ludhiana | (Punjab) | May |
| Mathura | (U. P.) | April, May |
| Miraj | (Karnataka) | January |
| Moirang | (Manipur) | May |
| Quilon | (Kerala) | June |
| Sirsi | (Karnataka) | January |
| Thumpamon | (Kerala) | December, January & May-July |
| Thiruvalla | (Kerala) | June, July |
| Trichur | (Kerala) | June |
| Trivandrum | (Kerala) | July |

For observing copulation the flies were separated into pairs immediately after emergence. The mating takes place within two to six days after emergence. In one instance (Table 2 ; pair E) it was observed only on the ninth day after emergence. They copulate between 0900 and 1800 hrs. There is no instance of copulation occurring at night. Instances of copulation a second time were also noticed as in the case of pair H. Nishijima (1960) reported the occurrence of copulation in *Meromyza satatrix* (L.) "within two days after emergence". Parker (1918) in *Chloropisca glabra* Meigen could observe mating only several weeks after emergence. Hall (1932) in *Hippelates pusio* Loew is silent on this aspect.

The male of a pair kept in jar is not attracted to the female on the first day after emergence. Just before copulation the female remains at one place, vibrating its wings. The male comes closer and moves around, then mounts the female and holds the latter near the base of the wings by the fore legs. The second pair of legs are used in holding

the female's abdomen while the hind pair remains on the substratum or on the leaf. The male bends its abdomen downwards, forming approximately an angle of 90°, and the genitalia are extended into the female genital chamber. The abdomen of the female is slightly raised apically due to the insertion of the male copulatory organs. All these show that the mating is quite similar to that of other Acalypterate flies. The copulation goes on, if undisturbed, and the maximum time of copulation noticed in *O. fusidentata* is 2 hours 10 minutes (Table 2; pair J).

TABLE 2.—The emergence and the duration of copulation in 10 pairs of *O. fusidentata* under normal laboratory conditions (20-30° C and 30-36% R, H.) in March, 1968.

| Pair | Date of emergence in March 1968 | Copulation | | | Duration of copulation |
|---|---|---|---|---|---|
| | | Date | Time | | |
| | | March 1968 | From hrs. | To hrs. | |
| A | 17 | 21 | 0920 | 1010 | 50 mts. |
| B | 15 | 19 | 1600 | 1707 | 1 hr. 7 mts. |
| C | 15 | 18 | 1530 | 1700 | 1 hr. 30 mts. |
| D | 16 | 18 | 1100 | 1235 | 1 hr. 35 mts. |
| E | 16 | 25 | 1400 | 1510 | 1 hr. 10 mts. |
| F | 17 | 19 | 1030 | 1155 | 1 hr. 25 mts. |
| G | 15 | 19 | 1125 | 1300 | 1 hr. 35 mts. |
| H | 17 | 19 | 1500 | 1645 | 1 hr. 45 mts. |
| | | 21 | 1100 | 1205 | 1 hr. 5 mts. |
| I | 15 | 19 | 1100 | 1250 | 1 hr. 50 mts. |
| J | 16 | 19 | 1400 | 1610 | 2 hrs. 10 mts. |

and the minimum 50 minutes (pair A). Nishijima (1960) in *M. saltatrix* (L.) observed it lasting from four to forty seven minutes only. After a successful mating the two separate, the female remains on the spot for some time while the male flies away.

*Pre-oviposition*

The female rests for a few days after copulation before starting to oviposit. During this time it feeds on honey and sugar solution and flies around in the jar. In *O. fusidentata* the pre-oviposition period varies from two to five days under normal laboratory conditions (Table 4). In *M. saltatrix* also Nishijima (1960) noticed the pre-oviposition period lasting for two to three days.

*Oviposition*

As the time for oviposition comes nearer the fly becomes restless and starts flying vigorously within the cage surveying the suitable site for

egg-laying. Mostly the eggs are laid on the inside of the sheathing leaf at the base of the main stem. The fly takes about twenty to forty seconds to lay an egg, then it moves about, comes again after two minutes or more to lay the next egg which in most cases is laid very near to the former. Thus in some cases as many as ten to fifteen eggs, arranged in three to four rows, are laid very close together. The micropyles are usually directed towards the apical ends of the plants if the eggs are laid on the main stem, in the distal end of the blade away from the main stem, or the sheathing leaf of the main stem. But the eggs are also laid with their micropylar ends directed slightly downwards if laid at the junction of the blade and the sheathing leaf. This may be to facilitate the larva coming down through the sheath to bore into the stem. In this it differs from *M. saltatrix* where Nishijima (1960) observed the micropyle being always directed upwards. After each egg is laid the female cleans her ovipositor with her hind legs.

They show definite preference in selecting the place of oviposition for the maximum number of eggs are laid in the dried up or drying up leaf sheath, mostly at the basal part of the stem (Table 3). This protects the eggs from direct exposure to the atmosphere when the eggs are laid outside in the open field. Moreover the humidity here would be more than in any other exposed part of the plant.

TABLE 3.—The number and percentage of eggs laid on different parts of the plant.

| No. of eggs land | On leaf blade | on exposed stem | On the blade at the junction of stems | In the leaf sheath | On the tube in which grass is planted |
|---|---|---|---|---|---|
| 1298 | 196 | 30 | 56 | 1003 | 13 |
| Percentage | 15.10 | 2.3 | 4.31 | 77.27 | 1 |

Presumably the few eggs laid on the glass tube is accidental.

*Number of eggs and oviposition period*

Since the eggs are laid singly and the oviposition period lasts for two weeks or more it is not easy to ascertain the exact number of eggs laid in the field by a single fly. In the laboratory the female laid on an average forty eggs (Table 4) during the entire oviposition period which ranged from nine to seventeen days. The maximum number on record is 57 (Fly H) and the minimum 25 (Fly E). However a number of eggs (10-15) were found unovulated in the ovaries which were observed on dissecting out the females which had died in the jar after normal egg-laying. The diet of the fly did not greatly affect the oviposition rate nor

TABLE 4.—The emergence, copulation, pre-oviposition, oviposition post-oviposition and longevity of 10 pairs of *O. fusidentata* un conditions (20-30° C and 30-36% R. H.) in March—April, 1968.

| Pair | Date of emergence | Date of copulation | Pre-ovi position | Oviposition, Date | | | | | | | | | | | | | | | | Total no. of eggs | Post-oviposition |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | March | | | | | | | | | | April | | | | | | | |
| | March '1968 | March 1968 | (days) | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 1 | 2 | 3 | 4 | 5 | 6 | | (days) |
| A | 17 | 21 | 4 | — | — | — | — | 3 | — | 4 | — | — | 16 | — | 7 | 5 | — | 3 | 2 | — | 40 | 4 |
| B | 15 | 19 | 3 | — | 5 | 6 | — | — | 10 | — | 7 | — | — | — | 6 | — | 4 | — | — | — | 38 | 5 |
| C | 15 | 18 | 3 | 3 | — | 6 | 11 | — | — | — | 4 | — | 4 | — | 3 | — | 3 | — | — | — | 34 | 6 |
| D | 16 | 18 | 4 | — | 5 | — | — | 17 | — | 6 | 5 | — | — | 4 | — | 2 | — | — | — | — | 39 | 3 |
| E | 16 | 25 | 2 | — | — | — | — | — | — | 4 | — | 9 | 5 | — | 4 | — | — | 3 | — | — | 25 | 2 |
| F | 17 | 19 | 2 | 4 | 5 | — | 21 | — | — | 6 | — | 5 | 4 | — | 4 | 3 | 2 | — | 1 | — | 55 | nil |
| G | 15 | 19 | 2 | 5 | — | — | 6 | — | 6 | — | 12 | 8 | 5 | — | — | — | 3 | — | 2 | 2 | 49 | 4 |
| H | 17 | 19 & 21 | 5 | — | — | — | 4 | — | 6 | — | 19 | 9 | — | 7 | — | 5 | 4 | 3 | — | — | 57 | 1 |
| I | 15 | 19 | 3 | — | 3 | — | — | 12 | — | 5 | — | 4 | 3 | — | — | 2 | — | — | — | — | 29 | 4 |
| J | 16 | 19 | 5 | — | — | — | 7 | — | 13 | — | — | 5 | 4 | — | 4 | — | — | — | — | — | 33 | 5 |

Average No. of eggs laid is 40.

der normal laboratory

| Died | | Longevity | | Average longevity | |
|---|---|---|---|---|---|
| ♂ | ♀ | ♂ (days) | ♀ (days) | ♂ | ♀ |
| 3.4.68 | 9.4.68 | 17 | 23 | | |
| 2.4.68 | 8.4.68 | 18 | 24 | | |
| 3.4.68 | 9.4.68 | 19 | 25 | | |
| 3.4.68 | 5.4.68 | 18 | 20 | 18 days | |
| 2.4.68 | 6.4.68 | 17 | 21 | 22 days. | |
| 4.4.68 | 5.4.68 | 18 | 19 | | |
| 4.4.68 | 10.4.68 | 20 | 26 | | |
| 4.4.68 | 5.4.68 | 18 | 19 | | |
| 30.3.68 | 6.4.68 | 15 | 22 | | |
| 5.4.68 | 6.4.68 | 20 | 21 | | |

the number of eggs laid. Three flies fed purely on water alone laid on an average as many as 36 eggs, the number not varying much from the average for those that were fed on a solution of sugar and honey. This observation tallies with that of Horber (1950) on *Chlorops pumilionis* where he noticed a single fly, kept with water alone, laying as many as 97 eggs. Nishijima (1960) also could not observe much influence of the diet on the egg-laying in *M. saltatrix* (L.)

