Philipp. Ent. 3 (2): 89-108 October (1974) 1975

BIOLOGY OF THE SWEET PEA LEAF MINER, PHYTOMYZA HORTICOLA GOUREAU (DIPTERA: AGROMYZIDAE) IN THE PHILIPPINES[1]

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The sweet pea leaf miner, Phytomyza horticola Goureau, causes 90% damage to the plant by mining the leaves at its early stage. Damaged plants mature early, have few flowers and are stunted. Eighteen host species, mostly cultivated flowering plants, were observed in Benguet. The pest is present throughout the year but abundant during the planting season. The sweet pea varieties observed were equally attacked.

The developmental stages of the pest are similar for both sexes except in longevity. The incubation period ranged from 2 to 4 days (mean 2.80 ± 0.09 days), usually 3 days; the total larval period, 10 to 14 days (mean 11.11 ± 0.18 days), usually 10 days; and the pupal period, 9 to 12 days (mean 10.25 ± 0.15 days), usually 9 days. The larva underwent 3 stadia: the first stadium ranged from 2 to 3 days (mean 2.65 ± 0.65 days), usually 3 days; the second stadium, 4 to 5 days (mean 2.58 ± 0.19 days), usually 4 days; and the third stadium, 4 to 6 days (mean 4.97 ± 15 days), usually 5 days. The total developmental period (egg laying to emergence) ranged from 21 to 30 days (mean 23.49 ± 0.35 days), usually 24 days.

The female adult lived from 9 to 12 days, usually 9 days when fed and 3 to 5 days, usually 4 days without food. The male adult when confined with female lived from 4 to 10 days, usually 6 days and from 2 to 4 days, usually 2 days when alone.

An unidentified eulophid parasite (Hymenoptera) was observed on the larvae.

The sweet pea leaf miner, *Phytomyza horticola* Goureau has become a major obstacle in the successful production of sweet pea in the province of Benguet. This vegetable, being a semi-temperate crop, is grown only in areas where the climate is cool. In recent years, leaf miner infestation has considerably reduced the crop yield to 50%, thus making sweet pea even more expensive.

To control this pest, chemical insecticides have been tried and some were found effective. This solution, however, is at most temporary. Hence, there

[1] Contribution No. 87; received for publication 10 June, 1975. Based on a thesis presented by the senior author in partial fulfillment of the requirements for the degree of Bachelor of Science in Agriculture under the direction of the junior author, University of the Philippines at Los Baños.

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is a need to evolve a pest management system to contain this pest in a more practical way that is less expensive and more permanent. However, before an efficient system can be attained, certain information concerning the pest must be gathered such as its life history, natural enemies, and host range.

The sweet pea leaf miner was first described by Macquart in 1835 as *Phytomyza geniculata.* Since it was peroccupied by another agromyzid described by Brulle in 1832, Meigen renamed it as *Phytomyza atricornis* in 1838. Griffiths (1967), however, concluded that *P. horticola* Goureau is the valid name since *P. atricornis* has been applied by many authors to one or both of the two species, *P. syngenesiae* (Hardy) and *P. horticola,* for which he has designated neotypes. The synonymy of *P. horticola* is as follows:

Phytomyza geniculata Macquart, 1835 (preoccupied)
P. atricornis Meigen, 1838
P. nigricornis Hardy, 1849
P. horticola Goureau, 1849
Chromatomyra syngenesiae Hardy, 1849
Phytomyza linariae Kaltenbach, 1857
P. tropaeoli Dufour, 1857
P. fediae Kaltenbach, 1860
P. lateralis Goureau, 1888
P. chrysanthemi Kowartz, 1891
P. subaffinis Malloch, 1914

In the Philippines, the pest was recorded as a pest of sweet pea by Baltazar (1968) and, except for its control, no studies have been conducted on its life history, host range, and natural enemies.

It was reported from different countries that the pest undergoes several generations per year: 15 complete generations in New Zealand (Kelsey, 1937); 3 generations between March and June in Italy (Melis, 1935); and in Japan, 5 generations (3 in spring and 2 in autumn; Kuroda, 1938). Kuroda (1938; 1939) also reported that the pest multiplies all year round and sometimes very rapidly when the temperature is suitable. The larvae are greatest in number between 15 and 20°C (59 to 68°F) and emerge between early morning and noon but not later in the day. The adult flies feed and the female oviposits only during daytime. The female adult feeds on plant juices, the male on sugary substances.

The life history of the pest from several countries is listed in Table 1.

The pest is considered as the commonest polyphagous species of leaf miner. The Commonwealth Institute of Entomology (1965), which prepared a distribution map of the pest, showed that it is common and widespread throughout Europe, Asia, U.S.S.R., the Pacific, and North America. It damages several crops of economic importance with 68 host species belonging to 14 families

TABLE 1. **Summary of the life cycle of** Phytomyza horticola **Goureau from several countries.**

Country and Author	*Egg**	*Larva**	*Pupa**	*Month*	*Temperature*
India (Atwal *et al.*, 1969)	3.7	10.2	10.9	January — April	
New Zealand (Kelsey, 1937)	7.0	9.0	7.0		
Japan (Kuroda, 1938)	7.0	9.5	10.0	March — June	
Tuscany (Melis, 1935)	2.0	14.5	13.0		67°F
England (Miles and Cohen, 1936)	4.0	10.5	11.0		
New Delhi (Ahmad and Gupta, 1944)	3.9	11.1	15.1		55.4-59.0°F (13-15°C)
	2.2	5.2	6.8		73.4-82.4°F (23-28°C)
Australia (Wallace, 1938)	4.5	7.5	10.0		
India (Cohen, 1936)	4.0	10.5	11.5		

* expressed in days

in India (Table 2), 300 species from the Palearctic region, 100 species from France, 27 species in the Nearctic region, and 16 species in the Ethiopian region (Trehan and Sehgal, 1963).

