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STUDIES OF SOME AGROMYZIDAE IN QUEENSLAND

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SUMMARY

The Agromyzidae of Queensland included in this study belong to two subfamilies, Agromyzinae and Phytomyzinae, and comprise 16 species in nine genera.

Three of the genera—*Melanagromyza, Cerodontha* and *Haplomyza*—contain the seven species indigenous to this State. The other species are in the genera *Ophiomyia, Phytobia, Liriomyza, Phytomyza, Pseudonapomyza* and *Melanagromyza.*

The larvae of 13 species are leaf miners, one mines in leaves and stems, one mines in fruit, while the larval habitat of one has yet to be determined.

Each species is discussed under various headings, including history; geographical distribution; adult taxonomy, morphology and behaviour; larval morphology and behaviour; puparium; plant damage; hosts; localities and parasites.

I. INTRODUCTION

Several of the species of Agromyzidae occurring in Queensland are of considerable economic importance. The earliest reference to the family in this State concerned bean fly (*Melanagromyza phaseoli* (Tryon)) (Tryon 1895*a*), a major pest of beans and related crops. Other species of importance are cabbage leaf miner (*Liriomyza brassicae* (Riley)), cineraria leaf miner (*Phytomyza atricornis* Meigen), and aster leaf miner (*Phytobia humeralis* (Roser)).

Improvements in the methods of control for the economic species are still required. Studies with this aim are in hand by Departmental officers but in support of the work correct classification of the material handled is essential, together with a knowledge of behaviour, plant damage, host range, distribution, life histories and natural control. The present studies have provided much information in these fields.

II. COLLECTION AND EXAMINATION OF MATERIAL

Biological studies were of primary concern and therefore wherever possible material of immature stages was collected *in situ* in living plant tissue. This was held under conditions enabling further development of larvae and pupae and the emergence of adults. As none of the larvae could be successfully transferred to fresh leaves in the larval stages, special attention to handling methods during breeding was often necessary. Rain-forest plants in particular soon shrivelled after collection. This was prevented to some extent by collection into plastic bags and using detached leaf culture adapted from Yarwood (1946).

Some pupae for breeding were held *in situ*. Others were easily removed and held alive on damp sand, sometimes for several months, before adult emergence.

Additional leaf material containing larvae and pupae *in situ* was treated in greening solution (Riker and Riker 1936) and stored in 5·0% formalin for later study.

Larvae required for detailed study were removed from the mines, dropped into hot water and then gently boiled in 5·0% caustic potash for a few minutes. After washing in distilled water these were stained in acid fuchsin, to enable detailed spiracle examination, and then permanently mounted in Canada balsam. Other specimens not required for staining were mounted in De Faure's medium.

Adults were held alive for some time before being killed, as considered desirable by Frick (1956*a*), by providing them with small cut pieces of fresh host tissue which enabled feeding by both sexes on the exuding sap. Dilute sugar solution on small, tightly rolled cotton-wool pads proved of value as supplementary food.

Adult males for slide mounting were boiled for a few minutes in caustic potash to render all parts of the genitalia visible for dissection. The tip of the abdomen, including the segment containing the anterior extremity of the apodeme, was extracted and the sternites and tergites then removed from anteriorly backwards. The prepared mounts showing the ventral view allowed detailed study and comprehensive illustrations to be made.

The adult stage of the more recently described species has previously been dealt with (Kleinschmidt 1960). Descriptions accompanied by illustrations are now given for immature stages of some species, the final or third instar being used for the larval stage. Supplementary descriptions of adults are given for some of the earlier described species. The author's descriptive work is patterned mainly on that of Frick (1952) and the nomenclature used in respect to male genitalia follows Frick (1952) and Crampton (1944).

Except where stated, all material was collected by the author.

III. GENERA AND SPECIES

(A) Family AGROMYZIDAE Fallén

The family Agromyzidae is well represented in Queensland, with 26 species in 10 genera. Of the 16 species dealt with in this study, the seven species indigenous to this State are contained in three genera, namely *Cerodontha, Haplomyza* and *Melanagromyza.* The genera *Liriomyza, Ophiomyia, Phytobia, Phytomyza* and *Pseudonapomyza* as well as *Melanagromyza* include species which have been imported either intentionally (*Ophiomyia lantanae* (Froggatt)) or accidentally. An unidentified species in the genus *Agromyza* also occurs in Queensland.

Agromyzid flies are very active and their habits are influenced by both temperature and light. Most adult feeding takes place about mid morning, preferably in bright sunlight. Later in the day the flies shelter on the under-sides of leaves. So long as light, either artificial or natural, is present, they continue to be active. Cold wet days greatly reduce activity and darkness induces rest, the flies remaining still or sluggish during the night if undisturbed. Humidity does not affect activity but it does affect longevity.

Some details on feeding and mating behaviour are given by Cohen (1936). In the present studies it was shown that oviposition takes place in the warmer part of the day by leaf puncturing in a similar manner to feeding, the egg being deposited in a hole made under the epidermis. Many leaf punctures are made by the ovipositor without eggs being laid, feeding taking place on the exuding sap. A count of five leaves on which *Liriomyza brassicae* was ovipositing showed a total of 251 punctures and of these only 16 contained eggs. Figures for various species show that about 100 eggs per female may be laid; the average, however, is much less.

Larvae of all of the Agromyzidae studied are permanent miners, i.e. living in the plant until fully fed, and all except *Liriomyza brassicae,* which is a winter species, occur mainly in the spring and late summer, especially after a rainy period which has stimulated plant growth.

The species of the family in Queensland belong to two subfamilies, namely Agromyzinae and Phytomyzinae. These may be separated as follows:

Sc complete, joining R_1 before reaching C and broadening at the point of union ..... AGROMYZINAE
Sc ends in C separately from R_1 with no broadening PHYTOMYZINAE

(a) Subfamily AGROMYZINAE Fallén

The subfamily Agromyzinae is represented by three genera, namely *Agromyza, Melanagromyza* and *Ophiomyia.* These may be separated as follows:

1. Halteres black 2
   Halteres pale ..... *Agromyza*
2. Carina between antennae prominent and fusiform ..... *Ophiomyia*
   Carina between antennae narrow and flattened ..... *Melanagromyza*

(i) Genus AGROMYZA Fallén

Detailed studies have not been made of this genus by the author, since only one specimen has been recorded. This was reared from the leaf of a grass, *Brachiaria miliiformis* (Presl.) Chase, in Brisbane. The specimen was damaged in transit overseas for check identification and therefore is indeterminable. It can be stated definitely, however, that the genus exists in this State.

(ii) Genus MELANAGROMYZA Hendel

Six local species are included in this genus; a key for their separation has previously been presented (Kleinschmidt 1960).

MELANAGROMYZA albisquama (Malloch)

Two specimens collected at Kenmore in May 1956 agree with the description and with a named specimen lent by Dr. D. J. Lee from the collection of the School of Public Health and Tropical Medicine in Sydney. Malloch's specimens were from Eccleston, Allyn R., N.S.W. Spencer (1963) has recorded this species from North Queensland.

Adult morphology

Body.—Brown with greenish blue sheen.

Head.—Four pairs fronto-orbitals (2 superior, 2 inferior), vertical intervals between successive fronto-orbitals equal. Orbital setulae numerous, dorsally directed above level of lowermost fronto-orbital; others erect; vertical triangle pruinose but slightly shinier than frons, extending to level of upper inferior fronto-orbitals before narrowing and disappearing. Frontal vitta more than one-half eye width, dull pruinose. Occipital setae forming a short v. Arista long, the basal one-eighth thickened; antennae widely separated, divergent, median carina plainly visible. Oral vibrissa almost twice length of longest of remaining bristles on sub-cranial margin. Gena with wide angle, narrow, about equal in depth to oral vibrissa.

Thorax.—Wing length almost 2 mm. Costa reaching M1+2, the wing tip lying at R4+5. M–m more than its own length (1·2 times) from R–m. Halteres brown. Calypters white with clear bright yellow margin and long white fringe. R–m at posterior end pointing outwards and backwards, being set obliquely. R–m approximately one-quarter M–m. Wing indices (from four specimens): costal, 3·1 (3·0—3·2); 4th vein, 3·2 (2·9—3·6); 4c, 1·2 (1·1—1·3); 5x, 1·6 (1·5—1·7). Thoracic bristles: 1 propleural, 1 humeral, 1 praesutural, 2 supra-alar (anterior only as strong as interior post-alar), 1 intra-alar (about three-quarters length strong supra-alar, which is in turn about equal in length to hind dorsocentral), 2 post-alar (inner weak but slightly stronger than short thoracic bristles), the longer post-alar only slightly anterior to the hind dorsocentral; dorsocentrals 2 + O, of approximately equal length, 2 notopleural, 1 strong mesopleural near centre of hind margin sclerite with one on either side, and a group of shorter bristles in front of these forming a vertical line down the sclerite, 2 strong sternopleural bristles and two shorter ones grouped at lower posterior edge of sclerite; 2 scutellar, the hind pair set close together at the distal end.

MELANAGROMYZA dianellae Kleinschmidt

Host and distribution

Dianella caerulea Sims, Coolangatta, Apr. 1956, and Deception Bay, Mar. 1957 (A. R. Brimblecombe); Kenmore, Mar. 1957. The host is native to Queensland.

Larval morphology

No live larvae were present in the material collected. The following information in respect of mandibles and spiracles was obtained from parasitized specimens.

The structure of the cephalopharyngeal skeleton of *M. dianellae* (Figure 1) is closely similar to that of *M. phaseoli* (Figure 7). The left and right mandibles, however, are of similar size and shape. These carry two teeth, the upper being the longer, and both pointing downwards at a greater angle than in *M. phaseoli*.

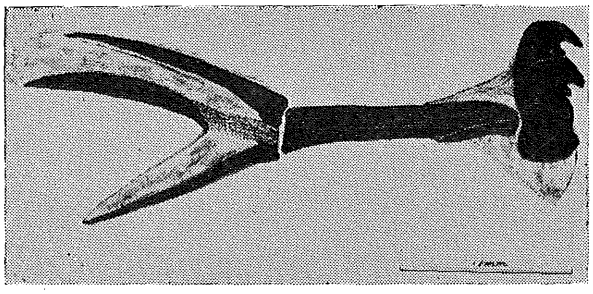


Fig. 1.—*Melanagromyza dianellae*—Larval mouth parts.

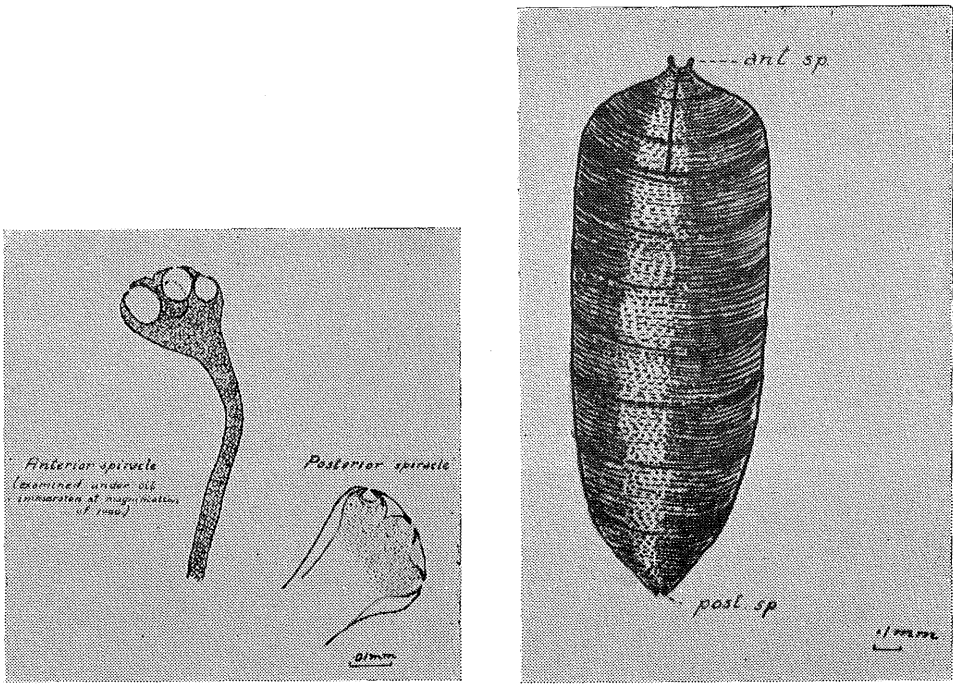


Fig. 2.—*Melanagromyza dianellae*—Larval spiracles. Left, anterior spiracle examined under oil immersion x 1,000. Right, posterior spiracle.

Fig. 3.—*Melanagromyza dianellae*—Puparium.

The anterior spiracles (Figure 2) are very small, 0·01 mm wide, each carrying four bulbs on the enlarged tip of a long stem. Each posterior spiracle (Figure 2) has three bulbs.

Larval behaviour

Mining occurs usually in the upper parenchyma, commencing as a thin line mostly near the tip of the leaf and extending straight along the margin or midrib, sometimes crossing from one to the other but never crossing the midrib (Figure 4). Several larvae may occur in a leaf and one sometimes may enter and follow the mine of another.

Excretal pattern

Larval excreta are scattered along the mine as small black pellets, occurring frequently but having no distinct arrangement.

Plant damage

The mines are whitish with a rust red stain surrounding the pupal cell. As many as five mines may occur in a leaf. These extend usually for 2–3 in. in the long strap-like leaf, mostly separated from each other but sometimes adjacent. The collections made indicate that attacks take place in the late summer and autumn months.

Puparium

Pupation occurs in a cell in the mine, usually about half of the distance back from the end, but with the anterior spiracles projecting through the upper epidermis. The puparium is black, elongate and somewhat torpedo-shaped, averaging 1·9 mm long and about one-third as wide (Figure 3).

