THE BIOLOGY AND CONTROL OF *Sciara coprophila*, LINTNER (SCIARIDAE: DIPTERA) ON HOUSE PLANTS

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ON HOUSE PLANTS

by

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INTRODUCTION

Many complaints regarding serious outbreaks of small, black flies around potted plants in homes and greenhouses were received by Prof. A.V. Mitchener of the Dept. of Entomology of the University of Manitoba, from residents in the city of Winnipeg, suburbs and rural districts. At his suggestion this investigation was undertaken, and it was under his supervision that it was carried out.

Upon investigation in several homes, there were found in the soil of potted plants numerous white, black-headed larvae, feeding upon the roots of plants. Flies taken from places visited, along with specimens sent in from various points proved in nearly every instance to be *Sciara coprophila*, Lintner.

Judging from the literature, scant attention has been given by the economic entomologists to the fungus gnats causing injury to potted plants. Much more attention has been paid to the gnats attacking mushrooms, consequently to date there is quite an accumulation of knowledge concerning the biology and control of the latter. The purpose of this paper, therefore, is to deal with the bionomics and control of *Sciara coprophila*, Lintner, as the latter was identified in almost every case where an outbreak occurred.

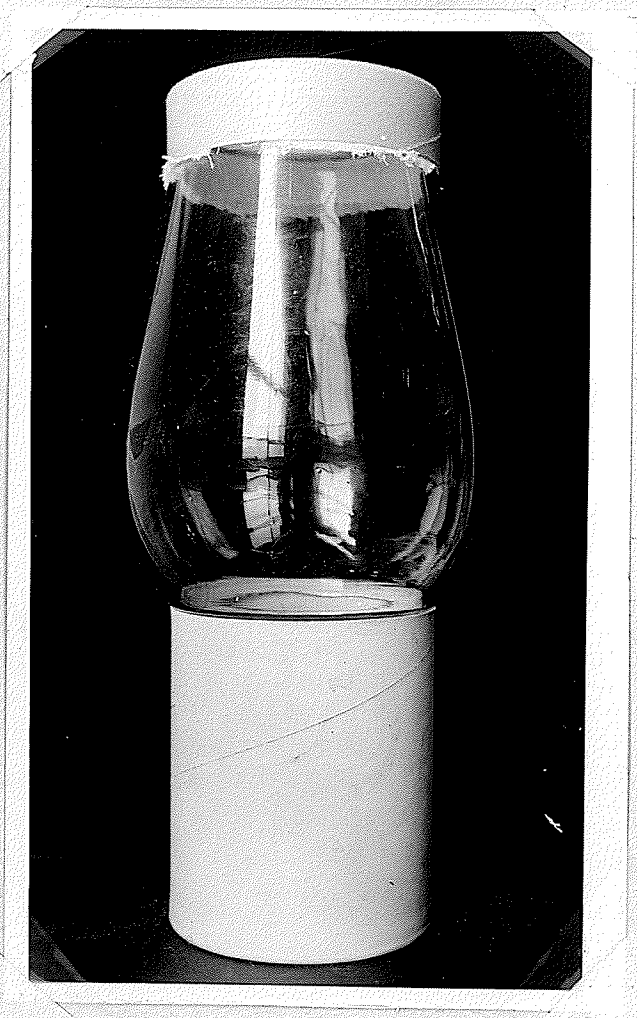


Fig. 1. - Breeding Cage (about half the original size).

Different stages of its life history, particularly the larval, were required at all times during the experiments. It was therefore necessary to establish breeding cages in the laboratory. Ten of these were set up at intervals, so that adults, eggs, larvae and pupae could be had whenever needed. Many broods were successfully reared, using methods recommended by F.H. Butt (1).

A breeding cage (fig. 1) consisted of a layer of agar one inch thick on the bottom of a one pint paper carton. On top of that a quarter-inch layer of bran, and a half-inch layer of sheep manure (not too dry) were placed. Above all was placed a two inch layer of wet sphagnum moss, which had been sterilized in the autoclave for twenty minutes in order to rid it of mites. A chimney lantern was then tightly fitted over the top of the carton, the open end of the lantern being covered with a piece of cheese cloth, to prevent flies from escaping, and to allow the entrance of air.

The daytime temperature in the laboratory during the period at which the various experiments were conducted was fairly constant, at 70° F.

The investigation was carried out during the autumn of 1934 and the winter of 1935.

GENERAL NOTES ON FUNGUS GNATS

The fungus gnats generally speaking, are flies of medium or small size, somewhat mosquito-like in form. They are

exceedingly numerous both in genera and species . More than one hundred genera containing over fifteen hundred species have been reported from Europe, North America and Australia.

CLASSIFICATION:-

All the fungus gnats according to C.A. Johannsen (2) were included in the family Mycetophilidae of the Order Diptera. He divided this family into four subfamilies, viz:- Bolitophilinae; Sciophilinae; Mycetophilinae and Sciarinae. All Sciara species were included in the last subfamily.

In the new classification as adopted by Dr. C.H. Curran (3) and by E.O. Essig (4), the subfamily Sciarinae is elevated to the rank of a family, Sciaridae, of which Sciara coprophila, Lintner is a member. The former author calls the insects of family Sciaridae "Dark winged Fungus Gnats", the latter calls them "Root Gnats" - indeed an appropriate term, as they do a great deal of damage to the roots of plants. The insects belonging to this family are closely related to the Mycetophilidae in which they were formerly included. The two can be distinguished by the fact that the former have shorter coxae, different eye formation and wing venation; "The R-M crossvein being in the same right line with the second section of the radial sector, and the cubitus forking near the base of the wing" (Johannsen 1912). Generally speaking the wing venation of Sciaridae is characteristic and typical, although a very few genera of the family Mycetophilidae have similar venation.

Even as early as 1911 Prof. Enderlein in a paper "Archivf Naturgeschichte" put forth a new arrangement of the genera, based upon what seemed to be good support. He separated the Sciaridae from the Mycetophilidae upon the form of the eyes.

In the former he found that the eyes possessed slender projections passing over the base of the antennae, the two processes meeting or nearly meeting each other, and forming a sort of bridge over the base of the scape. In the latter the eyes are oval, sometimes more or less emarginate, but not adjacent to the base of the antennae - that is, the eyes are not produced toward each other.

CHARACTERISTICS OF THE FAMILY SCIARIDAE, THE DARK WINGED FUNGUS GNATS ACCORDING TO DR. CURRAN (3):-

1. Wings present, rarely reduced.
2. Antennae composed of six or more freely articulated segments.
3. Mesonotal suture, transverse, not V-shaped.
4. Wings without a network or folds, or creases.
5. Ocelli present.
6. Costa ending at or near the wing tip.
7. Discal cell absent.
8. Tibia with apical spurs.
9. Eyes more or less connected by a projection above the base of the antennae.

CHARACTERISTICS OF THE GENUS SCIARA:-

1. Proboscis not greatly elongate.
2. Wings with microscopic setulae, but not hairy.
3. Claws not toothed.
4. Face not produced.
5. Forks of the fourth vein not arcuate, antennae never pedicellate.

Species of Sciara are not so easily distinguished from each other upon superficial examination. Identification of the species is chiefly based on male characters, notably the hypopygium - the shape of the claspers. On closer examination it is found that the ovipositor in the female varies somewhat in structure in each species. Color may also be used as a distinguishing feature.

