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VEGETABLE WEEVILS AND THEIR NATURAL ENEMIES IN ARGENTINA AND URUGUAY

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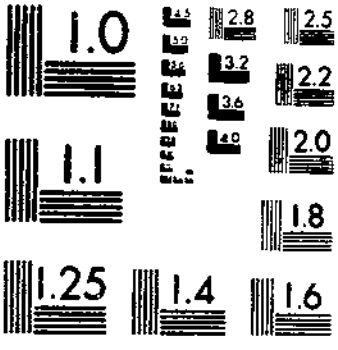

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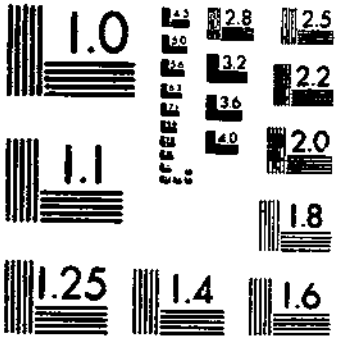

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Vegetable Weevils and Their Natural Enemies in Argentina and Uruguay[1]

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INTRODUCTION

When the South American parasite laboratory of the Bureau of Entomology and Plant Quarantine was established in 1940 in Montevideo, Uruguay, one of the projects assigned to it was the search for natural enemies of *Listroderes* to be introduced into the United States in an attempt to control the vegetable weevil (*Listroderes costirostris* var. *obliquus* Klug). These investigations covered the period 1942–45.

It was some time before *Listroderes* was discovered. Many examinations of cultivated crops, such as cabbage, turnip, and radish, failed to produce any sign of this weevil. Occasionally a few larvae were found on leaves of wild radishes. Eventually the larvae in sufficient quantities for large-scale collecting were found underneath and among the thick blanket of chickweed called "capiqui" or "moco de oveja" (*Stellaria media*), which usually covers garden fields in parts of Argentina and Uruguay in winter after the cultivated crops have been removed.

Parasites were collected and reared principally around the cities of Santa Fe and Rosario, Province of Santa Fe, in Argentina, and near Montevideo, Department of Canelones, in Uruguay. Small collections were made in La Plata, Province of Buenos Aires; in General Pico, Province of La Pampa; and in Cordoba, Province of Cordoba, in Argentina; and in the Departments of Rocha, San Jose, and Colonia, in Uruguay.

It was not possible for the authors to identify the various species of *Listroderes* collected, because the systematics of the groups is not clear. More than 20,000 adults were sent to specialists for study of this genus. From the few hundreds sent in at the earliest date 8 species and several races or varieties have been identified tentatively. Probably many more will be found when the larger shipments are studied.

Listroderes costirostris obliquus, a species of a uniform dark grayish-brown, is the principal one found in Uruguay, and is common in the Santa Fe zone of Argentina. *Listroderes apicalis* Waterh. is found in Santa Fe and in Mendoza, Province of Mendoza, Argentina.

ECONOMIC IMPORTANCE OF LISTRODERES IN SOUTH AMERICA

It appears from the 4 years' observations that *Listroderes* is not an important pest of truck crops in South America. Only one record of consequence is to be noted. In October 1943 a field of young sprouting potatoes near Melilla, Department of Canelones, Uruguay, was destroyed by adults of this species. The larvae apparently do little damage to cultivated crops.

The principal plants upon which *Listroderes* feed are capiqui and mastuerzo. The others appearing in the list below are only occasional hosts and are listed approximately in the order of preference, as judged by their frequency in collections.

HOST PLANTS OF LISTRODERES

Stellaria media (L.) Cyr., chickweed, capiqui, moco de oveja
Coronopus didymus (L.) J. E. Smith, mastuerzo hembra, quinque de zorrino, wart cress, swine's cress

Cerastium humifusum Camb.
Matricaria chamomilla L., manzanilla
Bursa bursa-pastoris (L.) Britt, shepherd's purse, bolsita, bolsa de pastor, yerba de los chingolos, mastuerzo macho
Cichorium sp.
Soliva anthemifolia R. Br.
Brassica napus L., turnip, colza, nabo
Solanum tuberosum L., potato, papa
Rumex sp., dock, lengua de vaca
Lactuca sativa L., lettuce, lechuga
Apium graveolens L., celery, apio
Sisymbrium irio L., mostacilla
Sisymbrium sp.
Beta vulgaris L., common beet, remolacha
Stachys arvensis L., ortiga mansa
Silene gallica L., callabacilla
Cirsium lanceolatum (L.) Hill, bull thistle, cardo negro
Echium violaceum L., flor morada
Anthemis cotula L., manzanilla hedionda
Saponaria vaccaria L., soapwort, jabonera

SEASONAL HISTORY AND HABITS OF LISTRODERES

As in the United States (High [3]), the vegetable weevil in South America passes the summer (November to March) in the adult stage awaiting the cool of autumn to begin oviposition. The writers have collected adults mating on March 23. The earliest record of egg deposition in the laboratory, by females brought from the field, is April 23. Although larvae undoubtedly are present in the fields in May and June, they do not become abundant and large enough to be collected for parasites until late in July. The earliest adult emergence noted in rearing cages was on July 9.

Oviposition continues all winter in both Uruguay and Argentina, and larvae do not disappear until November. Some stragglers probably could be found until December, but generally the larvae become too scarce to warrant continued parasite collection; consequently this work was stopped early in November.

On April 18, 1943, a large number of *Listroderes costirostris obliquus* were found washed up along the beach of La Plata River near Montevideo. The adult weevils had undoubtedly flown out to sea and had been washed in by the waves. This incident is especially interesting in view of High's statement that one specimen of *Listroderes apicalis* was found on the deck of a ship at New Orleans, La.

NATURAL ENEMIES OF LISTRODERES

Apparently all the parasites that the writers have bred in the laboratory will breed upon any species of *Listroderes*, for there *Porizon argentinensis* Blchd., *P. parkeri* Blchd., *Epiplagiops littoralis* Blchd., and *Triaspis* sp. oviposited in or on any larva of *Listroderes*. Had more studies been made, some specific preferences might have been revealed, but for the present all these parasites are considered to be parasites of any species of *Listroderes*.

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[3] HIGH, M. M. THE VEGETABLE WEEVIL. U. S. Dept. Agr. Cir. 530, 25 pp. 1930.

PARASITES OF THE LARVA

Hymenoptera:
Ichneumonidae:
Porizon parkeri
Argentina: San Antonio de Areco, Province of Buenos Aires; Santa Fe, and Rosario, Province of Santa Fe; General Pico, Province of La Pampa; Mendoza, Province of Mendoza.
Uruguay: Departments of Canelones and San Jose.
Porizon argentinensis
Argentina: Santa Fe, and Rosario, Province of Santa Fe; Cordoba, Province of Cordoba; Mendoza, Province of Mendoza.
Thersilochini (genus unknown)
Argentina: San Antonio de Areco, Province of Buenos Aires; General Pico, Province of La Pampa; Santa Fe, Province of Santa Fe.
Braconidae:
***Triaspis* n. sp.**
Argentina: Cordoba, Province of Cordoba.
Uruguay: Departments of Canelones and Rocha.
Diptera:
Larvaevoridae:
Epiplagiops littoralis
Argentina: Santa Fe, Province of Santa Fe.
Uruguay: Department of Canelones.
***Pseudoclista* sp.** (aff. *atra* B. and B.)
Argentina: Santa Fe, Province of Santa Fe.
Nematoda:
Hairworm (*Mermis* sp. ?):
Argentina: Rosario and Santa Fe, Province of Santa Fe.
Fungi:
Entomophthora sphaerosperma Fres.
Beauvaria globulifera (Speg.) Pic.
Argentina: Generally distributed.
Uruguay: Generally distributed.

PARASITES OF THE ADULT

Hymenoptera:
Braconidae:
***Microctonus* n. sp.**
Argentina: Santa Fe, Province of Santa Fe.

Diptera:
Larvaevoridae:
Euoestrophasia aperta (B. and B.)
Argentina: Rosario, Province of Santa Fe.

***Hyalomyodes* sp.**
Argentina: Santa Fe, Province of Santa Fe.

NOTES ON PARASITES OF LISTRODERES FOUND IN ARGENTINA AND URUGUAY

ARGENTINA.—PROVINCE OF LA PAMPA: Near the town of General Pico on September 16, 1942, 5 larvae of *Listroderes* were found; 2 parasites issued from them, one *Porizon parkeri* and one undetermined Thersilochini.

On September 7, 1943, 400 larvae were collected; 50 pupae and 25 adults were also found on and associated with *Sisymbrium irio*, *Sisymbrium* sp., and *Brassica napus*. This lot was brought to the laboratory and reared, but no parasites were seen in the material.

PROVINCE OF CORDOBA: In 1943, with some difficulty, 140 larvae were collected around Cordoba on *Stellaria media* and *Echium violaceum*.

One empty cocoon of *Porizon* was found in the soil. From the 140 larvae were obtained 2 *Triaspis* and 2 *Porizon;* one of the latter died in the larval stage and the other produced an adult *P. argentinensis.*

PROVINCE OF MENDOZA: Mendoza. On August 28, 1943, 1,070 larvae were collected around Mendoza on *Sisymbrium irio.* Of this lot cared for in the laboratory 396 died, 7 were dissected, and 23 were killed by fungus disease; 644 produced *Listroderes* pupae or parasites. A first-instar larva of *Porizon* and an empty eggshell were found in one of the dissected larvae.

In addition to the larva of *Porizon* 3 cocoons of this species were formed. One, opened for observation, contained a pupa that had been killed by *Pediculoides;* a *Porizon parkeri* and a *P. argentinensis* issued from the other two cocoons.

PROVINCE OF BUENOS AIRES: La Plata. On August 17, 1942, 157 larvae and 3 adults were collected. Some adults were reared from the larvae, but no parasites were found.