TABLE 2. **Host plants of** Phytomyza horticola **Goureau found in India (Al-Azawi, 1967).**

1. Compositae
   - *Ageratum conyzoides* L.
   - *Centaurea cyaneus* L.
   - *C.moschata* L.
   - *Cosmos bipinatus* Cav.
   - *Gnaphalium purpureus* L.
   - *Launaca nudicaulis* L.
   - *Calendula oficinalis* L.
   - *Cyanura nepalensis* DC.
   - *Chrysanthemum coronarium* L.
   - *Coreopsis drummondii* Torr and Gray
   - *Asper* sp.
   - *Hemum* sp.
   - *Gaillardia* sp.
   - *Gerbera* sp.
   - *Helichrysis* sp.
   - *Sonchus oleaceus* L.
   - *Helianthus annuus* L.

2. Cruciferae
   - *Brassica campestris* L.
   - *B. juncea* Czem and Coss
   - *Raphanus sativus* L.
   - *Sisymbrium soeseii* L.
   - *Brassica napus* L.
   - *B. oleraceae* var. *botrytis* L.
   - *B. oleraceae var. gongyloides* L.
   - *B. oleracea var. capitata* L.
   - *Eruca sativa* Lamk.
   - *Lactuca sativa* L.
   - *Senebiera didyma* Pers.

3. Leguminoseae
   - *Lathyrus odoratus* L.
   - *Melilotus albus* Lamk.
   - *M. parviflora* Desf.
   - *Trigonella corniculata*
   - *Lupinus* sp.
   - *Pisum sativum* L.
   - *Phaseolus vulgaris*

4. Solanaceae
   - *Petunia* sp.
   - *P. hybrida*
   - *Solanum melongena* L.
   - *S. nigrum* L.
   - *Wethania somnifera* Dunal

5. Scrophulariaceae
   - *Antirrhinum majus* L.
   - *Linaria bipartita* Wild.
   - *Veronica anagallis* L.

TABLE 2. Continued . . .

6. Labiatae
Campanula sp.
Salvia involuctata Cav.
7. Papaveraceae
Mentha piparita L.
Papaver rhoes L.
8. Malvaceae
Athaea rosea L.
9. Linaceae
Linum usitatissimum
10. Tropaeolaceae
Tropaeolum majus L.
11. Vilaceae
Viola sp.
12. Urticaceae
Cannabis sativa L.
13. Liliaceae
Allium cepa L.
14. Polemoniaceae
Phlox drummondii Hook

Like other insect pests, *P. horticola* has several parasites mostly attacking the larvae (Table 3).

Having considered the seriousness of this pest in the country, this study was conducted to examine and investigate its biology, host range, natural enemies, and seasonal abundance. The experiment was done at the Mountain State Agricultural College Experimental Farm, La Trinidad, Benguet from March, 1974 to February, 1975.

TABLE 3. **Parasites attacking the larvae of** Phytomyza horticola **Goureau (Spencer, 1975).**

Family/Species	Country	Author
1. Braconidae		
Aphididius ervi Hal	Egypt	Assem (1966)
Chorebus canariensis Griffiths	Europe	Spencer (1970)
C. sativi (Nixon)	Europe	Spencer (1970)
Dacnusa areolaris Nees	Italy	Goidanich (1928)
Entendon sp.	Italy	Melis (1935)
Opius sp.	Egypt	Assem (1966)
Opius sp.	India	Sehgal (1941)
2. Eulophidae		
Achrysocharella formosa (Weswt.)	India	Al-Azawi (1967, 1971)
Achrysocharis sp.	Italy	Melis (1935)
Cirrospilus vittatus Wlk.	India	Al-Azawi (1967, 1971)
Closterocerus formosus Westw.	Italy	Goidanich (1928)
Derostenus sp.		
Diglyphus sp.	Egypt	Assem (1966)
D. isaesa	India	Al-Azawi (1967, 1971)
D. crassinervis Erdos		
Hemiptarsenus sp.	Italy	Goidanich (1928)
Pediobius scantha (Wlk.)	India	Al-Azawi (1967, 1971)
Pleurotropis sp.	Italy	Goidanich (1928)
Tetrastichus group *strubliana* Ratz.	India	Al-Azawi (1967, 1971)
Tetrastichus sp.	India	Sehgal (1941)
Solenotus sp.	India	Ahmad and Gupta (1941)
3. Pteromalidae		
Thinodytes cyzicus (Wlk.)	India	Al-Azawi (1967, 1971)
Sphegigaster orobanciae	India	Al-Azawi (1967, 1971)

MATERIALS AND METHODS

Five plots (1 x 6 meters) were planted to two sweet pea varieties, Chinese white and Chinese red. Twenty five leaves were selected at random. Each leaf was caged with nylon net to prevent possible attack by parasites and predators. Sweet pea leaves infested with larvae and pupae in the field were collected and reared in culture jars. Emerging adults were allowed to mate and the fertilized females were transferred to each of the caged leaf for a day. Cavities formed by each female in each caged leaf were recorded and the larvae that hatched therein were numbered. Daily observations were done to observe the feeding behaviour and developmental stages of the insect. Duration of each larval instar was recorded from potted plants. Other fertilized females were confined individually to vials and provided with fresh sweet pea leaves as food and as site for oviposition. The leaves were changed everyday and were inspected for any possible eggs laid. This procedure was

done until the females died, to determine the total number of eggs laid by a single female in a day and throughout its lifetime. Mating, feeding, and oviposition behavior for the pest were observed in laboratory cultures.