LIFE HISTORY OF Sciara coprophila, LINTNER

TECHNIQUE USED:-

A round half-pint paper carton lid about one inch deep was used. To one side on the bottom of it, a bit of sheep manure mixed with bran was placed, and on top of this, wet sphagnum moss, to prevent the breeding medium from drying out. At the opposite side, a piece of wet cotton was introduced to insure sufficient humidity. Water was added to both the sphagnum and the cotton every seven days. Several adult flies, males and females were allowed into the lid, which was quickly covered with an ordinary piece of square glass. This device enabled the investigator to examine the breeding cage from the top, both with the unaided eye and with the binoculars.

The above device was set up on February 27, 10:45 A.M., and was examined for eggs every half hour during the day. Mating was noticed on the same day at 2:20 P.M., and immediately after mating, the female began laying eggs. This lasted for a period of about twenty-five minutes, at the end of which the female died. She laid them in five different clumps, totaling thirty-five eggs in all. All of the flies were then liberated as they were no longer required. The data for the life histories were

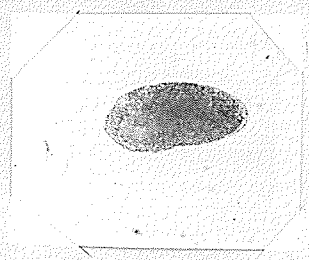
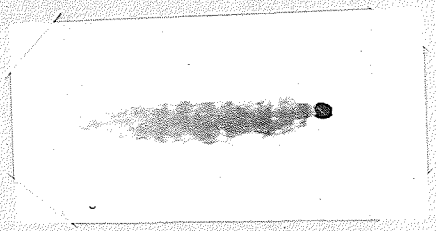


Fig. 2. Egg of Sciara coprophila, Lintner (enlarged about 125 times)

A



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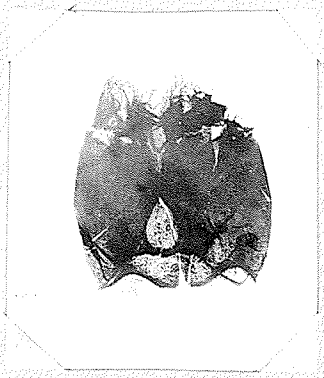
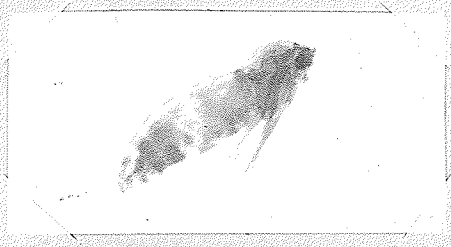


Fig. 3. - A. Larva of Sciara coprophila, Lintner, (enlarged about 8 times), showing the chitinized black head;

B. Head of the larva (enlarged about 125 times), showing the toothed mandibles and two lobed maxillae (only one maxilla shown in this case).

A



B

Fig. 4. - A. Pupa of Sciara coprophila, Lintner, (side view, (enlarged about 8 times), showing eyes and developing limbs;

B. Ventral view of another pupa of same species (enlarged about 8 times)

obtained by following the various stages in the cycle.

EGG STAGE:-

Description -

The individual eggs (fig. 2) are just visible to the naked eye. They are oval in shape, and measured 0.24 mm. in length by 0.12 mm. in width. They are usually laid in clusters and hence are quite easy to locate without the aid of the binoculars. In color they are pale yellowish when first laid, but gradually change to pearly white in about three days.

Duration of Egg Stage -

On Feb. 9, each of the eggs began to show a dark shadowy patch at one pole (the head of the future maggot). This continued to grow darker for several days, and on Feb. 13, some of the eggs hatched. The young larvae were quite active. The remainder of the eggs hatched on the following day (Feb. 14). The incubation period of individual eggs in the same clump varied slightly. All eggs had hatched by the end of the seventh day. The extent to which the incubation period will vary depends upon the amount of moisture and temperature. The eggs just before hatching were very shiny, particularly at the darkened pole.

THE LARVAL STAGE:-

Description -

The larva (fig. 3) when just hatched is very small, and grayish-white in color. It measures about 0.65 mm. in

length, and consists of twelve segments. It is footless more or less tapering at both ends, smooth, soft and has a small brownish-black head which is strongly chitinized. The head in the course of growth changes to black. The antennae are very small, and just visible under the binoculars. An examination of the mouthparts shows that the mouth is well adapted for cutting. The following parts can be recognized: A fleshy labrum with a strongly chitinized frame; flat lamelliform, mandibles toothed on the inner side; maxillae with inner and outer lobes, the former serrate and a small chitinized labium. The body of the larva is void of hair or bristles, which may be found in other fungus gnats. It had eight spiracles which are covered by small chitinized conical projections. The anterior pair of spiracles is the largest. The larva when mature or full-grown measures on the average about 7 mm. The constrictions between the segments now become more obscure.

Duration of Stage -

As soon as hatched the larvae were seen to migrate downward toward the manure-bran mixture upon which they fed. They began feeding immediately. At first they were quite transparent, but when examined on the following day after hatching (Feb. 15), the digestive tract was beginning to show as a dark streak throughout the length of the body. Contents of the digestive tract of a larva which had been dissected were examined. They consisted chiefly of the manure-bran mixture which had been ingested. A change in the larvae was observed on Feb. 18. They had increased greatly in size and were more than double that of newly hatched

larvae. By this time they began to take on a milky-white color which was the result of the appearance of the large fat bodies within their bodies. Subsequent increases in size were observed until they attained the maximum size of 7 mm. at the end of the eleventh day of feeding (Feb. 25). The larvae were now practically if not entirely filled with fat bodies, so that the internal organs were almost concealed. They now began to pass into the pupal stage. The length of the larval feeding period was about eleven days.

Prepupal Stage -

A few of the larvae were seen to move away from their food toward the drier parts of the medium such as fragments of dry sphagnum and bran. Some began to spin cocoons by binding small bits of bran, manure, etc., with fine silk threads. In one case a larva was seen constructing a tunnel or cell which was two-thirds its length, and then forming a cover over the opening of the cell by spinning out silk threads. In all stages of development the larvae have the power of spinning out threads. H.B. Hungerford observed larvae preparing for pupation, spend about twelve hours or more in constructing such a tunnel.

Before pupation the larvae contracts considerably in size to about 4 mm.

THE PUPAL STAGE (fig. 4):-

Description -

As soon as the larva becomes quiescent in the cocoon or in the cell, as the case may be, it is called a pupa - a

naked pupa, free from the last larval skin. When the pupa is just formed, it is milky-white in color and smooth in texture. Gradual changes take place in the pupa, until just before the emergence of the adult, the thorax becoming black and the abdomen revealing the pattern of the adult. The legs are plainly seen, and are applied to the breast and venter; the antennae are bent around the eyes and extends between the wings and legs; the prothoracic spiracle is seen slightly above the base of the wing and just behind the antennae; the abdominal spiracles are conspicuous on either side of the abdomen.

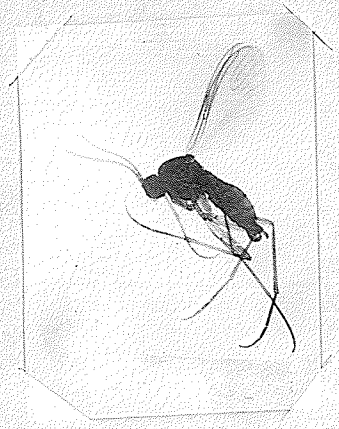
Duration of Stage -

Some larvae pupated on Feb. 26, the rest on Feb. 27. Those which pupated on Feb. 27 were presumably the ones hatched on Feb. 15. Under unfavorable conditions, the insect is known to hibernate as the pupa. The pupae as well as larvae succumb to dessication.

