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centrus both east and west of Vineland. It also shows the relative importance of *Glypta* and the sharp decline in the usefulness of this parasite as a control during the season of 1935.

		First generation		Second generation	
	Year	East	West	East	West
Macrocentrus ancylivorus Roh.	1932	10.1	.4	14.3	2.1
	1933	29.4	2.6	37.0	16.9
	1934	18.3	4.2	56.8	16.9
	1935	36.6	20.1	77.2	66.2
Glypta rufiscutellaris Cress.	1932	.6	.3	58.6	73.4
	1933	.5	.0	27.6	46.6
	1934	.4	.3	22.1	54.0
	1935	.7	.0	2.9	4.9

It will be seen from the above figures that *Glypta* was becoming less important as a peach moth parasite east of Vineland as early as 1932, and, with the exception of a slightly increased activity in 1934, it has decreased in importance every year until, in 1935, it played no practical role in peach moth control in the peninsula.

The following table, based on the parasite recovery records for the entire peninsula, shows more graphically the decline in the importance of *Glypta* and the increasing value of *Macrocentrus* in peach moth control.

	First generation		Second generation	
Year	*Macrocentrus*	*Glypta*	*Macrocentrus*	*Glypta*
1932	8.5	.5	10.8	63.6
1933	27.8	.4	25.3	37.4
1934	12.3	.4	38.6	39.4
1935	30.8	.5	74.4	3.2

The decline of *Glypta* and the increasing importance of *Macrocentrus* is a decided advantage in securing a more evenly distributed and consistant parasite control. *Macrocentrus* is yearly parasitizing an increasing number of first generation larvae, which were previously free of parasite attack, and has also become more active against second generation larvae than *Glypta* was in 1931 and 1932, the years of its greatest abundance.

TWO PARASITES OF THE WHITE APPLE LEAFHOPPER *(TYPHLOCYBA POMARIA* McA.*)*

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ABSTRACT

Studies were made during the seasons of 1933, 1934 and 1935 at Vineland Station, Ontario, of the live-histories and habits of two important parasites of the white apple leafhopper. *Anagrus armatus* var. *nigriventris* Gir. feeds within the leafhopper eggs and parasitisms of over 70 per cent have been recorded. The insects spend the winter as grubs in the host eggs, mature in the spring, and attack hopper eggs deposited in the leaves of apple during the summer. The autumn generation preys on the overwintering host eggs laid in the apple limbs. *Aphelopus* parasites

attack leafhopper nymphs with the external parasitic sacs later forming on the adults. The winter is passed in the mature larval state in a cocoon below the ground surface. The adults emerge in late May to attack the first brood nymphs. A cocooning and pupal period averaging 40 days occurs during June and July to be followed by a fall brood feeding in the leafhoppers of the second generation.

Introduction

For the past three years a study has been made of the habits and life-history of the white apple leafhopper, *Typhlocyba pomaria* McA. In the course of the investigation, two parasites were found to be important factors in checking the ravages of this apple pest. The insects in question are an egg parasite, *Anagrus armatus* variety *nigriventris* Girault, and an adult parasite, *Aphelopus* nr. *microleucus* Perkins. Observations were not made over a sufficiently long period to determine which species is the more important control factor, but during the three years of observation, the egg parasite appeared to be more numerous. Egg parasitisms of over 70 per cent have been recorded and in 1934 adult parasitism ran as high as 36 per cent and averaged 16.8 per cent in some leafhopper collections. The notes which follow were prepared from observations made during the seasons of 1933, 1934 and 1935, at Vineland Station, Ontario.

The Egg Parasite

General Life-history.—*Anagrus armatus* variety *nigriventris* Gir.[1] passes the winter as a partially grown grub about 0.4 mm. in length within the egg of its host, and in June and July emerges as a very small four-winged fly. (Plate I., fig. 1.) The adults appear at the time when eggs of leafhoppers are being laid in the leaves of apple, and thus the parasites find an abundance of host material. The summer brood or broods of adult parasites commence to emerge during the third week of July and continue until October. Very likely the earliest ones to appear continue to attack summer eggs, but those coming after August 20, find overwintering leafhopper eggs in which to oviposit. Thus, in a general way, the life-history of the parasite follows closely that of the host.

Description of the Adult Anagrus.—This tiny mymarid (Plate II., figs. 4 and 5) is about 0.5 mm. in length, the male being slightly shorter than the female. The adults are extremely active when one considers their size, and in captivity have been observed to fly very readily and with considerable rapidity. When confined in test tubes they lived but a short time, 24 hours or less, but it is altogether likely that their span of life is much greater in the orchard. The antenna of the female is 9-jointed, terminating in a club; that of the male is 13-jointed and filiform. In both sexes the antennae are long. The wings are very characteristic, being narrow and graceful with very long marginal cilia. The fore wing is curved, clavate and narrow proximad, gradually enlarging distad, then more rapidly enlarging to a pear-shaped apical head. The posterior wing is very narrow and slender, a little shorter than the fore wing, and tapering to a long point. In colour, specimens of the species vary considerably, some being much lighter than others. Generally the abdomen is dark, the thorax yellow, and the pronotum and head dark.

[1] Determined by A. B. Gahan, United States National Museum.

The Overwintering of the Parasite.—The insect passes the winter as a partially grown larva (Plate I., fig. 3) within the host egg. Apple limbs containing eggs of the white apple leafhopper were brought into the laboratory during the winter and the eggs were examined under the binocular microscope. In dissecting, the parasitized egg is readily identified by the whitish streak of fatty tissue present within the body of the partially grown parasitic grub. If the host egg is not too deep beneath the bark tissue this area of fat within the parasite can be made out indistinctly, but usually the egg is too well buried to observe this.

A number of eggs were dissected and in every case when parasites were present they filled about one-half of the egg cavity. In size the larva was approximately 0.4 mm. in length. Every parasitied egg examined contained but a single grub.

Larval Development.—During April and May the tiny overwintering grub feeds within the host egg, moults, and increases in size until at maturity it measures from 0.6 mm. to 0.7 mm. in length, and practically fills the egg cavity. The early larva (Plate I., fig. 3) possesses prominent ventral appendages (V) and ear-like organs (E), as well as chitinous mandibles (M). The white fatty tissue in the larval body is very conspicuous. As the larva develops to maturity the ear-like organs and ventral appendages decrease in size and become much less prominent, until at full growth they appear as illustrated in Plate I., fig. 2. At the close of feeding, the larva casts its skin and goes into the pupal stage. A mature larva dissected from the host egg and placed in a 0.6 per cent sodium chloride solution pupated while under microscopic observation. This pupa is shown in Plate I., fig. 4. The pupae vary in length from 0.55 mm. to 0.6 mm., being shorter than the mature larvae. They occur in the overwintering host eggs in early June.

Spring Emergence.—Adult emergence commenced on May 31, in 1934, nearly three weeks before any eggs of the apple leafhopper were laid in the orchard, and continued, from the overwintering eggs, until July 26, a period of 56 days. The peak occurred on June 29, and over 50 per cent of the adults appeared during the week starting June 28. In 1935, the span of adult first brood emergence was June 10 to July 19 inclusive, with the peak coming in late June and early July just as in 1934. The rate of emergence was as follows:

	1934		1935	
First adult appeared	May 31		June 10	
June 18	4.4%	of emergence	3.2%	of emergence
June 27	24.1%	" "	14.9%	" "
July 4	85.3%	" "	67.6%	" "
July 26 (1934)-July 19 (1935)	100.0%	" "	100.0%	" "

There seems to be a temperature correlation with the emergence, for during the time when the maximum number of inscts appeared the average temperatures were considerably higher than those of previous days.

Habits of the Newly Emerged Adult.—An adult male *Anagrus* (Plate II., fig. 4) was observed emerging from an overwintering egg on an apple limb in the spring of 1935. When first noticed the specimen was just forcing its abdomen out of the round exit hole, having already emerged to this point. The wings were folded along the dorsum of the thorax and

Table No. 1 gives the time of emergence of 320 adults from overwintering eggs laid in the bark of 10 apple limbs each about one foot long.

TABLE I.