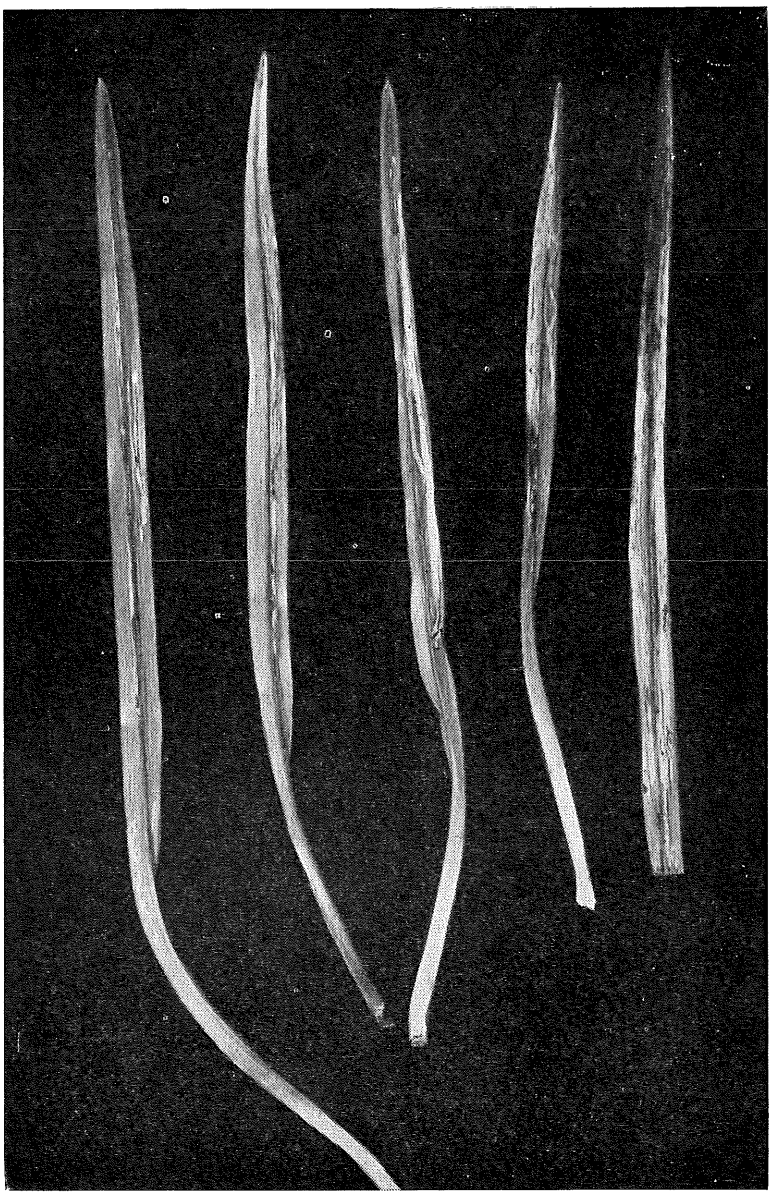


Fig. 4.—*Melanagromyza dianellae*—Leaves of *Dianella caerulea* showing larval mines, positions of puparia, and excretal pattern.

The longitudinal fracture for adult emergence proceeds directly backwards from between the anterior spiracles almost to the posterior margin of the third segment, where it joins the transverse fracture.

Parasites

Braconidae: *Opius* sp.; Coolangatta, Mar. 1957 (A. R. Brimblecombe). Pteromalidae: Gen. and sp. indet.; Deception Bay, Mar. 1959 (A. R. Brimblecombe).

MELANAGROMYZA indigoferae Kleinschmidt

Limited material was available for this species and detailed studies of immature stages were not possible.

Host and locality

Indigofera suffruticosa Mill., Eight Mile Plains, May 1958 (R. C. Colbran). The host is an introduced species from the West Indies but has long been naturalized in Queensland and occurs often in dense stands on roadsides and unused land.

Plant damage

The host material available showed that larvae had been numerous. At the time of collection, however, only puparia were present and most of these were empty or parasitized.

The mines are short ophionomes in the upper parenchyma, showing little variation in width and not confined to any particular part of the leaf. Little difference is shown between normal leaf colour and that of the mined tissue.

Puparium

Pupation occurs within the mine. The puparium is black and averages 1·32 mm in length and 0·57 mm in width. From the material collected on May 5, adults emerged from 12th to 30th of that month.

Parasites

Parasitism shown in puparia was about 80%.

Pteromalidae: Gen. and sp. indet.; Eight Mile Plains, May 1955 (R. C. Colbran).

MELANAGROMYZA phaseoli (Tryon)

History

This insect, known as the bean fly, was first recorded in Queensland, from Bulimba, Brisbane, in 1888 by Tryon (1895*a*), who described it under the name *Oscinis phaseoli* and included a short account of its habits and life cycle. Tryon (1895*b*, 1896, 1897) also referred to this fly as *Oscinis* sp. and *Oscinis fabae*. Coquillett (1899) in America redescribed it from specimens forwarded from New South Wales by W. W. Froggatt, who first recorded it in that State from the Gosford district in 1898 (Froggatt 1899).

Tryon (1895*a*) expressed the opinion that it is a native insect, although he could not find any indigenous Leguminosae as host plants. The fly has never been recorded extensively from native plants. The chief hosts belong to the genus *Phaseolus*. It would be reasonable to assume that native species of this plant genus, which commonly occur in south-eastern Queensland, should be amongst the hosts if the insect were indigenous. There are no such records. It is probable, therefore, that the fly originated outside Australia, possibly from southern Asia in fodder or packing straw.

Hosts and distribution

In addition to Queensland and New South Wales records, the pest is known to occur in the Northern Territory (Helson 1947). Occurrences, however, are widespread in many countries in the Pacific, southern Asia and Africa (Commonwealth Institute of Entomology, Distribution Maps of Pests, Series A (Agricultural) Map No. 130, 1961).

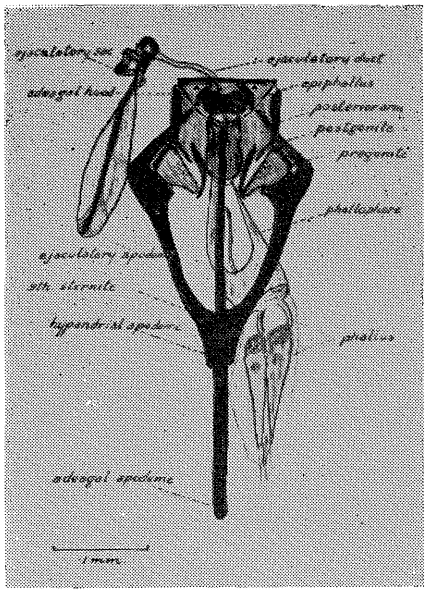
Recorded hosts in Queensland are confined to the leguminous genera *Phaseolus* (for which a definite preference is shown), *Dolichos, Vigna, Glycine* and *Crotalaria.* With the exception of *Crotalaria* (Papilionatae), these genera are all included in one tribe (Phaseoleae) (Bailey 1900), showing that the fly has a limited choice of hosts. These records show that the species occurs in all districts from the southern border north to Cairns and west to the dry inland districts of Dalby and Goondiwindi. It is uncommon in the Granite Belt, which supplies the State with large quantities of summer beans, since the climate there is unsuitable for overwintering.

In the following Queensland records those marked * are from the collections of the Department of Primary Industries (formerly Agriculture and Stock) and include those marked + from Annual Reports of the Department for the years stated. The sign = indicates that the collector was H. Tryon. Localities are not repeated for subsequent records from particular hosts.

Crotalaria mucronata Desv., *Newmarket, Brisbane, Mar. 1949 (P. Cheetham). *Dolichos lablab* L. *Brisbane, Mar. 1945 (A. R. Brimblecombe); *Tarzali, Jan. 1967 (G. W. Saunders); *Walkamin, Jan. 1968 (J. D. Brown). *Dolichos uniflorus* Lam., *Cooroy, June 1969 (D. Smith). *Dolichos* sp., + = New Farm, Brisbane, 1888-92. *Glycine max* (L.) Merrill, *Moggill, May 1945 (J. A. Weddell). *Phaseolus atropurpureus* DC., *Cooroy, Nov. 1968 (D. Smith); Mareeba, May 1969 (I. C. Cunningham); *Walkamin, Jan. 1968 (J. D. Brown). *Phaseolus lathyroides* L., *Ayr, Apr. 1948 (W. A. Smith); *Helidon, Apr. 1949 (A. May); *Brisbane, Feb. 1958 (A. R. Brimblecombe); *Nambour, Dec. 1960 (W. A. Smith). *Phaseolus lunatus* L., + = Brisbane, 1888-92; + = Townsville, 1905. *Phaseolus panduratus* Mart. ex Benth., *Malanda, Jan. 1967 (G. W. Saunders). *Phaseolus vulgaris* L., + = Brisbane, 1888-92; + = Rockhampton, 1899; + = Cairns, 1901; + = Bundaberg, 1904; + = Townsville, 1905; *Sunnybank, Feb. 1910 (E. Jarvis); + = Cleveland, 1911; + = Sandgate, 1911; + = Nambour, 1911; + = Woodford district, 1912; + = Gympie district, 1912; *Brisbane, Jan. 1919; + = Rosewood, 1919; + = Mooloolah, 1919; Bowen, May 1929; *Bli Bli, 1930; *Eudlo, 1930; *Nambour, Sept. 1931 (W. A. T. Summerville); Bowen, Oct. 1931; *Toowoomba and Dalby, Apr. 1954 (A. May); *Nerimbera, Aug. 1954 (A. May); *Lawgi, Apr. 1955 (T. Passlow); *Ravenshoe, July 1955 (T. Manefield); *Atherton, Mar. 1956 (T. Manefield); *Goondiwindi, Feb. 1958 (A. May); *Stanthorpe, Feb. 1958 (M. Bengston). *Vigna* sp., + = Childers, 1898; Cairns, Gordonvale (A. P. Dodd) (Dodd 1917); *Nambour, 1933 (A. R. Brimblecombe); *Ayr, May 1948 (W. A. Smith); *Brisbane, Dec. 1954. *Vigna catjang* Walp., + = Brisbane, 1910. *Vigna sinensis* (L.) Endl. ex Hassk., *Nambour, 1933 (A. R. Brimblecombe). *Vigna unguiculata* Walp., Esk, Feb. 1950 (J. A. Weddell).

Adult morphology

The original description by Tryon (1895*a*) was rather brief. The redescription by Coquillett (1899) gave a more complete picture of the species. These descriptions, however, did not include the male genitalia (Figure 5). The present studies show that in lateral view the long, slender side-pieces of the ninth sternite or hypandrium are concave dorsally, lying parallel to the aedeagal apodeme. At their broadest part the side-pieces are produced ventrally into two short, broad, postero-ventral processes. Immediately posterior to these lie the pregonites, which bear about six sensory pores anteriorly and numerous fine setae on the inner ventral surface. Two long arms constitute the posteriorly and dorsally directed extensions of the side-pieces, which in slide specimens appear to be curved inward. Anteriorly the ninth sternite is broadened to form a short blunt structure representing the hypandrial apodeme. The ninth tergite is a large bristly sclerite bearing ventrally the surstyli which carry numerous short sharp spines, and where the pair approximate, about half a dozen long setae. The cerci are bristly structures, especially at the distal end. The aedeagal apodeme is a long, slender, rod-like structure extending forward to the centre of the third abdominal segment and backward to a point well within the ninth tergite. That part of the postgonites visible ventrally lies close to the phallophore on either side. The phallus, especially at the distal end, is not so heavily sclerotized as the remaining structures. The ejaculatory apodeme, lying in the left side of the abdomen, is a long elliptical structure.



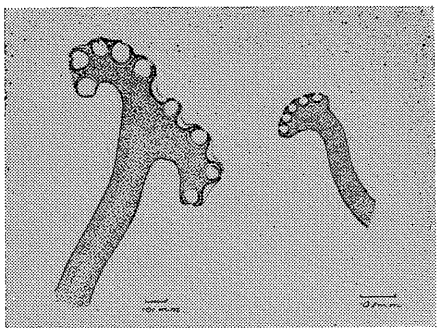


Fig. 5.—*Melanagromyza phaseoli*—Male genitalia (ninth tergite removed).

Fig. 6.—*Melanagromyza phaseoli*—Larval spiracles. Left, posterior. Right, anterior.

Larval morphology

Body length of the fully grown larva is about 4·0 mm. The mouthparts (Figure 7) when viewed laterally show that the left mandible, which is the larger, has one well-developed tooth dorsally and two lower weakly developed teeth. The right mandible is similar but only about half the height of the left and carries

usually only one secondary tooth, which is not always visible in slide preparations. The phragmata posterior to the labial sclerite are neither long nor broad, the dorsal and ventral arms of the dorsal process being of approximately equal length, lying parallel to each other and well separated. The ventral process is represented by one arm, the ventral, which is shorter than either arm of the dorsal process.

The posterior spiracles (Figure 6) consist of a variable number of spiracular bulbs (usually 8-10) situated on two large lobes on each side of the central stalk. The anterior spiracles (Figure 6) each shows five bulbs when viewed laterally.

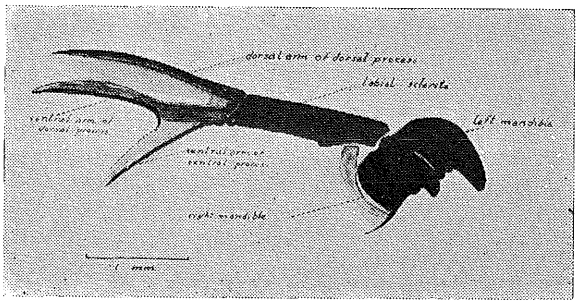


Fig. 7.—*Melanagromyza phaseoli*—Larval mouth parts.

Parasites

Numerous parasites have been bred from bean fly pupae, in most instances taken from cowpeas.

Braconidae: *Opius oleracei* Fischer; Nambour, Jan. 1961 (H. G. Greening); Nudgee, Feb. 1955.

Chalcididae: *Morismorella shakespearei* Girault; Queensland.

Eulophidae: *Achrysocharis douglassi* Girault; Cairns, Oct. 1915 (A. P. Dodd); Nambour, Dec. 1933 (A. R. Brimblecombe). *Hemiptarsenus semialbicornis* Girault; Cairns, Aug. 1915 (A. P. Dodd); Nambour, Dec. 1933 (A. R. Brimblecombe). *Hemiptarsenus* sp.; Brisbane, Feb. 1958 (G. Ettershank). *Neodimmockia agromyzae* Dodd; Gordonvale, 1917 (A. P. Dodd).

Eupelmidae: *Eupelmus gravi* var. *brevicinctus* Girault; Glasshouse Mts., 1912 (W. J. Ross).

Eurytomidae: *Eurytoma larvicola* Girault; Cairns, Aug. 1915 (A. P. Dodd). *Eurytoma* sp.; Brisbane, Feb. 1955.

Pteromalidae: *Eurydinotellus viridicoxa* Girault; Cairns, Aug. 1915 (A. P. Dodd); Nambour, Dec. 1933 (A. R. Brimblecombe). *Polycystomyia benefica* Dodd; Cairns, Aug. 1915 (A. P. Dodd). *Pterosema subaenea* Dodd; Cairns, Aug. 1915 (A. P. Dodd). *Trigonogastra agromyzae* Dodd; Gordonvale, 1917 (A. P. Dodd).

Girault in making the identifications of *Hemiptarsenus semialbicornis* and *Achrysocharis douglassi* thought them to be hyperparasites (Departmental records).

MELANAGROMYZA pisi Kleinschmidt

Host and distribution

Pisum sativum L., Toowong (Brisbane), Apr. 1953, and Ormiston, Sept. 1953 (A. R. Brimblecombe).