Anatomical observations and illustrations of the specific structures of the different stages were based on both live and preserved specimens mounted in Hoyer's medium. Binocular and compound microscopes, a lepitograph, drawing paper, and a slide projector were used. An ocular micrometer was used in measuring the dimensions of the different stages.

Different species of host plants infested with sweat pea leaf miner in the field were collected for possible parasites and noted for the host range of the pest. Different plant species were also tried as possible hosts. Collected parasites were brought to Dr. Clare R. Baltazar of the National Institute of Science and Technology (NIST) for proper identification.

The intensity of infestation on different sweet pea varieties was undertaken by counting the number of larvae and pupae present in the leaves collected at random from each variety, while the seasonal abundance of the pest was done by visiting sweet pea plants monthly.

RESULTS AND DISCUSSION

Duration of the Different Stages

TABLE 4. **Duration (days) of the different stages of** Phytomyza horticola **Goureau based on 56 individuals.**

Developmental period	Range	Mean	Usual
Incubation period	2-4	2.80 ± 0.09	3
First stadium	2-3	2.65 ± 0.65	3
Second stadium	4-5	2.58 ± 0.19	4
Third stadium	4-6	4.97 ± 0.15	5
Total larval period	10-14	11.11 ± 0.18	10
Pupal period	9-12	10.25 ± 0.15	9
Total developmental period (Egg laying to emergence)	21-30	23.49 ± 0.35	24

The egg. — The incubation period in both sexes ranged from 2 to 4 days with a mean of 2.80 ± 0.09 days, usually 3 days (Table 4). Average durations of the egg stage in other countries are shown in Table 1.

The larva. — The total period from eclosion to pupation ranged from 10 to 14 days in both sexes. The larvae underwent 3 stadia. The first stadium ranged from 2 to 3 days with a mean of 2.65 ± 0.09 days, usually 3 days. The second stadium ranged from 4 to 5 days with a mean of 4.58 ± 0.19 days, usually 4 days and from 4 to 6 days with a mean of 4.97 ± 0.15 days, usually 5 days in the third stadium. The average durations of the total larval period in other countries are shown in Table 1.

The pupa. — The pupal period ranged from 9 to 12 days with a mean of 10.25 ± 0.15 day, usually 9 days. Table 1 shows the average pupal period in other countries. In India (Ahmad and Gupta, 1944), the pupae undergo aestivation and the adults emerge from December to January when the prevailing temperature is 17°C, and in Japan (Kuroda, 1938) they hibernate and the adults emerge in mid-March. In the study conducted, it was observed that the pupal period is prolonged during the rainy season and the adults do not emerge until the rainy season is over.

The adult. — Under laboratory conditions, the females lived longer when provided with food while the male longevity is longer when confined together with the female. As shown in Table 5, the presence or absence of the host did not affect the male longevity since the male depends on the female in making incisions on the leaf surface for plant sap to ooze and be fed upon.

The female longevity (Table 5) ranged from 9 to 20 days with a mean of 14.29 ± 0.87 days, usually 9 day and from 4 to 10 days with a mean of 6.95 ± 0.54 days, usually 6 days in the male when both sexes were confined together and provided with food. When the male flies were reared alone they survived for 2 to 4 days with a mean of 3.80 ± 0.23 days, usually 2 days, although provided with food. The females without the host lived from 3 to 5 days with a mean of 3.80 ± 0.18 days, usually 4 days.

Behavioral Studies

Feeding. — The larvae feed on the parenchymatous cells of the leaf throughout their life stage by mining underneath the epidermal layer. In this manner, they are partly protected from adverse external factors and are able to survive better during the rainy season. When feeding, the body remains stationary except the anterior end which swings in the arc of a circle. The mouth hooks move dorsoventrally as the larva removes the swathe of tissues. It feeds sidewise from right to left and removes the leaf tissues as it moves forward. The larva is a solitary feeder and never leaves the mine to form another. The mines constructed therefore are linear and tortuous and the individual tracks are easily traced (Fig. 1). The larva starts feeding on the oviposition hole and terminates near the leaf midrib where it pupates. The

TABLE 5. **Longevity (emergence to death) of** Phytomyza horticola **Goureau adults.**

Longevity (days)	Combined with host		Separated	
	Female	Male	Female w/o host	Male w/ host
1				
2				9
3			8	6
4		5	8	5
5		2	4	
6		3		
7		1		
8		2		
9	3	2		
10	2	5		
11	2			
12	1			
13	2			
14	1			
15	2			
16	1			
17	1			
18	1			
19	2			
20	3			
Average (days)	14.50	7	3	4
Range (days)	9-20	4-10	2-4	4-5
Individuals used (total)	21	24	20	20

width and length of the mine are concomitant to the larval stage. Some larvae follow the leaf outline and if they reach the edge they turn to the unmined portion. Larvae that were excised out of the mines were unable to tunnel back and failed to survive.

The larvae, as they progress forward, deposit frasses which are black and granule-like along the mines. Added to these are two cephalopharyngeal skeletons since the larvae cast their cephalopharyngeal structure as they molt. This is one way to determine if the larva has molted by tracing its track and counting the number of cephalopharyngeal structures cast where a mine has widened.