*Rate of egg-laying*

The flies laid a maximum of 21 and a minimum of 1 egg a day at normal laboratory conditions (Table 4). The rate of egg-laying progressively rises until it touches an all time maximum for the entire period towards the second half of the first week after which there is a steep fall (Table 4). This trend is continued throughout the remaining oviposition period.

Another significant feature is the relation between the sudden spurt in the egg-laying, together with the number of eggs laid, and the longevity of the flies. The flies F & H (Table 4) lived for only 19 days and in their case there was a steep rise in the egg-laying rate. Again they had laid the maximum number of eggs.

## The egg

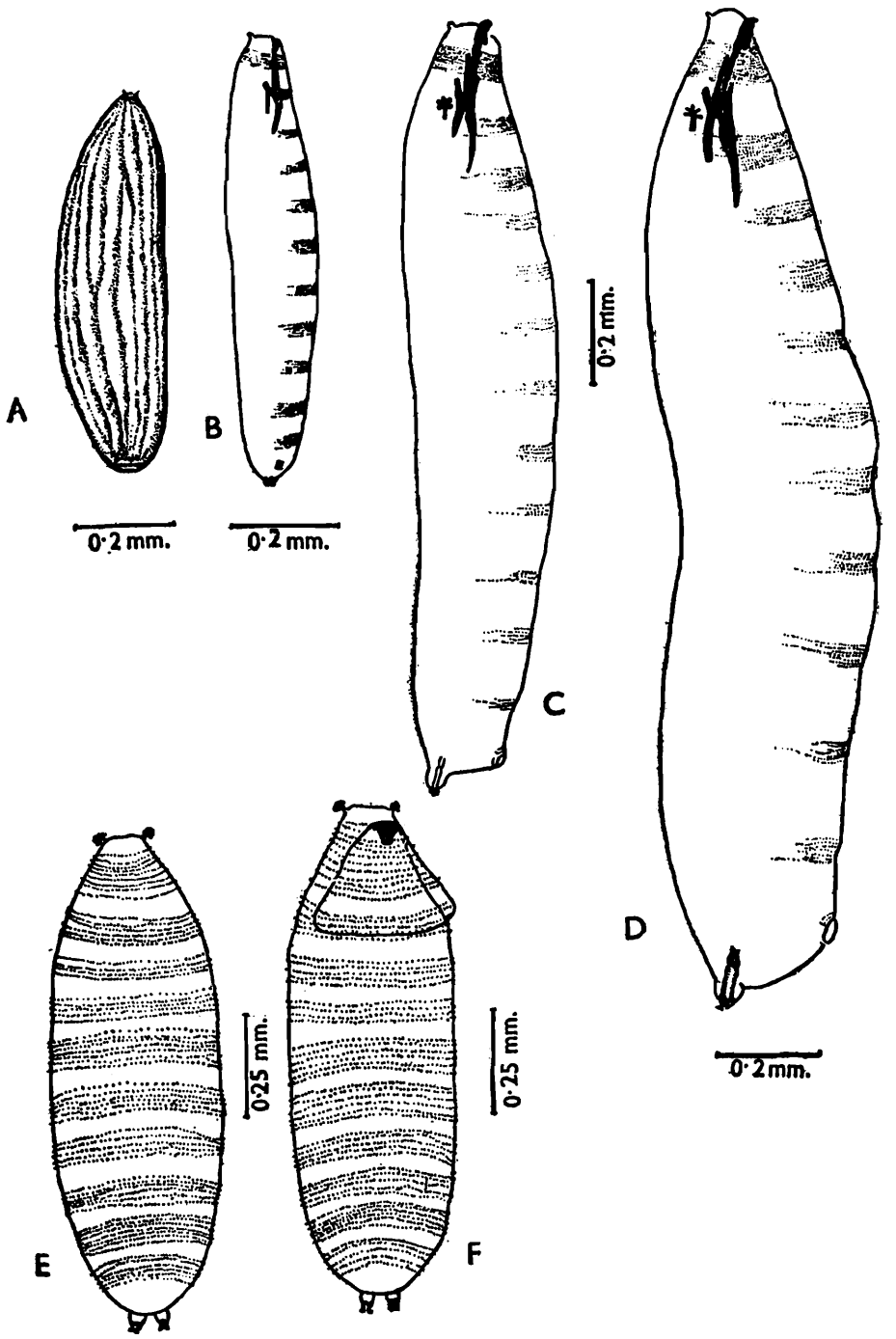
The freshly laid egg (Text-fig. 2A) of *O. fusidentata* is snow-white and is cylindrical-fusiform. It is slightly sickle or crescent-shaped. The egg is striated and sculptured with the terminal micropylar area on the asymmetrically tapered apex. The chorion is raised in longitudinal ridges, these approximately number 14 to 16, most of which extend the whole length but some end abruptly. The space between the ridges is concave but it is not marked off into rectangular areas by transverse ridges as described in *M. saltatrix* (L.) (Nishijima, 1960) and *Chloropisca glabra* Meigen (Parker, 1918) and under the present investigations observed in *Tropidoscinis indicus* Cherian. The microphyle is a cup-shaped structure traversed by small micropylar canals converging to a point internally. The micropyle measures from 0·032 to 0.036 mm in diameter. The length of the egg varies from 0.75 to 0.91 mm. At its broadest portion the egg measures about 0.17 to 0.28 mm.

It is not always easy to distinguish isolated eggs of *O. fusidentata* from those of *T. indicus* Cherian which are laid on the same host plant but the following characteristics may be helpful in differentiating the eggs of the two species.

| | *O. fusidentata* Cherian | *T. indicus* Cherian |
|---|---|---|
| 1. | Length 0.75 – 0.91 mm | Length 0.5 – 0.6 mm |
| 2. | Micropyle on asymmetrically tapered apex. | Both ends almost equally blunt. |
| 3. | Eggs long, slightly crescentic. | Short and blunt. |
| 4. | Transverse ridges connecting the longitudinal ridges absent. | Transverse ridges present ; these divide the chorion into rectangular areas. |
| 5. | Micropyle cup-shaped and the cup distinctly projecting outside. | Micropyle rounded, not distinctly projecting outside. |

### *Hatching*

The glistening, snow-white, freshly laid egg becomes milky-white




Text-fig. 2—*O. fusidentata*, A – Egg, B—First instar larva, C—Second instar larva, D—Third instar larva, E—Pupa, F—Puparium.

within 12 to 15 hours after oviposition. It is attached to the plant by a cementing material, which can withstand slight shakes and make the eggs remain in position. The first internal organ to make its appearance is the cephalo-pharyngeal skeleton, which is visible within 28 to 34 hours after oviposition. Later the posterior spiracles and tracheae of the posterior region make their appearance. Very slow movements of the skeleton are discernable through the chorion at this stage. Segmentation of the developing larva is noticeable.

At the time of hatching a split is observed at the micropylar end, partly splitting the micropyle which may extend to about one-fourth the length of the egg. Through this split the mouth parts of the larva begin to come out and the larva exhibits elastic movements, shaking its body sideways. The movements last usually for about eight minutes. but at times is prolonged for about half an hour and the larva finds its way out of the egg shell. However those larvae that try to hatch under dry conditions fail to escape completely and die.

One interesting phenomenon which attracted the attention is the strict periodicity of hatching. The larvae, under the present observations, always hatched between 2.00 and 6.00 A. M. Under varying conditions of temperature and humidity in the laboratory they did not hatch during day time. Similar observation is reported by Nishijima (1960) in *M. saltatrix* (L.) Workers like Japson and Southwood (1960), Goodliffe (1942), Parker (1918), Nishijima (1960) and Hall (1932) are silent on the fate of the egg shell. In *O. fusidentata* they were found remaining on the spot even a day or two after hatching so that a dried up egg and an egg from which the larva had come out were distinguishable only by the slit in the anterior part of the egg shell in the latter.

