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BULLETIN

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ENTOMOLOGICAL RESEARCH.

VOL. IX. 1918.

ON THE MOSQUITOS OF MACEDONIA.

By JAMES WATERSTON, Lieut. R.A.M.C.,

Entomologist to the Malaria Commission, Salonika.

This report, which is of a preliminary nature, deals with the species of CULICIDAE met with in Macedonia by the British Malaria Commission during the latter half of 1917. The collections of the Commission have been augmented by material forwarded from time to time to the Malaria Enquiry Laboratory, Salonika, by various Medical Officers and others in the field. While engaged in working out these and other blood-sucking Arthropods, I had the privilege of examining, through the kindness of Dr. Joyeux, of the Mission Antipaludique, samples of species taken within the areas under French control. As our reports are to appear almost simultaneously, and as my colleague has devoted special attention to the larval morphology of these insects, I have confined myself here mainly to the adults, and field notes. I desire to thank heartily the following officers for material and notes supplied—Majors Bissett and Armour; Captains Boyd, Candler, Peacock and Carnwath. I have also been indebted in many ways to the kindness of Lt.-Col. C. M. Wenyon, O.C. the Malaria Enquiry Laboratory. For the work of identification the Trustees of the British Museum (Nat. Hist.) have afforded every facility, and in this connection my best thanks are due to Mr. Lang of the Museum Staff. Again, as on many another occasion, it is a pleasure to acknowledge the assistance ungrudgingly rendered by Dr. G. A. K. Marshall, Director, Imperial Bureau of Entomology.

Natural Enemies of Mosquitos.

Though no examinations of the stomach contents of birds were made, it was fairly certain from their actions that swallows (*Hirundo, Delichon* and *Cotile*) destroyed numbers of mosquitos. During the scrub and grass fires initiated as a measure of mosquito control these birds might be seen moving in hundreds backwards and forwards across the line of the advancing fire. Of the work of other species it is impossible to speak definitely. Some of the smaller waders, resident

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during the summer, *e.g.*, *Tringa* (*Totanus*) *ochropus*, *T. hypoleucus* and *Aegialitis minor* were constantly observed feeding in shallow pools on mud flats or in woods near the Vardar, and the absence of larvae in these situations was remarked. That larvae had been previously present could not however be ascertained.

Various small species of fish and the fry of larger forms control the larvae to some extent. Yet even when fish were present, very little cover seemed to afford the larvae protection; for example, both fish and larvae were found in pools above Likovan. In other cases, especially in clear gravelly or rocky pools, the fish-control appeared to be effective. In the Gumus Dere in September I found a few larvae and no fish in some of the upper parts, but as one went towards the Struma the fish increased and the larvae disappeared. In Ardzan Lake the clear reed pools are patrolled by shoals of fry and I found no larvae there; on the other hand small fish were found on the lakeward side of the barrier of broken reeds, etc., behind which larvae of *Anopheles sinensis* abounded. Several species of small fish occur, but only one, *Gobius rhodopterus*, Gunth.,* has as yet been identified.

Under laboratory conditions many insect larvae collected with those of mosquitos were predatory on the latter, *e.g.*, various Odonata, Ephemerids, *Chrysops*, etc. *Nepa cinerea* and *Notonecta glauca* also took their toll, but the evidence was confusing as to what takes place under natural conditions. In some pools, for instance, *Notonecta* swarmed and little else living could be found; in other cases larvae occurred with the bugs. A good deal depended apparently on the size of the sheet of water and whether the sides were clear or fringed with weed. One small pond in the Struma Valley, about 40 yds. long by 6–7 yds. wide, produced a steady supply of larvae and had ultimately to be oiled. Yet the water teemed with dragon-fly, Ephemerid and Coleopterous larvae, and after oiling, the following large water-beetles were secured :—*Cybister lateralimarginatus*, de G., 8 ♂, 16 ♀; *C. tripunctatus*, Oliv., 3 ♂; *C. tripunctatus* var. *gotschi*, Chd., 1 ♂; *Dytiscus marginalis*, L., 1 ♂; *D. dimidiatus*, Berg., 1 ♀; *Colymbetes fuscus*, L., 1 ♂; and *Hydrophilus piceus*, L., 1 ♀. I have quoted the numbers, which are noteworthy in so small a sheet of water. Not all the specimens killed by the oil were secured.

Adult dragonflies also account for many mosquitos, although I have seen only CULICINI hunted. About 15 species of dragonflies were secured by only intermittent collecting, and of these the most active were species of *Anax*, *Orthetrum*, and *Sympetrum*.

Towards the end of the season larvae became badly overgrown with colonies of *Vorticella*. These however did not prevent the completion of development. There was also a tendency for the long branched clypeal, lateral, terminal and palmate hairs to break off. Under these circumstances some examples were unable to grip the water surface sufficiently and appeared to drown. Many other individuals that died showed shortly before this an abundant growth of a fungus allied to *Saprolegnia*; but whether the fungus was a primary or secondary factor in this was not determined.

Throughout the autumn occasional mosquitos with acari were captured. Such cases occurred more frequently towards the end of the season.

---

* Determined by Dr. C. T. Regan, F.R.S.

Among the factors favourable to the larvae, one noted, especially in the streams, the shelter afforded by watercress (*Nasturtium officinale*). Floating pieces of weed uprooted by water-birds in feeding also often harboured larvae. In the lakes the dense formation of *Salvinia* frequently found inshore was clear of larvae except along its outer edges; larvae also were to be found in clear spaces enclosed by this fern. Patches of *Spirogyra* were a sure draw for larvae, which in such a situation were often very inconspicuous owing to the green contents of the gut.

Genus Anopheles, Mg.

It is difficult, after so short an experience, to speak with finality on the relative abundance, distribution and seasonal prevalence of the following four species of *Anopheles*, nor would any figures of, for example, the percentage that each species formed of the total specimens examined (unless based on collections made in a great variety of situations throughout a whole season) be of particular value. We observed, however, a decrease in the numbers of *maculipennis*, with a corresponding increase on the part of *palestinensis* towards the end of August and throughout September. But whether the abundance of the latter species has any direct relation to the rise in the curve of subtertian malaria is still undetermined. There was, in 1917, no well-defined end to the mosquito season; *maculipennis*, *palestinensis* and *sinensis* entered our camps in decreasing numbers to about the middle of November (Karasouli District). But for three weeks later occasional active specimens of *maculipennis* were taken on the wing. The larvae too are very resistant to cold and may continue to show activity under a covering of ice. Lt.-Col. C. M. Wenyon even records a case in which after the water in a basin containing *maculipennis* larvae had been frozen into a solid block he succeeded in resuscitating them by thawing and four hours' exposure to sunshine.

Anopheles maculipennis, Mg.

We found this species everywhere throughout the season, but the numbers observed varied considerably. At Karasouli in July and early August it was apparently the dominant form as imago, and probably as larva also. At Lahana however by the middle of the month *maculipennis* was distinctly scarcer. Its numbers began to recover about mid-September and Lt.-Col. Wenyon found it common in October. At Karasouli I believe a similar fluctuation was observed. In October I found *maculipennis* and *palestinensis* both in numbers there; and on evenings when *sinensis* put in an appearance, the three species were about equally represented. The later examples of this species were larger and more distinctly spotted, particularly the females, than those taken earlier, in some of which the spots were nearly absent even in bred specimens. Such examples closely approach *bifurcatus* in size and general appearance, and as a matter of fact many mosquitos sent us as the latter species proved on examination to be *maculipennis*.

Anopheles bifurcatus, L.

Although eventually discovered in a variety of localities this species was nowhere numerous; it may however prove to be abundant in the spring. The first undoubted examples seen were bred from larvae taken early in September from a well and stream in a nullah south of the Seres Road, kilo 58½. The locality was indicated to us by Captain Carnwath. Larvae were subsequently secured in small numbers near Kocanmah, Mekes and Likovan, and also from pools below the overhanging banks of the Vardar. The imago was only once detected in tents, when a few were taken near Karasouli (Oct.). Lt.-Col. Balfour found it in dug-outs near Langaza, and Captain Valentine detected the species near Hortiack.

In its early stages *bifurcatus* is often cannibal. I have seen full-grown larvae gradually devouring those of the first and second instars, although the usual food was present. The victim is seized by the tail and only the empty head-capsule is rejected. One lot of about 25 larvae was kept in conditions under which *maculipennis* and *palestinensis* reached the imaginal state within three weeks. Five or six *bifurcatus* grew normally, while in the others development was retarded. The smaller specimens one by one disappeared and when, after two months (in late November), chopped flies were given instead of green weed, the survivors fed up, but only two imagines resulted—the others dying in the attempt to pupate.

Anopheles palestinensis (Theo.).

Pyretophorus palestinensis, Theobald, Mon. Cul., iii, p. 71 (1903).

„ *nursei*, Theobald, Mon. Cul., iv, p. 66 (1907).

„ *cardamitisi*, Newstead & Carter, Ann. Trop. Med., iv, p. 379 (1910).

Anopheles superpictus var. *macedoniensis*, Cot & Hovasse, Bull. Soc. Path. Exot., x, p. 890, fig. (Dec. 1917).

This is the *Anopheles* which has been commonly diagnosed as *A. superpictus*, Grassi. However *superpictus* and *palestinensis* may ultimately be found to compare, the Macedonian specimens examined are referable to the eastern form, in which the tarsi are unbanded. *A. nursei* and *cardamitisi* offer apparently no features of specific value to separate them from *palestinensis*. This synonymy, I find, has already been suggested by Edwards (Journ. As. Soc. Bengal, ix, p. 48, June 1913), who had before him the types of *palestinensis* and *nursei* and a paratype of *cardamitisi*. For the name *macedoniensis* there seems to be no justification.

This is, numerically, the chief autumnal species all over the hilly country west of the Struma—a remark which holds possibly for Macedonia more generally, but I am unable to speak from personal experience. At Karasouli only one example was taken up to and during the second week of August. Later a pair was shown me by Major Bisset from Hortiack (first week in August), where the species was reported to have appeared in some numbers. During the second half of August and in September, *palestinensis* was abundant in the Lahana district and the Struma Valley, breeding in clear hill streams, and where these were outside the canalised areas one occasionally found the larvae in shoals. During September a careful count was made of the mosquitos taken in tents, wards, etc., in one Casualty Clearing Station, and *palestinensis* there formed from 94 per cent. to 98 per cent. of the Anopheline total, the only other species present being *maculipennis*. Breeding imagines from larvae locally obtained produced practically the same figures. On returning to Karasouli in October, I found this species common, and during the first fortnight of that month I bred some examples from larvae taken in temporary pools at the sides of the Vardar. At the end of August *palestinensis* was common near Sakavca and round Wessex Bridge on the Struma, but owing to the very thorough sanitary measures that had been put into operation it was practically certain that the river itself must be the source of these mosquitos. After some searching, larvae at different stages and pupae were procured by dipping in the water behind the piles of the bridge. As the larvae increased in number after a week, eggs must have been taken up with the water. In the stream itself larvae were found right in the current, hanging on to snags on the sheltered side. It is unlikely that these larvae had been swept into the main stream from tributaries, for August was a period of excessive drought, during which many streams disappeared and others became a series of shallow pools, any movement of the water being underground.

Anopheles sinensis, Wied.

Anopheles sinensis, Wiedemann, Aussereurop. Zweifl. Ins., i, p. 547 (1828).

Anopheles pseudopictus, Grassi, Atti R. Acad. Lincei Rendic., viii, 1, p. 102 (1899).

Although occasionally taken at some distance from standing water, this is essentially a lacustrine breeder, two of its strongholds being in Lakes Ardzan and Amatovo. Major Bissett first showed it to us from The Pond near Ardzan village, and during the summer it occurred in various localities from Spankovo to Karasouli. At the latter station I found that *sinensis* occurred most plentifully on evenings when there was a gentle S.E. breeze. On some nights it failed to put in an appearance at all, though other Culicines and Anophelines occurred. The specimens taken were chiefly females.

The larva of this species was not found till 10th October, when large numbers were seen at the top of Ardzan below Galavanci. At intervals during the next three weeks the Ardzan and Amatovo area was explored and four to five hundred larvae from various places were reared. Less than 5 per cent. produced *maculipennis,* the rest were *sinensis.* Some notes on the larval haunts may be given. Except below Dragomir, Lake Ardzan shows a broad fringing belt of dense high reeds (*Arundo phragmites*). This belt expands at the top end of the lake, and elsewhere it varies in depth, being broken in places by one or two lagoon-like pools which lead by wandering channels to the main lake. Towards Amatovo the reed-beds merge with the vegetation clothing the marshy land between the lakes. The west side of Amatovo shows similar reed-beds to those of Ardzan, the east bank being generally clearer.

Opposite Dragomir the lake shore is gravelly or muddy, but clear of vegetation, and here neither Anopheline nor Culicine larvae could be found in the lake in-shore, nor, when a boat had been procured, did the lake itself and the lagoons in the reed-beds opposite prove more remunerative. Great areas of the reed-beds towards the clear deep water were equally barren. The strongholds of the larvae lay in-shore, as a rule in quite shallow water. Below Galavanci they swarmed along the sides of a lane of water between the shore and the reed-beds, here 30–50 yards distant. Broken reed stems and other drift lined the shore, and amongst this drift, or in the little pockets which it cut off along the lake edge, the larvae occurred. In some places the roots of *Arundo, Typha* and a species of water lily formed a solid floating raft in whose interstices larvae were abundant. In reeds one found them again, sheltering in spots defended by the Hydropterid plant, *Salvinia natans*. Along the west side of Amatovo, *sinensis* was very plentiful, its presence depending on patches of *Spirogyra* in the shallows.

Observations were made to ascertain whether, and if so at what time, the larvae would die out with the approach of colder weather. By the 31st October they had practically vanished from below Galavanci, while from the 20th onwards it was difficult to get many at Vardino. On 1st Nov. only a few examples could be found in these localities. During the week in which this diminution in the numbers of *sinensis* was observed my visit to the lakes had been paid between 2 and 4 o'clock

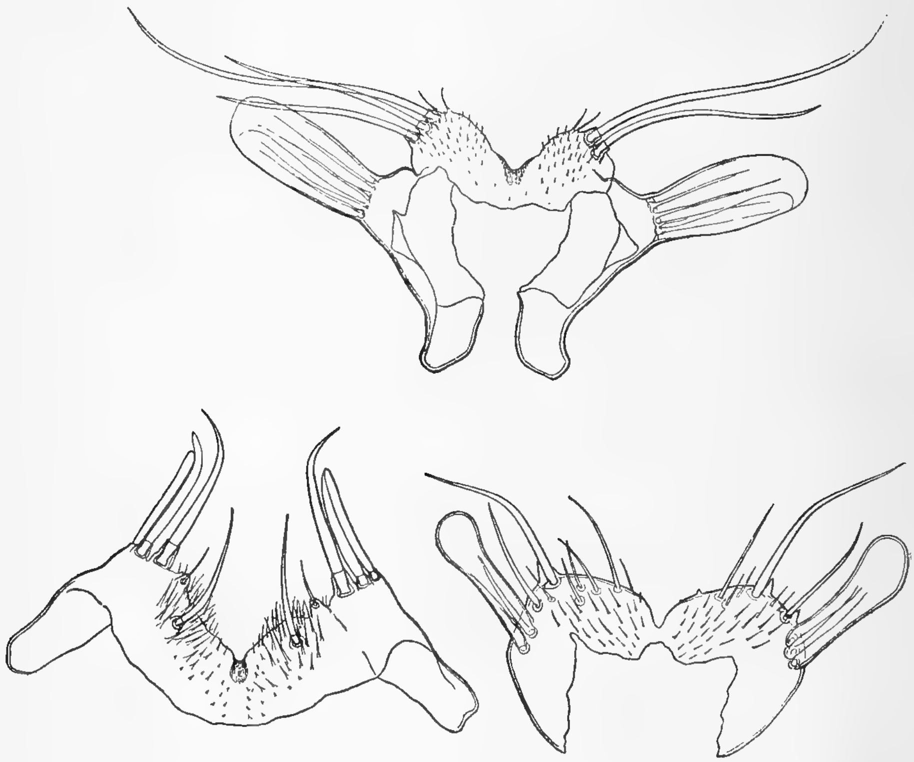

Fig. 1. Inner basal lateral lobes of the male genital armature of *Anopheles sinensis* (top), *A. maculipennis* (left), and *A. palestinensis* (right).

in the afternoon. Returning on the forenoon of 2nd Nov. to Amatovo during a spell of bright sunshine we found the larvae quite numerous; the inference being, I think, not that the stock had up to then been seriously depleted, but merely that the daily period of larval activity had been shortened. The examples so collected showed no signs of hibernating when brought down to the Laboratory, but fed up and pupated a little more slowly than others from the same site taken a fortnight earlier. The last imagines from this batch emerged during the first week in December. Probably hatching out under natural conditions stopped at least a fortnight earlier, for during that time the weather was extremely cold and the Laboratory was heated.

On a last visit to Amatovo (29.xi.17) no larvae could be found and only an occasional *Chironomus* and a *Dixa* were beaten from the reed-beds.

A. sinensis breeds on till late in the season. Two blood-gorged females were taken in a tent at Karasouli and, after being given two days to clear up, were transported to the unwarmed Laboratory at the base (13th Oct.). On the morning of the 21st numerous empty egg-shells were found on the water over which the females had been confined. The gut of the young larvae was well filled and they were probably 2–3 days old. The first change of skin took place on the 24th–25th. There was no subsequent change, all dying by about the middle of November.

Stegomyia fasciata, F.

This species is said to be exceedingly common within the town of Salonika, occurring particularly in churches, etc. Many complaints of its persistent biting have been received. Major Armour showed me one or two examples taken at Kalamaria, where however I have seen only a single specimen alive. Before leaving, I received several examples from Lt. J. M. Wallace, taken at the Base Laboratory. How far *S. fasciata* is to be found inland is deserving of attention, but no data are at hand, nor in numerous collections made near the town were larvae of this species encountered.

Genus OCHLEROTATUS, Arrib.

Ochlerotatus dorsalis (Mg.).

In the last week of September and during the first half of October this species was annoying and persistent in its attacks in the Kalamaria District, in houses, tents, wards, etc. It was active in the early evening and late afternoon and attacked one viciously. No signs of breeding-places could be discovered in the hospital, where it was most regularly seen; but about three-fourths of a mile off, on flat ground by

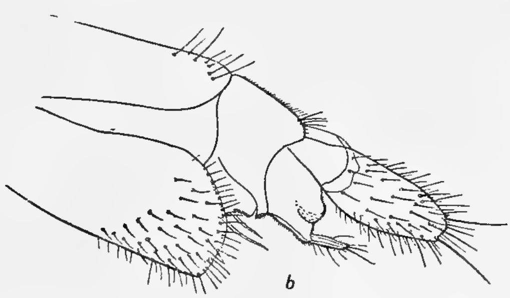

Fig. 2. Terminal segments of abdomen of *Ochlerotatus dorsalis*, ♀.

the shore, its numbers increased, and here there had been recently some standing pools behind the beach. Along the shore of Mikra Bay it was frequently found, and in the marshes it was in thousands. Col. Wenyon took about this time several examples of *Ochlerotatus* on the Struma, which appear to belong to this species; the specimens are however much rubbed. Like those from Mikra they bit severely.

Genus TAENIORHYNCHUS, Arrib.

Taeniorhynchus richiardii, Fic.

Taken only near Karasouli in tents, wards, etc., and not commonly, but often full fed. It occurred from July to October, and only females were secured, which suggests that the breeding centre lay at some distance from camp.

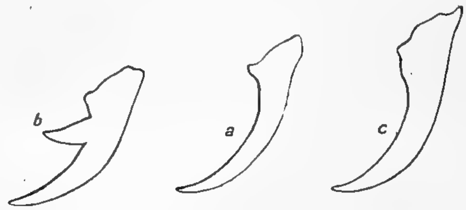

Fig. 3. Hind tarsal claws of (*a*) *Taeniorhynchus richiardii*, (*b*) *Ochlerotatus dorsalis*, and (*c*) *Theobaldia longiareolata.*

Genus THEOBALDIA, N.-L.

Two species of *Theobaldia*, both belonging to the section with distinctly spotted wings, were found, of which that first met with is undoubtedly referable to *T. longiareolata*, Mcq. The second I have called provisionally *T. annulata*, Schrank. The imagines agree well with British examples of this species, but there are some distinct larval differences whose weight it is at present difficult to estimate.

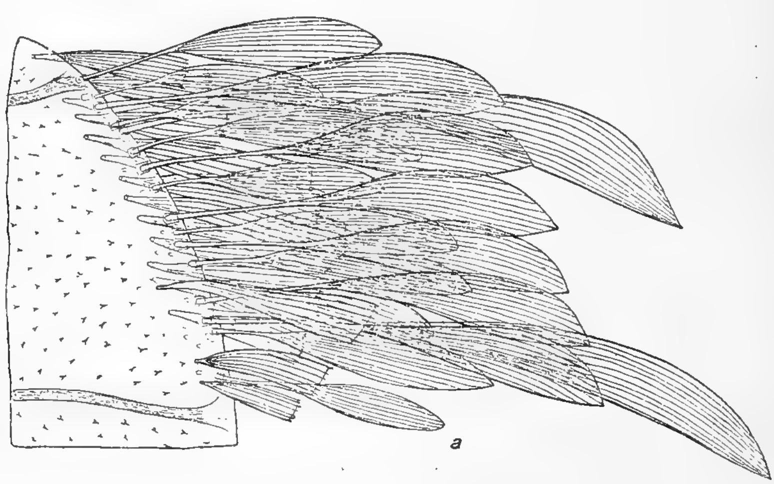

Fig. 4. Costal scales between the branches of the second longitudinal vein in *Taeniorhynchus richiardii.*

Theobaldia longiareolata, Mcq.

