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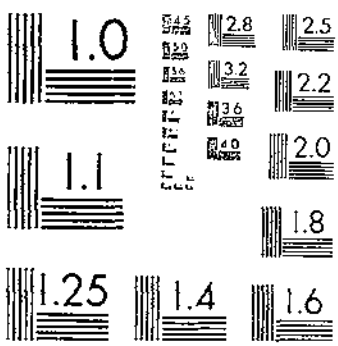

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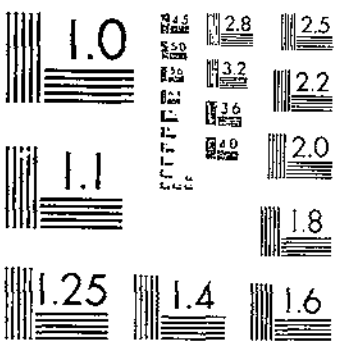

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THE PARASITES OF THE SUGARCANE BORER[1] IN ARGENTINA AND PERU, AND THEIR INTRODUCTION INTO THE UNITED STATES

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INTRODUCTION

Five species of Diatraea moths are reported in the United States, but only one of these, *Diatraea saccharalis* (Fab.), causes extensive injury to both sugarcane and corn. *D. crambidoides* Grote also does damage, but seems to confine itself largely to corn. It has been estimated that *D. saccharalis* alone causes an annual loss of over $8,700,000 in Louisiana.

The borer kills many young plants and considerably reduces the sugar content of the older cane. Because the larva spends practically its entire developmental period within the cane, and consequently is inaccessible, chemical control is practically impossible.

[1] *Diatraea saccharalis* (Fab.); order Lepidoptera, family Pyralidae.

[2] The courtesies and privileges accorded by the large number of owners of sugarcane estates in Peru and Argentina, and the help rendered in many ways by W. E. Cross, director, and H. E. Box, entomologist, of the Estación Experimental Agrícola de Tucumán, and other members of the station staff are gratefully acknowledged. Special thanks are due to A. H. Paton, former manager, and D. Campbell, present manager, of the Cartavio sugar estate in Peru, and to several employees who rendered help in many ways. Valuable assistance was rendered by the two temporary assistants in this work, Miguel E. Ibáñez in Argentina and Federico L. Echeandía in Peru. Acknowledgments are also made to H. C. Hullock, of the Bureau of Entomology, and W. H. Freeman, of the Bureau of Plant Quarantine, U.S. Department of Agriculture, who received and attended to the transshipment of the parasites in New York, and to J. V. Gist, of the inspection station at Miami, Fla., who arranged for the transshipment of the parasite consignments sent by airplane from Peru to New Orleans.

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Four species of parasites have been reared from Diatraea in the United States, but only one occurs in large numbers, this being the egg parasite *Trichogramma minutum* Riley. A tachinid fly, *Lixophaga diatraeae* Townsend, which is parasitic in the borer larva, was introduced from Cuba in 1918, 1919, and 1920 (*6, p. 64–65*) [3] and became established. It was found in the field for several years, but up to the present (1932) has not become an important factor in the control of the borer. It was apparent that these two parasites were not sufficient for the biological control of the borer, and that if others that would aid in reducing the injury caused by the borer could be introduced, it would be well worth the effort.

The introduction of parasites from South America for the control of the sugarcane borer, *Diatraea saccharalis*, was started in 1928.

THE FIELD OF INVESTIGATION

Wherever sugarcane is grown one or more species of moth borers that attack the cane are usually present. In each producing region various parasites live upon the sugarcane borer, *Diatraea saccharalis*. In the Province of Tucuman, Argentina, one parasitic fly and two parasitic wasps were reported as being quite effective. Inasmuch as Tucuman has a climate similar to that of New Orleans, it was thought that if these parasites could withstand the Argentine winters they might likewise withstand the climatic conditions in Louisiana.

Investigations were therefore started in August 1928, with headquarters at Tucuman. A year later, during the winter months of June and July, a trip was made to the sugarcane district along the coast of Peru. This trip revealed that two species of the parasites present in Argentina could be obtained in Peru, one of them in much larger numbers, and at a season of the year more suitable for shipment to Louisiana.

Investigations were conducted in Argentina until May 1930, and thereafter the field work was carried on in Peru with headquarters at Trujillo.

This bulletin deals only with the biology and collection of the parasites and their shipment from South America. The methods of receiving, handling, and releasing them will be dealt with by another writer.

THE PARASITES, THEIR BIOLOGY, COLLECTION, AND SHIPMENT

During the course of the studies upon the natural enemies of the sugarcane borer in South America the following 11 species of parasites were found in Argentina and Peru:

Parasites of the egg:
- Hymenoptera:
  - *Trichogramma minutum* Riley (Trichogrammatidae).
  - *Telenomus alecto* Cwfd. (Scelionidae).

Parasites of the larva:
- Diptera:
  - *Paratheresia claripalpis* Van der Wulp (Dexiidae).
  - *Leskiomima jaynesi* Aldrich (Tachinidae).

[3] Italic numbers in parentheses refer to Literature Cited, p. 25.

Parasites of the larva—Continued.
Hymenoptera:
Ipobracon tucumanus (Bréthes) (Braconidae).
Ipobracon rimac Wolcott (Braconidae).
Bassus stigmaterus (Cress.) (Braconidae).
Apanteles xanthopus (Ashm.) (Braconidae).
Nematoda:
Hexamermis microamphidis Steiner (Mermithidae).
Fungi:
Botrytis delacroixii Sacc. (Mucedineae).
Mucor botryoides Lendner (Mucoraceae).

No true pupal parasite was found, though larvae and puparia of *Paratheresia claripalpis* were sometimes found within borer pupae which had become parasitized while in the late larval stage.

PARATHERESIA CLARIPALPIS VAN DER WULP

The dexiid fly *Paratheresia claripalpis* (fig. 1), previously referred to as *Paratheresia signifera* Tns. and as *Sarcophaga diatraeae*

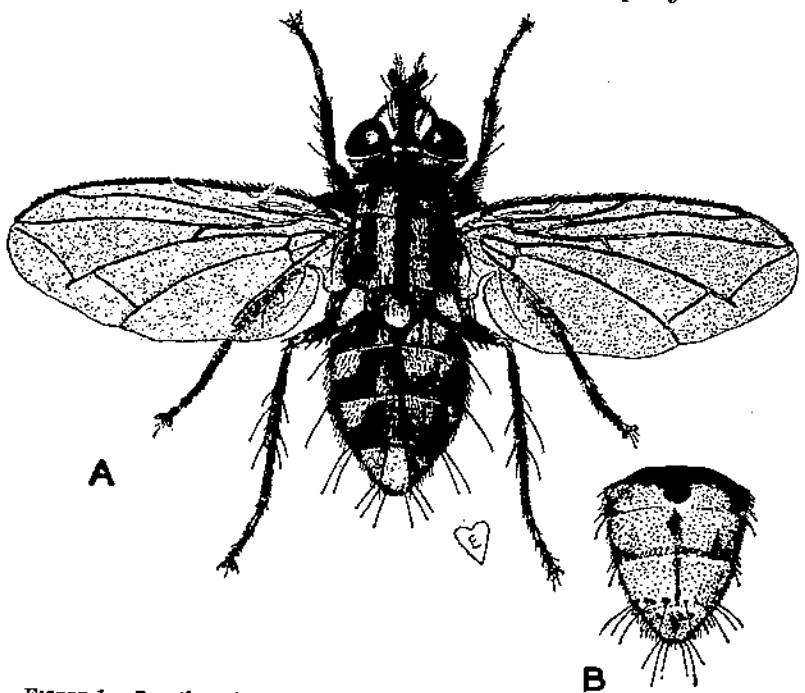

FIGURE 1.—*Paratheresia claripalpis:* A, Female; B, abdomen of the male. × 6.

Bréthes, is the most important larval parasite of the sugarcane borer in Argentina and Peru. It is also known to occur in Demerara, Trinidad, Venezuela, and Mexico. In Peru it is active throughout the year. In Argentina, though the usual hibernating stage is the first instar, within the host, those parasites that succeed in reaching the pupal stage before cold weather may emerge as adults on warm days during the winter; and therefore the fly can be found in all stages during the winter as well as the summer. Although all the borers in the cane which is taken to the mill are destroyed, a great number are left in the field in the tops and stubble, and it is in these

borers that the parasite usually survives until the following season. There are several overlapping generations each year.

From 6 to 14 percent of the borers in mature cane in Argentina were found to be parasitized in 1928.

