A Thesis Entitled,

THE DISTRIBUTION AND ECONOMIC STATUS OF WEST INDIAN GRYLOLALPINAE.

Presented in partial fulfilment of the requirements for the Associateship of the Imperial College of Tropical Agriculture, Trinidad.

By

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The Economic Status of the Gryllotalpinae.

The family Gryllidae is separated from the remainder of the Orthoptera Saltatoria by the possession of three jointed tarsi and an excerted acicular ovipositor. The sub-family Gryllotalpinae is aberrent in respect that the ovipositor is concealed and the femora of the posterior legs are not markedly elongated while the prothorax and its appendages, the forelegs are strongly adapted to the burrowing habit of these insects.

Some eleven species of four genera have assumed the status of agricultural pests and found a place in the literature of economic entomology.

Gryllotalpa gryllotalpa. Linn.  
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(Vulgaris. Latreille.)

is the common mole cricket of Europe. Its range extends from Western Asia through North Africa and Europe to Southern England where it is now a comparatively rare insect and an object of interest only to the collector. In Trans-Caucasia it causes damage to tea and citrus; in some of the steppes of Russia it occurs in enormous numbers with resultant loss to the market gardener.

In Italy rice, wheat, oats, rye and maize are reported as suffering from its activities. Throughout France it is known as a pest of market garden produce.

From Europe the pest has been introduced to New Jersey where it is recorded as attacking root crops and tobacco by and damaging young birch trees by attacking the roots, young shoots and germinating seeds.
**Gryllotalpa unispina** is reported as a pest in Turkistan.

**Gryllotalpa africanæ** has a wide distribution throughout the Tropics and Sub-Tropics of Africa, Asia and Australia.

In **East Africa** it destroys seedlings of cacao, coffee, rice and sorghum. In Uganda where apparently the insect is eaten by the natives and esteemed a delicacy, hand collecting is said to be successful.

In **Nigeria** cotton seedlings suffer considerably and from **San Thome** it is reported as a pest in the cacao nursery.

In **India and Hawaii** it is a pest of seed cane and in **Java** tobacco suffers most severely from its depredations.

In **Queensland** maize seedlings are severely attacked

**Gryllotalpa hirsuta** a species of which the male is apterous and the female macropterous occurs as a pest of tobacco in **Java** and **Borneo**.

**Gryllotalpa hexadactyla** ranges throughout South and Central America and the West Indies. In the United States, where it is frequently recorded as **Gryllotalpa borealis** its distribution is wide. It feeds on the roots of various plants but does not figure as a pest of any importance presumably because soil-dwelling insects compose a considerable proportion of its diet.

**Scapteriscus vicinis** is a species of the Neo Tropics and Sub-Tropics and is very destructive in **Porto Rico**.
Scapteriscus didactylus occurs in Mexico, the West Indies and Central and South America. There seems little doubt that it has frequently been confused with vicinis and that the distribution of the two species overlaps. Its distribution and economic importance will be further discussed.

Scapteriscus variegatus occurs in Columbia, Trinidad and Honduras (Catalogue of Orthoptera. B.M.) as an occasional pest.

Scapteriscus abbreviatus is recorded from Pernambuco.

Schizodactylus Monstrosus occurs commonly in Bengal, throughout India, Egypt and the Sudan. It is recorded as a pest of cotton and tobacco.

Brachytrypes membranaceus is found in East and West Africa and in French West Africa damages young cotton plants.
The Gryllotalpinae of the West Indies.

There seems in the past to have been considerable doubt as to the specific designation of the West Indian mole cricket. Rhen and Hebard are of opinion that the common species of the South Eastern United States, the West Indies and South America "which has been frequently recorded as Scapteriscus didactylus represents instead vicinis of Scudder."


According to Scudder's description (Memoirs, Peabody acad. Sci. Vol.1 no.1.) "the pronotum (of S. Vicinis) is proportionately shorter and stouter than in S. didactylus. The anterior portion of the lower edge of the fore femora has a deep angulated incision. . . . . . The tibial dactyls are parallel, approximated and separated at the base by a scarcely perceptible space."

The tibial dactyls of S. didactylus on the other hand, are separated at the base by at least one half the width of the dactyls.

Moreover the tegminal venation of S. didactylus differs entirely from that of S. vicinis as figured by Scudder.

On these characteristic, the mole cricket of the genus Scapteriscus prevalent throughout Trinidad may be identified as Scapteriscus didactylus of Scudder, and specimens submitted to the Imperial Bureau of Entomology have been identified as such. No specimen examined by the writer could be referred to the species vicinis.
The species is very abundant in Trinidad and records of its occurrence in the other islands of the Lesser Antilles are as follows.

Grenada and Barbados. There is no record of the occurrence of the species in these islands though their insect faunas have been thoroughly investigated.

St. Vincent. Brunner and Wattenwyl (Proc. Zoo. Soc. 1892) record the species from this island. The writer has taken a few specimens at light and the species is well represented from St. Vincent in the collection of the Imperial College of Tropical Agriculture.

St. Lucia. The collection of the Imperial College contains records of this insect from St. Lucia.

British Guiana. The writer has found the species represented in a collection of local insects examined at Berbice Estate, British Guiana.

A second species of mole cricket of the genus Gryllotalpa is common throughout Trinidad though not so abundant as Scapteriscus didactylus and certainly of less economic importance. This species is Gryllotalpa hexadactyla Latreille. It is widely distributed throughout the islands of the Lesser Antilles.


In the collection of the Imperial College, Trinidad, the species is recorded from Barbados, St. Vincent, St. Lucia and Montserrat. The writer has taken it in British Guiana.