Locally common: Hadji Bairamli; near Lahana; Mirova; Mahmudli; Hortiack; Karasouli; Amatovo. Abundant in the first locality in August and

September; on 25th August a large brood hatched out from a pool, and a similar hatching was noted about four weeks later. The species continued to be taken well on into October.

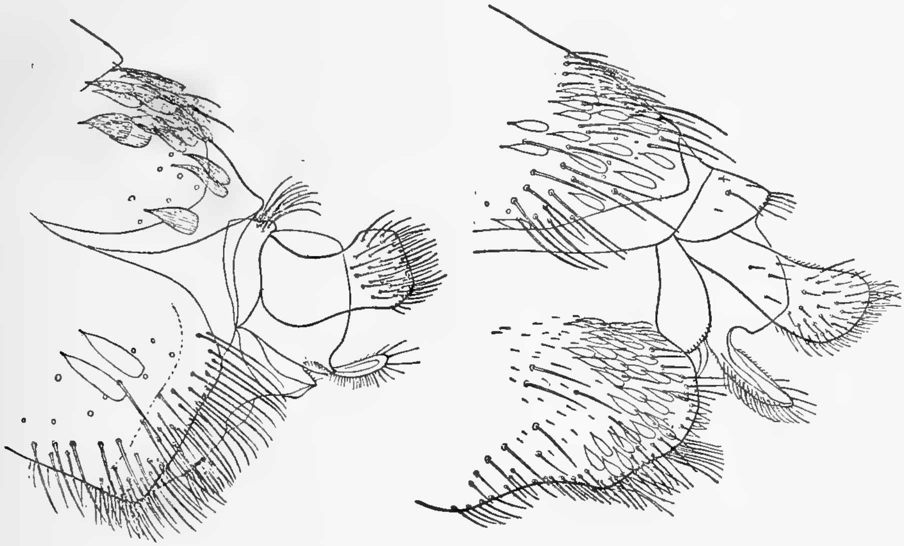

Fig. 5. Terminal segments of abdomen of females of *Taeniorhynchus richiardii* (left) and *Theobaldia longiareolata* (right).

Theobaldia annulata, Schrank.

During the last week in September a darker, stouter example was noticed in a batch of full-fed *longiareolata* larvae. The specimen was isolated, and pupating on 30th Sept. produced on 4th Oct. a female of *annulata*. A pure strain of *annulata* was later found in a well near the Experimental Farm at Mikra (24.xi.17) and from these larvae several imagines were reared. They were still emerging during the first week of December. The siphon of all these larvae is broader and the spines of the comb less numerous and stouter than in any English examples of *annulata* that I have seen.

Genus Culex, Linn.

Besides the species dealt with below, a single male of the *pipiens* group was raised from larvae taken in Lake Amatovo in November. The palpi were scantily set with bristles (cf. *hortensis*) and there are some colour differences of uncertain value. The genitalia are neither those of *pipiens* nor of *fatigans*. For the latter, careful search has been made, but without result. In a long series of preparations of the male genitalia only *pipiens* could be detected.

Culex mimeticus, Noé.

A conspicuously spotted insect with a superficial Anopheline appearance, occurring all over the country but nowhere very numerous. It is a stream-breeder, and we took it in various nullahs round Lahana, Likovan, Milovci (Giol Ajak), and below Oreovica. Dr. Niclot and others reared it from the neighbourhood of Salonika;

It was also in Dr. Joyeux' Serbian collection. The larvae were generally found in shaded situations. This species was never in my experience met with in tents or dug-outs, nor was any instance of its biting brought to my notice.

Culex pipiens, L.

So far as was observed, this is the most widely spread mosquito in Macedonia, occurring wherever one collected; no special localities need therefore be indicated. Larvae were found from sea-level up to 800 metres (near Nicolson's Neck), the highest point at which investigations were made. The females oviposit both in clean and foul water. Larvae were collected from pools in hill streams, at the sides of the Vardar, round the margins of lakes, in horse-troughs, water-logged tins, hoof-marks on lake margins, etc. As a rule slack water with plenty of algae was preferred, but larvae were found in great numbers in the following environments:—(*a*) In an artificial washing pool about 18 in. deep and a yard across, near Hadji Bairamli, throughout September. This pool was seldom clean, being contaminated with organic matter and occasionally slightly milky with soapsuds, yet frequent visits showed no diminution in the stock of *pipiens.* There also occurred *Culex hortensis, Theobaldia longiareolata* (abundant) and *T. annulata* (a few), with one or two examples of *Anopheles palestinensis.* (*b*) In November a similar association of *pipiens* and *Theobaldia annulata* larvae was discovered in a larger and deeper well at Mikra. No green algae were seen here, but many dead invertebrates were floating on the surface, and larvae brought to the laboratory fed up rapidly on fresh-chopped *Musca domestica.* (*c*) In extremely foul-smelling but quite clear rocky pools of sewage-effluent in the glen below Ravna. This water turned cloudy and "rotted" when kept a few days. With *C. pipiens* was found *A. palestinensis,* in some numbers. (*d*) In a deep dug-out which was abandoned through striking a spring. There were hundreds of larvae in 1 to 2 inches of water, which was perfectly clear and developed no algae on standing for a week. The gut of these larvae was filled merely with fine sediment from the bottom of the dug-out. The resulting imagines were slightly smaller than usual. (*e*) One or two bred from larvae taken from a reserve tank of water said to have been regularly chlorinated. This water had been stored throughout the summer, and from the early months till August the surface had been oiled, and there were no complaints. In September chlorinating was substituted for oiling and shortly afterwards larvae were noted. When I inspected the tanks there were many small larvae, judged to be about 10 days old, moving at the surface. The water in the tanks was run off, a careful examination of the contents of one of them being made. There was evidence of recent chlorination of the water, and at the bottom were hundreds of dead and decaying half-grown larvae. Some examples from the top layer were transferred to lake water well supplied with weed, and ultimately a few dwarfed specimens were bred out, in December 1917. Had these larvae remained where found, it is, I think, unlikely that they would have reached the imaginal condition. At the time of their first discovery, *Ochlerotatus dorsalis* was causing considerable annoyance in camp, but its probable breeding ground lay much further afield.

C. pipiens was also found breeding in low marshy ground near the sea (Mikra), but exact tests have yet to be made of the salinity of the water in which it occurred.

This species formed only a small percentage of the mosquitos taken in tents, etc. Once or twice blood-gorged females were taken in such situations, but though doubtless a common biter, no specific complaints against it were made. Some hundreds of examples in all were bred out, and the average size is decidedly small. Larger examples had however begun to appear in late November and early December.

Culex hortensis, Fic.

This species was first identified from the Lahana district, where it occurred in three localities :—(*a*) Near Hadji Bairamli in a partly artificial pool near one of our camps (see notes on *C. pipiens*). This site was quite in the open, though there were one or two isolated trees near. (*b*) In the Likovan stream ; and (*c*) on the Mahmudli spur—larvae sent by Capt. Lovell-Keays (24th Sept.). Later one ♂ and one ♀ were bred from larvae from Lake Amatovo (Oct. 1917). Ficalbi, who found *hortensis* in many places in Italy, considers it a sylvan species and believed it lived on the juices of plants, neither attacking animals or man, nor occurring in houses. I have not seen the precise spot on the Mahmudli Spur where the third lot of larvae—which produced only males—were gathered, but the other sites are in open country, though patches of scrub, vineyards and woody nullahs occur near by. But males, and on one occasion what was apparently the blood-gorged female, were certainly found along with *C. pipiens* in tents, etc. *C. hortensis* is similar to, but a little smaller than, *C. pipiens.* It is a blackish or dark greyish mosquito with nearly white bands at the *apices* of the abdominal segments, in which the scales are relatively broad ; while *pipiens* is a browner or dark buff species with paler bands at the *bases* of the segments. The male of *hortensis* can be told at a glance, with a low power lens, by the sparsely clad palpi and stout thumb-like inner chitinous lobe of the side-pieces of the genital armature.

Uranotaenia unguiculata, Edw.

U. unguiculata, Edwards, Journ. As. Soc. Bengal, ix, p. 51 (June, 1913).

Of this very interesting small mosquito Major C. Joyeux bred a few examples from larvae collected at (*a*) Vlochichta, near Koritza, and (*b*) Yenidje-Vardar. He also found this species (larvae only) at Kastorta. Four imagines examined from the first locality bear the date 24th Sept., and two from the second 15th and 17th May, respectively. I have myself only one specimen (♀) bred from a larva taken from a pool beside the Vardar, north of Karasouli (9.x.17). The larva will shortly be described and figured by Major Joyeux.

U. unguiculata is remarkable for the extreme development of the upper of the two lateral lines of bluish white scales towards the front of the mesonotum. These lines however do not meet antero-medianly. *U. unguiculata* evidently belongs to the African *bilineata* group. In making his description, Edwards had before him a single ♂ (now in the Indian Museum, Calcutta), but the species has since occurred in Egypt (Boulac Dacrur, 20.xii.1908, Dr. L. H. Gough, 1 ♂ in British Mus., det. F. W. Edwards). *U. unguiculata* is the only *Uranotaenia* found in the Palaearctic region and the above records form a considerable extension westwards of its ascertained range.

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Comparatively little has been written on the mosquitos of Macedonia, but the following papers may be quoted :—

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NOTES ON THE ETHIOPIAN FRUIT-FLIES OF THE FAMILY TRYPANEIDAE, OTHER THAN DACUS (S.L.) (DIPT.).—II.*

By Prof. M. Bezzi,

Turin, Italy.

(Plate I.)

XVII. Ocnerioxa, Speiser, 1915.

This genus was recently described by Dr. Speiser and is a very characteristic one, on account of its elongate and slender body and bare 3rd longitudinal vein. The species belonging here, as long ago pointed out by Loew, have a great resemblance to those of the genus *Elaphromyia*, but they are at once distinguished by the thin and black occipital row, by the pointed lower angle of the anal cell and by the non-reticulate wing pattern. The genus is evidently allied to *Ocneros*, but has nothing to do with *Rioxa*. I will give here some additional details to the short description of Dr. Speiser.

Head a little broader than high, occiput flat, hollowed above, with less developed lateral swellings; frons as broad as one eye, a little prominent above the base of antennae; face concave, with no distinct middle keel, and with rather prominent mouth border; cheeks linear; jowls narrow. Eyes of greater size, rounded, nearly as broad as high. Antennae inserted a little below the middle line of eyes, about as long as the face; third joint 3–4 times as long as the two basal joints together, rounded at tip; arista bare. Proboscis short; palpi broadened at end and bristly. Thoracic chaetotaxy complete; Dr. Speiser has overlooked the very thin and short *scp.*, and the *dc.*, which are placed much behind, only a little before the line of the *prsct.* Scutellum flat, bare on disc, with distinct lateral keels. Abdomen elongate, not bristly at end; male genitalia small; ovipositor swollen, conical, broad, as long as the last three abdominal segments together. Legs rather stout; front femora with 2–3 bristles; middle tibiae with one spur; hind tibiae with an undeveloped row of bristles. Wings very long and narrow with parallel borders; no distinct costal bristle, or a very thin one; stigma very long; 2nd, 3rd and 4th longitudinal veins perfectly straight and gradually diverging outwardly; small cross-vein placed on the last fifth of the discoidal cell, hind cross-vein straight, perpendicular or oblique outwardly at its upper end, as long as its distance from the small cross-vein; point of the anal cell longer than the second basal cell; discoidal cell long, much narrower at base than at end.

The species are as follows:—

1(4). Macrochaetae of head and body yellow; 2 lower *or.*; antennae as long as the face, with the third joint 2–3 times as long as the two basal joints together; legs rather stout, the front femora with scattered bristles below; wings very narrow and longer than the body, with no distinct costal bristle, very long stigma and long point of the anal cell.

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*For Part I see Bull. Ent. Res. viii, pp. 215–251.

2(3). Mouth-border yellow like the face; mesophragma yellow, with a black stripe; wings with only two hyaline spots at fore border and with the lower apical angle of the discoidal cell hyaline. . . . *pennata*, Speis.

3(2). Mouth-border with a black stripe; mesophragma shining black; wings with 4–5 hyaline costal spots and with the discoidal cell wholly infuscated. *woodi*, sp. n.

4(1). Macrochaetae quite black; antennae only half as long as the face; legs more slender, with the front femora not bristly beneath; wings broader and shorter than the body, with a rather distinct costal bristle, a short stigma and the point of the anal cell not long. . . . *gracilis*, Loew.

1. **Ocnerioxa pennata,** Speiser, Deut. Ent. Zeits., 1915, p. 103.

This species is very like the following one, but may be distinguished by the entirely yellow frons and face, and by the somewhat different wing pattern

Originally described from N. Kamerun, Mubi, near Jarua. I have before me a cotypical male specimen received from the author.

2. **Ocnerioxa woodi**, sp. nov. (Pl. i, fig. 1).

A beautiful fly of strange coloration.

♂♀. Length of body, 4·5–5 mm.; of the ovipositor, 1·2 mm.; of the wing, 5–6 mm.

Head of a pale yellowish colour; occiput shining, with 4 black stripes radiating from the neck to the vertical bristles and to below the middle of eyes; ocellar dot black; frons opaque, shining at vertex and on the basal stripes, and above the lunula with a more or less broad, black, transverse band; along the upper mouth-border there is a very striking, black stripe; jowls with fuscous subocular patch. Antennae entirely of a pale yellowish colour, like the palpi and the proboscis, but the third joint is a little infuscated. The occipital swellings are paler, almost whitish, clothed with pale yellowish hairs. All the bristles are yellow, only the outer *vt.* and those of the rather strong occipital row being black. Thorax on the back of a light whitish-yellow colour, less shining and with pale pubescence; on the sides it is adorned with 4 parallel, black stripes, 2 on each side, the interior going from above the humeri to the lateral angles of the scutellum, the outer along the noto-pleural line to the root of the wings; the former of these stripes is in continuation with the horizontal streak of the occiput. Pleurae of a much paler, yellowish-green colour, not spotted, with a whitish pubescence beneath; mesophragma quite shining black. All the bristles are yellow, sometimes infuscated at end; the *st.* is quite white. Scutellum of a lighter colour than the back of thorax, and with yellow bristles. Halteres pale yellow. Abdomen of oval shape, more shining than the thorax, with yellowish pubescence and black bristles; it is of a yellowish-green colour, in the male the elongate 4th segment being entirely black and shining, in the female the segments 3–5 having a black spot on each side and the second having a narrow black hind border. Venter greenish yellow; ovipositor entirely reddish. Legs entirely pale yellow, with pale pubescence and yellowish bristles, even the terminal spur of the middle tibiae being yellowish; claws black. Wings wholly infuscated; along the fore border there are 3 small elongate hyaline spots in the very long stigma (while in *pennata* they are wanting), and 2 rather larger ones in the marginal cell; at the hind border there is a broad hyaline indentation in the second posterior cell; the greater part of the 3rd posterior cell and the whole of the axillary cell are likewise hyaline, while the discoidal and the anal cells are entirely infuscated. The dark teeth or projections are situated at the end of the 5th longitudinal vein and a little after the middle of the discoidal cell. The stigma is darker than the surrounding parts. The small cross-vein is narrowly yellowish; the veins are dark yellowish, but the costa is lighter.

Type ♂ and type ♀ with some additional specimens from Nyalasand, Limbe, Chiromo, Ruo River, 22.ix.1916, collected by Mr. *R. C. Wood*, in whose honour this strange insect is named.

3. **Ocnerioxa gracilis,** Loew, Berl. Ent. Zeits., v. 1861, p. 270, pl. ii, fig. 8.

Originally described from Caffraria and not recorded subsequently. Its position in the present genus is very doubtful, as can be seen from the very different characters above recorded. I have provisionally placed it here only on account of its bare third longitudinal vein, and of its resemblance to *Elaphromyia* recorded by the author.

XVIII. Tephritis, Latreille (*Urophora*, R.D.).

Prof. Hendel has used the present name for the species placed by Loew and other authors in *Urophora*, on account of the fact that the type species of the genus is *solstitialis*, L., the same thing was already pointed out by Coquillett in 1910; but Latreille in 1810 had established that the type of his own genus was *cardui*, a species which is at any rate congeneric with the former.

The present genus seems to be represented in the Ethiopian fauna by gall-making species, which have the wings not or very little patterned; they may be distinguished as follows* :—

1(2). Scutellum black; wings quite immaculate at end .. *indecora*, Loew.
2(1). Scutellum yellow; apex of the wings at end of the first posterior cell with a faint greyish shade .. .. *vernoniicola*, sp. n.

1. **Tephritis indecora,** Loew, Berl. Ent. Zeits., v, 1861, p. 282, pl. ii, fig. 16.

Described from Caffraria, and never recorded subsequently.

2. **Tephritis vernoniicola,** sp. nov.

♂. Length of the body 4–4·5 mm.; of the wing 3·5–4 mm. Head of a reddish colour, but with the occiput broadly black on the middle and above; frons shining, with a black ocellar spot and with distinct but small longitudinal furrows; face pale yellowish, proportionally narrow, with a small middle keel and not at all prominent at the mouth-border; the rather broad cheeks and the jowls in continuation with them are shining reddish, unspotted. Antennae wanting in case of the type; there are only the basal joints, which are pale yellowish. Proboscis short, with short terminal flaps, and pale yellow in colour, like the small palpi.

* *Urophora basilaris*, Macquart (1835) seems to be an Ortalid.

The cephalic bristles are broken off in the type, only the inner *vt.* being present, which are black like those of the occipital row. Thorax entirely black, even on the pleurae, and rather shining; the humeri and a narrow notopleural line are reddish; on the back it seems to be a little grey dusted; the bristles are black, but they are mostly broken off. Scutellum yellowish red, with black sides at base. Mesophragma shining black. Halteres yellow. Abdomen entirely black, rather shining, with black bristles at end. Legs and coxae entirely yellow. Wings hyaline, with yellow veins, but with the costa darkened on its apical half. No

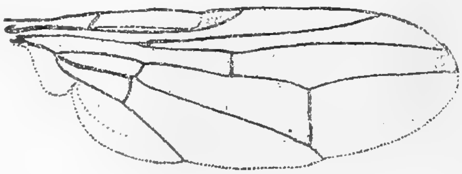

Fig. 1. *Tephritis vernoniicola*, Bezzi, sp. n.

costal bristle; stigma short, honey yellow; the extreme tip of the wings, between the ends of the 3rd and 4th longitudinal veins, has a faint greyish shading; in the rest there is no trace of bands, but the wing is rather broadly yellowish at base. The last portion of the 4th vein is straight, but slightly converging with the 3rd, the 1st posterior cell being smaller at the end than in *indecora*; small cross-vein placed about in the middle of the discoidal cell.

Type ♂ and an additional specimen, both in poor condition, in the writer's collection from Erythraea, Adi Ugri, bred from fusiform galls on twigs of *Vernonia abyssinica* (*Dr. J. Baldrati*).

XIX. Staurella, Bezzi (1913).

I have to record here this Oriental genus only because it is recorded as Ethiopian by Prof. Hendel; but at present I do not know any Ethiopian species belonging to it.

The genus is closely allied to *Rhacochlaena*, of which it has the reduced chaetotaxy and a similar wing pattern; but it is at once distinguished by the quite bare 3rd longitudinal vein. Owing to this fact I now think that the Indian species, *S. nigripeda*, Bezzi (1913), which has a bristly 3rd vein, is better placed in *Rhacochlaena*, inasmuch as its wing pattern is very like that of *R. toxoneura.*

XX. Carpomyia, A. Costa.

Of this genus the following species of very wide geographical distribution is represented in the collection before me:—

1. **Carpomyia incompleta,** Becker (1903); Bezzi (1911, 1913); Silvestri, Boll. Labor. Zool. Portici, 1916, xi, p. 176, fig. 8.

A characteristic little fly, which is at once distinguished by its entirely pale yellowish body with only two black spots on the mesophragma, and by the incompletely banded wings.

Prof. Silvestri has recorded this species from the Sudan, Khartoum, and from Erythraea, Keren. In the collection before me there are two specimens from the Sudan, Zeidali, 10.iii.1910, "Nalebak fruit-fly" (*H. H. King*).

XXI. Craspedoxantha, Bezzi (1913).

The present genus is closely allied to the following one, *Terellia,* some species of which show a black-spotted body and a similar course of the 3rd longitudinal vein, as *falcata,* which has also a *caput buccatum* (gen. *Orellia,* R. D.) and a very long point of the anal cell; but it is distinguished by the different form of the head and of the eyes, and by the peculiar wing pattern. In the present genus the *prsc.* are placed about in the same position as the *dc.*, thus resembling a first *dc.* pair. It is not a Trypaneine, and seems to be well represented in the Oriental and Ethiopian regions. The Ethiopian species are as follows :—

1(2). Scutellum with two black spots at end; pleurae with a black spot before the root of the wings .. .. *marginalis,* Wied.

2(1). Scutellum and pleurae quite devoid of black spots .. *manengubae,* Speis.

1. **Craspedoxantha marginalis,** Wiedemann (1830).

Originally described in the female sex from the Cape, and never seen subsequently.

2. **Craspedoxantha manengubae,** Speiser, Deut. Ent. Zeits., 1915, p. 104.