During the season of 1928–29 in Argentina from 2 to 22.7 percent of the borers in "dead hearts" [4] were found to be parasitized. These figures include Paratheresia puparia found at the time of examination and those which developed later from the borers. The following season the parasitization in the dead hearts was much higher, ranging from 12.9 to 68.9 percent, with an average of 34.8 percent, based on collections made on 16 different days in the two localities where the borers were most abundant. These latter percentages represent only the parasitization apparent at the time of cutting the dead hearts, as the borers that seemed healthy were used for other experiments and were not held for the emergence of additional parasites. The figures for this second season (1929–30) in Argentina compare closely with those obtained the same season in Peru, where the apparent parasitization for three fields in Cartavio averaged 32 percent. The next season, however, a total parasitization as high as 73.7 percent was noted in one field in Peru; in this case all the borers were held until the full parasite content could be determined.

The percentage of parasitization in corn was also slightly higher in Argentina in 1929–30, being 31.2 percent as compared with 29.1 percent in the preceding season.

FIELD OBSERVATIONS

During the first two years in Argentina considerable time was spent in the field trying to observe the behavior of the adults of Paratheresia, but with little success. It was not until the summer months of 1930–31 in Peru, when more flies were present, that field observations of value were obtained. Even though the infestation of the borer in both cane and corn is much greater in Peru than in Argentina, and more adult flies are actually present, yet very few were observed in the corn or cane fields—perhaps only one or two in a period of three or four hours of search.

The flies were found, however, gathered on the trunks and branches of some of the trees surrounding the fields and sometimes at a considerable distance from any field. The trees principally frequented were a kind of willow (*Salix* sp.), which is the commonest tree along the borders of the cane fields of Peru and along most of the roadways and large irrigation ditches. In some locations the flies were resting on the trunks, but again, in places that appeared identical, search for hours failed to reveal a single fly. Flies were also seen resting on soursop (*Annona muricata*), mango (*Mangifera indica*), guava (*Psidium guajava*), hog plum (*Spondias* (*lutea?*)), and orange and lemon (*Citrus* spp.), and have also been seen on the sides of buildings.

The flies are most often found on the side of the tree away from the wind, and their usual position when at rest is with the head

[4] A young sugarcane plant killed by a borer larva is called a "dead heart" because the central part of the plant, or "heart," dies first. These plants often have the outer leaves normally green, while the inner leaves are dry and dead.

downward. They are very rapid fliers and dart back and forth, chasing one another in the bright sun, and often return to approximately the same place after a short flight. They are also active on cloudy days, although not so active as on bright, sunny days. On the tree trunks and branches the males always greatly outnumbered the females, but the greater proportion of flies collected in the cane fields were females. Upon dissection the females collected in the field proved to have been mated, though they were not always ready to larviposit, whereas those from the tree trunks had not mated or had mated only recently. It appears that, on emerging, the flies gather on tree trunks at the field borders and return to the cane fields only for food and to deposit their larvae. In Peru there are strong winds in the afternoon, at which time more flies are found on the trees.

The flies feed on juices of the cane, the secretion from mealybugs, and the honeydew of such aphids as *Sipha flava* Forbes and *Aphis maidis* Fitch, which feed mainly on cane and corn, respectively. The flies have been seen feeding on the juice of recently cut cane lying in the field.

COLLECTION AND SHIPMENT

During the first season in Argentina and Peru the puparia of *Paratheresia claripalpis* were collected by cutting out dead hearts in the cane and by splitting corn that was still green. The cane had to be cut very close to the ground in order not to injure the puparium inside, and great care was necessary to see that other shoots of cane were not cut or injured. A greater number of puparia were found in corn and were easier to obtain. In cases where the corn was being cut for fodder it was only necessary to get permission to split the stalks, but in other fields the crop had to be bought, as splitting the stalks destroyed its value. Boys were hired to collect puparia and were paid according to the number they obtained. During the second and third seasons in Peru, puparia were obtained in large numbers from the owners of small corn patches. These men were first shown samples of the puparia and the full-grown fly larvae, and arrangements were then made to buy similar specimens from them. In this way it was not necessary to buy any cornfields or supervise the cutting of the corn, and this method enabled collections to be made over a larger territory. Only those collections were bought that were in good condition and contained a fair proportion of newly formed puparia and full-grown fly larvae. If there were no larvae in the lot, it was a certain indication that the puparia had been obtained in corn that had become mature and dry, and that only a very small percentage of them would be alive.

When the puparia were received they were packed in damp sphagnum moss in small tin boxes, and a small quantity of charcoal was placed in each tin to absorb any foul gases that might be given off by decaying puparia. Several of these tin boxes were packed in a strong wooden box 9 by 12 by 7 inches, the wooden boxes being placed in ice boxes keeping a temperature of approximately 55° F. while in transit to the steamship. On board they were placed in the vegetable room of the ship at a temperature usually between 36° and 40°. The boats were met in New York, and the parasites were packed in another ice box and sent by train to New Orleans.

The puparia were thus kept cool in storage from the time they were collected until they reached New Orleans.

A total of 637,063 puparia were forwarded from Argentina and Peru during the three seasons, as shown in table 1.

TABLE 1.—*Shipments of puparia of Paratheresia claripalpis*

Date	Country from which shipped	Puparia shipped
		Number
Jan. 24 to Apr. 18, 1929	Argentina	7,146
June 22 to July 11, 1929	Peru	27,754
June 23 to July 30, 1930	do	158,148
Apr. 23 to July 31, 1931	do	444,017
Total		637,063

An average emergence of 21.5 percent was obtained from the puparia shipped, and a total of 107,424 flies were released on 14 plantations in Louisiana (*5*).

SECONDARY PARASITIZATION

It was known that the puparia of *Paratheresia claripalpis* had been exposed to attack by secondary parasites, consequently every precaution was taken in shipment to prevent the escape of these secondaries en route and while in transit in the United States.

Secondaries were found rarely in Tucumán, and only two species were reared from the material collected there and shipped to Louisiana. The species *Aulatopria tucumana* Bréthes, reported attacking the puparia in Argentina (*3*), was not reared by the author.

In Peru, however, hyperparasitization was found to run very high, and eight species have been reared from puparia obtained in that country. The most common of these is *Thysanus dipterophaga* Gir. This is an external parasite of the fly pupa within the puparium. Several adults of this species were placed in a vial with 10 freshly formed fly puparia on July 5 and allowed to remain until July 15, when they were removed. By August 12 three healthy Paratheresia had emerged, and between September 1 and 8 six of the puparia produced a large number of the secondaries. Thus from 56 to 63 days elapsed from the time the puparia were exposed to attack until the adult secondary parasites emerged. The number of secondaries which develop in one host puparium is variable, ranging from 14 to 75, with the average between 30 and 40.

The following are the species of secondary parasites reared from the puparia of *Paratheresia claripalpis*:

Family:	
	From Argentina:
Pteromalidae	*Pachycrepoideus dubius* Ashm.
Diapriidae	*Spilomicrus* sp.
	From Peru:
Eulophidae	New genus and species.
Pteromalidae	*Melittobia* sp.
Signiphoridae	*Thysanus dipterophaga* Gir.
Signiphoridae	*Thysanus* n. sp.
Eupelmidae	*Eupelmus peruvianus* Cwfd.
Eupelmidae	*Eupelmus cushmani* Cwfd.
Spalangiidae	*Spalangia muscidarum* Rich.[5]
Diapriidae	*Trichopria* sp.

[5] Also reared in Tucumán, Argentina, from puparium of *Muscina stabulans* Fallén.

A large number of phorid flies, reared from the material from Peru, have been identified as *Megaselia scalaria* Loew and *Megaselia* sp. The maggots of these species appeared to feed on decaying material, however, and were not parasitic on live fly puparia.

LIFE HISTORY

The fly larva, after being deposited upon the stalk of cane or corn, crawls about in search of host borers, and is guided possibly by the dark appearance of the burrow entrance and the odor of the host. When a borer has been found, the larva seeks a tender spot in a fold of the skin between the segments of the host, usually on its ventral side. It spends several minutes in searching for this point of entry and then penetrates the integument in a very short time. Inside the host it lies free in the body cavity. The duration of this first instar is variable and is considerably extended under Argentine conditions where the fly usually passes the winter months in the first larval stage within the hibernating host.