Date	Number emerged	Date	Number emerged
May 31	1	July 2	26
June 2	2	" 3	25
" 11	3	" 4	10
" 12	4	" 5	10
" 13	1	" 6	9
" 15	3	" 7	2
" 18	2	" 9	8
" 19	3	" 10	2
" 20	2	" 13	2
" 21	6	" 15	1
" 23	1	" 16	1
" 25	34	" 17	1
" 26	7	" 18	5
" 27	8	" 20	1
" 28	31	" 22	1
" 29	59	" 24	1
" 30	21	" 25	1
July 1	24	" 26	2

abdomen and extended beyond the end of the body. The insect was wet at first but gradually dried off. Just as soon as it left the host egg it started to walk around, only stopping to preen the wings, first one and then the other, with the metathoracic legs, and to run the long antennae through the prothoracic legs. The cilia of the wings being wet were matted together and the insect was working to get these long hairs straightened into place. No attempt was made to fly while the insect was drying off. When disturbed it worked its wings and "jumped" away but took no sustained flight. The leg action was extremely vigorous carrying the minute body over the bark at a rapid rate. The antennae were constantly in motion, feeling the surface as the insect moved along. After a period of approximately ten minutes the specimen was lost to view, and when last seen appeared to be ready for its first flight.

Percentage of Parasitism of Overwintering Leafhopper Eggs, 1935.—In order to secure some information on the amount of parasitism of overwintering leafhopper eggs by *Anagrus*, four twigs were caged and the nymphs hatching from the eggs recovered and counted. On June 1 these twigs were transported to a dark cage (Plate II., fig. 3) and the parasites recorded as they emerged into the vials. The results are presented in table No. II.

TABLE II.

	Insects in:				
	N. Cage	S. Cage	E. Cage	W. Cage	Totals
Newly-hatched leafhopper nymphs recovered	75	146	37	77	335
Anagrus parasites recovered	84	79	32	12	207
% Parasitism	52.8	35.1	46.4	13.5	38.2

During March, another group of leafhopper eggs was examined under the binocular to determine the parasitism by *Anagrus armatus*. The invading insect, a half-grown grub at this time, is conspicuous enough to be distinguished immediately. Table III. shows the results secured.

TABLE III.

Date eggs examined	Total eggs dissected	Number normal	Number parasitized	Per cent parasitism
March 11	46	9	37	80.4
March 12	30	9	21	70.0
March 13	67	15	52	77.6
March 14	43	14	29	67.4
Total	186	47	139	74.8*

* Material from the McKenzie orchard, Vineland Station.

Summer Emergence.—The first exit holes of the parasites were observed on apple leaves in the orchard on July 16, in 1934, and leaves which had been transferred to the dark cages produced the first adults on July 17. These individuals were the first of the second brood which attacked the summer leafhopper eggs. From this date until the end of the season (October 10), *Anagrus* flies emerged practically continuously as shown by the following insectary records.

TABLE IV.

Cage No.	Date set up	Contents	Emergence started	Emergence completed	Number of parasites
3	July 16	100 leaves	July 17	Aug. 7	54
4	Aug. 16	100 leaves	Aug. 17	Sept. 13	35
5	Aug. 20	100 leaves	Aug. 27	Oct. 10	48

In 1935, the summer broods of the egg parasite commenced to emerge from leafhopper eggs laid on the foliage of apple on July 18. The tiny insects were present in the orchard from this date until the end of October. Text-Figure 1 shows the time of emergence of 927 *Anagrus* adults throughout the summer. The first large peak on the graph represents the emergence of the 557 specimens from the overwintering leafhopper eggs. The next group (July 18 to August 14) indicates the first generation emergence from summer host eggs. Then follows a small continuous series ending in another fairly prominent peak (September 18 to October 28), which represents a second and possibly a third generation of adults.

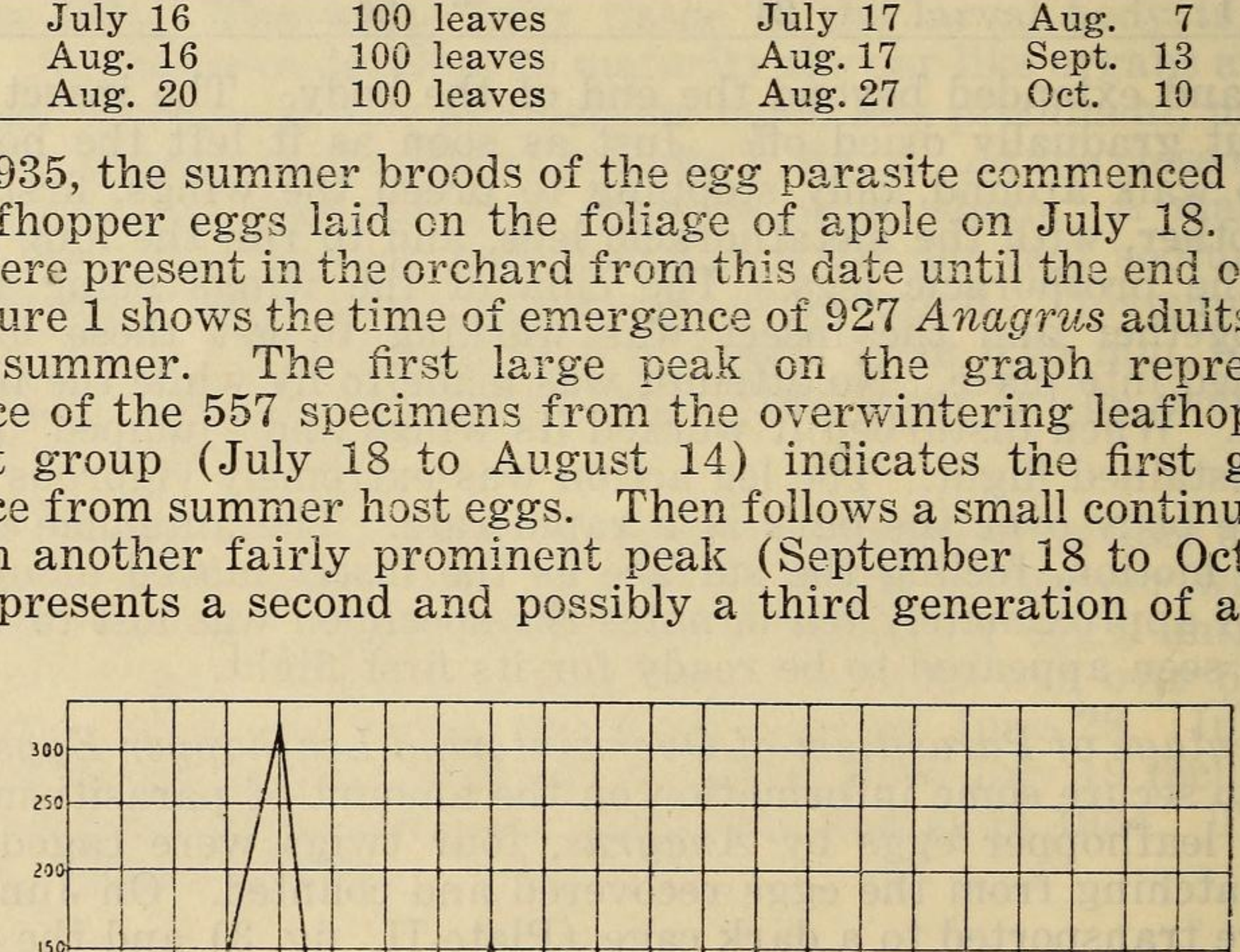

FIG. 1.—Graph to show the time of emergence of 927 leafhopper egg parasites throughout the season of 1935.

During 1935, the number of egg parasites in the orchard declined considerably as the season progressed. We are at a loss to account for this decrease. Large numbers of *pomaria* eggs hatched normally during the period of the second generation; and should have been parasitized in view of the very large population of parasites present in the orchard in June and July. Some factor or group of factors was responsible for destroying the parasites. Starvation would not account for the loss as host eggs were plentiful. It is altogether likely that a predator or parasite attacked the minute *Anagrus* itself in some stage, but we gathered no evidence during the season to prove this.

What Egg Parasitism Looks Like in the Orchard.—When the adult parasite is ready to emerge from the host egg it cuts a round hole, quite regular in outline, through the egg chorion and the enclosing plant tissue, and issues forth. These circular holes are to be found on the egg blisters (Plate II., fig. 2) on the limbs of apple, as well as on the mid-ribs and main veins (Plate II., fig. 1) of the foliage, where the summer host eggs are deposited. Where the summer eggs are parasitized, the leaf tissue immediately surrounding the parasite exit hole takes on a deep brown colour and collapses to form a depression. This tissue-killing does not occur where the egg of the leafhopper hatches normally.

