PART 6.

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TRANSACTIONS OF THE SOCIETY FOR BRITISH ENTOMOLOGY

VOL. 5. 9TH NOVEMBER, 1938. PART 6.

THE DESCRIPTION OF THE PUPARIA OF FOURTEEN BRITISH SPECIES OF SPHAEROCERIDAE (BORBORIDAE, DIPTERA).

By W. H. GODDARD, D.I.C.

(East Anglian Institute of Agriculture, Chelmsford, Essex).

Few descriptions have been recorded of the eggs and puparia of the British Sphaeroceridae. Richards (1930, p. 319) gives references to descriptions of the larvae and puparia of four species, and the identification of two of these species appears to be very uncertain.

In this paper I have attempted to describe the eggs and puparia of the species which I have been able to breed, and also record the localities and habitats of these and other species whose puparia I was unable to obtain.

The work was carried out at the Imperial College Biological Field Station, Slough, Bucks, during the winter months of 1933 to 1935. I wish to thank Prof. J. W. Munro for the facilities afforded to me there, and Dr. O. W. Richards for the identification of the material. My thanks are also due to Mr. G. E. J. Nixon for the identification of *Phaenopria cameroni* Kieff., which emerged from one of the puparia.

METHODS.

The flies were bred on several different materials, including decaying lawn-mowings, garden refuse, and the dung of cows, deer, sheep and mice.

Sterilisation of the materials used for food for the larvae was found necessary, to kill all other eggs and larvae, so as to be sure that the puparia described from the flies bred really belonged to the same species and were not already in the material.

Flies collected *in copula* were placed in 3 in. glass tubes with an inch of moist material at the bottom. These tubes were covered with muslin and kept at laboratory temperature, and given a few drops of water whenever they showed any signs of becoming dry.

Several species were treated in this manner, but the only three that were successfully bred from the eggs to the adults were *Leptocera silvatica* (Meigen), *L. heteroneura* (Hal.) and *Sphaerocera subsultans* (L.). Another method of obtaining the puparia was then tried.

Cow-dung, deer-dung, mouse-dung and other materials were collected and examined for larvae and puparia. The puparia were removed and placed separately in 3 in. glass tubes on damp cotton wool, and the larvae were returned to their various foods. By examining the material daily, considerable numbers of puparia were obtained. When the flies emerged they were identified; this eliminated any possibility of describing puparia which did not belong to the species bred.

This method proved more successful, and the puparia of the following species were obtained:—*Leptocera palmata* (Richards), *L. crassimana* (Hal.), *L. talparum* (Richards), *L. manicata* (Richards), *L. vagans* (Hal.), *L. bequaerti* (Villen.), *L. melania* (Hal.), *L. fungicola* (Hal.), *Copromyza stercoraria* (Meigen) and *C. glacialis* (Meigen).

Difficulty was experienced in keeping the adults alive in an attempt to obtain the eggs of these species. Many died before they became mature specimens. This was partly due to the fungi which appeared in some of the tubes, and also to very large numbers of nematodes which appeared in the tubes and destroyed larvae, pupae and occasionally the adults. When the nematodes attacked the pupae, the adult flies failed to emerge, leaving the puparia unidentifiable.

Descriptions of the Puparia: Introductory.

The anterior spiracular processes afford one of the most obvious differences in the puparia of all the species examined, but this character alone is insufficient to separate the closely allied species with any certainty. Smaller differences such as the length and width of the puparia, the numbers and size of various foveae, and the extent to which the abdominal segmentation is indicated have also been used in describing the puparia.

With all these characters it has been extremely difficult to separate some species, and in the keys which follow allowance must be made for slight variation in the puparia of some species.

The mouth-parts have been examined, and these appear to be practically identical in all species.

To avoid confusion, the segments of the puparia have been numbered one to eleven, segment one being the prothoracic segment and segment eleven being the last abdominal segment.

The puparia which have been described in this paper have been divided into groups according to the different types of anterior spiracular processes. Each group has a key by which it should be possible to determine the species. The species are numbered and more detailed descriptions of the puparia follow after the keys.

The descriptions of the eggs of the three species *Leptocera silvatica* (Meigen), *L. heteroneura* (Haliday) and *Sphaerocera subsultans* (L.) follow the descriptions of their respective puparia.

Puparia. Key to Groups.

1. Anterior spiracular process spine-like ..... *Group 1.*
— Anterior spiracular process not spine-like ..... 2.
2. Anterior spiracular process palmate ..... *Group 2.*
— Anterior spiracular process not palmate ..... 3.
3. Anterior spiracular process consisting of three small tubercles arising from a common base ..... *Group 3.*
— Anterior spiracular process consisting of eight small tubercles arising from a common base ..... *Group 4.*

Puparia. Key to Species.

Group 1.

Anterior spiracular process spine-like.

Including *Leptocera vagans* (Haliday), *L. heteroneura* (Haliday), *L. palmata* (Richards), *L. talparum* (Richards), *L. crassimana* (Haliday) and *L. manicata* (Richards).

1. Tubercles branching from, and resting close to, main spine-like structure ..... *palmata.*
— Tubercles branching from, but not resting close to, main spine-like structure ..... 2.
2. Spine-like process with eleven or twelve tubercles branching from it ..... *vagans.*
— Spine-like process with ten or less tubercles branching from it ..... 3.
3. Length of spine-like processes equal to distance between them ..... *crassimana.*
— Length of spine-like processes less than distance between them ..... 4.
4. Longitudinal foveae absent from the mid-point near the lateral margins of the segments ..... *heteroneura.*
— Longitudinal foveae present at the mid-point near the lateral margins of some segments ..... 5.

5. Longitudinal foveae situated at the mid-point near the lateral margins of segments two to eleven inclusive (dorsal view) distinct ..... *talparum.*
— Longitudinal foveae situated at the mid-point near the lateral margins indistinct .... *manicata.*

GROUP 2.

Anterior spiracular process palmate.

Including *Copromyza glacialis* (Meigen), *C. equina* (Fallén), *C. stercoraria* (Meigen), *Leptocera silvatica* (Meigen) and *L. bequaerti* (Villeneuve).

1. Longitudinal foveae situated at the mid-point near the lateral margins, not continuous on segments two and three (dorsal and ventral view) ..... *C. glacialis.*
— Longitudinal foveae situated at the mid-point near the lateral margins, continuous ..... *L. silvatica, L. bequaerti.*
2. The lobes forming the posterior spiracular process only partly visible from the ventral surface ... *C. stercoraria, C. equina.*

GROUP 3.

Anterior spiracular process consisting of three small tubercles arising from a common base.

Including *Leptocera fungicola* (Haliday) and *L. melania* (Haliday).

1. Ventral surface with distinct transverse wrinkles on segments four, five and six ..... *L. melania.*
— Ventral surface without transverse wrinkles ... *L. fungicola.*

GROUP 4.

Anterior spiracular process consisting of eight small tubercles radiating from a common base ..... *Sphaerocera subsultans.*

DETAILED DESCRIPTIONS OF PUPARIA AND EGGS.

Leptocera silvatica (Meigen) (Fig. 1).

The puparium is brown. In the five specimens measured the length varied from 3·42 to 3·82 mm. and the width at segment seven from 1·0 to 1·11 mm.