A third species Scapteriscus Variegatus. (Burmiester) has apparently been recorded from Trinidad (Kirby -synonymic catalogue of Orthoptera. B.M. Vol.II).
This is the only record of its occurrence available and the species has not been taken by the writer.

The species is represented in the Imperial College Collection from the islands of St. Kitts and Dominica.

Ballou records it from Barbados (Rehn - West Indian Bulletin Vol. 7.)

Description of Scapteriscus didactylus.

The head and its appendages.

The head (Fig. 1) is an elongated capsule measuring some 9 m.m. in length from the occiput to the apex of the Clypeus and some 4 m.m. in greatest breadth, the line of greatest breadth occurring at approximately half the distance from the vertex to the posterior suture of the post Clypeus. The median and lateral arms of the epicranial suture are strongly developed, the latter extending to the antennal sclerites and completely enclosing the frons. The Clypeus is separated from the frons by a well marked suture and is completely divided by a transverse suture into two sclerites, the post Clypeus and the Clypeus.

The antennae are filiform, measure some 12 m.m. in the adult and contain 76 to 80 joints.

The compound eyes are reniform and comparatively small while the vertex bears two large hyaline hyaline ocelli above and between the eyes.

The labrum (Fig. 2.) is large, approximately 2 m.m. in greatest length and breadth, light brown in colour, darker towards the base with a median line dark brown in colour. Two lateral membranous areas are present. The somewhat thickened edges are setiferous, and six pairs of setae are arranged on either side of the median line. On the under side
the position of the median line is occupied by a raised chitinized fold possibly representing the epipharynx. The labrum extends downwards to cover the tips of the mandibles

The mandibles (Fig.3). Ventrally the mandible articulates by means of a rounded condyle with a concave process of the post gena while on the dorsal surface a pit with somewhat raised edges receives a convex process of the post Clypeus. The mandibles are operated by powerful and firmly attached adductor and abductor muscles. They are adapted for cutting and crushing, bearing five bluntly pointed teeth and a basal molar surface. The tips of the area mandibles, the teeth and molar are black and heavily chitinized while the remained is light brown in colour.

The maxillae (Fig.4) The cardo is firmly attached to the head capsule. The stripes bears a large outer palpifer and is further divided into three apparent Sclerites which separate readily along the sutures. The inner sclerite is the sub - galea or parastipes present in many orthoptera and the remaining two sclerites are formed by the division of the stipes consequent on the coincidence of the inner sutures of the subgalea and palpifer. This is indicated by examples observed in which these sutures did not coincide, the stipes forming one continuous sclerite with a median constriction. Intermediate cases were also noted.

The lacinia averages some 3 m.m. in length, is highly chitinized and setiferous along its inner margin and bears three sharply pointed teeth. The galea is more lightly chitinized, spatulate, slightly setiferous and of the same length as the lacinia which it overlaps.
The maxillary palpus consists of 5 joints. The two basal joints are small measuring together about 1 m.m.; the 3 proximal joints are approximately equal in length averaging about 1.5 m.m., the last broadly rounded at its apex.

The labium or second maxillae. (Fig. 5.)

The submentum is large, some 2.5 m.m. in length and 2.2 m.m. broad, forming a considerable portion of the floor of the head capsule (Fig. 6.) The mentum and prementum are well developed, the former measuring 8 m.m. \( \times 1.7 \) m.m. The paired glossae are dark and highly chitinized at the tip while the paraglossae bear long setae. The labial palpi consists of 3 joints, the basal joint \( 2/3 \) of the length of the second and third joints which are approximately equal. The third joint is bluntly rounded and pale in colour at the tip.

The hypopharynx (Fig. 7) is represented by a median fleshy process closely approximated to the dorsal surface of the mentum and pre-mentum. Two lateral chitinized areas (see Fig.) suggest vestiges of the superfliciae.

The tentorium (Fig. 8.) is relatively simple consisting of a median chitinized plate, the body of the tentorium, a pair of anterior arms originating at the clypieo - frontal suture and a pair of posterior arms originating just above the suture of the cardo. The dorsal arms are not developed.

The Thorax.

The prothorax is sub-ovate, convex, in colour testaceous above with irregular fuscous markings. Normally a light median line is visible with a rectangular fuscous area on either side, basally. Average of measurements for 20 adult \( \Phi \Phi \) gives a pronotal length of 8.1 m.m. and a breadth of 7.5 m.m.
The mesothorax is concealed by the overlapping of the prothoracic shield and notum and pleurae of the metathorax are covered with a fine fulvous pubescens.

The closed tegmina and the folded wings completely cover the metanotum.

The tegmina are leathery, testaceous and heavily veined. The left tegmen overlaps the right. The venation differs with the sexes but shows no individual variation. The longitudinal veins are fuscous and heavily marked, the transverse veins not so pronounced. In both sexes the 8th longitudinal vein is incomplete. The venation of both sexes of Scapteriscus didactylus is figured (Fig. 9.). The tegmina terminate about the posterior suture of the 6th abdominal segment and cover rather less than 2/3 of the abdomen.

The wings are delicate and membraneous with a complex venation. They are folded fan-wise, the rolled tips extending beyond the abdomen almost to the tips of the cerci.

The prothoracic legs. (Fig. 10). The coxa is short and stout, the trochanter long, almost equal in length to the femur, its anterior part spatulate with dark and heavily chitinized cutting edges. The femur is short and broad, its greatest breadth rather more than 2/3 its greatest length.

The tibia are short bearing two long tibial dactyles, dark, heavily chitinized and bluntly pointed, separated at the base by a space approximately equal to half the breadth of the dactyl at the base.