Proportion of Sexes.—Daily collections made throughout the season gave the following results:

Total *Anagrus* examined	281
Number of females	197
Per cent males	29.9
Per cent females	70.1

The Autumn Population of Anagrus in an Infested Orchard, 1934.—An examination was made of a series of leaves picked at random from the trees of the observation orchard in order to discover the number of parasites present. The counts were made on August 15, 16, 17, 20, 22, 23, and a total of 199 leaves were carefully examined. It was assumed that the nymphs present on a leaf represented those which hatched normally from eggs laid in that particular leaf. The results in summary form were:

Number of leaves examined	199
Number of *T. pomaria* nymphs present	1657
Number of *Anagrus* exit holes	1121
Eggs parasitized	40.4%

The maximum number of *Anagrus* exit holes in any one leaf amounted to 31, and the average for the leaves examined was 6. One particular leaf showed a population of 52 insects, 21 being nymphs of the white apple leafhopper, and 31 eggs which gave rise to parasites. The percentage of parasitism for the various collections is given in table No. V.

TABLE V.

Date	Number of leaves examined	Number of leafhopper nymphs	Number of *Anagrus* exit holes	Per cent parasitism
August 15	31	180	213	54.2
" 16	46	327	239	42.2
" 17	26	154	113	42.3
" 20	35	302	143	32.2
" 22	30	314	180	36.4
" 23	31	380	233	38.0
Total	199	1657	1121	40.4

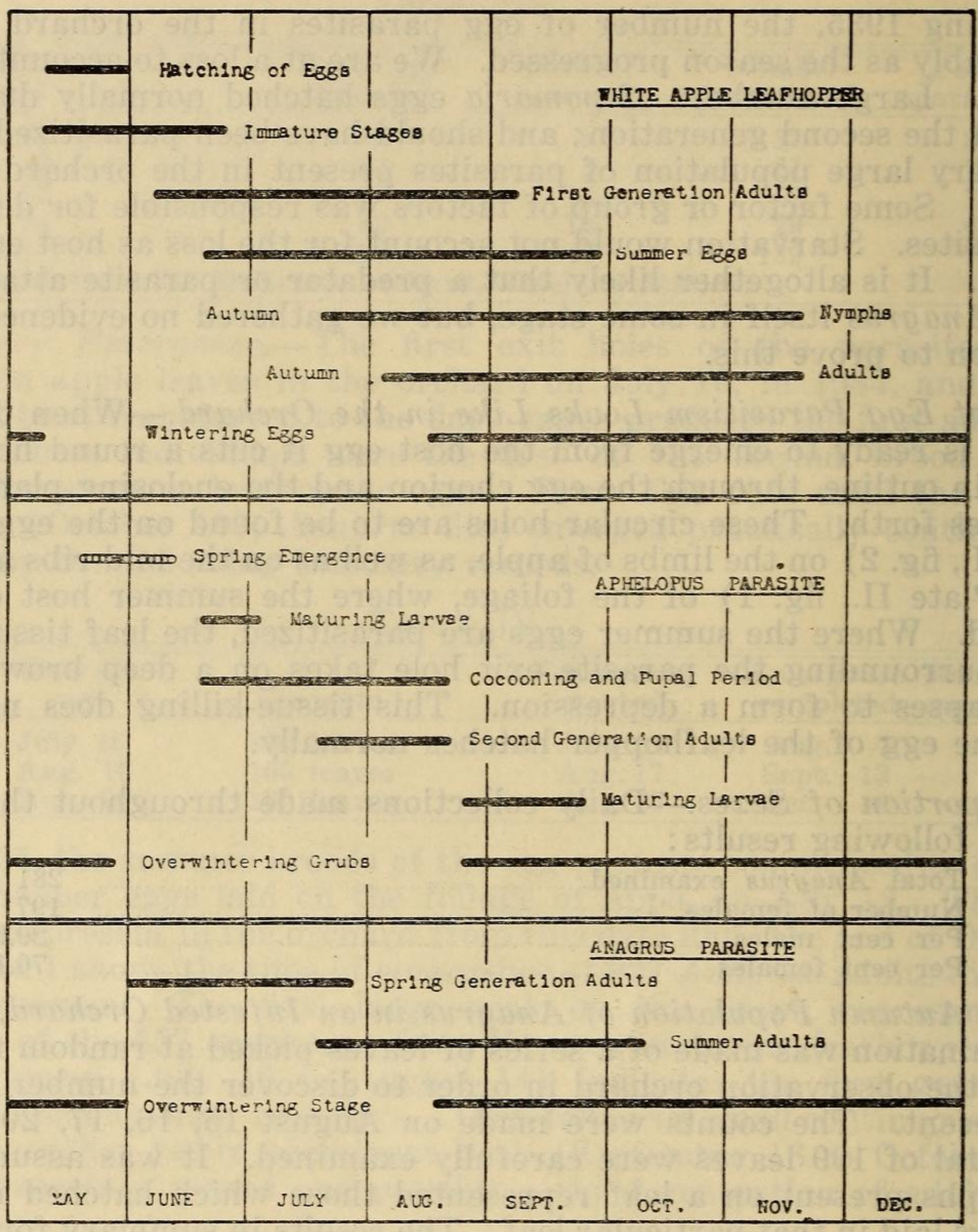

FIG. 2.—Graph to show the life-histories of the two parasites, *Anagrus* and *Aphelopus*, compared with that of the host, *T. pomaria*, 1934.

THE ADULT PARASITE

White apple leafhoppers afflicted with parasites were extremely numerous during the flight of the spring brood in a heavily infested orchard in 1934. The parasite in question was determined by G. S. Walley[1] as belonging to the genus *Aphelopus* and near to the species *microleucus* Perkins. According to Imms (5) the genus is one of the family Bethylidae (Dryinidae).

General Life-history.—*Aphelopus* overwinters as a grub spun up in its cocoon of silk below the surface of the ground. In late May the adults emerge and vigorously fly away in search of their prey. The adult leafhoppers are visibly parasitized from mid-June until early July. The cocooning and pupal period of the parasite in July and August lasts for an average of 41 days. A second brood of adults emerges in time to attack

[1] Entomological Branch, Ottawa.

the autumn generation of white apple leafhoppers. The first leafhoppers with characteristic *Aphelopus* sacs were taken on August 28 in 1934, and mature grubs left their hosts during the period August 30 to September 25. These mature grubs overwinter.

Description.—The mature parasite (Plate III., fig. 5) is about 2 mm. in length, and black in body colour. The pro- and mesothoracic legs are pale yellow, while the metathoracic legs are dark brown to black. The coxae and trochanters of all three pairs are yellowish white. The clypeus and mandibles are whitish, and stand out prominently against the black of the rest of the body. Viewed from above the abdomen is compressed laterally, and is shorter than the thorax. The antennae are filiform.

Spring Emergence.—Only one specimen was overwintered successfully in captivity during the winter of 1933-34, and this adult emerged on May 27. Due to improved technique in handling the mature grubs, the overwintering of *Aphelopus* material was more successful in 1934-35. Out of a total of 77 grubs placed in soil tubes in the insectary 49 adults emerged, a mortality of 36.4 per cent. Emergence occurred in 1935 during the very short period May 30 to June 4, the peak coming on June 3, when 17 insects appeared. At this time in the orchards the white apple leafhoppers were for the most part in the second and third instars.

Spring Parasitism.—On June 18, the first parasitic sac was observed protruding from an adult male leafhopper, and on the following day eight specimens were collected. The accompanying table records a collection of 957 leafhoppers, 161 of which were parasitized, giving a percentage of 16.8. On June 25, in a collection of 250 leafhoppers the parasitism was 36.0 per cent, the largest recorded in the season of 1934.

TABLE VI.

LEAFHOPPER PARASITISM IN THE MCKENZIE ORCHARD, 1934

Date of collection	Leafhoppers collected		Leafhoppers parasitized		% Parasitism
	males	females	males	females	
June 20	15	44	1	0	.....
" 21	11	48	3	1	.....
" 22	16	47	3	1	.....
" 22	65	287	17	4	6.0
" 23	36	57	11	4	16.1
" 25	21	60	13	13	32.1
" 25	132	118	61	29	36.0
Total	296	661	109	52	16.8

Sex and Parasitism.—It is interesting to observe that, out of a total of 472 parasitized leafhoppers collected during the period June 18 to July 3, 1934, 261 or 55.3 per cent were males and 44.7 per cent females. In early collections parasitized males predominated; e.g. in the first 229 parasitized leafhoppers taken, 69.0 per cent were males. In view of this, and as the earliest hoppers to mature are invariably males, it is evident that *Aphelopus* is at work soon enough to attack the earliest appearing individuals in the orchard.