The puparium tapers evenly both posteriorly and anteriorly. The two anterior spiracular processes each consists of a dark brown palmate structure, similar to *L. bequaerti* Villen., with seven short tubercles branching from it, which are lighter in colour towards the apex. They are situated anteriorly on the sides of segment one.

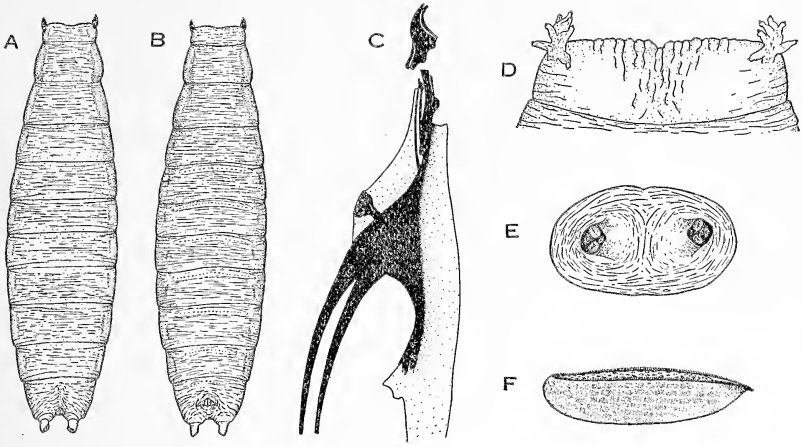

Fig. 1.

Leptocera silvatica (Meigen). A, Dorsal view of puparium; B, Ventral view of puparium; C, Mouth-parts of the larva; D, Segment one showing anterior spiracular processes; E, End view showing posterior spiracular processes; F, Egg.

Dorsal view. The segmentation of the puparium is indistinct except for the last three segments. The dorsal surface is covered with fine transverse lines, which become larger and more uneven on the last segment.

Segments one to ten have a longitudinal fovea situated at the mid-point near the lateral margin of each. These vary in size, and extend approximately for $\frac{1}{2}$, $\frac{3}{4}$, $\frac{3}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{3}$, $\frac{1}{3}$ the length of the segments respectively. On segments two and three the foveae join to make one long furrow.

The posterior spiracular processes are situated terminally and consist of two small tubercles with dark flattened ends which slope towards the centre of the last segment. The distance between the apices of the two tubercles is slightly less than half the width of the posterior margin of segment eleven.

Ventral view. The ventral surface is covered with fine transverse lines which are more distinct than on the dorsal surface. They are larger on segment eleven, especially near the anal opening, which is situated centrally on this segment. There are longitudinal foveae situated at the mid-point near the lateral margins of segments two to ten inclusive. On segments two and three the foveae join and form a long furrow. On segments four, five, six and seven they are smaller, and on segments four and five can only be seen with difficulty. A row of pseudopods is visible on segments five to eleven inclusive.

The ten eggs measured varied in length from 0·63 to 0·68 mm. and in width from 0·2 to 0·23 mm. The egg is oval with the dorsal surface flattened except for a slightly raised area in the centre, which falls away towards the anterior end to form a slight hollow. The egg tapers anteriorly to form a slight lip. There is a row of small spine-like processes round the edge of the dorsal surface. The entire surface of the egg is covered with minute indentations which are smaller and more numerous on the dorsal surface and can only be seen in certain lights.

Leptocera bequaerti (Villeneuve) (Fig. 2).

The puparium is brown. The length of the specimen drawn is 3 mm. and the width at segment six is 0·89 mm. Anteriorly the puparium tapers gradually to the posterior margin of segment three, which measures 0·72 mm., and then more abruptly to the anterior margin of segment one, which measures 0·28 mm. Posteriorly the puparium tapers evenly to the last segment, the base of which measures 0·56 mm. and the apex 0·33 mm. The two anterior spiracular processes each consists of a palmate structure with six small tubercles. The width of a process is 0·06 mm. and the length 0·07 mm. They are situated anteriorly on the sides of segment one.

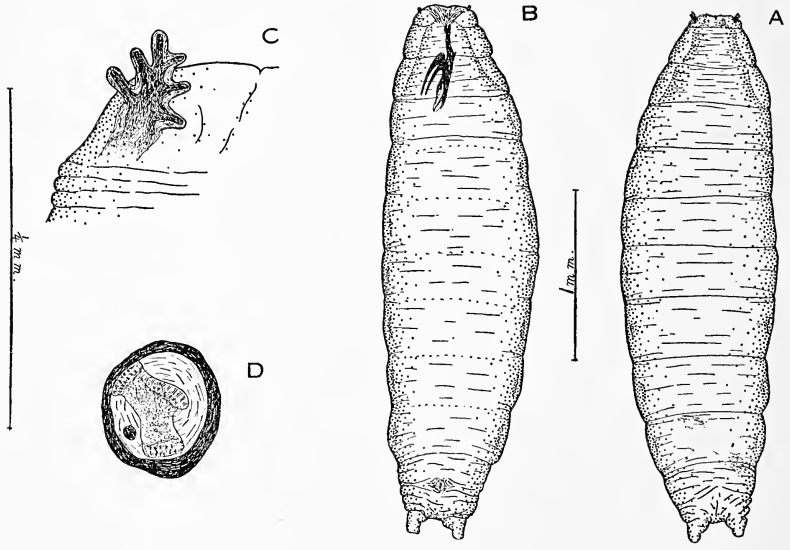

Fig. 2.

Leptocera bequaerti (Villeneuve). A, Dorsal view of puparium; B, Ventral view of puparium; C, Part of segment one showing anterior spiracular processes; D, Posterior spiracular plate.

Dorsal view. The segmentation of the puparium is distinct especially on segments one, two, three, nine, ten and eleven. The anterior margin of segment one is wrinkled between the anterior spiracular processes. There is also a raised and rounded area on segments one, two and three, at the sides of which is a furrow which becomes less deep at the junction of segments one and two, and two and three. Segments four to ten have a shallow fovea on the lateral margins which decreases in size to segment seven and on this segment is difficult to see. It then increases to segment ten, where it is situated centrally on the lateral margins and extends to half the length of this segment. Two lobes situated terminally on segment eleven form the posterior spiracular processes. The spiracular openings are situated on the apex of each lobe. The distance between the lobes is approximately one-third of the width of the apex of the segment.

The dorsal surface is covered with fine transverse lines. On segment two and three these lines are more pronounced, and on segment eleven they become shorter and deeper.

Ventral view. Segments two and three have two longitudinal furrows, one each side of the mouth-parts, which are situated centrally and can be clearly seen inside the puparium. Segments four to ten inclusive have a longitudinal fovea situated at the mid-point near the lateral margins of each; these extend $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$ the length of the segments respectively. A row of pseudopods is visible on segments five to ten inclusive. The ventral surface is covered with transverse lines which become coarser on segments one, two, three and ten, and shorter and thicker on the last segment, especially near the anal opening, which is situated centrally on this segment.

Leptocera fungicola (Haliday) (Fig. 3).

The puparium is yellow-brown. The length of the specimen drawn is 1·8 mm. and the width at segment six is 0·59 mm. Anteriorly the puparium tapers gradually from segment six to segment four and then more abruptly to the anterior margin of segment one, which measures 0·19 mm. Posteriorly it tapers evenly from segment six to the posterior margin of the last segment, which measures 0·17 mm.