Adult behaviour

Oviposition and feeding punctures occur on the upper leaf surface without preference for any particular part. Sometimes a raised lump develops at the oviposition site due to proliferation of leaf tissue.

Larval morphology

The larva is pale yellow in colour with black mouthparts (Figure 8). The right mandible is larger than the left but both in lateral view are broad basally. Each has a single large tooth at the upper extremity and on the right mandible a smaller projection immediately below it. The dorsal and ventral processes are deep structures, united broadly to the labial sclerite on the cephalopharyngeal skeleton. The ventral process is slightly shorter than the dorsal. Both dorsal and ventral arms of the dorsal process are present, but are joined posteriorly to form a broad structure with an unsclerotized area separating the basal sections of the two arms. Only the ventral arm of the ventral process is present. The point of entry of the salivary duct is visible as a small process on the ventral side of the labial sclerite.

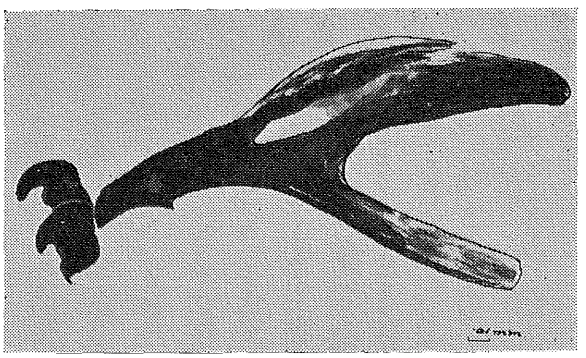
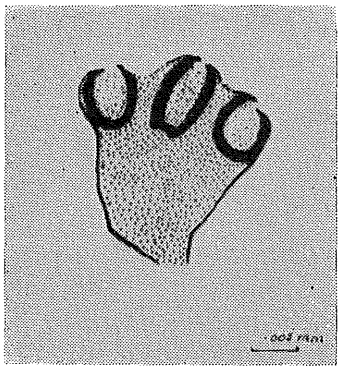


Fig. 8.—*Melanagromyza pisi*—Larval mouth parts.

The anterior spiracles are extremely small and not clearly definable even under oil immersion magnification. The posterior spiracles (Figure 10) with three bulbs are similar to those occurring in other species of the genus.

Fig. 9.—*Melanagromyza pisi*—Leaves of *Pisum sativum* showing larval mines, positions of puparia, and excretal pattern.



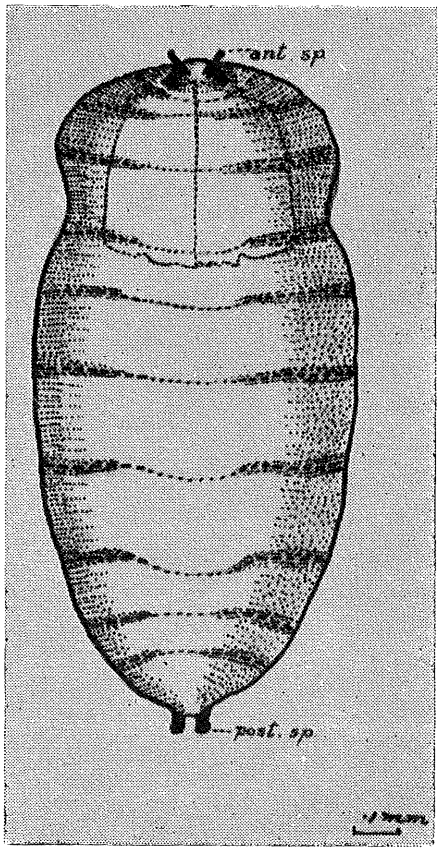


Fig. 10.—*Melanagromyza pisi*—Posterior spiracle.
Fig. 11.—*Melanagromyza pisi*—Puparium.

Larval behaviour

Larvae tunnel in the upper parenchymatous tissue. Several may occur in a single leaf, from which they are unable to migrate to another section of the compound leaf. Some tunnels occur near the leaf edge and others near the larger veins but mining positions are irregular.

Excretal pattern

The excretal pattern is determined by the moulting habits of the larva. At each moult excreta is expelled; there are thus three evenly spaced dark pellets, the first a short distance from the beginning of the mine, the second, which may be scattered, usually about halfway along the mine, and the third near the pupa in the pupal cell. All are placed medianly in the mine. The first and second deposits are each accompanied by the larval exuvium of the respective stage.

Plant damage

Larvae have been found only in well-nourished plants in spring and autumn. The mines are linear, averaging three-quarters of an inch in length, whitish when viewed from above and not noticeable from below. When held against the light they are normally pale green from both sides of the leaf. Each begins as a fine straight mine, later becoming wider and irregular (Figure 9). It may cross on itself or another mine, amalgamation with other mines giving a large, completely mined area with small islands of unmined tissue.

Puparium

Pupation occurs in the rounded end section of the mine anywhere beneath the upper leaf surface, through which the anterior spiracles project. Several pupae may occur in heavily mined leaves. On formation, the puparium (Figure 11) is pale, finally black and shining, which makes it conspicuous in the white mined leaf. Size varies but averages about 1·5 mm in length and half this in width. At the anterior end there is a constriction behind the head region, the remainder of the body showing broad segmentation. The dorsal surface is convex but slightly flattened and pitted to some extent, while the sides are smooth. The posterior spiracles are situated on a projection slightly broader than long, pointing backward from the posterior end of the body. The median emergence slit (Figure 11) proceeds backward from between the anterior spiracles but the lateral breaks are slightly more than half of the distance from the median line to the lateral margin. The emerging fly pushes the two flaps forward; these remain attached anteriorly like a double lid.

Parasites

Parasitism in this species has reached 50%. Species bred are as follows; all were from material collected by A. R. Brimblecombe.

Braconidae: *Opius cinerariae* Fischer; Brisbane, Sept. 1953.

Eulophidae: *Hemiptarsenus* sp.; Brisbane and Ormiston, Sept. 1953. *Tetrastichus* sp.; Ormiston, Sept. 1953.

Pteromalidae: Gen. and sp. indet.; Toowong, Apr. 1953.

MELANAGROMYZA polyphyta Kleinschmidt

The species *M. polyphyta* established by Kleinschmidt (1960) was synonymized with *M. atomella* Malloch by Spencer (1963).

Differentation between some Agromyzid species is difficult and points of difference other than morphology may be of importance. Spencer, in determining the synonymy of the widely distributed and polyphagous species *M. atomella,* placed some importance on the colour of the puparium and used this character in supporting the status of *M. polyphaga* Spencer (1963).

With regard to the discussion on the synonymy of *M. atomella,* Spencer (1963) stated that it can now be regarded that "the puparium in all cases is pale yellowish-brown". In contrast, all puparia bred in the present study under the name of *M. polyphyta* were at first yellowish when newly formed but later were entirely black with dark spiracles and mandibles. This fact is sufficient therefore to warrant withholding the synonymizing of *M. polyphyta* with *M. atomella.*

Hosts and distribution

In many instances, due mainly to parasites, adults of this species were not bred from collected material but a close study of mines and immature stages enabled an insect-host relationship to be established. Hosts marked * therefore can be assumed to harbour this species pending the collection of further material. Where the insect determinations were made on characters of the mines, together with those of (a) larvae, (b) pupae, or (c) larvae and pupae, the host records are respectively marked (ML), (MP), (MLP). Collectors of material marked (A), (B), (C) are respectively A. R. Brimblecombe, M. Bengston and B. R. Champ.

**Acalypha wilkesiana* Muell. Arg., Toowong, Brisbane, Mar. 1957 (A) (ML). **Alphitonia excelsa* (Fenzl.) Benth., Kenmore, Brisbane, Feb. 1959 (MP). **Brachychiton* sp., Buranda, Brisbane, Feb. 1955 (MP). **Breynia oblongifolia* Muell. Arg., Kenmore, Jan. 1955 (MLP). **Camellia japonica* L., Buranda, Feb. 1955 (A) (MP). **Capsicum annuum* L., Toowong, Dec. 1954 (A). *Cassia coluteoides* Collad., Toowong, Jan. 1955 (A); Kenmore, Mar. 1956, 1957. **Cestrum parqui* L'Herit., Buranda, Mar. 1955 (MP). **Citrus aurantifolia* Swingle, Toowong, Mar. 1956 (A) (ML). **Coffea arabica* L., Kenmore, Apr. 1956 (ML). **Cudrania javanensis* Trec., Moggill, Oct. 1955 (ML). *Erythrina crista-galli* L., Kenmore, Apr. 1956. **Euphorbia pulcherrima* Willd., Kenmore, Mar. 1959 (MP). *Eustrephus latifolius* R. Br., Tallebudgera, Mar. 1953; Redland Bay, Mar. 1953 (B); Kenmore, Apr. 1953. **Gardenia jasminoides* Ellis, Kenmore, Feb. 1957. **Hydrangea macrophylla* Ser., Toowong, Apr. and Sept. 1955 (A). **Kigelia pinnata* DC., Kenmore, Mar. 1959 (MP). **Lonicera periclymenum* L., Toowong, Mar. 1937 (A) (MLP). **Melia azedarach* L. var. *australasica* C.DC., Kenmore, Mar. 1954 (MP). *Murraya paniculata* (L.) Jack, Brisbane, May 1952 (C); Botanic Gardens, Brisbane, Mar. 1957 (MLP). **Passiflora caerulea* L., Toowong, Mar. 1957 (A). *Passiflora edulis* L., Toowong, Mar. 1957 (A) (MP). *Passiflora foetida* L., Ayr, May 1958 (W.A. Smith). *Passiflora suberosa* L., Kenmore, Apr. 1953. *Vigna sesquipedalis* Fruswirth, Toowong, Apr. 1953 (A). **Plumeria rubra* L., Kenmore, Apr. 1956 (MP). **Quisqualis indica* L., Toowong, Feb. 1959 (A) (MP). **Salix babylonica* L., Buranda, Jan. 1955 (MP).

From the range of hosts given it is not possible to determine definitely whether the species is native to Australia but it may be noted that the more consistently mined species are indigenous to this country. Introduced garden plants attacked are mined to a much lesser extent. According to Spencer (1963) the species ranges from India to Micronesia, and Japan.

Adult behaviour

The behaviour of the fly is similar to that of *Melanagromyza phaseoli* in many respects. Body size is much smaller and the punctures made in host leaves are smaller and less noticeable.

Larval morphology

Larvae are cream-coloured, shiny and translucent, and resemble those of the bean fly in shape but are approximately half the size.

The mandibles (Figure 12) are short and broad; the terminal tooth, usually simple in this genus, is modified to form a broad, flat structure with a serrated edge, the number of notches present varying from 4 to 9. These may be blunt, or sharp, with pointed, rounded or flattened edges. This variability applies to specimens bred from one host at one time as well as among specimens from different hosts. The left mandible is vertically narrower, carrying fewer serrations than the right. The paraclypeal phragma has both dorsal and ventral processes well developed but narrow, the ventral being shorter than the dorsal; both arms of the latter are well separated, of nearly equal length and approximated distally, the upper bending down towards the lower.

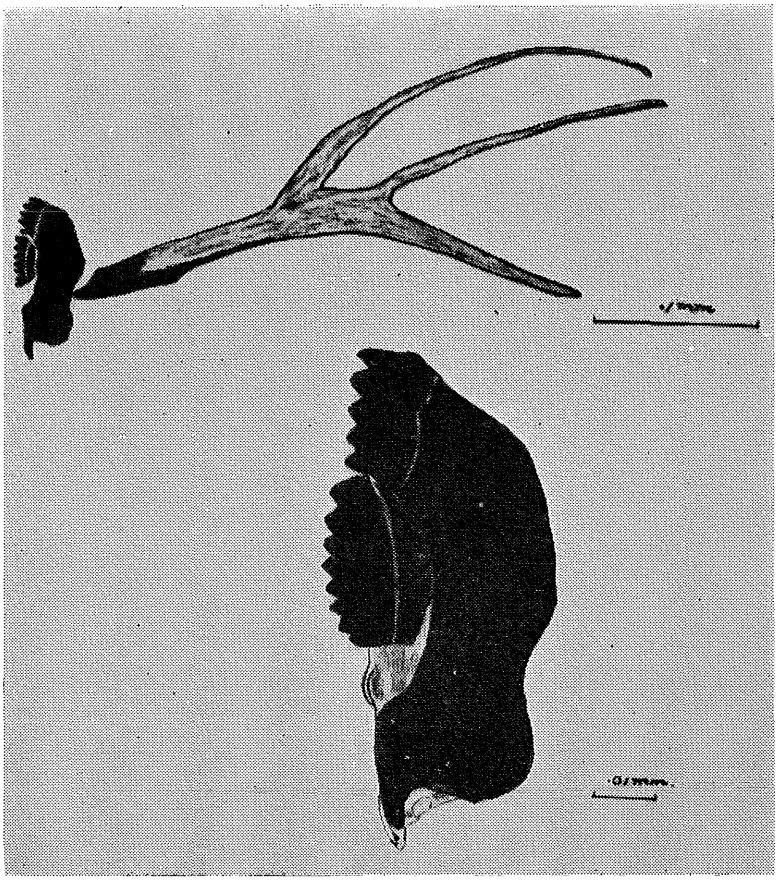


Fig. 12.—*Melanagromyza polyphyta*—(above) larval mouth parts; (below) mandibles.

The paired anterior spiracles (Figure 13) are small, situated dorsally, and each borne on a long upwardly directed stem. In slide preparations six small bulbs are visible on the expanded upper portion in two rows of three. The posterior spiracles (Figure 13) are larger; each has three bulbs.

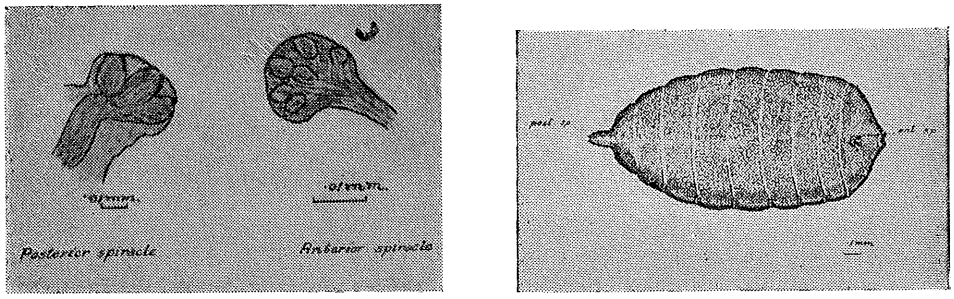


Fig 13.—*Melanagromyza polyphyta*—Larval spiracles. Left, posterior. Right, anterior.

Fig. 14.—*Melanagromyza polyphyta*—Puparium.