Jose C. Paz. At this point near Buenos Aires 54 larvae were collected in August 1942. Eight of them produced hairworms, but no other parasites. Most of the larvae were killed by fungus disease; only 3 adult weevils issued.

San Antonio de Areco. In August 1942, 3,646 larvae were collected and reared: 15 percent were parasitized by *Porizon parkeri* and 4 percent by hairworms. Two specimens of the Thersilochini were also reared from this material. Of 112 larvae dissected, 16 percent contained *Porizon parkeri* and 11 percent contained hairworms (table 1).

PROVINCE OF SANTA FE: Rosario. On August 10, 1943, 408 cocoons of *Porizon* and a number of empty ones were collected by sifting 300 square meters of top soil to the depth of about 3.5 cm. under a thick growth of *Stellaria.* In some cases there were 15 to 20 cocoons per square meter, often bunched or clinging to the roots of *Stellaria.* A total of 236 adults emerged at once from the cocoons; 102 others were eventually dissected, most of them containing live pupae or adults; the remaining 70 cocoons contained *Porizon* that had died in stages varying from larvae to fully developed adults.

In addition to these collections, 787 larvae, a number of pupae, and 300 recently emerged adult *Listroderes* were taken from August 10 to 19, 1943, near Rosario. Most of the larvae were killed by the fungi, *Entomophthora sphaerosperma* Fres. and *Beauvaria globulifera* (Speg.) Pic., although 104 adults of *Listroderes* and 10 hairworms did emerge. Cocoons of 24 *Porizon argentinensis* and *P. parkeri* were formed. No *Epiplagiops* were found in this locality.

From the lot of 300 adults 1 puparium of a fly, *Euoestrophasia aperta* (B. and B.), was found. Dissection of adults revealed the larval remains, and established that this fly is a true parasite of the adult. One other similar puparium was found in soil, but the fly did not issue.

Santa Fe. Most of the parasites were collected from 1942 to 1945.

In 1942 approximately 15,000 larvae were gathered for rearing. Most of them died of fungus disease, and the remainder either developed to the pupal stage or were parasitized.

This collection was made in two lots. The first, brought in on September 9, was practically all destroyed by fungi. Dissection of 67 larvae showed 7 parasitized by *Epiplagiops littoralis,* 1 by *Porizon* sp., and 7 by *Mermis* worms; 15 were killed by fungus disease.

The second lot, of approximately 7,000 specimens brought into the laboratory on September 30, gave somewhat better results in the rearing, although many were lost because of fungus diseases. Dissection and examination of 100 larvae with a binocular microscope showed 52 percent parasitized by *Epiplagiops* and 22 percent by *Porizon* (table 1). It was possible to account for only 3,049 larvae of this lot in the rearing trays. Of them, 52 percent died of fungus disease. 33 percent produced *Epiplagiops* puparia, and 15 percent produced *Porizon*. Probably the figure obtained by the dissection of the 100 larvae is most significant for this lot.

In 1943 collections were continued around Santa Fe. A preliminary dissection of 100 larvae on August 15 showed 8 percent parasitized by *Epiplagiops* and 19 percent by *Porizon;* a second dissection of 100 larvae on September 29 showed 16 percent parasitized by *Epiplagiops* and 11 percent by *Porizon* (table 1).

The gross collections for rearing in 1943 consisted of about 92,000 larvae and 19,000 adults. The larvae were all sizes, and many of the small ones did not develop well in captivity, undoubtedly because of crowded and inadequate feeding conditions. Many others died of fungus disease. It is estimated that approximately half of the 92,000 larvae developed to the adult stage or to the stage producing parasites. Utilizing thus the estimated quantity of 46,000 larvae from which 4,370 *Porizon* cocoons and 8,083 *Epiplagiops* were procured, the respective parasitization would be 10 and 18 percent. A number of hairworms also issued from these larvae.

In 1944 collections were poor. The scarcity of larvae was probably due to drought and high temperature in the preceding 5 months. From September 20 to 30, 11,223 larvae and 35,122 adults were collected. Relatively few of the larvae died in rearing cages, 6 percent being parasitized by *Porizon* and 10 percent by *Epiplagiops* (table 1).

About nine times as many *Porizon argentinensis* as *P. parkeri* occur in Santa Fe, as judged from a large lot identified by Blanchard. Parasitization of the adults by *Hyalomyodes* and *Microctonus* was less than 0.1 percent.

In 1945 about 70,000 host larvae were collected and reared. From 6 percent of them were procured cocoons of *Porizon argentinensis* and *P. parkeri*. Many *Epiplagiops* cocoons and a few *Pseudoclista* sp. puparia were also obtained and some hairworms, but no records were kept of these species. Many of the larvae died in the rearing cages. Parasitization was probably at least twice as high as the figure given.

URUGUAY.—DEPARTMENTS AROUND MONTEVIDEO: In 1943, 9,012 larvae were collected from September to the latter part of October. They were freely attacked by diseases, and many were lost. From this lot were procured 163 puparia of *Epiplagiops* and 23 cocoons of *Triaspis*. Parasitization of all species was low at the beginning but higher late in the season. This increase was especially noticeable in *Epiplagiops*, which increased from practically nothing earlier in the season to 25 percent by October 15. On that date parasitization by *Porizon* was 5 percent and by *Triaspis* 0.2 percent (table 1).

In 1944 collections were begun on July 1, at which time larvae were scarce. They became increasingly abundant thereafter, the peak being reached between September 25 and October 10. However, by October 23 they had become so scarce that further collections seemed unwarranted. During this period 22,649 larvae were collected, and

388 cocoons of *Porizon* were found in soil. Some of the larvae, observed with a binocular microscope, were seen to contain an egg of *Porizon*. These larvae were separated and shipped to the United States. From the remaining lot there was obtained 952 *Porizon* and 90 *Triaspis* cocoons, and 880 *Epiplagiops* puparia.

In 1945, 10,941 larvae were collected. Some containing hairworms were sent to the United States. The remainder were placed in outdoor cages having concrete bases for rearing *Porizon*, and 482 cocoons of *P. parkeri* were procured.

TABLE 1.—*Percent parasitization of Listroderes in Argentina and Uruguay, 1942–45*

Locality and parasite	1942	1943	1944	1945
Argentina				
San Antonio de Areco:				
Porizon parkeri	16			
Ichneumonid, Thersilochini	(1)			
Hairworm	11			
Total	27			
Santo Fe:				
Porizon spp. (*parkeri, argentinensis*)	22	11	6	6
Ichneumonid, Thersilochini	(1)			
Microctonus sp.			(1)	
Epiplagiops littoralis	52	16	10	(1)
Pseudoclista sp.			(1)	(1)
Hyalomyodes sp.		(1)	(1)	
Hairworm	(1)	(1)	(1)	(1)
Total	74	27	16	6
Uruguay				
Porizon parkeri		5	22	17
Epiplagiops littoralis		25	22	6
Triaspis sp.		2	(1)	
Hairworm		(1)	(1)	12
Total		30. 2	44	35

[1] Indicates present in very small numbers.

To obtain more definite data on parasitization of *Listroderes* in Uruguay large numbers of larvae, taken at random in fields throughout the seasons of 1944 and 1945, were examined for parasites under the microscope (table 2). These examinations probably did not show all the parasites, however. Some *Porizon* eggs may be laid so far into the interior of the host that they cannot be seen through the larval skin, and no *Triaspis* eggs or larvae can be seen through the host larval skin. It is estimated, however, that parasitization missed in this manner did not exceed 1 percent. Other experiments have shown that in mixed parasitization by these two species *Epiplagiops* always predominates at the expense of *Porizon*. Therefore, the effec-

TABLE 2.—*Results of microscopic examination of Listroderes larvae for parasitization by Porizon parkeri and Epiplagiops littoralis; 1,000 larvae examined in 1944 and 1,690 in 1945 in Uruguay*

Parasitization by *Porizon* alone			Parasitization by *Epiplagiops* alone			Parasitization by both species			
Number of parasite eggs in 1 host	Number of weevils parasitized		Number of parasite eggs in 1 host	Number of weevils parasitized		Number of parasite eggs in 1 host		Number of weevils parasitized	
	1944	1945		1944	1945	*Porizon*	*Epiplagiops*	1944	1945
1	142	167	1	121	39	1	1	62	24
2	46	55	2	36	25	1	2	33	6
3	20	31	3	5	4	1	3	8	----
4	2	14	4	3	6	1	4	----	5
5	5	14	13	----	1	2	1	12	6
6	2	6	----	----	----	2	2	20	----
7	----	2	----	----	----	2	3	5	----
10	----	1	----	----	----	2	5	7	----
----	----	----	----	----	----	3	1	8	8
----	----	----	----	----	----	3	3	12	----
----	----	----	----	----	----	4	1	5	10
----	----	----	----	----	----	5	1	----	6
Total	217	290	----	165	75	----	----	172	65

tive parasitization by each species, from data in table 1, was found to be as follows:

	1944 (percent)	1945 (percent)
By *Porizon parkeri*	22	17
By *Epiplagiops littoralis*	22	6

In 1945, 12 percent of 2,230 specimens were parasitized by hairworms. To illustrate the random distribution of the eggs of these two species, 421 eggs of *Porizon* were found in 277 weevils in 1944 and 594 eggs in 312 hosts in 1945; whereas 310 eggs of *Epiplagiops* were found in 225 hosts in 1944 and 165 eggs in 97 hosts in 1945.

PARASITES OF THE LARVA OF LISTRODERES

PORIZON PARKERI Blanchard

(Fig. 1)

Porizon parkeri has been found in Uruguay; and in San Antonio de Areco, Province of Buenos Aires; in Rosario and Santa Fe, Province of Santa Fe; in General Pico, Province of La Pampa, and in Mendoza, Province of Mendoza, Argentina.