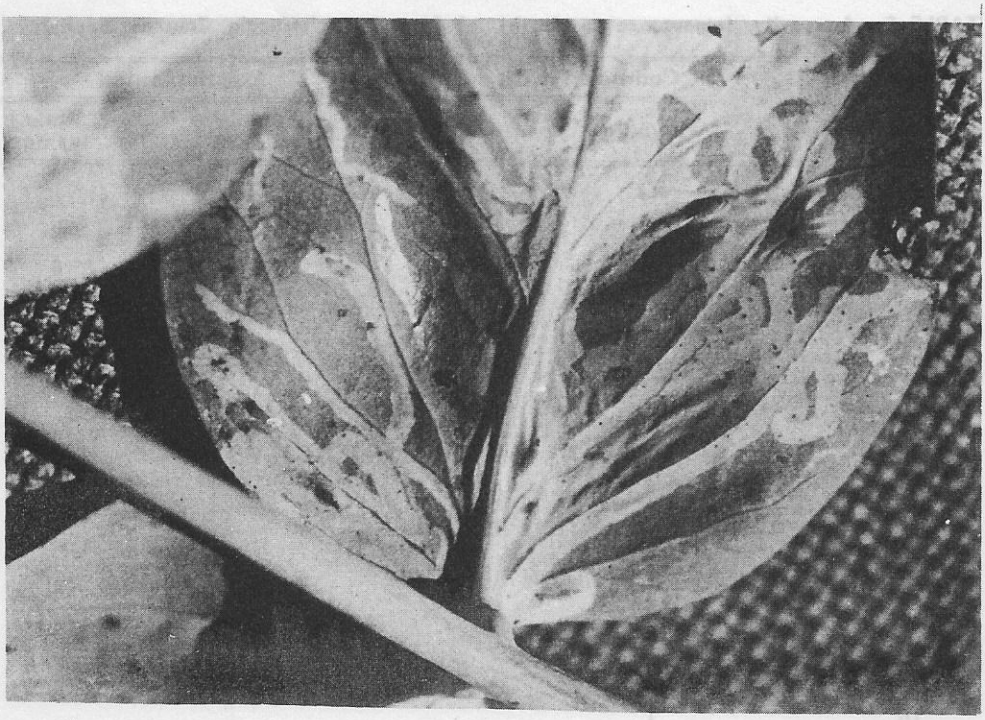


Fig. 1. Appearance of mines constructed by larvae of *P. horticola.*

The adult flies fed on the sap that exuded from the incisions made by the female ovipositor. To form an incision, the female inserted its ovipositor back and forth in the leaf tissue. In the field, it was observed that the young shoots were preferred. However, the female may feed on mature and stunted leaves if given no choice. Feeding occurred during daytime as similarly observed by Kuroda (1939). Feeding incisions appeared brownish after several days.

Oviposition. — The process involved in oviposition is similar to feeding. It was then difficult to determine if a female was laying eggs or feeding, coupled with the added problem that the eggs are minute and deeply embedded within the leaf tissue. Oviposition occurred only during daytime, which confirms the observations by Kuroda (1939). Oviposition sites were less numerous than feeding sites, so the number of incisions present in a leaf is not a good index in determining the number of eggs laid. Like in feeding, the lower surfaces of young shoots were best preferred, perhaps because young leaves are easily pierced by the female ovipositor and can provide enough food for the larva throughout its growth. Also, eggs laid underneath the leaf surface are less exposed to dessication and possible attack of natural enemies. The incisions made for oviposition turned brownish after several days.

The eggs were laid individually on a single cavity, seldom in pairs. A single female could lay as many as 100 to 310 eggs throughout its laying period with an average of 265.75 eggs (Table 6). Majority of the eggs were laid between the first and third days and the maximum number laid within 24 hours was 15. The number of eggs that successfully hatched out of 12 to 17 eggs was 8 eggs. The total percentage of eggs laid by 12 individuals ranged from 52.77 to 96.75%, with an average of 92.61%. A study conducted by Cohen (1936), however, revealed that a single female can lay 358 eggs for about a month, and the maximum number of eggs laid in a day is 50. On the other hand, Kuroda (1939) found that egg viability is influenced by temperature, being highest at a range of 15 to 20°C (59 to 68°F).

Emergence of the fly occurred early in the morning and noon but not later in the day.

Mating. — Mating took place 2 to 5 hours after emergence. A single female was mated more than once by the same or different males. The mating process is similar to that of other Dipterans whereby the male mounts onto the back of the female.