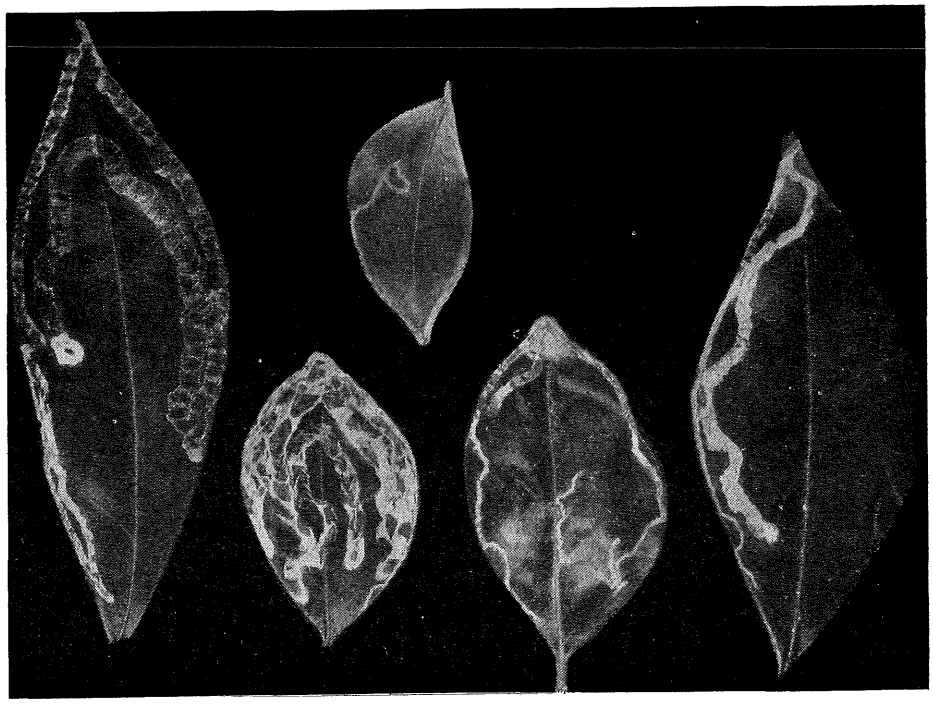


Fig. 15.—*Melanagromyza polyphyta*—Leaves of *Murraya paniculata* showing larval mines near leaf margin.

Fig. 16.—*Melanagromyza polyphyta*—Leaves of *Breynia oblongifolia* showing larval mines, and positions of puparia. (Three lower leaves on left mined by lepidopterous larvae).

Larval behaviour

Mining occurs almost entirely on the upper side of the leaves and is chiefly epidermal. In most leaves it begins near the margin and follows this for the greater part of its length (Figure 15). In such hosts as *Cassia coluteoides, Lonicera periclymenum* and *Breynia oblongifolia* (Figure 16), two larvae can mine completely a single leaflet, whereas larger leaves, e.g., *Passiflora caerulea* (Figure 17), can easily support four larvae to maturity. Mines are retraced at random, the larva then eating the exuded sap in the mine already excavated. The upper wall of the mine collapses inwards, tending to close the space, so the miner now in the reverse direction makes the chewing movements which it would normally make in a new mine. Some new cells are included in the feeding or the larva veers into new tissue. Each larva can mine for a comparatively long distance, usually not crossing the midrib. Sometimes the fully grown larva, approaching pupation, may extend the mine slightly in isolated places into the upper parenchyma and perhaps into the spongy mesophyll. In these instances the mine turns creamy-buff coloured or brown, the eroded tissue hardening and preventing further breakdown.

Larvae have been found in all seasons except the midwinter months, but mainly in the later summer and autumn following the summer rains. Average duration of the final instar during the warmer weather is 3 days. The fully grown larva forms a broad pupal cell at the end of the mine just beneath the upper epidermis and pupation thus is within the mine.

Excretal pattern

No excretal pattern is visible in epidermal mines, probably because there is little solid matter devoured in this region. Where mining extends into the upper parenchyma there is a scattered excrement line of small black deposits for a short distance, usually on one side of the mine.

Plant damage

Attacked leaves are young although mostly full-sized. Early mines are fine and tend to be inconspicuous as the epidermis closes in behind the larva. The later mines are broad, often more than 1·0 mm wide, linear and silvery, and in these outer wall collapse is irregular. The silvery appearance is accentuated by the penetration of air under the cuticle. Irregular collapse of the mine tends to exclude the air, so the remaining isolated patches give the effect of a line of silver islands. As the mine ages it becomes whitish and more distinct, especially in the older leaves.

Each mine includes a comparatively large proportion of the leaf area. With several larvae in the one leaf and with mines crossing and anastomosing, most of the leaf can be damaged (Figures 16 and 17). In narrow leaves, e.g. *Eustrephus latifolius* (Figure 18) and *Salix babylonica,* the whole width of the leaf is mined for some distance or even for the entire length.

Puparium

The newly formed puparium is at first yellowish, later entirely black, with dark spiracles and mandibles.

In the broader leaves its orientation varies but usually lies at an angle to the midrib. In strap-like leaves, e.g. *Eustrephus,* where the mines are longitudinal, the puparium lies lengthwise. Size varies considerably but averages about 2·0 mm in length and 1·0 mm in width. The surface pattern shown often represents the imprint of the adjacent cells of the host tissue (Figure 14).

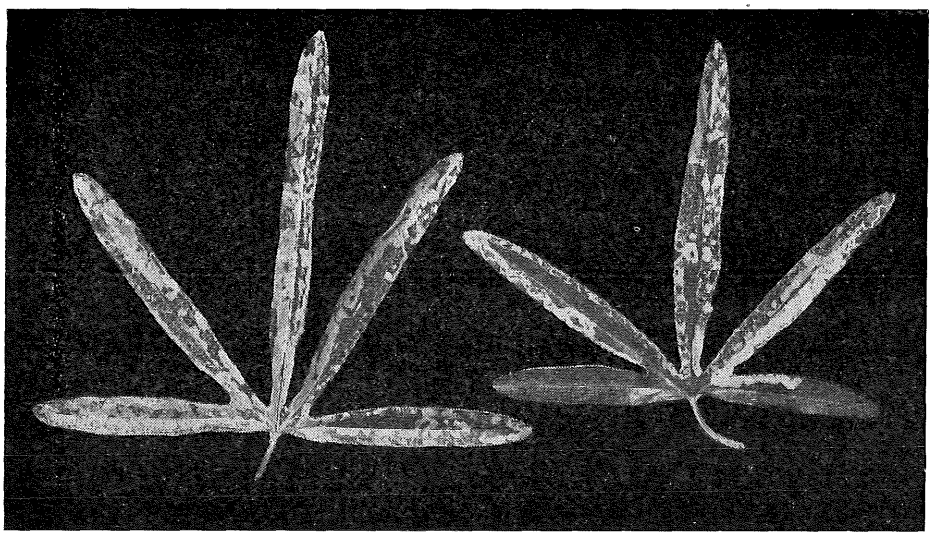


Fig. 17.—*Melanagromyza polyphyta*—Leaves of *Passiflora caerulea* showing larval mines, and positions of puparia.

The paired anterior spiracles lie close together dorsally on the prothorax, each at the end of a long stem which projects through the epidermis of the host plant. Each has six pores surrounding the expanded bulb-like portion at the top. The posterior spiracles are on a pair of stout projections extending backwards from the eighth abdominal segment. These are stouter than the anterior spiracles. A pale line marking the direction of fracture for adult emergence begins at a point in front of the anterior spiracles and passes back between them for about one-quarter of the body length.

The pupal period varied from 18 to 20 days in late autumn and was less in the spring.

Parasites

Parasitism in this species in all hosts was often high. Two parasites were bred:

Braconidae: *Opius atricornis* Fischer; Kenmore, Mar. 1953; Tallebudgera, Mar. 1953; Toowong, Apr. 1953 (A. R. Brimblecombe).

Eulophidae: *Achrysocharis* sp.; Kenmore and Tallebudgera, Mar. 1953. *Enaysma* sp.; Redland Bay, Mar. 1953.

MELANAGROMYZA wikstroemiae Kleinschmidt

Host and distribution

Wikstroemia indica (L.) C. A. Mey, Tallebudgera, Mar. 1953, and Kenmore, Feb. 1954; Redland Bay, Mar. 1953, Imbil, Sept. 1953, Currumbin, Jan. 1958, Coolangatta, Jan. 1959, and Deception Bay, Mar. 1959 (A. R. Brimblecombe); Dunwich, Mar. 1953 (A. Webber).

The only host recorded by the author is a native shrub and is the only one in the genus. The insect is almost certainly indigenous. Plants in most parts of south-eastern Queensland have been infested; possibly the geographical range of the insect is as extensive as that of the host.

The monophagous habit shown may be due to the host genus, in Queensland, being monospecific (Bailey 1901).

Adult behaviour

Flies have been bred in most months from September through to June, more particularly in March. Oviposition occurs on the lower leaf surface but numerous feeding punctures are made on both surfaces, principally the upper, near the leaf tip and midrib. A small swelling may develop at the feeding site, or the tiny hole may be surrounded by a white rim of dead tissue.

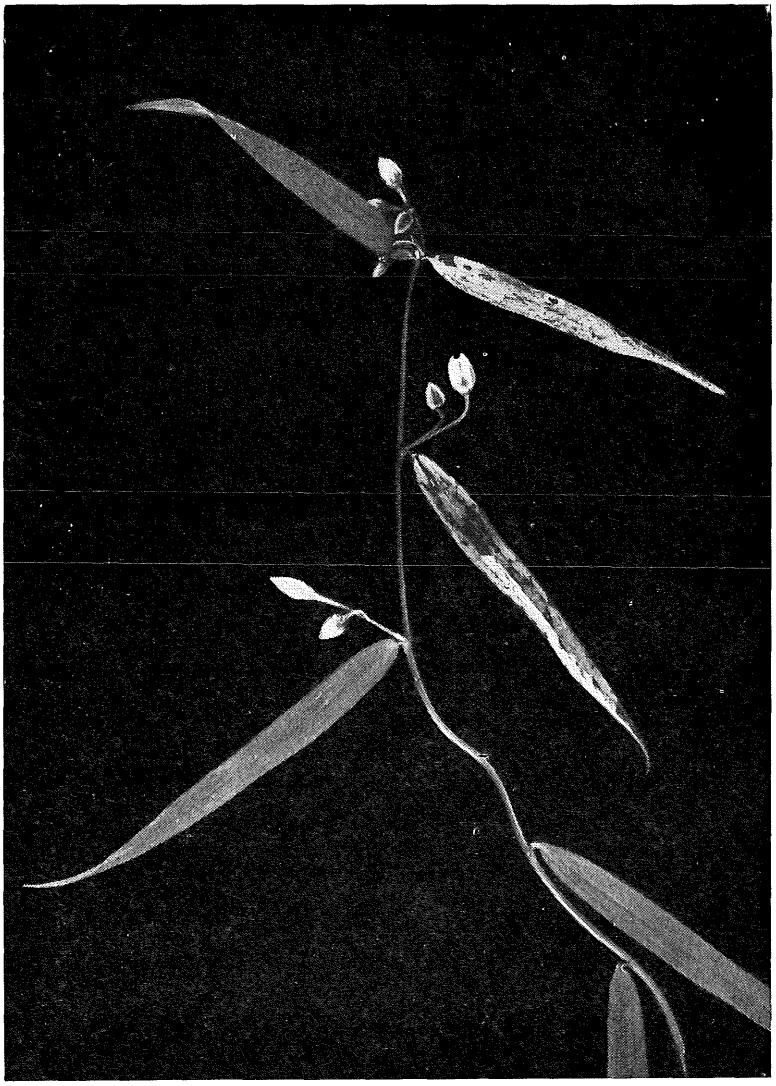
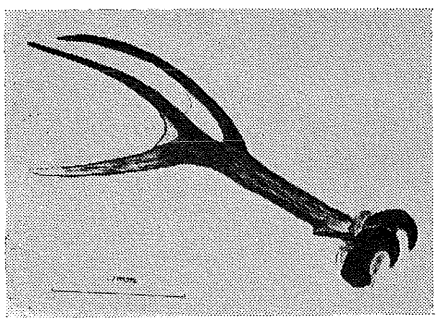


Fig. 18.—*Melanagromyza polyphyta*—Leaves of *Eustrephus latifolius* showing larval mines, and positions of puparia.

Larval morphology

The dissected mouthparts (Figure 19) show that the left mandible is longer than the right. Each carries a single, large, curved tooth at its upper extremity. The dorsal and ventral arms of the dorsal process of the cephalopharyngeal apparatus lie almost parallel and are of approximately equal length and width. The ventral arm extends slightly further distally and the dorsal curves down distally towards it. The ventral process has only one arm, the ventral, which is shorter than and approximately as wide as the arms of the dorsal process in lateral view.

Spiracles are extremely small and indistinct.



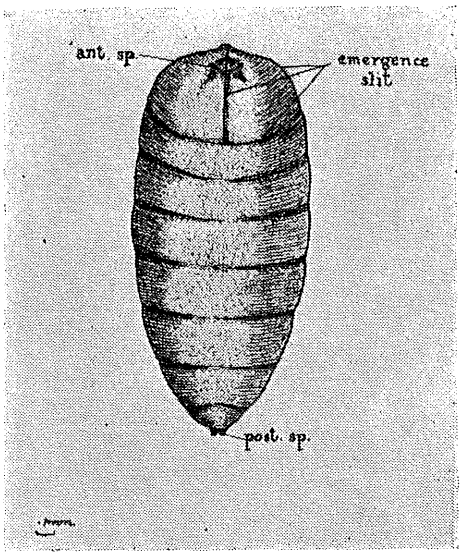


Fig. 19.—*Melanagromyza wikstroemiae*—Larval mouth parts.

Fig. 20.—*Melanagromyza wikstroemiae*—Puparium.

Larval behaviour

The larva first eats a shallow mine through the lower parenchyma, later tunnelling to the upper surface, where it makes a conspicuous pale green mine. Often more than one larva is present in a leaf, but even when the fly is numerous the number per leaf rarely exceeds three, which is sufficient to mine completely an average-sized leaf (Figure 21).

Excretal pattern

The excrement shows a well-defined pattern in the narrow mine (Figure 21) and is arranged as a line of small black deposits spaced at regular intervals either in the middle or more usually towards one edge of the mine.