In potted plants the pupae are generally found close to the surface of the soil in much drier situations than the larvae. One of the infested pots was examined. Most of the pupae were in the first inch of oil; a few however, were deeper. They have the power to work their way up before emerging as adults, some, nevertheless, become imprisoned in the deeper parts and die. The pupae breathe through the spiracles, but do not feed. They were found either in delicate cocoons or in tunnels, the entrances of which were covered by a fine mesh of thin silk threads.

Emergence of Flies -

The flies do not take to flight immediately on emerging.



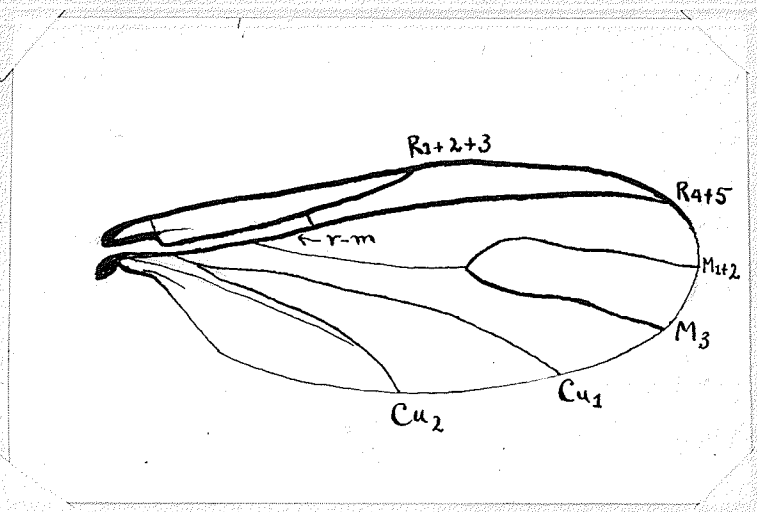


Fig. 5. - A. Male of Sciara coprophila, Lintner, (enlarged about 8 times)

B. Wing of Sciara coprophila, Lintner (enlarged about 40 times), showing the venation - Comstock System.

Fig. 6. - Hypopygium of Sciara coprophila, Lintner, (enlarged about 125 times), showing the shape of the claspers.

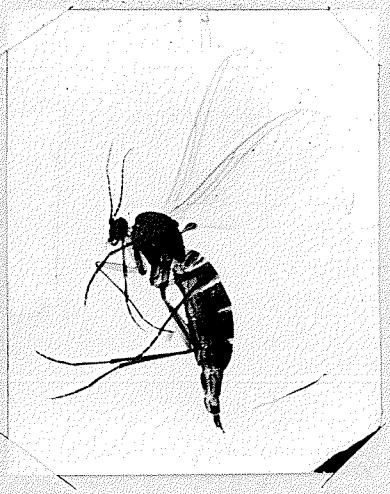


Fig. 7. - Female of Sciara coprophila, Lintner, (enlarged about 8 times)

A newly emerged fly was removed to a large jar. Upon examination its wings were found to be crumpled and soft and the body light in color. Not more than twenty minutes elapsed, before it assumed the normal color, and the wings became fully extended and dry. The fly was now capable of flight whereas only twenty minutes before, it was only able to walk and run.

Under the above conditions, the period which elapsed from one generation to another, i.e., from the time the female oviposited, until the emergence of the adult was twenty-four days. Broods reared in breeding cages already described, serving as general checks also took twenty-four days for a complete life cycle. The latter may be prolonged if conditions are unfavorable to the various stages. The extent to which it may vary depends on temperature, humidity and available food. During the hot summer months when the temperature is above 70° F., the life cycle may be considerably shortened.

ADULTS:-

Description of the Male -

The male (fig. 5) measures on the average of about 2.5 mm. in length, though dried specimens may be a trifle shorter. Both head and thorax are black and subshining. The antennae are about three-quarters of the length of the body. It has fifteen joints and is setose. The palpi are short, have four joints, and are fuscous in shape. The thorax is highly arched, scutellum small and setose. The abdomen is more or less cylindrical (more

so in the female) and laterally compressed. It consists of six visible segments, is dark brown to black in color, and terminates into a complex hypopygium, which is characteristic to each species. The claspers (fig. 6) are fuscous in shape, also characteristic and peculiar to each species. In color, the coxae and legs are dusky yellow. The former are not very elongate. The wings are of a grayish color, and hyaline. The haltres are brown with yellowish petiole.

Description of the Female -

The female (fig. 7) measures on the average of 3 mm. in length. It is very much like the male in color. The hind tarsus, however, are slightly shorter than the tibia. The antennae are about half the length of the body. The abdomen is quite cylindrical, especially in the gravid female. Lobes of the ovipositor are dusky.

Duration of Life -

Primarily, longevity of the flies, both males and females in aggregation was determined under the following conditions:

(a) With food, moisture being present.
(b) Without food, moisture being present
(c) Without food or moisture.

(a) With food and moisture:- A half pint paper carton was used as a cage. It was almost filled with moist soil rich in humus. A watch-glass containing honey was placed on top of the soil, and a chimney lantern with cheese cloth covering its open top was tightly fitted over the box. The soil was watered every day. Newly

emerged males and females were then introduced on Feb. 28, and kept thus in captivity. Theflies were quite frequently seen to alight on the watch-glass during all times of the day. They seemed to lap up the honey. Four of the flies were accidentally stuck to the honey and perished. The flies began dying off in about ten days, the last one died on March 14. The males were the last to die.

In this instance some of the flies died after ten days, the majority lived for eleven or twelve days, while the remainder died fourteen days after emergence

(b) Without food but with moisture:- A similar cage as in (a) was employed, only this time, however, duplicate cages were used, one partly filled with wet sphagnum moss, the other containing a geranium plant rich in humus. The flies in both these cases were found to live for a maximum period of four days.

(c) Without food or moisture:- Similar apparatus as in (a) and (b) was used, the carton, however was empty and absolutely dry. The flies lived for about twenty-four hours.

Secondly, longevity was next determined with males and females singly, as follows:

(1) A male and a female, each was caged singly in a small jar, containing no moisture. They lived for a very short period. The former lived ninety-eight and a half hours, the latter lived only forty-eight hours.

(2) Honey was introduced into two similar jars, one containing a male and the other a female; the former lived for

about ninety-five hours, while the latter lived about fifty hours. Here, however, the flies were not seen to feed at anytime. They probably would have lived longer had they fed.

From the above data it may be concluded that fed flies in aggregation live longer than those unfed. Without food or moisture when singly, lived longer than those aggregated, possibly due to the latter's greater activity; for, here, there is a mixture of males and females. The males evidently seemed to live longer. This is possibly due to their apparent scarcity. In their natural habitat, i.e. not in confinement, these flies might probably have lived longer, since in confinement they wore themselves out by continually knocking against the sides of the container.

Proportion of Sexes:-

Judging from the material available, it seems evident that the females are numerically preponderant over the males. Samples of Sciara coprophila, Lintner caught at random as well as samples sent in were examined for sex determination. The average percentage of males and females found was 30.1% of the former and 69.9% of the latter.

Generation per Year:-

It is not an easy matter to determine with absolute accuracy the exact number of generations of Sciara coprophila, Lintner, since conditions are not always suitable to its breeding. According to Nowlin (5), the height of their breeding season is in April and early May. In the laboratory, however, Dr. O.A.

Johannsen according to C.A. Thomas (6), successfully reared in a bottle containing commercial spawn a series of generations of the fly for a period continuing over a year and a half. Thus it can be seen that under suitable breeding conditions, the fly can live over a prolonged period.