Originally described in the male sex from Kamerun, Dschung, October 1912; there are in the collection some specimens of both sexes from Nyasaland, Mt. Mlanje, 6–17.vi.1912 (*S. A. Neave*) and Chiromo, Ruo R., 22.ix.1916 (*R. C. Wood*).

To the description of Dr. Speiser may be added :—All the bristles of head and body are of a yellowish colour. *Oc.* rather strong; bristles of the occipital row short, thin, acute; *scp.* indistinct; *dc.* placed at level of the posterior *npl.* and thus much before the *a. sa.*; one *mpl.*; *pt.* strong, but always weaker than the *st.* The ovipositor is reddish, with the end narrowly black, and sometimes with a small black spot on each side at base; it is elongate conical (in dried specimens apparently flat), 2·5 mm. long, but when completely exserted 4 mm. long. Front femora with 4–5 strong bristles beneath; hind tibiae with a complete row of long and rather stout bristles. Wings (Pl. i, fig. 2) without costal bristle, and of a rather narrow and long shape; stigma elongate, but always shorter than the second costal cell; first posterior cell at the middle about 3 times as broad as the submarginal cell; discoidal cell only a little shorter than the second posterior cell, with the small cross-vein placed beyond its middle; point of the anal cell longer than the second basal cell.

Terellia, Robineau-Desvoidy (1830).

Incidentally recorded here because Prof. Hendel on p. 92 of his work on the Trypaneid genera of the world records it as an Ethiopian one. It is taken in the sense of *Trypeta* of Loew and other authors, with the addition of the species with banded wings, which in Robineau-Desvoidy are placed in a separate genus under the name of *Sitarea.*

I have not seen Ethiopian species of the present genus, but probably *hynia,* Walker (1849), from Sierra Leone, may belong here.

XXII. Aciura, Robineau-Desvoidy (1830).

The condition of this and the two following genera is at present quite unsatisfactory, as they include evidently different elements. Even the two typical European species of *Aciura* are hardly to be considered as congeneric; *rotundiventris* has black *vt.* bristles, occiput swollen above, eyes narrow in profile, yellow pubescence on thorax, short and broad ovipositor and no, or ill-developed, costal bristle on the wings; while *coryli* has yellowish *vt.* bristles, occiput hollowed above, eyes more rounded, black thoracic pubescence, long and narrow ovipositor and a well developed costal bristle, which is often double.

I have now distinguished the genera only on account of the dusted or not dusted back of mesothorax, without considering the colour of the bristles of the occipital row or the number of the scutellar bristles. Thus I have included in *Aciura* species with all these characters; in *Platensina* the bristles of the occipital row are usually of the stout and obtuse type, but as they are sometimes thin, I have in the table of the genera repeated the genus.

The Ethiopian species provisionally placed in *Aciura* can be distinguished as follows:—

1(14). All the bristles of the occipital border are whitish, only the longer inner *vt.* being black; wings black at hind border, with 3 or 4 hyaline indentations; body elongate.

2(3). Wings quite cuneiform, with a very narrow base and with rudimentary axillary cell; only 2 scutellar bristles; thorax on the back with black pubescence .. .. *angusta,* Loew.

3(2). Wings not cuneiform, with normally developed axillary cell; scutellum usually with 4 bristles

4(13). No hyaline spots on the middle of the wings, or only a single dot or streak in the black apical patch; the hyaline indentations of the hind border are long and narrow, not paired.

5(12). Wings with only 3 hyaline indentations at the hind border, the apical one in the first posterior cell being wanting.

6(7). There is a hyaline spot in the middle of the apical black patch *oborinia,* Walk.

7(6). No hyaline spot in the apical black patch.

8(9). Only 2 scutellar bristles; axillary cell rather narrow; the 2 hyaline indentations of the 3rd posterior cell extend with their tips into the discoidal cell; thorax with yellow pubescence; halteres pale yellowish *semiangusta,* sp. n.

9(8). Scutellum with 4 bristles; axillary cell rather broad; the first two indentations of the hind border stop at the 5th longitudinal vein, the discoidal cell being entirely black; thorax with black pubescence; halteres black.

10(11). In the hyaline base of the wings there is only a short black border in the first costal cell .. .. *caeca,* Bezzi.

11(10). There is a broad black marginal stripe in the two costal cells extending from the base to the stigma .. .. *tetrachaeta,* sp. n.

12(5). Wings with 4 hyaline indentations at the hind border, the 4th being extended across the last portion of the 3rd longitudinal vein into the submarginal cell .. .. *capensis*, Roud.

13(4). There are 3 hyaline rounded spots, 2 being in the discoidal cell; the 4 hyaline indentations at the hind border are short and broad, and disposed in 2 pairs .. .. *ternaria*, Loew.

14(1). All the occipital bristles are black; only 2 scutellar bristles; wings broadly hyaline at the hind border, with a single middle fuscous stripe reaching the hind border .. .. *binaria*, Loew.

1. **Aciura angusta,** Loew, Berl. Ent. Zeits., v, 1861, p. 271, pl. ii, fig. 9.

A narrow elongate species, very distinct from any other on account of its rudimentary axillary cell, the wings being therefore almost pedunculate at base.

All the bristles around the occipital border are whitish, only the longer *vt.* being black; the *pvt.* are rather thick and rather obtuse, while those of the occipital row are thin and acute. These characters are also present in the following 4 species: *oborinia, semiangusta, caeca* and *tetrachaeta,* and in the Indian *xanthothrica,* which thus form a natural group, having a very constant wing pattern, like that of the two European species (*coryli* and *rotundiventris*), and a narrow elongate body, with the ovipositor narrow and about as long as the abdomen. The peculiar shape of the hind cross-vein is also characteristic for the group.

To Loew's description may be added:—One *mpl.*; thoracic bristles sometimes in part of a dark yellowish colour; *st.* stouter than the short and weak *pt.*

Originally described from Caffraria, and recorded by Becker from Sokotra, there are in the collection some specimens of both sexes from Umbilo, Durban, 3.v.–1.vi. 1914 (*L. Bevis*).

2. **Aciura oborinia,** Walker (1849).

Distinct from the other species on account of the hyaline dot in the centre of the broad apical black patch of the wings, recalling that to be observed in *A. coryli.*

Originally described from the Congo, but never found subsequently.

3. **Aciura semiangusta,** sp. nov. (Pl. i, fig. 3).

Very like the two following species, from which it is distinguished by the hyaline streaks of the discoidal cell.

♀. Length of the body, 4 mm.; of the ovipositor, 1·5 mm.; of the wing 4·5 mm. Occiput hollowed above, entirely black, with dark grey dust; all the bristles at its border are whitish, the upper ones rather thick but acute at end, the other rather thin; inner *vt.* black, like the frontal bristles. Frons flat, not prominent in profile, dark reddish brown, with the sides white-dusted in front; it is distinctly longer than broad, and bears 3 pairs of strong lower *or.*; there is a triangular, black, rather shining ocellar plate, with very short *oc.*; lunula normal. Eyes higher than broad, but not much narrowed; cheeks linear; jowls very narrow; genal bristle strong, black. Antennae inserted at middle of the eyes, a little shorter than the face, entirely dark reddish, with the 3rd joint about twice as long as the 2nd; arista microscopically pubescent. Palpi and proboscis dark yellowish. Thorax entirely black on the back, with short yellowish pubescence and with dark grey dust, which makes it opaque; the pleurae are more shining, but always with a faint grey dust. The bristles are black and strong; *dc.* placed before the line of the *a. sa.*; 1 *mpl.*; *st.* much stronger than the *pt.*; *scp.* not distinct. Mesophragma shining black; scutellum short and broad, very like the thorax, with only the basal pair of bristles, which are strong and very long. Halteres pale yellowish. Abdomen long and narrow, entirely black, with a dark brassy dust, with short black pubescence and with undeveloped bristles at end; it is slightly but distinctly shining; ovipositor more shining; venter entirely black. Legs rather long; coxae dark brown, with whitish dust; femora black, with narrowly reddish tips; 4 anterior tibiae reddish, more broadly on the front pair; tarsi reddish; front femora with 2 stout bristles beneath; hind tibiae without posterior row of bristles. Wings like those of *angusta*, but not so narrow at base, the axillary cell being well developed; costal bristle long and double; stigma short; 3rd longitudinal vein at end parallel with the 4th; small cross-vein placed on the last fifth of the discoidal cell; hind cross-vein much longer than its distance from the small one, and S-shaped; lower angle of the anal cell acute but not produced. The pattern is very like that of *angusta*; but there is no isolated black band in the hyaline part of the base, there being only a marginal streak in the 1st costal cell, ending obliquely in the middle of the 2nd costal cell; of the two hyaline indentations of the fore border, the first ends truncately at the 3rd and the 2nd ends acutely at the 4th vein, the black streak between them being oblique and rather broad. The three indentations of the hind border are oblique and narrow; the first crosses the base of the discoidal cell, ending at the 4th vein; the 2nd, which is the narrowest and shortest of all, enters with a point into the discoidal cell; the 3rd ends at the fourth vein just along the hind cross-vein. There are no hyaline isolate spots; the axillary cell is greyish hyaline. The veins are black, but they are pale yellowish in the hyaline indentations, which are distinctly whitish in colour.

Type ♀, a single specimen from N. W. Rhodesia, Chilanga, 30.vii.1913 (*R. C. Wood*).

4. **Aciura caeca,** Bezzi, Bull. Soc. Ent. Ital., xxxix (1907), 1908, p. 150.

Distinguished by the entirely black discoidal cell and by the second costal cell not being margined with fuscous.

Originally described from Erythraea, Keren, and not found subsequently.

5. **Aciura tetrachaeta,** sp. nov. (Pl. i, fig. 4).

Very like the above-described *semiangusta*, but distinguished by its greater size, 4 scutellar bristles and differently patterned wings.

♀. Length of the body, 5 mm.; of the ovipositor, 3 mm.; of the wing, 5·5 mm. Head and its bristles and appendages as in *semiangusta*, but the front is more lightly coloured and has no distinct black, triangular ocellar plate; the lunula is much broader and more developed than usual. Thorax, scutellum and mesophragma entirely brassy black, rather shining, with faint dust; on the back the short pubescence seems to be black; the bristles are black; the apical pair of the scutellum are half as long as the basal ones and cross each other. Halteres with black knob.

Abdomen shining, with no distinct dust and with very short black pubescence, the ovipositor is very long, and when completely exserted measures 4 mm., in length. Legs black, with yellowish coxae and tarsi, and the four anterior tibiae yellowish; front femora with 3 bristles beneath; hind tibiae with a row of short black bristles. The wings are as in *semiangusta,* but still broader and with the axillary cell broader; costal bristle long; cross-veins less approximate, the hind one S-shaped; lower angle of the anal cell a little more produced. The pattern is also very similar, but the marginal basal streak is complete, being equally broad from the base to the stigma; the two anterior indentations are of equal length, their tips passing a little beyond the 3rd longitudinal vein; the two posterior indentations end at the 5th vein and thus do not enter into the discoidal cell, which is entirely black; the first of these indentations has a slight greyish shade towards its middle.

Type ♀, a single specimen from N. W. Rhodesia, Chilanga, 23.vii.1913 (*R. P. Wood*).

6. **Aciura capensis,** Rondani (1863).

This species seems to be allied to the preceding ones and has likewise 4 scutellar bristles; but it is distinguished by the hyaline apical indentation, which is wanting in all the other species.

Described from the Cape and not found subsequently.

7. **Aciura ternaria,** Loew, Berl. Ent. Zeits., v, 1861, p. 273, pl. ii, fig. 10.

A very distinct species owing to its wing pattern, which is very different from that of all the preceding species and is very near to that of *Tephrella*; it may therefore belong to this latter genus, but Loew says that the thorax is black.

Originally described from Caffraria, and not recorded subsequently.

8. **Aciura binaria,** Loew, Berl. Ent. Zeits., v, 1861, p. 274, pl. ii, fig. 11.

A little species, smaller and shorter than the preceding ones, and very different from all on account of its very peculiar wing pattern.

Described from Caffraria; there is a male specimen from Umbilo, Durban, 26.iv.1914 (*L. Bevis*).

The present species may perhaps be better placed in *Spheniscomyia*; but it is left here on account of its 2 scutellar bristles and its 3 lower *or.* bristles; it needs evidently the formation of a new genus, as is shown by its very peculiar wing pattern. Costal bristle distinct; hind cross-vein arched outwardly; lower angle of the anal cell acute but not produced.

XXIII. Spheniscomyia, Bezzi (1913).

I have redescribed the genus in my paper on the Indian fruit-flies; but at present it may be characterised by the peculiarly banded type of wing pattern, and by the 4 scutellar bristles, the apical pair being as stout or stouter than the basal one, and being divergent instead of crossed; the frons is shorter and has only 2 pairs of lower *or.*; the hind cross-vein is long, straight, and perpendicular. The genus is thus restricted to two very widely spread species, of which only one is at present recorded from Africa and is represented in the collection.

1. **Spheniscomyia sexmaculata,** Macquart (1843); Bezzi, Mem. Ind. Mus., iii, p. 148, pl. x, fig. 53.

This easily recognisable species is known from many localities in the Ethiopian region. There are some specimens from Nyasaland, Chiromo, Ruo R., May 1916 (*R. C. Wood*); and I have received numerous specimens from Erythraea, Ghinda, October-December 1916 (*Dr. A. Mochi*).

XXIV. Tephrella, Bezzi (1913).

Originally proposed by me for an Indian species with only 2 scutellar bristles, with ill-developed costal bristle, and with *Aciura*-like pattern of wings with 3 hyaline spots in the middle. I adopt it here for a very homogeneous group of African species, which has 4 scutellar bristles, well developed and often double costal bristle and no hyaline spots in the middle of the wings. All the known species have been found also in Erythraea, and they may be distinguished as follows:—

1(10). Apex of the wings devoid of hyaline spots.

2(7). In the second posterior cell there is a single hyaline indentation.

3(6). Apical half of the submarginal cell entirely black, without hyaline spot; costal cells margined with black.

4(5). The second hyaline indentation of the fore border is not united with the middle indentation of the hind border .. .. *bezziana*, Enderl.

5(4). The second hyaline indentation is united with the middle one, thus forming a single hyaline band in the middle of the wing extending from the fore to the hind border .. .. *nigricosta*, Bezzi.

6(3). Apical half of the submarginal cell with a broad hyaline spot just before the end of the second longitudinal vein; costal cells not margined with black .. .. *cyclopica*, Bezzi.

7(2). Second posterior cell with 2 hyaline indentations, or with a second broad hyaline spot.

8(9). Third posterior cell with a single hyaline indentation, as usual; abdomen wholly black .. .. *tephronota*, Bezzi.

9(8). Third posterior cell with a broad hyaline spot besides the indentation; abdomen wholly red .. .. *rufiventris*, sp. n.

10(1). Apex of the wings with a broad hyaline spot between the ends of the 3rd and 4th longitudinal veins .. .. *hessii*, Wied.

1. **Tephrella bezziana,** Enderlein, Zool Jahrb., xxxi, 1911, p. 424, fig. F.

Originally described as a *Trypeta* from Asmara, Erythraea, and very like the following species, of which it is obviously only a form and probably the typical one, in which the middle indentations of the wings are not fused together to form a single hyaline band across the whole wing.

2. **Tephrella nigricosta**, Bezzi, Bull. Soc. Ent. Ital., xxxix (1907), 1908, p. 156.

Described from Erythraea, Ghinda and Keren, and not found subsequently.

3. **Tephrella cyclopica,** Bezzi, Bull. Soc. Ent. Ital., xxxix (1907), 1908, p. 152.
W-fuscum, Enderlein, Zool. Jahrb., xxxi, 1911, p. 425.

A very distinct species owing to the broad hyaline spot before the end of the submarginal cell (Pl. iv, fig. 5). Described from Erythraea, Keren; and if I have well interpreted the short description of Dr. Enderlein, *Trypeta W-fuscum*, likewise described from Erythraea, is the same species. There are in the collection two specimens from the Sudan, Khartoum, 29.x.1910 (*H. H. King*).

4. **Tephrella tephronota,** Bezzi, Bull. Soc. Ent. Ital., xxxix (1907), 1908, p. 154.
A species which is easily distinguished by its wing pattern.
Described from Erythraea, Adi Caie, and not found subsequently.

5. **Tephrella rufiventris,** sp. nov.

This species is very distinct from all the others here recorded on account of its red (not black) abdomen and of its 4 (not 3) hyaline indentations or spots on the hind border of the wings.

♀. Length of the body, 4·5 mm.; of the ovipositor, 0·8 mm.; of the wing, 4 mm. Head entirely yellowish, but the occiput with a broad, blackish, grey-dusted spot in the middle; frons narrow, not broader than the eye, entirely opaque and devoid of dark markings, even the ocellar area not being infuscated; face short, cheeks linear, jowls narrow and without any spot. Antennae entirely yellow, as long as the face; third joint rounded at the tip; arista microscopically pubescent. Proboscis and palpi pale yellowish, the latter with yellowish hairs. Cephalic bristles dark yellow, only the *oc.* and the upper *or.* being infuscated or even blackish. Thorax black, with only the humeral calli reddish, but it is densely clothed with brassy dust, being however rather shining; on the pleurae the dust is of a more grey colour; the short pubescence of the back is yellow; the bristles

Fig. 2. *Tephrella rufiventris*, Bezzi, sp. n.

are dark yellowish or more or less infuscated; the *dc.* are placed a little before the line of the *a. sa.* Scutellum flat, triangular, its dust being a little more faint than that of the thorax; there is a little yellow pubescence on the disc and 4 long marginal bristles, blackish in colour, those of the middle pair being decussate at the tip and only a little thinner than the basal ones. Post-scutellum and mesophragma shining black, with grey dust. Halteres pale yellowish. Abdomen entirely red, even on the venter, shining, with short yellow pubescence and with dark yellowish bristles at end; ovipositor shining black, but with the apical segment reddish, and if exserted measuring 1·5 mm. in length. Legs and coxae entirely reddish yellow; front femora with 1–2 stout and dark yellowish bristles beneath; hind tibiae with no distinct postical row. Wings with strong costal bristle; the blackish pattern is in general of the usual type, but the costal cells are not margined with black, and thus the base of the wings is broadly whitish hyaline, without dark markings; the short stigma is black; the first hyaline indentation of the fore border ends at the 3rd longitudinal vein, while the second enters with a short point into the first posterior cell. At the hind border there are 4 hyaline spots, 2 in the 2nd and 2 in the 3rd posterior cell; the first or basal is the largest of all, of rounded shape and fused with the hyaline axillary cell; the second is a rather small and rounded spot; the third is a narrow, long, sinuous indentation, which along the hind cross-vein reaches the 4th longitudinal vein; the fourth or last is a spot of oval outline, placed at about the middle of the third posterior cell. The veins are black, but they are pale yellowish at base, and ferruginous in the hyaline indentations of the fore border.

Type ♀, a single specimen in the author's collection from Erythraea, Ghinda (*Dr. A. Mochi*). It is curious to note that Dr. Mochi has found in Erythraea the present species alone, which is certainly different from the four other species previously found in Erythraea.

6. **Tephrella hessii,** Wiedemann (1819).

Originally described from the Cape, and never recorded subsequently.

I place this species here provisionally, on account of its wing pattern, which is however more marked than in the preceding species. It consists of 2 hyaline indentations at the fore border and 4 at the hind border, 2 in the 2nd and 2 in the 3rd posterior cell; there are besides a broad apical hyaline spot, another hyaline spot below the end of the 2nd longitudinal vein (as in *cyclopica*) and a small hyaline triangular indentation at the end of the submarginal cell.

III. Subfamily TRYPANEINAE.

XXV. Platensina, Enderlein (1911).

This Oriental genus, which was independently described by me in 1913 under the name of *Tephrostola*, is well represented also in the Ethiopian fauna. It belongs to the group of the forms which must be considered as a connecting link between the two subfamilies, Ceratitinae and Trypaneinae, and between the forms with an indented and those with a reticulate wing pattern. With these forms are to be included the "genus" *Tephrella* (which owing to the fact of its *Aciura*-like wing pattern was placed by me at the end of the preceding subfamily), and the "genera" *Platensina, Pliomelaena* and *Spathulina*, in which the pattern is more like the reticulate type, but in which the black parts always predominate over the hyaline ones.

In the present subfamily the distinction of the genera is even more unsatisfactory, and I have based it mainly on the characters of the wing pattern; but there are passages from *Pliomelaena* to *Euaresta* and from the latter to *Euribia*, and thus it is not always easy to find a definite means of distinguishing them. In the table of the genera I have placed *Tephrella* and *Platensina* in both subfamilies, because in some cases a doubt may arise as to whether the occipital bristles are of the Ceratitine or of the Trypaneine type.

The Oriental species of the present genus are *acrostacta*, Wied., *reinhardi*, Wied., *sumbana*, Enderl., and probably also *Tephritis euryptera*, Bezzi; of African species I refer to it the following:—

1. **Platensina diaphasis,** Bigot, Ann. Soc. Ent. France, lx, 1891, p. 384.

Described from Assinia as an *Oedaspis*, there are in the collection two specimens from the Gold Coast, Aburi, 1912–13 (*W. H. Patterson*).