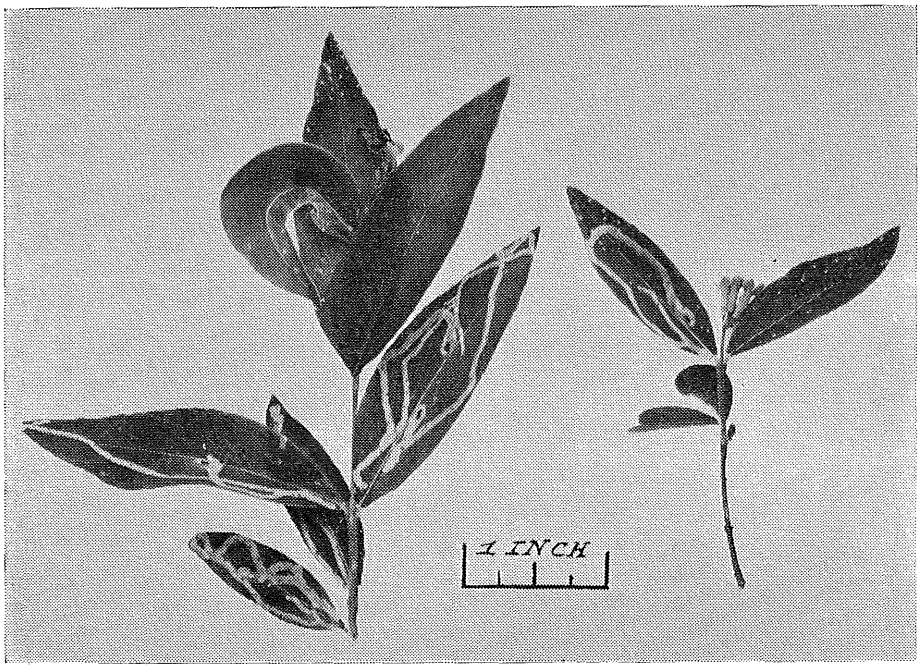


Fig. 21.—*Melanagromyza wikstroemiae*—Leaves of *Wikstroemia indica* showing adult punctures, mines, positions of puparia, and excretal pattern.

Plant damage

Plant damage reaches a peak in late summer. The early and narrowest part of the mine in the lower parenchyma is made by the first two larval stages. The under-surface of the leaf is pale and the white coloured mine is not clearly visible. The mine in the upper parenchyma, made by the third stage, is about the same length as that on the lower side but is much wider. In this region it varies from 0·6 to 1·5 mm in width and is conspicuously pale yellowish-green against the dark upper leaf surface. The complete ophionome is long and winding, occasionally crossing its own path. There is no tendency as in some species of this genus to follow the leaf margin. The damage can be so serious that the leaves are completely mined and the plant as a result may become defoliated by leaf drop.

Puparium

The mine widens at its terminus, which may be anywhere near the upper surface of the leaf. Pupation takes place *in situ* just beneath the epidermis, through which the anterior spiracles project. The puparium (Figure 20) is black and about twice as long as wide; length varies between 1·9 and 2·18 mm with a mean of 2·04 mm. Surface markings are often imprinted by the plant cell margins due to pressure of the leaf epidermis while the puparium is hardening.

Fly emergence is through a hole made dorsally in the puparium, which splits from a point near the apex along the median line between the anterior spiracles to a transverse line then forwards laterally on each side to the apex.

Parasites

Braconidae: *Opius atricornis* Fischer; Imbil, Apr. 1953 (A. R. Brimblecombe); Kenmore, Feb. 1954; Redland Bay, Mar. 1953 (A. R. Brimblecombe).

Eulophidae: *Achrysocharis* sp.; Kenmore, Feb. 1954.

Eupelmidae: *Eupelmella* sp.; Kenmore, Feb. 1954.

Pteromalidae: Gen. and sp. indet.; Dunwich, Mar. 1953 (A. Webber).

(ii) Genus OPHIOMYIA Braschnikov

The genus *Ophiomyia* is common in Europe and America. The only species known to occur in Australia is the introduced lantana seed fly (*O. lantanae* (Froggatt)).

OPHIOMYIA lantanae (Froggatt)

Lantana seed fly was first introduced into Queensland from Hawaii by Tryon in 1914 (Tryon 1914), but owing to unfavourable weather conditions the attempt to establish it was not successful (Tryon 1915). A further introduction was made in 1917 by H. Jarvis (Tryon 1918) and flies were subsequently liberated and established in Brisbane and nearby areas, at Mooloolaba on the Near North Coast and at Mackay, Gordonvale and Cairns. Dissemination both artificially and naturally soon covered most of the State. Flies were found in the Sydney area of New South Wales in May 1919; this could indicate rapid spread from Queensland since no artificial introduction into that State was known (Froggatt 1919; Tryon 1919).

The economic aspects of the history of this fly in Australia and adjacent countries, together with much of the biology of the species, have been studied by various authors, including Jepson (1916), Froggatt (1919), Aldrich (1923), Perkins and Swezey (1924), Subramaniam (1934), Veitch (1935), Beeson and Chatterjee (1940).

Host and distribution

Lantana fly is a native of Mexico and Guatemala (Frick 1952). It has been purposely introduced into Hawaii, Samoa, Fiji, Caroline Is., New Caledonia, Australia and India in attempts to control the host plant. *Lantana camara* L. is the only host in Queensland and distribution of the fly is throughout the lantana-infested area, which covers most of the eastern coastal and subcoastal portions of the State.

Synonymy

Agromyza lantanae Tryon 1915 (nomen nudum).

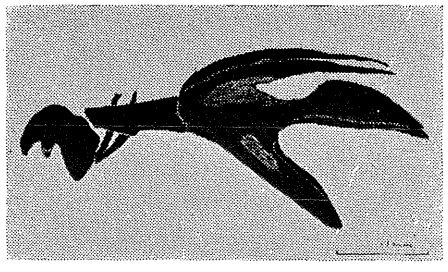
Agromyza lantanae Froggatt 1919.

Ophiomyia lantanae (Froggatt): de Meijere 1925.

This insect (without name) was first mentioned in literature as early as 1902 (Perkins 1902). Various subsequent references following its introduction into Hawaii used only the name *Agromyza* sp. Tryon (1915), in discussing the first introduction into Queensland, called it *Agromyza lantanae* but made no mention of the appearance of the insect. Froggatt (1919), under the impression that it was originally described as *Agromyza lantanae* by Perkins in 1902, gave only a brief description which was sufficient to validate the name. This was later supplemented by Aldrich (1925) from Hawaiian material.

Larval morphology

The mouthparts (Figure 22) are rather robust. The left mandible is larger than the right and carries two teeth, one above the other, on a broad base. The right mandible bears only one visible tooth at its upper extremity, approximately level with the lower of the left mandible. The dorsal arm of the dorsal process of the cephalopharyngeal skeleton is narrow and pointed distally, the ventral arm being expanded into a broad plate distally with a narrow neck at the base. The ventral process is fairly broad and shorter than the arms of the dorsal process. A central area of weakness shows where the ventral process is partially divided into dorsal and ventral arms.



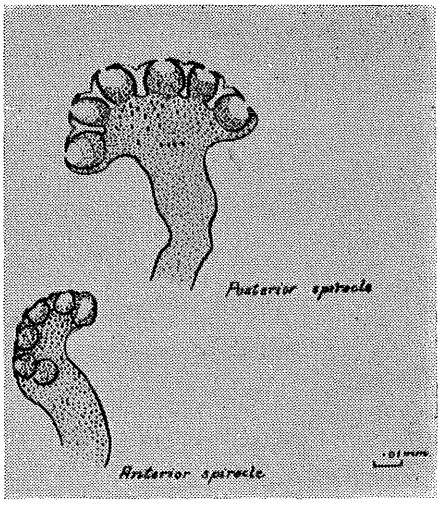


Fig. 22.—*Ophiomyia lantanae*—Larval mouth parts.

Fig. 23.—*Ophiomyia lantanae*—Larval spiracles.

The anterior spiracles in slide preparations showed six bulbs (Figure 23). The posterior spiracles also have six bulbs on a wide expansion at the distal end of the stalk (Figure 23).

Parasites

Braconidae: *Ipobracon* sp.; Brisbane, Oct. 1954. *Opius atricornis* Fischer; Brisbane, Oct. 1954.

Pteromalidae: *Syntomopus* sp.; Brisbane, Oct. 1954.

(b) Subfamily PHYTOMYZINAE Fallén

The subfamily Phytomyzinae is represented in Queensland by six genera, namely *Cerodontha, Haplomyza, Liriomyza, Phytobia, Phytomyza and Pseudonapomyza.* These may be separated as follows.

1. Scutellar bristles 4 2
   Scutellar bristles 2 ..... *Cerodontha*

2. Costa reaching to tip of M1 + 2 3
   Costa reaching to tip of R4 + 5 4

3. Scutellum yellow.....5
   Scutellum concolorous with mesonotum; body colour grey and black.....*Phytobia*

4. Body colour grey and yellow.....*Phytomza*
   Body colour black.....*Pseudonapomyza*

5. M-m cross-vein normally absent.....*Haplomyza*
   M-m cross-vein normally present.....*Liriomyza*

(i) Genus CERODONTHA Rondani

Species of the genus *Cerodontha* are common in Europe; some occur in America and a few in other countries. One species is now recorded from Queensland.

CERODONTHA australis Malloch

History

This species was described in 1925 from material collected in New South Wales.

The material bred in the present study was poor. It agreed with Malloch's description of *C. australis* and although this name is used, confirmation from better material is desirable.

Host and locality

Poa annua L., Brisbane, Nov. 1958 (A. R. Brimblecombe).

Adult behaviour

Punctures made in the leaf by the adult female, unlike those of most other Agromyzidae, are elongate. Feeding punctures may be very numerous and often almost contiguous, resembling a chain along the length of the leaf.

Larval morphology

The final stage larva is pale yellow, about 3·5 mm long and with dark mandibles each bearing two equally sized teeth.

Larval behaviour

The larva mines between the two epidermal layers (Figure 24), retracing its direction of feeding to form a blotch mine and eventually a pantonome. A disturbed larva immediately reverses its direction of feeding. Tunnelling, however, is usually towards the stem and pupation takes place between the leaf sheaths surrounding the lower part of the grass stems.

Excretal pattern

Excretal deposits occur but are not very noticeable. The pellets are fine and scattered closely in the early section of the mine, later being evenly spaced throughout the mine length and progressively larger in size.

Plant damage

Damaged leaves turn pale or pale yellow in colour and eventually die back from the tip. Early damage is not clearly defined owing to the presence of chlorophyll-bearing tissue remaining beneath the upper epidermis. Plants in an advanced stage of attack are easily distinguished by dying leaves.

Damage by a lepidopterous larva was also found in the leaves of the host (Figure 24). This resembled that of *C. australis,* but the mines were clear, with thickly deposited frass lines composed of small dark pellets.

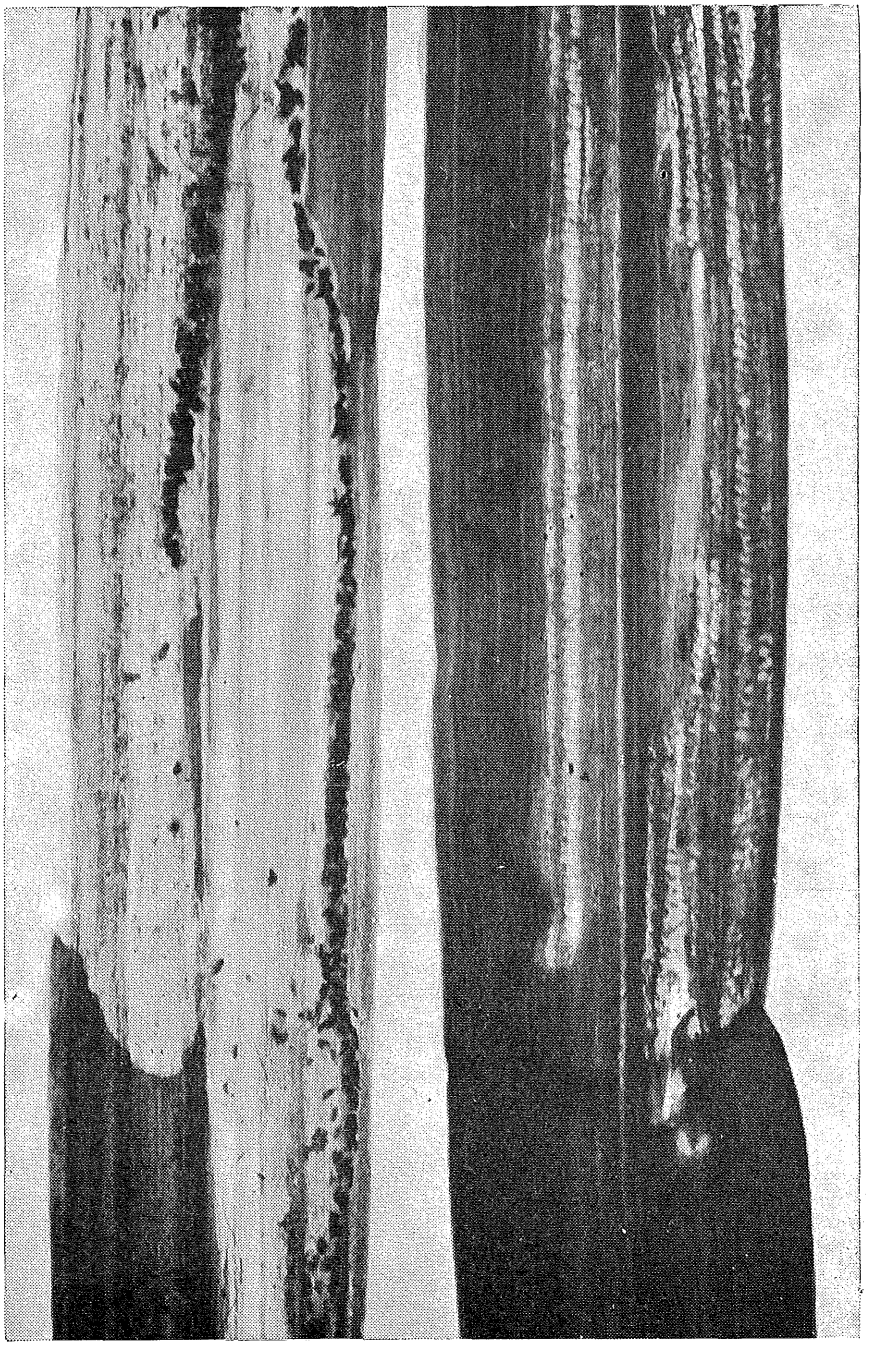


Fig. 24.—*Cerodontha australis*—Parts of leaf laminae of *Poa annua* showing (right) larval mine, (left) lepidopterous mine.

Puparium

Many puparia were found but in most instances adult emergence had occurred. Normally only one was present in each leaf. The length averaged 2·2 mm and was twice the width. When newly formed the puparium is whitish, then turning yellow and finally darkening to pale brown. Segmentation is distinct. Spiracles are apically branched and project from both anterior and posterior ends.

(ii) Genus HAPLOMYZA Hendel

Several species are known from America, with a few in other countries including Australia. Two species occur in Queensland, namely *H. caulophaga* Kleinschmidt and *H. imitans* Malloch. Spencer (1963) has synonymized *H. imitans* with *H. chenopodii* Watt and transferred both this species and *H. caulophaga* to the genus *Liriomyza*. In this paper, however, they are retained in *Haplomyza*.