The tympanum is located on the upper surface of the inner aspect of the tibia and is exposed, a generic character of Scapteriscus.
The tarsus articulates with the tibia by means of a movable joint. The dactyrs of the tarsus are two in number, cultrate, more sharply pointed than those of the tibia the second about 2/3 the length of the first. The terminal joint of the tarsus is short, spinous and bears 2 long acicular claws.

The mesothoracic legs are normal, coxae short, stout, femur unarmed; tibia with 3 stout spines at the apex, tarsus 3jointed, the third joint terminated by claws.

Mesthoracic legs. The coxae are short, femur somewhat elongated, blotched with testaceous, thickened but not strongly adapted for leaping. Tibia 2/3 length of femur, inner edge armed with 8 spines. Tarsus longer than tibia, 3rd joint dilated.

The Abdomen. Ten abdominal segments may be distinguished dorsally. The 10th, almost concealed by the 9th bears the cerci. These latter organs are unsegmented, some 7 m.m in length or about 1/3 the length of the abdomen and sparsely covered with long rufescent hairs.

Ventrally seven abdominal segments may be distinguished in the female and eight in the male. The 8th abdominal segment of the male is produced into a stout central tooth narrowing regularly throughout and docked at the tip.

The pleurae are well developed, light in colour and bear the eight spiracles. abdomen

The colour of the abdomen is fulvous - testaceous above and dull fulvous beneath.
The Alimentary canal. The oesophagus is normal, long and narrow; proventriculus large, dilated, connecting with oesophagus laterally by means of a narrow channel; ventriculus with 6 chitinous teeth; hepatic ceca 2" in number.

Malpighian tubules very numerous uniting to form a single renal tube which enters the mesenteron, a characteristic common to the Gryllotalpinae.

The Ovary (Fig.11) is a compact organ composed of 10-12 panoistic ovarioles united by means of their terminal filaments which in turn are attached to the body wall.

Each oviduct bifurcates forming two short lateral branches into which the ovarian tubules open.
Description of Gryllotalpa hexadactyla.

The second species of mole cricket which occurs (Plate I) in Trinidad and the West Indies is a smaller insect, less heavily built and possesses markedly longer anal cerci.

The length of a well grown specimen is about 2.7 mm, pronotal length 7.9 mm., breadth 6.1 mm., length of cerci 12.5 mm.

The genus gryllotalpa is readily separated from Sapteriscus by the presence of four dactyls on the tibia of the fore legs. Moreover the tympanum is concealed and is represented externally merely by an elongated narrow slit. The trochanter of the fore leg is short and rounded (Fig. 12).

Head dark brown or black in colour, compound eyes and hyaline ocelli present, epicranial suture not readily distinguishable. Antennae inserted at base of compound eyes, 12 mm. in length and composed of 110 joints. Labrum black, Clypeus mottled.

Mouth parts similar to those of S. didactylus Prothorax finely pubescent with irregular dark markings and light median line. Tegmina extending to posterior margin of 3rd abdominal segment.

The plaits of the folded wings extending beyond the abdomen.

Sapteriscus variagatus. (Burmester.)

The third species is readily distinguished by the fact that the wings are shorter than the tegmina. The tegmina cover half of the abdomen and this distinguishes the species from Sapteriscus Abbreviatus of Scudder in which the tegmina cover less than half of the abdomen.
Life History of Scapteriscus didactylus.

The Gryllotalpinae are soil living insects, and Scapteriscus is well adapted to this mode of life. It constructs galleries which ramify in all directions and at various depths in the soil.

In the wet season these are constructed just below the surface and their progress can be traced by the breaking of the soil. Even in the wet season the burrows may penetrate to a depth of 8 inches and in the dry season the crickets probably go considerably deeper than this in their search for moisture.

Flights of the insects occur in October, November and December. They are strongly attracted towards light and become noticeable at this time by invading houses.

The number of flights noted during the months October to March are shown below.

<table>
<thead>
<tr>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
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<td>7</td>
<td>8</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>0</td>
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</tbody>
</table>

Flight apparently follows a shower in the afternoon and usually takes place on overcast evenings invariably between the hours of seven and ten.

So far no efforts have been made to explain the meaning of the flight period but it is not improbably associated with mating. Examination of 22 captures at light showed 12♂♂ and 10♀♀ indicating an approximately equal number of each sex in the flight.

During December the first and last females of five flights to enter a room, attracted by light were taken and the spermathecae examined. Of the five which entered at the beginning of the flight none had been fertilized while of the five which entered at the end of the flight 3 had been fertilized. These figures are indicative but far from conclusive.
Egg laying. From December till April adult females were kept in cages 24" x 8" x 1½" provided with glass tops and bottoms and covered with dark cloths. The soil in the cages was kept moist while sprouted corn and sliced sweet potato were provided for food.

It was endeavoured to keep an adult of each sex in a cage but this invariably resulted in the violent death of at least one of them in a few days. Even in a cage of these dimensions when two meet in the middle of a burrow they apparently fight until one succumbs.

Mites proved a serious difficulty, it being difficult to keep the cages free of them.

From time to time the soil in the cages was carefully examined for eggs.

None were obtained until February.

On February 1st it was found that in one cage containing a single female a small chamber had been constructed in a corner of the cage and 6" below the surface. The chamber was about 2" in diameter, roughly spherical and forming a blind pocket from the burrow. It contained one egg. Within 2 days 10 more eggs were laid by this female but these were scattered throughout the soil.

These were the only eggs obtained and they failed to hatch.

The eggs measured 3.1 m.m by 1.8 m.m., oval in shape, light grey and with a smooth surface. They gradually changed colour, becoming yellow, made no growth and four days after oviposition they were found to have shrivelled up completely in spite of being kept under moist conditions.