Early in the second instar the larva effects a respiratory connection with the outside air in the form of a dark chitinous funnel which envelops the posterior segments of the parasitic larva and usually appears at one of the spiracles on the eighth abdominal segment of the host. In case the borer contains two fly larvae, the respiratory funnels are usually found at two large spiracles of the eighth abdominal segment. This funnel has been found to occur also at any of the other abdominal or thoracic spiracles. In the case of artificially parasitized borers, this funnel was never evident within 24 hours, but was often found 48 hours after the parasite larva had entered the borer. When connected with its funnel, the parasite larva lies with its head directed towards that of the host. The feeding during this period is largely in the mid-abdominal and thoracic regions. This second instar covers from 77 to 144 hours, with an average of 130.6 hours, according to the laboratory observations. At the end of this feeding period a rupture is made in the skin of the borer, usually near its middle. The larva becomes detached from the funnel, molts, reverses its position, and then feeds in the posterior portion of the host's abdomen. The time spent in this position was found to be from 23 to 54 hours and to average 31 hours. The larva then leaves the empty borer skin and forms a puparium within the tunnel that the borer has made. The observed period between completion of feeding and pupation covered from 22 to 72 hours, with an average of 36.3 hours.

The time spent in the puparium averaged 21.5 days. Thus there was an average total period of 31.7 days from the time the larvae were placed on the host borers until adult flies emerged. The mean temperature during these observations was approximately 80° F.

The average time spent by the fly larvae in the various instars is as follows: First instar, free within the borer, 2 days; second instar, connected by funnel, 5.4 days; third instar, free within the borer, 1.3 days, and free outside the borer, 1.5 days; and in the puparium (as larva and pupa), 21.5 days; a total of 31.7 days.

Previous investigations in Argentina had shown that from 17 to 21 days were spent in the puparium at a mean temperature of 78.6° F., while 37 to 44 days were required at a mean temperature of 64.3°.

Thus it is seen that with a considerably lower temperature the length of time spent in the puparium was doubled.

Fifteen fly puparia were reared from 500 borer pupae. The parasite larvae had no doubt been in the borers when the latter transformed to the pupal stage, as those borers showing parasitization sometimes pupated before the fly puparia were formed.

The newly hatched first-instar larva (fig. 2, A) is white and approximately 1 mm in length. The mouth hook is present, and the sensory papillae are very prominent. The posterior spiracles are stalked, and there are also two long setae upon the posterior segment (fig. 2, B).

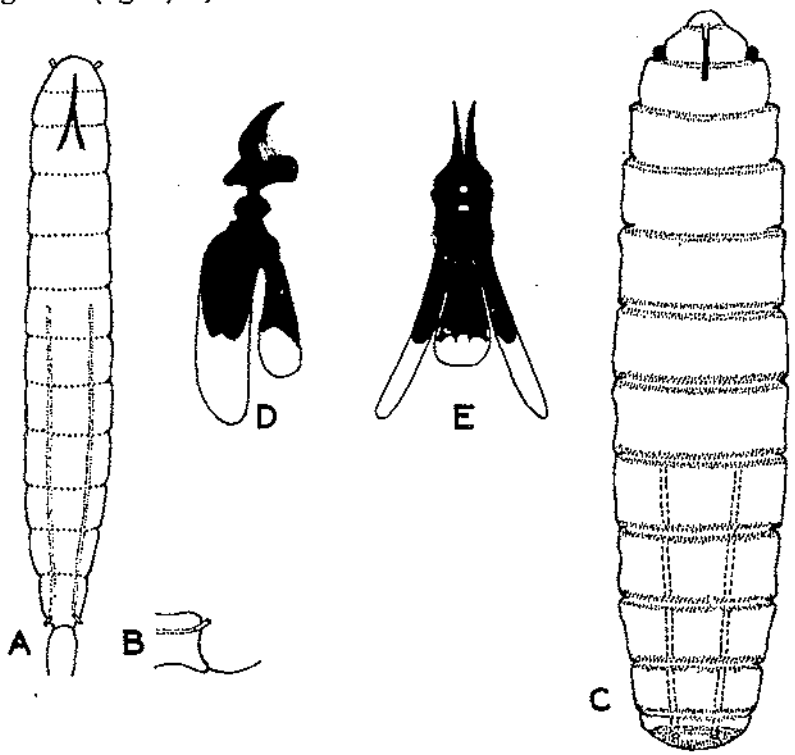

FIGURE 2.—*Paratheresia claripalpis:* A, First-instar larva, × 80; B, lateral view of caudal end of larva; C, third-instar larva, × 9; D, third-instar larval mouth parts, lateral view; E, same, dorsal view.

The second-instar larva (fig. 3, A) is 2 to 9 mm long and white. The mouth parts consist of one strong, curved hook. The posterior segments are enveloped in a chitinous tracheal funnel. This funnel appears to be attached to the spiracle of the host but actually is attached to the short spiracular trunk between the spiracle and the main tracheal trunk (fig. 3, B).

The third-instar larva (fig. 2, C) is 10 to 12 mm long and still white. The mouth parts consist of two strong, curved hooks, as illustrated in figure 2, D and E. The margins of all the segments bear numerous short, stout spines, and the last segment has several concentric rows of these spines surrounding the two spiracles.

The puparium (fig. 4, A) is 8 to 9 mm in length, dark brown with a dull reflection, and the surface is finely striate. The posterior spiracles have three elongate depressions at the former tracheal openings.

The fly is somewhat larger than the house fly and its wings are held at a wider angle when at rest. There is a decided difference between the males and females, not only in the shape of the abdomen but also in the markings and coloration. The males are much lighter in color (fig. 1), and the females have a dark rust-colored band near the tip of the abdomen.

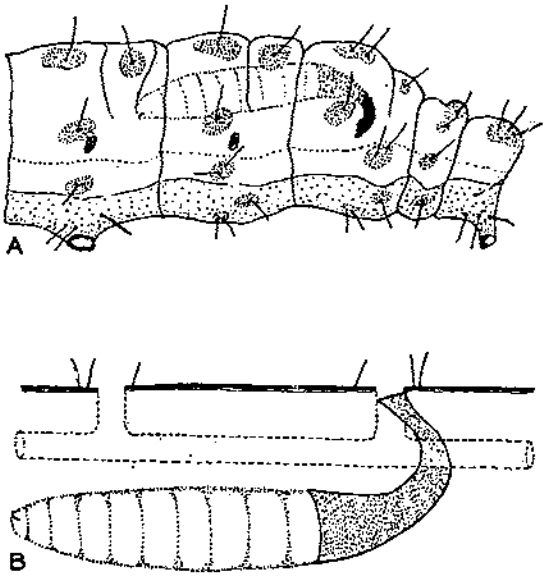

FIGURE 3.—A. *Paratheresia claripalpis*, second-instar larva showing tracheal funnel apparently attached to spiracle of host borer; B, cross section showing tracheal funnel actually attached to trachea just beneath spiracle.

The flies were found to mate within 3 or 4 days after emergence On one occasion a pair not over 40 hours old, was found mating. While mating the female is very often in the usual resting position with head directed downward, and the body of the male is at nearly a right angle to that of the female, with the tips of the wings and the hind legs resting on the tree or side of the cage. The usual period of mating was 5 or 6 minutes, but one pair was observed in union for 21 minutes.

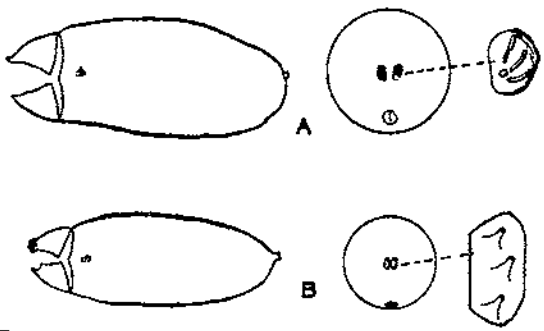

FIGURE 4.—Distinguishing characters of puparia: A, Puparium of *Paratheresia claripalpis* (× 5) and diagram of posterior spiracle (much enlarged); B, puparium of *Leskiomima jaynesi* (× 5) and diagram of posterior spiracle (much enlarged).

Several types of wire cages were tried for rearing the flies, but they all proved unsatisfactory, and mating was not obtained until cloth-covered cages were used. These cloth-covered cages were 36 inches long, 16 inches wide, and 14 inches high, and similar to those used at the gipsy moth laboratory (*4, p. 18*) for emergence and mating of tachinid flies. A sliding glass window 5 by 6 inches was placed in one end so that the flies could be observed. Granulated

sugar, in small tin cups, was placed in the cages for food, and a sponge in a small tin was kept moist with water. The cloth was also sprinkled three or four times each day. The length of life of the fly in the field is not known, but flies in these cloth cages lived to a maximum of 41 days.