To the description of this West African species may be added:—

Head entirely yellowish, immaculate; frons narrower than the eye; antennae shorter than the face, the third joint rounded at tip, with a shortly plumose arista; cheeks and jowls linear; proboscis thick. Cephalic bristles black, but the *pvt.* and the outer *vt.* yellowish, those of the occipital row being yellow but rather acute at end; inner *vt.* very long and dark yellowish on their apical half; *oc.* stout; *or.* 2 + 3. Thorax and scutellum opaque, being clothed with a dense grey dust; the pleurae and the scutellar border are distinctly reddish; the mesophragma is black, rather shining, with a faint greyish dust. Thoracic and scutellar bristles dark yellowish, but sometimes they are blackened at the extreme base; the *dc.* are placed before the line of the *a. sa.*; *scp.* not distinct; *mpl.* 1; *pt.* stouter than the *st.*; apical scutellar bristles about as long as the basal ones, and decussate at the tip. The short pubescence of the back is black; the very large and flat, triangular scutellum is bare on the disc, bearing some pale hairs on the sides. Abdomen shining black, with black pubescence and with short black bristles; the narrow sides of the first two segments and greater part of the venter are reddish; ovipositor of a shining blackish-brown colour, flat, 0·8 mm. long. Front femora with 2–3 very stout and yellowish bristles beneath; hind tibiae without distinct row. Wings (Pl. i, fig. 6) broad, with a distinct costal bristle and with a very narrow axillary lobe; 2nd and 3rd longitudinal veins very divergent towards the end; 3rd vein bare; hind cross-vein straight, as long as its distance from the small one or only a little longer; small cross-vein placed beyond the middle of the discoidal cell; lower angle of the anal cell acute and a little produced.

Note.—The very characteristic *Trypeta lunifera*, Loew (Berlin. Ent. Zeits., v, 1861, p. 268, pl. ii, fig. 7), from Caffraria, has the wings very broad and a bare arista; it is very doubtful whether it belongs here or not, because Loew does not say if the 3rd longitudinal vein is bristly or bare, and because its yellow pleural stripes show probable affinity with the CERATITINAE.

XXVI. EUTRETOSOMA, Hendel (1914).

The present genus was erected incidentally by Prof. Hendel in his great work on the South American Trypaneids, with the type *Eutreta oculata*. I have adopted this name here for the reception of some species which are distinguished by their broad and rounded wings, but differ from the preceding ones in having very numerous hyaline spots on the disc and in having a well developed axillary lobe; they have besides black spots on the face and on the frons, thus approaching the American species of *Eutreta*.

This genus is also represented in the Oriental Region, as I have an undescribed Indian species before me. The African species provisionally placed here can be distinguished as follows :—

1(2). Wings with the fore half yellow and adorned with some eye-like spots ; very small species of 2·5 mm. in length .. .. .. *oculatum*, Hend.

2(1). Wings not so patterned ; species of greater size.

3(8). Legs yellow ; wings with very numerous and very small, pale dots.

4(5). Apex of the wings with a broad black border, which is devoid of hyaline spots .. .. *frauenfeldi*, Schin.

5(4). Apex of the wings with a hyaline spot.

6(7). Stigma immaculate ; no black spots on the disc of wings .. *bipunctatum*, Loew.

7(6). Stigma with 2 hyaline spots near the costa ; on the disc of wings there are some spots of a deep black colour .. .. *millepunctatum*, sp. nov.

8(3). Legs black, with white rings at knees, on tibiae and on hind tarsi ; wings with 4 connected white apical spots .. .. *polygramma*, Walk.

1. **Eutretosoma oculatum,** Hendel, Abh. Ber. K. Zool. Mus. Dresden, xiv (1912), 1914, p. 55, pl. iii, fig. 43.

A small species, and very distinct owing to its peculiar wing pattern.

Described from Mozambique, Rikatla.

2. **Eutretosoma frauenfeldi,** Schiner, Novara Dipt., p. 276, pl. iii, fig. 4 (1868).

Described as an *Icaria* from the Cape, and not recorded subsequently ; it may be distinguished by the black border of the wings.

3. **Eutretosoma bipunctatum,** Loew, Berl. Ent. Zeits., v, 1861, p. 280, pl. ii, fig. 15.

Recognisable by the broad hyaline spot at the apex of the wings, between the ends of 3rd and 4th longitudinal veins. Described as a *Trypeta* from the Cape and not recorded subsequently.

4. **Eutretosoma millepunctatum,** sp. nov.

Easily recognised by the white marginal and black discoidal spots of the wings.

♀. Length of the body, 4 mm. ; of the ovipositor, 1·2 mm. ; of the wing, 4 mm. Head entirely yellowish ; occiput with 4 blackish spots, 2 in the middle above the neck, and one on each side of the upper border of the rather distinct lateral swellings ; frons with parallel sides, broader than the eye, without dark ocellar spot, but with a velvety black streak in front on each side of the root of the antennae ; lunula broad ; face with a dark brown cross-band near the mouth-border ; cheeks linear ; jowls narrow, with a brown spot on the sides, near the rather prominent upper mouth-border. Antennae short, not exceeding the middle of the face, entirely reddish yellow ; second joint globular, prominent, beset with numerous short and thick black spicules ; 3rd joint as long as the 2nd, rounded at tip, with a narrow dark basal border ; arista with short but distinct pubescence. All the cephalic bristles are of a pale yellowish colour, but the occipital row is formed by numerous short, thick, black bristles and among them some (3–4) yellow ones ; *or.* 2 + 3 ; *oc.* stout. Thorax reddish brown, with a broad blackish middle patch and with blackish rounded spots eat the bas of the macrochaetae ; pleurae more reddish, with two black spots on the mesopleura and a broader one on the sternopleura; scutellum reddish, broadly black at base above, and with 4 black spots at the base of the 4 macrochaetae; mesophragma black. All the bristles are pale yellowish; *dc.* placed much before the line of the *a. sa.*; 1 *mpl.*; *scp.* indistinct; the pubescence of the back is yellowish; 4 scutellar bristles, those of the middle pair being shorter and crossed at the tips. Halteres pale yellowish. Abdomen broad, reddish brown, with 4 rows of broad black spots, the 2 middle rows being more marked; the pubescence is pale yellowish, but is black on the black spots; bristles black; ovipositor flat, reddish. Legs entirely reddish, but the femora with two black spots in the middle forming a more or less complete ring, which is more developed on the hind pair, in which there is also a black spot at base beneath; front femora with 4–5 yellowish bristles beneath; hind tibiae with a well-developed row of black bristles. Wings broad and rounded, with obtuse end and with rather broad axillary lobe; costal bristle long and double; small cross-vein placed beyond the middle of the discoidal cell; lower angle of the anal cell shortly produced. The wings are entirely and intensely black, even at the extreme base and on the axillary lobe; they are adorned with very numerous whitish dots, which are more abundant in the marginal and submarginal cells, and scarcer in the hind half of the wing; on the axillary lobe they are fewer but broader; besides in the middle of the wing there are some more intensely black spots on the 3rd and 4th longitudinal veins, four of which are better defined and form a square, being symmetrically placed about the small cross-vein. Around the whole border of the wings there is a series of slightly larger and more whitish, elongate spots, 1 in the first costal cell, 2 in the second costal, 2 in the stigma (the first being the smaller), 3 in the marginal, 2 in the submarginal (the second of which is smaller), 1 at end of the first posterior cell occupying the space between the ends of 3rd and 4th longitudinal veins, 4 in the second posterior cell, the last of which is much smaller, 3 in the third posterior cell being all very small, and 4 or 5 in the axillary cell, which are larger and more elongate. Third longitudinal vein bare.

Type ♀, a single specimen in the writer's collection from Erythraea, Ghinda, March 1916 (*Dr. A. Mochi*).

5. **Eutretosoma polygramma,** Walker (1861).

The peculiar wing pattern and the very different coloration of the legs are distinctive features.

Described from Natal, and not recorded subsequently.

XXVII. Elaphromyia, Bigot (1859).

Of this very peculiar genus, which I described for the Oriental fauna under the name of *Paralleloptera* (1913), there are in Africa the two following species :—

1. **Elaphromyia adatha,** Walker (1849).

Described from Congo and not recorded subsequently; it is closely allied to the following species, from which it seems to be distinct in having the wing base broadly hyaline.*

* [In *E. adatha* it is not the basal half of the wing that is hyaline, but the basal half of the posterior border only; *E. ulula* is undoubtedly synonymous with this species.—Ed.].

2. **Elaphromyia ulula,** Loew, Berl. Ent. Zeits., v, 1861, p. 279, pl. ii, fig. 14. —? *melas*, Bigot, Rev. Mag. Zool., vii, 1859, p. 10.

A very characteristic species, the synonymy of which was established by Prof. Hendel in 1914. Loew described it from N'Gami, collected by Wahlberg; and Bigot has it from Port Natal.

XXVIII. Spathulina, Rondani (1856).

This old name is used here for a natural group of species, which was already indicated by me in my paper of 1908 on the Diptera of Erythraea (pp. 160–161) and in my paper of 1913 on the Indian fruit-flies (p. 160). I had previously called this group *Melanoxyna* in my collection; but at present I think that Rondani's name is quite applicable to it. The name *Spathulina* was first proposed in the Prodr., i, 1856, p. 113, with the type species *S. sicula* (undescribed, but in the generic diagnosis is the remark: *proboscis paulo producta*); in 1871 the genus was by its author united with *Ditricha* (type *guttularis*); but in the same paper is to be found the description of *D. sicula*, which is evidently the same as *Tephritis tristis*, described from Spain by Loew in 1869. I think therefore that as type of the genus *Spathulina* must be assumed the species *tristis*, Loew (= *sicula*, Rondani); and that in it are to be placed the Oriental *parca*, Bezzi (1913), the Egyptian *parceguttata*, Becker (1903), and the following Ethiopian species :—

1(6). Stigma devoid of hyaline spots.

2(3). Marginal cell with only 2 hyaline spots; submarginal cell entirely black at end .. .. *semiatra*, Loew.

3(2). Marginal cell with 3 hyaline spots; submarginal cell broadly hyaline at end.

4(5). The apical hyaline spot of the submarginal cell is well separated from that of the first posterior cell .. .. *parceguttata*, Beck.

5(4). Apical spot of the submarginal cell broadly united with that of the first posterior cell, thus forming a broad hyaline patch, in which there is an isolated black spot at end of the 3rd longitudinal vein *acrosticta*, sp. n.

6(1). Stigma with hyaline spot.

7(8). Marginal, submarginal and first posterior cells, each with only 2 hyaline spots; discoidal cell likewise with 2 hyaline spots .. .. *aldabrensis*, Lamb.

8(7). The above-named cells each with 4 hyaline spots; discoidal cell with 3 hyaline spots .. .. *margaritifera*, Bezzi.

1. **Spathulina semiatra,** Loew, Berl. Ent. Zeits., v, 1861, p. 276, pl. ii, fig. 12.

Originally described from Caffraria, and not found subsequently. The scutellum of the present species is described as having 4 bristles.

2. **Spathulina parceguttata,** Becker, Mitt. Zool. Mus. Berlin, ii, 1903, p. 134, pl. 4d, fig. 48.

Described from Egypt, Cairo, and here recorded only on account of its great resemblance to the following species, and therefore of its probable presence in the Ethiopian region.

3. **Spathulina acrosticta,** sp. nov.

A species very distinct from any other on account of the isolated black spot at the end of the third longitudinal vein.

♀. Length of the body, 3·5 mm. ; of the ovipositor, 0·6 mm. ; of the wing, 3·5 mm. Head rather depressed, entirely pale yellowish, with the occiput a little infuscated in the middle and the frons with a yellow middle stripe ; all the bristles are black, but the *pvt.*, the *vt.* and those of the occipital row are whitish ; there are 2 lower *or.* Antennae shorter than the face, yellow, with the third joint rounded at end ; arista bare. Palpi and proboscis yellow. Thorax and scutellum black, clothed with a dense grey dust, opaque ; the bristles are black, only the *pt.* being whitish ; mesophragma black, faintly dusted. Scutellum with only the basal pair of bristles. Abdomen entirely shining black, with black bristles ; ovipositor shining black, obtuse, depressed. Legs entirely yellow ; hind tibiae without distinct row of bristles. Wings elongate, broadly hyaline at base, with the following hyaline spots : 1 at end of the second costal cell, limited interiorly by a narrow black streak ; 3 of about equal size in the marginal cell ; 2 in the submarginal cell, one below the middle of the three above named, and the other at the end ; 2 of greater size and of rounded shape before and behind the small cross-vein ; 1 at end of the first posterior cell, forming the broad hyaline apical patch in which is the isolated black spot.

Type ♀, a single partly damaged specimen from Durban, Umbilo, 26.iv.1914 (*L. Bevis*).

4. **Spathulina aldabrensis,** Lamb, Trans. Linn. Soc. London, Zool., xvi, 1914, p. 319, fig. 12 & pl. xix, fig. 9.

Described as a *Tephritis* from the Island of Aldabra. The scutellum has a long basal and a very small apical pair of bristles.

5. **Spathulina margaritifera,** Bezzi, Bull. Soc. Ent. Ital., xxxix (1907), 1908, p. 160.

Closely allied to *semiatra*, but easily distinguished by the more numerous hyaline spots of the wings.

Described from Erythraea, Adi Ugri.

XXIX. Euaresta, Loew (1873).

This artificial genus is taken here in a somewhat wider sense than that attributed to it by Loew, and more corresponding to that used by Hendel, but without the restriction of the radiating marginal wing pattern. Thus I provisionally place here the species which differ from *Euribia* in having a more extensive black pattern on the wings, with a few hyaline spots. They are distinguished from the preceding genus in having a short proboscis and usually 4 scutellar bristles of equal size. But this latter character must be used with caution, because in some species (for example, in *megacephala*, Loew) the apical bristles are wanting.

For the species in which the black pattern of the wing is not radiating at apex, the new subgenus *Pliomelaena* is erected here. The African species can be distinguished as follows :—

1(2). Black wing pattern radiating at end and at the hind border (*Euaresta* s. str.) ; stigma entirely black ; the greater part of the third posterior cell and the whole axillary cell hyaline.. .. .. *planifrons*, Loew.

2(1). Black wing pattern not radiating, the hyaline apical spots being smaller (*Pliomelaena*, subgen. nov.); stigma with a yellowish or hyaline spot at base; axillary and third posterior cell infuscated, with hyaline spots.

3(4). Halteres whitish; frons as broad as or broader than the eye; first posterior cell with 2 hyaline dots, besides the apical hyaline spot .. *brevifrons*, sp. n.

4(3). Halteres with blackish knob; frons narrower than the eye; first posterior cell with a single hyaline spot .. .. *strictifrons*, sp. n.

1. **Euaresta planifrons,** Loew, Berl. Ent. Zeits., v, 1861, p. 277, pl. ii, fig. 13.

A true *Euaresta*, very like the Mediterranean *pulchra*, Loew.

Described from Caffraria, and not recorded subsequently.

I have seen a male specimen from Grahamstown (*Miss M. Daly* and *Miss M. Sole*), June 1903, which differs only in having the base of the 3rd posterior cell entirely black, thus only the axillary cell is hyaline.

Subgenus Pliomelaena, nov.

2. **Euaresta** (**Pliomelaena**) **brevifrons,** sp. nov. (Pl. i, fig. 8).

A species very much a like true *Euribia*, but with more sparse hyaline spots on the wings, the black pattern being prevalent.

♂♀. Length of the body, 4–4·5 mm.; of the ovipositor, 1 mm.; of the wing, 4–4·5 mm.

Head yellowish, unspotted, with only a darkish central area on the middle of the occiput; frons opaque, about as broad as long; face short, with rather prominent mouth-border; cheeks linear; jowls narrow. Antennae entirely yellowish, about as long as the face; third joint obtuse at end, as long as the first two joints together, with a bare arista; palpi and proboscis yellowish, the latter being short and not geniculate. Cephalic bristles long and stout; *pvt.* and *vt.* yellowish, like those of the occipital row, which are typical; *oc.* and *or.* dark yellowish or blackish; 3 lower *or.* Thorax black, but clothed with dense grey dust, so that the ground colour is invisible; pleural sutures slightly reddish; the back is clothed with yellowish pubescence. Chaetotaxy complete; bristles dark yellowish or blackish, those of the back being inserted on small black dots; no distinct *scp.*; 2 *mpl.*, the lower one being smaller; *st.* and *pt.* stout. Scutellum large, triangular, flat, black and grey-dusted on the disc, reddish at border and below, with 4 equally long yellowish bristles, inserted on small black dots, those of the apical pair being crossed. Mesophragma black, with dense greyish dust. Halteres whitish. Abdomen shining black, with short yellowish pubescence, and dark yellowish or blackish bristles; ovipositor flat, shining black, elongate, acute. Male genitalia black, rounded, prominent. Legs entirely pale yellowish; front femora with yellow bristles beneath; hind tibiae with an indistinct hind row, more distinct near the middle in the female. Wings elongate with distinct costal bristle; third longitudinal vein bare; second vein slightly divergent, third and fourth parallel; the two cross-veins are straight, perpendicular and parallel; lower angle of the anal cell acute but not produced. The base is hyaline up to the basal and anal cross-veins, but with a brown spot in the middle of the second costal cell at fore border; stigma elongate, with a hyaline basal spot ; marginal cell with 3 hyaline spots, the first two being larger and more approximated ; submarginal cell with 3 hyaline spots, the largest of which is placed below the first two spots of the marginal cell, forming with them a pyramid, the second is very small, and is placed just after it, and the middle-sized third one is placed at the fore border a little behind the end of the second longitudinal vein ; first basal and first posterior cells in all with 4 hyaline spots, one before and one beyond the small cross-vein, one in middle and one at end, this last being rather small, and therefore the black is not radiating ; discoidal cell with 2 hyaline spots, a middle one of greater size and one placed before the middle of the hind cross-vein ; 2nd posterior cell with 3 elongate hyaline spots, forming 3 indentations ; third posterior and axillary cells with 8–10 hyaline spots, forming a kind of reticulation.

Type ♂, type ♀, a single couple of specimens from Durban, Umbilo, 21.vi.1916 (*L. Bevis*).

Another male specimen from the same locality, but caught 21.ii.1914, is a little different in the wing pattern, the discoidal spots being much smaller, chiefly that in the middle of the discoidal cell ; the 3 indentations of the 2nd posterior cell are shorter, the last being divided into several smaller spots. In this specimen also all the bristles of the head and body are of a pale yellowish colour.

3. **Euaresta (Pliomelaena) strictifrons,** sp. nov. (Pl. i, fig. 7).

Nearly allied to the preceding species, but distinguished by the narrower frons and the somewhat different wing pattern.

♀. Length of the body, 5 mm. ; of the ovipositor, 1 mm. ; of the wing, 5 mm. Head and its appendages as in the preceding species, but the frons is much narrower, being narrower than the eye and only twice as long as broad ; the 3 lower *or.* are black. Thorax black on the disc, reddish on the sides of the back and on the whole of the pleurae ; scutellum black with reddish border ; all the bristles are yellowish ; the pubescence and the dust of the back are not well preserved in the type. Mesophragma shining black, with faint dust. Knob of the halteres blackish. Abdomen shining black, with black pubescence ; it is more elongate than that of the preceding species, but the ovipositor is shorter and broader. Legs entirely pale yellowish and more slender ; front femora with 3 darkish bristles beneath. Wings like those of *brevifrons*, but with the following differences : they are distinctly broader, and thus the second longitudinal vein is more divergent ; the costal cell has 2 broad and rounded brown spots ; the basal hyaline spot of the stigma is broader ; the third and smaller hyaline spot of the marginal cell is wanting ; submarginal cell with another hyaline spot at the extreme base ; the middle hyaline spot of the first posterior cell is wanting ; the discoidal cell has a single hyaline spot ; the second posterior cell has likewise 3 hyaline spots, but they are smaller and not like indentations ; third posterior and axillary cells with less numerous and smaller hyaline spots.

Type ♀, a single damaged specimen from Durban, Umbilo, 20.xii.1913 (*L. Bevis*).

XXX. Ensina, Robineau-Desvoidy (1830).

As already stated by Prof. Hendel, the present genus must be extended to embrace other species besides the typical *sonchi* ; and since the prolongation of the proboscis is very variable in the different species, I think it is better to restrict the genus to those in which the form of the head has the very characteristic shape which may be seen in *sonchi* and in *sororcula*. But in addition to these, the African fauna contains a number of species with a very long proboscis, in which the head is less or not at all depressed, like *dubia, anceps, ignobilis*; even these species must be provisionally placed here. The species in which the apical part of the proboscis is shorter than the lower part of the head, are to be placed in *Euribia*, the genus *Oxyna* being restricted to the very peculiar group of *flavescens* and closely allied forms.

Thus defined, the artificial genus *Ensina* will contain the following Ethiopian species :—

1(2). Head depressed, with the lower border very long ; wings with a faint and scattered reticulation .. .. *sororcula*, Wied.

2(1). Head not or less depressed, with the lower border less elongate.

3(6). Wings banded, *i.e.*, with the reticulation reduced to form some dark bands.

4(5). Apex of the wings, between the ends of 3rd and 4th longitudinal veins, with a hyaline spot .. .. *myiopitoides*, Bezzi.

5(4). Apex of the wings between the above-named veins entirely black *anceps*, Loew.

6(3). Wings reticulate as usual.

7(10). Stigma black, with or without hyaline spot ; wing pattern of a dark brown colour.

8(9). Femora yellow ; first basal cell, and the submarginal and discoidal cells at base with very numerous hyaline spots ; stigma black *dubia*, Walk.

9(8). Femora with black base ; the above-named cells with only a few hyaline spots ; stigma with a more or less developed hyaline spot *ignobilis*, Loew.

10(7). Stigma yellow ; femora yellow ; wings with a very faint pattern *siphonina*, sp. n.

1. **Ensina sorocula,** Wiedemann (1830).