The preoviposition period is long, probably at least 2 months. Thus the female which oviposited on February 1st was captured at light on October 29th. Van ZwalUwenburg gives the period for S. vicenis as 79 days (Bull. 23, Porto Rico Agric. Sta.) and the period for didactylus would appear to be similar.
The Nymph. Right definite instars have been found. Work was commenced at a period when it was impossible to obtain eggs and nymphs were taken from the field. The youngest nymph obtained proved to belong to the 4th instar, all others taken in the field from October to April belonged to the 5th instar or above.

It has therefore been possible to commence rearing only from the 4th instar and from this stage five moults have been observed, the 5th disclosing the adult insect.

The 4th instar nymph (fig. 13) has a total length of 17.5 m.m. The pronotum measures 4.9 m.m. in length and 3.9 m.m. in breadth, while the head breadth at its junction with the thorax is 3 m.m. The head and prothorax are testaceous. The ocelli are obvious as elongate hyaline raised areas but the cephalic sutures are not yet marked. The position of the future wing pads is indicated by slightly raised areas on the meso and metathorax. Ten abdominal segments may be distinguished dorsally and seven ventrally, the 10th bearing the cerci. The autennae have 83 joints.

The mouth parts are essentially similar to those of the adult.

The fore limbs are not so well developed as in the adult but in this stage the tarsus articulates movably with the femur, the dactylus of both acting together as cutting organs. (fig. 13)

Ten days after capture the 4th instar specimen moulted and with others of the 5th instar taken in the field was reared to the adult stage.

The 5th Instar.

The 5th instar nymph has a length of 20.2 m.m. (average of 10 measurements), a head breadth of 3.6 m.m., while the pronotum measures 6.5 m.m. by 4.9 m.m.
Beyond the increase in size this instar resembles the previous one except in the slightly greater development of the raised areas representing the future wing pads.

The time occupied in completing the instar was 27 days, moulting taking place, as in all cases, during the night. In moulting the whole covering is shed, even the insect chitinous sheath of mouth parts and claws, the emerging from the cast skin by way of a dorsal split extending from the front of the prothoracic shield to the region of the 3rd abdominal segment.

The 6th Instar.

After the 5th moult the nymph attains a length of about 23.0 m.m. and the wing pads are disclosed (Plate 2).

The wing pads are of the same testaceous colour as the body with a lighter central and a darker basal area. Venation is represented by numerous longitudinal fuscous lines. At this stage the sexes are first distinguishable, the toothed 8th abdominal segment of the male becoming visible.

In five specimens reared through the instar the minimum duration was 25 days, maximum 40 days and average 33 days.

The 7th Instar. (Plate 3)

The 7th instar nymph measures 24-27 m.m. in length. The wing pads attain a length of 4.5 m.m. and 6.1 m.m. respectively. The ocelli are well developed and the lateral arms of the epieranal suture visible. Duration 38 days.

The 8th Instar.

The 8th instar nymph (Plate 3) varies from 26-31 m.m. The wing pads are now well developed, the first extending to the posterior suture of the 1st Abdominal segment and the 2nd extending to the posterior limit of the 3rd abdominal/
abdominal segment.

The epicranial sutures are well developed and the forelegs have attained a degree of adaptation only slightly less than that of the adult. Duration of 8th instar 41 days.

Apart from one 1st instar nymph taken in the field during October no stages below the 4th were taken until May. During May and June the lower instars could be obtained in considerable numbers.

All captures were carefully measured and in this way the eight instars could be readily distinguished. Within the instar the total body length varied considerably, the pronotal measurements slightly but the width of the head at its junction with the pronotum was found to be relatively constant, increasing in a regular geometric progression.

The average ratio of increase of the head breadth measure may be obtained by dividing the measure for the 2nd instar by that for the 1st, continuing to divide each measure by the one preceding it, adding the resultant ratios and dividing by the number of measures.

In the table below the actual head breadth measures, the average ratio of increase and the head measures calculated by means of this factor are shown.
### Actual Measurements

<table>
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<th>Number of Measurements</th>
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<th>Wing Pads</th>
<th>Pronotum Length</th>
<th>Breadth</th>
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<td>-</td>
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<td>-</td>
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### Calculated Measurements

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<th>3.0 m.m.</th>
<th>3.6 m.m.</th>
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<th>4.4 m.m.</th>
<th>5.4 m.m.</th>
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<tbody>
<tr>
<td>1st</td>
<td>1.7</td>
<td>(1.7 x 1.18) = 2.01</td>
<td>(2.01 x 1.18) = 2.37</td>
<td>(2.27 x 1.18) = 2.80</td>
<td>(2.80 x 1.18) = 3.38</td>
<td>(3.30 x 1.18) = 3.89</td>
<td>(3.89 x 1.18) = 4.59</td>
<td>(4.59 x 1.18) = 5.42</td>
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</table>

Average ratio of increase 1.18.

The approximation is sufficiently close to demonstrate that the measure increases as a geometric progression and to preclude the possibility of an instar having been overlooked.

Other measurements of the eight instars are shown below, expressed in millimetres.
Nature and extent of damage.

The species concerned as an agricultural pest is *Scapteriscus didactylus* though *Gryllotalpa hexadactyla* appears to be instrumental in the destruction of lawn grasses.

*Scapteriscus* is a plant feeder of catholic and indiscriminate taste. It attacks all grasses from the coarse indigenous savanna grass to Java grasses introduced for lawns.

Its depredations as a pest of lawns, golf greens and savannas are widespread. The grass becomes thinned and withered as a result of the pest destroying the roots.

In gardens further damage is caused by cutting off and devouring flower seedlings.

An allied species is reported as a serious pest of cane in Porto Rico where the young shoots may be cut off as soon as they grow out from the setts.