Actual larviposition has not been seen in the field, but has been observed in the cloth breeding cages. Freshly emerged flies were placed in a cage on March, 2, 3, and 4, and mating was observed on March 5. On March 13 a female was seen walking about on one of the pieces of cane. She stopped, lowered the tip of the abdomen, and appeared to expel a larva, then moved about an inch farther and repeated the movement. This was done three times. These movements were all made near one of the nodes of the cane. Upon removing the cane one fly larva was found crawling about near where the fly had been seen. It would appear that the fly expels the larvae singly. At another time a fly was observed with her abdomen at the entrance to a borer tunnel, but on examining the cane no larva was found. The fly larvae are able to penetrate the frass that is found in the aperture of the tunnel, as borers have been found successfully parasitized in infested canes where all the entrances were filled with frass at the time of larviposition.

In unfertilized females the ovaries are big, containing a large number of eggs, and the ovisac is twisted; whereas in gravid females the ovaries are considerably reduced, and the ovisac is distended with eggs and larvae (fig. 5).

The ovisacs of gravid females were found to contain 500 or more eggs and larvae. In one female which had been mated the ovisac was found to be full of eggs, a few of which had developed to the maggot stage; about a dozen of these maggots were ready for deposition. The ovisac contained 559 eggs and larvae, but the ovaries were very small and contained only a few eggs each. In another female 532 eggs, none of which had developed, were found in the ovisac.

The gestation period is from 9 to 10 days, though one female that was dissected 8 days after mating contained, in the lower portion of the distended egg sac, larvae that were sufficiently developed to penetrate borers when placed upon them. These larvae developed normally, and formed puparia.

LESKIOMIMA JAYNESI ALDRICH

Specimens of a slender yellow tachinid reared from larvae of *Diatraea saccharalis* were determined by J. M. Aldrich to be a new species, which he had recently described as *Leskiomima jaynesi* (*1*). Dr. Aldrich stated that he had received one specimen of the same species from H. E. Box, who also had reared it from the sugarcane borer, and one other specimen collected by H. H. Smith in "Piedras B.," Brazil.

In Argentina, during the season of 1928–29, only two Leskiomima flies were reared. These emerged on November 28 and December 15, 1929, in a field cage containing a large supply of cane heavily infested with Diatraea borers. This cane had been cut and placed in the cage in the latter part of September, which was very late, considering that the grinding season commences in Tucumán during June.

In January 1929, while dead hearts were being cut open, several puparia of this species were found. These puparia appeared to be from one locality, and most of them were found in a small portion of land near Lules. All of the borers collected from this place were examined, several by dissection, but no fly larvae were found other than those which appeared to be Paratheresia.

The puparia of Leskiomima (fig. 4, B) are readily distinguishable from those of Paratheresia (fig. 4, A). They are smaller, being from 6 to 7 mm in length. At the anterior end are several short spinelike projections, there is a thoracic spiracle in the form of a

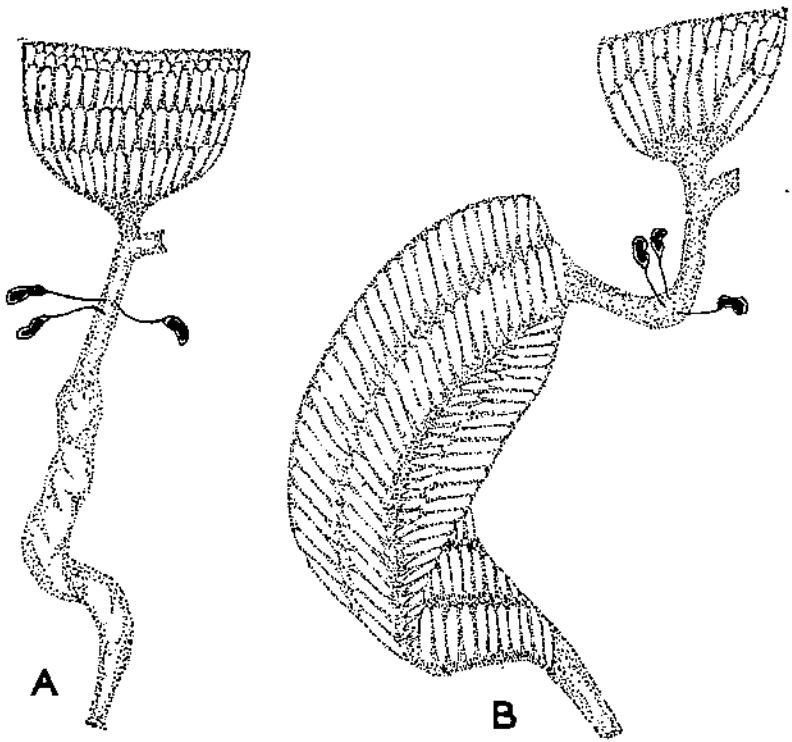

FIGURE 5.—Reproductive organs of *Paratheresia claripalpis*: A, Condition before mating, showing twisted ovisac; B, after fertilization, showing eggs and larvae in distended ovisac.

projecting tube, and each of the two posterior spiracles consists of three spinelike tubes protruding at the end.

Several reared flies were placed in a cage in February with borer-infested cane, but no parasitization resulted.

Although this fly was not found in large numbers, it may do appreciable good at times in certain small areas.

IPOBRACON TUCUMANUS BRÉTHES

GENERAL OBSERVATIONS

A large number of species of Ipobracon occur throughout Argentina, but during the investigation only a single species was definitely

found to be parasitic upon Diatraea larvae in that country. This species has been determined by C. F. W. Muesebeck, of the Bureau of Entomology, to be *Ipobracon tucumanus*.

Ipobracon in Argentina no doubt usually passes the winter months (June, July, and August) in the adult stage. The adults can be found on warm days throughout the winter. It has been proved also that they can stand long periods of cold. Three females which emerged from a field cage were placed in a tin containing excelsior and the top was covered with muslin. This tin was placed in an ice box having a temperature between 43° and 50° F. One female lived for a month and the other two lived for over two months.

Though some 2,000 borers were removed from cane during August 1928, and continued examinations were made during September and October, the first cocoons of Ipobracon were not found until October 16. In 1929, however, a few cocoons were found in August.

It is interesting to note the number of Ipobracon cocoons found in comparison with the number of fly puparia found. In examining growing cornstalks in January 1929, at Tucumán, a record (7) of the borers and parasites obtained was kept. This showed 46 Ipobracon cocoons and 1,460 puparia and larvae of Paratheresia, or a proportion of 1 to 32. However, over 250 paralyzed borers were found at this time. A large number of these borers no doubt had been stung by Ipobracon females, and credit should be given to this species even if no parasitization was apparent, as paralyzed borers never recover.

A record of 58 collections made between February and May 1929 showed 5,762 fly puparia, 350 Ipobracon cocoons, and 47 Bassus cocoons. The Ipobracon and the fly were present in the proportion of 1 to 16.

The foregoing ratio is considerably different from that found during the previous winter. In a small lot of mature cane, cut the last week in September and placed in a field cage, there were two Ipobracon cocoons to every fly puparium when the cane was examined in November. This is explained by the fact that the cane had been standing through the winter months of June, July, August, and September, during which time the overwintering adults of Ipobracon are capable of ovipositing on warm days, whereas there is seldom a period of continuous warm weather long enough for the flies to emerge and complete the gestation period.

SHIPMENTS

A total of 421 cocoons were shipped from Tucuman between October 30, 1928, and May 13, 1929. One shipment of adults, containing 50 females and a few males collected in Guemes, was sent on May 13, 1929. In 1930, between April 16 and 19, 185 females were collected in the field near Tucuman and shipped on April 22.

BREEDING EXPERIMENTS

As it was very difficult to obtain either the adults or cocoons of Ipobracon in large numbers for shipment, efforts were made to rear them. It was hoped that these wasps could be bred under controlled conditions for two or three generations, and by such methods sufficient

numbers could be obtained to permit shipment, either as adults or cocoons, to Louisiana.

In the middle of September 1929, Ipobracon adults were collected in the field and placed in a cage containing short pieces of artificially infested cane. The borers were placed in this cane by making a small hole with a steel punch for each one. The hole was then plugged with cotton for a short time, thus confining the borer until it had started feeding. The infested canes were then placed on end in damp sand.