*Incubation period*

The eggs are very sensitive to the amount of moisture. Deficiency of moisture is very detirmental to its development and lack of moisture even for short intervals is fatal. Submergence of the egg in tap water upto 24 hours is not fatal but if the eggs are kept in water for a longer period they do not hatch. This observation differs from that of Jepson and Southwood (1960) who got the eggs of *Elachiptera cornuta* and *Oscinella frit* hatched when allowed to remain in tap water at laboratory temperature for three to four days. In *O. fusidentata* at 25°C and 70—90% R. H. the maximum incubation period on record is 5 days 11 hours and 8 minutes while the minimum is 4 days 10 hours and 30 minutes with an average of 4 days 18 hours and 39 minutes (Table 5).

TABLE 5.—Average incubation period of the eggs of *O. fusidentata* at 25°C. and 70-90% R. H.

| Egg-laying Date Time | Hatching Date Time | Incubation period days | hrs. | mts. | Average |
|---|---|---|---|---|---|
| 23.4.1968 1655 hrs. | 28.4.1968 0325 hrs. | 4 | 10 | 30 | |
| 23.4.1968 1700 hrs. | 28.4.1968 0525 hrs. | 4 | 12 | 25 | |
| 23.4.1968 1530 hrs. | 28.4.1968 0437 hrs. | 4 | 13 | 7 | 4 days |
| 23.4.1968 0925 hrs. | 28.4.1968 0440 hrs. | 4 | 19 | 15 | 18 hrs & 39 mts. |
| 23.4.1968 1015 hrs. | 28.4.1968 0450 hrs. | 4 | 18 | 35 | |
| 24.4.1968 1720 hrs. | 30.4.1968 0325 hrs. | 5 | 10 | 5 | |
| 24.4.1968 1652 hrs. | 30.4.1968 0400 hrs. | 5 | 11 | 8 | |
| 27.4.1968 1145 hrs. | 2.5.1968 0430 hrs. | 4 | 16 | 45 | |
| 27.4.1968 1800 hrs. | 2.5.1968 0530 hrs. | 4 | 11 | 30 | |
| 27.4.1968 1320 hrs. | 2.5.1968 0430 hrs. | 4 | 15 | 10 | |

TABLE 6.—The average incubation period of *O. fusidentata* eggs at 30° C. and 70-90% R. H.

| Egg-laying Date Time | Hatching Date Time | Incubation period days | hrs. | mts. | Average |
|---|---|---|---|---|---|
| 18.4.1968 1448 hrs. | 21.4.1968 0500 hrs. | 2 | 14 | 12 | |
| 18.4.1968 1745 hrs. | 22.4.1968 0355 hrs. | 3 | 10 | 10 | |
| 18.4.1968 1415 hrs. | 21.4.1968 0335 hrs. | 2 | 13 | 20 | 3 days |
| 19.4.1968 0915 hrs. | 22.4.1968 0420 hrs. | 2 | 19 | 5 | 2 hrs & 31 mts. |
| 19.4.1968 1040 hrs. | 22.4.1968 0500 hrs. | 2 | 18 | 20 | |
| 19.4.1968 1248 hrs. | 22.4.1968 0530 hrs. | 2 | 16 | 42 | |
| 20.4.1968 1630 hrs. | 24.4.1968 0220 hrs. | 3 | 9 | 50 | |
| 20.4.1968 1624 hrs. | 24.4.1968 0340 hrs. | 3 | 11 | 16 | |
| 20.4.1968 0810 hrs. | 24.4.1968 0425 hrs. | 3 | 20 | 15 | |
| 20.4.1968 1510 hrs. | 24.4.1968 0310 hrs. | 3 | 12 | | |

At 30°C and under same conditions of R. H. eggs took a maximum of 3 days, 20 hours and 15 minutes and a minimum of 2 days, 13 hours and 20 minutes, with the average working round to 3 days, 2 hours and 31 minutes, to hatch (Table 6). From this it is evident that the duration of the egg stage is shortened by the rise of temperature. Hall (1932) in *Hippelates pusio* has reported a maximum incubation period of 30 days and a minimum of 2 days with an average of 3.7 days. In *M. saltatrix* (L.) Nishijima (1960) observed a maximum of 16.5 days at 15°C. and a minimum of 3.9 days at 30°C.

*Egg viability*

From the observation it is evident that the egg viability depends on humidity. The percentage of hatching shows a remarkable decline in proportion to the lowering of R. H. (Table 7). A very steep fall in the rate of hatching is noticeable below 70% R. H. Eggs kept under normal laboratory conditions never hatched showing that humidity is the important factor determining the percentage of hatching. It is evident from Table 7 that hatching is more controlled by humidity than temperature though the latter determines the incubation period (Tables 5 & 6.)

TABLE 7.—The hatching percentage of the eggs of *O. fusidentata* at different temperature and humidity.

| Temperature | Humidity 50—60% | | Humidity 70—80% | | Humidity 90—100% | |
|---|---|---|---|---|---|---|
| | No. of eggs kept. | Hatched (%) | No. of eggs kept. | Hatched (%) | No. of eggs kept. | Hatched (%) |
| 25°C | 30 | 20 | 30 | 70 | 30 | 83 |
| 30°C | 30 | 30 | 30 | 77 | 30 | 90 |

## Duration of larval stadia

The newly emerged larva finds its way into the stem and starts feeding on the contents. Under normal conditions the change from the first instar to the second and from the second instar to the third takes place inside the stem itself. The contents of one stem are more than sufficient to see the larva through upto pupation. In most cases the larvae pupated within the stem but instances are on record to show that they pupate at times outside the stem within the leaf-sheath.

In the present observation, under laboratory conditions ($27 \pm 3$°C and 70—80% R. H.), the whole larval period ranges from 9 days 7 hours to 12 days 13 hours as is evident from Table 8. But those first instar larvae which were allowed to enter in the stems infested by some larvae of an

*Atherigona* sp., the details of which are given elsewhere, took only 7 days 5 hours and 40 minutes to 8 days 12 hours for completing the larval development (Table 9). The reason for a steep fall in the duration in the latter instances may perhaps be attributed to the availability of ready made food, even for the first instar larva, to start with. Moreover the humidity in the decayed material in the stem may have helped in accelerating the rate of development. This is not the case with the one infesting a fresh stem for here it takes some for the contents of the stem to decay and raise the temperature and also provide food.

The influence of temperature and humidity on the duration of the larval period has been reported in some Chloropids. Hall (1932) in *Hippelates pusio* recorded a minimum of 5 days and a maximum of 46 days "the length of the larval period depending on the medium, the moisture present and the temperature". In *M. saltatrix* Nishijima (1960) observed a maximum of 37 days at 15°C and a minimum of 13 days at 30°C., the duration of the larval stadia shortening in proportion to the rise of temperature upto the optimum. In *Chloropisca glabra* Parker (1918) has reported a minimum of 9 days and a maximum of 20 days.

## DESCRIPTION OF INSTARS

*First instar*

*Measurements*—

Length 1.3 to 1.6 mm

Width 0.28 to 0.4 mm

The newly emerged first instar larva (Text-fig. 2B) is glistening white with very slender transparent and subcylindrical body tapering anteriorly and truncated posteriorly. Body divisible into head, three thoracic and eight abdominal segments, the segmental boundaries being only faint ; the antenna two segmented, a little longer than thick ; no trace of the anterior spiracles ; the posterior spiracles (Text-fig. 4O) borne on two spiracular lobes, each with a truncated apex. There are three stigmatic openings (80) on each lobe, bearing four branched processes (Text-figs. 4C, D ; BH) typical of the larvae of Oscinellinae (Jepson and Southwood, 1960). The spiracular lobes are separated by about 0.024 mm. The absence of anterior spiracles and the relatively feeble cephalo-pharyngeal skeleton serve to distinguish it from the succeeding instars.