As was found in working out the life history under laboratory conditions, twenty-four days elapsed from one generation to another. This would permit about fifteen generations per year.

HABITS OF THE ADULTS

General Habits:-

The adults of this species inhabit moist situations or any place where fungi will thrive, especially in manure. For that reason they are so commonly abundant in soils rich in manure.

The adults apparently do not feed much, although they were seen on moist leaves, lapping up moisture. On one occasion, a cotton wad attached to one end of a string was suspended into a breeding cage. Many flies landed on it and seemed to lick the honey. But the flies were reared equally as well in breeding cages where honey or similar food was absent. Whether they lapped up the moisture from the wet sphagnum moss is problematic. It seems possible that feeding is not essential for their reproduction.

The flies are not good fliers, but good runners, hard to capture. When disturbed they are inclined to hide under bits of earth or on the underside of leaves. Frequently they leave the pots and invade all parts of the house, and since they are pos-

itively phototropic, are commonly seen on the window panes, in residences and greenhouses. Indeed mushroom growers take advantage of this peculiar habit in controlling them. The flies become quite inactive, practically lifeless when the temperature falls below 40°F., but become active again when the temperature is raised. They are indirectly injurious to plants by carrying the spores of various moulds and the hypopi of ? Troglyphid mites. During the course of the investigation flies taken from a mushroom cellar, harboured on their underside near the thorax, as many as six to eight of these hypopi.

The adults when in abundance prove to be of great nuisance. It is for this reason alone that the housewife's wish for their erradication seems justifiable. One lady reported having these flies hover about the dining table, and frequently alighting on the food. Here agin from a hygenic point of view their extermination should be effected. Too, an informant reports having these pests hover about his person, particularly the face when he is seated near a lamp. The above statements can be corroberated by the investigator who found them very annoying while experimenting, when the flies were accidentally liberated from the breeding cages.

Mating time and methods:-

Mating was observed during all times of the day in their natural environments and in the laboratory. For a close observation of the method, two adults, a male and a female, were introduced into a watch-glass containing at one side a piece of cotton soaked in water. The male it was noticed, here as well as in other instances, is always the aggressor. Both flies were

seen to run about very energetically, the male being the more active. The latter was then seen to run up from behind the resting female, then lowered or curled down the tip of his abdomen, open the claspers which were now projecting under and in front of its head, and exposed the genital parts. It then backed up a little more toward the female to grasp it with the claspers, This act was repeated many times before actual copulation took place, for on several occasions the female was actually seen to repulse the male when just about to be seized by the latter's claspers. If the female is to copulate with the male, she stands still and allows to be seized at the tip of her abdomen. During this process the female had her wings folded on its back, while the male's were fully extended horizontally. Immediately after seizure, the male inserted its penis into the genital orifice of the female, and then pivoted as if on an axis, so that it turned over with its dorsal side up - they were facing in the opposite directions.

The length of time these insects remained in copulation just described was fifteen minutes. This period of copulation on other occasions was seen to vary; five and ten minute periods were also observed. In the majority of cases, however, duration of copulation either in the natural habitat or in confinement did not exceed ten minutes.

Preoviposition period:-

Preoviposition period means the period from the time the fly emerges from the pupa until it oviposits its eggs. To determine this period, fifteen almost full-fed larvae were introduced into a 20 c.c. test tube, half-filled with moist sheep manure. They soon pupated and adults emerged on March 10, in

the morning. The testtube was examined for eggs at intervals each day; no eggs were found until about 10:00 A.M., on March 12. They were lying close to the glass. The preoviposition period under these donditions, was two days. Similar observations were made with potted plants covered with chimney lanterns, this being perhaps, the closest to their natural environment. In this case also the preoviposition period wasfound to be two days.

The newly emerged female has a rather flat, more or less laterally compressed abdomen. Upon dissection the ovaries were found in a very rudimentary state of development, the eggs being very small and bright-yellowish in color. The two egg masses on either side in the abdominal cavity represented by the two ovaries were embedded in a yellowish gelatinous fluid. In a female cut open on the second day, the eggs were quite large and assumed a whitish color, the yellow fluid being practically gone. Each ovary by this time looked like a bunch of grapes. Just at the end of the preoviposition period, the abdomen became greatly distended, assuming a cylindrical form. At this point the female was ready for oviposition.

Oviposition:-

Previous to oviposition, the pregnant female will seek out a declivity in the soil, insert its ovipositor into some crevice, usually where the soil comes away from the pot, or around the stem where the soil is generally loose and lay its eggs. She will sometimes go down deep in the soil to oviposit. In the breeding cages, females were found below the two inches of loose sphagnum moss, where they laid their eggs. In potted plants

the egg masses are rarely laid in direct sunlight, but are usually found adhering to the undersurface of fragments of soil.

The process of oviposition under laboratory conditions was noticed in the fore and late afternoon. A female was observed in the act of oviposition. It inserted its ovipositor into the sphagnum moss, but did not lay the eggs into one clump. It laid them in five different batches of 1, 3, 7, 10 and 14 eggs in each. The process of egg-laying was continued for twenty-five minutes. Since this was the only occasion upon which oviposition was noted and it was not observed in their natural habitat, does not provide a satisfactory basis for establishing the period of oviposition. It was found that the female in question died after laying the eggs. Upon dissection no more eggs werefound in the abdominal cavity. This fly had no doubt oviposited before, perhaps in the breeding cage from where it had been taken, since many pregnant flies were dissected and nearly two hundred eggs were counted in each case. Many females were also found dead in the breeding cages beside clumps of eggs.

It seems, therefore, quite probable from the evidence gathered, that after laying the last batch of eggs, the female dies. It also seems probable that it oviposits intermittently, and that mating is essential before each oviposition.

Larger clumps of eggs were also found, in many cases containing over seventy eggs. They were held together by a gelatinous substance. Eggs as they were being deposited resembled a string of beads, coiled in a small mass.

HABITS OF THE LARVAE

Larvae upon hatching are quite active, and seek the deeper parts of the soil. They crawl over it in a snake-like fashion. Old larvae do not move about with such ease. When disturbed they quickly retract the heads into their bodies with a jerking motion.

The larvae can tolerate quite a bit of moisture. A few larvae were kept alive for three days in a watch-glass completely filled with water, and containing manure.

Feeding is by means of laterally opening and closing its jaws, and ingesting tiny fragments of soil. A larvae was seen to eject through its mouth a drop or two of colorless liquid, probably containing digestive juices which renders the food partly digestible. Frequently it was seen to defaecate while in the act of feeding.

Their feeding on healthy roots and perfectly sound tissues may be considered as accidental and not specific, since the larvae habitually feed on dead fungi and rotted vegetation. But as the larvae for the greater part of their lives move about in the deeper parts of the soil of potted plants, they will no doubt sooner or later come upon the roots system and start working on it.

From one of the infested pots in the laboratory, its plant which had not made any progress of growth for some time, was pulled out of the soil and examined. Numerous larvae were found feeding on the fine roots, and a few were found inside the main stalk, which was almost decomposed.

The location of the larvae in the pots varies. Upon observations made of three inch pots, was found that most of the

larvae were located about one and a half inches from the surface, a few, however, were found as deep as two or more inches from the surface, some just beneath the top.

DISTRIBUTION OF Sciara coprophila, LINTNER

The study of distribution of this species was divided into three parts.