DESCRIPTION OF STAGES

The adult of *Porizon parkeri* has a black thorax, reddish abdomen, and an ovipositor less than 1 mm. in length. For a complete description of this species and of *Porizon argentinensis* the reader is referred to the original descriptions by Blanchard.[4]

The egg (fig. 1, *A*) of *Porizon parkeri* varies somewhat from the usual hymenopteran type, in that it has upon one side a small elongate tubercle-like protrusion within which is a small black spot. This spot is quite apparent in the ovarian eggs when females are dissected. The writers are ignorant of the nature of this peculiarity, but after oviposition this tubercle is always next to and in contact with the skin of the host. After the egg has hatched the black spot can still be seen on the old eggshell. The ovarian egg is white, but after deposition it turns dark gray, almost black, within an hour.

The fully formed first-instar larva (fig. 1, *B*) has a brownish thimble-shaped head, 11 body segments bearing brownish sclerotized plates, a longer whitish penultimate (ninth abdominal) segment, and a tapering caudal appendage that represents the tenth abdominal segment. The head has 2 strong sickle-shaped mandibles and 5 pairs of what are apparently sensorial organs. The 3 thoracic and the first 7 abdominal segments bear platelike sclerotizations in the middle of the segment and extending from the dorsum almost to the ventral line, where it terminates in a sort of hump or coarse tuberclelike protrusion. There are 2 plates on each segment, 1 on each side (fig. 1, *B*, *a* and *b*). The first thoracic plates each bear 5 pairs of circular spots which may be sensorial organs; segments two and three bear 4 pairs of spots on each plate, whereas abdominal segments have only 1 pair on each, situated near the lower termination of the plate. The eighth abdominal segment has a corresponding pair of plates, but

[4] BLANCHARD, EVERARD E. DOS NUEVOS ICHNEUMONIDOS, PARASITOS DE LISTRODERES. Soc. Ent. Argentina Rev. 12: [305]-309. 1945.

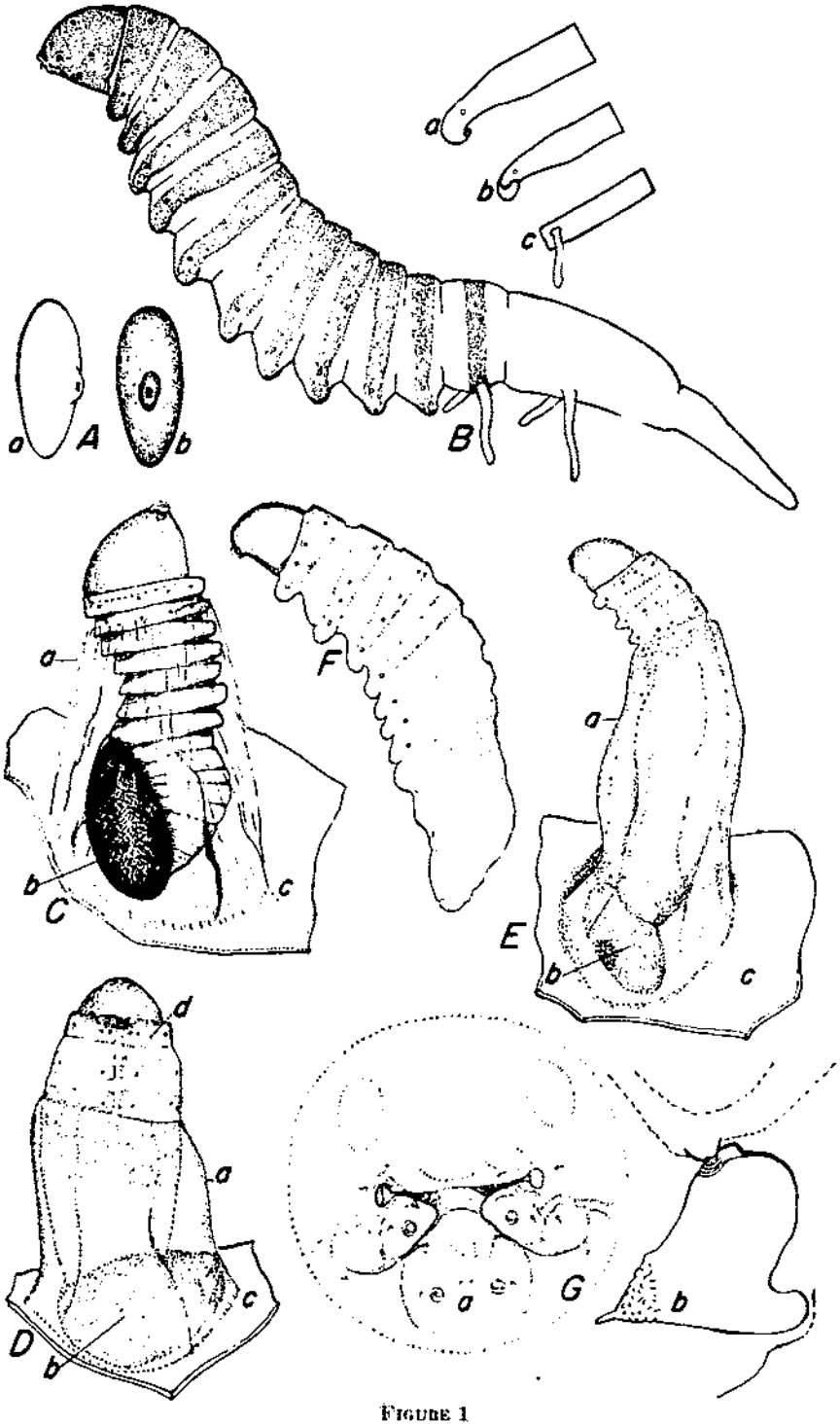

FIGURE 1

the ventral termination of them is more abrupt and the tuberclelike process is absent. However, from a circular hole in this plate, which appears to be homologous with the ventral circle on the other abdominal segments, there protrudes a fleshy process, or pseudopod, almost as long as the width of the larva at this point. The ninth abdominal segment has no sclerotized plate, but has a pair of the fleshy pseudopods (fig. 1 *B*, *c*). The last segment is simple. The dorsal separation of the plates (fig. 1, *D*) is quite distinct in larvae and also in cast skins. The first-instar larvae in process of hatching, and the larva partially formed but removed from the retaining envelope are shown in figures 1 *C*, *D*, *E*, and *F*. No spiracles or signs of a tracheal system have been seen by the writers in this instar.

The second instar is of the usual caudate-ichneumonid type, that is to say, the only distinguishing feature is the small stub of a tail process. The mouth parts are so poorly differentiated that they can hardly be distinguished; there is still no sign of spiracles or a tracheal system.

The third instar is similar to the second, except that the caudal process is shrunken to a small nodule and can hardly be seen. There are no spiracles or signs of a tracheal system.

The last larval instar, which is presumed to be the fourth, is of the regular hymenopteriform type, having nothing in particular to distinguish it from other ichneumonid larvae of this group unless it be the absence of the auxillary lateral tracheal trunk in the thorax, which is usually found in ichneumonid larvae. The tracheal system is simple and regular, the larva possessing 9 pairs of very small, open spiracles; the most characteristic features of the mouth parts (fig. 1, *G*, *a*) are the rather widened and sclerotized upper ends of the labial sclerome forming a reinforcement laterally and anteriorly for the hypopharynx, and the pointed apices and rugose distal portions of the mandibles (fig. 1, *G*, *b*).

The cocoon is a rather compact, cylindrical, light-brown structure with a darker brown, rather wide, irregular band around its middle.

BIOLOGY

Porizon parkeri adults mate immediately after emerging. Oviposition usually begins 2 or 3 days later, although a few eggs may be laid the first day.

The female has about 22 ovarian tubes on each side, and 11 days after emergence there are 7 eggs in each tube and considerably more down in the oviduct. It is estimated that a female produces about 400 eggs.

The female crawls around the leaves of the food plant looking for host larvae and palping with the antennae. When a host is en-

FIGURE 1.—*Porizon parkeri*, immature stages: *A*, Egg, *a*, at deposition; *b*, 2 hours after deposition. *B*, First-instar larva, lateral view; *a*, of first abdominal segment from above; *b*, same from below; *c*, of ninth abdominal segment showing ventrolateral pseudopod. *C*, Hatching first-instar larva 10 days old, dorsal view; *a*, retaining hypodermal "envelope" covering posterior two-thirds of body; *b*, egg attached to skin of host; and *c*, a section of skin of host. *D*, Hatching, first-instar larva 11 days old, dorsal view; *a*, *b*, and *c*, same as in *C*; *d*, dorsal plate divided medially. *E*, Hatching first-instar larva 13 days old, lateral view; *a*, *b*, and *c*, same as in *C*. *F*, First-instar larva removed from retaining eggshell and envelope. *G*, Last-instar larva; *a*, front view of head, *b*, mandible.

countered, she rapidly bends her abdomen underneath the body and, thrusting the ovipositor forward into the skin, lays an egg in any part of the body. Occasionally eggs are laid well within the body, but generally just under the skin and outside the layer of hypodermal cells, so that often they actually appear to be on the outside of the larval skin. Sometimes the egg will be left protruding somewhat, in which case it does not hatch.

The egg is white when first laid, but apparently some constituent in the blood of the host causes it to turn dark. When an egg is laid partially outside the body the exposed part remains white. Within 15 minutes after deposition, the part of the egg within the body turns gray and within an hour is almost black.

After 5 days, at a temperature of approximately 20° C., the egg splits at one end and along the ventral anterior portion and the larva begins to exsert the head. The body is not yet well formed and the head is still whitish. The larva slowly issues from the egg over a period of 17 to 18 days.

In 10 to 11 days after deposition of the egg, the larvae are about two-thirds out of the egg (fig. 1, *C* and *D*), and the head, thorax, and first three or four abdominal segments have attained their characteristic coloration. The posterior part of the larva is somewhat "amorphous," although indications of segmentation can be seen. The whole caudal portion is enclosed in a sort of "cartridge" or membranous envelope. The muscles, heart, and other parts of the thorax and first 4 to 5 abdominal segments are distinct, but in the sixth to tenth abdominal segments these organs become successively less distinct and are apparently in process of forming while the midgut is somewhat swollen with ingested materials.