In Trinidad the mole cricket cannot be classed as a pest of cane probably because the bulk of this crop is grown on fairly heavy soil while the cricket prefers a loose and sandy soil.

It is recorded as a pest of rice in some places, but enquiry would indicate that it causes no damage to this crop either in Trinidad or British Guiana.

Cotton seedlings in the cotyledon stage have been found to suffer somewhat and material damage may be caused in the cacao nursery. Seedlings of maize, tomato, cabbage and lettuce are also attacked.
Control on Lawns.

Fumigation with carbon bisulphide and treatment with sodium silicofluoride have been tried. For this purpose an area measuring 40' x 22' was pegged out on an infested lawn. This was further divided into three plots, two outer ones measuring 40' x 8' and a middle one 6' x 40'.

The middle plot was kept as a control and the two outer plots treated, one with C S 2 and one with sodium silicofluoride. This was applied evenly over the area by means of a rotary fan duster. The dust burned the grass slightly. The application appeared to diminish the activity of the pests for a little but reinvasion followed rapidly and reinestation was complete within three days.

Carbon bisulphide emulsion at the rate of one part of the stock described below to 150 parts of water by volume was applied uniformly by means of a watering can, and the grass rolled with a light roller immediately after application. In this concentration no harm is done to the grass and the treatment results in a fairly satisfactory measure of control. The crickets apparently vacated the treated area or were killed by the C S 2. Six days after application burrows were observed around the edges of the treated plot and seven days later the burrows had invaded the area and were approaching its centre.

Twenty days after treatment the plot was completely reinested and showed no improvement on the control.

To be effective, therefore, this application of the emulsion on a small area would have to be repeated every three weeks.

An experiment carried out at the Royal Botanic Gardens, Trinidad in 1926 seems to indicate that when a large area is treated rapidly more permanent success may be expected.
The stock emulsion was made in the following way:

\[ \text{C S 2} \quad \text{250 cc.} \]
\[ \text{Soap} \quad \text{12.5 gms.} \]
\[ \text{Water} \quad \text{88 cc.} \]

The soap is dissolved in the water by boiling, the whole cooled, the C S 2 added and churned to make a uniform stable emulsion.

This was used at the rate of 1 part stock to 80 parts water by volume the treated area then being sprayed with three times this volume of clear water. The application was made by means of watering cans.

A preliminary test was made over a small area on January 5th. Next day the area was dug and four crickets taken, two dead and two alive, the live crickets succumbing within two days.

On January 7th the grass appeared slightly burned. A few mole cricket burrows were visible. On January 8th a greater number of burrows were visible indicating that the treatment does not prevent rapid reinfestation.

Between January 5th and 19th 45, 314 sq. feet were treated in 20 working hours. Sixty gallons of stock were used at the following cost.

\[ \text{Cost of Stock} \quad \$66.90 \]
\[ \text{" Labour} \quad \$6.24 \]
\[ \text{\underline{Total}} \quad \$73.14. \]

or about \$16 per 100 sq. feet.

The lethal effect was tested by treating an area of 80 sq. feet which was dug up and examined for crickets 24 hours later.

56 were found of which 29 were dead and had apparently been killed by the emulsion. 6 had been killed by a cordyceps fungus and 21 were alive and apparently healthy.

The emulsion burned the grass slightly but it rapidly recovered.
recovered.

The area showed a marked improvement in the condition of the grass after treatment.

This improved condition has been maintained and heavy reinfestation has not occurred within two years after treatment. Around the bandstand slight reinfestation occurs from time to time owing to the attraction of the lights.

It should, however, be noted that the soil treated contains a Cordyceps fungus which attacks and kills the mole cricket, and that climatic conditions have not been such as to favour reinfestation. Scapteriscus virginiensis has recently become a pest of golf courses in the coastal region of Alabama and North Carolina.

Thomas (Bull. U.S. Golf Assoc. Greens section, VI, No 9 pp 197-200, 1926) reports satisfactory results from the use of 1 part 75% commercial CS2 emulsion mixed with 400 parts of water and applied at the rate of 2 U.S. quarts per square foot. The cost is about £2 for one application to a green and gives 95% control for a month after which reinfestation begins.

Criddle mixture as a means of control has been favourably reported on from Grenada.

Plantation Seedlings.

The mole cricket causes occasional damage to cacao seedlings in the nursery, the insect chewing through the stem at ground level.

At River Estate, Trinidad, where the soil of the seed bed is very light and sandy as many as 60 seedlings have been eaten through in one night and a total loss of 40% is sometimes caused before the stems become sufficiently woody to resist attacks.
At River Estate a portion of the seed bed had been covered with a mulch of Cedar wood sawdust 1 ½" deep for the purpose of preventing rain splashing of the soil over the seedlings. On this plot no gaps whatever had been caused by mole crickets. This suggests a method of protecting seedlings or small beds which are liable to heavy infestation.

Damage to cotton seedlings on the College farm was reported as due to mole crickets. Inspection showed that while a certain amount was due to this insect the greater part of the damage was caused by a heavy reinfestation of Millipedes (Julus and Blanjululus spp.).

Fine calcium arsenate dusted over a small experimental plot reduced the infestation greatly.

**Tobacco.**

*Scapteriscus didactylus* causes extremely serious losses to tobacco seedlings in the field after transplanting. Should the growing of this crop become extensive in Trinidad the mole cricket will undoubtedly prove a pest of major importance.

The extent of the damage is shown by the following observations on a number of seedling tobacco plants of four varieties.