Cocooning and Pupation.—When the grub is mature it leaves the host and falls to the ground, and at once searches for a suitable location to spin the cocoon. The spot chosen is beneath the ground surface. The cocoon

TABLE VII.
ORCHARD COLLECTIONS OF PARASITIZED LEAFHOPPERS

Date	Total leafhoppers	Males	Females	Per cent parasitism Males	Females
June 18	1	1	0	100.0	0
" 19	8	8	0	100.0	0
" 20	7	6	1	85.7	14.3
" 21	15	12	3	80.0	20.0
" 22	41	30	11	73.1	26.9
" 23	15	11	4	73.4	26.6
" 25	116	74	42	63.8	36.2
" 26	26	16	10	61.5	38.5
" 27	62	21	41	33.9	66.1
" 28	98	57	41	58.2	41.8
" 29	48	14	34	29.2	70.8
" 30	24	8	16	33.3	66.7
July 3	11	3	8	27.3	72.7
Totals	472	261	211	55.3	44.7

is white in colour, oval in shape, regular in outline, and about 2-3 mm. in length. Particles of earth adhere to the surface but are not incorporated in the construction of the cocoon.

Length of the Combined Cocooning and Pupal Periods.—In 1934, records were kept of 70 individuals in the insectary, and the time elapsing from larval maturity to emergence of the adult varied from 24 to 48 days, the average being 41 days. These figures were taken from larvae which left the hosts from June 23 to July 3.

The maximum, minimum, and average duration of the cocooning and pupal periods for 143 specimens in 1935 were respectively, 51, 31, and 42.5 days. These records were taken from grubs maturing from June 28 to July 6 inclusive.

Adult Emergence, Second Brood.—The adult Bethylids emerged from the cocoons located in the soil from July 17 until August 20, 1934, the maximum emergence taking place on August 8. At this time second brood nymphs of the white apple leafhopper were quite abundant, all stages from

TABLE VIII.

Date	Adults emerged 1934	1935	Date	Adults emerged 1934	1935
July 17	1	0	Aug. 7	36	0
" 19	1	0	" 8	50	0
" 20	1	0	" 9	20	0
" 21	1	0	" 10	19	0
" 23	1	0	" 11	15	0
" 24	3	0	" 12	17	4
" 25	3	0	" 13	15	12
" 26	4	0	" 14	4	30
" 27	3	0	" 15	9	22
" 28	7	0	" 16	13	27
" 30	3	0	" 17	3	16
" 31	0	0	" 18	3	4
Aug. 1	0	4	" 19	1	4
" 2	3	2	" 20	1	1
" 3	11	0	" 21	0	2
" 4	8	3	" 22	0	1
" 5	0	5	" 23	0	6
" 6	30	0	" 24	0	0
				286	143

newly hatched to fifth instar specimens being present on the trees. An adult *Aphelopus* was observed in the orchard reconnoitering on the under surface of a leaf on August 14. In the following year emergence of second brood adults did not commence until August 1, two weeks later than in 1934. The span of emergence was August 1 to 24, with the peak coming on August 14. Table No. VIII. shows the emergence records of 286 specimens reared in 1934 and 143 in 1935, under insectary conditions.

Larval and Pupal Mortality.—In the insectary rearing of this insect the mature grubs were treated in five ways, namely:—

In sphagnum moss in petri dishes.

In glass sealers containing damp soil and moss.

In glass tubes plunged in soil.

In pots with growing apple seedlings.

In vials containing damp soil and moss.

The emergence of adults from all five locations is given in summary form below:

Emergence from petri dishes:

Number of grubs placed	30
Number of adults emerging	6
Emergence	20%

Emergence from glass sealers:

Number of grubs placed	244
Number of adults emerging	176
Emergence	72.1%

Emergence from soil tubes:

Number of grubs placed	18
Number of adults emerging	18
Emergence	100%

Emergence from potted plants:

Number of grubs placed	136
Number of adults emerging	71
Emergence	52.2%

Emergence from vials:

Number of grubs placed	44
Number of adults emerging	12
Emergence	27.3%

The soil tubes proved to be the best method of rearing these insects, for out of a total of 18 larvae no deaths were recorded. Under insectary conditions outlined above the mortality was 39.4 per cent, but in the orchard this would most probably be much lower.

Parasitizing Leafhoppers.—In 1934, two preliminary tests were made in the insectory to determine if it were possible to parasitize leafhoppers when confined in cages. Using a potted plant with a celluloid cage, 3 *Aphelopus* adults were confined with 10 partly grown nymphs on August 3. On August 20 the characteristic protruding sacs were noticed on the adult leafhoppers, and four days later eight grubs emerged from the parasitized hosts. In a second cage of similar type 6 adult parasites were placed with 15 nymphs on August 7. Parasitic sacs were visible on August 31 on the leafhoppers, and mature grubs commenced to leave the hosts on September 4. Out of the 15 leafhoppers in the cage, 13 were parasitized.

The adult parasite deposits eggs in the nymphs of the leafhoppers. The following information secured in the 1935 season shows the parasitism secured with material confined in cages under insectary conditions.

Cage No. 2: Partially grown nymphs caged with 5 specimens of *Aphelopus* on May 31, and removed from the parasites on June 3, some days before any of the leafhoppers matured. The first parasitic sacs were noticed on June 27, and this cage yielded 6 parasitied leafhoppers in all.

Cage No. 5: Plant infested with nymphs in various stages of development placed in gauge cloth cage containing a plentiful supply of adult parasites. Nymphs placed on June 3 and removed on June 4. Parasitic sacs were noticed on the adult leafhoppers on June 27, and four "mummies" were collected from the foliage of the plant at a later date.

Cage No. 7: Plant with nymphs placed with parasites on June 4 and removed June 5. Practically all of the adults showed parasitic sacs on July 5, and grubs were maturing on July 7. Seven mummied leafhoppers were removed from the foliage on July 17.

Cage No. 8: Eleven second brood adult parasites were placed with nymphs of all stages on August 15. The parasites were removed on August 19, before the nymphs had reached maturity. The first parasitic sacs were observed on September 5, and a number of the adults were parasitized. These leafhoppers were reared in confinement under insectary conditions and could not have been parasitized before being placed with the insectary parasites.

Fall Parasitism in the Orchard.—Under orchard conditions the first parasitized leafhoppers were taken on August 28, in 1934, and the mature grubs commenced to leave the hosts two days later. These autumn brood larvae matured from August 30 (August 24 in the insectary) to September 25 in the McKenzie orchard. In 1933, mature grubs were taken from August 23 to September 9.

Habits of the Parasitized Leafhoppers.—By the time the parasitized leafhoppers are recognized in the orchard, the laval sac has become of considerable size. As the *Aphelopus* grub reaches maturity the sac pushes up one wing and elytron, usually the left ones, out of place (Plate III, fig. 6). The host for the most part is about as active as the normal leafhoppers at this time. A day or two before the grub leaves the host body, the leafhopper becomes sluggish, and is readily captured. Large numbers, with practically mature grub sacs attached (Plate III, fig. 3), congregate on the trunks of large apple trees, but, when disturbed, always seem to possess enough energy to fly to the foliage. At the time when the parasitic grub is devouring the entire internal organs prior to leaving, the host

takes a firm hold of the leaf and forever remains in this "death grip" (Plate III, fig. 2). These "mummied" leafhoppers are to be found on the apple foliage for the whole season—the death grip being so powerful as to withstand the winds and rains of four months in some instances.

The Larval Sac.—According to Fenton[3] the larval sac is constructed from the cast skins of the larva. These skins are attached to each other, and the whole sac joined to the host by means of a chitinous ring with hooks. The sac is attached to the leafhopper on the side of the abdomen protruding from between two abdominal segments, usually the second and third. In size, when nearly mature, it is about as large as the host's abdomen, more oval in shape and not quite as long.

The Mature Larva.—When full grown the larva averages about 3 mm. in length (Plate III, fig. 4). It is quite pointed at the head end, and bluntly rounded towards the posterior. The body is whitish in color and sparsely pubescent. Although the folded skin makes it difficult to determine, there are 13 segments present. The head is distinct, light brown in color, with the curved mandibles being the most prominent feature. The labrum, maxillary palps, and labium with the prominent spinneret are distinctly visible.

Habits of the Mature Larva.—When the whole internal organs of the host are consumed the mature grub splits the retaining sac open and wriggles out. The insect is extremely active at this time. If the location chosen by the leafhopper just prior to the grub maturing is unstable the usual occurrence is for the grub to simply fall or roll off the leaf and drop to the ground. When the "footing" is more or less safe, it immediately makes for the edge of the leaf, and unhesitatingly falls to the ground. In no instance was an attempt made to find a way to the ground simply by crawling. One individual under observation dropped from a leaf to a crack in the bark of a limb, disappeared, then re-appeared again, and fell off the branch to the ground—a drop of six feet. When located on the soil surface the larva was hurrying along, falling off clods and working itself into the soil. Finally an inviting crevice was reached, into which it dropped and was not seen again.