On the thirteenth day the larval segmentation is complete to the seventh abdominal segment, the last 3 segments being developed but of a pale color. The whole larva can be detached from its envelope (which extends as far forward as the first abdominal segment), thus leaving a funnellike sheath somewhat similar to the integumentory respiratory sheath of some parasitic dipterous larvae. Figure 1, *E* shows a larva in its sheath and figure 1, *F*, one detached from the sheath.

On the fourteenth day the first free larva was observed. Others of the same age were not out, but were like those on the thirteenth day. The caudal process distends considerably after hatching.

By the seventeenth day 5 out of 6 larvae were out of the eggs. Some at this time were working through and feeding on the fat body and some were free in the blood of the host.

Examination of material 18 days after oviposition showed the larvae of *Porizon parkeri* to be practically all hatched and completely free of the egg and envelope. Most of them were working their way into the fat body and feeding upon it. Evidently only 1 larva per host survives, for in many cases of hyperparasitization the excedent parasites were dead in the first stage, usually with injury to the posterior part of the body; some were free in the body cavity of the host, others still in the hatching envelope.

By the twentieth day larvae have molted to the second instar and a few are molting to the third, as evidenced by the old cast skins. The skin of the first instar is cast free, usually being split down the dorsum, with the head still attached. It is in this condition that he ringlike

segments can be best seen and studied. The skins of the second and third instars, if found still adhering to the larva, can be recognized, but if completely shed they are lost to ordinary sight.

Apparently there are 4 larval stages.

Twenty-two days after oviposition some larvae are fully grown, have emptied the host completely, and have emerged from the old host skin. There is no larval feeding from the outside of the host.

The parasite does not cause the death of the host larva until after the latter has gone 1 to 2 inches into the soil and constructed its pupal cell. The parasite cocoon, spun in this cell, is begun approximately 1 day after issuance from the host larva. Thus from egg to cocoon requires approximately 25 days. One cocoon was found completely spun on the twenty-fourth day after oviposition at approximately 20° C.

SEASONAL HISTORY

Apparently there is only 1 generation of *Porizon parkeri* in Uruguay and Argentina. Adults began to emerge on May 18, 1945, from cocoons placed in the laboratory in October 1944 and continued to emerge up to August 17.

If host larvae were available in the field in May, 2 generations might be possible. To give further weight to this possibility, in 1945 in the fields in Uruguay 197 cocoons of *Porizon parkeri* were found clustered around the roots of chickweed from July 25 to August 27. Adults issued from these cocoons from August 31 to October 10. However, most of the host larvae collected and dissected from July 4 to August 24 were small and contained no parasites. The earliest record of *Porizon parkeri* oviposition in the field in 1945 was August 27, when 10 eggs were found by dissection. The peak of oviposition in the field was from September 18 to October 5.

The treatment to which cocoons were subjected in the laboratory, not being exactly the same as the conditions in nature, may have caused the premature emergence of some of the adults, for the general emergence period in the field is later than that recorded in the laboratory. However, in the field the earliest emerging adults may find few or no hosts in which to oviposit, and the following generation is propagated by the late-emerging adults.

The period of maximum oviposition appears to be, as stated, the latter part of September. Hatching of eggs and growth of the first-stage larva continues during late September and early October, and cocoon formation is practically completed by the end of October. The larva pupates in the cocoon and the pupa transforms to adult, but remains in a quiescent stage within the cocoon until the next year. If dissected out the adult cannot crawl or fly; life is indicated only by sluggish movements of the legs.

PORIZON ARGENTINENSIS Blanchard

Porizon argentinensis, similar in general appearance to *P. parkeri* except that it has the abdomen black instead of reddish, is found in Rosario and Santa Fe, Provinces of Santa Fe, and Cordoba, Province of Cordoba, in Argentina. It has not been found in Uruguay.

Inasmuch as the egg, larva, and cocoon of this species cannot be distinguished with certainty from those of *P. parkeri*, in the localities

where both species were collected in quantities it was not possible to keep the records of the two entirely separated. *Porizon argentinensis* is an important and valuable natural enemy of *Listroderes*.

Occasionally the writers have found a first-instar larva of *Porizon* that differs slightly from *P. parkeri*, in that there are only 6 dorsolateral plates and the pseudopods are shorter. Apparently this larva is not abundant enough to be that of *P. argentinensis*, for most of the first-instar larvae collected in Santa Fe, where *P. argentinensis* is the predominant parasite, are identical with those of *P. parkeri*. Although this larva has also been found in Uruguay, no adults of *P. argentinensis* have been reported.

TRIASPIS n. sp.

(Fig. 2)

Triaspis n. sp. has been found in the Department of Rocha, and Canelones, Uruguay, and in the Province of Cordoba, Argentina.

Triaspis is a negligible factor in the control of *Listroderes*, never having been found in quantities greater than 0.5 percent in any of the above localities, nor has it been reared from any other host.

DESCRIPTION OF STAGES

The adult of *Triaspis* n. sp. is about 4.5 mm. long and is black with reddish-brown legs; the ovipositor is 1 mm. long.

The recently deposited egg (fig. 2, *A*) is white, without spines or adornments, and has one end drawn out into a long, slightly arched point; the other end is also slightly pointed but short. The shape changes so that when ready to hatch the egg is almost spherical, as in many internal braconids, such as *Microctonus*, *Apanteles*, and *Euphorus*.

The first-instar larva (fig. 2, *B*) is of the mandibulate type, having a wide, slightly pigmented head with long falcate mandibles (fig. 2, *C*). The body, consisting of 12 additional segments and a short caudal process (about as long as the 5 preceding segments), tapers gently posteriorly and is without spines or other adornments. The late first-instar larva, just before molting, is considerably larger and the caudal process points ventrally (fig. 2, *D*).

The second-instar larva (fig. 2, *E*) has very little to distinguish it. The mandibles and head capsule lack color; the head is almost spherical; and the body is practically cylindrical, truncate posteriorly with the caudal process shrunk to a small ventral tubercle.

The third-instar is similar to the second, with the caudal process reduced still further.

The ultimate larva is of the usual hymenopteriform type having 9 pairs of open spiracles. The principal mouth parts are shown in figure 2, *F*. The mandibles are pectinate as is usual in most braconid larvae.

The cocoon is thin, almost transparent, light brown, and about 5.5 mm. long by 3 mm. wide.

FIGURE 2.—*Triaspis* n. sp., immature stages: *A*, Recently deposited egg; *B*, first-instar larva; *C*, head of first-instar larva; *D*, first-instar larva after feeding and nearly ready to molt to second stage, side view; *E*, second-instar larva; *F*, portion of head of last instar showing mouth parts.

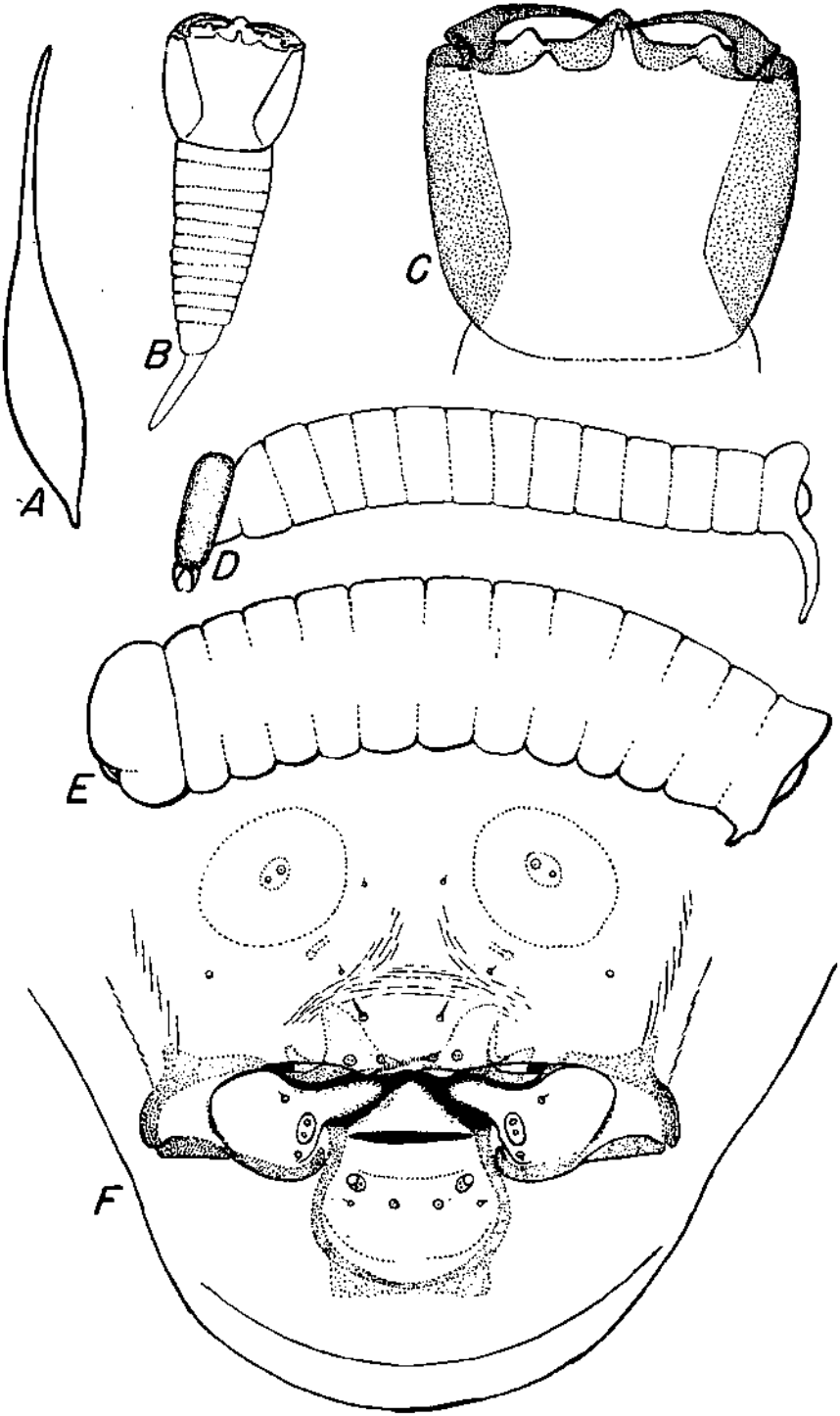

FIGURE 2

BIOLOGY

Triaspis n. sp. mates immediately after emergence and the females begin oviposition at once. The eggs are laid freely in host larvae of any age except in large larvae that have gone into the soil and constructed pupal cells. These latter do not seem to be so attractive to females as younger larvae. In oviposition cages, composed of small glass globes with cloth bases, containing a few pieces of lettuce leaves among which the *Listroderes* larvae are distributed, the females move around rapidly searching out the larvae and quickly stinging them. The larvae are washed in water and dried on blotting paper before being introduced into the cages, in order to take away the dirt, and salivary juices and excrement that they usually expel upon being touched. This procedure helps to prolong the life of the adults used in laboratory rearing. The lettuce leaves, although utilized, are not absolutely necessary, but serve to prevent the host larvae from drying out or "bunching" in clusters. After oviposition is well under way the leaves are discarded.