HAPLOMYZA caulophaga Kleinschmidt

Host and locality

Beta vulgaris L. var. *cicla* L., Nudgee (Brisbane), Sept. 1957.

Adult behaviour

No oviposition or feeding punctures were noted. The eggs probably are laid in the leaf petiole or midrib, since the tunnels found were in only these parts of the plants.

Larval morphology

No specimens of larvae were obtained. The cephalopharyngeal skeleton (Figure 25), however, was extracted from the pupal case. The two mandibles are identical, slightly longer than wide, each with two teeth, the upper tooth larger than the lower. In lateral view a round projection, although actually exterior to the lower tooth, appears to jut from its upper surface. On the side of the base of each mandible is a long rod with a dorsal inwardly pointing process. The labial sclerite is short and deep, the dorsal process of the skeleton being very deep, flattened laterally, short, almost straight, and about one-and-a-half times as long as the ventral process.

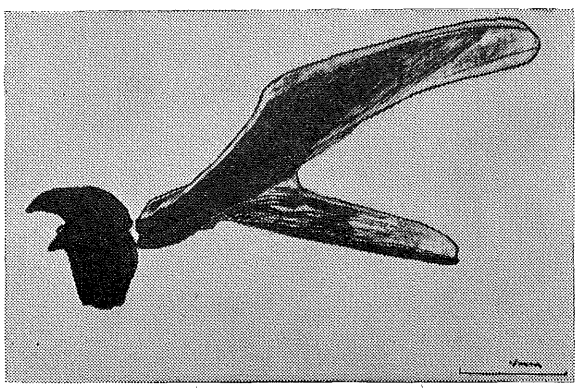


Fig. 25.—*Haplomyza caulophaga*—Larval mouth parts.

Larval behaviour

Larvae tunnel in the soft, white, spongy tissue between the vascular strands in the leaf petioles and midribs. The mines are colourless, about 1·0 mm wide, 3–4 in. long and more or less parallel to the surface. When fully grown, larvae approach the surface, where a "window" or a hole indicates the site of pupation.

Plant damage

Mined celery leaves are discoloured and look unpalatable. Badly mined leaves turn brown and die.

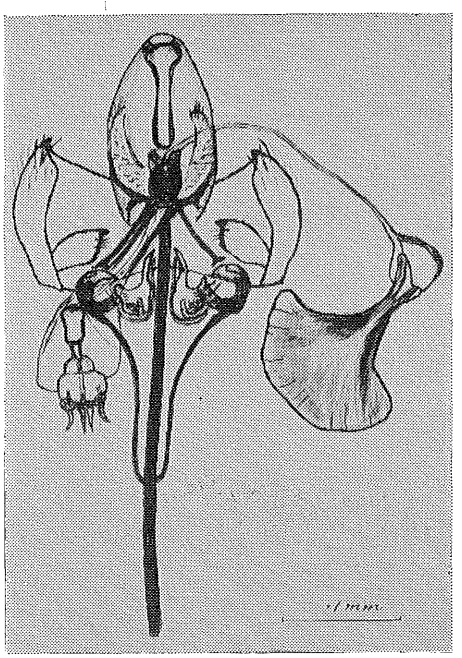
Puparium

The puparium is pale brown in colour, 2·3 mm long and 0·8 mm wide, more or less barrel-shaped, smoothly convex dorsally, rather flattened and noticeably segmented ventrally. The anterior end is rounded and smooth. Both pairs of spiracles are dorsal and in each pair they are well separated, the posterior pair being larger than the anterior and slightly closer together.

HAPLOMYZA imitans Malloch

History

Malloch (1934) described *Haplomyza imitans* from specimens bred at Sydney, New South Wales, October 1931, from spinach, wall-flower and *Stellaria media.* Another collection record of this species from that State in 1930 (Anon. 1947) concerned a larva mining in silver-beet stalks and leaf veins and therefore could perhaps relate to *H. caulophaga.*



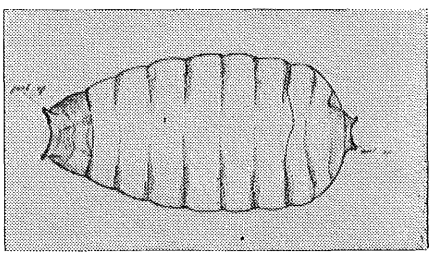


Fig. 26.—*Haplomyza imitans*—Male genitalia.

Fig. 27.—*Haplomyza imitans*—Puparium.

Hosts and distribution

Chenopodium album L., Stanthorpe, Oct. 1954 (A. W. S. May). *Coronopus didymus* (L.) Sm., Brisbane, Oct. 1954. *Stellaria media* (L.) Vill., Buranda, Sept. 1954; Stanthorpe, Oct. 1954 (A. W. S. May); Toowong, Nov. 1957 (A. R. Brimblecombe).

Taxonomy

Frick (1952) indicated that adults of *H. chenopodii* Watt described in 1924 from New Zealand and *H. imitans* are similar. Further similarities are shown in host plants, life history and adult habits and suggest that *H. imitans* might be a synonym. Such synonymy is claimed by Spencer (1963), who also placed the species in the genus *Liriomyza.*

Adult morphology

Adults are very similar to those of *H. caulophaga,* although the male genitalia (Figure 26) are quite distinct. The ninth sternite is not greatly curved dorso-ventrally; the side pieces are slightly widened from above downwards; the sternite in ventral view is deeply V-shaped with the apex rounded; the posterior extremities with the attached pregonites are widely separated. The postgonites are irregularly shaped and lie on each side of the median line. The aedeagal apodeme extends posteriorly beyond the anterior margin of the ninth tergite and anteriorly extends far beyond the ninth sternite. The ninth tergite is laterally broad and short to accommodate the large aedeagal hood; a short, heavily sclerotized spine lies at the ventral posterior angle on each side, surrounded by several strong bristles similar to those on the exterior surface. The surstyli lie towards the antero-ventral angle of the ninth tergite and are separated from it by a complete suture. They are broad structures bearing a spine at the distal end similar to that on the tergite and anterior to it lies a group of hairs. The epiphallus is long, slightly broadening posteriorly and bears two short, ventrally pointing processes. The aedeagal hood is a large structure longer than the ninth tergite and about twice as long as wide. The phallus posteriorly is short and wide. The ejaculatory apodeme is widely fan-shaped distally, with curved margins; both stem and base are short and narrow. Cerci are small and bristly.

Adult behaviour

Collections so far made show that adults are present in spring and early summer. Punctures are made on the upper leaf surface and may be very numerous, many probably representing feeding punctures.

Larval morphology

The small white larvae are long and slender. Mouthparts (Figure 28) consist of paired strong mandibles articulating with the short, fairly broad labial sclerite, which in turn joins the dorsal and ventral processes. The long, slender dorsal process is widely curved and distally directed towards the ventral process, which is straight and reaches posteriorly and slightly ventrally to about three-quarters of the distance reached by the dorsal process. The right mandible is longer dorso-ventrally than the left and bears two large teeth, the upper larger than the lower, with a small rounded projection lying beneath the upper tooth. The left mandible also has two strong teeth separated by a rounded projection and is somewhat square, the upper tooth lying approximately opposite the lower of the right mandible.

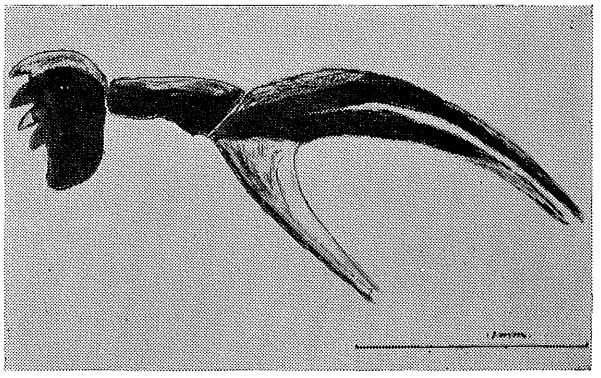


Fig. 28.—*Haplomyza imitans*—Larval mouthparts.

The anterior spiracles are very small, 0·01 mm in diameter, with, in slide specimens, four bulbs visible in some specimens and five in others, all of equal size. The posterior spiracles also are small, well separated and each bearing three bulbs on a short stem.

Larval behaviour

The larvae mine in the parenchyma, sometimes in both upper and lower layers. Several larvae may be present in a leaf and cross each other's mines. The fully grown larvae in laboratory-held material emerged from the leaf and pupated on the soil.

Excretal pattern

The excretal pattern shown in some parts of the mine is a thin, discontinuous, irregular black line, either single or double.

Plant damage

Mines occur in leaves, petioles and stems of the hosts. The mines while fresh are pale green; a whitish appearance develops later, making them evident from the surface, or from both surfaces where tunnelling includes both parenchymatous layers. They are not noticeable in narrow leaves unless the infestation is heavy. The mine is a simple ophionome, fairly narrow and winding. Badly affected leaves turn brown and prematurely die.

Puparium

The puparium (Figure 27) is brownish-orange, dorsally convex, ventrally flattened, anteriorly wide and posteriorly narrowing. Length is 1·5 mm and width 0·5 mm. Segmentations are clearly depressed both dorsally and ventrally. Spiracles are black.

Parasites

Parasitism varied up to 23·0%.

Braconidae: *Opius cinerariae* Fischer; Brisbane, Oct. 1954. This species was from a mixed infestation of *H. imitans* and *Liriomyza brassicae* in *Chenopodium album*.

Eulophidae: *Achrysocharis* sp.; Stanthorpe, Oct. 1954 (A. W. S. May). *Enaysma* sp.; Brisbane, Oct. 1954. *Hemiptarsenus* sp.; Stanthorpe, Oct. 1954 (A. W. S. May).

Specimens of *Enaysma* sp. were from a mixed infestation of *H. imitans* and *L. brassicae* in *Coronopus didymus*. Since it was also bred from *L. brassicae* alone, its inclusion as a parasite of *H. imitans* might be doubtful.

(iii) Genus LIRIOMYZA Mik

Species of the genus *Liriomyza* occur in many countries. Characters and synonyms of the genus are given by Frick (1952).

Two species have been described from Australia in *Liriomyza* as a subgenus of *Agromyza* (Malloch 1927), namely *L. pallidicentralis* and *L. tricolor*. An introduced species, *L. brassicae* (Riley), occurs in Queensland.

LIRIOMYZA brassicae (Riley)

History

Cabbage leaf miner (*L. brassicae*) is widespread in Europe and America and is known also in Canary Is., West Indies, Fiji and Hawaii. It was described from America but may have originated from Europe. Undoubtedly it has been introduced into Australia.

Specimens from various hosts in Queensland have been compared with authentic material of *L. brassicae* received from Dr. Frick, collected at Laurel, California. The two groups of specimens were identical in both external morphology and male genitalia. A record of *Agromyza pusilla* from *Tropaeolum majus* L. in Brisbane by Tryon in 1911 (Departmental record) must have been *L. brassicae,* since *A. pusilla* does not occur here and no other species has been bred from this host in Queensland. A similar record was made in 1918. It is also possible that some early records of *Phytomyza affinis* from Victoria (French 1900) and of *A. pusilla* from New South Wales (Malloch 1918 and 1925) might refer to *L. brassicae.*

Hosts and distribution

Brassica caulorapa Pasq., Annerley, June 1941 (W. A. McDougall). *Brassica chinensis* L., Toowong, Oct. 1959 (A. R. Brimblecombe). *Brassica napus* L., Ormiston, Oct. 1949 and Toowong, Apr. 1953 (A. R. Brimblecombe). *Brassica oleracea* L. var. *botrytis* L., Nudgee, May 1952 (A. R. Brimblecombe); Ormiston, Mar. 1953 (B. R. Champ). *Brassica oleracea* L. var. *capitata* L., Cleveland, Feb. 1941, Redland Bay, Aug. 1943 and Toowong, May 1950 (A. R. Brimblecombe); Annerley, May 1952 (W. A. McDougall); Ormiston, Mar. 1954. *Brassica rapa* L., Brisbane, Aug. 1943 (A. R. Brimblecombe). *Cardamine hirsuta* L., Kenmore, May 1959. *Cheiranthus cheri* L., Brisbane, May 1955. *Cleome spinosa* L., Buranda, Nov. 1954. *Coronopus didymus* (L.) Sm., Brisbane, Oct. 1953. *Lepidium hyssopifolium* Desv., Brisbane, Oct. 1954. *Lobularia maritima* Desv., Toowong, July 1956 (A. R. Brimblecombe). *Matthiola incana* (L.) R.Br., Kenmore, June 1950. *Pisum sativum* L., Ormiston, Sept. 1953 and Toowong, Sept. 1953 (A. R. Brimblecombe). *Raphanus sativus* L., Brisbane, Aug. 1943 (H. Jarvis). *Sisymbrium orientale* L., Brisbane, Sept. 1953. *Tropaeolum majus* L., Brisbane, Mar. 1911 and South Brisbane, Oct. 1918 (H. Tryon); Toowong, May 1949 (A. R. Brimblecombe); Annerley, May 1952 (W. A. McDougall); Ormiston, Apr. 1952 (B. R. Champ).

Adult morphology

In the wing the cross-veins R-m and M-m are sometimes absent. This was shown in specimens bred from *Pisum sativum,* but otherwise they were identical with *L. brassicae,* including male genitalia. Meigen (1830) mentioned the absence of this vein in some specimens of *Agromyza pusilla* (now *L. pusilla*) to which *L. brassicae* is closely related and as which, in the past, it has been misidentified. Frick (1952) has given a detailed list of the synonymy of *L. brassicae.*

Adult behaviour

Eggs are deposited in any part of either the upper or lower leaf surfaces. Feeding punctures are small oval holes in a slightly sunken area due to depletion of sap in the surrounding tissue, although there may be no discoloration. On small-leaved plants oviposition appears to be more commonly near the leaf margin (Figures 29 and 30).