<table>
<thead>
<tr>
<th>Type</th>
<th>No. of Plants under observation</th>
<th>No. destroyed</th>
<th>Per. of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Burley</td>
<td>928</td>
<td>350</td>
<td>38.0%</td>
</tr>
<tr>
<td>Yellow Mammoth</td>
<td>928</td>
<td>245</td>
<td>26.5%</td>
</tr>
<tr>
<td>Hickory Prior</td>
<td>928</td>
<td>188</td>
<td>20.2%</td>
</tr>
<tr>
<td>Kentucky one Sucker</td>
<td>928</td>
<td>165</td>
<td>17.9%</td>
</tr>
</tbody>
</table>

---

*College Estate 1927.*
No records for previous years have been kept and without such it is impossible to say whether the apparent preference for certain varieties is actual or merely fortuitous. It has, however, been observed that White Burley and Yellow Mammoth have in previous years been most severely attacked.

A plot of tobacco of the species *Nicotiana rustica* adjacent to the one under observation was also inspected at intervals and it was observed that not a single plant was attacked by mole crickets.

**Experiments on Control.**

To test the value of poison baits and soil fumigation for control of mole crickets a plot was laid out and planted with tobacco seedlings of the variety Hickory Prior. To the North and South this plot was bounded by a field of tobacco and a road, respectively, and to the East and West by a banana plantation and a grass trace.

Eleven plots were laid out as shown in the diagram below.

<table>
<thead>
<tr>
<th>GRASS TRACE</th>
<th>ROAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLOTS</td>
<td>1A</td>
</tr>
<tr>
<td>Plants</td>
<td>50</td>
</tr>
<tr>
<td>Poison</td>
<td></td>
</tr>
<tr>
<td>Bait</td>
<td></td>
</tr>
</tbody>
</table>

Plots 1A & 1B were used for testing poison bait composed of Paris green and flour, the mixture containing 3% of Paris green.
In Plot 1A shallow trenches were made round the stem of each plant and 1" from it. These were filled with the Paris green mixture. In Plot 1B the mixture was merely broadcast on the surface between the plants.

Plot 2 was left untreated to serve as a control.

Plots 3A, 3B, 3C were treated with Carbon Bisulphide emulsion, the stock being made up as previously described (p.22.), diluted with clear water and sprayed on the soil around the plants.

On Plot 3A a concentration of 1 part stock to 150 parts of water by volume was used.

On Plot 3B, 1 part stock to 12 parts water, and on Plot 3C, 1 part stock to 25 parts water, were used.

Plot 4 was untreated.

Plots 5A & 5B were treated with a kerosene and soap emulsion containing naphthalene (Paranap) and prepared as follows.

56lbs. of soft soap is added to 2gals. of water and this is allowed to simmer over a fire with constant stirring until a uniform melt has been obtained. 6lbs. of Naphthalene is added, the whole removed from the fire and 2gals. of Kerosene added to the mixture which is stirred.

The product is gelatinous and dissolves readily in water to give a milky emulsion.

Plot 5A was treated with this mixture in a concentration of 25 parts stock to 100 parts water (by vol.) and Plot 5B with a concentration of 10 parts stock to 100 parts water.

The plots were treated only once and following treatment were examined each morning and the number of plants destroyed by mole crickets noted.

The result is shown in the accompanying table.
<table>
<thead>
<tr>
<th>Number of Plants</th>
<th>Plot 1A</th>
<th>1B.</th>
<th>2A.</th>
<th>2B.</th>
<th>3C</th>
<th>4A</th>
<th>5B</th>
<th>2 and 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>Flour &amp; Paris G</td>
<td>Flour &amp; P.G.</td>
<td>C S2</td>
<td>1/150</td>
<td>C S2</td>
<td>1/100</td>
<td>C S2</td>
<td>1/25</td>
</tr>
<tr>
<td>Date</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.11.27</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>22.11.27</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>23.11.27</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>24.11.27</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>25.11.27</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>26.11.27</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>27.11.27</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>28.11.27</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>29.11.27</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>30.11.27</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1.12.27</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2.12.27</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>3.12.27</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4.12.27</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>5</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>11</td>
<td>10</td>
<td>20</td>
</tr>
</tbody>
</table>
From the table it will be observed that damage from mole crickets commences as soon as the seedlings are planted out reaching a maximum during the 2nd, 3rd and 4th days after transplanting.

In the first day after transplanting damage is very slight and it has been noted that damage commences at the edges of the field gradually extending to the middle and indicating an invasion of crickets from the grass surrounding the field. When the surface of the ground is very dry the burrows may be seen starting from the grass and gradually extending into the field from plant to plant.

Fourteen days after transplanting all plants had become sufficiently fibrous to resist attack and no further losses occur.

**Paris Green and Flour.** Treatment with poison bait gives fairly satisfactory results when the bait is broadcast, the plot **in** so protected showing a loss of 5 in 50 as compared with 20 in 50 on the control plot.

In the case of the plants protected by a ring of poison the loss rises to 15 in 50 but the difference is partly explained by the position of the plot in close proximity to the grass trace which served as the chief source of infection.

**Carbon Bisulphide Emulsion.**

In a concentration of 1 part stock to 150 parts of water 0.8% emulsion appears to give a measure of protection somewhat less than Paris green broadcast, the plot treated with the emulsion showing a loss of 6 in 25.

On increasing the concentration to 1 part stock in 100 parts of water the loss falls to 2 in 25. In this concentration the measure of protection is good and the plants/
plants suffer no harmful effects. Indeed plants so treated show a somewhat more rapid growth, producing larger and thicker leaves of a slightly darker green. Whether the effect is due to partial sterilization of the soil, to the actual manurial value of the sulphur or to the operation of both factors is a matter of doubt.

When the concentration is increased to 1 part stock in 25 parts of water the effect is markedly harmful. The plants become yellowish and wilted and apparently receive a severe check.