The longevity of adults of *Triaspis* n. sp. was not exactly determined. Some females in oviposition cages, although at times receiving rough treatment from host larvae, lived as long as 2 weeks, depositing 10 to 15 eggs a day.

The egg hatches in 3 or 4 days at ordinary temperatures, and by the eighth day the larva is in the late first stage. Fourteen days after oviposition, dissections showed the larvae to be in the late second stage, with some molting into third-instar larva and others already of that instar. Eighteen to twenty days after oviposition the larva has reached the ultimate stage and worked its way out of the host larva, completing its feeding from the outside; a day later it spins its cocoon. Some cocoons have been formed 19 days after oviposition. The cocoon period requires from 10 to 12 days, thus bringing the complete life cycle to 31 or 32 days.

SEASONAL HISTORY

Several thousand host larvae brought into the laboratory from September 29 to October 20, 1945, produced a small number of *Triaspis* cocoons by November 15. Adults issued from them from November 15 to 27.

Undoubtedly adults continue breeding in the field as long as larvae of *Listroderes* are present, for in the laboratory they laid eggs immediately.

It is not known how this insect passes the summer period, but it probably has some alternate host.

EPIPLAGIOPS LITTORALIS Blanchard

(Figs. 3 and 4)

Epiplagiops littoralis was discovered in 1942 in the first large collections of *Listroderes* made in Santa Fe, Argentina. It was described by Blanchard,[5] the name being derived from the location of its discovery, i. e., the littoral zone of the Plata River.

[5] BLANCHARD, EVERARD E. UN NUEVO EXORISTIDO, IMPORTANTE PARASITO DEL GORGOJO DE LAS HORTALIZAS (LISTRODERES OBLIQUUS KLUG). Soc. Ent. Argentina Rev. 11: [450]–455. 1945.

Epiplagiops littoralis has also been found near Montevideo, Uruguay. No *littoralis* appeared in collections made at Rosario, Argentina, also on the littoral, only 300 kilometers from Santa Fe, nor in collections from San Antonio de Areco, Province of Buenos Aires, Argentina. Blanchard states (communicated) that he has specimens from the Province of Buenos Aires but has no host data.

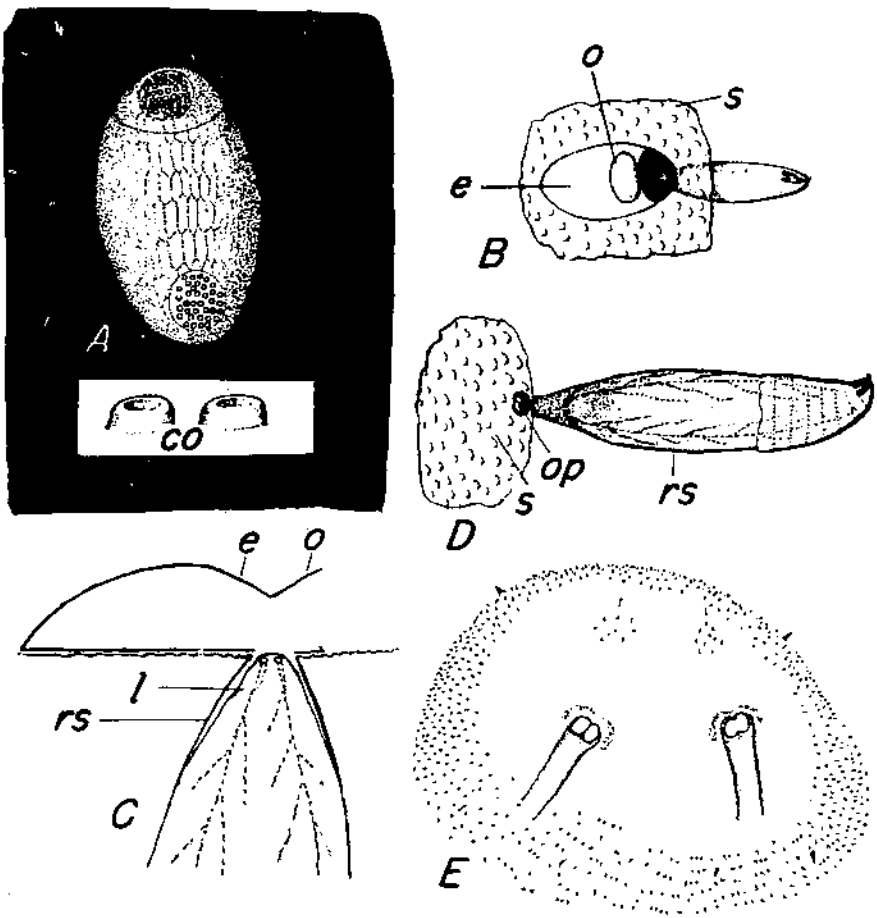

FIGURE 3.—*Epiplagiops littoralis*, immature stages: *A*, Egg showing (*co*) two cornicles greatly enlarged. *B*, Eggshell on skin of host, with a first-instar larva attached at the point of entry, showing (*e*) the eggshell, (*o*) the operculum, and (*s*) the skin of host. *C*, First instar of larva *in situ*, a schematic diagram of posterior portion, showing (*e*) and (*o*) same as in *B*, (*l*) the larva, and (*rs*) the respiratory sheath. *D*, First-instar larva with posterior portion enclosed in respiratory sheath (*rs*) showing (*s*) the skin of host and (*op*) the opening in the skin to which the respiratory sheath is attached. *E*, First-instar larva, last segment showing armature and spiracles.

DESCRIPTION OF STAGES

The egg (fig. 3, *A*) of *Epiplagiops littoralis* is white, oval when seen from above, and flattened ventrally, the upper surface being

covered with a chalky white substance in which can be seen fine reticulations of elongate hexagonal form. The lower surface is a thin membrane. Anteriorly on the upper surface is a small, clearly delineated operculum that is very plain immediately after the egg has been deposited. On the operculum is a group of small beadlike organs (fig. 3, *A*, *co*) set in a circular space which bears no chalky white material. Posteriorly and dorsally is another group of these organs: the operculum group consists of 30 to 44 separate organs and the posterior group, 41 to 55.

Figure 4, *A*, *a* shows the buccopharyngeal armature of the first-instar larva with the tip enlarged; figure 3, *E*, the posterior spiracles and integumental spines of the first-instar larva; figure 3, *B*, *C*, and *D*, the first-instar larva in position of feeding and the method of attachment to host skin; figure 4, *A*, *b*, the buccopharyngeal armature of the second-instar larva; figure 4, *A*, *c*, the outline of buccopharyngeal armature of the third-instar larva; figure 4, *B*, the posterior spiracular plates of the third-instar larva and the shape of the plates

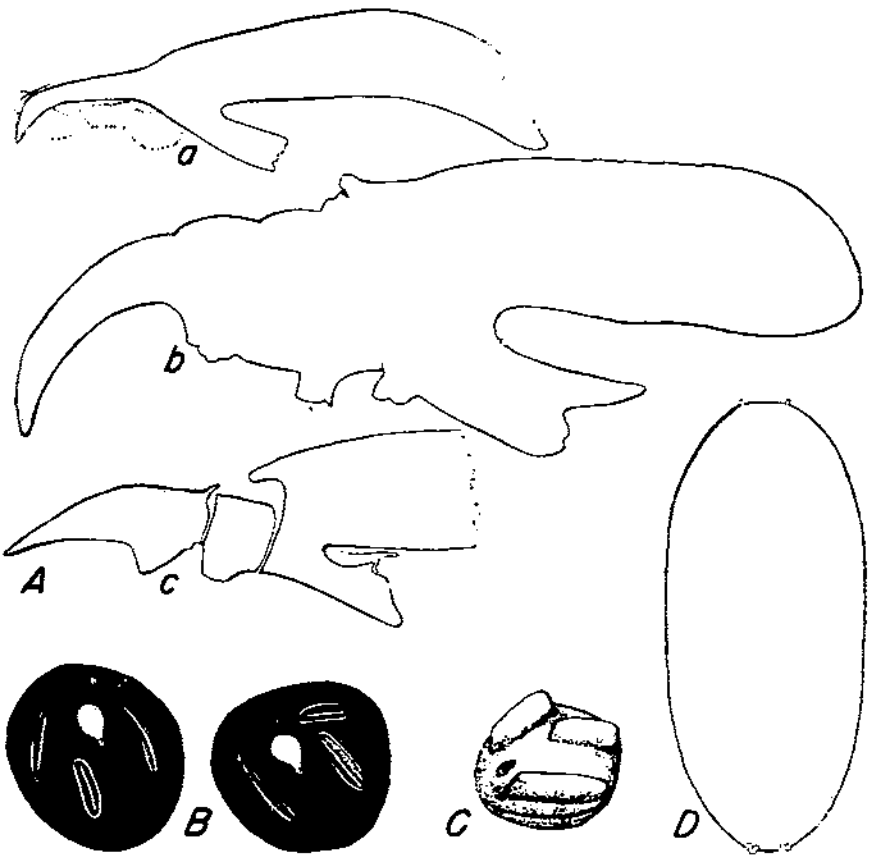

FIGURE 4.—*Epiplagiops littoralis*, immature stages: *A*, Buccopharyngeal armature of *a*, first-instar, much enlarged; *b*, second instar; *c*, third instar. *B*, Third instar, posterior spiracles. *C*, Puparium, one of the stigmal plates showing arrangement of respiratory cornicles. *D*, Puparium, outline, showing position of spiracular plates and the prothoracic cornicles.

and relative position of the openings; figure 4, *C*, the outline of the spiracular plates seen somewhat in profile; and figure 4, *D*, the shape of the puparium in dorsal position.