1. Residences in the city of Winnipeg were visited (mostly by request) and specimens of flies were taken from the plants for identification. The fungus gnats in each case were found to be Sciara coprophila, Lintner.
2. Mushroom cellars were visited in the city and suburbs. (Five in all) and specimens were again taken for identification of the species. Sciara coprophila, Lintner, although the prevalent species in these cellars, was not the only pest. In one mushroom cellar at Fort Garry site, another fungus gnat was found - Sciara prolifica, Felt. It is known to be injurious to the mycelium and mushrooms, but was present in a much smaller proportion than the former species. Other dipterans found in this cellar and in one other case were: Forcipomyia ciliipes, coq. (Ceratogogomidae); Psychod sp. (Psychodidae); Megaselia (opheochaeta sp.) (Phoridae); Drosophila sp. (Drosophilidae); Sphaerocera subsultans Fabr. (Borboridae). These may be regarded as being scavengers rather than injurious. Flies taken from the other three cellars consisted entirely of Sciara coprophila, Lintner.

Incidentally, other pests injurious to mushrooms such as mites and springtails were found in the beds of these cellars. Some cellars being more infested than others.

3. Samples taken from house plants were sent in from the following rural districts in Manitoba, viz. Ashern, Austin, McCreary, (from a mushroom cellar), Wawaneesa, Pilot Mound, Souris. In all the above cases with the exception of McCreary, the species were identified as Sciara coprophila, Lintner. The McCreary sample consisted of three distinct species of which the dominant was Sciara coprophila, Lintner, and the other two were unidentified species of Sciaridae. Two other samples received from Keewatin, Ontario, and Sturkwelher, N.D., were identified as other species of Sciaridae.

From the evidence presented in the foregoing study, it was definitely shown that Sciara coprophila, Lintner is the prevalent species among the fungus gnats in Manitoba, which attack not only roots of plants but the growing, fleshy fungi such as mushrooms. Their economic importance with regard to the latter must not be overlooked as the mushroom industry is rapidly increas- in Manitoba.

Since mushrooms serve as hosts for Sciara coprophila, Lintner, it is worthy of a little space to briefly describe the relation of the latter to the former. It is only within recent years that the economic entomologists began to realize the actual damage the larvae of this species were inflicting on the mushrooms. O.A. Johannsen, 1912, states "Though occasionally reported as injuring mushrooms, the members of Sciarinae (now Sciaridae) are not as a rule regarded as serious pests of the fleshy fungi, differing in this respect from the species of other subfamilies. After partial decay of fungous growths, however, the larvae of Sciara are found in abundance, and it is this fact, which in some case at

least, have led observers and growers to attribute the destruction of these gnats when in all probability the injury was caused by species of Mycetophila, Exechia or Phorids". But in a recent publication by C.A. Thomas (7), who reported recovering maggots of Sciara coprophila, Lintner from a mushroom cellar in Pennsylvania which caused direct damage to the Mycelium and tissues of the mushrooms. "The larvae feed on the mycelium or bore into the tissues of the mushrooms, which may be entirely honeycombed within."

It must be borne in mind that fungus gnats are not the only pests in mushroom cellars. Considerable damage is also caused by springtails and mites, already mentioned.

Various controls are recommended in the literature, some of which are claimed to be quite effective. But as yet, there is no method found which will completely erradicate these flies and other pests. Consequently considerable sums of money are annually lost by mushroom growers. Even the most scrupulous grower will suffer a loss of about 35% of his entire annual yield.

HOST PLANTS

Owing to the fact that Sciara coprophila, Lintner is most prevalent in very well fertilized soils with abundance of moisture, it is apparent that it does not have any preference for any particular plants. During the investigation it was found that badly infested soils were those which had the most organic fertilizer and most moisture. The flies will not thrive well in ordinary soils. This was demonstrated by almost filling a one pint paper carton with ordinary, fine sifted soil, and fitting over it a chimney lantern, and males and females were introduced into it. The

soil was kept moist. The complete life cycle took about thirty days. The flies which emerged were very small and weak; they could hardly fly. They died the same day of emergence. This apparently indicates that the developing larvae did not get sufficient nourishment and it seems likely that many larvae perished in the soil.

In brief, it may be concluded, that any plant growing in soil rich in any sort of organic fertilizer, such an manure, will become a victim to these larvae. In all homes examined where organic fertilizers were used, infestations were found.

INJURY

That larvae of Sciara coprophila, Lintner caused direct injury to the roots and occasionally to the parts above the soil of potted plants, is now a well-established fact. It is a common experience for housewives to find that sometime or other their plants assume a sickly appearance and at the same time to notice numerous larvae in the soil. Their relation between the existence of these larvae in the soil of potted plants and their becoming sickly looking was not always associated. In 1918 H.B. Hungerford reported many outbreaks occuring during the winter months and also that the fungus gnats concerned invariably proved to be Sciara coprophila, Lintner. He stated, "Since this was the first time that these flies had been brought to our attention, were not only at loss regarding means of exterminating them, but, moreover were skeptical as to the actual damage they were doing, being more inclined to attribute the sickly appearance of the plants to some physiological condition of the soil or surroundings". He then carried out series of experiments to determine the nature of injury.

He observed that when larvae were introduced into a flat glass containing the growing roots of a geranium plant under all sorts of soils and conditions, they attacked the roots even in pure, well rotted manure, and in soils rich in dried blood and blood fertilizers. He further stated, "We have frequently watched them eating the root hairs of various rootlets, and devouring sound growing roots". He claimed that injury to the plant became obvious only when the larvae were quite numerous. He reported of a certain large conservatory in which most of the plants such as begonias, coleus species, ferns, etc., were ruined through such infestations.

Another reference regarding injury caused by these larvae may be made to J.M. Hawley (8), who, while testing the growth of beans noticed that those growing in the soil at a temperature of 76° F. were seriously affected by them.

Many references were found to deal with other species of Sciara as being injurious to a diverse number of plants. In certain cases, only Sciara species was mentioned, as at that time many species of Sciara had not been described. But suffice it to say that many species of Sciaridae of which Sciara coprophila, Lintner is a member are of great concern to the agriculturists.

The investigator examined well authenticated cases of injury to the roots and fleshy parts of plants caused by the larvae of Sciara coprophila, Lintner. These plants were brought into the laboratory, as their owners could not understand their sickly condition.

A dark blue (Dutch) hyacinth bulb was brought in by a resident in the city. Upon examination it was found to be

helplessly infested with larvae which fed about the roots. Some of these larvae were seen on and between the scales of the bulb, greedily devouring the tissues. The top scales were already partly decayed. The rot probably set in after the feeding of the larvae was initiated. The injury to the roots was so severe that scarcely any of them were left, and consequently growth was retarded. The plant became stunted. The owner asserted that it should have been in bloom as he had a similar plant of the same age and species which was in bloom. The latter bulb was found to be void of infestation. Flies reared from these larvae were Sciara coprophila, Lintner.

Two potted genanium plants, rather sickly looking were taken into the laboratory. The soil was teeming with larvae. The pot which was rich in manure was more seriously affected. It was observed that most of the tender roots were gone. The larvae were now attacking the larger roots. Again the flies reared were Sciara coprophila, Lintner.

During one of the experiments a potted geranium plant was covered with a chimney lantern and many adult flies were introduced. Several weeks later the plant assumed an unhealthy appearance and finally died. The plant was taken out of the soil and examined. The rootlets were entirely eaten away (fig. 8). The main stalk was well rotted and its interior contained several larvae.

It was clearly shown in the above cases that there can be no doubt as to their injurious work upon plants.