The cephalo-pharyngeal skeleton (Text-fig. 3A) varies in length from 0.2 mm to 0.27 mm with an average of 0.224 mm. It is brownish having two similar halves lying opposed to each other along its longitudinal axis. Each half comprises an anterior mouth-hook or mandibular-hook (MH) and the posterior pharyngeal sclerite (PS) with a small, heavily tanned, piece in between. The mouth-hooks, measuring 0·05 mm, are sickle-shaped structures bearing a large apical tooth followed by

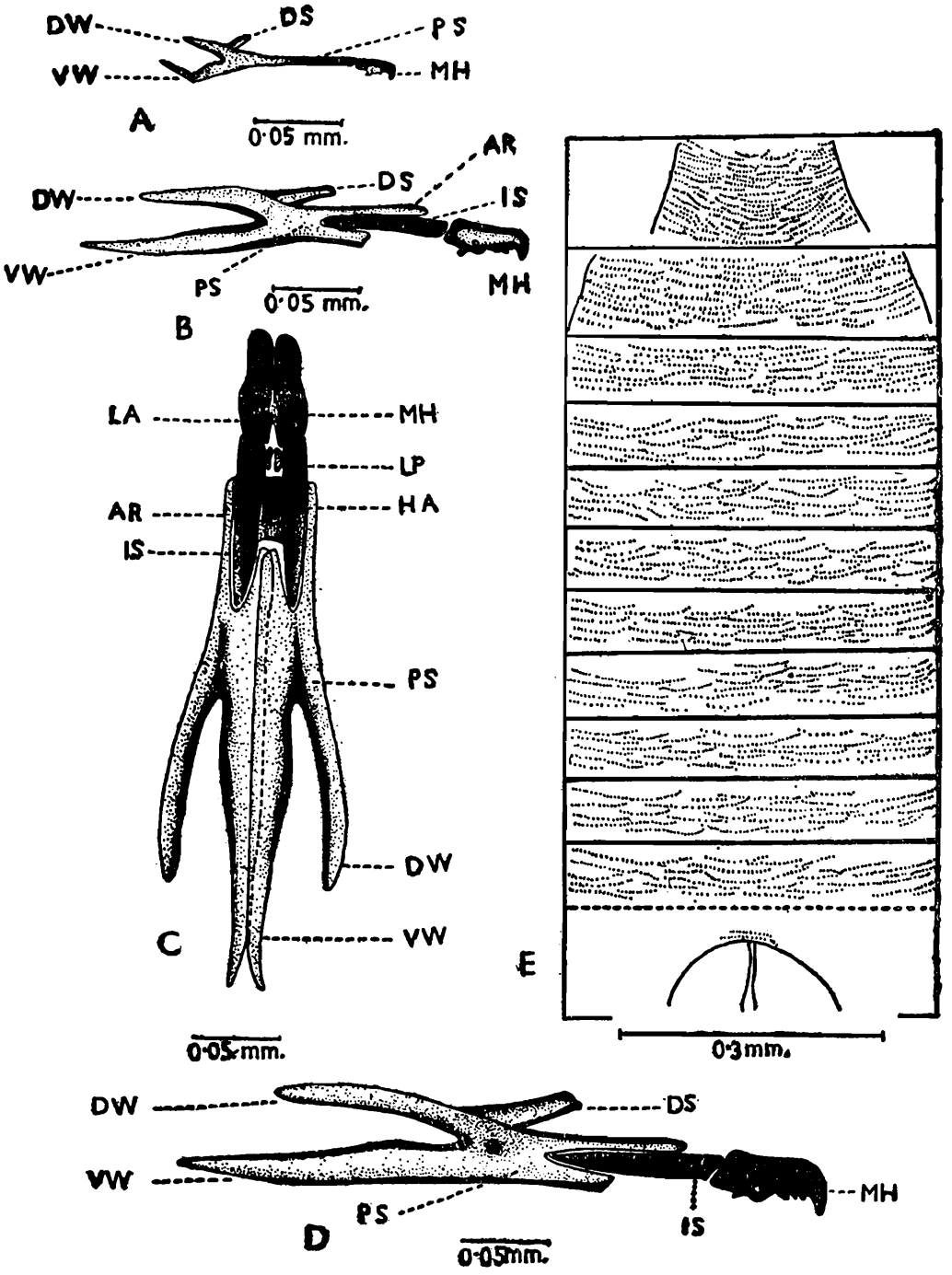
TABLE 8.—The duration of the larval period of *O. jusidentata* at 27° C.±3° C. and 70-80% R. H.

| Larvae hatched Date / Time | Pupated Date / Time | Duration days | hrs. | mts. | Average |
|---|---|---|---|---|---|
| 16.4.1968 0425 hrs. | 27.4.1968 1330 hrs. | 11 | 9 | 5 | |
| 16.4.1968 0315 hrs. | 26.4.1968 1100 hrs. | 10 | 7 | 45 | |
| 16.4.1968 0400 hrs. | 28.4.1968 1040 hrs. | 12 | 6 | 40 | |
| 16.4.1968 0424 hrs. | 27.4.1968 1700 hrs. | 11 | 12 | 36 | 11 days |
| 16.4.1968 0320 hrs. | 28.4.1968 1620 hrs. | 12 | 13 | | 3 hrs. & 22 mts. |
| 17.4.1968 0530 hrs. | 27.4.1968 1225 hrs. | 10 | 6 | 55 | |
| 17.4.1968 0420 hrs. | 26.4.1968 1140 hrs. | 9 | 7 | 20 | |
| 17.4.1968 0510 hrs. | 28.4.1968 1645 hrs. | 11 | 11 | 35 | |
| 17.4.1968 0530 hrs. | 28.4.1968 1830 hrs. | 11 | 13 | | |
| 17.4.1968 0400 hrs. | 27.4.1968 2144 hrs. | 10 | 17 | 44 | |

TABLE 9.—The duration of the larval period of *O. fusidentata* in the stem infested or left over by the larvae of *Atherigona* sp.

| Larvae hatched Date / Time | Pupated Date / Time | Duration days | hrs. | mts. | Average |
|---|---|---|---|---|---|
| 14.4.1968 0230 hrs. | 22.4.1968 1330 hrs. | 8 | 11 | | |
| 14.4.1968 0440 hrs. | 22.4.1968 1430 hrs. | 8 | 9 | 50 | 4 days |
| 15.4.1968 0330 hrs. | 22.4.1968 1820 hrs. | 7 | 14 | 50 | 2 hrs. |
| 15.4.1968 0500 hrs. | 22.4.1968 2122 hrs. | 7 | 16 | 22 | |
| 15.4.1968 0430 hrs. | 23.4.1968 1630 hrs. | 8 | 12 | | |
| 16.4.1968 0332 hrs. | 24.4.1968 1120 hrs. | 8 | 7 | 48 | |
| 16.4.1968 0435 hrs. | 23.4.1968 1005 hrs. | 7 | 5 | 40 | |
| 14.4.1968 0450 hrs. | 24.4.1968 1520 hrs. | 8 | 10 | 30 | |

two accessory cusps. The pharyngeal sclerites are very slender with the anterior prolongations measuring more than half of its length. The dorsal sclerite (DS) is faintly tanned and ends bluntly.




Text-fig. 3.—*O. fusidentata,* A—Cephalo-pharyngeal skeleton of first instar larva, B—Cephalo-pharyngeal skeleton of second instar larva, C & D—Cephalo-pharyngeal skeleton of third instar, E—Ventral spicules of third instar larva.

The pharyngeal sclerite bifurcates posteriorly giving rise to the dorsal (DW) and ventral wings (VW). The ventral arm is pointed posteriorly and is turned inwards, with a wing process (WP) nearer to the proximal end, whereas the dorsal arm tapers off. There is no intermediate sclerite but the small heavily tanned piece which is seen between the mandibular-hook and the pharyngeal sclerite is probably the precursor

of the intermediate sclerite of later instars. The whole cephalo-pharyngeal skeleton is lightly tanned except for the anterior ends of the pharyngeal sclerites and the posterior ends of the mouth-hooks. The dentate sclerite is not visible. The anus is seen as a slit-like opening on the ventral side of the last adbominal segment.

Spicular zones.—Ventral distribution :

Thoracic 1 : Many broken rows (13-15) of closely set very small spicules.

Thoracic 2 & 3 : 5-6 rows of fine spicules as preceding.

Abdominal 1 : 7-8 rows of closely set small spicules of uniform size.

Abdominal 2-8 : About 9—10 transverse rows of small spicules forming almost an elleptical figure in each segment. All are of uniform size.

The duration of the first instar larva varies from 1 day 23 hrs. to 3 days 1 hr. and 40 mts. with an average of 2 days 6 hrs. and 20 mts. as shown in table 10. After entering the stem the larva starts feeding only after some time.

*Second instar*

*Measurements*— Length : 1.96 to 2.6 mm

Width : 0·46 to 0.53 mm

The second instar larva (Text-fig. 2C) is whitish-yellow and can easily be distinguished from the first by the presence of the anterior spiracles (Text-fig. 4 A). These are fan-shaped structures projecting laterally from the posterior margin of the first thoracic segment. The number of digitate processes varies from four to five.