The cage used was a cylinder of wire screen 10 or 12 inches in diameter and 18 inches high. A circular wire food cover of similar diameter was fastened to the top of this cylinder with brass paper fasteners, and this formed the top of the cage. To the bottom edge of the cylinder was sewed a strip of cloth 6 inches wide. This cage fitted nicely over the empty half of a kerosene tin, and the cloth was tied snugly against the tin with a string. The tins were filled with damp sand into which the infested canes were stuck. By untying the string, wasps could be added without disturbing the cage. To transfer the wasps to another tin of fresh borers it was only necessary to jar the tin to make the wasps fly to the upper part of the cage, which could then be moved with very little chance of any escaping. These cages were all used within a large outdoor cage which was supported by bricks set in a creosote solution for protection against ants and other insects.

The Ipobracon adults collected in the field readily oviposited on the borers in the cages. At the end of November most of the original adults, in addition to those that had emerged, were still alive. It was difficult to obtain hosts at this time, as the overwintering borers were just turning to pupae, and the moths were emerging. Several hundred borers had been collected and placed in canes during July, August, and September, but the mortality due to handling was exceedingly heavy, as they had to be removed from drying canes to fresh canes two or three times.

The reared adults failed to give as good results in breeding as did those collected in the field, and it was not long before their numbers began to decrease rather than increase. Mating was never observed in the cages, and very likely did not take place, and this may be the main reason for the poor results obtained from the second generation.

Two newly emerged virgin females were placed in a cage with unparasitized borers for oviposition. The progeny consisted of four males, which indicates that this species is capable of producing males parthenogenetically.

Later, experiments were tried with two large wire cages, 6½ feet square by 6½ feet high, placed over plots of uninfested corn. To infest the corn with borers two methods were used: (1) Placing two or three grown larvae on each stalk of corn; (2) placing borer eggs, which had been laid on paper in the laboratory, in the crevices where the leaf sheath joined the stalk. It was found that a much heavier infestation resulted from the eggs.

In one of these cages 13 reared females of Ipobracon were placed and in the other 26 field-collected females. Upon cutting open the corn in both of these cages only six cocoons were found. The adults flew about the top of the cage a good deal, indicating that perhaps a

large cage is not so suitable for breeding purposes as the smaller cages. Not enough adults were obtainable, however, to give these large cages a fair trial.

LIFE HISTORY AND HABITS

The Ipobracon female inserts her ovipositor in the entrance to a tunnel, stings the borer, and then lays an egg. She is unable to select the point of stinging or to choose any definite position for the egg, owing to the variable position of the borer in the tunnel. Females which appeared to be ovipositing have been noticed at the entrances to borer tunnels, but on cutting open the cane or corn immediately after the female left, it was often found that there was no borer in the tunnel. It appears that the female must make a great many attempts for each borer actually parasitized, for the borers are often a considerable distance from the entrance hole or have already completed development and emerged.

The parasitic larva feeds externally upon the host borer at any point along its body, either ventrally or dorsally, by thrusting its mouth parts through the skin. Upon completing its feeding the larva spins a cocoon within the borer tunnel. This cocoon varies in size, depending on the size of the host upon which the larva has fed, the average being from 12 to 17 mm in length and about 4 mm in diameter. It is cylindrical, with blunt ends. The color ranges from light to dark tan, those formed in cane being darker than those in corn.

Record was kept of the period from oviposition to the emergence of the adult. Those adults which developed from eggs laid between September 19 and 28 required an average of 45.1 days, the mean temperature during this period being 69.1° F. Those which developed from eggs laid between November 12 and 16 required an average of only 25.3 days at a mean temperature of 78.5°. Thus, with the temperature approximately 10 degrees higher, only about half as much time was required in November as was required during September and October.

IPOBRACON RIMAC WOLCOTT

The only species of Ipobracon found to be parasitic upon Diatraea in Peru was *I. rimac* (fig. 6). It was very abundant in the coastal area near Trujillo, and is known to be present from Lima on the south to Chiclayo on the north. Adults can be found during all the months of the year, and at times large numbers of them, both males and females, were seen flying around corn and cane fields; at other times hundreds of males were seen flying about, but no female was visible.

SHIPMENTS

On July 9, 1929, a shipment of 150 females and 316 field-collected cocoons was made from Cartavio, Peru. The following year, between July 7 and September 9, over 20,000 females were shipped from the region around Trujillo to New York by boat and thence to New Orleans by train. In 1931, on April 23 and May 7, consignments of 4,069 and 1,794 adults, respectively, were sent by boat to New York. On May 8 the first shipment of adults by airplane was made, this

being from Trujillo to Miami, Fla., and thence to New Orleans by train. From May 8 to September 4 a total of 32,200 adults were shipped by the air-and-rail route. These were subject to the changes in temperature encountered en route, whereas those shipped by boat were placed in the artificially cooled vegetable room of the ship.

During the first 2 years of this work the adults were shipped in tin cans 5½ inches in diameter and 9½ inches high. Several small holes were punched in the tops of the cans to allow circulation of air, and one large hole, stopped with a cork, was provided for introducing the wasps. Several small holes were also punched in the bottom to allow ventilation and to drain off any water that might collect in the can. A 5-ounce bottle containing pure water was wired to the inside of each can. A piece of gauze inserted in

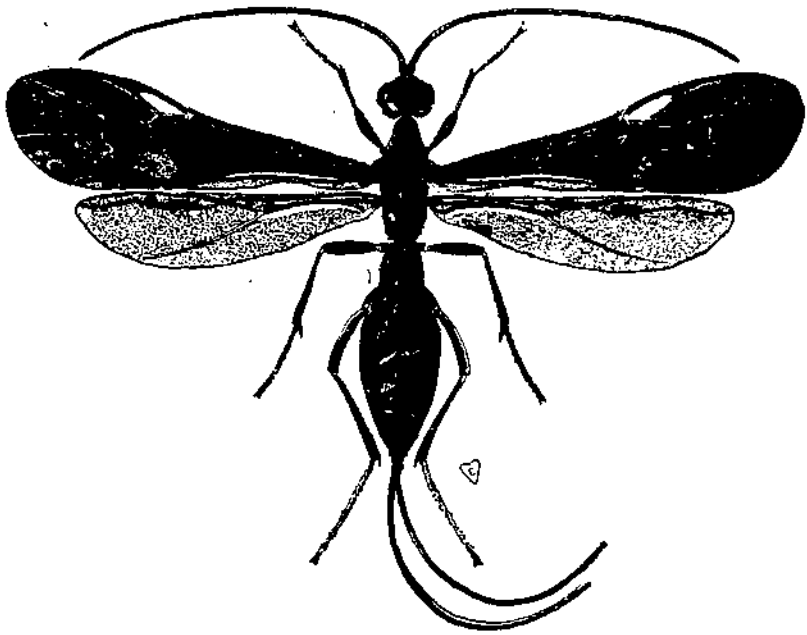

FIGURE 6.—*Ipobracon rimac*, female. ×5.

the bottle served as a wick, while a plug of cotton was held in place around this wick and over the mouth of the bottle by another piece of gauze. A small tin cup, about 1 inch long, one half inch wide, and one half inch deep, was soldered to the inside of each can, and filled with granulated sugar for food. A small quantity of excelsior was placed in each container to furnish a foothold and to allow the wasps to crawl about. Later, by using a crate, without any cans, and improving the water container, the percentage received alive was increased considerably. In one crate shipped by airplane and containing 1,000 wasps, 915, or 91.5 percent, were received alive in New Orleans 7 days after being collected in Peru. From 22,168 females sent in cans, only 1,409, or 6.4 percent, were received alive, while from 15,895 sent in crates, 12,049, or 75.8 percent, were received alive. This crate was made of thin wood and measured 12

inches long, 6 inches wide, and 9 inches high, with solid ends, bottom, and top. The two sides were covered with wire screening and black cloth, with three or four strips of wood to protect the sides from being damaged. A small tin cup containing graulated sugar was nailed to each end of the crate and also a drinking fountain containing a sponge and water. The wasps were placed in the crate through a 1-inch hole made in the top.

The drinking fountain (fig. 7) consisted of a tin can, 4 inches by 1½ inches by 1 inch, tightly sealed except for an opening three fourths inch high across one side of the bottom. At this point was soldered a cuplike arrangement 1½ by 1 by 1 inch, making the entire container L-shaped. In this lower portion a sponge was placed, which was kept moist by the water in the upright portion of the fountain. The tin was necessarily airtight, except for this opening at the bottom, so that the water would not run out. After the fountain had been filled and the sponge inserted, the fountain was inverted and nailed to the end of the crate.