BIOLOGY

This fly mates immediately after emergence. To induce mating the male fly oscillates the anterior part of its body from side to side rapidly in the presence of the female. Mating lasts about an hour and apparently occurs only once, for when the sexes were left together for a long period no more mating occurred. The maturing of the eggs evidently requires several days. Mated flies were given host larvae immediately, but did not lay the first eggs until 3 days later. Egg laying was not abundant, however, until after 4 or 5 days. Thirteen females laid 825 eggs, and dissections showed they could have laid more. Although on two occasions an egg already transformed into a larva, but not hatched from the eggshell, was noted down in the uterus, no larval development was seen above this point.

In another experiment 3 flies lived from 27 to 31 days, and deposited 601 eggs. Dissections showed their egg supply to be practically exhausted.

Oviposition takes place by preference on larvae that are not completely grown or, at least, are not ready to pupate. When the female perceives a suitable host she clambers over it and curls her abdomen somewhat under or around and in a movement lasting about 3 to 4 seconds sticks an egg on it. The egg is usually laid with its long axis transverse to the long axis of the host body; otherwise there is no particular orientation, it being laid indifferently on thorax or abdomen.

The larva is formed in 2 to 3 days at summer temperatures. When ready to hatch it pierces a hole in the lower membranous portion of the eggshell near the anterior end exactly under the operculum and forces its way into the host larva. During this activity the operculum is pushed off, thus allowing for a supply of air through the opercular aperture and the ingress aperture. When inside, the larva remains at this point, constructing an integumental respiratory sheath. The old eggshell remains over this breathing hole until eventually it is worked off by movements of the host larva or by rubbing against leaves. The parasite larva becomes entirely surrounded with a membrane, the funnellike basal portion of which turns black, so that one can separate parasitized from unparasitized larvae on sight. The larval stage is longer when the egg is laid on a host having a poorly developed fat body. On well-developed host larvae that are supplied with good fat body, the egg-to-pupation period of the parasite requires 9 days in a warm room. In the field the parasite generally kills the host while it is still in the larval stage but after having formed its pupation cell in the soil.

By the time the parasite larva has completed its feeding, the host larva is generally dead and sloughing away, exuding an offensive odor. The parasite larva works its posterior spiracles out through the host's skin and continues feeding until the host is consumed, after which the parasite emerges from the old skin and pupates.

Only 1 parasite emerges from a single host. Any other parasites, and there are often 3 or 4 eggs on a single host, apparently die or are consumed by the most vigorous parasite. Often there will be 1 or

more *Porizon*, several *Epiplagiops*, and a nematode, or a combination of the three, in a single host. In these cases the nematode appears to vanquish the other parasites. When a host larva is parasitized by larva of *Epiplagiops* and of *Porizon* of approximately the same age, the *Porizon* succumbs and the *Epiplagiops* completes its life successfully.

SEASONAL HISTORY

The egg stage of *Epiplagiops littoralis* is found in Uruguayan fields early in September. The first puparium was found on September 12. By the end of the month all stages of the fly are abundant. By November the *Listroderes* larvae have practically disappeared and the fly is lost from sight until the next year. The latest record of fly emergence is December 3.

In Santa Fe, Argentina, practically the same seasonal history prevails. The earliest puparia were noted on September 9. Eggs and first-instar larvae were found in dissections on August 20. The period of maximum puparium formation was from October 1 to 10, in 1943.

PSEUDOCLISTA sp. (aff. atra B. and B.)

(Fig. 5)

Pseudoclista sp. appeared in a rearing tray of *Listroderes* in Santa Fe, Argentina, in 1944, at which time the writers were doubtful as to the true host. In 1945, however, about a dozen specimens were found, and it was possible to isolate the puparia with the host larval skins. Examination of the latter proved beyond doubt that *Pseudoclista* sp. is a primary parasite of *Listroderes* larvae. It appears to be unimportant in the biological control of *Listroderes*.

The buccopharyngeal armature of the first, second, and third instars are shown in figure 5, *A*, whereas the stigmal plate of the puparium projecting from the host skin (ventrally in the thoracic region) within which the puparium is formed is shown in figure 5, *B*.

NEMATODE

An unidentified species of a large hairworm of the *Mermis* type has been reared from *Listroderes* larvae collected in Santa Fe, Argentina, and in Uruguay. Parasitization by this worm in one restricted locality in Uruguay in 1945 was as high as 78 percent, while the average parasitization in the southern part of Uruguay was 12 percent.

The biology is unknown to the writers. The larvae bearing these nematodes are usually semitransparent, owing to the absence of a fat body, and usually have 10 to 20 worms in each.

In 1945 a number of parasitized larvae bearing these nematodes were sent to California in an attempt to establish them there.

FIGURE 5.—*Pseudoclista* sp., immature stages: *A*, Larva, buccopharyngeal armature of *a*, first instar; *b*, second instar; *c*, second instar, terminal sclerome (*d'*, distal end); and *d*, third instar. *B*, Puparium: *a*, within remains of host showing spiracular plate protruding ventrally; *b*, stigmal plate showing its quasi globular form and enlarged base.

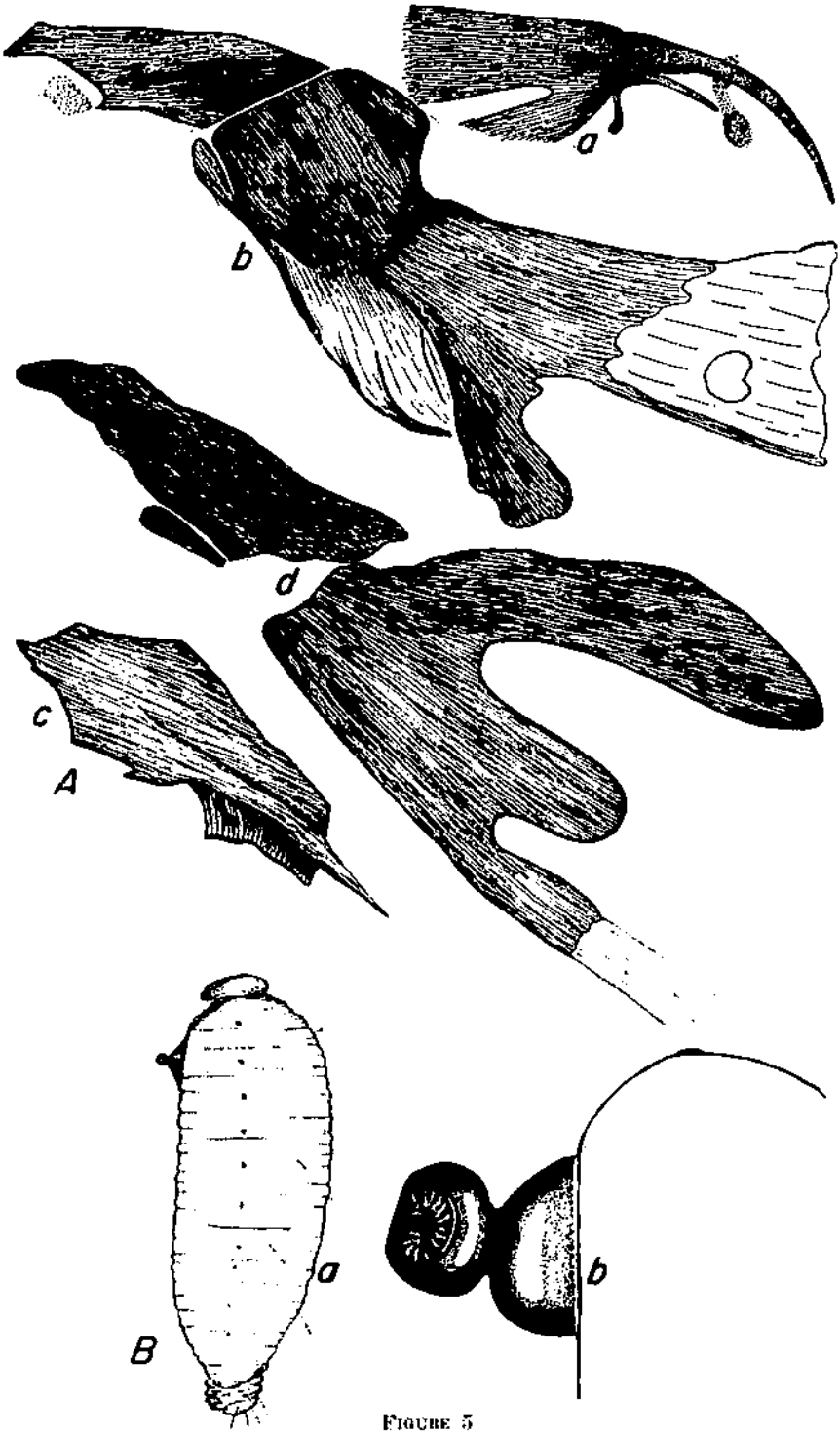

FIGURE 5

FUNGI

Two fungi, *Entomophthora sphaerosperma* Fras. and *Beauvaria globulifera* (Speg.) Pic, attack the larvae of *Listroderes* in Argentina and in Uruguay. Although at times these fungi cause considerable losses in rearing cages, they do not seem to be an important factor in the control of the vegetable weevil in nature.