A typical *Ensina*, which has a very wide distribution in tropical and subtropical countries of the Old World, and possibly even in America, *piceiola* or *humilis* being probably only a variety of it.

The male of *E. bisetosa*, Enderlein (1911), from Formosa, is this same species, while the female belongs to some other species.

There are in the collection several specimens from Nyasaland, Chiromo, Ruo R., May 1916 (*R. C. Wood*) ; from Durban, Umbilo, 24.v.1916 (*L. Bevis*) ; and I have received numerous specimens from Erythraea, Ghinda, March 1916 (*Dr. A. Mochi*). In my paper of 1908 the species is recorded under the name of *vacillans*, Wollaston.

2. **Ensina myiopitoides,** Bezzi, Bull. Soc. Ent. Ital., xxxix (1907), 1908, p. 158.

Recognisable by the brown pattern of the wings being disposed in bands, though not so distinctly as in the following species.

Described from Erythraea, Adi Ugri, and not found subsequently.

3. **Ensina anceps,** Loew, Berl. Ent. Zeits., v, 1861, p. 283, pl. ii, fig. 17.

Very distinct from any other species on account of the well differentiated dark bands of the wings.

Originally described from Caffraria, I have received from Grahamstown several specimens, which differ in some points from the Loew's description. The longer vertical bristles are black; the bristles of the occipital row are black, but those of the upper border are whitish; on the wings there is a dark band going from the middle of the 2nd costal cell to the 4th longitudinal vein, of which there is no trace in Loew's figure; moreover the 3 dark bands are broader and the apical one is prolonged over the 4th longitudinal vein.

4. **Ensina dubia,** Walker (1853), Loew, Berl. Ent. Zeits., v, 1861, p. 288, pl. ii, fig. 20.

Very distinct on account of its rich wing-pattern, and thus presumably belonging to some other genus.

Described from the Cape and Caffraria, and not found subsequently.

5. **Ensina ignobilis,** Loew, Berl. Ent. Zeits., v, 1861, p. 293, pl. ii, fig. 23.

Allied to *sororcula,* but with the head not depressed.

Originally described from the Cape, I have seen a female specimen from Grahamstown, October 1903 (*C. W. Mally*), which shows a rounded pale yellowish spot in the stigma. Characteristic for the present species is the small cross-vein broadly margined with fuscous. Another female specimen from Grahamstown, April 1903 (*Miss M. Daly* and *Miss M. Sole*), has the stigma entirely black and thus seems to belong to a different species, with less numerous hyaline spots in the middle of the first posterior cell.

6. **Ensina siphonina,** sp. nov.

Distinct from all the other species on account of its yellow stigma and of its very faintly marked reticulation of the wings. It is placed in the present genus only on account of its very long and bicubitate proboscis, which is about as long as the entire body.

♀. Length of the body, 4 mm.; of the ovipositor, 0·7 mm.; of the wing, 4 mm. Head as broad as high, not depressed, with the occiput swollen beneath and with the lower border rather short. Occiput black, clothed with dense grey dust, but pale yellowish and whitish-dusted at the eye borders and below; frons flattened, not prominent, broader than the eye, orange-yellow, with a narrow whitish border near the eyes; ocellar triangle greyish; face yellowish; cheeks and jowls narrow, reddish, white-dusted; mouth-border rather prominent. Antennae entirely reddish, as long as the face; third joint acute at its upper end; arista bare. Palpi reddish yellow, with some short black bristles at end; proboscis yellow, very long, its last portion being longer than the head. Of the cephalic bristles, the *pvt.*, the outer *vt.* and the first of the upper *or.* are whitish, like the short bristles of the occipital row; all the other bristles are black; only 2 lower *or.* Thorax and scutellum black, but densely grey-dusted and clothed with short yellow pubescence; on the back there are 2 brown but not much marked longitudinal stripes along the dorso-central lines;

the bristles are black and inserted on small black dots ; *scp.* not distinct ; 1 *mpl.* ; *st.* stout ; *pt.* yellow ; apical scutellar bristles half as long as the basal ones and decussate. Mesophragma grey ; halteres yellow ; abdomen black, but densely grey-dusted, with yellow pubescence and with black bristles at end ; on segments 2–4 there are 2 broad median brown spots, which are however not very distinct ; venter pale greyish. The short and broad, flattened and obtuse ovipositor is shining black. Legs rather stout, entirely reddish yellow ; front femora with 2–3 yellowish bristles beneath ; hind tibiae with ill-developed row ; the single spur of the middle tibiae is black. Wings rather narrow and elongate, with short but distinct costal bristle ; 3rd longitudinal vein bare ; 3rd and 4th veins perfectly parallel throughout the whole portion after the small cross-vein ; hind cross-vein rather perpendicular, as long as its distance from the small cross-vein ; lower angle of the anal cell distinctly produced. Veins yellow, only the two cross-veins, and some portions of the longitudinal veins corresponding to the dark spots, are blackish. The reticulation is very faint and similar to that of *Euribia lauta*, Loew (*veliformis*, Becker), but differently disposed ; the stigma is entirely yellow, with a small black dot at end. The reticulation is of the type of that of *elongatula* ; only the dark part forming the 3 hyaline spots of the marginal cell is a little more marked ; the hyaline spots of the rest of the wing are perfectly rounded and disposed in two longitudinal rows in the discoidal and posterior cells.

Type ♀, a single specimen from British E. Africa, Embu, 12.xii.1913 (*G. St. J. Orde-Browne*).

XXXI. Euribia, Meigen (1800).

With the removal of the species with broad wings and with black-spotted head to form *Eutretosoma* ; and of those with predominating black in the wing pattern to form *Spathulina, Euaresta* and *Pliomelaena* ; and of those with very elongate proboscis and with depressed head to form *Ensina* ; and of those with prominent frons to form *Camaromyia* ; and of those with buccate head and with very broad frons to form *Campiglossa* ; and of those with the fuscous pattern of the wings limited to the fore half to form *Acanthiophilus* ; and of those with star-like wing pattern to form *Trypanea*, there remain in the present genus only forms with decidedly reticulate wing pattern, which covers about the whole of the wings, and is not or very slightly radiating at the apex or at the hind border, with non-depressed head, with flattened and not very broad frons, and with short or elongate proboscis ; but in this last case, the apical part of the proboscis is always shorter than the lower border of the head.

Thus limited, we can distinguish in the genus the following Ethiopian species :—

1(4). Third antennal joint with a sharp point at its upper end ; body with yellow bristles and devoid of black stripes or spots on thorax or abdomen ; wings with a colourless stigma and a deep black spot in the middle of the disc.

2(3). Wing pattern fainter and more diffuse ; abdomen mainly pale yellow ; ovipositor longer than the abdomen .. .. .. *perpallida*, sp. nov.

3(2). Wing pattern more pronounced, and denser ; abdomen entirely black ; ovipositor much shorter than the abdomen .. .. *discipulchra*, sp. n.

4(1). Third antennal joint rounded at end; body with black bristles and with dark-striped or dark-spotted thorax or abdomen; wings with a coloured stigma and devoid of deep black central spot.

5(6). Stigma entirely black; wings with a broad black border, in which are included a few sharply defined hyaline marginal spots *praetexta*, Loew.

6(5). Stigma black, with a broad hyaline spot at base; wings without the above described pattern.

7(8). Wings with a distinct dark band, which includes several hyaline spots, across the middle, apical hyaline spot much narrower than the space between the ends of the 3rd and 4th longitudinal veins *caffra*, Loew.

8(7). Wings devoid of a distinct dark middle band; apical hyaline spot extending over the whole space between the above-named veins.

9(10). Thoracic dark stripes less distinct; subapical dark spot of the wings interrupted by some hyaline streaks .. .. .. *dissoluta*, Loew.

10(9). Thoracic stripes sharply defined; subapical spot not interrupted *tristrigata*, sp. n.

1. **Euribia perpallida,** sp. nov.

A handsome species, forming with the following one a distinct group, characterised by the sharp point of the third antennal joint and by the peculiar wing pattern.

♂♀. Length of the body, 2·5–3 mm.; of the ovipositor, 1·5 mm.; of the wing, 2·5–3 mm. Head entirely pale yellowish, with only a black, grey-dusted, double spot on middle of the occiput; frons flattened, not at all prominent, about as broad as long, with a greyish ocellar spot and with a more or less distinct longitudinal yellow middle stripe; face short, not prominent at the mouth-border; cheeks linear; jowls narrow and unspotted. Antennae entirely pale reddish, as long as the face; third joint with a sharply produced upper angle; arista whitish, bare. Proboscis thick, not bicubitate, yellowish; palpi pale yellowish, with short and whitish bristles at end. In profile the head is higher than broad, and is wholly occupied by the rounded eyes. Cephalic bristles pale yellowish, those of the occipital row thick but rather acute at end; *oc.* rather short; 2 lower *or.*; in the male specimens there is a pair of bristles in the middle of the frontal band, about as strong as the *oc.*, but wanting in the female.* Thorax densely clothed with grey dust and with yellowish pubescence; the pleural sutures are reddish; there are no distinct dark stripes on the back, only the bristles being placed on small black dots; scutellum like the thorax, but paler, and in the female with two fuscous dots; mesophragma black, grey-dusted. All the bristles are pale yellowish; the *dc.* are placed much before the line of the *a. sa.*; the middle scutellar pair is weak and crossed. Halteres yellowish. Abdomen pale yellowish; in the male there is a very narrow, blackish-grey, basal band on the 2nd and 3rd segments, and a broader one, divided into two broad spots, on the 4th segment; in the female these basal dark bands are more developed; the pubescence and the bristles are yellowish; male genitalia pale yellow; ovipositor shining reddish with black end, flattened, of elongate triangular

* These bristles seem to be homologous with the crossed frontal pair (*Kreuzborsten*) of the Anthomyiidae; their presence here may be accidental, as such bristles are not known to occur in the Trypaneidae; but the present case is very important theoretically.

shape. Legs entirely pale yellowish; front femora with 2–3 yellow bristles beneath; even the spur of the middle tibiae is yellowish; hind tibiae with no distinct row. Wings elongate, with a distinct costal bristle; 3rd longitudinal vein bare and perfectly straight; last portion of the 4th vein distinctly curved at base; small cross-vein placed after the middle of the discoidal cell; lower angle of the anal cell acute but not produced. The veins are pale yellowish, but infuscated in the fuscous parts of the wing pattern. The pattern is formed by a diffuse reticulation, which is yellowish brown in colour; the base is not spotted; the stigma is quite colourless, with a black basal dot at the insertion of the costal bristle; in the marginal cell there are 2 perpendicular dark streaks, forming 3 broad hyaline spots; submarginal, first posterior and second posterior cells, each with 2 rows of ill-defined and broad, rounded hyaline spots, those of the 2nd posterior cell being more numerous in the male than in the female; discoidal cell with only the apical half darkened and in this with 4 hyaline spots disposed in 2 rows; 3rd posterior cell with some spots at border; axillary cell quite hyaline. In the middle of the wing, on the space between the 2 cross-veins, there is a more fuscous patch, which bears in the centre the characteristic elongate spot of a deep black colour, preceded by a rounded hyaline spot near the small cross-vein; this black spot recalls that which is to be observed in the North American *Euaresta bella*, Loew, but is more intense.

Type ♂ and type ♀, a single pair of specimens, from Nyasaland, Chiromo, Ruo R., 23.ix.1916 (*R. C. Wood*).

2. **Euribia discipulchra,** sp. nov.

Nearly allied to the preceding species, but certainly distinct on account of its smaller size, darker colour and much shorter ovipositor.

♀. Length of the body, 2 mm.; of the ovipositor, 0·3 mm.; of the wing, 2 mm. Head and its appendages as in the preceding species, but the frontal band is of a darker orange-yellow colour and the antennae are of a darker reddish colour. Thorax and scutellum black, densely grey-dusted; the scutellum is reddish at end, with the dark dots more distinct. The bristles are as in the preceding. Abdomen entirely black, grey-dusted, with yellow pubescence and with yellow bristles; ovipositor very short and broad, obtuse, flattened, of a shining reddish colour, with black end. Legs as in the preceding species. Wings likewise; but the dark pattern is more blackish and better defined. The dark middle patch is broader and more striking; its central deep black spot has at the 2 ends, on each side, a very sharply defined, whitish hyaline, rounded spot, which contrasts with the black streak, forming a very curious and elegant pattern.

Type ♀, a single specimen from Nyasaland, Chiromo, Ruo R., 23.ix.1914 (*R. C. Wood*).

3. **Euribia praetexta,** Loew, Berl. Ent. Zeits., v, 1861, p. 286, pl. ii, fig. 19.

Very different from all the other species on account of the extensive black pattern of the wings, and thus approaching *Euaresta*, but without any radiating margino-apical pattern.

Described from Caffraria and not recorded subsequently.

4. **Euribia caffra,** Loew, Berl. Ent. Zeits., v, 1861, p. 290, pl. ii, fig. 21.

Characterised by the middle dark cross band, which is not distinguishable in the two following species.

Described from Caffraria, and not found since.

5. **Euribia dissoluta,** Loew, Berl. Ent. Zeits., v, 1861, p. 291, pl. ii, fig. 22.

The diffuse and paler reticulation of the wings is the principal feature of the species.

6. **Euribia tristrigata,** sp. nov. (Pl. i, fig. 9).

Nearly allied to the preceding species, but distinguished by the more marked thoracic pattern and by the more definite and closer dark pattern at the apex of the wings.

♂♀. Length of the body, 3–3·2 mm.; of the ovipositor, 1 mm. (if exserted, 2 mm.); of the wings, 3–3·2 mm. Head reddish, but with the occiput broadly black, grey-dusted; frons flattened, not prominent, orange-yellow on the front half, the middle band being divided by a longitudinal median whitish stripe, and with whitish eye-borders; the narrow ocellar dot is black; lunula whitish; face yellow in the middle, whitish on the sides, slightly prominent at the upper mouth-border; the narrow cheeks and jowls are white. Antennae reddish yellow, shorter than the face; third joint rounded at tip; arista bare; palpi whitish; proboscis yellowish, with short recurrent flaps, but not properly geniculate. All the bristles of the hind border are whitish, and also the first of the superior *or.*; the longer *vt.* is black, like the *oc.* and the other *or.*; 2 lower *or.*; *oc.* long and stout. Thorax black, but clothed with a dense grey dust, which is darker on the back and lighter on the pleurae; on the back there are 3 well-marked, longitudinal, blackish stripes, those on the dorso-central lines being a little broader than the middle, and being all evanescent behind; pubescence pale yellowish. All the bristles are black and inserted in small black dots. Scutellum flat, triangular, yellowish, grey-dusted, with blackish base and a more or less broad dark spot on each side; apical bristles not weaker than the basal ones, and crossed at the tip. Mesophragma black, with dense grey dust. Halteres whitish. Abdomen black, with dense grey dust; the narrow hind borders of the segments, but the entire end half of the last segment in the male, are yellowish red; there are 4 parallel longitudinal rows of rounded black spots, those of the middle broader, and more elongate in the male; pubescence yellow, bristles black; male genitalia yellow, white behind; ovipositor long, flattened, shining red, narrowly black at end. Legs rather short and stout, entirely reddish; front femora with 2–3 black bristles beneath; hind tibiae with no distinct row. Wings elongate, with short but distinct costal bristle; 3rd longitudinal vein bare, perfectly straight and parallel with the likewise straight last portion of the 4th. Wing pattern very like that of *dissoluta*, but with a dark praeapical band, which is not interrupted by hyaline streaks, and therefore the rounded spot below the end of the 2nd longitudinal vein, the apical one and that below the end of the 4th vein are more sharply defined. Lower angle of the anal cell acute, and rather produced; small cross-vein placed on the last third of the discoidal cell.

Type ♂ and type ♀, and some additional specimens of both sexes in the writer's collection, and a ♂ cotype in the British Museum, from Erythraea, Ghinda, December 1916 (*Dr. A. Mochi*).*

XXXII. Campiglossa, Rondani (1870).

The species of the present genus are robust and have a light grey, dark-spotted body; they have a very broad and rather buccate head, and are easily recognisable by the rather broad wings, which have a peculiar and rich wing pattern, recalling that of *Hoplochaeta.* But in *C. grandinata,* Rondani, evidently a member of the present genus, the wing pattern is like that of the *Euaresta*-group with non-radiating border (*Pliomelaena*), being however distinguished by the more numerous hyaline discal dots. All the known species of *Campiglossa* have two hyaline spots in the stigma, and usually these spots are of very great size.

1. **Campiglossa perspicillata,** sp. nov. (Pl. i, fig. 10).

A robust and handsome species, very near *irrorata,* Fallén, and *cribellata,* Bezzi, but distinguished from both in having all the macrochaetae of head and thorax whitish, and the basal hyaline spot of the stigma reduced to a narrow streak.

♀. Length of the body, 4·5 mm.; of the ovipositor, 1 mm.; of the wing, 4 mm.; breadth of the wing, 2·2 mm. Head very broad, broader than high and distinctly broader than the thorax; occiput dark grey on middle and above, whitish below; frons flattened, but rather prominent in front of the antennae, about 3 times as broad as the eye and distinctly broader than long; it is whitish, with a double longitudinal yellow stripe, more orange on the front half; the broad ocellar triangle and the large lunula are whitish; face short and broad, with less prominent mouth-border, entirely whitish; cheeks proportionally broad and white; jowls broad, immaculate, distinctly buccate. Antennae short and thick, considerably separate at base, pale yellowish in colour; third joint not longer than the thickened and short bristly second joint, distinctly darker than it in colour and obtuse at end; arista long, thickened at base, microscopically pubescent. Mouth opening very broad; palpi whitish, with a few short black bristles at end; proboscis short and thick, with the terminal part distinctly bent backwards. All the bristles are whitish and those of the occipital row are thickened; *oc.* stout; only 2 lower *or.* Thorax and scutellum black, but densely covered by a pale greyish, almost bluish dust, which is more whitish on the pleurae; there are no distinct dark markings, but the dorsal bristles are inserted on darkish dots; the short pubescence is whitish; all the bristles are stout and whitish; the *prsc.* are placed only a little behind the line of the *a. sa.* and thus the *dc.* are placed much before it, very near the suture. Scutellum convex and short; its basal bristles are very long and inserted over blackish spots; the apical ones are very short, rudimentary, decussate. Mesophragma like the back. Halteres whitish. Abdomen broad, coloured like the thorax, with 2 rows of broad, rectangular, not sharply defined, blackish, transverse spots, but the basal segment is immaculate; bristles whitish; ovipositor short, flattened, obtuse, shining black. Legs pale yellowish, but the 4 posterior femora distinctly darkened by dark grey dust; they have whitish hairs and 4–5 bristles on the front pair

* [The specimen figured is from Nyasaland, Mt. Mlanje, 23.iv.1913 (*S. A. Neave*).—Ed.]

beneath; tibiae of the middle pair with black apical spurs; hind tibiae without distinct row. Wings proportionally short and broad, rounded at end, with a small but distinct costal bristle. The 2nd, 3rd and 4th longitudinal veins are straight and distinctly diverging, chiefly the two former; 3rd vein bare; discoidal cell very broad at end and there about three times as broad as at base, the hind cross-vein twice as long as its distance from the small cross-vein, which is placed on the last third; lower angle of the anal cell acute and a little produced; axillary lobe well developed. The pattern is like that of the Indian *cribellata,* but with some peculiarities. The base is whitish hyaline, with 2 parallel dark streaks in the costal cell and a quadrate spot at base of the first basal cell. The stigma has a broad rounded hyaline spot and a narrow basal hyaline streak. Around the border of the wings there is a regular series of equal and rounded spots, grouped thus: 3, 2, 1, 3, 3; after this border there is a band with numerous and small hyaline dots; 2 symmetrical hyaline spots of greater size are in the first posterior cell, just before the apical spot between the ends of the 3rd and 4th vein; the centre of the wing is black, with several small hyaline spots, and between them 5 of greater size are placed in the form of a circle around the small cross-vein and at very regular distances from it; there are 2 in the submarginal cell, 1 in the first basal, 1 in the first posterior and 1 in the discoidal cell. All the hyaline spots are distinctly whitish.

Type ♀ and an additional specimen of the same sex from Durban, Umbilo, 31.x.1914 (*L. Bevis*).

2. **Campiglossa cyana,** Walker (1849).*

It is very probable that the present species, described from Sierra Leone as a *Noeeta,* may belong here, owing to the description of its proboscis. It seems to have a wing pattern very like that of the preceding species, but it differs in having the ovipositor ferruginous in the middle and the femora banded with black.

XXXIII. Camaromyia, Hendel (1914).

Prof. Hendel is his recent work on the South American fruit-flies has erected this genus for the very characteristic *Trypeta bullans,* Wied. (= *tenera,* Loew), which has a singular geographical distribution, being found in South Europe and in South America, and has besides a very remarkable sexual dimorphism. Hendel has described a second species, *C. philodema,* from Chile, and has recorded as belonging here the North American *aequalis,* Loew; I have to add to the genus the North American *gemella,* Coquillett, and the following Ethopian new species, of which only the female is known, which however has the peculiar wing pattern and the protuberance of the frons. *C. aequalis* and *gemella* have the 3rd antennal joint rounded at the end, while in *bullans* and the new species here described it has a rather sharp upper point at the tip.

* [An examination of the type specimen shows that this species is not a *Campiglossa* but an *Euribia,* and it runs down next to *E. dissoluta,* Lw., and *E. tristrigata,* Bezzi, in the author's key to that genus. It may be distinguished from these two species, *inter alia,* by the markings in the 2nd posterior cell; th s has along its margin three widely separated small round spots, the innermost being larger than the other two, and in the centre there is a small spot of the same size as the outer marginal ones and a minute dot. In the other species the markings are larger, irregular and for the most part confluent.—Ed.].