While the use of CS 2 emulsion at a concentration of 1 in 100 would give a useful measure of protection against the cricket, its use on a field scale is obviously prohibited on account of cost. It would, however, appear to be of value for the protection of seed-beds liable to infestation.

**Paranap.**

The application of the Herosene emulsion containing naphthalene had the immediate effect of destroying crickets present in the soil. Five of these appeared on the surface during the spraying and all died within two hours.

Apparently, however, its repellant effects are transient and it does not prevent rapid reinvasion.

Moreover in the concentration used it is highly harmful to the plant causing wilting and killing the plant when applied close up to the roots.

**Grass Planting.**

A practice sometimes carried out in Trinidad as a means of protecting tobacco from mole cricket is to plant the seedlings in holes the bottoms of which are lined with grass.
It is believed, apparently, that the crickets will feed on the grass and leave the seedlings untouched.

The method would appear to be one of very doubtful value but in order to test it a plot of 40 seedlings (Plot 6) was planted in this manner and compared with 40 seedlings in an adjacent plot transplanted at the same time but without any protection.

The results are shown below.

Tobacco Plot (Hickory Prior) planted Dec. 7th., 1927.

<table>
<thead>
<tr>
<th>Number of Seedlings Destroyed By Mole Crickets.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examined</td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td>9/12/27.</td>
</tr>
<tr>
<td>11/12/27.</td>
</tr>
<tr>
<td>14/12/27.</td>
</tr>
<tr>
<td>17/12/27.</td>
</tr>
<tr>
<td>21/12/27.</td>
</tr>
<tr>
<td>23/12/27.</td>
</tr>
<tr>
<td>24/12/27.</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

The results would seem to indicate that grass planting is of no value whatever in protecting the seedlings and probably serves merely as an attraction.

Replanting. The method of dealing with the pest most commonly applied is to dig out each morning plants cut off by mole crickets, removing the earth in the vicinity to a depth of about 8 inches. Frequently the insect is found in this earth and can be destroyed.

A new seedling is then transplanted from reserves in the seed bed.
Maize.

While reported as a serious pest of maize seedling in some of the islands the mole cricket seems to cause no considerable damage to this crop in Trinidad.

Observations have of necessity been confined to plots on the College farm where little damage was caused to maize seedlings by mole crickets, though in captivity they feed readily on the germinating seeds and gnaw off the young seedlings at the base.

In a plot of maize adjacent to the heavily infested tobacco field a negligible proportion of seedlings on the margin were destroyed, the extremely small loss being partly accounted for by the presence of an abundance of the preferred food plant in the vicinity.
Trapping as a means of Control.

It has been suggested that traps may be prepared by sinking empty cigarette or tobacco tins in the soil of heavily infected plots with the rim of the tin just below ground level. The method would seem to be of no practical value. During November twelve such traps were maintained on a heavily infected plot, three being baited with flour.

Maintenance was a matter of difficulty since the tins rapidly became filled with silt washed in by the rains.

No mole crickets were taken in the traps during the month of observation, the catches invariably consisting of a few millipedes and very large numbers of the predaceous carabid *Pheropsophus equinoctialis*.

Light Traps.

Trapping by means of light is unlikely to be of any practical value for two reasons.

Firstly the cricket is positively phototropic only to light of considerable intensity and secondly it is only on the rare and irregular occasions of large flights that even a light of sufficient intensity would have any effect.

Tests with the common paraffin hurricane lamp proved that it had no attraction whatever for the cricket.

Four such lamps were lighted in the field during five nights of December after it had been noted that crickets were in flight.

These were kept burning from 7.30 to 10.30. The lamps were placed in rectangular vessels measuring 12" x 10" x 2\(\frac{1}{2}\)" and a solution of creosote was placed in each vessel to a depth of 1\(\frac{1}{2}\)".
No adult crickets were taken either when the pans were placed on the ground or raised 2 feet above it, nor were crickets attracted to the vicinity of the lamps.

It is, however, noteworthy that two 5th instar nymphs were taken in pans placed on the ground. This indicates that the nymphs may come to the surface and migrate during the night.

Coloured globes of red, green, yellow and blue were no more successful in attracting crickets.

An examination of the general catches made on six occasions during which these were exposed in the field indicated an order of efficiency of green, red, blue and yellow, green being only slightly inferior to white light in its attractive powers.

A general count of the numbers of each order caught is shown below but it should be noted that small homopterous Hemiptera (mostly Jassidae) were caught in such enormous numbers in each pan that no count was made.

<table>
<thead>
<tr>
<th>Captures at Light</th>
<th>Green</th>
<th>Red</th>
<th>Blue</th>
<th>Yellow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthoptera.</td>
<td>12</td>
<td>14</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Isoptera.</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Thysanoptera.</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hemiptera.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coleoptera.</td>
<td>22</td>
<td>10</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Lepidoptera.</td>
<td>12</td>
<td>14</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Diptera.</td>
<td>40</td>
<td>22</td>
<td>39</td>
<td>12</td>
</tr>
<tr>
<td>Hymenoptera.</td>
<td>26</td>
<td>4</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>116</strong></td>
<td><strong>65</strong></td>
<td><strong>50</strong></td>
<td><strong>33</strong></td>
</tr>
</tbody>
</table>

The hymenoptera taken consisted almost entirely of the vespid species Apoica Pallida and Braconida, chiefly Apanteles spp - an argument against any system of light trapping.
Natural Enemies of the Mole Cricket.

Predaceous enemies.

Chief place among the predaceous enemies of the mole cricket is taken by various diurnal lizards. Thus Brooks (Report. Agric. Dept. St. Lucia 1910) states that the mole cricket has become a serious pest only since the introduction of the mongoose. The mongoose is charged with exterminating the "Ground Lizard" which kept the cricket in control.