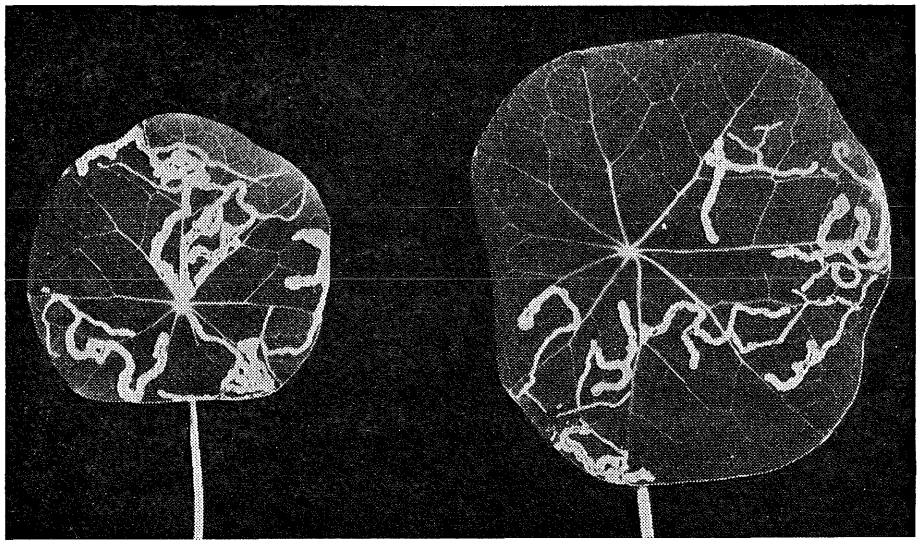


Fig. 29.—*Liriomyza brassicae*—Leaves of *Tropaeolum majus* showing larval mines and excretal pattern.

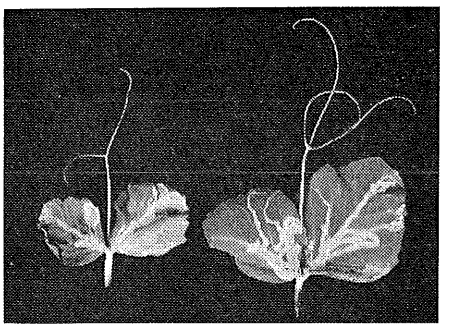
Although this species attacks numerous hosts, it is most commonly found in cabbages. All the hosts are cruciferous except *Tropaeolum* (Tropaeolaceae), *Pisum* (Leguminosae) and *Cleome* (Capparidaceae). The families Cruciferae, Tropaeolaceae and Capparidaceae are systematically unrelated but they are biochemically related in that all contain myrosin, an enzyme necessary for the production of mustard oil from sulphur-containing glycosides.

Larval morphology

The larva is bright yellow in colour and may be up to 4·0 mm in length when fully fed. Larval characters of the group to which this species belongs have been dealt with in detail by de Meijere (1925).

Larval behaviour

Larvae mine in the parenchyma on the upper and lower sides of the leaf, commonly crossing from one side to the other. Any part of the leaf lamina may be mined but in the smaller leaves tunnels often commence near the leaf margin. Larvae may be very numerous in the one leaf, especially in cabbage (Figure 31).



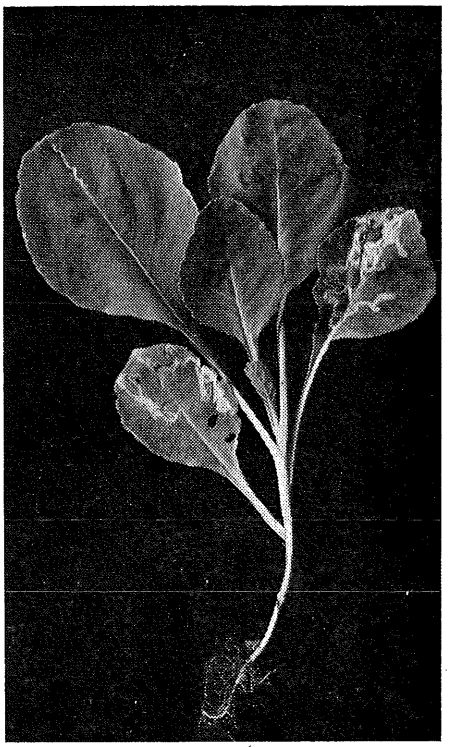


Fig. 30.—*Liriomyza brassicae*—Leaves of *Pisum sativum* showing mines and excretal pattern.

Fig. 31.—*Liriomyza brassicae*—Leaves of *Brassica oleracea* var. *capitata*.

Although all or part of the parenchyma may be eaten, the first instar eats only one layer, either the palisade or spongy tissue. This part of the mine is an ophionome about three-quarters to one inch long. At this point, possibly following the first larval moult, the mine widens and meanders back and forth or crosses itself to form a blotch mine. In some instances the initial linear part is on one side of the leaf and the blotchy mine on the other, so the mine may appear as only a linear or blotch mine unless the leaf is turned.

This is one of the few species in which the larva does not pupate *in situ*. When the larva is fully fed it always mines to the upper parenchyma and makes a linear cut with the mandibles in the upper epidermis near the end of the mine. Another cut may be made at an angle to the first to form a long, narrow V. If the opening is not large enough, the point of the V may be extended. The larva then emerges head first, projecting vertically from the leaf little by little until it overbalances onto the surface. It rolls or crawls downwards and pupates at the leaf base as in cabbage or in or on the soil.

Excretal pattern

The excretory line in the tunnel is of black deposits forming a discontinuous and somewhat wavy line along one side or alternate sides of the mine, with some irregularly placed larger deposits.

Puparium

The puparium is formed within a few hours after larval emergence, but still requires some time to harden. When newly formed it is yellow, darkening to brownish-grey in about 3 days. The average length is 1·89 mm, with a range from 1·5 to 2·2.

Parasites

Braconidae: *Opius cinerariae* Fischer; Brisbane, Oct. 1954.

Eulophidae: *Achrysocharis* sp.; Buranda, Mar. 1953; Toowong, Apr. 1953 (A. R. Brimblecombe). *Enaysma* sp.; Brisbane, Oct. 1954. *Hemiptarsenus* sp.; Brisbane, Apr. 1953. *Tetrastichus* sp.; Ormiston, Sept. 1953 (A. R. Brimblecombe).

Eupelmidae: Gen. nr. *Anastalus* sp.; Buranda, Mar. 1953.

Opius cinerariae and *Enaysma* sp. were from mixed infestations of *Haplomyza imitans* and L. *brassicae*.

(iv) Genus PHYTOBIA Lioy

The genus *Phytobia* is represented in most countries of the northern hemisphere. Only an introduced species occurs in Queensland.

PHYTOBIA humeralis (Roser)

History

Specimens representing the first record of *Phytobia humeralis* in Queensland were bred from aster plants (*Callistephus chinensis* Nees) in 1924. On some occasions since, damage has been of importance in both nursery and garden plants.

Hosts and distribution

P. humeralis is widely distributed in Europe and North America and now is recorded in Australia. Although the hosts are cosmopolitan there are apparently no published records from other countries. Hosts recorded by Frick (1956) belong to Compositae and Scrophulariaceae. In Queensland only hosts in Compositae have been found and these are confined to a few genera. The insect is common through the south-eastern part of the State. Particular records are as follows.

Aster subulatus Mich., Kenmore, Apr. 1953. *Callistephus chinensis* Nees, Sherwood, Jan. 1942; Sunnybank, Dec. 1948. *Erigeron bonariensis* L., Mt. Alford, Dec. 1954. *Erigeron floribundus* (H.B.K.) Schultz-Bip., Brisbane, Jan. 1953; Tallebudgera, Mar. 1953; Claredale, Sept. 1953 (W. A. Smith); Moggill, Oct. 1955; Kenmore, June, 1958.

Adult morphology

The detailed description given by Frick (1956*b*) did not include the male genitalia. This has now been examined in both lateral and ventral views from dissected material (Figure 32).

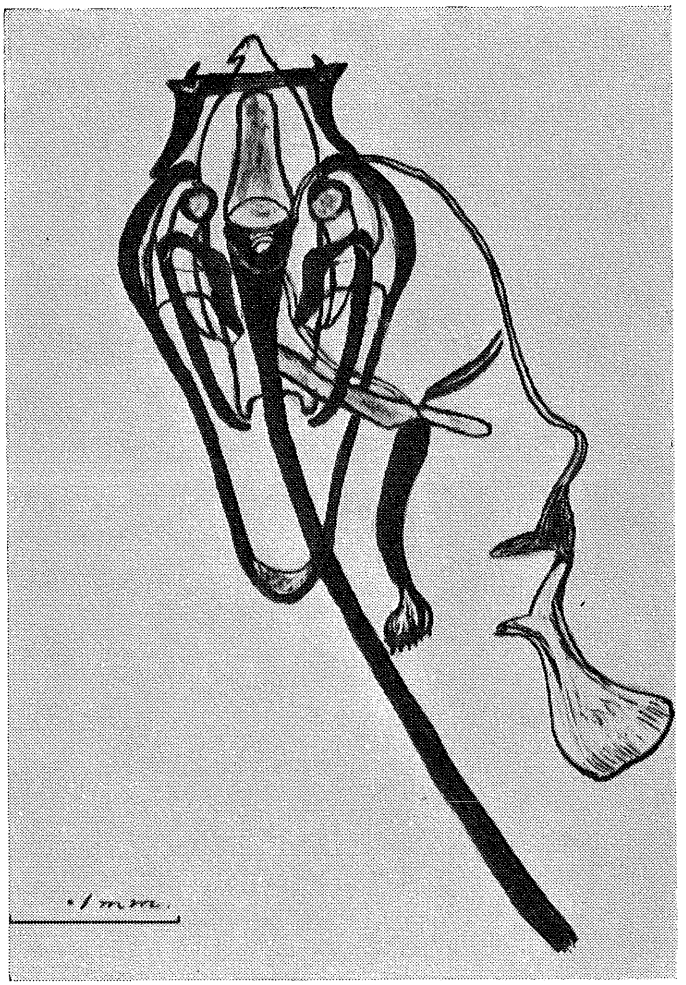


Fig. 32.—*Phytobia humeralis*—Male genitalia (ventral view).

Ninth tergite with posterior angles turned inwards and upwards, bearing numerous short strong straight spines with blunt points mostly directed inwards, dorsally narrowest at centre and indented at both anterior and posterior margins. Surstyli joined to anterior ventral angles of ninth tergite by a suture; short, inwardly directed bearing a few short strong spines pointing backwards, and several longer bristle-like setae directed inwards. Cerci short and covered with short hairs. Ninth sternite without hypandrial apodeme; the long sidepieces turn downwards anterior to the posterior angles, widen considerably and curve inward as two semicircular ventral processes. Paired posterior arms from the posterior angles of the sidepieces project backwards and are directed inwards dorsally. Pregonites directed inwards from ninth sternite, moderately broad, each with a seta posteriorly and a very long curved process about half of the length of the ninth sternite sidepiece. Postgonites in ventral view longer than main body of pregonites, ventrally directed, and rounded in cross-section and bearing two projections

Aedeagal apodeme long, about twice length of ninth sternite sidepieces, reaching well forwards and terminating posteriorly opposite margin of ninth tergite. Aedeagal hood long, roughly oval viewed dorsally, strongly curved dorso-ventrally and reaching to anterior margin of ninth tergite; a dorsally directed short pointed process and shorter ventrally directed process at posterior end. Epiphallus long and slender, curved to become ventrally concave at posterior end. Phallophore fairly broad anteriorly, not greatly elongated, the posterior section very short and lying posterior to the ninth tergite. Phallus fairly broad basally, carrying a pair of ventral processes about equal in length to the basal section, and widened and flat distally; median section tubular, widest at posterior end, about equal in length to basal section, with a pair of bent ventral processes shorter than those of the basal section, broad and flattened distally, distal section two very short wide tubular structures. Ejaculatory apodeme with a broad blade widening distally to about twice the width of its narrowest central part, the distal angle sharper on the curved side.

Adult behaviour

Feeding and oviposition punctures are made on the upper leaf surface.

Plant damage

The mine begins as a fine ophionome in the palisade parenchyma. The short linear section soon widens into a blotch mine in which the epidermis is raised to form a blister mine or physonome (Figure 33).

Fig. 33.—*Phytobia humeralis*—Leaves of *Erigeron floribundus* showing larval blister mines, and positions of puparia.

No preference is shown for direction of larval feeding but mines appear to be more common near the leaf centres and bases. Normally the pale brown blisters are scattered on the plant. In heavy infestations mines may be numerous in the one leaf and may amalgamate to form one large mined area, or sometimes, as in *Erigeron,* covering the whole leaf area. Mines may extend into leaf petioles or occur in bracts and petals.

In Queensland the only commercially grown plant suffering damage is aster (*Callistephus chinensis*). The insect is not a major pest but the sporadic infestations can result in retarded growth or cause the leaves to be unsightly or the flowers to be unmarketable. Only individual growers may thus suffer loss, although persistent attacks may be common in small plantings in home gardens.

Parasites

Braconidae: *Opius atricornis* Fischer; Brisbane, Apr. 1954; Moggill, Oct. 1958. *Opius cinerariae* Fischer; Toowoomba, Oct. 1956. *Opius oleracei* Fischer; Moggill, Oct. 1955.

Eulophidae: *Achrysocharis* sp.; Claredale, Sept. 1953 (W. A. Smith). *Hemiptarsenus* sp.; Buranda, Apr. 1953; Claredale, Sept. 1953 (W. A. Smith); Tallebudgera, Mar. 1953.

Eupelmidae: *Eupelmus* sp.; Claredale, Sept. 1953 (W. A. Smith).

Pteromalidae: *Trigonogastra* sp.; Claredale, Sept. 1953 (W. A. Smith).

The species from the Claredale material were from a mixed infestation of *Phytobia humeralis* and *Phytomyza atricornis.*

(v) Genus PHYTOMYZA Fallén

The genus *Phytomyza* is a large one with a number of species in most countries. Spencer (1963) stated that four species are known from Australia; one of these, *P. atricornis* Meigen, cineraria leaf miner, occurs in Queensland.

PHYTOMYZA atricornis Meigen

History

Cineraria leaf miner is probably a native of Europe but has become almost cosmopolitan. Although not specifically mentioned, it was first recorded from cinerarias in Brisbane in 1907 and in the following year from Toowoomba (Tryon 1908). Entry to Australia was probably from New Zealand, where it is the commonest of leaf miners (Wise 1953). The first appearance in Australia is alleged to have been in Western Australia soon after 1895 (Lea 1906). Damage in cinerarias was later noted in Victoria (French 1900). Mention of occurrences in crucifers as well as Compositae in that State by French probably involved two species.

Hosts and distribution

Records in Australia are from all States but not from above the tropic. Queensland host records are all confined to the family Compositae. Many of the hosts recorded overseas, although occurring here, have not been found attacked. Some early records from this State refer to the insect *Phytomyza nigripennis* mining cinerarias, dandelions and common sowthistle. These records undoubtedly must have been intended as *P. nigricornis,* which is a synonym of *P. atricornis.* Particular records are as follows.