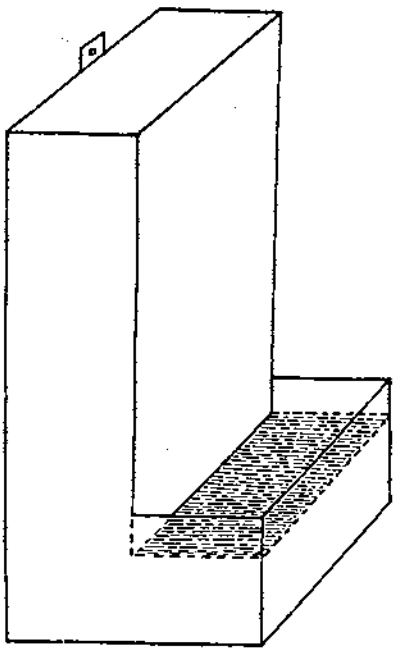

FIGURE 7.—Drinking fountain used in shipping adults of *Ipobracon rimac*.

A total of 59,632 field-collected Ipobracon females were shipped during the three seasons, and from this number 16,161 were released in Louisiana (*5*).

REARING METHODS

Females collected in the field readily oviposited upon borers in cane when placed in cages in the laboratory. The cages (fig. 8) used were 20 inches square by 2 feet high and were covered with wire netting, with the bottoms made of solid boards. Pieces of cane infested with borers were leaned against the inside of the cages. Food in the form of a sugar and water solution was sprinkled on the top of the cage at least once each day.

Of 19 females collected in the field on January 6, 1931, and placed in a cage with infested cane, 6 were still alive on February 1. During this time 42 cocoons were obtained; from these 10 females and 13 males emerged. A greater number probably would have emerged had not some of the cocoons been destroyed by ants. On February 12 an experiment was started with 5 females and 6 males, all of which had emerged recently. Canes with fresh borers were placed in the cage from time to time. The last female died on April 5, and during the intervening time 30 cocoons were obtained, which produced 18 males. No females were obtained, a fact which indicated that no mating had taken place. A similar difficulty was encountered with the Argentine species.

LIFE HISTORY

Pieces of cane containing freshly inserted borers were placed in a cage with field-collected adults of *Ipobracon rimac*. Ovipositions were obtained, and it was found that the egg stage lasted from 24 to 48 hours.

The female stings the borer and paralyzes it so that it is unable to crawl about, though it is still able to move its legs and mouth parts slightly. Several such paralyzed borers were kept under observation. None recovered; all became black and diseased and eventually died.

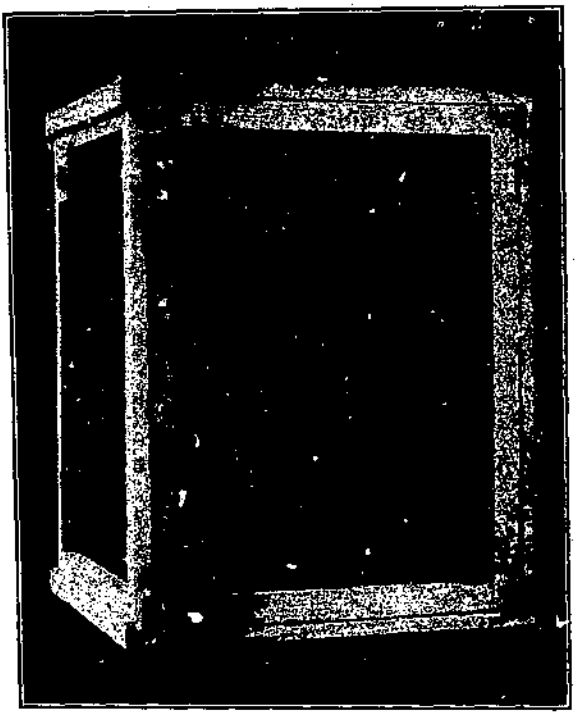

FIGURE 8.—Type of cage used for rearing *Ipobracon rimac*.

The egg is 3 mm long and 0.5 mm wide and glossy white when first laid. It is fastened by a mucilaginous substance at almost any point on the host larva. In one or two instances it was found adhering to the borer by only a small portion of the ventral face, the remainder of the egg protruding beyond the body of the borer.

Immediately after hatching the larvae move about over the body of the borer and soon start feeding, usually feeding at the same point until fully developed. It was noticed that a large proportion of the parasite larvae fed at the lateral and ventral areas of the host between the fifth and sixth segments, though the egg may have been placed between the legs or even dorsally.

On April 14 a mass of silk was found in a vial containing a borer on which an Ipobracon egg had been laid on March 31. The Ipobracon larva had unsuccessfully tried to spin a cocoon. By April 19 a white pupa was formed and on May 8 an adult male emerged. This particular individual required 38 days from deposition of the egg to the time of emergence, but earlier in the season, under the higher temperatures of January, the time required for development was usually much shorter. In these experiments the borer tunnels were not disturbed until the parasite cocoon had been formed. In January it required 8 or 9 days from the time the egg was laid until the cocoon was formed, and the cocoon period was from 11 to 14 days.

Thus there was a total period of from 19 to 23 days from oviposition to emergence, when the mean temperature of the period was 80.2° F.

The adult females of *Ipobracon rimac* are 10 to 11 mm in length and the males are somewhat smaller. They are shining black, with the anterior three fourths of the abdomen dark red. The length of the ovipositor is slightly less than that of the body.

BASSUS STIGMATERUS (CRESS.)

The wasp *Bassus stigmaterus* was found in very small numbers in Argentina, but in Peru it was more numerous, though never very abundant. It is a delicate species, both in the adult and in the cocoon stage. During the first season in Argentina 111 cocoons of this species were shipped to the United States, and the next year only 16 cocoons, while none were sent from Peru.

A cornfield was examined on December 10, 1931, near Chiclayo, Peru, and from a few of the cornstalks the following borer and parasite material was obtained from an original borer population of 72—40 apparently healthy borers, 7 borer pupae, 8 borers showing signs of parasitization by the fly *Paratheresia claripalpis*, 13 fly puparia, 1 Ipobracon cocoon, and 3 Bassus cocoons. Later 4 additional Bassus females emerged from these borers. In this total of 72 hosts, therefore, there was 9.7 percent parasitization by Bassus. This parasitization, which was the highest found, occurred at the warmest season of the year, when this species appears to be most numerous. Among the 8 borers showing the funnel of the fly parasite *P. claripalpis* on December 10, one produced a Bassus cocoon by December 27; from this cocoon a female emerged on January 4. In this single case of apparently multiple parasitization the Bassus proved to be the stronger. However, the fly is regarded as a much more effective parasite, and instances of multiple parasitization are very rare, owing to the limited number of the wasps.

LIFE HISTORY

During November and the early part of December 1930 over 600 borers were collected from corn near Trujillo. After being carefully examined for signs of parasitization, they were inserted in pieces of cane in a cage and later examined from time to time. The live borers found on splitting the cane were reinserted in fresh cane. From these borers 6 female Bassus later emerged. One of these Bassus larvae was in the borer at least 8 days and another at least 18 days without the host showing any visible sign of parasitization. In both instances the cocoon of the parasite was formed only 6 days later. The length of time spent in the cocoon ranges from a week to 10 days.

Bassus stigmaterus makes a cocoon decidedly different from that of Ipobracon. It is thin, a transparent grayish-white, about 16 mm long and 4 mm in diameter, and tapers to pointed ends. It is extremely delicate and is difficult to handle without injuring the contents, whereas the Ipobracon cocoon is comparatively strong and not injured by handling.

The female Bassus is about 9 mm in length and dark red. The body is much more slender than that of the Ipobracon and the ovi-

positor is longer than the body. No males of this species were reared or collected.

In Argentina this species passes the winter months in the first larval instar within the host borer. It is readily seen that the duration of this instar is the most variable and depends largely on the season of the year. The later larval instar periods and the pupal period within the cocoon are very short.

TELENOMUS (PROPHANURUS) ALECTO CWFD.

The egg parasite *Telenomus alecto* was not found in the Province of Tucuman, though collections of egg clusters were made in search of it during the seasons of 1928–29 and 1929–30. Box (*2*) has reported finding it in the Province on only one occasion. However, it was found to be present in fairly large numbers at Guemes, in the adjoining Province of Salta.

Between February 18 and 21, 1929, collections of egg clusters were made at Guemes, and 190 egg clusters were obtained in 9 hours. Only five scars were found on leaves indicating where egg clusters had been washed off, and no cluster was found that was not parasitized at least in part. The failure to find unparasitized clusters may have been due to the fact that because of their light color they were considerably harder to discern on the leaves than were the parasitized eggs, which are black. In this lot of 1,709 eggs were 943 parasitized eggs in apparently good condition, 742 parasitized eggs from which the parasite had emerged, and 24 eggs not parasitized. The parasitized eggs included those attacked either by Trichogramma or by Telenomus.