Orchard Cultivation and Survival of Parasites.—From the third week of June until early August the *Aphelopus* parasites are in the pre-adult stage just beneath the soil surface around the apple trees. The cocoon is not a very substantial affair, being very readily crushed and the grub itself is easily destroyed. Thus the discing and cultivation of an orchard when these insects are in the ground is going to kill a large percentage of them. This sort of thing occurred in 1934 in the McKenzie orchard where the spring parasitism was in the neighborhood of 30 per cent. The spring population of *Aphelopus* was high, but the orchard was ploughed once (about June 20) and disced and cross-disced at least four times during July, which undoubtedly was responsible for the destruction of a large number of the pupating parasites. As it turned out in this particular orchard, it was extremely difficult during the period of maximum leafhopper abundance to find a single parasitized individual. The natural mortality of the pupae would not account for this tremendous decrease as the same material was used in the insectary records, where the mortality was around 39 per cent.

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Explanation of Plates

PLATE I

FIGURE 1.—*Anagrus armatus* var. *nigriventris* Gir. adult female enlarged 70 times.

FIGURE 2.—Mature larva of *Anagrus* enlarged 115 times. Note the reduced ear-like organs and the much smaller ventral appendages when compared with fig. 3.

FIGURE 3.—Larva of *Anagrus* approximately one-half grown. E, ear-like organs; F, creamy white fatty tissue; M, mandibles; V, ventral appendages. Enlarged 150 times.

FIGURE 4.—Pupa of *Anagrus*, newly formed. Enlarged 110 times.

FIGURE 5.—*T. pomaria* egg showing the parasitic grub in position within the egg. This is the overwintering stage. Enlarged 80 times.

PLATE II

FIGURE 1.—Exit holes of the egg parasite in the midrib of an apple leaf. Enlarged 5 times.

FIGURE 2.—Overwintering egg blisters on an apple limb showing the parasite exit holes. Enlarged 12 times.

FIGURE 3.—Cage used for emergence records of the egg parasite in 1934. Reduced.

FIGURE 4.—*Anagrus armatus* var. *nigriventris* adult male. Enlarged 20 times.

FIGURE 5.—Female adult. Enlarged 20 times.

PLATE III

FIGURE 1.—Cage used for rearing *Aphelopus* consisting of glass soil tubes placed in a flower pot of soil, and the whole plunged in the ground to provide an even supply of moisture. Reduced.

FIGURE 2.—*Aphelopus* parasitized leafhoppers. The grub has left the host which remains on the leaf in a "death grip". Two-thirds natural size.

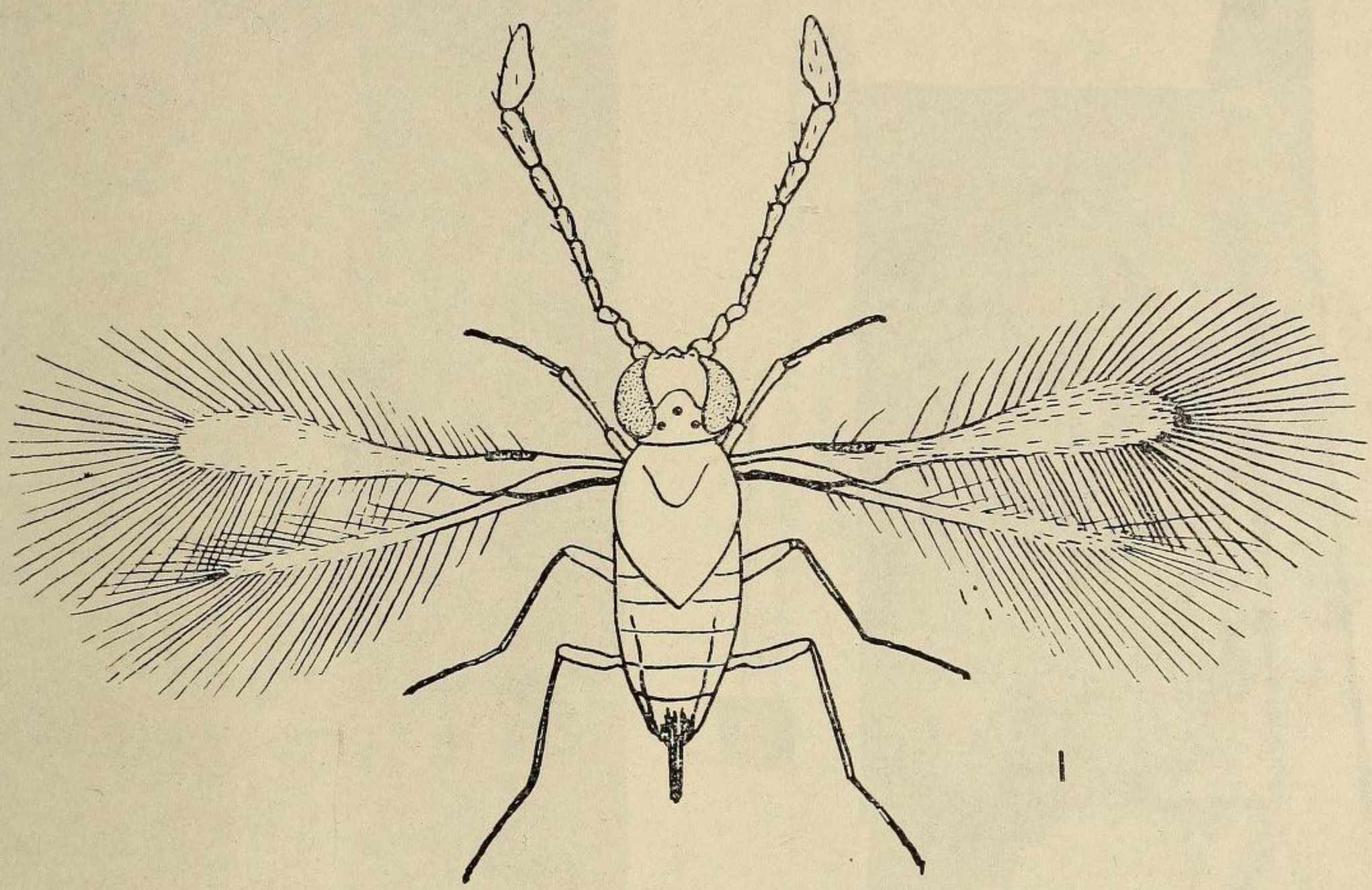
FIGURE 3.—Parasitized leafhopper showing *Aphelopus* sac. Ventral view enlarged 12 times.

FIGURE 4.—The mature larva of *Aphelopus*. The parasite leaves the host when this stage is reached. Enlarged 9 times.

FIGURE 5.—Adult *Aphelopus*. Enlarged 6 times.

FIGURE 6.—Characteristic position of a parasitized leafhopper after the grub has left the body. Note the spreading wings usually as in this case on the left side. Enlarged 7 times.

Plate I.