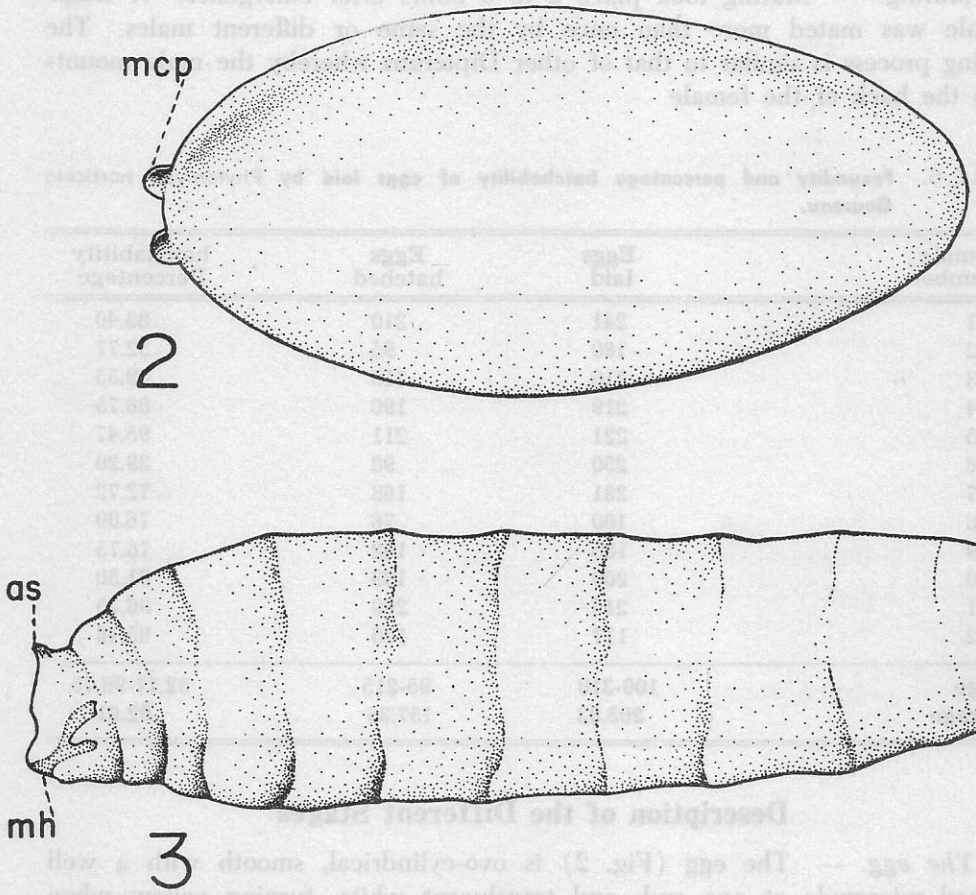
TABLE 6. **Fecundity and percentage hatchability of eggs laid by** Phytomyza horticola **Goureau.**

Female Number	Eggs laid	Eggs hatched	hatchability Percentage
1	241	210	83.40
2	180	95	52.77
3	310	215	69.55
4	219	190	86.75
5	221	211	95.47
6	250	98	39.20
7	231	168	72.72
8	100	76	76.00
9	185	142	76.75
10	200	183	91.50
11	216	209	96.75
12	117	100	85.48
Range	100-310	95-215	52.77-96.75
Average	205.83	157.35	92.61

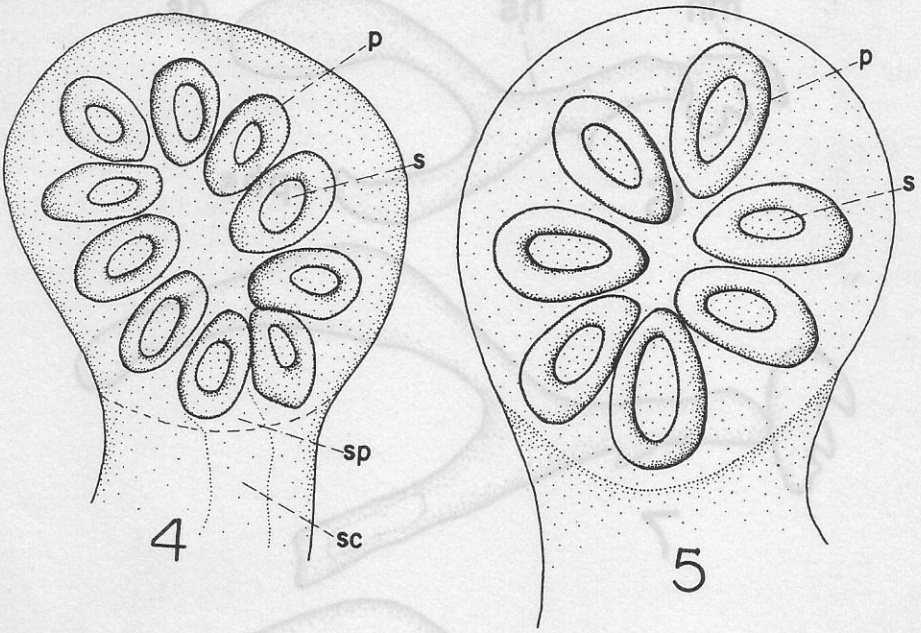
Description of the Different Stages

The egg. — The egg (Fig. 2) is ovo-cylindrical, smooth with a well defined micropyle at one end, and translucent white, turning yellow when about to hatch. The length ranged from 0.33 to 0.39 mm and the average is 0.36 mm. While the width ranged from 0.11 to 0.19 mm and the average is 0.15 mm.

The larva. — The larva (Fig. 3) is transparent, cylindrical, elongated, with 11 body segments and moderate intersegmental constrictions. It is creamish yellow, becoming brown when about to pupate. The anterior end bears a black cephalopharyngeal sclerite with a scythe-like paired mouth hooks, each with two teeth. It has paired anterior and posterior spiracles mounted on a stalk-like structure projected upward and outward the dorsal side of the body. The anterior spiracles arise from the prothoracic segment with 10 pores (Fig. 4), while the posterior spiracles arise from the last segment of the body with 7 pores (Fig. 5). The spicular structures of the larva differentiate it from other species.