PARASITES OF THE ADULT OF LISTRODERES

MICROCTONUS n. sp.

(Fig. 6)

The parasite *Microctonus* n. sp., of the braconid subfamily Euphorinae, was found in cages of adult *Listroderes* collected at Santa Fe in 1944. It has not been collected from any other locality. It is a negligible factor for controlling *Listroderes*, only about 2 dozen specimens having been reared from approximately 30,000 adults. No other host is known.

DESCRIPTION OF STAGES

The adult of *Microctonus* n. sp. is blackish, about 3.5 mm. long, and has a very short ovipositor. The male is similar in appearance to the female.

The egg when first laid (fig. 6, *A*, *a*) is about 0.18 mm. long by 0.09 mm. wide (including the peduncle) and of the usual whitish color. At one end is a slightly inflated peduncle about as long as the body of the egg; the other end is slightly pointed. After a few hours of incubation the peduncle shrinks somewhat (fig. 6, *A*, *b*). As incubation progresses the egg becomes more spherical in outline and increases enormously in size; and as is customary with many braconid eggs, a layer of large cells is formed surrounding the embryo (fig. 6, *A*, *c*). When the larva is ready to issue, it bursts the shell of the egg and works its way out; the cells surrounding the embryo also flow out and many are seen free in the body cavity of the host.

During this development, the egg, deposited in the hypopharynx, works posteriorly by degrees through the beak, head, and into the thorax and probably to the abdomen. One beetle, having been exposed to adults for several days, when dissected, had 8 eggs distributed from the hypopharynx to the second thoracic segment in stages of development varying from newly laid to well-formed larva, the more advanced being uniformly situated posteriorly.

The first-instar larva (fig. 6, *B*) has a large flat head that is broader than the thorax, 12 other segments, and an elongate but rather blunt, caudal appendage approximately as long as the preceding 10 segments.

The head (fig. 6, *C*) bears 2 small sensorial papillae above the epipharyngeal region, a faintly discernible maxillary and labial region with buttonlike maxillary palpi and a labial projection resembling a spinerette. The mesal borders of the hypostomal sclerome are covered with tuberclelike rugosities. The mandibles are long, simple, and ensiform.

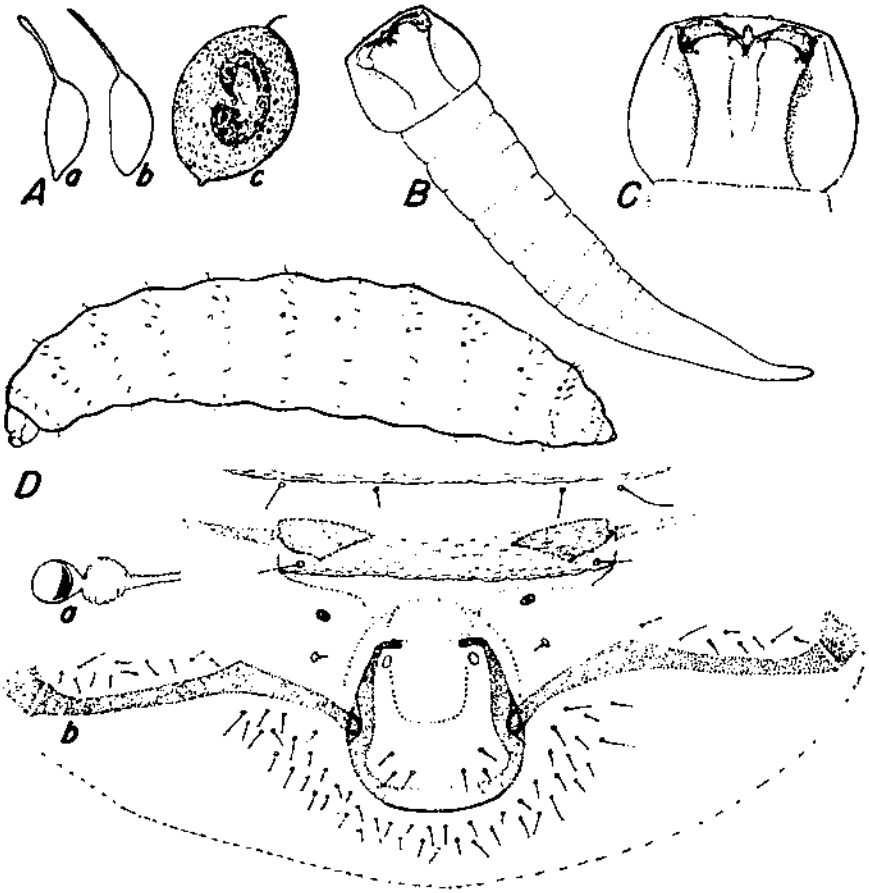

FIGURE 6.—*Microctonus* n. sp., immature stages: *A*, Egg, *a*, ovarian; *b*, recently deposited; *c*, 5 days after deposition. *B*, First-instar larva. *C*, Head of first-instar larva. *D*, Last-instar larva, *a*, spiracle; *b*, part of head showing principal mouth parts.

The body is subcylindrical, tapering gently to the extremity of the caudal process.

The intermediate instars have not been observed, but by treating with potash a last-stage larva found dead in a cocoon, it has been possible to observe some of its characteristics (fig. 6, *D*). It is of the usual hymenopterous type, rather slender, arched, and widest at the fifth abdominal segment. The head is smaller than the first thoracic segment. There are 13 body segments, the last being without setae; the others bear a transverse row of sparse setae, those on the eleventh abdominal segment being most abundant. There are 9 pairs of open spiracles located on the second thoracic and the first eight abdominal segments. The spiracle (fig. 6, *D*, *a*) consists of a funnel-shaped opening followed by an almost spherical atrium.

The head of the last-instar larva of *Microctonus* n. sp. (fig. 6, *D*, *b*) has been studied only in pieces taken from old cocoons. No antennal

foramina or eye marks are visible. The sclerotized portions above the mouth are not pronounced, the labral region being indicated by a fold in the skin; four sensorial setae are above this fold and two are on it; the mandibles are simple, small, and almost triangular in shape and, unlike most other last-instar braconid larvae, they have no teeth. Two small rodlike scleromes represent the pleurostoma and give support to the mandibular apophyses; although the hypostomal sclerome is not pronounced, neither are the mesal borders of maxillary areas, these being fleshy lobes; the labial sclerome is quite distinct, being rather heavy, more or less U-shaped, widest and heaviest at its middle, where the ginglymal sockets give articulation to the maxillary scleromes. They are also distinctly sclerotized, and extend outwards to the border of the head, where they have a membranous articulation with the stublike cardinal scleromes. Groups of rather strong sensorial setae are above the maxillary sclerome, on the lower part of the labium, and below and laterad of the labial sclerome.

The cocoon is white, and of the general form of an *Apanteles* cocoon; it is spun near the dead host whence the larva issues, or in trash or on soil nearby. It is not attached, except occasionally to the dead host.

In the laboratory this parasite was not reared from egg to adult. However, mating and oviposition were observed, and larvae were reared through the first stage.

BIOLOGY

Mating of *Microctonus* n. sp. in ordinary glass tubes occurred immediately after emergence.

Females lived 6 to 9 days in cages with water and pure honey as food. Their lives were probably shortened considerably by the exhausting efforts in ovipositing in the adult weevils and by the somewhat harsh treatment they received from the weevils. Oviposition begins 2 to 3 days after emergence and mating.

For ovipositions, female *Microctonus* were placed in small globe cages with a cloth base, and adult weevils were supplied.

The act of oviposition is a most peculiar one. The female faces the adult weevil with antennae spread in a more or less horizontal plane. If the weevil is moving when the parasite approaches, it stops, lowers its head until the beak touches the surface upon which it rests; the parasite begins to "palp" the beak of the weevil with its antennae, at the same time slightly raising the abdomen and preparing to sting. Eventually the weevil raises its head as if to shake off this nuisance. At this instant the *Microctonus* quickly curves its abdomen underneath the thorax and thrusting forward drives the ovipositor in between the mandibles of the beetle and into the soft skin of the mouth. An egg is deposited inside the body cavity in the hypopharynx. As the weevil struggles to free itself from the attack, the *Microctonus* quickly withdraws its ovipositor and retreats, frequently receiving severe blows from the beetle and occasionally losing a leg or antenna.

HYALOMYODES sp.

Four specimens of *Hyalomyodes* sp. were reared from about 70,000 adults collected at Santa Fe in 1943 and 1 specimen from approximately the same number of host adults collected in 1944. This fly is a negligible factor in the biological control of the weevil.

EUOESTROPHASIA APERTA (B. and B.)[6]

(Fig. 7)

One specimen of *Euoestrophasia aperta* was reared from 300 adult *Listroderes* collected in Rosario, Province of Santa Fe, Argentina, and 1 obtained from a pupa found in soil.

By dissection of the adult weevils from which the parasite issued the puparium was isolated; the larval respiratory sheath was found to be in the left side of the mesothorax attached to the trachea near the spiracle. The first-instar buccopharyngeal armature taken from this sheath, this armature of the third-instar larva taken from the puparium, the outline of the puparium with its unusual posterior stigmal plate, and the latter considerably enlarged are shown in figure 7, *A-C*.

This fly appears to be unimportant in the control of *Listroderes*.