The two anterior spiracular processes each consists of three very short finger-like processes arising from a common base. They are similar in shape to the anterior spiracles of *L. melania* Hal., but are shorter and thicker. The width of one complete process is 0·03 mm. and the length 0·02 mm. They are situated anteriorly on the sides of segment one.

Dorsal view. The segmentation of the puparium is indistinct except for segments one and eleven. The surface is smooth except for a few scattered transverse lines. The anterior margin

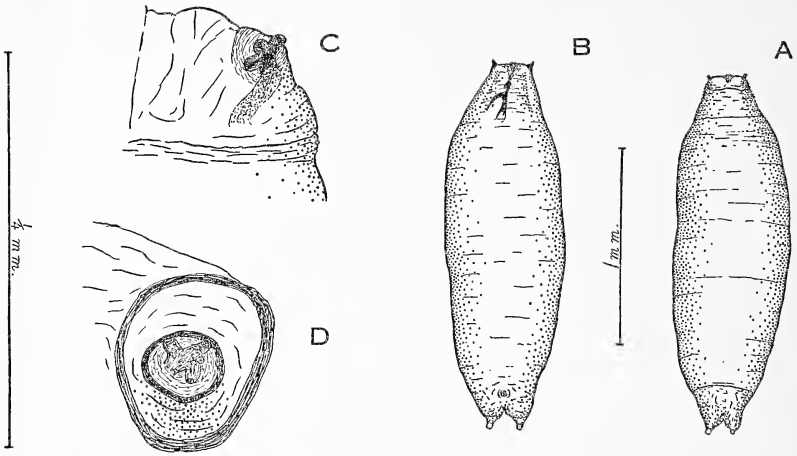

Fig. 3.

Leptocera fungicola (Haliday). A, Dorsal view of puparium; B, Ventral view of puparium; C, Part of segment one showing anterior spiracular processes; D, Posterior spiracular plate.

of segment one is raised centrally to form two small vertical ridges between the anterior spiracular processes. The lateral margins of segments one and two are also slightly corrugated.

Segment eleven is covered with numerous irregular wrinkles which become closer towards the apex. The posterior third of segment eleven is constricted centrally and forms two lobes, on the ends of which are the posterior spiracles. These lobes project beyond the end of the puparium. The posterior spiracular processes are similar to those of *L. melania* Hal., but *L. melania* has no lobes. The distance between the spiracles of *L. fungicola* Hal. is half the basal width of segment eleven.

Ventral view. Segments two and three have two shallow longitudinal furrows, one on each side of the mouth-parts, which can be clearly seen inside the puparium. Segments four to ten inclusive are smooth except for a few scattered transverse lines. The pseudopods are extremely difficult to see. The anal opening is situated centrally on segment eleven, which is wrinkled as on its dorsal surface.

Leptocera heteroneura (Haliday) (Fig. 4).

The puparia are light yellow-brown. They vary in length from 2·0 to 2·1 mm. and in width from 0·7 to 0·8 mm.; eight were measured. The puparium tapers evenly both anteriorly and posteriorly. The two anterior spiracular processes each

consists of a black spine-like process similar to *L. manicata* (Richards), with seven or eight short pale tubercles branching from it. The spine-like processes are shorter than those of *L. manicata* and measure approximately half the distance between the two processes. They are situated anteriorly on the sides of segment one.

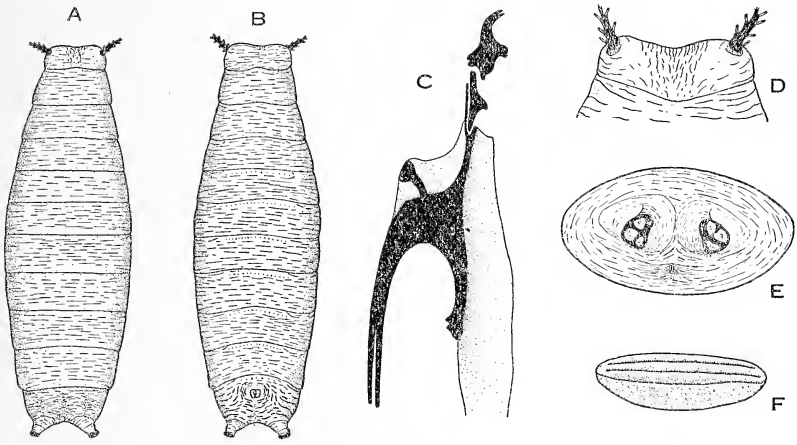

Fig. 4.

Leptocera heteroneura (Haliday). A, Dorsal view of puparium; B, Ventral view of puparium; C, Mouth-parts of larva; D, Segment one showing anterior spiracular processes; E, End view showing posterior spiracular processes; F, Egg.

Dorsal view. For its size the segmentation of the puparium is distinct. The surface is covered with fine transverse lines. On the last segment there are two oval depressions situated directly above the base of the two tubercles which form the posterior spiracular processes. These tubercles are situated laterally on the posterior margin of segment eleven. The spiracular openings are on the flattened ends of the tubercles, which slope slightly towards the centre of the segments.

Ventral view. A row of pseudopods is visible on segments five to eleven inclusive. The surface is covered with fine transverse lines which become much coarser on segment eleven, especially near the anal opening, which is at the centre of this segment.

The eggs are oval and vary in length from 0·43 to 0·45 mm. and in width from 0·1 to 0·16 mm.; ten were measured. The dorsal surface is flattened and has four longitudinal ridges. The remainder is rounded and is covered with minute depressions, which are visible only in certain lights.

Leptocera crassimana (Haliday) (Fig. 5).

The puparium is brown and varies considerably in size. Two were measured. These varied in length from 2·31 to 2·55 mm. and in width at segment seven from 0·75 to 0·78 mm. The two anterior spiracular processes each consists of a black spine-like process, similar to *L. manicata* (Richards), with eight or nine short pale tubercles branching from it. The length of each process is approximately the same as the distance between them. They are situated anteriorly on the sides of segment one and are often curved inwards towards the centre of the segment.

Dorsal view. The segmentation is distinct. The surface is covered with fine transverse lines which become coarser on segments one and eleven. There is a longitudinal fovea situated at the mid-point near the sides of segments two to ten inclusive; the foveae vary in size, and on segments two to five inclusive extend for approximately $\frac{3}{4}$, $\frac{3}{4}$, $\frac{1}{2}$, $\frac{1}{2}$ the length of the segments respectively. From segments six to ten inclusive the foveae become very small and do not extend for more than one-sixth of the length of the segments. Two terminal tubercles

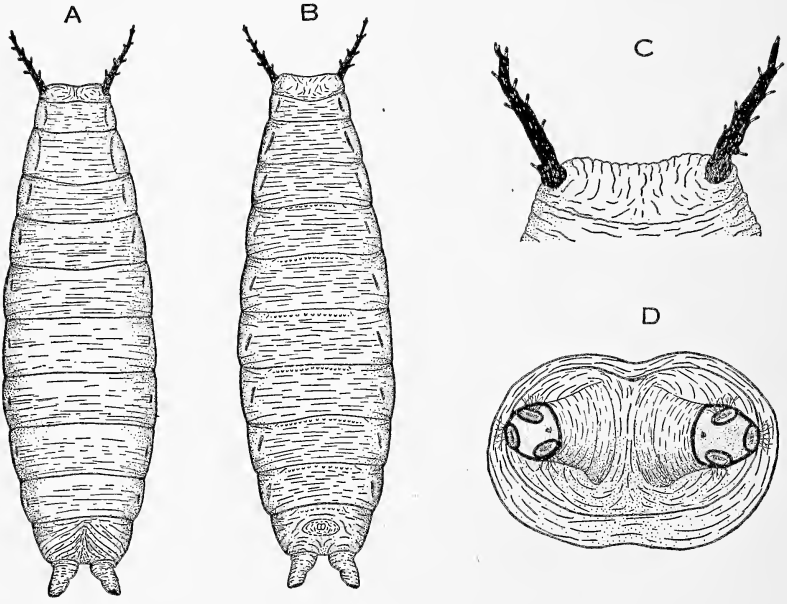

Fig. 5.