Figs. 2-3. *Phytomyza horticola*, 2, egg, 3, larva, dorsal aspects. (mcp, micropyle; as, anterior spiracle; mh, mouthhooks; ps, posterior spiracle)



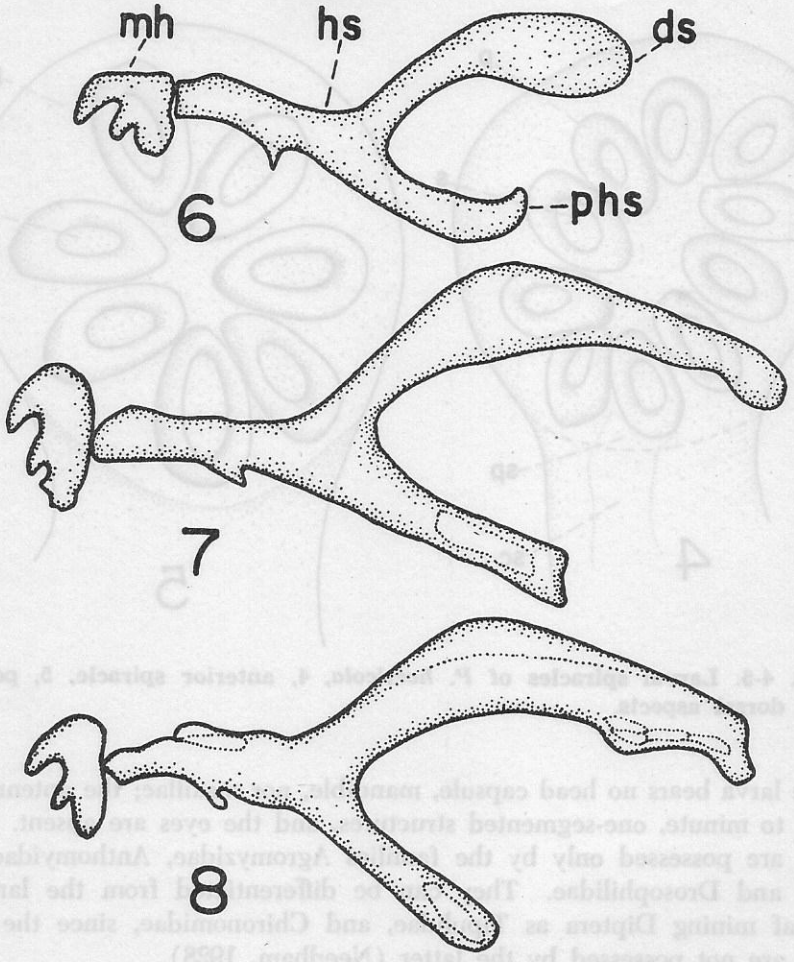
Figs. 4-5. Larval spiracles of *P. horticola*, 4, anterior spiracle, 5, posterior spiracle, dorsal aspects.

The larva bears no head capsule, mandible, nor maxillae; the antennae are reduced to minute, one-segmented structures, and the eyes are absent. These features are possessed only by the families Agromyzidae, Anthomyidae, Trypetidae, and Drosophilidae. They can be differentiated from the larvae of other leaf mining Diptera as Tipulidae, and Chironomidae, since the above features are not possessed by the latter (Needham, 1928).

The first-instar larva has small mouth hooks and less chitinized hypostomal sclerite. Its length ranges from 0.04 to 0.48 mm and the average is 0.15 mm. The mouth hooks of the second-instar larva are wider and the hypostomal sclerite is longer than that of the first instar. This larva ranges from 1.40 to 2.10 mm long with an average of 1.75 mm; its width ranges from 0.55 to 0.63 mm and with an average of 0.49 mm. On the other hand, the third-instar larva has unequal mouth hooks but is similar to that of the second-instar larva in size. Its length ranges from 3.20 to 3.50 mm with an average of of 3.35 mm, while its width ranges from 0.05 to 1.50 mm with an average of 1.00 mm. The form and structure of the cephalopharyngeal structures serve as an index for differentiating each instar (Figs. 6, 7, and 8).

The larva is visible through the transparent epidermal sheath of the leaf.

The pupa. — The puparium (Fig. 9) is flattened, elongate and ovoid. It is boat-shaped and, like the larva, visible through the transparent epidermal sheath since it is within the leaf tissue. The color varies from light to dark



Figs. 6-8. Cephalopharyngeal skeleton of larva of *P. horticola*, 6, first instar, 7, second instar, 8, third instar, lateral aspects. (ds, dorsal sclerite; hs, hypostomal sclerite; mh, mouth hook; phs, pharyngeal sclerite; t, teeth)

brown. The slit found in between the protruded anterior spiracles on the epidermal sheath serves as the passage for the emerging fly. The pupal case remains intact in the leaf so that the total number of adults that had emerged from a single leaf can be ascertained by counting the number of pupal cases at the exit hole on the slit.

The pupal length ranges from 2.10 to 2.50 mm with an average of 2.30 and its width ranges from 1.50 to 2.00 mm with an average of 1.75 mm. Cohen (1936) reported that the length measurement is one possible way of separating both sexes while at their immature stage. The male adult emerges from the pupa which measures 2.20 mm, the female measuring from 2.30 mm to 2.50 mm long.