1. **Camaromyia acrophthalma,** sp. nov.

Very distinct from all the other known species on account of its peculiar pattern at the apex of the wings, the hyaline spot between the ends of the 3rd and 4th longitudinal veins being replaced by a brown, eye-like spot; besides, the ovipositor is much longer than in the other known females.

♀. Length of the body, 4 mm.; of the ovipositor, 2 mm.; of the wing, 4·5 mm. Head entirely whitish yellow and immaculate, even on the occiput, with only a small black ocellar dot; frons gently rounded in the middle and prominent in profile, about as broad as long; lunula whitish; face narrower than the frons, projecting very little at the upper mouth-border; eyes rounded; cheeks and jowls narrow. Antennae yellowish, a little shorter than the face; third joint twice as long as the second, attenuated towards the end and distinctly pointed at tip; arista bare. Palpi broad, spatulate, pale yellowish, with black bristles; proboscis yellow, short and simple. All the cephalic bristles are whitish; 3 lower *or.*, the anterior one being smaller; *oc.* long and stout. Thorax and scutellum entirely pale yellowish, clothed with whitish dust and with whitish pubescence; all the bristles are pale yellowish; middle *scp.* well developed; *prsc.* and *dc.* placed well forwards; apical scutellar bristles long and crossed. Mesophragma black, grey-dusted; halteres whitish. Abdomen coloured and dusted like the thorax, and likewise with whitish pubescence and whitish bristles; ovipositor longer than the abdomen, with the basal half swollen and conical, and the apical half cylindrical; it is of a shining reddish colour, broadly black at the end and clothed with whitish pubescence in the basal part. Legs entirely pale yellowish; front femora with 5–6 yellow bristles beneath; apical spur of the middle tibiae yellowish; hind tibiae with no distinct row. Wings long and narrow, with a distinct costal bristle; 2nd, 3rd and 4th longitudinal veins slightly diverging near the end, the last portion of the fourth being bent at base; 3rd vein bare; small cross-vein placed after the middle of the discoidal cell and parallel with the hind cross-vein; discoidal cell twice as broad at end as at base; lower angle of the anal cell acute but not produced. Veins pale yellowish, but darkened on the dark parts. Pattern of typical shape, but of a very pale colour, only the apical patch being dark brown; stigma colourless; the base broadly, half the 3rd posterior cell and the axillary cell almost hyaline. The apical blackish pattern occupies the lower end of the submarginal, the end of the first posterior and the upper end of the 2nd posterior cell; at apex there is the peculiar eye-shaped spot.

Type ♀, a single specimen from Nyasaland, Chiromo, Ruo R., 23.ix.1916 (*R. C. Wood*).

2. **Camaromyia helva,** Loew, Berl. Ent. Zeits., v, 1861, p. 294, pl. ii, fig. 24.

To judge from Loew's description of the head and from the figure of the wing, the present species may belong here. But as the proboscis is described as bicubitate and the bristles of the frons and thorax as black, its location here is doubtful.

Described from Caffraria, I have recorded it in 1908 from Erythraea as an *Oxyna*, but wrongly, as the abdomen is said to be spotted; probably I had before me a specimen of the above-described *Euribia tristrigata*.

XXXIV. ACANTHIOPHILUS, Becker (1908).

I here adopt this name for the species which have dimidiate (but always reticulate) wings, thus recalling the condition found in *Ocneros* (*Hemilea*), with which the present genus was originally believed to be related by its author.

1. **Acanthiophilus helianthe,** Rossi (1790).

Recorded by me in 1908 from Erythraea, Adi Caie; and I have now a specimen before me, certainly belonging to this widely spread South European and Mediterranean species.

2. **Acanthiophilus ochraceus,** Loew, Berl. Ent. Zeits., v, 1861, p. 295, pl. ii, fig. 25.

I refer with doubt to the present genus this species, which has a faint wing pattern, like that of *lauta*, but has several darker spots on the anterior half.

Described from Caffraria and not recorded subsequently.

XXV. TRYPANEA, Schrank (1795).

Even this genus is very doubtful in its limits, being absolutely an artificial one, but the species can easily be recognised on account of the star-shaped apical pattern of the wings, and seem to form a natural group, because they are well represented in all the zoological regions. Most of the Ethiopian species have a bicubitate proboscis, and usually only 2 bristles on the scutellum; I can distinguish the following, some of which are probably only varieties, and are in part closely allied to European or Mediterranean forms.

1(8). Stigma black, and broadly united with the apical black spot; the single basal hyaline spot of the first posterior cell is smaller than the distance between the 3rd and 4th longitudinal veins.

2(7). Second longitudinal vein long, its distance from the end of the first being longer than that from the end of the second; in the black apical spot there is a deep black dot on the 3rd vein before its end.

3(6). Sixth longitudinal vein long; the discoidal cell crossed by a single fuscous ray near its end.

4(5). Scutellum with only 2 bristles; the black apical spot sends 3 rays to the hind border of the wing; no black spot on middle of the 5th vein; lower angle of the anal cell acute .. .. *augur*, Frauenf.

5(4). Scutellum with 4 bristles; 4 rays reaching the hind border; a black spot on the 5th vein, lower angle of the anal cell a right angle, not prolonged *auguralis*, Bezzi.

6(3). Sixth vein short; the discoidal cell crossed by 2 fuscous rays, one in the middle and another at end; scutellum with 4 bristles *hexapoda*, sp. n.

7(2). Second longitudinal vein short, its end being nearer to the end of the first; the apical spot is more blackened near the end, but has no distinct deep black spot on the 3rd vein; scutellum with 2 bristles *confluens*, Wied.

8(1). Stigma colourless or yellowish, not united with the apical black spot, or only with a narrow, incomplete and slightly coloured streak; scutellum with 2 bristles; basal hyaline spot of the first posterior cell extending from the 3rd to the 4th vein.

9(14). Apex of the wings with the usual blackish fork; base of the first posterior cell with a single hyaline spot of greater size.

10(13). Species of greater size, measuring 3–4 mm. in length; ovipositor short and flattened.

11(12). Ground-colour of thorax and abdomen fulvous .. .. *aira*, Walk.*

12(11). Ground-colour of thorax and abdomen black .. .. *peregrina*, Ad.

13(10). Species of smaller size, 2–3 mm. in length; ovipositor longer than the abdomen and cylindrical .. .. *urophora*, sp. n.

14(9). Apex of the wings entirely hyaline and devoid of the usual fork; base of the first posterior cell with 2 hyaline spots.

15(18). There is a narrow but distinct dark streak extending obliquely from the stigma to the small cross-vein; macrochaetae yellowish.

16(17). Lower angle of the anal cell a right angle; a complete dark band goes from the stigma across the middle of the discoidal cell to the hind border of the wing; abdomen testaceous; no abbreviated apical ray on wing *aucta*, Bezzi.

17(16). Lower angle of the anal cell acute; no such band going from the stigma to the hind border; abdomen black or only reddish at sides; there is an abbreviated apical ray on wing .. .. .. *amoena*, Frauenf.

18(15). There is no streak at all from the stigma; macrochaetae dark brown or black.

19(20). There is an abbreviated apical ray on wing, no black spot on the middle of the 5th longitudinal vein; ovipositor longer than the abdomen *diversa*, Wied.

20(19). No abbreviated apical ray; a black spot on the middle of the fifth longitudinal vein; ovipositor shorter than the abdomen.. *decora*, Loew.

1. **Trypanea augur,** Frauenfeld (1856).

A pretty species, easily recognisable by its characteristic wing pattern and by the want of the apical pair of scutellar bristles.

In Egypt the present species lives on *Zygophyllum album*, as observed long ago by Frauenfeld. Becker records the species from Aden; I have received from Erythraea, Ghinda, June 1916 (*Dr. A. Mochi*) a male specimen, which agrees very well with Egyptian specimens in my collection received from Becker and Dr. Escher-Kündig; it has the abdomen broadly reddish on the sides.

2. **Trypanea auguralis,** Bezzi, Bull. Soc. Ent. Ital., xxxix (1907), 1908, p. 163.

Closely allied to the preceding species, and perhaps only a variety of it, distinguished by having 4 scutellar bristles and a somewhat different wing pattern.

Described from Erythraea, Adi Caiê, and not found since.

* [The characters given in the key do not apply to Walker's type, which has a wing pattern very similar to that of *T. amoena*, Frf., and *T. stellata*, Fues. The apex of the wing is hyaline; there are two spots in the base of the 1st posterior cell; the ground-colour of the thorax and abdomen is black dorsally, not fulvous; no oblique stripe from the stigma to the small cross-vein; and the lower angle of the anal cell is a wide acute angle.—Ed.].

3. **Trypanea hexapoda,** sp. nov. (Pl. i, fig. 12).

A small species with 4 scutellar bristles, distinct from all the allied species in having the discoidal cell crossed in the middle by a dark ray, which does not reach the hind border of the wing; but it has 6 complete rays, whence the name.

♀. Length of the body, 2·5–2·7 mm.; of the ovipositor, 0·4 mm.; of the wing, 2·5–2·7 mm. Occiput black, grey-dusted, but yellowish on the sides and below; frons flattened, elongate, as broad as the eye, twice as long as broad, only slightly prominent above the root of the antennae; the middle frontal stripe is yellow, opaque, with broad whitish orbits and greyish ocellar dot. Face short and yellowish, like the narrow and immaculate jowls; mouth-border distinctly prominent. Antennae short; second joint projecting and reddish; third joint as long as second, distinctly attenuated but not acute at end, and more or less darkened; arista brownish, bare. All the bristles around the occipital and vertical borders are whitish and thick; the *oc.* and the *or.* are dark brownish; only 2 lower *or.*; *oc.* rather stout. Palpi and proboscis dark yellowish; the latter is rather long and bicubitate, its last portion being as long as the basal one. Thorax black, densely grey-dusted; in well preserved specimens it seems to be cinereous on the back, with a dark, longitudinal, middle stripe; the pubescence is yellowish; the bristles are dark brownish or even blackish, but those of the pleurae are whitish; chaetotaxy normal. Scutellum and mesophragma coloured like the thorax; the former has 4 bristles, those of the apical pair being much shorter and crossed. Halteres pale yellowish. Abdomen black, dark grey-dusted, with yellowish pubescence and with yellowish or brownish bristles; ovipositor short, flattened, broad, obtuse, shining black, with short whitish pubescence at base. Legs entirely yellowish, rather short and stout, chiefly those of the front pair; front femora with 3–4 yellowish bristles beneath. Wings rather elongate, with a distinct costal bristle; 2nd, 3rd and 4th longitudinal veins straight and gradually diverging towards the end; second vein ending in the middle between the ends of the third and first; third bare; hind cross-vein much longer than its distance from the small cross-vein; lower angle of the anal cell a right angle and not produced; 6th vein very short, not produced into a spurious continuation. The pattern is like that of *augur,* but it is more blackish and agrees more with that of *confluens*; the deep black spot at end of the 3rd vein is very distinct. Characteristic of the species are: a dentiform projection of the black of the first basal cell along the 3rd longitudinal vein towards the base of the wing; and a dark ray, which, crossing the middle of the discoidal cell, ends towards the middle of the 3rd posterior cell. The 3 hyaline spots of the black apical patch are disposed as in *confluens.*

The present species seems to be allied to *cosmia,* Schin., which is recorded from Aden by Becker.

Type ♀, and an additional specimen of the same sex from Gold Coast, Aburi, March-April, 1911, on leaf of *Tabernaemontana* (*L. Armstrong*).

4. **Trypanea confluens,** Wiedemann (1830).

Allied to the preceding species, but distinct from it and from all the others on account of the short 2nd longitudinal vein. From the preceding it differs in having only 2 scutellar bristles, the lower angle of the anal cell acute, and the 6th longitudinal vein longer; besides, the wing pattern is different, having only 3 rays produced to the hind border of the wing.

Described from the Cape and recorded from Rhodesia.

5. **Trypanea aira,** Walker (1849).

Described from the Congo and not recorded subsequently. It seems to have a wing pattern more reduced than that of the preceding species, and thus more approaching to that of the two following.

6. **Trypanea peregrina**, Adams, Kans. Univ. Sci. Bull., iii, 1905, p. 170.

Described from Rhodesia, Salisbury, and apparently closely allied to the following new species.

7. **Trypanea urophora,** sp. nov. (Pl. i, fig. 11).

An elegant little species, distinguished by its very long and cylindrical ovipositor, and by its wing pattern, which is much like a diffuse reticulation of the *Euribia* type, but covering only the apical half of the wings. It is closely allied to the European species *mamulae* and *gnaphalii*, differing in the less developed dark pattern of the discoidal cell, which in the female is entirely hyaline; but it is possibly, like *peregrina*, only a form of those.

♂♀. Length of the body, 2·2–2·8 mm.; of the ovipositor, 1.6 mm.; of the wing, 2·4–3 mm. Head broad, occiput black, grey-dusted; frons flattened, not prominent, broader than the eye, only one and a half times as long as broad, opaque yellowish, with whitish lunula, broad whitish orbits and whitish ocellar triangle, in which there is a dark dot; face short, pale yellowish; cheeks and jowls narrow, whitish, the latter immaculate. Antennae reddish yellow, as long as the face, 3rd joint about twice as long as the not projecting second joint, broad and rounded at tip; arista short, dark brownish, bare. Palpi and proboscis pale yellowish, the latter long and geniculate, but with the recurrent flaps shorter than the basal part. The bristles of the hind border are whitish and thickened; those of the frons are dark brownish; the 2 lower *or.* and the *oc.* are strong. Thorax, scutellum and mesophragma black, clothed with dense cinereous dust, chaetotaxy complete, except the *scp.* which are, as usual, rudimentary; all the bristles are pale yellowish, those of the basal scutellar pair being long and inserted on rather broad dark dots; the apical pair is wanting. Halteres whitish. Abdomen coloured like the thorax, with rather long pale yellowish pubescence and with some short bristles of the same colour at end; ovipositor shining black, cylindrical and not much swollen at base; clothed with long scattered brownish hairs. Legs entirely yellowish; front femora with 3–5 yellowish or brownish bristles beneath; hind tibiae with no distinct row. Wings elongate, with a small costal bristle; 2nd longitudinal vein long, nearer to the end of the 3rd than to that of the first; third vein bare; 2nd, 3rd and 4th veins straight and slightly diverging towards the end; hind cross-vein arched outwardly and only a little longer than its distance from the small cross-vein; lower angle of the anal cell acute but not much produced; 6th vein rather short and not prolonged into spurious continuation. The wings are whitish-hyaline; the veins are pale yellowish, but they are dark brown on the dark parts of the pattern. The pattern is blackish, and very like that of *peregrina* as described by Adams; the stigma is colourless, with only the upper exterior angle darkened; a more or less indicated and interrupted oblique fuscous streak departing from the stigma goes to the small cross-vein, which is bordered with fuscous and is isolated from the rest. The blackish apical patch is nearly round, and has no hyaline spots in it, but has 7 great hyaline spots or indentations along its border, thus forming the projecting rays; these are: one at fore border, directed obliquely; one below the end of the 2nd vein; 2 on the ends of the 3rd and 4th veins forming the usual fork; and 3 in the 2nd posterior cell, the last of which is placed just on the hind cross-vein. There is besides the remnant of a less infuscated band below the 5th vein on the middle of the discoidal cell, not reaching the hind border. Characteristic for the species are: 2 hyaline contiguous rounded spots at the end of the first posterior cell, just before the large apical hyaline spot, thus giving a peculiar shape to the base of the apical fork or Y-shaped spot; the hyaline spot at base of the first posterior cell in front of the small cross-vein is of greater size, extending from the 3rd to the 4th vein; it is chiefly the breadth of these 4 hyaline spots which gives to the wing an appearence of reticulation, together with the rounded shape of some of the hyaline spots which form the radiating fuscous streaks.

Type ♂, type ♀, and some additional specimens of both sexes from Durban, Umbilo, February–April 1914 (*L. Bevis*).

8. **Trypanea aucta,** Bezzi, Mem. Ind. Mus., iii, 1913, p. 166, pl. x, fig. 69; var. **repleta,** var. nov.

Perfectly corresponding with the Indian female described by me in the important characters of the obtuse anal cell and of the complete middle band of the wings, but differing in the following peculiarities, on which I have to erect here a new variety under the name of *repleta*.

♂. Length of the body, 3·5 mm.; of the wing, 3·5 mm. The hyaline spot at the apex of wing just below the end of the second longitudinal vein is reduced to a

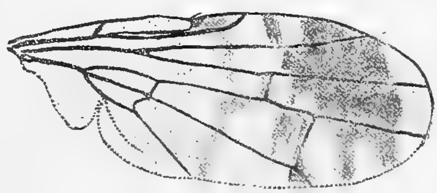

Fig. 3. *Trypanea aucta*, Bezzi, var. *repleta*, nov.

very small dot. The apical hyaline space is broader, being much extended below the 4th vein, and occupying the whole terminal angle of the second posterior cell. The hyaline indentation between the 2 terminal rays of the hind border is entirely wanting, and thus there are only 3 (not 4) dark rays reaching the hind border in the 2nd posterior cell. The apical hyaline spot of the discoidal cell is reduced to a very small streak. The small cross-vein is margined with fuscous as in the typical *aucta*, as mentioned in the original description, but omitted in the figure.

Type ♂, a single specimen in the author's collection from Erythraea, Ghinda, June 1916 (*Dr. A. Mochi*).

9. **Trypanea amoena,** Frauenfeld (1856).

Of this well known species, which is widely spread over Europe, Mediterranean countries and the entire Oriental region to the Philippines, I have before me a male specimen from Erythraea, Ghinda, June 1916 (*Dr. A. Mochi*).

10. **Trypanea diversa,** Wiedemann (1830); Loew, Berl. Ent. Zeits., v, 1861, p. 298, pl. ii, fig. 27.

A peculiar species, described from the Cape by Wiedemann and Loew; I have not yet seen it.

11. **Trypanea decora,** Loew, Berl. Ent. Zeits., v, 1861, p. 300, pl. ii, fig. 28.

Described from the Cape and not recorded since; it is perhaps only a variety of *amoena*, as already suspected by Prof. Hendel.

IV. Subfamily: SCHISTOPTERINAE.

This subfamily is a very peculiar one, and representatives of it are to be found only in the Ethiopian and Oriental regions, all the three known genera being present in Africa. The character of the *dc.* shows their affinity with the TRYPANEINAE.

XXXVI. RHABDOCHAETA, de Meijere (1904).

Of this rather aberrant Oriental genus the following Ethiopian species has been described.

1. **Rhabdochaeta spinosa,** Lamb, Trans. Linn. Soc. London, Zool. xvi, 1914, p. 320, fig. 13 & pl. 19, fig. 10.

Seychelles, from various localities.

XXXVII. RHOCHMOPTERUM, Speiser (1910).

Only the following species is known.

1. **Rhochmopterum neuropteripenne,** Speiser, Wiss. Ergebn. Schwed. Exped. Kilimandjaro, x, Dipt., 1910, p. 186.

Described from Kilimanjaro.

XXXVIII. SCHISTOPTERUM, Becker (1903).

There is a single species at present known, which is Mediterranean and Ethiopian.

1. **Schistopterum moebiusi,** Becker, Mitt. Zool. Mus. Berlin, ii, 1903, p. 137, pl. 4, fig. 49.

Found in Egypt, Siala, on the plant *Conyza dioscorides*, by Becker.

EXPLANATION OF PLATE I.

Fig. 1. *Ocnerioxa woodi,* Bezzi, sp. n. × 5.

2. *Craspedoxantha manengubae,* Speis. × 5.

3. *Aciura semiangusta,* Bezzi, sp. n. × 5.

4. ,, *tetrachaeta,* Bezzi, sp. n. × 6.

5. *Tephrella cyclopica,* Bezzi. × 6.

6. *Platensina diaphasis,* Big. × 5.

7. *Euaresta strictifrons,* Bezzi, sp. n. × 5.

8. ,, *brevifrons,* Bezzi, sp. n. × 6.

9. *Euribia tristrigata,* Bezzi, sp. n. × 7.

10. *Campiglossa perspicillata,* Bezzi, sp. n. × 6.

11. *Trypanea urophora,* Bezzi, sp. n. × 7.

12. ,, *hexapoda,* Bezzi, sp. n. × 7.

WINGS OF AFRICAN TRYPANEIDÆ.

SOME NEW SPECIES OF TACHINIDAE FROM INDIA.

By John D. Tothill,

Entomological Branch, Department of Agriculture, Ottawa, Canada.

A collection of Indian Tachinid flies was received some time ago through the kindness of Dr. A. D. Imms. An examination has shown that most of the specimens are new, and these are described forthwith. In the use of genera a conservative course has been adopted, and the new species have been placed for the time being at least in genera already in use.

The type specimens have been deposited for the present in the National Collection of Insects maintained by the Entomological Branch of the Department of Agriculture at Ottawa.

Gymnochaeta immsi, sp. n.

Bright bluish green species with smoky wings. No appendage at bend of M. 1+2 (fourth vein). Palpi black, except the tips which are reddish. Length 12–13 mm.