Leptocera crassimana (Haliday). A, Dorsal view of puparium; B, Ventral view of puparium; C, Segment one showing anterior spiracular processes; D, End view showing posterior spiracular processes.

form the posterior spiracular processes. These tubercles have flattened ends which bear the spiracular openings, which slope slightly towards the centre of the last segment.

The three spiracular openings are situated on the outer margins of the spiracular plate, and on the outer margins of the openings there is a row of extremely fine branched hair-like processes, which, however, can only be seen with high magnification.

Ventral view. The ventral surface is covered with fine transverse lines which are more distinct than on the dorsal surface. They become coarser on segments one and eleven. There is a longitudinal fovea situated at the mid-point near the sides of segments two to ten inclusive, the fovea extending for one-third of the length of the segments except on segments two, three and four, where it extends $\frac{1}{2}$, $\frac{2}{3}$, $\frac{1}{2}$ the length of the segments respectively. A row of pseudopods is visible on segments five to eleven inclusive. The anal opening is situated centrally on the last segment.

Leptocera palmata (Richards) (Fig. 6).

The puparium is pale brown. The length of the specimen drawn is 2·66 mm. and the width at segment six is 0·98 mm. From segment six the puparium tapers evenly both anteriorly and posteriorly, the width of the anterior margin of segment

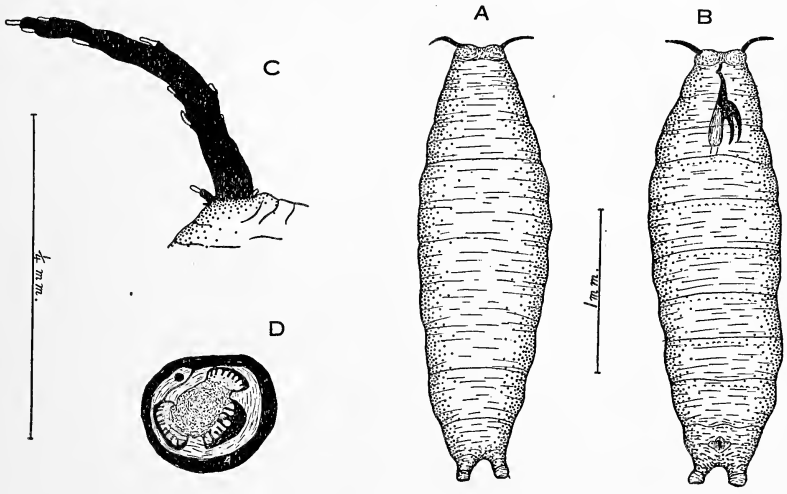

Fig. 6.

Leptocera palmata (Richards). A, Dorsal view of puparium; B, Ventral view of puparium; C, Part of segment one showing anterior spiracular process; D, Posterior spiracular plate.

one and the posterior margin of segment eleven being 0·29 mm. The two anterior spiracular processes each consists of a black spine-like process similar to *L. manicata* (Richards), with eleven or twelve short pale tubercles branching from but resting close to the main structure. The length of the process is approximately two-thirds of the distance between them. They are situated anteriorly on the lateral margins of segment one.

Dorsal view. The segmentation is very indistinct. The surface is covered with fine transverse lines which become coarser on segments one and eleven. The two tubercles situated terminally on segment eleven form the posterior spiracular processes. The spiracular openings are situated at the ends of the lobes, which are paler than at their base. The distance between them is half the width of the posterior margin of segment eleven.

Ventral view. The surface is covered with fine transverse lines which become coarser on segment eleven, especially posteriorly to the anal opening. A row of pseudopods is visible on segments five to ten inclusive. I have been unable to ascertain whether pseudopods are present on segment eleven. The anal opening is situated centrally on segment eleven, in the centre of a flat diamond-shaped area. There is a small black spot situated each side of the anal opening on this area.

Leptocera manicata (Richards) (Fig. 7).

The puparium is pale brown. The length of the specimen drawn is 2·16 mm. and the width at segment seven is 0·72 mm. The puparium tapers evenly anteriorly from segment seven to the centre of segment four, and then tapers more abruptly to segment one, where it is 0·3 mm. wide. Posteriorly, the puparium tapers evenly to the posterior margin of segment eleven, which is 0·28 mm. wide.

The two anterior spiracular processes each consists of a long black spine-like process with eight or nine short pale tubercles branching from it. The length of each process is slightly less than half the width of the anterior margin of segment one. They are situated anteriorly on the sides of segment one.

Dorsal view. The segmentation is distinct except between segments four and five, five and six, six and seven, and seven and eight.

There is a longitudinal fovea situated at the mid-point near the sides of segments two to ten inclusive. These vary in size and extend for approximately $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{3}$, $\frac{1}{5}$, $\frac{1}{3}$, $\frac{1}{3}$, $\frac{1}{3}$, $\frac{1}{4}$ the length of the segments respectively. The dorsal surface is covered with fine transverse lines which become coarser on segments one and eleven.

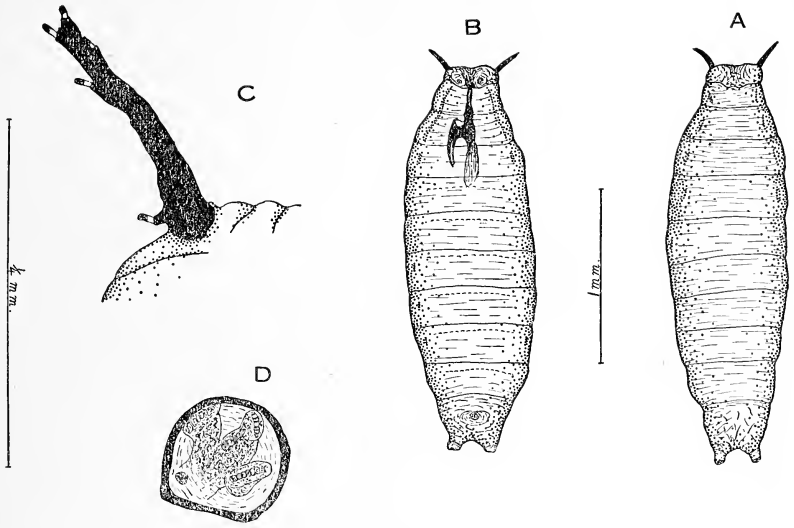

Fig. 7.

Leptocera manicata (Richards). A, Dorsal view of puparium;; B, Ventral view of puparium; C, Part of segment one showing anterior spiracular process; D, Posterior spiracular plate.