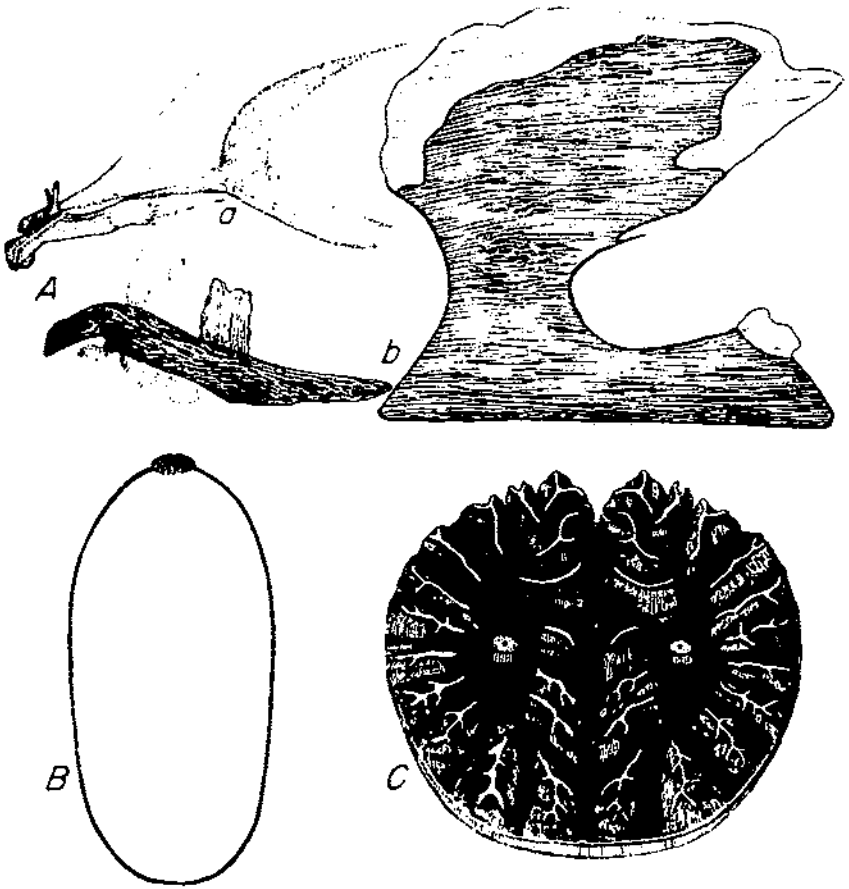

FIGURE 7.—*Euoestrophasia aperta* (B. and B.), immature stages: *A*, Buccopharyngeal armature of *a*, first-instar larva; *b*, third-instar larva. *B*, Puparium outline, and stigmal plate. *C*, Puparium, stigmal plate, oblique dorsal view.

[6] Identified by M. T. James. The late C. H. T. Townsend identified this fly as *Cenosoma* sp.

INTRODUCTION INTO THE UNITED STATES OF NATURAL ENEMIES OF LISTRODERES

The introduction into the United States of natural enemies of *Listroderes* began in 1942 with the sending of *Porizon* cocoons and *Epiplagiops* puparia.

The earlier sendings were handled by H. D. Smith at the Parasite Receiving Station at Hoboken, N. J., who bred out the *Epiplagiops* flies and forwarded them with the *Porizon* cocoons to the Citrus Experiment Station at Riverside, Calif.

The *Epiplagiops* were shipped in small flat boxes packed in sphagnum moss; these boxes in turn were arranged in a larger box with honey agar for food and water for drinking, in such a manner that the flies could emerge and find space and footing, food and drink in the

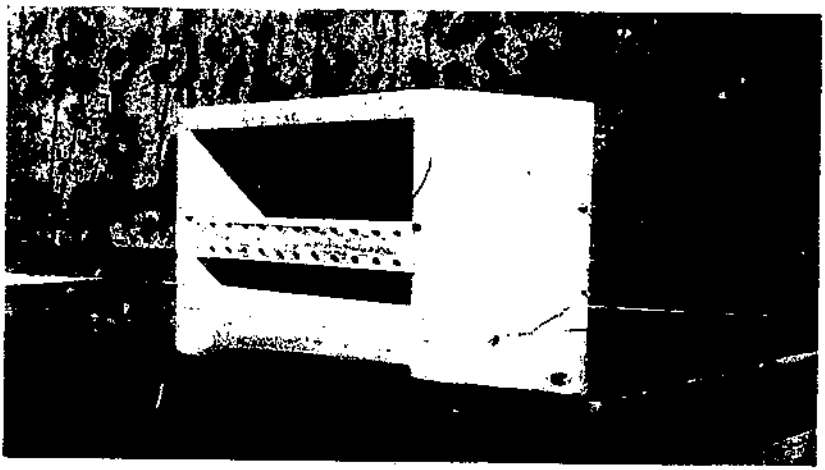

FIGURE 8.—Cage used in shipping puparia and adults of *Epiplagiops littoralis*.

outer box (fig. 8). The objection to this arrangement for shipping is that the flies emerge in the dark and consequently many flatten themselves out trying to go into cracks to escape. However, over a thousand flies arrived at the Citrus Experiment Station, where they were bred and released over a period of 2 years, after which the efforts to establish this species were dropped. No field recoveries have been recorded.

Since *Epiplagiops* does not go into a diapause as does *Porizon*, this fly probably passes the summer period on some other host. Efforts to breed it on larvae of *Graphognathus leucoloma* (Boh.) (*sens. lat.*) resulted in abundant oviposition, but no flies developed through to the adult stage.

From a total of 195 cocoons of *Triaspis* shipped to the United States in 1943, 58 adults arrived alive in California, and were utilized for breeding and release. This parasite does not appear to have become established in the United States.

In 1944, 244 larvae of *Listroderes* parasitized by *Triaspis* were shipped to California in a mixture of moist sawdust and ground sphagnum. All of them died in the larval stage, undoubtedly because of some noxious effect of the untreated sawdust.

The *Porizon* cocoons were shipped in small flat boxes without any arrangement for emergence, as they do not emerge at once. Six small shipments of newly emerged mated females of *Porizon parkeri* were made by first-class air mail, but because 10 to 12 days were required in transit these shipments were not successful. *Porizon* has not become established in the United States, owing to the difficulty of changing the established seasonal rhythm of this insect from the southern hemisphere and bringing it out of its aestivating state (November to April) in the United States while host larvae are present.

The nematodes were shipped in their host larvae packed in moist sphagnum moss, care being taken to select only parasitized larvae. Selection is not difficult under a binocular microscope, for the worms can usually be seen through the skin.

The parasites sent to the United States during 1942–45 are shown in table 3.

TABLE 3.—*Numbers of parasites of Listroderes shipped to the United States from South America, 1942–45*

Parasites	1942	1943	1944	1945	Total
Porizon argentinensis and *P. parkeri*	644	4, 983	2, 396	4, 700	12, 743
Triaspis sp.	0	195	244	0	439
Epiplagiops littoralis	1, 107	8, 083	0	0	9, 190
Nematodes	0	0	0	[1] 885	885
Grand total	1, 751	13, 261	2, 640	5, 585	23, 257

[1] Host larvae containing approximately 10 to 15 nematodes each.

SUMMARY

Several species of *Listroderes*, including *costirostris* var. *obliquus* Klug and *L. apicalis* Waterh. have been found in Uruguay and Argentina, where their larvae feed principally on chickweed (*Stellaria media*). They cause little damage to crops, only one important loss being noted—a field of young potatoes was destroyed by adults feeding on the sprouts. Oviposition and larval development extends throughout the winter, from April to November. The summer is passed in the adult stage.

Natural enemies of the larva include 3 ichneumonids, *Porizon parkeri* Blchd., *P. argentinensis* Blchd., and an unknown Thersilochini; 1 braconid, *Triaspis* n. sp.; 2 larvaevorids, *Epiplagiops littoralis* Blchd. and *Pseudoclista* sp. (aff. *atra* B. and B.); 1 hairworm of the *Mermis* form; and 2 fungus diseases, *Entomophthora sphaerosperma* Fres. and *Beauvaria globulifera* (Speg.) Pic. Natural enemies of the adult beetles are 1 braconid, *Microctonus* n. sp., and 2 larvaevorids, *Euoestrophasia aperta* (B. and B.) and *Hyalomyodes* sp.

Porizon and *Triaspis* are solitary internal parasites of the larva, the egg being deposited within the host larva. Apparently there is only 1 generation of *Porizon* each year, but probably 2 or more of *Triaspis*. The summer period is passed by *Porizon* as an adult in diapause within the cocoon.

Epiplagiops deposits an undeveloped egg externally on the host larva, the parasite larva penetrating the host at a point under the egg and there forming an integumentory respiratory envelope. The parasite larva leaves the host to pupate.

Among the natural enemies of *Listroderes* only *Porizon*, *Epiplagiops*, and the hairworm appear to be of any importance in control in South America, 27 percent of the weevils being killed by these parasites in 1942 at San Antonio de Areco and 74 at Santa Fe, in Argentina; in 1943, 26 percent at Santa Fe and 30 percent in Uruguay; in 1944, 16 percent at Santa Fe and 44 percent in Uruguay; and in 1945, 6 percent at Santa Fe and 34 percent in Uruguay. The hairworm, although generally distributed, appears to be of value only in restricted localities where in 1945 at one point in Uruguay, this species alone attained a parasitization of 78 percent. The fungus diseases do not seem to be effective in the field, but are exceedingly troublesome in the laboratory.

Introductions into the United States since 1942 have included 12,743 *Porizon*, 439 *Triaspis*, 9,190 *Epiplagiops*, and 885 *Listroderes* larvae bearing 10 to 15 nematodes each.

The 2 species of *Porizon*, *Triaspis* sp., and *Epiplagiops littoralis* have been reared and released in infested fields in California. None of them are known to have become established. Difficulty was experienced in breaking the estivating diapause of the adult *Porizon* to adapt them to the seasonal rhythm of the Northern Hemisphere. *Epiplagiops*, having a heterodynamic seasonal rhythm, evidently requires an alternate host.

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