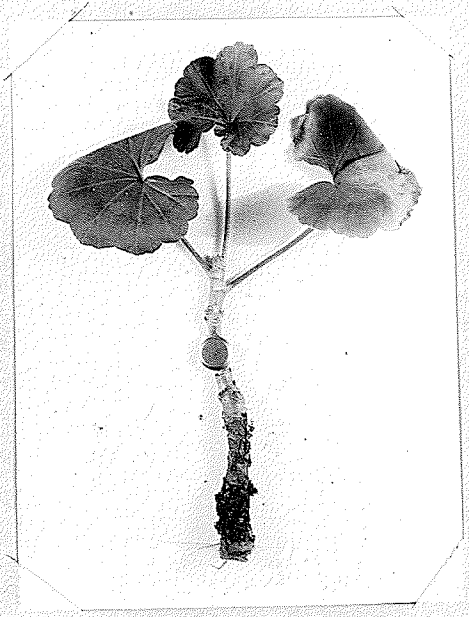


Fig. 8. - Geranium plant (about 1/2 original size), showing the destructive work of larvae of Sciara coprophila, Lintner

CONTROL MEASURES

One of the aspects of this investigation, as previously mentioned, was the control of infestations of Sciara coprophila, Lintner. To date, controls recommended by various investigators did not prove satisfactory, since in most cases the insecticides used (especially in form of a solution), either failed to kill the larvae or injured the plants.

The efforts of the investigator were mainly directed towards killing the larvae, chiefly by reason of their accessibility.

Series of experiments were conducted, using a few larvicides, both contact and stomach poisons, some of which had been previously recorded, but were used here with certain modifications. Others, however, had not been previously recorded in connection with killing the larvae of Sciara coprophila, Lintner. Their toxicity upon the plants was seriously considered - thus excellent larvicides were discarded as they proved fatal to the plants. The value of the larvicides used were first tested on larvae in a watch-glass. These tests were simple and could be closely examined under the binoculars.

The chemicals used were as follows: Black leaf "40" mixed with commercial lux; Ammonium sulphate; Tripple super calcium phosphate; Ammonium phosphate; Pyridine; Arsenate of lime; Derris; Benzaldehyde; Potassium ferrogyanide; Pyrethrum; Sodium fluride; Sodium fluosilicate and formaldehyde.

The above materials were first tested in watch-glasses as to their effectiveness on the larvae, and only those which showed any promise were tried on the soil of potted plants.

Various strengths were used to determine the minimum dosage that would kill them.

Let us now consider the effect of each of the materials on larvae in a watch-glass. The larvae were introduced into watch-glasses with a bit of its feeding medium. Young larvae were used. The results obtained are as illustrated in the following charts: Chart 1. (Contact poisons); Chart 11. (Stomach Poisons).

The data obtained from the above preliminary tests cannot be considered as absolutely accurate, since conditions here are very different from those in the soil of potted plants. For instance, in the case of contact larvicides, the larvae in the watch-glass are more or less immersed in the solution, while in the pots the larvicidal solution is drained and the larvae can move about freely. The same holds good for stomach poisons as the latter may be washed away in the soil of pots. Also the stretching of the larvae in the solution (larvicidal) may not always be attributed to the effect of the poison, for larvae submerged in pure water will do the same.

The above data does, however, throw light on their comparative values as larvacides e.g. Pyridine in ratios 1:100 - 1:400, has an almost instantaneous lethal effect on the larvae. Whereas Ammonium sulphate has no effect on them. No. 7,8,10 in Chart 1. and No. 2, and 3 in Chart 11. / showed promise of being good larvicides but could not be used since they are toxic to plants in the proportions used.

All the others, with the exceptions of No. 2 & 3 in Chart 1, showed favorable promise, Pyridine being at the top

EXPERIMENTAL SERIES

The experiments were begun on Jan. 17, 1935. About

CHART 1.—showing the effect of different concentrations of various contact poisons on the larvae of sc. copyrophila, Lintner.

Chemicals used	Ratios used.	EFFECTS 1:50	1:100	1:200	1:300	1:400	1:500	Remarks
	1. Black leaf "40"& common lux	died in 3 hours	died in 3 hours	died in 3 hours	died in 5 hours	died in 30 hours	died in 30 hours.	
	2. Ammonium sulphate	no effect	no effect	no effect	no effect	no effect	no effect	Slightly sol. in H^2O
	3. Triple super ca. phosphate	"	"	"	"	"	"	Slightly sol. in H^2O
	4. Ammonium phosphate	Slow lethal effect;died in 2 hours	Slow lethal effect; died in 2 hours	Slow lethal effect; died in 2 hours	Died in about 10 hours	no effect	no effect	Slightly sol. in H^2O
	5. Pyridine	Died within 2 minutes	Died within 2 minutes	Died within 2 minutes	Died within 2 minutes	Died in about 10 minutes	Died in about 10 minutes	
	6. Fresh Derris	Died in 24 hrs.	Died in 24 hrs.	Died in 24 hrs.	No effect	No effect	No effect	No effect when used as a dust
	7. Benzaldehyde	Died in about 5 minutes	Died in about 5 minutes	Died within an hour	Died in about 2 hours	Dead in about 10 hours	Died in about 10 hours	Toxic to plants in the ratios used. Practically insol. in water
	8. Potassium ferrocyanide	Died in about 2 hours	Died in about 2 hours	Died in about 2 hours	Died in about 2 hours	Died in about 2 hours	Died in about 2 hours	Toxic to plants in ratios used
	9. Pyrethrum	no immediate effect						no effect as a dust
	10. Formaldehyde	Died in 10 minutes	Died in 10 minutes	Died in 10 minutes	Died in 10 minutes	Died in one hour	Died in one hour	Toxic to plants in ratios used

CHART II. Showing the effect of stomach poisons on larvae.

Chemicals used	Ratios	Effect	Remarks
1. Arsenate of lime and manure	At the rate of 1 part of arsenate of lime to 20 parts of weight of manure	All died the following day	Practically insol. in water
2. Sodium fluride	"	"	Toxic to plants
Sodium fluosilicate	"	"	"

a month prior to this date, a large number of geranium plants were transplanted from the greenhouse into half-pint paper cartons, punctured in the bottom to allow irrigation of water. The purpose of using paper cartons was chiefly because chimney lanterns fitted tightly over these cartons. The top of the chimney lantern was of course covered with a piece of cheese cloth. Later however, as the supply was running short, it was necessary to use potted geranium plants in all cases. As the chimney lantern did not fit over these pots (the edges of the former rested on the edges of the latter), it was necessary to paste over the junction of the two rims strips of gum paper.

Series I. (Jan. 17, 1935):-

Into the soil of each of seven cartons containing geranium plants, thirty-five young larvae were introduced. The soils of these plants were treated as follows: Three were treated with Pyridine, one in the ratio of 1 c.c. to 300 c.c. of water, the other two being treated in the ratio of 1 c.c. to 500 c.c. of water. Three were treated with Amonium phosphate, Derris and Black leaf "40"; in all cases using ratios of 1 gm. to 200 c.c. of water. The latter chemical contained one teaspoonful of commercial lux; one carton was untreated and served as a check. The soil in the cartons had a fair amount of humus and moisture. The solution in each case was liberally poured on, so that the soil was permeated with it. The plants were watered the next day, and each following day. The results obtained are as recorded in Chart III.