Two tubercles situated terminally on segment eleven form the posterior spiracular processes. The spiracular openings are situated on the flattened ends of the lobes. The distance between the two lobes is half the width of the posterior margin of the segment.

Ventral view. Segments two and three form a slightly raised and rounded area, and have a shallow longitudinal furrow near the sides. Segments four, seven, eight and nine have a longitudinal fovea situated near the sides. On segment four it is at the mid-point, on segments seven, eight and nine on the anterior half of the segments. The foveae extend for approximately $\frac{1}{3}$, $\frac{1}{5}$, $\frac{1}{5}$, $\frac{1}{4}$ the length of the segments respectively. There are two small black spots, situated one on each side of the mouth-parts on segment one. The whole surface of the puparium is covered with fine transverse lines which become coarser on segments one, ten and eleven. A row of pseudopods is visible on segments five to ten inclusive.

Leptocera talparum (Richards) (Fig. 8).

The puparium is pale brown. The length of the specimen drawn is 2·35 mm. and the width at segment seven is 0·77 mm. From segment seven the puparium tapers evenly both anteriorly

and posteriorly. The width of the anterior margin of segment one and the posterior margin of segment eleven is 0·24 mm. The two anterior spiracular processes each consists of a long black spine-like process with eight or nine short pale tubercles branching from it, similar to *L. manicata* (Richards). The length of each process is slightly less than the distance between them. They are situated anteriorly on the sides of segment one.

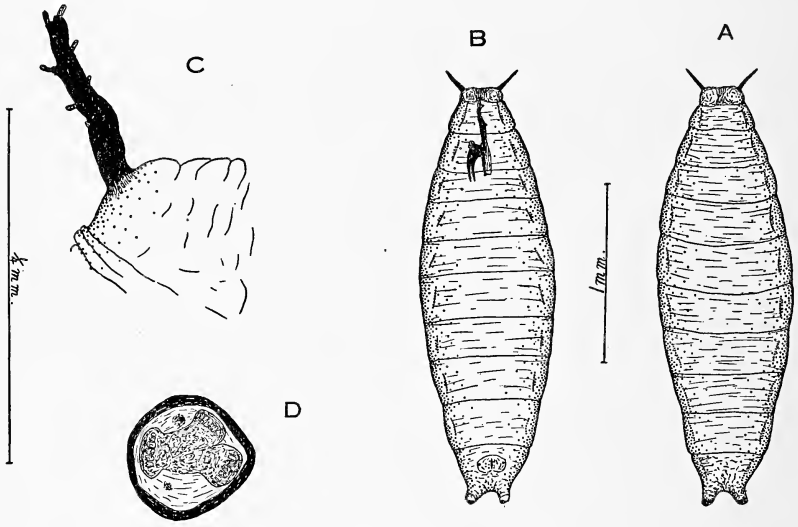

Fig. 8.

Leptocera talparum (Richards). A, Dorsal view of puparium; B, Ventral view of puparium; C, Part of segment one showing anterior spiracular process; D, Posterior spiracular plate.

Dorsal view. The segmentation is indistinct except between segments two and three, and ten and eleven. There is a longitudinal fovea situated at the mid-point near the sides of segments two to eleven inclusive. The foveae vary in size and extend approximately $\frac{3}{4}$, $\frac{3}{4}$, $\frac{2}{3}$, $\frac{2}{3}$, $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$, $\frac{2}{3}$, $\frac{2}{3}$, $\frac{1}{2}$ the length of the segments respectively. The dorsal surface is covered with fine transverse lines which become coarser on segments one and eleven. Two tubercles situated terminally on segment eleven form the posterior spiracular processes. The spiracular openings are situated on the ends of the lobes. The distance between the lobes is half the width of the posterior margin of segment eleven.

Ventral view. Longitudinal foveae are situated at the mid-point near the sides of segments two to ten inclusive. These vary in size and extend approximately $\frac{3}{4}$, $\frac{3}{4}$, $\frac{2}{3}$, $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{2}$, $\frac{1}{3}$

the length of the segments respectively. The entire surface of the puparium is covered with fine transverse lines, which become coarser on segment eleven. The pseudopods are extremely difficult to see. On each side of the anal opening, which is situated centrally, there is a minute black spot.

Leptocera melania (Haliday) (Fig. 9).

The puparium is yellow-brown. The length of the specimen drawn is 1·6 mm. and the width 0·5 mm. The anterior spiracular processes each consists of three short thick finger-like processes arising from a common base. They are black-brown in colour. The measurements of one complete process are 0·026 mm. long and 0·02 mm. wide. They are situated anteriorly on the sides of segment one.

Dorsal view. There is a longitudinal fovea situated at the mid-point near the sides of segments two to ten inclusive. They vary in size, on segment two being very shallow and extending not more than one-third of the length of the segment, while on segments three and four they are deeper and extend to half the length of the segments, and on segments five and six they are still deeper and arise from the anterior edge of the segment, curving towards the centre. Their length is approximately one-quarter the width of the segments. On segments seven to ten inclusive the foveae are reduced considerably. They are more parallel to the long axis of the puparium and extend $\frac{1}{3}$, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{3}$ the length of the segments respectively. On the posterior third of the last segment there is a W-shaped depression. The pos-

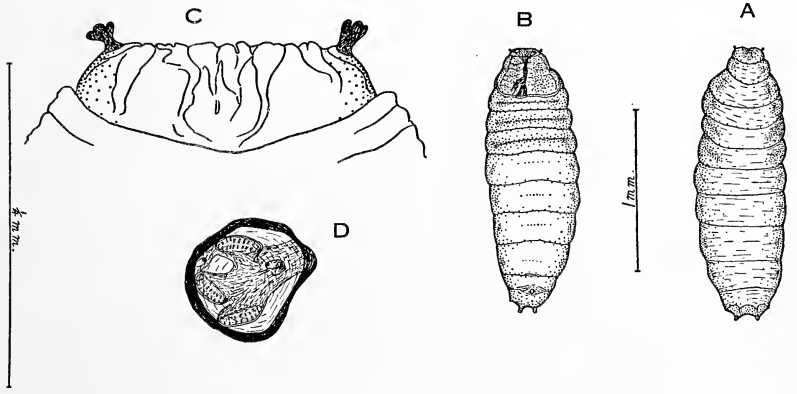

Fig. 9.

Leptocera melania (Haliday). A, Dorsal view of puparium; B, Ventral view of puparium; C, Segment one showing anterior spiracular processes; D, Posterior spiracular plate.

terior spiracular processes are situated terminally and consist of two small brown papilliform processes, the distance between them being one-third of the anterior width of the last segment.

Ventral view. Segments two and three form a slightly raised area and have two shallow longitudinal furrows, one each side of the centrally placed mouth-parts, which can be clearly seen inside the puparium. Segments four, five and six have a central transverse furrow extending for about three-quarters the width of each segment and deepening at their extremities. On the lateral parts of segments seven to ten inclusive there is a longitudinal depression one-third of the length of the segments. The depressions on segment ten are very shallow and can only be seen with difficulty. The anal opening is situated centrally on the last segment.

Leptocera vagans (Haliday) (Fig. 10).