Bidens pilosa L., Brisbane, Sept. 1953. *Chrysanthemum frutescens* L., Southport, Aug. 1953 (A. R. Brimblecombe). *Chrysanthemum parthenium* Pers., Brisbane, Nov. 1955 (A. R. Brimblecombe). *Dahlia pinnata* Cav., Brisbane, Sept. 1950. *Erigeron bonariensis* L., Mt. Alford, Dec. 1954. *Erigeron floribundus* (H.B.K.) Schultz-Bip., Brisbane, Sept. 1953; Claredale, Sept. 1953 (W. A. Smith). *Galinsoga parviflora* Cav., Brisbane, Oct. 1954. *Gazania hybrida* Hort., Brisbane, 1954 (A. R. Brimblecombe). *Gerbera jamesonii* Bolus, Toowoomba, Dec. 1949 (A. W. S. May). *Gnaphalium japonicum* Thunb., Brisbane, Sept. 1953. *Helianthus annuus* L., Brisbane, Sept. 1950. *Helichrysum* sp., Brisbane, Sept. 1953. *Hypochoeris radicata* L., Brisbane, Oct. 1954. *Lactuca sativa* L., Brisbane, Sept. 1950. *Lactuca serriola* L., Brisbane, 1954. *Senecio cruentis* DC., Brisbane, Aug. 1907, Ipswich, Sept. 1930, and Toowoomba, Aug. 1908 (H. Tryon). *Sonchus oleraceus* L., Brisbane, Oct. 1918, and Toowoomba, Oct. 1918 (H. Tryon).

Parasites

Braconidae: *Apanteles ruficrus* Hal.; Brisbane, Oct. 1948. *Opius oleracei* Fischer; Brisbane, 1953; Toowoomba, Oct. 1947.

Eulophidae: *Achrysocharis* sp.; Brisbane, 1953; Buranda, Apr. 1953. *Chrysocharis* sp.; Brisbane, 1953. *Epilampus* sp.; Brisbane, 1953; Tallebudgera, Nov. 1954. *Hemiptarsenus* sp.; Brisbane, 1953.

Pteromalidae: *Sphegigaster* sp.; Brisbane, 1953. *Trigonogastra* sp.; Brisbane, 1953. Gen. and sp. indet.; 2 species.

(vi) Genus PSEUDONAPOMYZA Hendel

The genus *Pseudonapomyza* is a small one with species native to the northern hemisphere. One species is recorded in Queensland.

PSEUDONAPOMYZA spicata (Malloch)

History

This species was described from Formosa and has been found in several other Pacific islands as far east as Hawaii. All records are from grasses and related plants including sugar-cane and maize. Records in Queensland were first made in 1953 but from the common occurrences noted it is possible that the fly has been present in this State for many years.

Host and distribution

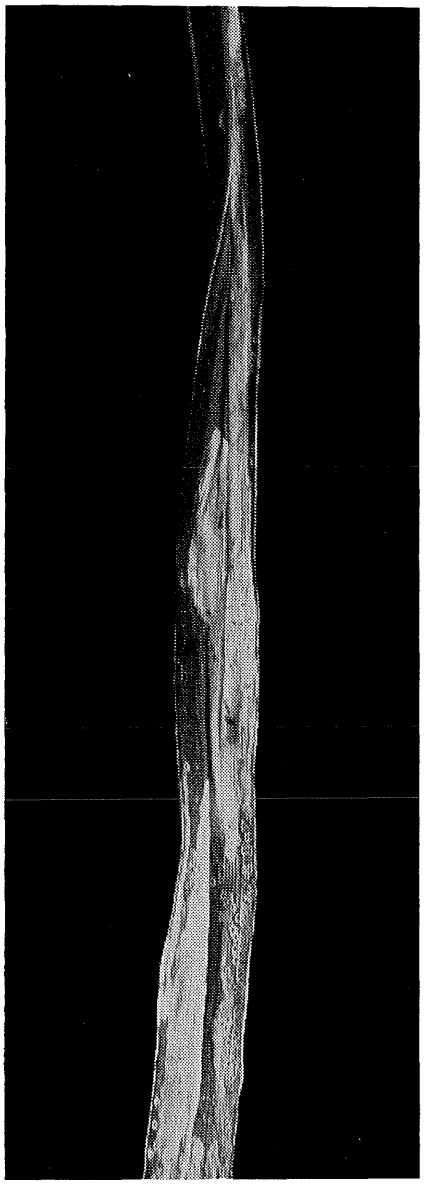
Eleusine indica (L.) Gaertn., Brisbane, April 1953. *?Paspalidium radiatum* J. Vickery, Kenmore, December 1957.

Synonymy

Phytomyza spicata Malloch, 1914.
Pseudonapomyza spicata (Malloch) Henning, 1941.

Adult behaviour

Punctures made by the adult females are numerous and often are shown in both mined as well as unmined tissue. Usually they are on the upper surface in groups of a dozen or more in a small area from which one or more mines lead. These areas are normally near the leaf tips, possibly because during development the leaves are folded at the midrib towards the base and enclose the upper surface except at the tip. The holes are quite distinct (Figure 34), with a noticeable margin which turns brown as the leaves age.



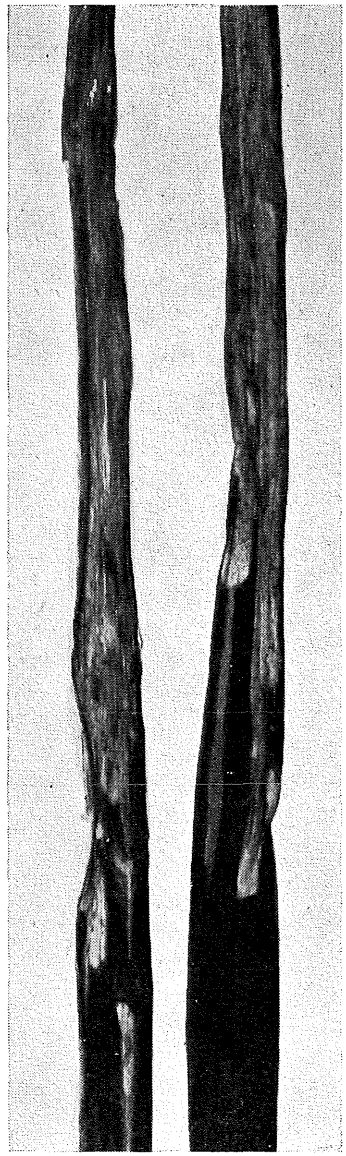


Fig. 34.—*Pseudonapomyza spicata*—Leaf of *Eleusine indica* showing adult punctures and larval mines.

Fig. 35.—*Pseudonapomyza spicata*—Leaves of *Eleusine indica* showing larval mines and excretal pattern.

Larval morphology

The larvae are whitish in colour. The mandibles (Figure 36) are equal in size, with two well-developed teeth evenly spaced, the upper being larger than the lower, and all four are usually visible in lateral view in slide preparations. The labial sclerite is fine and straight. The dorsal arm of the dorsal process is long, slightly curved and bent downwards distally. At the end is a small hook which may represent the distal end of the ventral arm. The ventral process is short and straight, directed backwards and downwards.

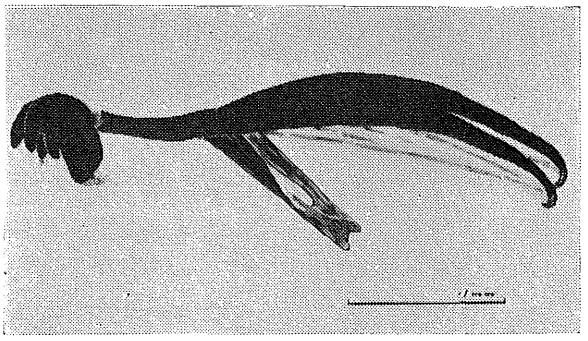
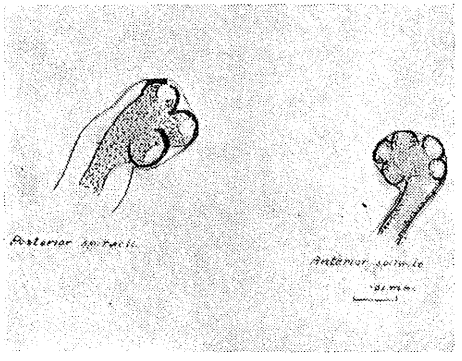


Fig. 36.—*Pseudonapomyza spicata*—Larval mouthparts.

The anterior spiracles (Figure 37) have five bulbs arranged in an incomplete circle at the top of a fine stalk. The posterior spiracles (Figure 37) consist each of three rounded bulbs arranged in a triangle at the end of a tubercle.



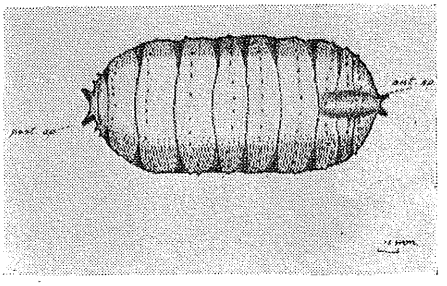


Fig. 37.—*Pseudonapomyza spicata*—Larval spiracles.

Fig. 38.—*Pseudonapomyza spicata*—Puparium.

Larval behaviour

Both parenchymatous layers are eaten by the larvae, which make conspicuous mines. Several larvae may occur in one leaf (Figures 34 and 35). When fully fed each larva cuts a fine long slit in the epidermis and emerges to pupate in the soil.

Excretal pattern

The excretal pattern (Figure 35) consists of numerous small black deposits scattered in the initial part of the mine and later more widely and irregularly spaced.

Plant damage

Mines are pale green to almost white and are visible from both sides of the leaf. Any part of the leaf can be attacked. The larva at first tunnels towards the leaf tip in a straight line for about one inch, then backwards and forwards to form a long, somewhat rectangular blotch mine (Figures 34 and 35). A common feature is for one part of a leaf, the tip or, less often, one side of the lamina, to be dead while the base or one side is still green. Plants with numerous mines soon lose their healthy green appearance and become unthrifty.

Puparium

The fully grown larva leaves the mine and pupates externally. The puparium (Figure 38) is yellow in colour, about 2·0 mm long, convex dorsally and flat ventrally. The spiny surface is distinctive and enables the pupa of this species to be differentiated from that of all other species recorded in Queensland.

IV. HOST LIST OF LEAF-MINING AGROMYZIDAE IN QUEENSLAND

HOST		INSECT
Family	*Genus and Species*	
Apocynaceae	*Plumeria rubra*	*Melanagromyza polyphyta*
Bignoniaceae	*Kigelia pinnata*	,, ,,
Capparidaceae	*Cleome spinosa*	*Liriomyza brassicae*
Caprifoliaceae	*Lonicera periclymenum*	*Melanagromyza polyphyta*
Caryophyllaceae	*Stellaria media*	*Haplomyza imitans*
Chenopodiaceae	*Beta vulgaris* var. *cicla*	,, *caulophaga*
	Chenopodium album	,, *imitans*
Combretaceae	*Quisqualis indica*	*Melanagromyza polyphyta*
Compositae	*Aster subulatus*	*Phytobia humeralis*
	Bidens pilosa	*Phytomyza atricornis*
	Callistephus chinensis	*Phytobia humeralis*
	Chrysanthemum frutescens	*Phytomyza atricornis*
	,, *parthenium*	,, ,,
	Dahlia pinnata	,, ,,
	Erigeron bonariensis	*Phytobia humeralis*
	,, ,,	*Phytomyza atricornis*
	,, *floribundus*	*Phytobia humeralis*
	,, ,,	*Phytomyza atricornis*
	Galinsoga parviflora	,, ,,
	Gazania hybrida	,, ,,
	Gerbera jamesonii	,, ,,
	Gnaphalium japonicum	,, ,,
	Helianthus annuus	,, ,,
	Helichrysum sp.	,, ,,
	Hypochoeris radicata	,, ,,
	Lactuca sativa	,, ,,
	,, *serriola*	,, ,,
	Senecio cruentus	,, ,,
	Sonchus oleraceus	,, ,,

HOST		INSECT
Family	*Genus and Species*	
Cruciferae	*Brassica caulorapa*	*Liriomyza brassicae*
	,, *chinensis*	,, ,,
	,, *napus*	,, ,,
	,, *oleracea* var. *botrytis*	,, ,,
	,, *oleracea* var. *capitata*	,, ,,
	,, *rapa*	,, ,,
	Cardamine hirsuta	,, ,,
	Cheiranthus cheri	,, ,,
	Coronopus didymus	*Haplomyza imitans*
	,, ,,	*Liriomyza brassicae*
	Lepidium hyssopifolium	,, ,,
	Lobularia maritima	,, ,,
	Matthiola incana	,, ,,
	Raphanus sativus	,, ,,
	Sisymbrium orientale	,, ,,
Euphorbiaceae	*Acalypha wilkesiana*	*Melanagromyza polyphyta*
	Breynia oblongifolia	,, ,,
	Euphorbia pulcherrima	,, ,,
Gramineae	*Eleusine indica*	*Pseudonapomyza spicata*
	?Paspalidium radiatum	,, ,,
	Poa annua	*Cerodontha australis*
Lauraceae	*Cudrania javanensis*	*Melanagromyza polyphyta*
Leguminosae	*Cassia coluteoides*	,, ,,
	Crotalaria mucronata	,, *phaseoli*
	Dolichos lablab	,, ,,
	,, *uniflorus*	,, ,,
	Erythrina crista-galli	,, *polyphyta*
	Glycine max	,, *phaseoli*
	Indigofera suffruticosa	,, *indigoferae*
	Phaseolus atropurpureus	,, *phaseoli*
	,, *lathyroides*	,, ,,
	,, *lunatus*	,, ,,
	,, *panduratus*	,, ,,
	,, *vulgaris*	,, ,,
	Pisum sativum	*Liriomyza brassicae*
	,, ,,	*Melanagromyza pisi*
	Vigna catjang	,, *phaseoli*
	,, *sesquipedalis*	,, *polyphyta*
	,, *sinensis*	,, *phaseoli*
	,, *unguiculata*	,, ,,
Liliaceae	*Dianella caerulea*	,, *dianellae*
	Eustrephus latifolius	,, *polyphyta*
Meliaceae	*Melia azedarach* var. *australasica*	,, ,,
Passifloraceae	*Passiflora caerulea*	,, ,,
	,, *edulis*	,, ,,
	,, *foetida*	,, ,,
	,, *suberosa*	,, ,,
Rhamnaceae	*Alphitonia excelsa*	,, ,,
Rubiaceae	*Coffea arabica*	,, ,,
	Gardenia jasminoides	,, ,,
Rutaceae	*Citrus aurantifolia*	,, ,,
	Murraya paniculata	,, ,,
Salicaceae	*Salix babylonica*	,, ,,
Saxifragaceae	*Hydrangea macrophylla*	,, ,,
Solanaceae	*Capsicum annuum*	,, ,,
	Cestrum parqui	,, ,,
Sterculiaceae	*Brachychiton* sp.	,, ,,
Theaceae	*Camellia japonica*	,, ,,
Thymeleaceae	*Wikstroemia indica*	,, *wikstroemiae*
Tropaeolaceae	*Tropaeolum majus*	*Liriomyza brassicae*
Verbenaceae	*Lantana camara*	*Ophiomyzia lantanae**

* This species mines the fruit.

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