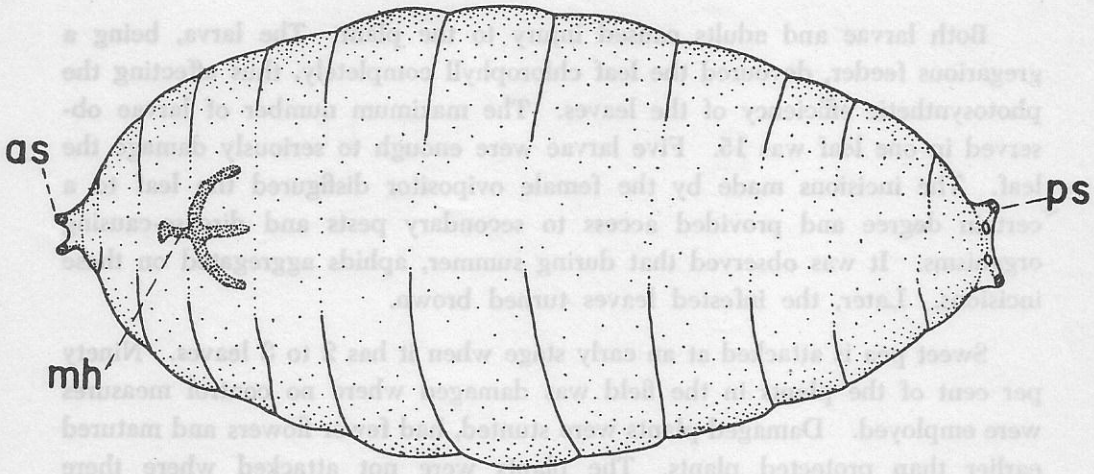


Fig. 9. Pupa of *P. horticola*, dorsal aspect.

The adult. — The adult has entirely black fore coxae, antennae and scutellum; the antennal grooves are slightly brown laterally; the face is yellow; and the forewings lack acrosticals. The difference between the male and female adults is shown in Figure 10.

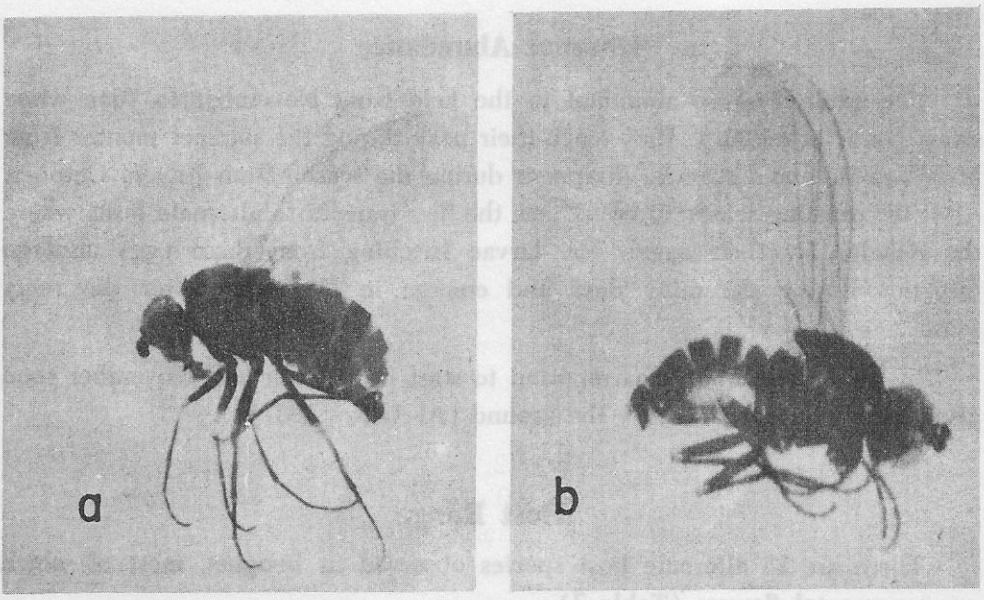


Fig. 10. Adults of *P. horticola*, lateral aspect, a, female, b, male.

Injuries to the Plant

Both larvae and adults caused injury to the plant. The larva, being a gregarious feeder, devoured the leaf chlorophyll completely, thus affecting the photosynthetic efficiency of the leaves. The maximum number of larvae observed in one leaf was 15. Five larvae were enough to seriously damage the leaf. The incisions made by the female ovipositor disfigured the leaf to a certain degree and provided access to secondary pests and disease-causing organisms. It was observed that during summer, aphids aggregated on these incisions. Later, the infested leaves turned brown.

Sweet pea is attacked at an early stage when it has 2 to 3 leaves. Ninety per cent of the plants in the field was damaged where no control measures were employed. Damaged plants were stunted, had fewer flowers and matured earlier than protected plants. The plants were not attacked where there were no alternate hosts around at the onset of planting season. Insecticide-treated plants were found to bear several incisions but with 2 to 3 larvae which were unable to pupate.

From the survey conducted it was found that the sweet pea varieties, Chinese red, Chinese white, and Giant peas did not vary in susceptibility to the pest. By random sampling it was noted that each leaf of each variety had 2 to 15 larvae.

Seasonal Abundance

The adult flies are abundant in the field from November to June when sweet pea is in season. They reach their peak during the summer months from March to June and seem to disappear during the season from July to October. After the planting season of sweet pea, the flies transfer to alternate hosts where the females lay their eggs. The larvae hatching from these eggs undergo pupation during the rainy days and emerge in November after the rainy season.

In India, infestation was reported to start in October and November soon after the plants appear above the ground (Al-Azawi, 1967).

Host Range

There are 18 alternate host species observed in Benguet, most of which are ornamental flowers (Table 7).