The length of the puparium varies from 2·4 mm. to 2·62 mm. and the width from 0·84 mm. to 0·98 mm.; four were measured. The two anterior spiracular processes each consists of a black spine-like process similar to *L. manicata* (Richards), with eleven or twelve short pale tubercles branching from it. The spine-like processes are shorter than *L. manicata,* and measure approximately half the distance between the two spiracular processes.

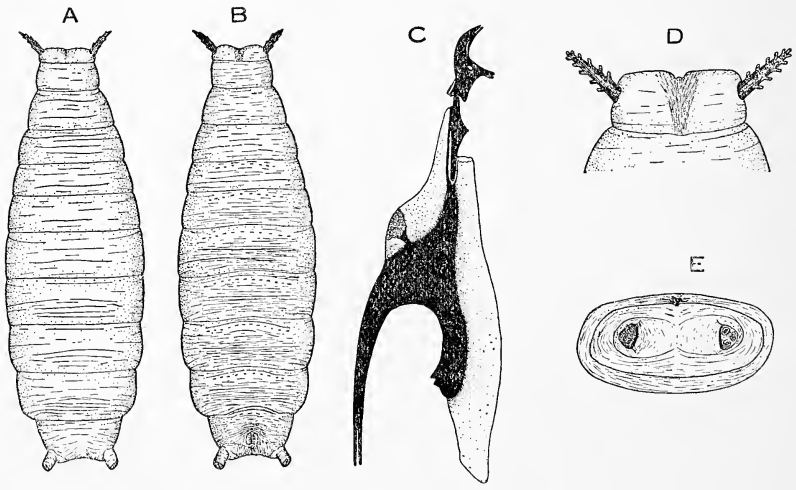

Fig. 10.

Leptocera vagans (Haliday). A, Dorsal view of puparium; B, Ventral view of puparium; C, Mouth-parts of larva; D, Segment one showing anterior spiracular processes; E, End view showing posterior processes.

Dorsal view. The puparium tapers evenly both anteriorly and posteriorly. The anterior margin of segment one is constricted centrally. The surface of the puparium is covered with fine transverse lines. The segmentation is distinct, especially between segments ten and eleven. Two short tubercles situated laterally on the posterior margin of segment eleven form the posterior spiracular processes. The spiracular openings are situated on the flattened ends, the distance between the ends being the length of the posterior margin.

Ventral view. The surface is covered with fine transverse lines. A row of pseudopods is visible on segments five to eleven inclusive. The anal opening is situated centrally on segment eleven.

Copromyza glacialis (Meigen) (Fig. 11).

The puparium is brown. The length of the specimen drawn is 3·44 mm. and the width at segment six is 1·03 mm. The puparium tapers evenly both anteriorly and posteriorly to the posterior margin of segment ten. Segment eleven is only three-quarters the width of segment ten. The two anterior spiracular processes each consists of a palmate structure similar to *C. stercoraria* (Meigen) with eight short tubercles. They are situated on the anterior half of the sides of segment one.

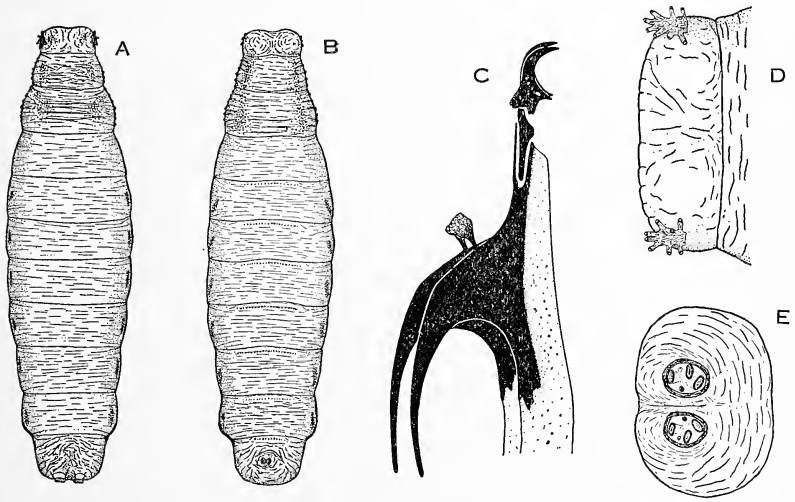

Fig. 11.

Copromyza glacialis (Meigen). A, Dorsal view of puparium; B, Ventral view of puparium; C, Mouth-parts of larva; D, Segment one showing anterior spiracular processes; E, End view showing posterior spiracular processes.

Dorsal view. The segmentation of the puparium is distinct. The surface of the puparium is covered with fine transverse lines which become coarser on segments one, two, three and eleven. Segments one, two, three and five to ten inclusive have a longitudinal fovea situated at the mid-point near the sides of each. These vary in size and extend approximately $\frac{1}{3}$, $\frac{1}{2}$, $\frac{1}{3}$ and $\frac{1}{5}$, $\frac{1}{3}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{3}$ the length of the segments respectively. The button-like processes situated terminally on segment eleven form the posterior spiracular processes. In the specimen drawn these could not be seen from the ventral surface. The distance between the processes is slightly less than the width of one of the buttons.

Ventral view. The ventral surface is covered with fine transverse lines, becoming coarser on segments one, two, three and eleven, especially near the anal opening, which is situated centrally on this segment. A row of pseudopods is visible on segments five to ten inclusive. Pseudopod-like structures are also present on segment four, but as yet I have been unable to ascertain whether they are true pseudopods. Segments two, three and five to ten inclusive have a longitudinal fovea situated at the mid-point near the sides of each. These vary in length and extend for the length of segments two and three, and for $\frac{1}{3}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{3}$ and $\frac{1}{3}$ the length of segments five to ten respectively.

Copromyza equina (Fallén).

I have compared the puparia of *C. equina* and *C. stercoraria* and have been unable to separate them with any certainty. The only difference I have found between the two species is in the size. Four of the six specimens of *Copromyza equina* are larger than the one specimen of *C. stercoraria,* which was measured. The remaining two are slightly smaller. The measurements are : — Length, 3·5—3·8 mm. ; width at segment seven, 1·16—1·31 mm.

Copromyza stercoraria (Meigen) (Fig. 12).

The puparium is brown. The length of the specimen drawn is 3·64 mm. and the width at segment seven is 1·24 mm. The puparium tapers evenly both posteriorly and anteriorly. The anterior margin of segment one is 0·42 mm. and the posterior margin of segment eleven is 0·48 mm. wide. The two anterior spiracular processes each consists of a palmate structure similar to *Leptocera bequaerti* with eight short tubercles. They are situated anteriorly on the sides of segment one.