The posterior spiracles (Text-fig. 4E) are lodged on characteristic spiracular lobes projecting from the posterior end of the last abdominal segment. It is slightly more clearly marked off from the general body surface than in the first instar. In almost all other details it is nothing but an enlarged version of the spiracle of the first instar larva, with three stigmatic openings and four groups of branched hairs (BH).

*Cephalo-pharyngeal skeleton* (Text-fig. 3B) :

It is long, rather better developed, than in the first instar larva and varies in length from 0.31 to 0.4 mm. The mouth-hook (MH) measures about 0.072 mm and has a foramen in the posterior half. The apical tooth is followed by three smaller teeth, the first of them being the smallest. Posteriorly each mouth-hook articulates with an intermediate sclerite (IS) which has developed conspicuously by now. It is 0.112 mm

TABLE 10.—The duration of the first instar larva at 27°±3° C. and 70-90% R. H.

| Larva hatched on Date Time | Changed into second inster Date Time | Duration of first instar days | hrs. | mts. | Average duration |
|---|---|---|---|---|---|
| 14.4.1968 0430 hrs. | 16.4.1968 0730 hrs. | 2 | 3 | | |
| 14.4.1968 0400 hrs. | 16.4.1968 1600 hrs. | 2 | 12 | | |
| 14.4.1968 0520 hrs. | 16.4.1968 0600 hrs. | 2 | | 40 | 2 days |
| 14.4.1968 0330 hrs. | 16.4.1968 0940 hrs. | 2 | 6 | 10 | 6 hrs. & 20 mts. |
| 15.4.1968 0450 hrs. | 18.4.1968 0630 hrs. | 3 | 1 | 40 | |
| 15.4.1968 0500 hrs. | 17.4.1968 0400 hrs. | 1 | 23 | | |
| 15.4.1968 0320 hrs. | 17.4.1968 1210 hrs. | 2 | 8 | 50 | |
| 16.4.1968 0410 hrs. | 18.4.1968 1030 hrs. | 2 | 6 | 20 | |
| 16.4.1968 0440 hrs. | 18.4.1968 0650 hrs. | 2 | 2 | 10 | |
| 16.4.1968 0430 hrs. | 18.4.1968 0400 hrs. | 1 | 23 | 30 | |

long and is encased partly in the extensions of pharyngeal sclerites (PS), the atrial rod (AR) above roofing about three-fourths its length and another prolongation of the ventral wing beneath. Each side of the pharyngeal sclerite is divided into a dorsal wing and a ventral wing. The dorsal sclerite (DS), projecting from the pharyngeal sclerite and ending bluntly anteriorly, is well tanned.

*Spicular zones.*—

Thoracic 1 : 15 to 18 irregular rows of small, fine and uniform spicules extending the whole length of the ventral side.

Thoracic 2 : 8 to 9 broken rows of uniform, fine, irregular, but more regular than those of the first zone, spicules extending almost the entire length of the ventral side.

Thoracic 3 : 9 to 10 rows as preceding.

Abdominal 1 : 8 rows of very fine uniform spicules.

Abdominal 2-8 : 4 to 5 broken rows of small uniform spicules, not extending the whole length of the ventral side.

Anal zone : 2 very small rows of pre-anal and 1 row of post-anal spicules.

The segmental boundaries of the larva are more clearly marked off than in the first instar. The anus is seen as a slit-like opening midventrally on the last abdominal segment. The colour of the larva turns yellowish due to its feeding on the decaying contents of the stem. The duration of the second instar, at 27°±3°C. and 70—90% R. H., varies from 3 days 8 hrs. and 10 mts. to 4 days 7 hrs. and 40 mts. with the average 3 days 19 hours and 21 mts. (Table 11).

*Third instar*

*Measurements*— Length : 3·0—4.5 mm

Width : 0·6—0·9 mm

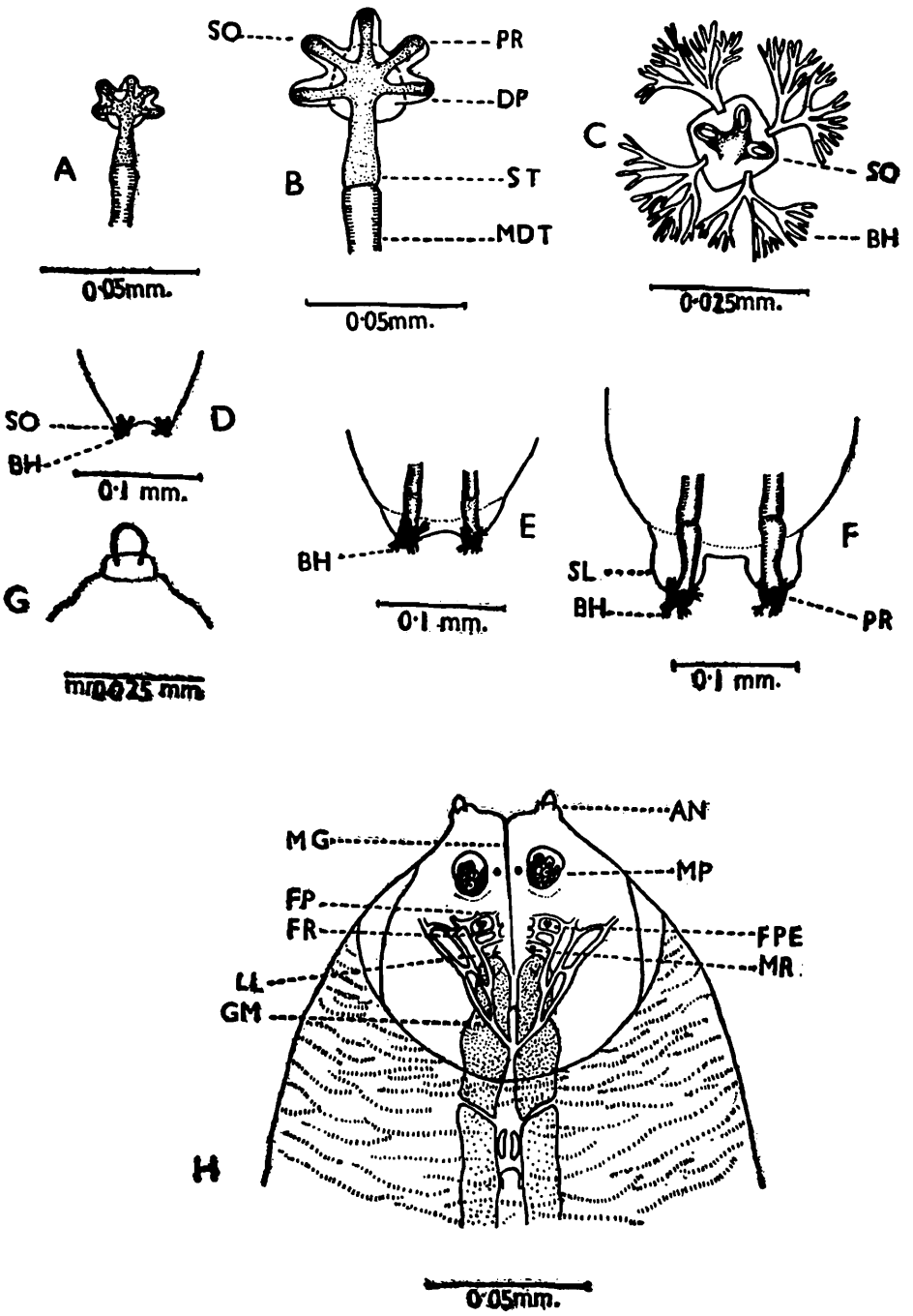
The third instar larva (Text-fig. 2D), the colour of which varies from creamy white to pale yellow, is a typical *Oscinella* larva. Body is subcylindrical, narrow anteriorly and truncated posteriorly, with twelve very distinct body segments.