One hundred of these clusters obtained in Guemes were examined on February 26, and each cluster was placed in a small vial and held for emergence. There were 141 eggs from which parasites had emerged and 745 eggs which still contained parasites. From this material there emerged over 1,000 adults of *Trichogramma minutum* and 75 of *Telenomus alecto*.

After emergence four or five Telenomus individuals were placed in a small glass vial with cane-borer eggs which had been laid upon paper. Fresh borer eggs were supplied on alternate days. No mating was observed, but oviposition took place, and later some of the eggs turned black. Upon dissection, each dark-colored egg was found to contain one parasite. However, the writer succeeded in obtaining only one adult from these eggs. This adult emerged on March 18 from a borer egg in which the parasite oviposited between February 27 and March 2, thus requiring between 16 and 19 days from the time of oviposition to the emergence of the adult, which is considerably longer than the time required for Trichogramma. On March 17, 36 black eggs were sent to New Orleans. Later, on May 13, 108 clusters were forwarded, 95 collected in Guemes and 13 in Tucuman. The majority of these were parasitized by Trichogramma, but a few appeared to be parasitized by Telenomus. No Telenomus adults were obtained from this material, but Trichogramma emerged, showing that they at least were not killed by the cold storage en route.

In 1930 a few parasitized eggs were seen in Guemes about the middle of February, but collections were not made until the first

week in March. All the clusters obtained were examined under a binocular in order to separate those parasitized by Telenomus from those parasitized by Trichogramma. In table 2 are given the results of these examinations. In 520 clusters, containing 5,118 eggs, 72.5 percent were parasitized by Trichogramma and 26.3 percent by Telenomus.

TABLE 2.—*Relative parasitization of eggs of Diatraea saccharalis by Trichogramma minutum and by Telenomus alecto, Guemes, Argentina, 1930*

Species	Eggs examined	Unparasitized eggs		Parasitized eggs			
				Already emerged	Not yet emerged	Total	
	Number	*Number*	*Percent*	*Number*	*Number*	*Number*	*Percent*
Trichogramma minutum				1,530	2,182	3,712	72.5
Telenomus alecto				451	893	1,344	26.3
Total	5,118	62	1.2	1,981	3,075	5,056	98.8

From this material 80 clusters, containing 611 eggs parasitized by Telenomus, were sent by airplane from Buenos Aires to New Orleans on March 11. A few parasites emerged from this shipment, but did not oviposit on the borer eggs furnished to them. Adults emerged from the eggs retained at Tucuman for rearing work, but they failed to oviposit, though they were kept under the same conditions as those of the previous year, when oviposition did occur.

Later, during the first week of April, 1930, when a large number of parasitized egg clusters were examined at Guemes, not one was found to be parasitized by Telenomus. This species apparently reaches its peak of abundance about the middle of the growing season, much sooner than Trichogramma. That more are not found later may be due to the rapid increase of Trichogramma towards the end of the season.

Telenomus is much larger than Trichogramma and only one individual emerges from a single Diatraea egg, whereas three or more Trichogramma usually emerge from one Diatraea egg.

Telenomus was found most numerous in Guemes, where *Diatraea dyari* Box was the prevalent host species. This host is much larger than *D. saccharalis*, and it may be that the eggs of the latter are somewhat too small to provide sufficient food for Telenomus. This may explain why the parasite is not more abundant where *D. saccharalis* occurs alone.

During the last half of January and the first week in February 1931 some 15,000 Diatraea egg clusters were collected in Peru in the search for *Telenomus alecto*. Of this number 4,634 were collected around Trujillo, 4,047 at Cartavio, 4,770 near Chiclayo, and 1,622 near Cayalti. The majority contained parasitized eggs from which the parasites had not emerged, as the collectors were instructed not to bring in dried-up or emerged clusters. From these egg clusters thousands of *Trichogramma minutum* emerged, but not a single Telenomus.

Telenomus alecto also occurs in British Guiana, Barbados, Trinidad, St. Vincent, Santa Lucia, and Puerto Rico.

TRICHOGRAMMA MINUTUM RILEY

The familiar egg parasite *Trichogramma minutum* was found to be present in both Argentina and Peru, but no special studies of it were made.

It was noticed in Argentina that the parasitization varied considerably in different sections during the same year and also from one year to another. During the first season Trichogramma was very scarce in Tucuman. Twelve egg clusters were found on February 24, 1929. One cluster had been parasitized by Trichogramma and the parasites had emerged, borer larvae had emerged from 5 clusters, and the remaining 6 contained larvae ready to hatch. That season it was abundant at Guemes, whereas during the following season it was abundant in both localities. The percentage of parasitization was highest toward the end of the growing season.

In Peru it is usually very abundant in older cane, and the percentage of parasitization is very high, but in young cane it is usually scarce.

Normally 3 or more Trichogramma emerge from 1 Diatraea egg. In one case 14 were reared from 2 eggs of the borer.

APANTELES XANTHOPUS (ASHM.)

A number of small white Apanteles cocoons were found in splitting open cornstalks in Tucumán for borer parasites. More of these were found during the last of March and the first of April than at any other time, and the majority of the cocoons were empty. Only one cocoon was found in each tunnel, and this tunnel was usually very small and very close to the side of the stalk. This would indicate that the parasite attacks the very small borers shortly after they eat into the stalk, or possibly even before they actually enter it.

A few live pupae in cocoons were found, and from one collected on March 28, 1929, a female emerged the next day. One collected on May 31 also produced a female some time later. These adults were determined by R. A. Cushman to be *Apanteles xanthopus* (Ashm.)

NEMATODA

Five specimens of mermithids obtained from Diatraea borers cut from corn in Tucumán were sent to Washington for and identified by G. Steiner as *Hexamermis microamphidis* Steiner.

Four of these mermithids were found on February 5, 1929, in cane that had previously been infested with borers obtained from corn. The fifth was obtained on January 16, 1929, from a borer that was found in corn on January 9. Only 7 parasitic worms were found in more than 3,000 borers removed from corn and held for observation. It is evident that the percentage of parasitization by this species is very low.

FUNGI

Dead borers entirely covered with a white fungus were found in cane and corn in Argentina. Specimens of these fungi were submitted to Washington for identification. Vera K. Charles, of the Bureau of Plant Industry, stated that two species of fungi were present, but a species of Botrytis tentatively identified as *Botrytis*

delacroixii Sacc. (family Mucedineae) seemed to be the predominant one.

Some borers that appeared to be healthy and had been placed in cane developed a fungus disease. This fungus was later identified as *Mucor botryoides* Lendner (family Mucoraceae) by Miss Charles, who stated: "This species, or varieties of it, have been reported as parasitic, but this is our first experience with it on this host, and therefore especially interesting."

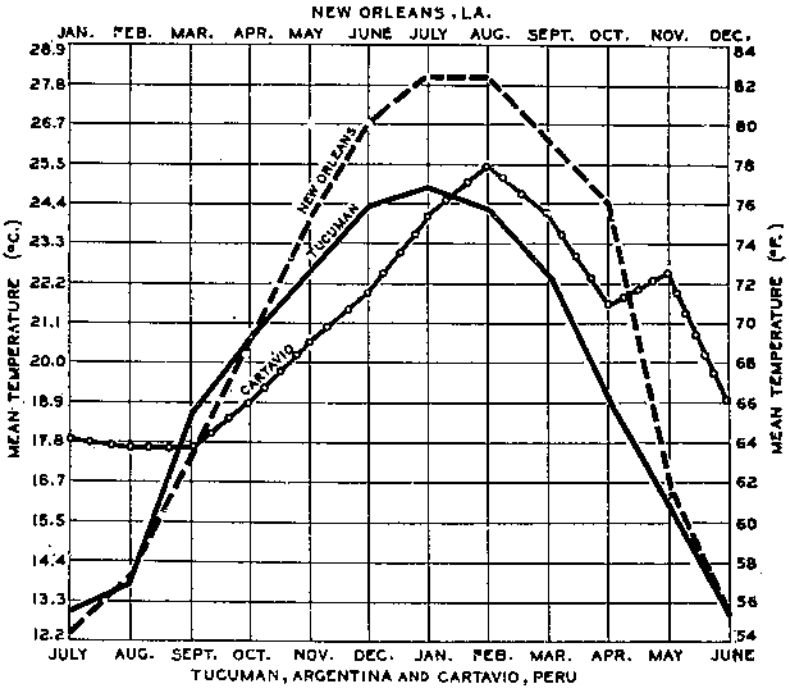

FIGURE 9.—Mean monthly temperatures at Tucuman, Argentina, Cartavio, Peru, and New Orleans, La. Temperatures recorded for 10 years at Tucuman and Cartavio and for 60 years at New Orleans.