Dorsal view. The segmentation of the puparium is distinct, especially between segments two and three, three and four, eight and nine, nine and ten, and ten and eleven. The sides of segment one and anteriorly of segment two are wrinkled. There

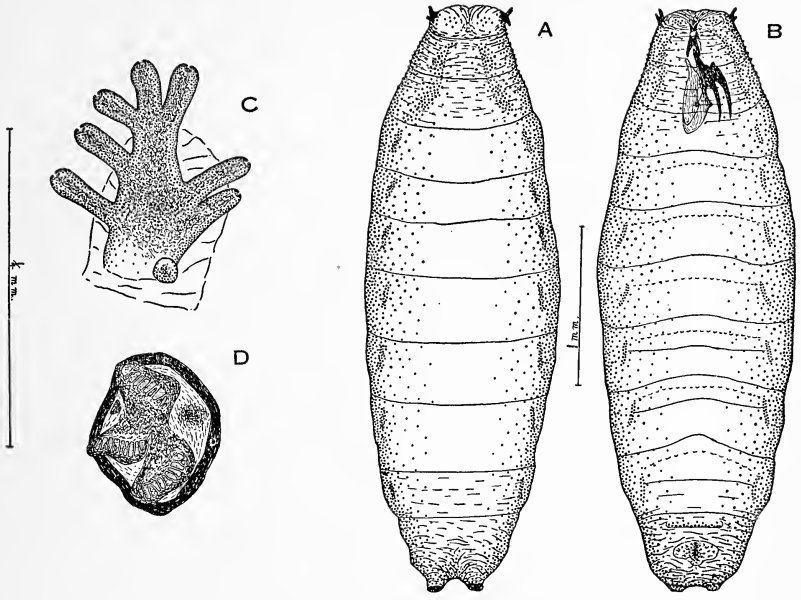

Fig. 12.

Copromyza stercoraria (Meigen). A, Dorsal view of puparium; B, Ventral view of puparium; C, Anterior spiracular process; D, Posterior spiracular process.

is a raised area situated centrally on segments two and three. Longitudinal foveae situated at the mid-point near the sides are present on segments two to ten inclusive. They extend for $\frac{2}{3}$, $\frac{2}{3}$, $\frac{1}{3}$, $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{3}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{3}$ the length of the segments respectively. The dorsal surface is covered with fine transverse lines. On segments one, two and three the lines become coarser, and on the last segment they develop into short irregular wrinkles. There is a row of minute spots in the sutures between the segments. They continue across the dorsal surface and end just short of the row of pseudopods on the ventral surface. Two lobes situated terminally on the dorsal surface of segment eleven form the posterior spiracular processes. These lobes are only partly visible from the ventral surface of the puparium. The spiracular openings are situated on the ends of the lobes. The distance between the lobes is one-third of the width of the posterior margin of the last segment.

Ventral view. There is a slightly raised and rounded area situated centrally on segment two. Segments two to ten inclusive have a longitudinal fovea situated at the mid-point near

the lateral margins of each. These vary in size and extend approximately $\frac{3}{4}$, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$ the length of the segments respectively. There is also a shallow transverse fovea situated centrally on the anterior margin of segment eleven. The pseudopods can be seen clearly, and arise from a point near the anterior ends of the longitudinal foveae of segments five to ten inclusive. The ventral surface is covered with fine transverse lines which become coarser on segment one and the lateral parts of segment two. Posteriorly segment eleven is coarsely wrinkled, especially near the anal opening, which is situated centrally on this segment.

Sphaerocera subsultans (Linnaeus) (Fig. 13).

The puparium is black-brown. The length varies from 3·36 to 3·85 mm. and the width at segment seven from 1·16 to 1·28 mm.; eight were measured. The puparium tapers evenly both anteriorly and posteriorly. The anterior spiracular processes each consists of eight short thin tubercles radiating from a common base. They are situated anteriorly on the sides of segment one.

Dorsal view. The segmentation of the puparium is distinct. The surface is covered with transverse lines which become

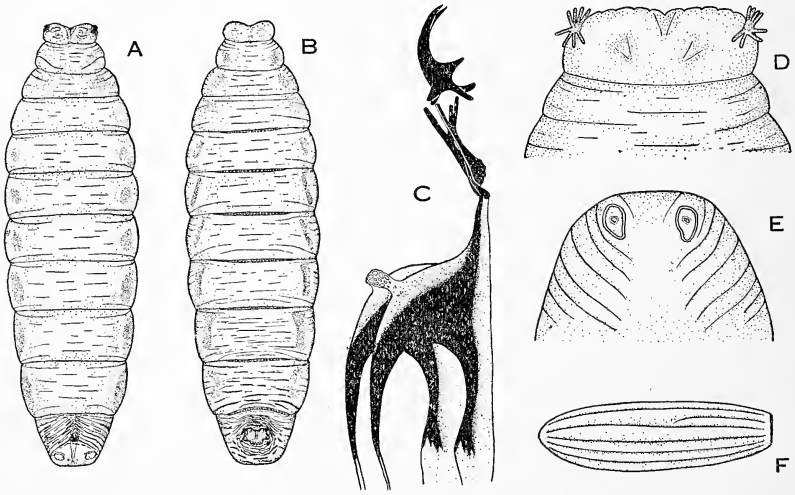

Fig. 13.

Sphaerocera subsultans (Linnaeus). A, Dorsal view of puparium; B, Ventral view of puparium; C, Mouth-parts of larva; D, Anterior end of puparium showing anterior spiracular processes; E, Dorsal view of segment eleven showing posterior spiracular plates; F, Egg.

coarser and more numerous on the anterior two-thirds of the last segment. Segments three, four and five have a shallow fovea situated at the mid-point near the sides of each; the foveae extend approximately $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{3}$ the length of the segments respectively. The foveae become elongate and more pronounced on segments six to ten inclusive, and extend $\frac{1}{3}$, $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{3}{4}$ the length of the segments respectively. There is a small deep cavity situated in the centre of segment eleven.

The posterior spiracular processes are situated on the posterior quarter of the last segment, and therefore cannot be seen from the ventral surface. They consist each of a small black oval opening in the surface of the puparium. The space between them is half the width of the posterior margin of segment eleven.

Ventral view. The ventral surface is covered with transverse lines which become coarser on segments nine, ten and eleven, especially near the anal opening, which is situated centrally on the last segment. The anal opening is situated in the centre of a pale, depressed, square area. Segments two, three and four have a shallow fovea situated at the mid-point near the sides of each; the foveae extend approximately $\frac{1}{3}$, $\frac{1}{2}$, $\frac{1}{2}$ the length of the segments respectively. These foveae become elongate and more pronounced on segments five to ten inclusive and extend $\frac{1}{2}$, $\frac{2}{3}$, $\frac{2}{3}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{3}{4}$ the length of the segments respectively.

Description of egg. The length of the egg varies from 0·72 to 0·78 mm. and the width from 0·24 to 0·27 mm.; seven were measured. The egg is white, and the surface is covered with thirteen or sometimes fourteen ridges, which extend for the whole length and end anteriorly at a flat disc through which the larva emerges.

Locality and Habitat Records.

As the eggs, larvae, pupae and adults were collected, the following data were noted :—

It will be seen that the term 'mouse-run' is used; by this is meant the tunnels made by mice at the base of long grass.

A few of the species mentioned in the paper have not been recorded for Buckingham by Richards (1930). These have been marked with an asterisk (*).

*1. *Leptocera fontinalis* (Fallén).
1 ♂, Bucks, Slough, decaying lawn-mowings, 16 Oct., '33.

*2. *Leptocera curvinervis* (Stenhammar).
2 ♂♂, 4 ♀♀, Bucks, Slough, garden refuse, 16 Oct.,' 33.

3. *Leptocera nivalis* (Haliday).
1 ♂, 1 ♀, Bucks, Slough, mouse-run, 17 Oct., '33.