TABLE 11.—The duration of the second instar larva of *O. fusidentata* at 27°±3° C. and 70-90% R. H.

| Second instar | Changed into 3rd instar | Duration of 2nd instar | | | Average duration |
|---|---|---|---|---|---|
| Date / Time | Date / Time | days | hrs. | mts. | |
| 18.4.1968 / 0730 hrs. | 21.4.1968 / 1820 hrs. | 3 | 10 | 50 | |
| 18.4.1968 / 0900 hrs. | 22.4.1968 / 1640 hrs. | 4 | 7 | 40 | |
| 19.4.1968 / 1130 hrs. | 23.4.1968 / 1310 hrs. | 4 | 1 | 40 | |
| 20.4.1968 / 0715 hrs. | 23.4.1968 / 1735 hrs. | 3 | 10 | 20 | 3 days |
| 20.4.1968 / 1740 hrs. | 24.4.1968 / 1800 hrs. | 4 | | 20 | 19 hrs & 21 mts. |
| 22.4.1968 / 1445 hrs. | 26.4.1968 / 1520 hrs. | 4 | | 35 | |
| 21.4.1968 / 0950 hrs. | 25.4.1968 / 1225 hrs. | 4 | 2 | 35 | |
| 22.4.1968 / 0600 hrs. | 25.4.1968 / 1745 hrs. | 3 | 11 | 45 | |
| 22.4.1968 / 1018 hrs. | 25.4.1968 / 1828 hrs. | 3 | 8 | 10 | |
| 22.4.1968 / 1400 hrs. | 26.4.1968 / 0935 hrs. | 3 | 19 | 35 | |

*Facial mask* (Text-fig. 4H) : Head is anteriorly divided by a median groove (MG), extending almost upto the mouth-hook, into halves. Each half is surmounted by a two segmented antenna (Text-figs. 4G. & H ; AN).

Maxillary palps (MP), one on each side, are well tanned and are of the open type. Each ring contains 5 papillae with a further pair lying antero-laterally just at its open end. Lying between the maxillary palp and the mouth-hook is the frontal palp (FP) which is comprised of three cells, the frontal papillae (FPE). Between the maxillary palps there is pair of




Text-fig. 4—*O. fusidentata*, A—Anterior spiracle of second instar larva, B—Anterior spiracles of third instar larva, C—Posterior spiracle (enlarged) of first instar larva, D—Posterior spiracle of first instar larva, E—Posterior spiracle of second instar larva, F—Posterior spiracle of third instar larva, G—Antenna of third instar larva, H—Facial mask of third instar larva.

prefrontal papillae, one on eaeh side. Immediately anterior to the mouth-hocks are the labral lobes (LL) which appear to assist in the chanelling of the food particles. Arising from each side of the mouth

opening and running antero-laterally is a pair of genal rami (GM), same as those observed by Nye (1958) in many species of *Oscinella*, which bifurcate and anastomose to form three cells on the jowls and one posterior to the frontal palp. On each side, between the frontal palps, there are two midfrontal rami (MR). The frontal rami (FR) border the three outer sides of the frontal palps. None of the rami or the cells is spiculate.

*Cephalo-pharyngeal skeleton* (Text-fig. 3C & 3D) : It varies in size from 0.57—0.63 mm and is an enlarged version of that of the second instar. Anteriorly there is a parir of mouth-hooks (MH) both working together in the vertical plane. Each mouth-hook is a heavily tanned blackish-brown structure with an apical tooth followed by four smaller teeth. There is a small foremen in the mouth-hook. Posteriorly each articulates with an intermediate sclerite (IS), the latter two are joined ventrally, nearer the anterior end, by a hypostomal arch (HA). Just above the arch a pair of liguloid plates (LP) are seen as small elongated, triangular pieces measuring about 0.02 mm. Anterior to these, but towards the posterior end of the mouth-hooks, a narrow liguloid arch (LA) is visible. The intermediate sclerite is heavily tanned anteriorly but becomes lightly tanned posteriorly before meeting the pharyngeal sclerite (PS). Each side of the pharyngeal sclerite is divided into a dorsal wing (DW) and a ventral wing (VW), the latter bearing the wing process on the inner aspect. There is an anterior prolongation of the ventral wing, the atrial rod (AR) over three-fourths the intermediate sclerite. Posteriorly part of the intermediate sclerite is floored also by the extention of the ventral wing. Fused to each pharyngeal sclerite, on each side, is a median dorsal sclerite (DS) which is tanned anteriorly. The whole of the pharyngeal sclerite is lightly tanned, being pale brown.

*Anterior spiracles* (Text-fig. 4B) : The anterior spiracles project from the posterior margin of the prothorax, in a plane at right angle to the long axis of the body. The main dorsal tracheal trunk (MDT) is continued into the spiracle as the spiracular trunk (ST). It is bulbous posteriorly but narrows before enlarging to form a spacious chamber from which projects the five digitate processes (DP). The spiracle is of the fan type. From the point where they project from the thorax the spiracles are loosely covered by a sheathing membrane reaching the end of the digitate processes where the chitin is thickened to form a peritreme (PR) surrounding the spiracular opening (SO).

*Posterior spiracles* (Text-fig. 4F) : They are borne on spiracular lobes (SL) separated by a distance of 0.07 mm. As in the anterior spiracle the spiracular trunk widens into a bulb and then narrows until it

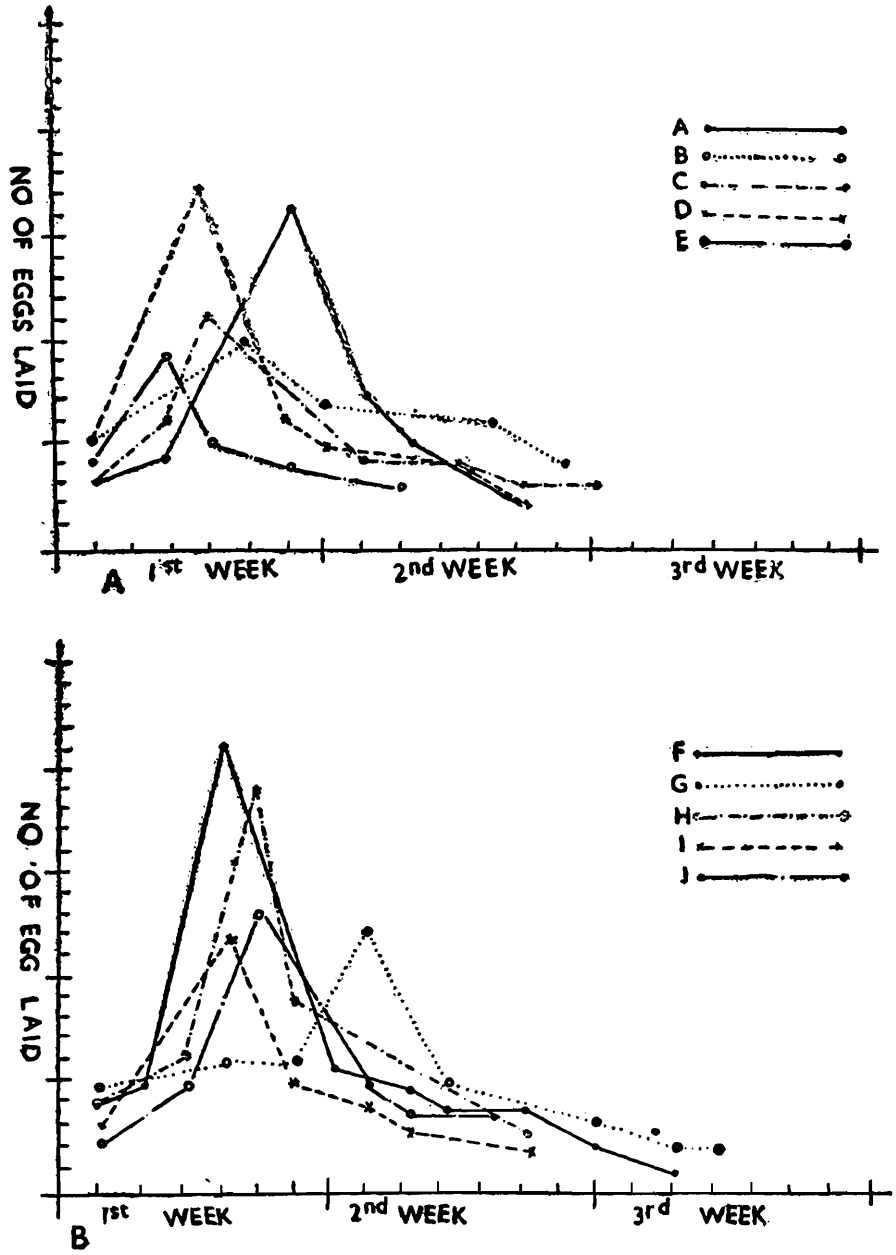
trifurcates. Each branch opens to the outside by a spiracular opening surrounded by the peritreme. From the cuticle between the peritremes (PR) there arise four tufts of branched hairs (BH).

The anus, in the form of a slit-like opening, is seen in the middle of the ventral side of the last abdominal segment.

Spicular zones (Text-fig. 3E) : Ventral distribution :

Thoracic 1 : 20-24 irregular broken rows of linearly grouped very small, pointed, uniform spicules.

Thoracic 2 : 12-15 irregular broken rows as preceding, extending the whole length of the ventral side.




Text-fig. 5.—Graphs showing the oviposition rates A—of flies A—E ; B—of flies F--J.