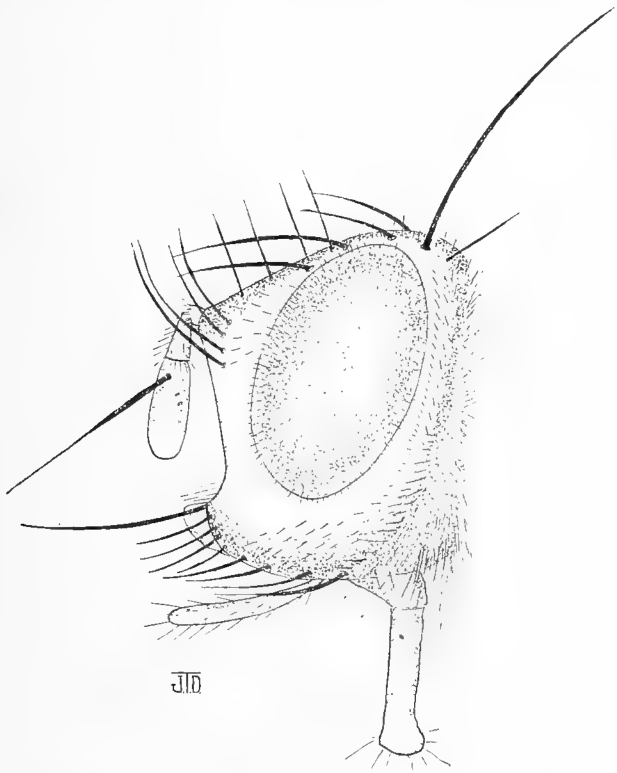

Fig. 1. Head of *Gymnochaeta immsi*, sp. n., ♀.

Head (fig. 1) at vibrissae about as long as at base of antennae; vibrissae far above the oral margin. Palpi black, with the tips slightly tinged with reddish. Eyes hairy. Cheeks (genae) white pollinose and covered on their lower three-fourths with black hairs. Sides of face white pollinose, bare, nearly half as wide as the facial depression. Facial ridges bristly on lower fifth. Facial depression white pollinose without any carina. All segments of antenna black ; the third segment in both sexes about one and one-half times length of second. Arista thickened on basal two-fifths, the second segment as long as broad. The front as wide in female, and three-fourths as wide in male, as either eye ; the sides of front white pollinose above the antennae, blending to greenish on either side of the ocellar triangle ; orbital bristles present in female and absent in male ; the frontal vitta dark brown, opaque, and twice as wide as either side of front at narrowest place. Ocellar bristles present in both sexes and directed forward.

Thorax bright bluish green and very thinly white pollinose. Two sternopleural bristles and four post-suturals. Scutellum bluish green, with three pairs of strong marginal macrochaetae and a weaker terminal pair. Legs black ; in female, tarsi slightly flattened out ; tarsal claws of male longer than in female ; middle tibiae with several bristles on the front side near middle. The wings (fig. 2) brownish, especially in the vicinity of the veins ; venation as in figure. R. 4+5 (third vein) with about five little bristles at base. M. 1+2 (fourth vein) destitute of an appendage. Tegulae white.

Fig. 2. Wing of *Gymnochaeta immsi*, sp. n.

Abdomen bluish green and shining ; the segments very thinly coated with whitish pollen. The second and third segments with strong discal as well as marginal bristles. The venter with a median longitudinal area bearing short, almost spinose bristles.

Described from one female (the type) and four male paratypes collected by Dr. A. D. Imms, near Bhowali, Kumaon, India, in July 1909, at an elevation of 5,700 feet.

This fine fly is about twice as large as *G. viridis*, Meig., and easily separated from it by the absence of an appendage at the bend of M. 1+2 ; by its much more clouded wings ; and by its bluish green rather than green colour. It is apparently more closely related to Wiedemann's species *rheinwardtii* from Brazil than to any of its Palearctic and Nearctic congeners. In the case of *rheinwardtii*, however, the palpi are reddish yellow and the wings as clear as water.

Servillia transversa, sp. n.

Abdomen black, with the sides yellowish red ; the bases of segments two, three and four with a wide pale-coloured band contrasting strongly with the remainder of the abdomen. Wings hyaline. Male with very weak or no ocellar bristles ;

female with ocellar bristles well developed. Head thorax and abdomen with abundant straw-coloured pile in amongst the bristles and macrochaetae. Length, 11–13 mm.

Head (fig. 3) as long at vibrissae as at base of antennae; vibrissae far above the oral margin. Palpi well developed, yellow. Eyes bare. Cheeks (genae) white pollinose and entirely covered with long straw-coloured pile. Sides of face white pollinose, with abundant straw-coloured pile on outer three-fourths; at narrowest point nearly half as wide as the facial depression at its greatest width. Facial ridges with bristles confined to lower sixth. Facial depression white pollinose, without any carina. All three segments of the antenna black, but varying occasionally to slightly reddish; in both sexes the second segment longer than the third. The arista thickened on basal three-fourths; the second segment one-third to one-fourth

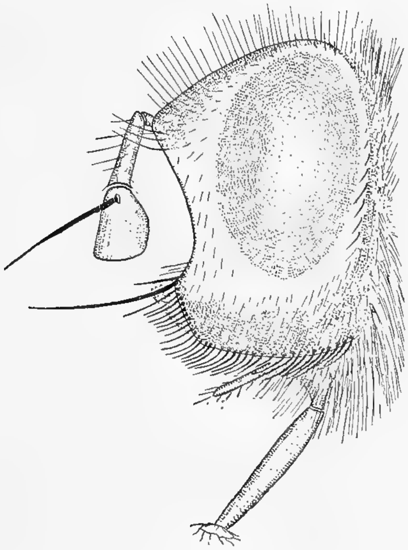

Fig. 3. Head of *Servillia transversa*, sp. n., ♂.

as long as the third. Front at narrowest point in female one and one-fourth, in male about three-fourths, the width of either eye; sides of front whitish pollinose at base of antenna, blending to almost black at the vertex. The frontal vitta opaque, about the colour of the eyes, and at narrowest point about as wide as either side of the front. Female with, male without, orbital bristles. Ocellar bristles present in female, very weak or absent in male.

Thorax black, covered with yellowish pollen not quite heavy enough to make it opaque. Long straw-coloured pile plentiful among the black bristles and macrochaetae. Two sternopleural bristles; the post-suturals varying from three to four. Legs reddish, with tarsal claws conspicuously longer in the male than in the female. Wings (fig. 4) hyaline; a conspicuous fold at the bend of M. 1+2 (fourth vein) looking at first sight like an appendage. A group of about six little bristles at base of R. 4+5 (third vein).

First segment of abdomen black, with the sides reddish yellow. The succeeding three segments with a broad straw-coloured transverse band at base, followed by a shining black area reaching to the hind margin; and with the sides slightly to entirely reddish yellow. No discal macrochaetae on first three segments.

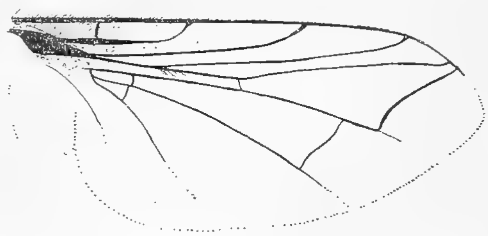

Fig. 4. Wing of *Servillia transversa*, sp. n.

Described from four males and three females collected in India by Dr. A. D. Imms at the following places and dates.

Dehra Dun: 1♂, 19.iii.13; 1♂, 1.iv.13; 1♂, 9.iv.13; 1♂, 18.iv.13—all taken on grass.

Binsar, Kumaon: 1♀, 23.v.12, 7,900 ft.; 1♀, 24.v.12, 7,700 ft.

Kalligan Range, Jaunsar: 1♀, 3.x.12.

This species is closely related to *S. lurida*, Fab., of Europe. It can be easily separated from this species however by the conspicuous pale abdominal bands, by the appendage-like fold at the bend of M. 1+2, and by its slightly greater width of front.

Servillia ursinoidea, sp. n.

An unusually large fly without any striking colour markings. Head thorax and abdomen with abundant long straw-coloured pile, as well as the usual bristles and macrochaetae. Sides of abdominal segments reddish. Wings hyaline. Third segment of antenna in male as broad as long. Width of front in male at narrowest point half to two-thirds the width of either eye. Length, 14 to 17 mm.

Head (fig. 5) at vibrissae as long as at base of antennae; vibrissae far above the oral margin. Palpi well developed, yellow. Eyes bare. Cheeks (genae) pale golden pollinose, covered almost to the eyes with long straw-coloured pile; around the oral margin a single row of black bristles; the distance from the oral margin to the lower end of eye is almost as great as the eye height. Sides of face pale golden pollinose, thickly covered with long pale golden pile; about one-third as wide as widest part of facial depression. Facial ridges with bristles confined to lowest fifth. Facial depression whitish pollinose, with no carina. All three segments of the antenna black, the second varying however to reddish; the second segment in the male a little longer than the third; the third segment in the male unusually broad, in fact as broad as long. The arista thickened on basal two-thirds, the second segment about a fourth as long as the third. Front in male at narrowest point about three-fourths the width of either eye; black, but in some specimens the colour largely masked by golden pollinosity. The frontal vitta opaque and about the colour of the eyes ; at narrowest point about as wide as either of the sides of front. No orbital bristles in male. Ocellar bristles in male reduced to mere hairs and sometimes absent.

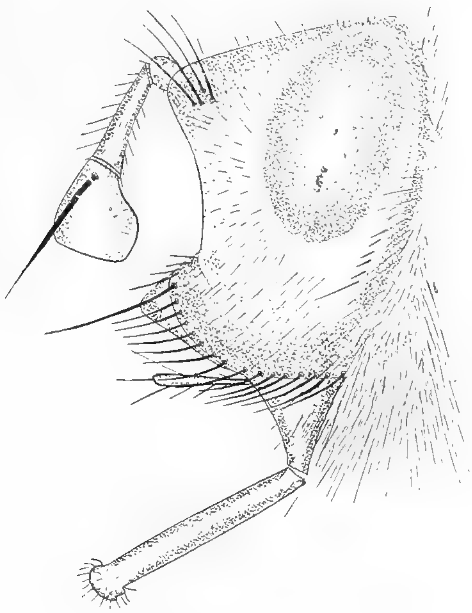

Fig. 5. Head of *Servillia ursinoidea*, sp. n., ♂.

Thorax black, but rendered almost opaque by golden pollinosity. Long golden pile abundant. Scutellum reddish. Usually three sternopleural bristles, but in the six specimens at hand they vary from two to four. Four post-suturals. Femora black, except the extreme distal ends, which are reddish. Tibiae and tarsi reddish. Tarsal claws and pulvilli noticeably long in the males. Wings (fig. 6) hyaline ; about eight little bristles at base of R. 4+5. Tegulae white.

Fig. 6. Wing of *Servillia ursinoidea*, sp. n.

Abdomen black, with the sides of all segments reddish. At the base of segments 2, 3, and 4 a wide but very faint transverse pale-coloured band. Rich golden pile abundant on every segment. No discal bristles.

Described from six males collected in India by Dr. A. D. Imms as follows :—

Binsar, Kumaon : 1 ♂, 25.v.12, in jungle at 7,700 ft.

Airadeo, Kumaon : 4 ♂♂, 31.v.12, 6,880 ft. ; 1♂, 3.vi.12, 6,880 ft.

This very large fly looks much like its Palearctic congener, *S. ursina*, Meig., and is evidently closely related to it. The width of the front is however nearly twice as great in the male of *ursinoidea* as in that of *ursina*. In the Indian fly moreover the third segment of the antenna in the male is much broader than in the male of *ursina.*

Gonia himalensis, sp. n.

The entire fly covered with pale golden pollinosity. Abdomen black, with yellowish red on sides of each segment and rendered sub-opaque on account of the pale golden pollen. Wings hyaline. Frontal vitta opaque, yellow. Third antennal segment in female three times, in male six times, as long as second. Second segment of arista only half as long as third.

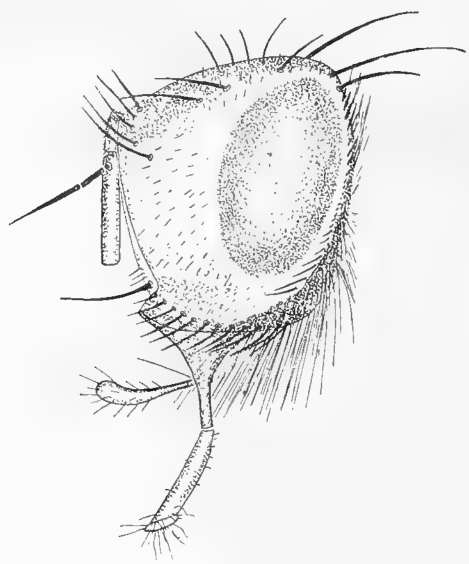

Fig. 7. Head of *Gonia himalensis*, sp. n., ♀.

Head (fig. 7) at vibrissae a little shorter than at base of antennae. Vibrissae plainly above the oral margin. Palpi well developed, pale yellow. Eyes bare. Cheeks (genae) pale golden pollinose and covered on their basal three-fourths with golden hairs ; a row of black bristles along the oral margin and ending at the vibrissae ; distance from the oral margin to base of eye about one-third the eye height. Sides of face at narrowest part about as wide as distance between the two vibrissae ; pale golden pollinose and covered with black hairs that at the lower end shade into the golden hairs of the genae. Facial ridges bare, except on lowest sixth. Facial depression pale golden pollinose, with a well-marked vertical carina. First two segments of antenna and sometimes base of third yellow ; third segment usually entirely black. Third segment in female three times, in male six times, as long as second. Arista thickened on basal three-fourths, the second segment one-third to one-half as long as the last. Front at narrowest point about one and one-fourth times in male, and one and one-half times in female, as wide as either eye. Sides of front at lower end opaque pale golden pollinose shading to shining yellow at the vertex. The frontal vitta opaque, cinnamon colour; at ocellar triangle only one-third as wide as either side of front. Orbital bristles in both sexes. Ocellar bristles in both sexes and directed backward.

Thorax opaque, golden pollinose on a black base; the scutellum sub-shining and yellowish; long golden pile abundant on both thorax and scutellum. Four sterno-pleural bristles and four post-suturals. Legs black, varying occasionally to slightly reddish in all segments; tarsal claws and pulvilli only slightly larger in male than in female. Wings (fig. 8) hyaline; with two to six little bristles at base of R. 4+5 (third vein).

Tegulae white. Abdomen subopaque pale golden pollinose on a black ground; the sides of all segments reddish yellow largely obscured in fresh specimens by the golden pollen. Second segment with a pair of median marginal macrochaetae, but no discals on segments two or three.

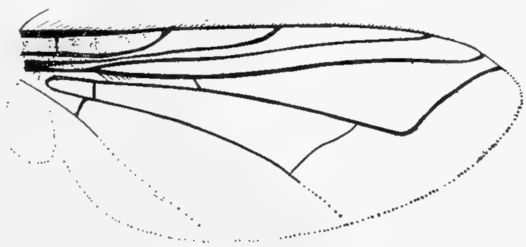

Fig. 8. Wing of *Gonia himalensis*, sp. n.

Described from seven males and nineteen females collected (except where otherwise specified) by Dr. A. D. Imms in the United Provinces, India. The field data are as follows:—

Binsar, Kumaon: 1 ♂, 2 ♀♀, 25.v.12, in jungle, 7,700 ft.

Bhowali, Kumaon: 1 ♀, 22.vi.12.

Dehra Dun: 1 ♀, 22.iii.12, on grass; 1 ♀, 2.iv.10 (*Jasman*); 4 ♀♀, 2.iv.13, on grass; 1 ♀, 2.iv.13 (*N. C. Chatterjee*); 1 ♀, 7.iv.13, on grass; 3 ♀♀, 9.iv.13; 1 ♀, 10.iv.13, on grass; 1 ♀, 17.iv.13, on grass; 1 ♀, 22.iv.12; 1 ♀, 23.iv.12; 1 ♂, 6.v.13; 2 ♂♂, 17.v.13; 2 ♂♂, 22.v.12; 1 ♀, 30.v.13; 1 ♂, 6.vi.12.

In size and general appearance this fly resembles both Nearctic and Palearctic specimens of *G. capitata*, DeGeer. The shortness of the second aristal segment will however serve to separate it from this species, as also from *G. divisa*, Meig., *G. fasciata*, Meig., *G. ornata*, Meig., and even *G. flaviceps*, Zett. In fact in this character alone the Indian species exhibits the condition found in *Spallanzania*; in habitus, however, the fly is clearly a *Gonia*. Macquart's species *rufitibialis* from Pondicherry, and Walker's *oestroides* from Hindustan, I have not seen, and both are unrecognisable from the descriptions.

Paraphania fuscipennis, sp. n.

Frontal depression and sides of face bright golden pollinose. Third segment of antenna in male at least six times as long as second. Palpi dark brown. Genae bare, golden pollinose. Wings dark brown, cell R. 5 open at margin of wing. Discal bristles present. Length, 12 mm.

Head (fig. 9) at vibrissae very much shorter than at base of antennae. Vibrissae on a level with the oral margin. Palpi dark brown, almost black. Eyes bare. Cheeks (genae) bare and golden pollinose; at the oral margin a single row of weak black bristles ending with the vibrissae; distance from oral margin to eye about one-third of eye height. Sides of face bare, bright golden pollinose; width of narrowest part equal to about three-fourths the distance between the two vibrissae. Facial

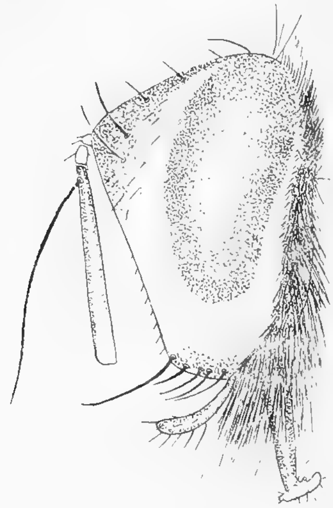

Fig. 9. Head of *Paraphania fuscipennis*, sp. n., ♂.

ridges with weak hairs on basal half. Facial depression bright golden pollinose, with no median vertical carina. Antenna in male almost reaching the oral margin, dark brown; second segment only slightly longer than first, third segment from six to eight times as long as second and flattened laterally, especially at distal end, where it tapers almost like the blade of an axe. Arista filiform, with no marked thickening even at base; first and second segments each about one and one-half times as long as broad; third segment about as long as last antennal segment; it is thickly clothed with very short hairs that are hardly as long as the arista is thick. Front at vertex about three-fourths as wide as either eye; black, except at the lower ends, where the colour blends to gold; frontal vitta opaque, black, twice as wide at narrowest point as either of the sides of front. No orbital bristles in male and all the frontal bristles notably weak. Ocellar bristles present and directed forward.

Thorax, including scutellum, with black ground mostly masked by gray pruinosity; four black longitudinal vittae, the outer pair being twice as wide as the inner. Three sternopleural bristles and three post-suturals; scutellum with three pairs of marginal bristles and no apical pair. Legs black, the tarsal claws and pulvilli in male greatly enlarged; no bristles on flexor surface of any of the tibiae. Wings (fig. 10) dark brown; cell R. 5 opening slightly before the extreme tip of wing; a very few bristles at base of R. 4+5 (third vein). Tegulae white.

Abdomen rather long and cylindrical; black and rather weakly grey pollinose. Disca bristles as well as marginal ones on each segment after the first.

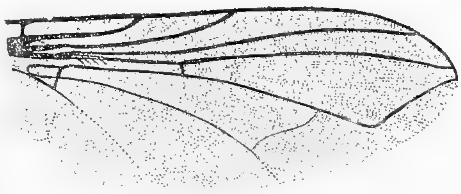

Fig. 10. Wing of *Paraphania fuscipennis*, sp. n.

Described from a single male collected by Dr. A. D. Imms, on 13th June 1912, at Chabuttia, Kumaon, India.

Of the affinities of this fly I am not at all sure, but in the absence of comparative material it seems more desirable to place it provisionally in Brauer and Bergenstamm's genus *Paraphania* than to propose a new genus for its reception. *Zambesa ocypteroides*, Walker, listed by V. d. Wulp from Singapore I have not seen, and the description is too meagre to have much value. *Duvaucelia* (*Curtocera*) *bicincta*, R. D., listed by V. d. Wulp from Bengal I have not seen either.

Chaetoplagia asiatica, sp. n.

Upper part of head and thorax golden pol'inose. Palpi yellow; cheeks (genae) as well as sides of face bearing strong macrochaetae. R. 1 (first vein) bristly on its entire length; R. 4+5 (third vein) bristly on almost its entire length. Three

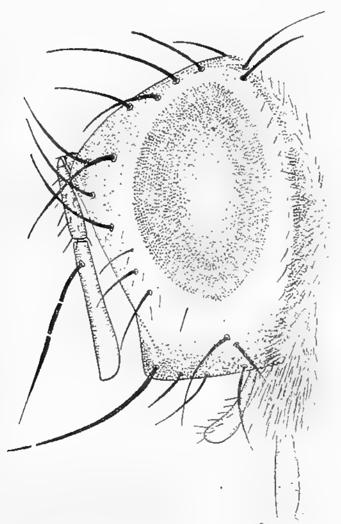

Fig. 11. Head of *Chaetoplagia asiatica*, sp. n.

sternopleural bristles and three post-suturals. Abdomen grey pollinose on a black ground; discal as well as median marginal bristles on segments 2, 3 and 4. Length, 8 mm.