It is probable that the term "Ground Lizard" refers to the species *Ameira exula* a burrowing species which feeds on the cricket.

According to Fredholm (Proc. Agr. Soc. Trinidad & Tobago Vol. 2 part 2) the common Trinidad garden toad gorges itself on mole crickets. The writer has confused these toads with mole crickets giving them no other source of food. The toads made no attempt to eat the crickets even when on the verge of starvation.

Birds.

The common tick bird or Merle Corbeau (*Crotaphaga ani*) is probably the most destructive of mole crickets among Trinidad birds.

Williams (Memoirs Dept. Agric. Trin. & Tobag.) states:-

"The stomach contents indicate that while capable of eating frog-hoppers the tick bird prefers larger prey, particularly grasshoppers. This conclusion is confirmed by dissections made in the cane fields of Porto Rico.

Westmore found after an examination of 41 stomachs that 91.3% of the food was animal and Orthoptera formed over 40%.

Westmore (Birds of Porto Rico) further concludes that 5.69% of the food of the bird consists of mole crickets.
Box in British Guiana has shown that the greater part of the food of the hawk Rupornis magnirostris consists of mole crickets or grasshoppers.

The sphecid family Larridae includes parasites of various species of Gryllotalpinae.

These are stoutly built wasps of moderate size. The middle tibiae bear one apical spur, the fore wings have three cubital cells and the abdomen is sessile. They are separated from the Benbycidae by the small concealed labrum.

Williams (Studies in Tropical wasps, Bull. Expt. Sta. of Hawaiian Sugar Planters' Assoc. Ent Ser No 19) states that 10 species of Larra prey upon mole crickets.

Attempts have been made to introduce some of these species into Hawaii for the control of the injurious Gryllotalpa Africana.

The report of the experimental station of the Hawaiian Sugar Planters' Association (1923-24) records the introduction of Larra americana and another species of this genus from Para. These were found to oviposit on mole crickets but failed to develop.

According to Williams, Larra Luzonensis a Philippine species attacks Gryllotalpa Africana and a few of these wasps were bred and sent to Hawaii in 1922. This effort at introduction also failed. (Hawaiian Planters' record XXVI, No 3)

Again in 1925 (Vide. Williams) a large consignment of parasitised crickets was sent to Honolulu.

The adults were liberated on sugar plantations and succeeded in establishing themselves in three places.

Larra Americana, a Brazilian species which, according to Williams is abundant about Belem, Para, Parasitises Scapteriscus didactylus. Its efficiency as
a parasite would seem to be somewhat doubtful since where it is abundant mole crickets occur in larger numbers, even to the extent of tunnelling the scant soil between the cobblestones in city streets.

*Larra Guiana* is a comparatively large species, dull red in general body colour with black markings on the thorax and abdomen. It occurs, but is rare, in Berbice, British Guiana and parasitises mole crickets of unascertained species; probably *Gryllotalpa hexadactyla* which from the writer's observations is the most common species in that region.
Summary.

(1) Two species of mole cricket are abundant in Trinidad, *Scapteriscus didactylus* and *Gryllotalpa hexadactyla*.

(2) The distribution of these species and of *Scapteriscus variegatus* in the West Indies is discussed.

(3) The adult of *S. didactylus* is described in detail.

(4) The life history of *S. didactylus* is discussed.

Flights of *adults* containing approximately equal numbers of each sex occur in October, November and December. Mating probably takes place during these flights.

Eggs are laid in the early part of the year.

There are eight larval *instars*. Instar 4, 5, 6, 7 and 8 are described and their durations shown.

(5) The importance of *S didactylus* as an agricultural pest is discussed.

(6) Control measures are suggested and tests carried out in the field.

For control on lawns Sodium Silicofluoride is of little value. Fumigation with carbon bisulphide emulsion gives effective control especially where large areas are treated.

Damage to plantation seedlings may be prevented by covering the seed bed with a mulch of Cedarwood sawdust.

For the protection of tobacco seedlings in the field the broadcasting of poison bait containing flour and Paris green gives good results. Carbon bisulphide emulsion in a given concentration is even more effective while a solution of Paranap has little repellent effect and is very injurious to tobacco seedlings.

The practice of grass planting is of no value.

The natural enemies of the mole cricket in Trinidad consists of a burrowing lizard (*Ameiva exula*) the tick bird (*Cratophilaga ani*) and a *Cordyceps* fungus.
FIG. 1 HEAD OF S. DIDACTYLUS.
CONDYLE

POST GENA.

MALAR

ADDUCTOR MUSCLE.

FIG 3 MANDIBLE (VENTRAL)
FIG. 4  MAXILLA
FIG. 6. VENTRAL VIEW OF HEAD.
Fig. 9. VENATION OF LEFT TEGMEN OF MALE S. DIDACTYLUS.
Fig. 9. Venation of left tegmen of female *S. didactylus.*
Fig. 10. LEFT PROTHORACIC LEG OF S. DIDACTYLUS.
FIG. 11  SECTION OF RIGHT OVARY OF S. DIDACTYLUS.
Fig. 12. Prothoracic leg of Gryllotalpa hexadactyla.
FIG. 13  S. DIPACTYLUS.
Fourth instar nymph.
Plate 1.
Gryllotalpa Hexadactyla.
Plate 2.
S. Didactylus.
6th. Instar.

Plate 3.
S. Didactylus.
7th. Instar.
Plate 4.
S. Didactylus.
8th. Instar.
Fig. 9. Tegminal venation of Scautopus vicinus (after Scudder)
Fig. Prothoracic leg of Scapleriscus vicinis (after Scudder)