Thoracic 3 : 7-8 irregular broken rows of fine pointed uniform spicules.

Abdominal 1 : 10-12 irregular broken rows as preceding.

Abdominal 2-8 : 8-11 irregular broken rows as preceding but rarely extending the whole length of the ventral side.

Anal zone : 2 small rows of fine spicules anterior to and one row posterior to the anus.

The third instar larva, to start with, is little bigger than the second but after a day or so it grows rapidly, assuming double the size of the latter. It is found actively devouring the contents of the decaying stem. The cephalo-pharyngeal skeleton moves about 90 to 120 times a minute.

The duration of the third instar larvae varies from 4 days 2 hrs. and 25 mts. to 5 days 1 hr. and 35 mts. with an average of 4 days 10 hrs. and 42 mts. at 27°±3°C. and 70—90% R. H. (Table 12).

TABLE 12.—The duration of the 3rd instar larva of *O. fusidentata* at 27°±3° C. and 70-90% R. H.

| 3rd instar Date / Time | Pupated Date / Time | Duration of 3rd instar days | hrs. | mts. | Average duration |
|---|---|---|---|---|---|
| 23.4.1968 / 1730 hrs. | 28.4.1968 / 0820 hrs. | 4 | 14 | 50 | |
| 23.4.1968 / 1420 hrs. | 27.4.1968 / 1720 hrs. | 4 | 3 | | |
| 23.4.1968 / 1100 hrs. | 28.4.1968 / 1235 hrs. | 5 | 1 | 35 | |
| 23.4.1968 / 0825 hrs. | 27.4.1968 / 1635 hrs. | 4 | 8 | 10 | 4 days |
| 24.4.1968 / 1340 hrs. | 29.4.1968 / 0905 hrs. | 4 | 19 | 25 | 10 hrs. & 42 mts. |
| 24.4.1968 / 1555 hrs. | 28.4.1968 / 1820 hrs. | 4 | 2 | 25 | |
| 24.4.1968 / 1825 hrs. | 29.4.1968 / 0810 hrs. | 4 | 13 | 45 | |
| 25.4.1968 / 1125 hrs. | 29.4.1968 / 1650 hrs. | 4 | 5 | 25 | |
| 25.4.1968 / 0910 hrs. | 29.4.1968 / 1540 hrs. | 4 | 6 | 30 | |
| 25.4.1968 / 1015 hrs. | 29.4.1968 / 1810 hrs. | 4 | 7 | 55 | |

Key to larval instars

1. Anterior spiracles absent ... ... First instar
   Anterior spiracles present ... ... 2

2. Mouth-hook with a main tooth and three accessory cusps ; the posterior spiracular lobes not clearly marked off from the last body segment ; 15-18 broken rows of spicules in the first thoracic segment ... ... Second instar

Mouth-hook with a main tooth and four accessory cusps ; spiracular lobes clearly marked off from the last segment ; 20-24 broken rows of spicules in the first thoracic segment ... ... Third instar

## PUPATION

The mature larva crawls down and rests at a point usually just above the node of the stem. The larva stops feeding and becomes immobile. The fiirst signs of approaching pupation are sluggishness followed by a shortening of the body. The movement of the cephalo-pharyngeal skeleton is accelerated preparatory to the withdrawal of the head inside the body. This stage lasts for about 4—6 hours. The larval skin is not shed off but becomes the outer covering of the puparium. When the puparium is first formed it is pale white and through its transparent wall the tracheal trunks can still be seen.

*Pupa*

*Measurements*— Length : 3.0—3.4 mm

Width : 1.2—1.4 mm

The freshly formed yellow pupa (Text-fig. 2E) is usually seen in the stem a little above the node. The puparium formed partly out of the larval skin hardens with the passage of time and its colour changes to yellow and then, through different shades of brown, to deep brown.

The body surface is grooved by wavy transverse lines representing the spicular zones of the last instar larva. In this and some other details it retains some of the morphological characters of the larva. The anterior and posterior spiracles are practically in the same form as in the third instar.

The anterior end of the pupa is flattened dorsoventrally. The body is marked off into eleven segments, the first, three representing thorax and the rest abdomen, head portion being withdrawn into the prothoracic segment. It is from the prothoracic segment that the anterior spiracles, each measuring 0.07 mm, are seen projecting anteriorly. Segments from four to nine are almost equal and are wider than the rest. The following two segments narrows down abruptly, the last one bearing the prominent posterior spiracles. Each posterior spiracle is seen at the tip of a tubercle which is nearly as long (0.08 mm)

TABLE 13.—The average pupal duration of *O. fusidentata* at 27°±3° C. and 70-90% R. H.

| Pupated on Date Time | Emerged on Date Time | Duration days | Duration hrs. | Duration mts. | Average duration |
|---|---|---|---|---|---|
| 27.4.1968 0820 hrs. | 6.5.1968 0710 hrs. | 8 | 22 | 50 | |
| 27.4.1968 1720 hrs. | 7.5.1968 0640 hrs. | 9 | 13 | 20 | |
| 27.4.1968 1230 hrs. | 6.5.1968 1830 hrs. | 9 | 6 | | |
| 28.4.1968 1635 hrs. | 6.5.1968 0710 hrs. | 7 | 14 | 35 | |
| 28.4.1968 2150 hrs. | 7.5.1968 0655 hrs. | 8 | 21 | 5 | 8 days |
| 28.4.1968 0810 hrs. | 6.5.1968 0700 hrs. | 7 | 22 | 50 | 16 hrs. & 5 mts. |
| 28.4.1968 0620 hrs. | 8.5.1968 0615 hrs. | 9 | 11 | 55 | |
| 29.4.1968 1650 hrs. | 8.6.1968 0735 hrs. | 8 | 14 | 45 | |
| 29.4.1968 1730 hrs. | 8.5.1968 0630 hrs. | 8 | 13 | | |
| 29.8.1968 1115 hrs. | 7.5.1968 0745 hrs. | 7 | 20 | 30 | |

TABLE 14.—The average pupal duration of *O. fusidentata* under normal laboratory conditions (20°–30° C. and 30-36% R. H.).

| Pupated Date Time | Emerged Date Time | Duration days | Duration hrs. | Duration mts. | Average duration |
|---|---|---|---|---|---|
| 20.4.1968 1540 hrs. | 3.5.1964 0710 hrs. | 12 | 15 | 30 | |
| 21.4.1968 1620 hrs. | 5.5.1968 0615 hrs. | 13 | 13 | 55 | |
| 21.4.1968 1000 hrs. | 4.5.1968 0700 hrs. | 12 | 21 | | |
| 22.4.1968 1430 hrs. | 4.5.1968 0730 hrs. | 11 | 17 | | 12 days |
| 22.4.1968 1830 hrs. | 5.5.1968 0645 hrs. | 12 | 12 | 15 | 16th hrs. & 19 mts, |
| 22.4.1968 1130 hrs. | 6.5.1968 0800 hrs. | 13 | 20 | 30 | |
| 23.4.1968 1420 hrs. | 6.5.1968 0750 hrs. | 12 | 17 | 30 | |
| 23.4.1968 1730 hrs. | 6.5.1968 0655 hrs. | 12 | 13 | 25 | |
| 23.4.1968 1810 hrs. | 5.5.1968 0625 hrs. | 11 | 12 | 15 | |
| 25.4.1968 1025 hrs. | 8.5.1968 0615 hrs. | 12 | 19 | 50 | |

as wide and separated by 0.09 mm. The nature of the stigmatic openings and the branched hairs are almost the same as in those of the third instar.

*The pupal period*

A reference to the tables 13 and 14 reveals that the pupal period is influenced to a great deal by the environmental conditions. Nishijima (1960) in *M. saltatrix* also noticed the length of the pupal stage being affected greatly by the temperature—a maximum of 23 days at 15° C and a minimum of 7.9 days at 30° C. Parker (9) in *Chloropisca glabra* has recorded a maximum of 291 days, the latter observed in pupa which overwintered. In *O. fusidentata*, it reaches a maximum of 13 days, 20 hrs. and 30 mts. under normal laboratory condition, whereas it is reduced to 7 days, 14 hrs. and 35 mts. under conditions of high humidity and optimum temperature. Unlike the eggs, the pupa can withstand low humidity as evidenced by the emergence of adults in the laboratory from pupae when the R. H. was low (20-35%).