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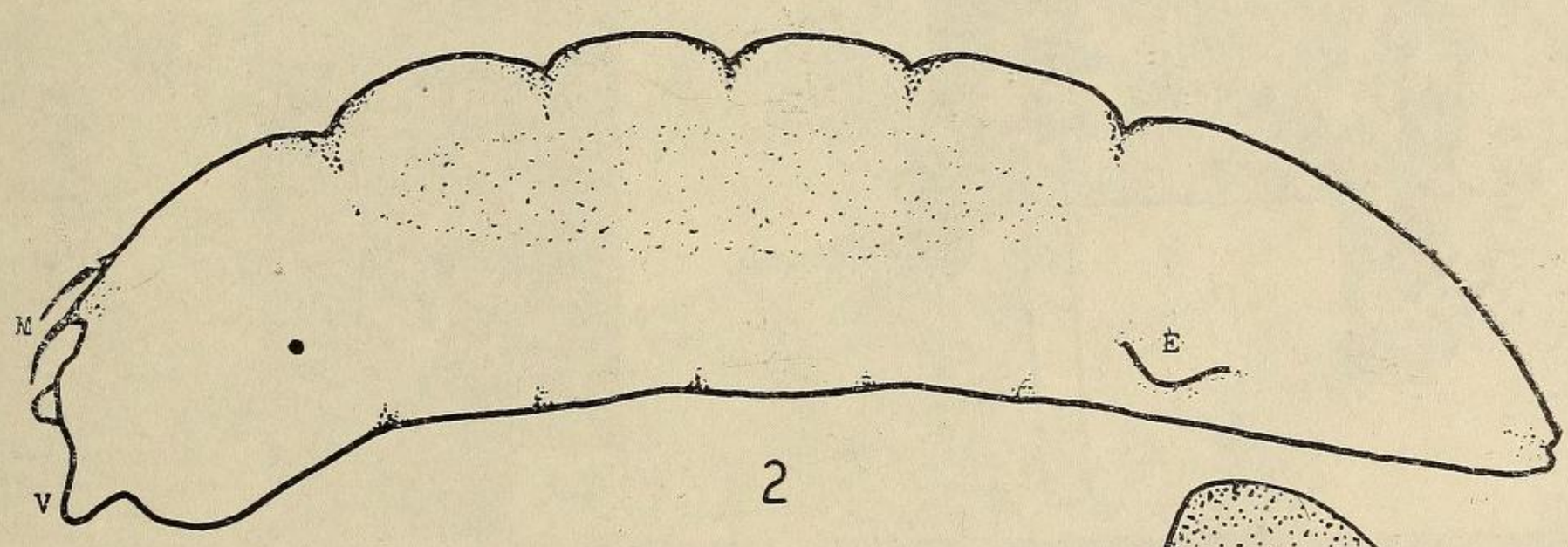

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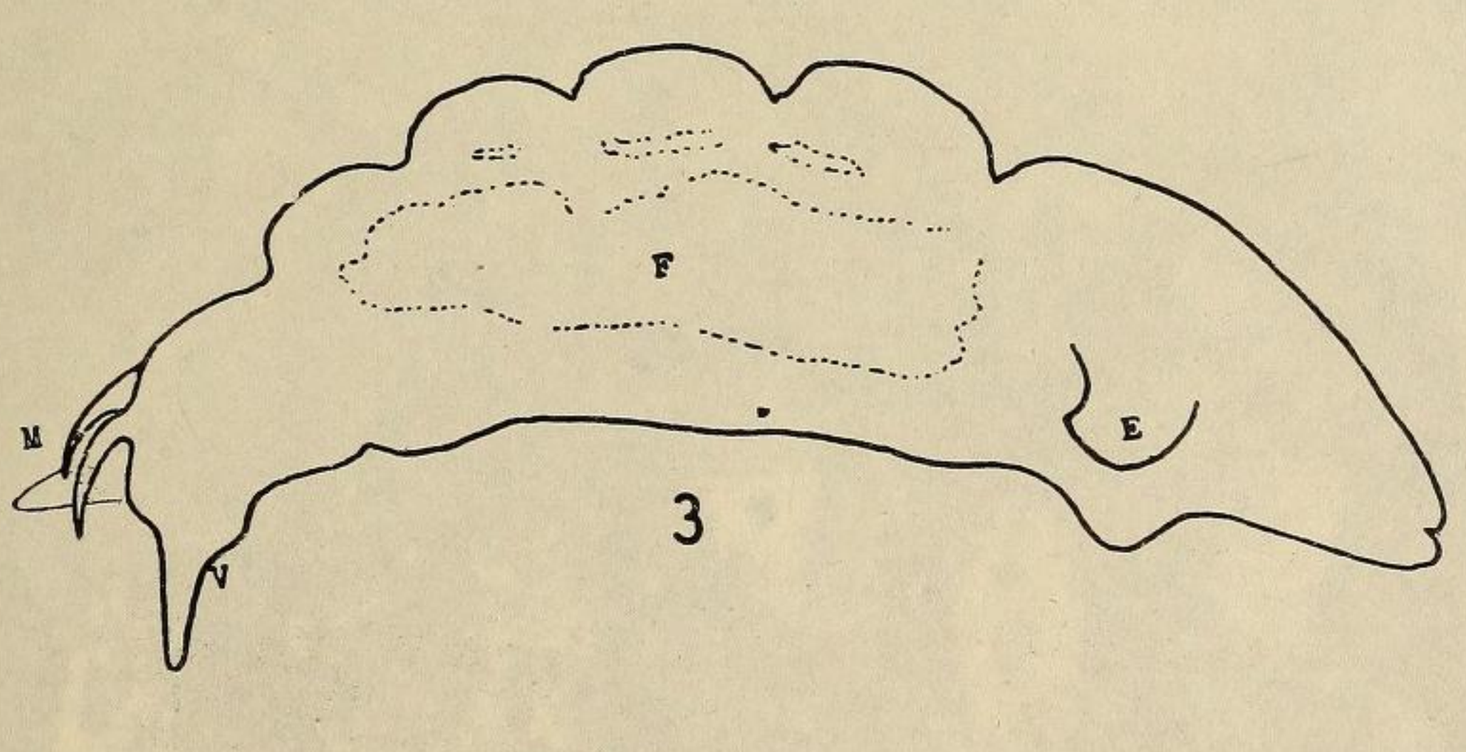

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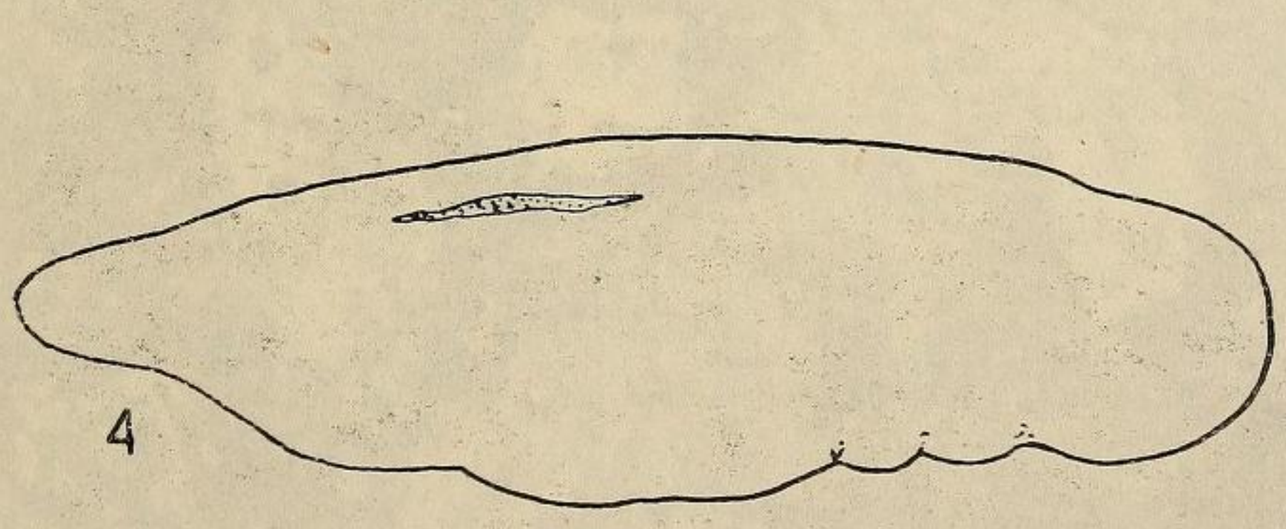

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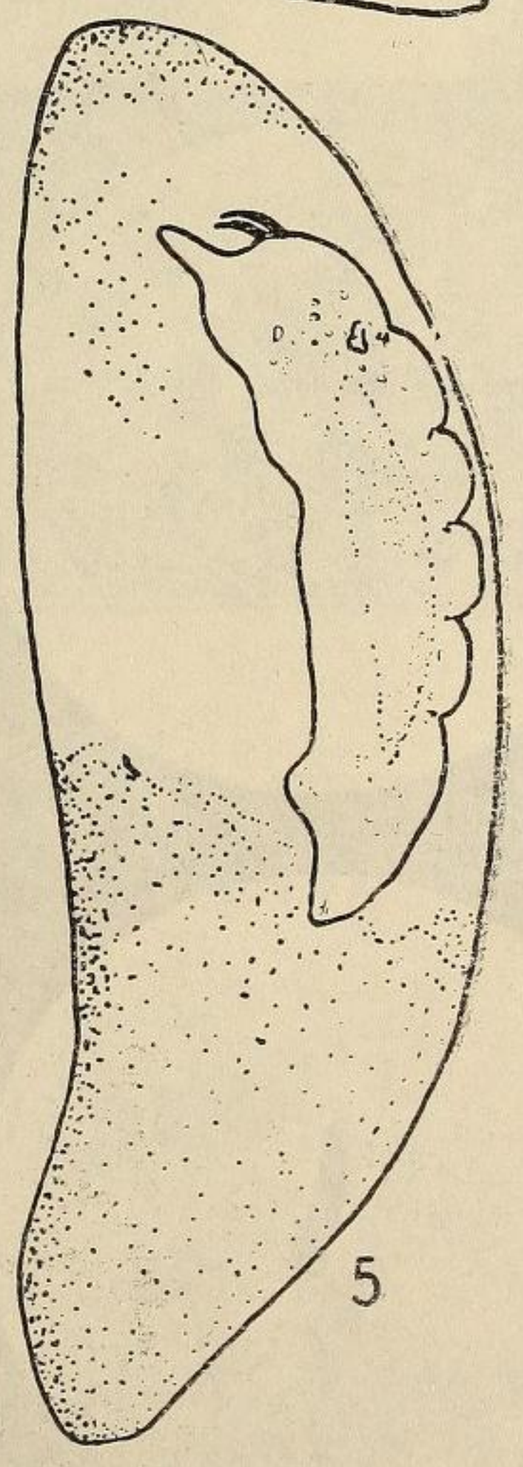