4. *Leptocera silvatica* (Meigen).
   2 ♂♂, 9 ♀♀, 9 pupae, Bucks, Slough; Berks, Windsor Great Park, in cow-dung, decaying lawn-mowings, 7-8 Feb., 31 Oct., '34.
   Three females collected on 7 Feb., '34, laid one hundred eggs the net day. One adult emerged on 23 March. When the eggs are laid they are buried in the decaying grass, except for the dorsal surface.

*5. *Leptocera bequaerti* (Villeneuve).
   1 ♂, 3 ♀♀, collected as larvae, Bucks, Slough, mouse-run, 14 Feb., '35.
   The four larvae pupated three days after being collected, and the adults emerged from sixteen to eighteen days later.

*6. *Leptocera fungicola* (Haliday).
   1 ♂, collected as pupa, Bucks, Slough, mouse-run, 23 Jan., '35.
   The adult fly emerged eight days after the pupa was collected.

*7. *Leptocera minutissima* (Zetterstedt).
   4 ♂♂, Bucks, Slough, rabbit-hutch, 13 June, '35.

*8. *Leptocera heteroneura* (Haliday).
   1 ♂, 3 ♀♀, Bucks, Slough, decaying lawn-mowings, 16 Oct., 1 Nov., '33.
   One female collected on decayed lawn-mowings on 16 Oct., '33, was placed in a tube with half an inch of sterilised decayed grass cuttings at the bottom. From this tube sixty-two flies emerged from thirty-one to thirty-eight days later. Four pairs of these flies were placed in four other tubes with decayed lawn-mowings.
   In the first tube eggs were laid five days after copulation had taken place. Four eggs were laid and one larva was seen two days later. In the second tube eggs were laid six days after copulation; seventy eggs were laid in ten days. The parent fly died four days later. The maximum number of eggs, twelve, was laid on the fifth day. In the third tube egg-laying commenced nineteen days after copulation. Sixty-five eggs were laid in sixteen days. The parent died four days later. The maximum number of eggs, fifteen, was laid on the eleventh day. In the fourth tube eggs were laid twelve days after copulation. Sixty-one eggs were laid in thirty-two days, the maximum number, sixteen, being laid on the eighth day. The eggs were scattered on the surface of the grass. Some were deposited on the glass of the tubes.

9. *Leptocera longisetosa* (Dahl).
   1 ♀, Berks, Windsor Great Park, deer-dung, 14 Oct., '33.

10. *Leptocera crassimana* (Haliday).
2 ♂♂, 2 ♀♀, 3 pupae, Bucks, Slough, decaying grass, 31 Oct., 12 Dec., '33, 9 Feb., '34.
The adults emerged from the pupae three days after being collected.

11. *Leptocera palmata* (Richards).
2 ♂♂, 1 ♀, Bucks, Slough, mouse-run, 1 Jan., '35.
3 ♂♂, 4 ♀♀, Surrey, Hindhead, dead rabbit, 8 Mar., '36.

12. *Leptocera manicata* (Richards).
10 ♂♂, 6 ♀♀, collected as larvae and pupae, Bucks, Slough, mouse-run, 8 Mar., '34, 28 and 29 Jan., 12 Feb., 8 Apr., '35.
The adults emerged from six to fourteen days after pupation.

13. *Leptocera talparum* (Richards).
13 ♂♂, 11 ♀♀, collected as larvae and pupae, Bucks, Slough, mouse-run, 18 Mar., '34, 12 Feb., 8 Apr., '35.
The adults emerged from five to eighteen days after pupating.

*14. *Leptocera rufilabris* (Stenhammar).
1 ♀, Bucks, Slough, decaying grass, 31 Oct., '33.

*15. *Leptocera luteilabris* (Rondani).
3 ♂♂, 3 ♀♀, Bucks, Slough, rabbit-hutch, 13 June, '36.

16. *Leptocera spinipennis* (Haliday).
1 ♂, 1 ♀, Bucks, Slough, mouse-run, decaying grass, 17 and 31 Oct., '33.

*17. *Leptocera aterrima* (Haliday).
1 ♀, Bucks, Slough, lawn-mowings, 31 Oct., '33.

*18. *Leptocera melania* (Haliday).
1 ♀ collected as pupa, Bucks, Slough, mouse-run, 1 Jan., '35.
The fly emerged sixteen days after the pupa was collected.

*19. *Leptocera vagans* (Haliday).
1 ♂, 4 ♀♀, Bucks, Slough, mouse-run, decaying grass, 16 and 17 Oct., '33.
One of these females was placed in a tube with some sterilised decayed grass. On 29 Nov., '33, twelve adults (10 ♀♀, 2 ♂♂) emerged and on 30 Nov., '33, ten more (9 ♀♀, 1 ♂).

20. *Leptocera lugubris* (Haliday).
2 ♀♀, Berks, Windsor Great Park, cow-dung, 24 Oct., '33.

*21. *Leptocera ferruginata* (Stenhammar).
1 ♂, Bucks, Slough, decaying grass, 3 Oct., '33.

22. *Copromyza nitida* (Rondani).
2 ♀♀, Hants, Alton, sheep-dung, 14 Nov., '33.

23. *Copromyza roserii* (Rondani).
    4 ♂♂, 1 ♀, Surrey, Hindhead, dead rook, dead rabbit, 18 Mar., '36.

*24. *Copromyza glacialis* (Meigen).
    1 ♂, 1 ♀, collected as larvae, Bucks, Slough, Farnham Royal, nest of field mouse, mouse-run, 24 Apr., '31, 12 Feb., '35.
    One fly emerged seventeen days after pupating.

25. *Copromyza equina* (Fallén).
    1 ♂, 2 ♀♀, Hants, Alton; Bucks, Slough; Berks, Windsor Great Park. In decaying lawn-mowings, cow-dung, sheep-dung, 13 and 24 Oct., 14 Nov., '33.

26. *Copromyza similis* (Collin).
    4 ♀♀, Berks, Windsor Great Park, cow-dung, deer-dung, 24 Oct., '33.

27. *Copromyza stercoraria* (Meigen).
    25 ♂♂, 27 ♀♀, collected as larvae, Bucks, Slough, mouse-run, 16 Mar., '34, 28 and 29 Jan., 11 and 14 Feb., 8 Apr., '35.
    The flies emerged seven to ten days after pupating.

28. *Sphaerocera subsultans* (L.).
    4 ♂♂, 2 ♀♀, Bucks, Slough, decaying grass, 16 Oct., 13 and 21 Nov., '33.
    A pair of flies was placed in a tube with some sterilised decayed grass. Thirty-six eggs were laid two days later, and one adult emerged thirty-three days after the eggs were laid.
    The eggs were scattered on the surface of the grass and not buried as in *Leptocera silvatica*.

*29. *Sphaerocera nitida* (Duda).
    3 ♀♀, Bucks, Slough; Hants, Alton; decaying grass, sheep-dung, 2 and 11 Nov., '35.

30. *Sphaerocera pusilla* (Fallén).
    1 ♂, 3 ♀♀, Bucks, Slough, decaying grass, 10 Oct., 14 Nov., '33.

Parasites.

Two parasites were reared from the Sphaerocerid pupae. Three specimens of *Phaenopria cameroni* Kieff. emerged from three puparia of one of the smaller species of *Leptocera* (probably *L. vagans*); one specimen of *Opius* sp. emerged from the pupa of *Copromyza* sp.

Many of the flies when collected were found to have several large red mites attached to various parts of their abdomens. These mites have not yet been identified.

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