TABLE 7. **Alternate host plants of** Phytomyza horticola **Goureau in Benguet.**

Family	Scientific Name	Common Name
1. Compositae	*Ageratum conyzoides* L.*	
	Bidens pilosa L.*	
	Chrysanthemum maximum Ramond	Shasta daisy
	C. carinatum Schousb.	Chrysanthemum
	Dahlia coccinea Cav.	Dahlia
	Helianthus annuus L.	Edible sunflower
	Helichrysum bracteatum Andr.	Everlasting
	Tagetes erecta L.	African Marigold
	Tithonia diversifolia Gray*	Wild sunflower
	*Crassocephalum crepidiodes**	
	Zinnia elegans Jacq.	Zinnia
2. Cruciferae	*Brassica pekinensis* Rupr.	Chinese cabbage
	B. oleraceae var. *capitata* L.	Cabbage
	Lactuca sativa L.	Lettuce
3. Liliaceae	*Allium cepa* L.	Green onion
4. Polemoniaceae	*Phlox paniculata* L.	Phlox
5. Scrophylariaceae	*Antirrhinum majus*	Snapdragon
6. Tropaeolaceae	*Tropaeolum majus* L.	Nasturtium

* Identified by Miss Norma E. Orlido, Botany Depaprtment, UPLB.

Natural Enemies

The collected parasites attacked the host larvae but the latter continued to cause damage before they succumbed to the parasites. The larvae that were attacked at their early stage managed to pupate but failed to emerge. Parasitized larvae have several black patches on their trunk (Fig. 11) as in the pupae of parasitized larvae that were able to pupate (Fig. 12).

Adult parasites were observed to be abundant in the field where sweet pea leaf miners were present, but were less in number than the host. The degree of parasitism was high (60%) during summer when the host was abundant, and low (10%) during the rainy season. One of two adult parasites was observed to emerge from a larva or pupa, although more than two parasites may occur per host. It was also found that the parasite takes a longer time to emerge than the host. As a result, some larvae remained unparasitized. However, there are always hosts available throughout the year for the parasites. The parasites do not seem to cause a significant degree of economic control.

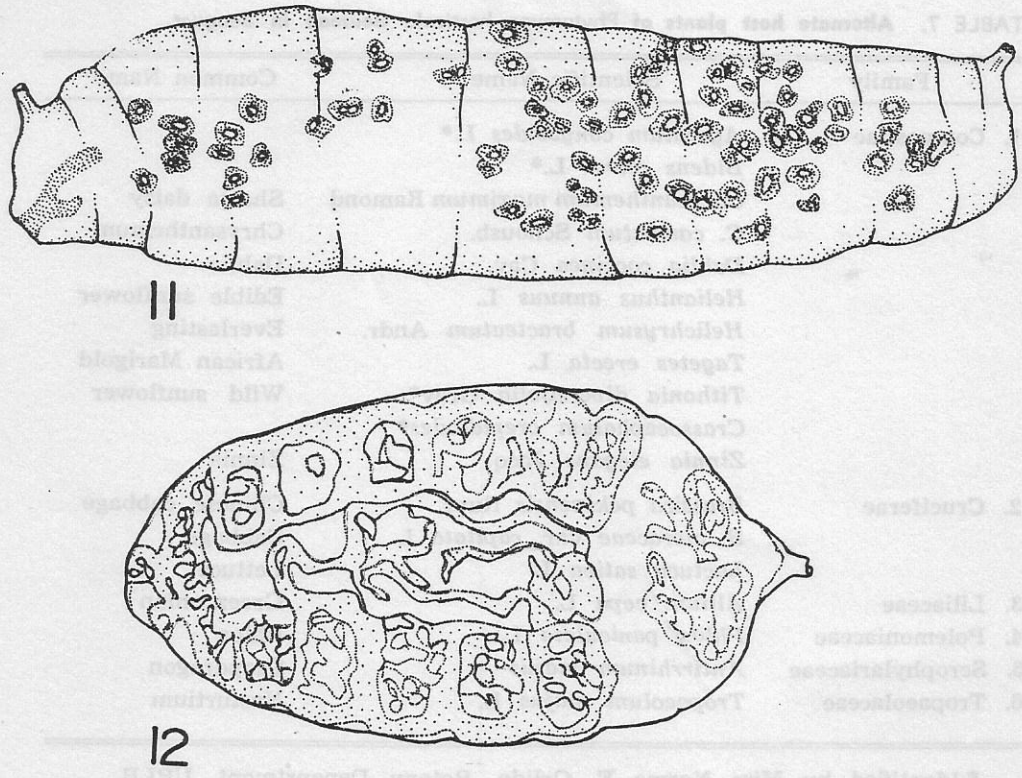


Fig. 11. A parasitized of *P. horticola*, 12, a parasitized pupa.

The parasite was identified by Dr. Clare R. Baltazar (National Institute fo Science and Technology) as belonging to the family Eulophidae, order Hymenoptera.

SUMMARY AND CONCLUSION

The larva was found to be the most destructive stage of the pest. It feeds on the leaf chlorophyll, depriving the plant of its photosynthetic activity, resulting in the reduction of plant vigor and vitality. The female adult also adds injury; its ovipositor forms cavities on the leaf surfaces, disfiguring the leaf and providing access to secondary pests and disease-causing organisms. Both larvae and adults were selective in their sites and time of feeding. The lower surfaces of young shoots were best preferred and the time of feeding, as well as oviposition, was early morning and noon. The pest caused 90% damage to the three sweet pea varieties studied.

A single female can lay more than 300 eggs throughout its lifetime and the percentage hatchability was 96%. Its longevity was dependent upon the presence of the host while that of the male depended on the female's presence.

The pest was observed in the field throughout the year but caused severe damage from March to June. It has 18 alternate host species belonging mostly to flowering plants.

The larvae were parasitized by an unidentified eulophid hymenopteran. Parasitism was high (60%) during summer.

The duration of the developmental stages of the pest was similar for both sexes, except for longevity.

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