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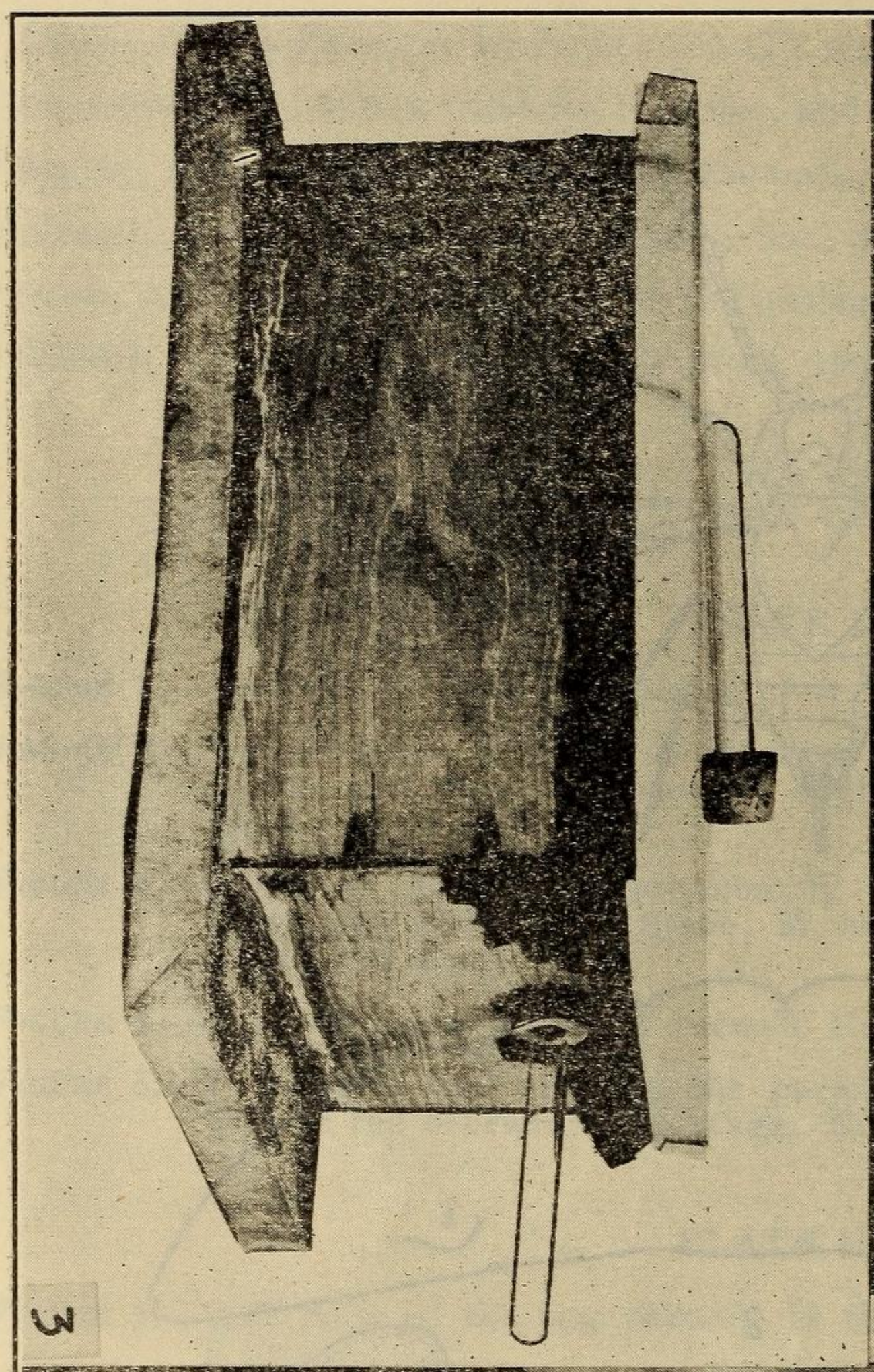

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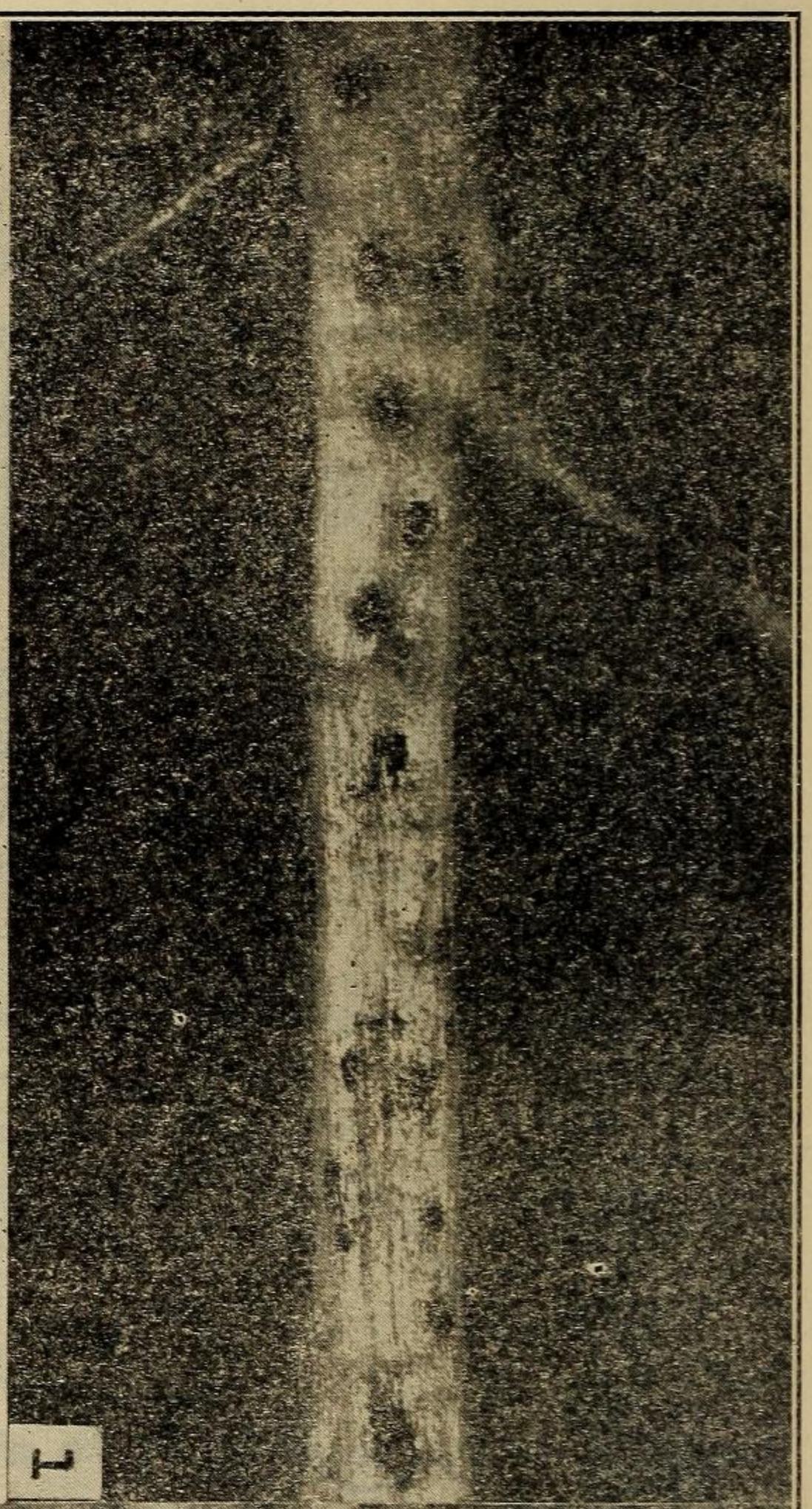