Series II. (Jan. 30, 1935):-

Four small jars 3" high, each half-filled with fine, dry sifted soil were set up as follows: Into one was introduced sheep

CHART III (Jan. 17, 1935)

Chart showing the effect of chemicals on larvae of Sciara coprophila, Lintner *in soil*

1. Chemicals used and ratios	Date of application	No. of larvae introduced	Total No. of flies emerged	Date when last fly emerged	Percentage Mortality
Pyridine 1 c.c. to 300 c.c. H_2O	Jan. 17	35	0		100%
Pyridine (1) 1 c.c.:500 c.c. H_2O	"	"	3	Feb. 7	91.5%
Pyridine (2) 1 c.c.:500 c.c. H_2O	"	"	4	Feb. 7	88.6%
Amonium phosphate 1 gr:200 c.c. H_2O	"	"	34	Feb. 8	8.1%
Derris 1 gm:200 c.c. H_2O	"	"	13	Feb. 6	62.1%
Black Leg "40" 1 c.c.:200 c.c. H_2O & Common Lux	"	"	21	Feb. 9	40%
Check	"	"	32	Feb. 11	8.6%

1. (1) and (2) designates duplication of the experiment.

manure mixed with arsenate of lime at the rate of one part to twenty parts by weight of manure. The soil was well soaked with water before the introduction of the poisoned manure. Fifty newly hatched larvae were then placed on top of the manure. They soon hid from view to avoid the light. The jar was then covered with a piece of cheese cloth. Into the check, manure was introduced but no larvicide. Frequent watering was not necessary, as there was no means of drainage.

In the same manner two more jars were set up, one containing bran and arsenate of lime in proportion of one to twenty by weight, and the other was the check. The jars were kept in the dark. The object of using bran was because the larvae were found to thrive just as well on it as on manure, and the former was more convenient to handle. Results obtained are as in Chart IV.

Series III. (Feb. 5, 1935):-

Fresh Derris and Pyrethrum were introduced into separate jars and thoroughly mixed with the sifted soil in them. These were then soaked with water and fifty larvae were put into each. Another jar was set up as a check.

No flies emerged, even from the check. The only possible explanation for this, is perhaps that the soil contained no humus or any other fertilizer; and also that it was too wet, since the water could not escape from below.

Series IV. (Feb. 8, 1935):-

Six cartons containing geranium plants were set up as follows: One carton from which $1\frac{1}{2}$" of soil were taken off was replaced by a similar quantity of sheep manure mixed with Arsenate of lime (1:20). In another carton the top soil was similarly replaced by sheep manure mixed with Arsenate of lime, but

CHART IV (Jan. 30, 1935)

Chart showing the effect of chemicals on larvae of Sciara coprophila, Lintner in soil

Chemicals used and ratios	Date of application	No. of larvae introduced	Total No. of flies emerged	Date when last fly emerged	Percentage Mortality
Manure & Ars. of lime 1 gm:20 gm. of manure	Jan.30	50	9	Feb. 28	72%
Bran & Ars. of lime 1 gm:20 gms. of bran	"	"	6	Feb. 25	84%
Manure check	"	"	42	Feb. 28	16%
Bran Check	"	"	3	Feb. 26	30%

25% of the mixture's weight was added in fine soil. Three cartons having the top layers of 1½" of soil removed was replaced by bran mixed with arsenate of lime (1:20). The last carton was the check. Results obtained are as in Chart V.

Series V. (Feb. 11, 1935):-

Four healthy potted geranium plants were picked from the greenhouse. The soil was fairly dry, and contained a fair amount of humus. In three of these the top soil was stirred up with manure and arsenate of lime (1:20). The fourth pot served as a check. Chimney lanterns were put over them as described previously. About twenty-five males and females were then introduced into them. The plants were watered each day.

Flies from the check began emerging on March 7. Fewer flies emerged from the poisoned pots.

It seems possible that some of the larvae ingested the poison and were killed, since the total number of flies in each treated pot was quite small. It is impossible to estimate the percentage mortality, since the number of eggs laid were not counted. There is reason to believe that if the plants were watered from underneath from a saucer, the percentage mortality would have been greater, whereas here they were watered from above and the poison might easily have been washed away.

Series VI. (Feb. 14, 1935):-

Fifty larvae (about five days old) were introduced into the soil of three potted geranium plants, the soil being fairly dry and fairly rich in humus. Two were treated with Pyridine (1 c.c. to 100 of water). The solution was poured on liberally so that the soil was quite soaked with it. Results obtained are recorded in Chart VI.

CHART V (Feb. 8, 1935)

Chart showing the effect of chemicals on larvae of *Sciara coprophila*, Lintner in soil

Chemicals used and ratios	Date of application	No. of larvae introduced	Total no. of flies emerged	Date when last fly emerged	Percentage Mortality
Manure & Ars. of lime 1 gm:20 gm. of manure	Feb.8	50	8	18	84%
Manure & Ars. of lime & Soil (25%) 1 gm:20gm. of manure	"	"	6	22	88%
Bran & Ars. of lime (1) 1 gm:20 gms of bran	"	"	9	26	82%
" (2)	"	"	1	20	98%
" (3)	"	"	2	21	96%
Check	"	"	46	28	8%

CHART VI. (Feb. 14, 1935)

Chart showing the effect of chemicals on larvae of Sciara coprophila, Lintner [in sol.]

Chemicals used and ratios	Date of application	No. of larvae introduced	Total no. of flies emerged	Date when last fly emerged	Percentage Mortality
Pyridine (1) 1:100 c.c. H^2O	Feb. 14	50	0		100%
Pyridine (2) 1:100c.c. H^2O	Feb.14	50	0		100%
Check	"	50	50	Feb.27	0

Series VII. (Feb. 28, 1935):-

Five healthy geranium plants were again picked from the greenhouse. Into the top soil of four of these, bran and arsenate of lime (1:20) was introduced. The fifth plant was the check. The general procedure was the same as in Series V. Results obtained here were the same as in Series V.

Series VIII. (Feb. 21, 1935):-

Five potted geranium plants were taken from the greenhouse, and fifty larvae were introduced into the soil of each of these. Two were treated with a solution of Pyridine (1 c.c.:200 c.c. of water); another two with the same chemical, only in the ratio of 1 c.c. :400; the last pot being the check. Results obtained are given in Chart VII.

Series IX. (Feb. 27, 1935):-

Eleven potted geraniums which were fairly dry and contained a small amount of humus were set up as follows: Six pots were treated with Pyridine thus: two in ratio of 1 c.c.:100; another two 1.c.c. :200 and the last two 1 c.c.:400 c.c. of water. Two pots were treated with a mixture of bran and arsenate of lime (1:20) by replacing the top 1½" of soil. Two more were treated with manure and arsenate of lime in the same manner as in the former case. The last pot was the check.

Only one check was set up, using bran and sheep manure in the same proportions, since the larvae were found to live on bran as well as on manure. Results obtained are as in Chart VIII.

Series X. (March 4, 1935):-

In the soil of eleven potted geraniums with fairly dry soil, and some humus, fifty larvae were introduced. Ten pots were

CHART VII. (Feb. 21, 1935)

Chart showing the effect of chemicals on larvae of Sciara coprophila, Lintner in soil

Chemicals used and ratios	Date of application	No. of larvae introduced	Total No. of flies emerged	Date when last fly emerged	Percentage Mortality
Pyridine (1) 1 c.c.:200 c.c. H^2O	Feb. 21	50	0		100%
" (2)	"	"	0		"
Pyridine (1) 1 c.c.:400 c.c. H^2O	"	"	0		"
" (2)	"	"	0		"
Check	"	"	48	March 13	4%

CHART VIII. (Feb. 27, 1935) - Showing the effect of chemicals on [illegible] larvae of Sciara coprophila, Lintner.