The percentage of borers showing fungous attack was very small, but when weather conditions are suitable such attacks may help considerably in reducing the borer infestation.

CLIMATIC CONDITIONS IN THE MAIN FIELDS OF INVESTIGATION

In comparing the monthly mean temperatures (fig. 9) of Tucuman, Argentina, Cartavio, Peru, and New Orleans, La., as shown in records covering a long period of years, it is seen that New Orleans has a mean of 82.4° F. for its hottest month (July), while the mean for Tucuman's hottest month (January) is only 76.8°, or 5.6° less. For the coldest month New Orleans has a mean of 54.5°, which is 0.9° colder than the mean for Tucuman. However, in comparing the extreme temperatures of these two places, Tucuman records 111°, while New Orleans records only 102°. In winter New Orleans is several degrees colder than Tucuman, sometimes as low as

20° and on very rare occasions still lower, while Tucuman seldom reaches a temperature lower than 26°. Cartavio, Peru, with 77.9° as its mean for the hottest month (August), is intermediate between New Orleans and Tucuman, being 1° warmer than the latter; however, it never reaches the extremely high temperatures of Tucuman, the maximum being 100°. The mean temperature for the coolest month in Cartavio is 63.6°, which is some 9° higher than that for New Orleans. The freezing point is never reached in Trujillo, Peru, the recorded minimum being 46°.

New Orleans has a more or less even rainfall through the year, with an average of 4.7 inches per month. The warmer months of June, July, and August show a slight increase over the winter

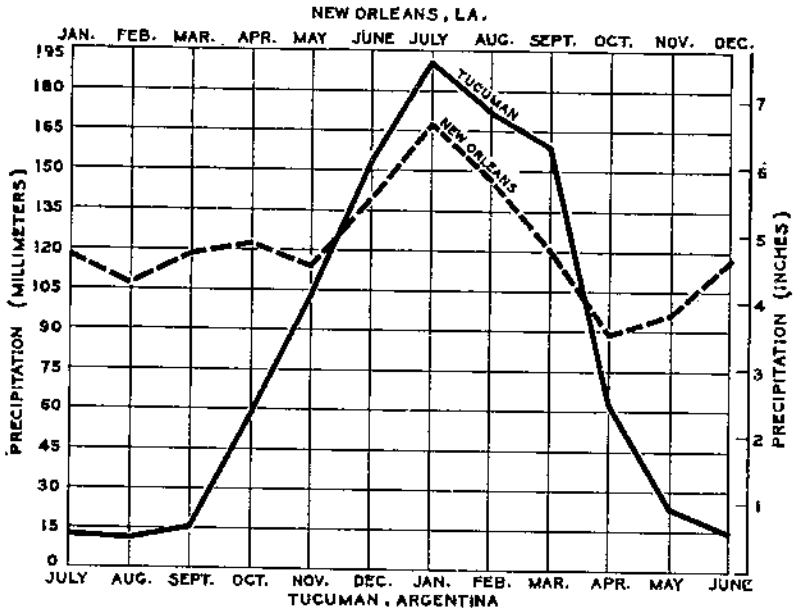

FIGURE 10.—Curves comparing the seasonal mean monthly precipitation at Tucuman, Argentina, with that at New Orleans, La. Precipitation recorded for 34 years at Tucuman and 83 years at New Orleans.

months. The average total rainfall per year (average for a period of 83 years) is 57.3 inches.

In Tucuman there are distinct wet and dry seasons, with approximately four fifths of the rainfall for the entire year occurring during the warm months from November to March, inclusive. From May to September, inclusive, the average rainfall is only one half inch per month. The average rainfall per year (average covering a period of 34 years) is 38.4 inches, which is 19 inches less than the average at New Orleans (fig. 10).

The coastal district of Peru is said to be rainless, though there is a slight precipitation occasionally. Heavy mists often occur, and the air is humid rather than arid. No records showing the relative humidity are available for comparison with records of the other stations under consideration.

AGRICULTURAL PRACTICES IN THE SUGARCANE DISTRICTS OF ARGENTINA AND PERU

The agricultural practices used in growing and handling the sugarcane crop in Peru and Argentina differ very greatly, largely because of climatic conditions.

The length of the growing season in Argentina is similar to the length of that in Louisiana, about 7 months; in both there is a nongrowing period due to low temperatures. The Argentine grinding season usually lasts about four months, beginning the middle of May or the first part of June, and extending into September or October, at which time the heavy rains begin, and the roads become impassable for the heavy 2-wheeled carts used to carry the cane from the field to the mill. In Argentina the cane is cut "white" or unburned, stripped, and topped, and later the trash is burned. In the northern portion of the cane-growing section irrigation is largely practiced, but farther south less irrigation is used, and the crop there is dependent on the actual rainfall.

In Peru the growing season is continuous, as the temperature never reaches the freezing point. However, the cane grows very little during the cool season and requires from 14 to 20 months to mature. The grinding season also is continuous, and the mills shut down only for necessary repairs. Here the cane is "fired" to eliminate the work of stripping. It is then cut and topped, and loaded on railroad cars which are run into the fields on portable tracks. Sugarcane culture is entirely dependent on irrigation from the rivers, which have their sources in the mountains; no rain falls in the cane-producing section. Cane, as well as all other crops in the coastal region of Peru, is grown only in the valleys through which water comes down from the mountains.

In Argentina practically no use is made of commercial fertilizers, whereas in Peru a very large quantity of guano is used. The varieties of cane grown in Peru, the soft kinds such as Bourbon, Cristalina, and Caledonia, appear to be more extensively attacked by the borer than do the hard P.O.J. 36 and 213 varieties grown in Argentina. It is also thought that in some cases in Peru an excess of fertilizer and water has made the cane softer and thus more readily damaged by the borer.

SUMMARY

Eleven species of parasites, including a nematode and two fungi, were found attacking the sugarcane borer (*Diatraea saccharalis*) in Argentina and Peru. The insects include 2 species of flies (1 dexiid and 1 tachinid) and 6 species of wasps (4 braconids, 1 trichogrammatid, and 1 scelionid).

The dexiid fly *Paratheresia claripalpis* is the most common parasite, both in Argentina and Peru. It has several generations a year in both countries, and the parasitization in the young cane (dead hearts) was found to range from 2 to 74 percent, with an average of about 32 percent. The percentage of parasitization in the older cane was found to be considerably lower. The climatic conditions under which this species lives in Argentina are similar to those of Louisiana. A total of 637,063 puparia were shipped from

Argentina and Peru during the three seasons. Ten secondary parasites were encountered.

The tachinid *Leskiomima jaynesi* was found only in Tucuman, Argentina, and in very small numbers. It appears to be localized, and not enough specimens were obtainable for study or shipment. Its life history is apparently similar to that of *P. claripalpis*.

Two species of Ipobracon were found to be parasitic upon Diatraea larvae; *I. tucumanus* in Argentina, of which 421 cocoons and 235 adult females were shipped during the first two seasons, and *I. rimac* in Peru, of which 59,632 adult females were shipped during the three seasons. Although *I. rimac* was present in large numbers in the cane fields, it never caused great parasitization.

Bassus stigmaterus was found in small numbers in both Argentina and Peru and only during the warmest months. On one occasion parasitization by this species was found to attain 9.7 percent. Only 127 cocoons of this species were shipped from Argentina during the first two seasons.

A scelionid, *Telenomus clecto*, was found in fairly large numbers, but only in the Province of Salta, Argentina, where *Diatraea dyari* occurs. This parasite will attack eggs of *D. saccharalis* and develop in them, but it was not found in eggs collected in localities where only *D. saccharalis* occurs. In 1929, 36 Diatraea eggs parasitized by this species in the laboratory and 108 field-collected parasitized egg clusters were sent to New Orleans. In 1930, 80 field-collected clusters containing 611 eggs parasitized by this species were sent by airplane.

Trichogramma minutum occurs in both Argentina and Peru and is quite effective, although it does not accomplish a high degree of parasitization until the latter part of the season, which is also true of this parasite in Louisiana.

Only two adults of *Apanteles xanthopus* were reared from cocoons found in small borer tunnels.

A few of the nematodes *Hexamermis microamphidis* were reared from borers in Argentina. The percentage of parasitization was extremely small.

Two fungi were found, *Botrytis delacroixii* and *Mucor botryoides*, but both are apparently of minor importance. No special effort was made to ship borers covered with fungus other than those sent for identification.

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