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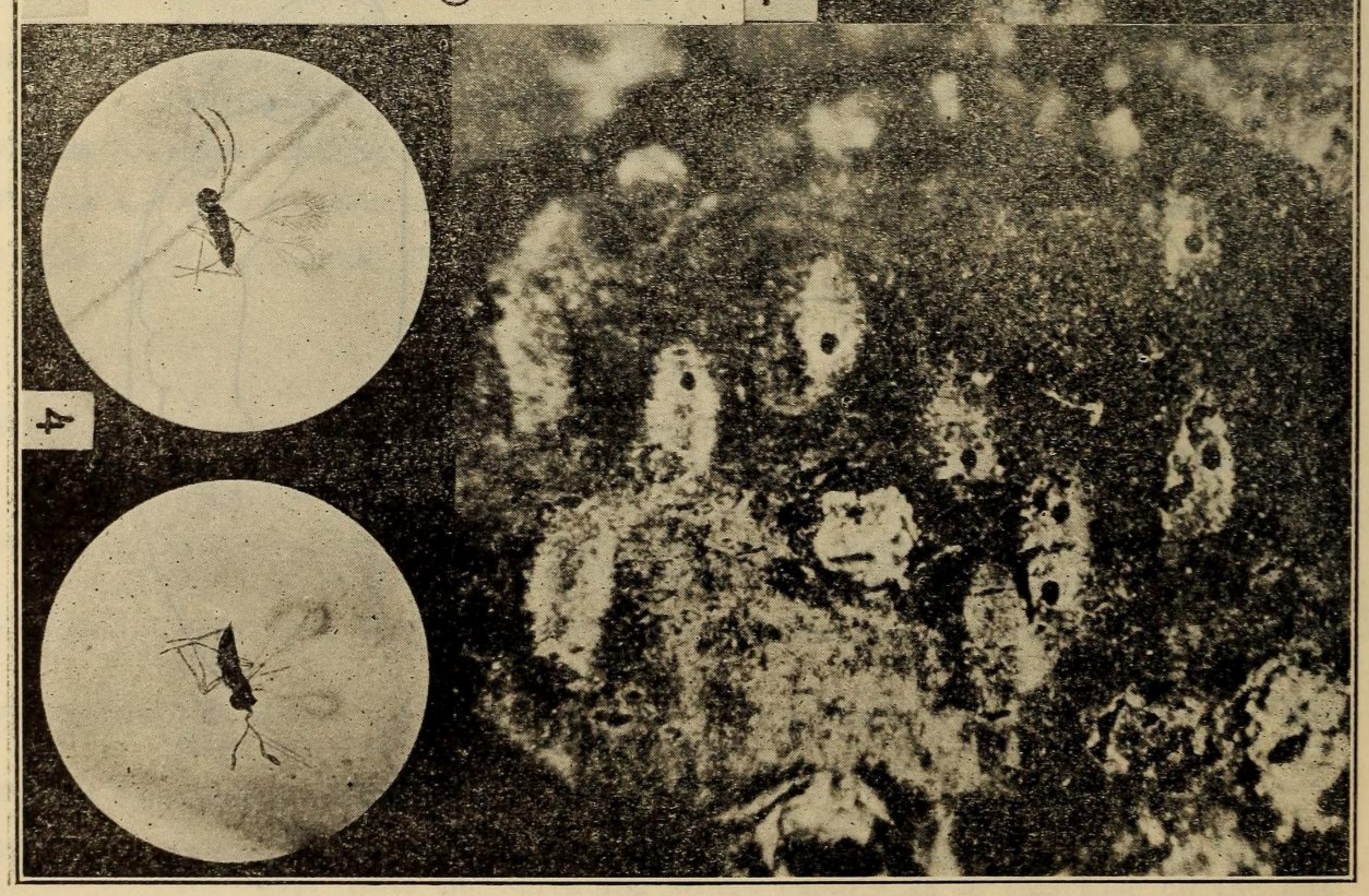

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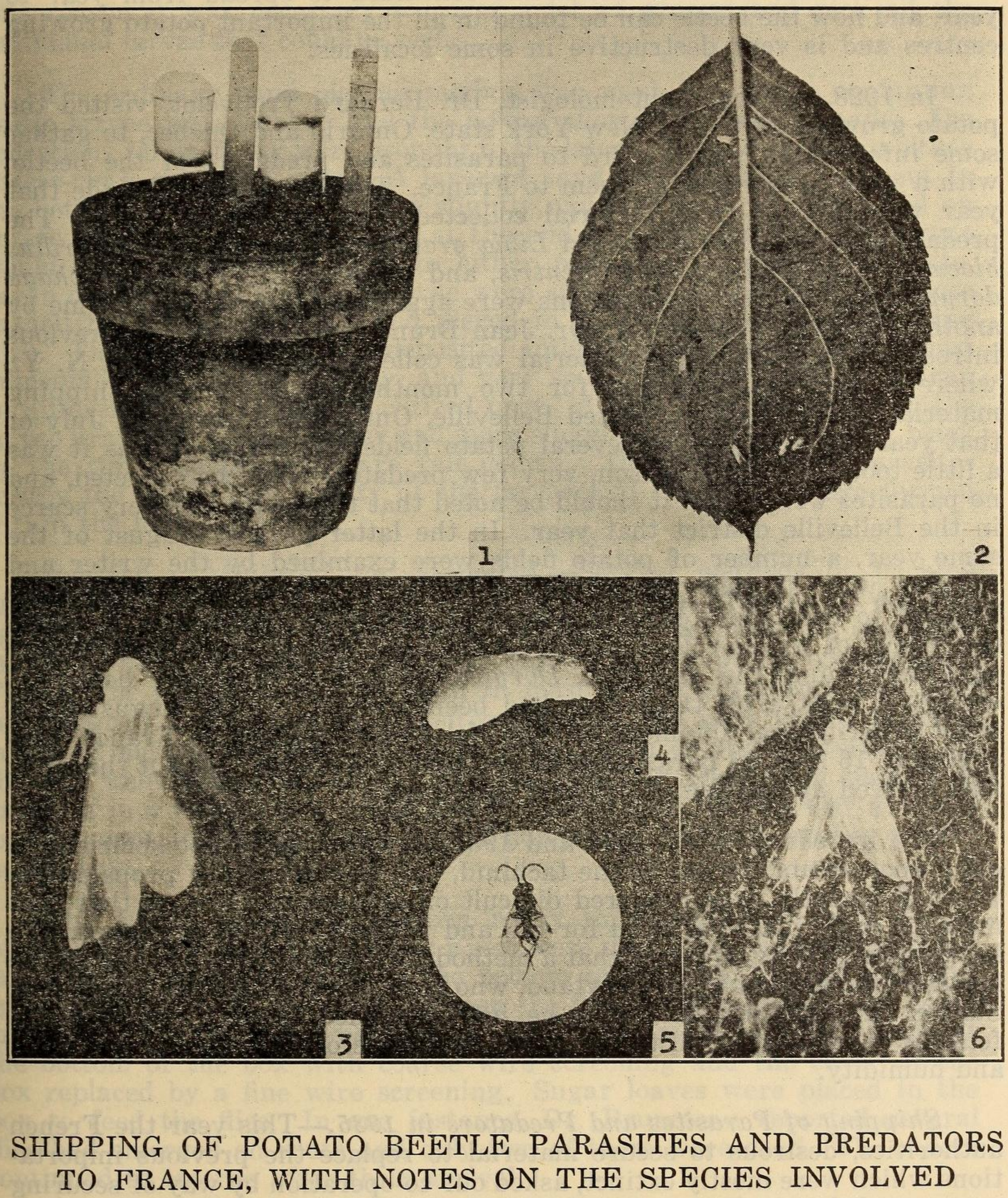
Plate III.



SHIPPING OF POTATO BEETLE PARASITES AND PREDATORS TO FRANCE, WITH NOTES ON THE SPECIES INVOLVED

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INTRODUCTION

The Colorado potato beetle has, on several occasions, between 1876 and 1922, been introduced into European countries but, in each case, the initial outbreaks were discovered and, through cultural and chemical means, were eradicated in time. In the summer of 1922, however, it was found to be firmly established in the Gironde District, in the centre of