Chemicals used and ratios	Date of application	No. of larvae introduced	Total No. of flies emerged	Date when last fly emerged	Percentage Mortality
Pyridine (1) 1 c.c.:100 c.c. H^2O	Feb.27	50	0		100%
" (2)	"	"	0		100%
Pyridine (1) 1 c.c.:200 c.c. H^2O	"	"	0		100%
" (2)	"	"	0		100%
Pyridine (1) 1 c.c.:400 c.c. H^2O	"	"	0		100%
" (2)	"	"	0		100%
Bran & Ars. of lime (1) 1:20)	"	"	9	March 14	82%
" (2)	"	"	7	" 12	86%
Manure & Ars. of lime (1) 1:20	"	"	8	" 12	84%
" (2)	"	"	6	" 13	88%
Check	"	"	45	" 16	10%

CHART IX (March 4, 1935)

Chart showing the effect of chemicals on larvae of Sciara coprophila, Lintner in [illegible] soils.

Chemicals used and ratios	Date of application	No. of larvae introduced	Total No. of flies emerged	Date when last fly emerged	Percentage Mortality
Pyridine (1) 1 c.c.:100 cc H^2O	March 4	50	0		100%
" (2)	"	"	0		"
Pyridine (1) 1 c.c.:200 c.c. H^2O	"	"	0		"
" (2)	"	"	0		"
Pyridine (1) 1 c.c.:300 c.c. H^2O	"	"	0		"
" (2)	"	"	0		"
Pyridine (1) 1 c.c.:400 c.c. H^2O	"	"	0		"
" (2)	"	"	0		"
Pyridine (1) 1 c.c.:500 c.c. H^2O	"	"	0		"
" (2)	"	"	0		"
Check	"	"	47		6%

treated with Pyridine solutions in the following proportions: 1 c.c.:100; 1:200; 1:300; 1:400 and 1:500 c.c. of water, duplicates being used in each case. The solutions were liberally applied to the soil. The results obtained were as given in Chart IX.

SUMMARY OF RESULTS

The data obtained from the above series of experiments cannot be considered as 100% accurate. Some larval deaths may have been due to mechanical injury while being transferred from breeding cages to experimental pots. It was noted that not all flies emerged on the same date. This was due to the fact that the larvae used were not all of exactly the same age.

A fair means of control was obtained by using mixtures of manure and arsenate of lime, bran and arsenate of lime (1:20 by weight). These mixtures as indicated in the various charts caused a mortality to larvae of over 60% in the case of the former mixture, about 90% in the case of the latter mixture (not considering Series V and VII.)

A good control was obtained by using Pyridine solutions in proportions of 1:100 - 1:500 killed all larvae in the soil. Except in one case where the ratio of 1:500 was used, a mortality of only 88.6% was obtained. But in other instances this ratio killed all larvae. The explanation for this former instance is that the soil was fairly moist - this making the dilution of pyridine much greater. In the other instances the soil was quite dry.

RECOMMENDATIONS FOR THE CONTROL OF Sciara Coprophila, LINTNER MAGGOTS OR LARVAE IN THE SOIL OF POTTED PLANTS

1. PYRIDINE - The results of experimental work carried out with pyridine warrant the recommendations of applications of this chem-

ical as a contact poison for the control of the larvae in question. This chemical can be obtained from Mallinckrodt Chem. Works - Toronto, and in U.S. from Eastman Kodak - Rochester.

Pyridine at a concentration as strong as 1 c.c. to 50 c.c. of water was found to be not toxic to a large number of plants, such as Begonia species, scented geraniums, Coleus species, asparagus species, cala lily, a variety of ferns, etc. It was clearly shown that no apparent injury resulted from its use.

ITS APPLICATION ON INFESTED SOIL -

Pyridine in a ratio of 1 c.c. to 500 c.c. of water may be used, providing that the soil is fairly dry. Some plants, however, cannot tolerate dryness. The investigator, therefore, suggests using a ratio of 1 c.c. to 300 c.c. of water for all house plants. As plants are watered at more or less regular intervals, it is advisable to apply the pyridine solution on infested soil as a substitution for watering. Care must be exercised to soak the whole of the infested soil. Watering may be resumed on the following day.

Applications may be made at any time as Pyridine solution (1:300) was found to kill eggs, and pupae as well as larvae, but should be made at least once a week.

2. ARSENATE OF LIME - This substance, as a larvicide, is inferior in its properties to Pyridine, but much easier to procure and costs less. Results of the experimental work carried out with this chemical, to some extent, warrant its recommendations.

ITS APPLICATION ON INFESTED SOIL -

Arsenate of lime (powder) should thoroughly be mixed with manure or bran, preferably the latter at the rate of 1 part by weight of the chemical to 20 parts by weight of manure or bran.

This mixture may either replace several inches of the infested top soil or it may be thoroughly stirred in the top soil of the pot.

It is advisable to water these plants from underneath from a saucer so as to prevent the poison particles from being washed down.

Another control method suggests itself from general observations and may be recommended. It is the substitution of artificial fertilizers for manure or other organic fertilizer.

SUMMARY

Many complaints were sent in to the Ent. Dept. by residents in Manitoba regarding serious outbreaks of small fungus gnats.

The species involved was invariably found to be Sciara coprophila, Lintner.

Fungus gnats injuring roots and occasionally healthy tissues of plants have received but scant attention from the economic entomologists.

Family Sciaridae was formerly regarded as a Subfamily of Mycetophilidae.

Life history of Sciara coprophila, Lintner required a period of twenty-four days under laboratory conditions at a temperature of 70° F. (food and moisture being available).

The length of the incubation period of the eggs was from six to seven days.

The larval stage occupied about eleven days; the pupal from four to five days.

It took about twenty minutes for the newly emerged adult

to become normal.

The male measured on the average of about 2.5 mm.; the female 3 mm. in length.

Fed flies in aggregation were found to live longer than unfed under the same conditions (laboratory conditions). The males lived longer than the females.

The proportion of the sexes varied in the different samples, caught at random and in those sent in. The average percentage was 30.1% of the males and 69.9% of the females.

Under favorable conditions, it was estimated that there may be fifteen or more generations per year. The peak of their breeding season is in April and early May.

The adults were not found to feed very much, only occasionally they lapped up honey, which was supplied to them.

Mating occured at all times of the day. The length of time they remained in copulation varied from five, ten to fifteen minute periods.

Preoviposition period under laboratory conditions was found to be two days.

Oviposition period under laboratory conditions was noted during the fore and late afternoon. Eggs in the majority of cases were laid in clumps, sometimes containing as many as over seventy eggs in one clump.

The larvae though omnivorous feeders were found to be injurious to potted plants through their feeding upon root-hairs, roots and occasionally sound tissues.

Fungus gnats have a very widespread distribution.

Sciara Coprophila, Lintner has been reported from U.S.A.

and Canada. It is widely distributed in Manitoba.

Large sums of money are lost through their infestations in mushroom cellars, as their larvae feed on the mycelium and mushrooms.

Sciara coprophila, Lintner does not seem to have preference for any particular plant. They were found to be attracted to a variety of plants as long as the soils were rich in manure and such like materials.

The only stage which was found to be directly injurious to plants was the larval. Injury by the larvae of Sciara coprophila, Lintner was chiefly confined to the roots of the plants, occasionally to the tissues.

Good control for the larvae of Sciara coprophila, Lintner was found by using a solution of Pyridine in ratios of 1:100 - 1:400 - it also killed the eggs and larvae.

A fairly good control for these larvae was obtained by using manure and arsenate of lime; bran and arsenate of lime.

Another control which suggests itself to the investigator is the use of artifi@ial fertilizer instead of organic fertilizers.

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