## EMERGENCE

The emergence of the adult is effected by the splitting up of the puparium. At first a small split developes laterally at the anterior end. This reaches almost the level of the first abdominal segment. The posterior ends of the lateral splits are joined by a dorsal transverse split which by now makes its appearance. All this time the ptilinium of the fly inside excerts pressure along the split. The increasing pressure of the ptilinium forces open the lateral halves. The whole of the dorsal region of the puparium over the thoracic segments splits off as a roughly quadrangular plate which may or may not become completely detached from the puparium. The anterior spiracles are seen attached to the dorsal plate.

Firstly the contracting and expanding movements of the ptilinial sacs are clearly visible. Then the eyes and other parts of the head followed by the first pair of legs come out. The fly holds the ground by the help of the legs and frees the entire body. The hind legs lift the folded wings and unfold it in course of time. The newly emerged fly is seen sitting quietly on the side of the glass jar.

The semi-transparent ptilinium is seen projecting from the head even for about half an hour and it is withdrawn only later. The pigmentation of the body is not affected by the time of emergence as it developes only within four to six hours after emergence.

Most of the workers like Parker (1918), Hall (1932), Frew (1923, 1924) and Goodliff (1942) are silent on the time of emergence. In *Meromyza saltatrix* Nishijima (1960) could not observe any emergence after early morning.

In *O. fusidentata* also even though the puparia were kept in darkness at various constant degrees of temperature and humidity the emergence of the flies was always observed from dawn to early morning.

Under humid conditions *O. fusidentata* comes out in three to five minutes time from the puparium (Text-fig. 2F) while under dry conditions they take ten minutes or more to emerge.

TABLE 15.—The ratio of emergence, mortality and sex-ratio of *O. fusidentata*.

| Source | Date | No. of pupae kept. | No. emerged | Male | Female | Sex-ratio |
|---|---|---|---|---|---|---|
| From the field | 2.10.67 | 52 | 43 | 21 | 22 | |
| Developed from eggs laid in the lab. | 7.10.67 | 38 | 30 | 12 | 18 | |
| From the field | 14.4.68 | 104 | 81 | 47 | 34 | |
| From the field | 25.4.68 | 58 | 47 | 19 | 28 | |
| Developed from eggs laid in the lab. | 5.5.68 | 23 | 18 | 8 | 10 | |
| „ | 10.5.68 | 18 | 14 | 8 | 6 | |
| Total | | 293 | 233 | 115 | 118 | 49.3 : 50.7 |

*Sex-ratio* :

The sex-ratio is calculated on the basis of adults emerged in the laboratory from pupae collected from the fields at random and also from those developed from the eggs laid in the laboratory. Most workers like Parker (1918) on *Chloropisca glabra*, Hall (1932) on *Hippelatus pusio*, Nishijima (1960) on *Meromyza satatrix*, Frew (1923) on *Chlorops taeniopus* Meij., *Meromyza nigriventris* and *Batrobia combinata* are silent on the sex-ratio. Goodliffe (1942), working on *Lasiosina*, *Chlorops* and *Stenopthalmus*. reported that females slightly out number the males. Table 15 reveals that the two sexes are nearly equally formed in *O. fusidentata*, with an average sex-ratio of 49.3 males to 50.7 females.

*Nature of infestation and damage to the host plants* :

Soon after hatching the active, migratory first instar larvae are found

moving in search of suitable sites for boring into the stem. They are seen waving their heads in the air, remaining attached to the stem with the posterior ends of the body. In many instances they were found to move anteriorly from the place of hatching and entering earbearing internodes above the one on which they had hatched. This observation differs from that of Frew (1923) in *Chlorops pumilionis* (Bjerkander) according to whose 'critical leaf theory' the larvae of *Chlorops pumilionis* cannot penetrate into an ear-bearing internode.

None of the larvae were found to pierce a fresh stem though subjected to varying degrees of temperature and humidity. But they enter stems which were showing signs of wilting. As many as ten to twelve first instar larvae were found entering a single such stem and feeding vigourously.

An important observation is the very close association of these larvae to those of a species of *Atherigona*. In most cases in the field *O. fusidentata* flies laid the eggs on stems infested or left over by the larvae of *Atherigona*. As such in the field the larvae, soon after hatching, entered such stems without any difficulty. To substantiate this observation first instar larvae, hatched out from eggs laid in the laboratory, were transfered to stems infested by *Atherigona*. In no time they found their way through the openings in the stem made by the *Atherigona* larva and started feeding. This observation, together with that of the larvae entering only the wilting stem, shows that the mode of infestation is secondary rather than primary.

The first instar larva is generally unable to migrate into other internodes from the first one it has entered as it is apneustic and cannot be expected to enjoy a long existence. The contents of one stem was found to be sufficient for seeing the larva through the immature stages upto pupation and as such there was no pressing need to find new supply of food by migrating to another stem. The larvae were found to feed on the products of decay rather than on the fresh stem material. A reference to Table 9 will reveal that the larvae which entered stems infested by the *Atherigona* larva took less number of days to complete the larval stage when compared with those that entered other stems. This can be attributed to the availability of ready made food together with the high humidity and temperature in the medium, all of which accelerate the rate of development.

The larvae bore into the stem usually before dawn but at times they are found moving on the stem up to 9.00 a. m. after which they die. The mortality rate of the first instar larva is the highest varying from 25 to 35% of the total number hatching out in the laboratory.

*Behaviour inside the stem* :

The larva crawls until it comes to the slit in the overlapping edges of the sheathing portion of the leaf and moves downwards along the shoot till it reaches the base of the shoot. Then it gradually enters the central shoot or the ear on which it feeds. The first instar larva is primarily migratory though it feeds and grows before moulting into the second instar.

The second and third instar larvae stay in and feed on the decaying central shoot or the ear. Very rarely they migrate to adjacent shoots of the primarily injured stem. When it happens it can probably be due to the lack of suitable food for the larva. But as mentioned earlier they were not found boring in an actively growing stem.

Infested plants can easily be distinguished by the yellow colour of the leaves which gradually begin to dry up. During peak periods of infestation many such grass leaves are seen in the field.

*Number of generations and seasonal abundance of O. fusidentata in Agra* :

The flies start appearing in the field early in February. These are forms emerging out from the overwintering pupae. Their abundance progressively increases upto the end of February. They lay eggs and adults developing from these start appearing by the end of March or the beginning of April. Flies of this generation give rise to the over-summering pupae so that adults are not seen in the fields of Agra after the first week of June. Flies from these pupae come out by the end of July or the beginning of August. They lay eggs and adults of the next generation start emerging out in September. It is they who give rise to the over-wintering pupae.

As such it is presumed that there are four generations of *O. fusidentata* in a year. The seasonal abundance of these flies is depending greatly on the emergence of the adults of the subsequent generations. Adults of all the four generations were found emerging out in the laboratory. In the February-June season the availability of the flies in the field touched an all time maximum for the entire year towards the middle of April. Similarly there is only one peak period in the July-November season and that is in September. As there is the possibility of the overlapping of generations flies were available in the fields all round the respective seasons though in varying abundance. The emergence of the adults of all generations was influenced by the humidity conditions in the field.

In April 1968 as many as 30 adults were caught at a sweep with an

insect net (45 cm deep and 30 cm in diameter). During the corresponding period in 1967 the number on an average was 25 only which was the maximum for the whole year. But in July-November season the number of flies collected at one sweep touched the maximum of 20 in 1967 and 15 in 1968. During both the seasons of the both the years the flies appeared in and disappeared from the fields approximately at the same time.

*Parasites*

The extent of parasitation of *O. fusidentata* in the field could not be studied but the nature and rate of parasitation could be observed in the laboratory. In October 1968 out of 60 adults emerged from pupae allowed to remain on the host plant in the laboratory as many as 24 (*i.e.*, about 40% of the total number emerged) were parasitized by *Gamasus* (Family : Parasitidae). These mites were found attached mainly to the ventral side of the abdomen, though sometimes on the thorax also. As many as 200 mites were found attacking a single fly (Pl. III, figs. 1 & 2). Most of such adults died in a day or two. Even flies from which the parasites were forcibly removed did not live long enough to lay eggs. The rate of parasitation was the maximum (40%) just before winter. Never was it this high in any other part of the year for in March 1968, out of 30 flies emerged only 6 were parasitized and in April out of 25 emerged only 4.

The actual extent of parasitation in the field could not be ascertained as the flies that are caught by sweepings are mostly active ones and forms that are attacked are inactive and in all possibility may be lying or sitting on the ground. Hence only 2-5% of the total flies caught from the fields were found parasitized by *Gamasus*.

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SUMMARY

Habitat and habits, copulation, oviposition, egg, incubation period, egg viability, hatching, duration of larval stadia, larval instars, pupa, pupation, emergence, nature of infestation of host plants, number of generations and seasonal abundance and parasitation of *Oscinella fusidentata* Cherian are described.

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