Head (fig. 11) at vibrissae almost as wide as at base of antennae. Vibrissae on a level with oral margin; palpi well developed, yellow. Eyes bare; cheeks (genae) white pollinose, two large black macrochaetae in the middle, a few black hairs along oral margin in a row terminating with the vibrissae. Distance from oral margin to base of eye almost half as great as eye height. Sides of face whitish pollinose below, becoming golden pollinose above, bearing a row of four stout macrochaetae; width at narrowest point equal to almost half the distance between the vibrissae. Facial ridges bare, with no bristles whatever above the vibrissae. Facial depression white pollinose, with no median carina. Antennae fully as long as face; first two segments reddish, third segment black, varying to somewhat reddish at base; length of third segment about twice that of second. Arista black, thickened on basal three-fourths; first two segments of equal length and together as long as third segment. Front at narrowest part one and one-half times as wide as either eye; sides of front bright golden pollinose, blending at lower end to white, frontal vitta about colour of eyes and opaque, at narrowest point narrower than either side of front. Orbital bristles present; ocellar bristles present, directed forward.

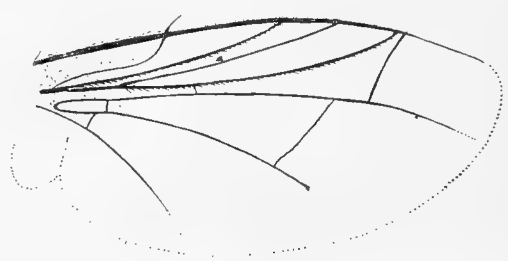

Fig. 12. Wing of *Chaetoplagia asiatica*, sp. n.

Thorax golden pollinose on black base, sub-shining. Three sternopleural bristles and three post-suturals. Scutellum with two pairs of marginal macrochaetae and a weak cruciate apical pair. Legs black, unusually bristly. Wings (fig. 12) hyaline, cell R. 5 terminating far before tip of wing. R. 1 (first vein) bristly for entire length; R. 2+3 destitute of bristles; R. 4+5 bearing bristles for almost entire length; bend of M. 1+2 (fourth vein) bearing a long appendage. Tegulae white.

Abdomen black, blue-grey pollinose on basal three-fourths of segments 2, 3 and 4; same segments bearing a pair of discal, as well as a pair of median, marginal macrochaetae.

Described from two specimens, apparently females, collected in Kumaon by Dr. A. D. Imms, who gives the following field data.

Khati, Kumaon: 30.v.09, 7,650 ft.

Bhowali, Kumaon: 20.vi.12.

This beautiful little fly is clearly congeneric with Coquillet's Nearctic *C. atripennis*, rather than with any Palearctic species known up to the present time. It seems to have the distinction of being the first species of the *Plagia* group to be described from any part of Asia.

Frontina kashmiri, sp. n.

Thorax and abdomen grey pollinose on a black ground. Wings hyaline. Palpi yellow. Facial ridges bristly on lower two-thirds. Third segment of antenna in male two and a half times the length of second. Eyes bare. Front of male at ocellar triangle about three-fourths the width of either eye. Thre esternopleural bristles and four post-suturals. Scutellum black. Second abdominal segment with a pair of median marginal macrochaetae. Hind tibiae with comb-like arrangement of bristles.

Head (fig. 13) at vibrissae much narrower than at base of antennae. Palpi well developed, yellow. Vibrissae inserted well above the oral margin. Eyes bare. Cheeks (genae) white pollinose, covered with short black hairs almost to the base

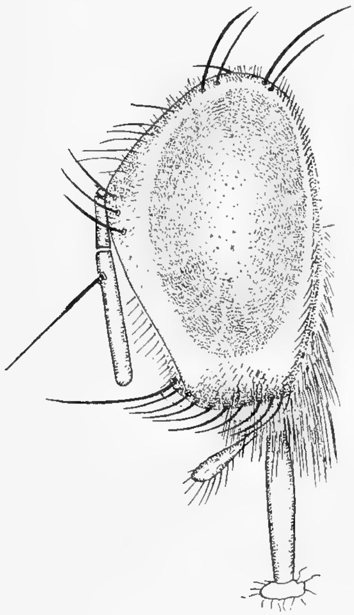

Fig. 13. Head of *Frontina kashmiri*, sp. n., ♂.

of eyes; a row of stouter bristles at oral margin, forming an obtuse angle with the bristles of the facial ridges. Distances from oral margin to base of eye equal to about one-third of eye height. Sides of face covered with silvery pollen, bare except for a few scattered black hairs; narrowest width equal to half the distance between the vibrissae. Facial ridges bristly on lower two-thirds. Facial depression silvery pollinose, without any carina. Antenna in male reaching lower three-fourths of face, the first two segments reddish, the last black; third segment in male two and one-half times the length of second. Arista thickened on basal two-fifths, the penultimate segment no longer than broad. Front in male at narrowest point about three-fourths the width of either eye, silvery pollinose below, grading to black at vertex; frontal vitta dull, dark brown, at narrowest point only a third as wide as either side of front. No orbital bristles in male; the frontal bristles extending to base of third antennal segment. Ocellar bristles present in male, directed forward.

Thorax sub-shining, black, covered with grey pollen; scutellum grey pollinose on a black ground, tinged slightly reddish at apex. Three sternopleural bristles and four post-suturals; scutellum with four marginal pairs of macrochaetae and a weak terminal non-cruciate pair. Legs black, the hind tibiae with a conspicuous comb-like row of bristles on outer side. Wings (fig. 14) hyaline; R. 4+5 (third vein) with a group of about three small bristles at base. Tegulae white.

Fig. 14. Wing of *Frontina kashmiri*, sp. n.

Abdomen sub-shining; pale golden pollinose on a black ground. No discal bristles; the second segment with a median marginal pair.

Described from a single male specimen taken by Dr. A. D. Imms at Dehra Dun, Kumaon. The fly was collected on grass on 30th April 1913.

As to affinities, I have little hesitation in placing the fly in the genus *Frontina*. The few weak hairs on the sides of face would prevent the fly from running here in any of the keys, but it has an evident *Frontina* habitus. I have unfortunately only one specimen and do not know to what extent these hairs vary in the species. The form can be separated from the Palearctic *F. tibialis* by the length of the third antennal segment, which is two and a half to three times the length of the second, instead of six times as long. It differs from *Frontina* (*Blepharella*) *lateralis*, Macq., which is recorded from Pondicherry, by its black scutellum and by its lack of yellow abdominal markings.

Lophosia excisa, sp. n.

An elongate black fly, with grey pollen on thorax and abdomen. Front of head strongly excised between the eyes. Palpi black; cheeks and sides of face bare. Eyes bare. Two sternopleural bristles and three post-suturals. Legs yellow, except tarsi, which are black. Wings slightly clouded with brown; a group of about three small bristles at base of R. 4+5 (third vein). Abdomen with five visible segments, the first one short; black and shining, except for the grey pollinose bands at bases of segments 3, 4, and 5.

Head (fig. 15) at vibrissae shorter than at base of antennae. Vibrissae on a level with the oral margin. Palpi well developed, black or very dark brown. Eyes bare. Cheeks (genae) bare, or covered only with very short velvety pile just long enough to escape being called pollinose; silvery; a row of black hairs at oral margin terminating at the vibrissae. Distance from oral margin to base of eye equal to about one-fourth of the eye height. Sides of face bare, silvery; narrowest width equal to about one-fourth of the distance between vibrissae. Facial ridges bare, except on lowest fourth. Facial depression silvery pollinose, slightly elevated vertically toward the middle. Antenna in male almost as long as the face, black but tinged with yellowish red; the third segment in male about two and a half times the length

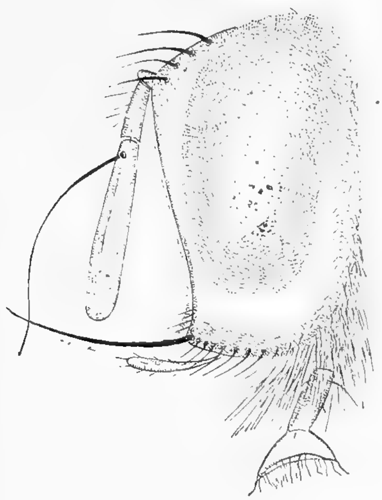

Fig. 15. Head of *Lophosia excisa*, sp. n., ♂.

of the second. Arista yellowish, thickened on basal third; the second segment not longer than broad. Front at vertex deeply excised; in male about half as wide as either eye; white pollinose below, shading to black at vertex; vitta dull deep chestnut in colour, at narrowest part about one and one-half times as wide as either side of front; no orbital bristles in male; the frontals reaching the base of second antennal segment. Ocellar bristles weak, directed forward.

Thorax, including scutellum, black, sub-shining, thinly covered with grey pollen. Two sternopleural bristles, three post-suturals. Scutellum with two strong marginal

Fig. 16. Wing of *Lophosia excisa*, sp n.

pairs of macrochaetae and no apical pair; at the base a weak pair of bristles inserted just above the margin. Legs yellow, except the tarsi, which are black; front tarsi in male somewhat enlarged; very few bristles on any of the legs. Wings (fig. 16) tinged with brown; a group of about three small bristles at base of R. 4+5 (third vein). Tegulae white.

Abdomen of five visible segments, the first very short; black and shining but for basal transverse bands of grey pollen on segments 3, 4, and 5. No discal bristles on any of the segments; a median marginal pair on the second, third, and fourth; the fifth segment with no dorsal bristles whatever.

Described from a male fly taken at Dehra Dun, Kumaon, by Dr. A. D. Imms. The specimen was taken on flowers on 26th August 1912.

Lophosia (*Paralophosia*) *imbuta*, Wied., is recorded from the East Indies; the description of this fly is too meagre however to indicate relationships and I have seen no specimens of it. Another fly that may be closely related is Mik's Palearctic *Atylostoma tricolor*, in this case also I have no material for comparison.

ON TWO SPECIES OF PHYSOTHRIPS (THYSANOPTERA) INJURIOUS TO TEA IN INDIA.

By Richard S. Bagnall, F.L.S.

The two species of thrips described in the following pages have been found on tea in sufficient numbers as to be regarded as pests, and they should therefore be made known to economic biologists. A member of the sub-order Tubulifera (*Haplothrips* sp.) was also found both by Prof. Maxwell Lefroy and Mr. Andrews on tea, but it seems to occur also on other plants; I have not yet had the opportunity of studying it.*

P. lefroyi is a strongly characterised species both in structure and coloration; whilst *P. setiventris*, when *both* sexes are taken, should be easily recognised by the black "tail" of the ♂. The former species may ultimately be removed from the genus *Physothrips*, with advantage.

Physothrips setiventris, sp. nov. (fig. 1).

♀. Length about 1·2 mm.

Head light grey-brown; prothorax and pterothorax yellowish, lightly shaded with grey-brown to brown; abdomen chestnut-brown. Antennal joints 1 and 2 grey-brown, as dark as or slightly darker than head; 3 pale yellow; 4 brown, with extremities clear or yellowish; 5, 6 and style chestnut-brown, concolorous with abdomen. Legs pale yellow; femora, chiefly along outer margins, scarcely noticeably tinged with grey or grey-brown. Fore wing with basal fourth (or thereabouts) clear, thence brown to the apical eighth (which is also clear), this brown area being somewhat lighter about the middle and giving a banded appearance; setae brown, cilia smoky.

Head about 0·7 as long as wide; cheeks subparallel, almost imperceptibly arched; dorsal surface irregularly transversely striate posteriorly. Eyes in greatest dorsal length occupying about 0·6 of the total length of head, moderately coarsely facetted, pilose; space between eyes about the width of one of them; ocelli set well back, posterior pair on a line drawn across the basal fifth of eyes, with a pair of well-developed interocellar bristles between them. Mouth-cone reaching well across prosternum; maxillary palpi long, 3-segmented the middle joint being the shortest. Antennae set below the vertex, sub-approximate, 2·3 times as long as the head; all usual setae long, prominent; segments minutely setose in more or less ring-form; relative lengths of segments approximately as follows:—16 : 28 : 40 : 36 : 24 : 29 : 5 : 10; form normal, segment 6 short and stouter than is usual, being approximately equal in length to 2; forked sense-trichomes on 3 and 4 with the arms widely branching (fig. 1 *c*).

Pronotum subquadrate, about 1·2 times as long as the head and 1·25 times as broad as long; posteriorly margined; surface sparingly setose. The pair of setae at posterior angles rather stout, subequal in length and about 0·45 the length of the prothorax. Pterothorax normal, only very slightly longer than broad. Legs normal, sparingly setose; hind tibia with a series of stout setae at apex within, and the

* *Haplothrips tenuipennis*, Bagn. (Ann. Mag. N H. (9) i, March, 1918).

hind tarsus furnished with more than usually stout setae. Wings fully developed, pointed apically. Fore wing about 14 times as long as wide across middle; veins indistinct; costa with 28 setae; lower-vein with 11–14, finishing just beyond the brown area, and the distal half of upper-vein with 1+1 setae near end, occupying the distal eighth or thereabouts; setae fairly long and moderately stout; cilia inclined to be sparse, lower fringe long, waved; median vein of hind wing very distinct, reaching almost to tip; brown.

Abdomen elongate-ovate, widest at about segment 4, slightly wider than pterothorax; segment 9 not much longer than 10 (1·2 to 1·3 times as long) with a pair of dorsal setae. Terminal setae rather long and stout. Posterior margin of tergite

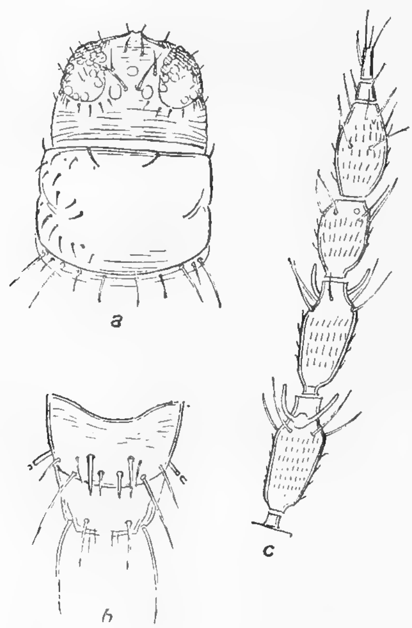

Fig. 1. *Physothrips setiventris*, Bagn., sp. n.: *a*, head and prothorax of ♀; *b*, end of abdomen of ♂, showing specialised spines on tergite 9; *c*, segments 3–8 of antenna of ♀.

8 furnished with a longish fringe; pleurites and intermediate tergites laterally finely striate, the striations being lined with microscopical setae, which show as fringes at the posterior margins. Intermediate sternites furnished with many irregularly placed setae in addition to the usual ones at posterior margins.

♂. Length, 0·9 to 1·0 mm.

Colour pale yellow, head as in ♀ but lighter; antennae with the two basal joints only lightly tinged with grey, otherwise as in the ♀. Wings as in ♀. Abdomen with segments 8 to 10 dark brown; 4 to 7 with more or less defined median patch dorsally, increasing in extent posteriorly, with sometimes a scarcely defined patch on either side; similar dorsal markings on 3, but scarcely noticeable. Eighth tergite with a longish postero-marginal fringe; pleurites as in ♀. Tergite

9 with 4 principal dorsal spines, the hindmost pair being shorter and stouter, situated one on each side of the median line, and the upper pair being more widely separated and about 1·5 times as long as the posterior pair (fig. 1 *b*).

Type in the British Museum of Natural History.

Received by the Imperial Bureau of Entomology from Mr. E. A. Andrews, of the Indian Tea Association. The data are as follows; India, Rington, T.E., Darjiling Dist., June 1916, from tea bushes (I.B.E. No. 119, Bagn. Reg. No. 285). There are female examples in material submitted by Prof. Maxwell Lefroy, taken at Lebong, India, on the same plant, Sept. 1908.

Physothrips lefroyi, Bagnall (fig. 2).

Physothrips lefroyi, Bagnall, Ann. Mag. Nat. Hist. (8) xii, 1913, p. 292.

♀. Length, 1·4 to 1·7 mm.

Yellowish white, lemon yellow to yellow in darker specimens; abdominal setae, setae end cilia of wings reddish brown. Antennae pale yellowish-white to lemon-yellow, with joints 2, 4 and 6 rich reddish-brown; 2 lighter distally, 4 yellowish

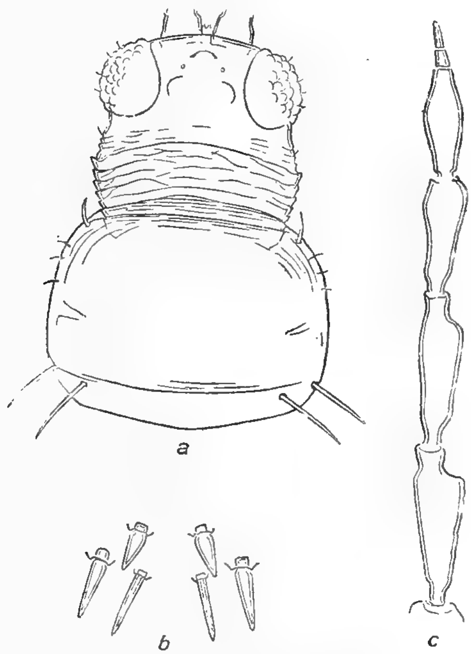

Fig. 2. *Physothrips lefroyi,* Bagn.: *a,* head and prothorax of ♀; *b,* specialised spines on tergite 9 of ♂; *c,* outline of segments 3–8 of antenna of ♀ (note that segment 3 is twisted—practically reversed—in the example figured).

basally and 5 lightly tinged with reddish brown distally; joint 1 almost clear, paler than any of the others.

Head as long as broad; eyes somewhat prominent and moderately coarsely facetted, pigmentation deep purplish-black; cheeks somewhat angularly swollen near middle, the surface behind this swollen part being considerably more strongly striate transversely than usual. Ocelli on a raised prominence, large, the posterior pair on a line drawn above the posterior margins of the eyes; inner margins with strong cresentic crimson hypodermal pigmentation. Antennae twice as long as the head, relative length of joints 3 to 8 as follows: 26 : 26 : 21 : 21 : 3 : 5. Three and four sharply constricted apically, and furnished with long forked trichomes.

Prothorax about as long as head and 1·35 times as broad as long; setae at posterior angles about 0·35 the length of the prothorax. Pterothorax large, broadest across mesothorax, where it is nearly as broad as long. Legs normal, rather stout, the hind tibia being furnished with a series of short, slender spines from before the middle to apex within; apical spines stout. Wings fully developed, pointed apically, Costal spines of fore-wing numbering over 40, somewhat slender and increasing in length in the distal half; lower vein with 14–17 spines and upper with 3 in the distal half, that is, one near middle of wing and 2 in distal third; cilia reddish brown. Abdomen ovate, slightly broader than the pterothorax; segment 8 rounded from base, thence narrowing sharply; 9 and 10 obconical. Apical setae long; a widely separated dorsal pair on 9.

♂. Smaller, more slender, with abdomen elongate, linear. General colour paler, spines lighter, and the antennae unicolorous; the special dorsal spines of the 9th tergite reddish brown.

Ninth tergite (fig. 1 *b*) with six stout dorsal spines; four moderately long forming an obverse arc, the outer pair being the stouter, and a pair of shorter and stouter ones on a higher plane and spaced much about the same as the inner pair of the other four. Also one pair of stout lateral spines. Apical setae very long and slender.

Type in Coll. Bagnall; University Museum, Oxford.

INDIA: Lebong, Darjiling, Bengal, in the flowers of tea, 6.ii.1909 (*Prof. Maxwell Lefroy*).

ON THE RUBBER THRIPS (PHYSOTHRIPS FUNTUMIAE, BAGN.) AND ITS ALLIES.

By Richard S. Bagnall, F.L.S.

The rubber thrips deserves to be more widely known, not only on account of its economic importance, but because it forms the type of a small group of the genus *Physothrips*, separated at once by the structure of the sternites 3 to 7 in the ♂. In some species the sternites are simple, but in most they are characterised by one well-formed and defined thinly chitinised area in the centre of each, either round, transverse or oviform, generally largish but sometimes reduced to a small puncture-like depression. These male features are found also in other genera. In *P. funtumiae* and its allies however the sternites 3 to 7 have numerous, usually irregular, depressions, smaller or greater, arranged in 2 to 4 more or less regular or defined transverse rows. In one species (*P. funtumiae*) the anterior row of areas is characterised by the possession of a long, transverse, median area; but this is occasionally broken up to a greater or less degree.

I now give tables and figures of the three species falling into this group, from which it will be seen that other features of more than usual interest exist. I would refer chiefly to the antennal antigeny in two species.

Stated briefly we find that the antennae—

(*a*) are the same in both sexes, both as regards colour and structure, in *P. marshalli*;

(*b*) agree in structure, but differ in colour, in the sexes of *P. funtumiae*;

(*c*) agree in colour, but differ in structure, in the sexes of *P. kellyanus.*

Sexual dimorphism in the direction of (*b*) is quite usual in the Terebrantian Thysanoptera, but in the direction of (*c*) it is of much rarer occurrence.

In 1915, however, Hood (Proc. Ent. Soc. Washington, xvii, pp. 128–132) characterised the new genus *Plesiothrips* for *Thrips perplexus*, Beach, the discovery of the ♂ illustrating a more extreme case of antennal antigeny than in *P. marshalli.*

I have pleasure in naming the new species in honour of my good friend, Dr. Guy A. K. Marshall, Director of the Imperial Bureau of Entomology.

Table of Females.

1. Fore-wings uniform brown. Fringe of posterior margin of tergite 8 distinct, longish. Chaetotaxy less strong; bristles of pronotum normal. Antennae either similar in the sexes or exhibiting dimorphism in colour. Size smaller. *Hab.* Africa 2

   Fore-wings with basal fourth or thereabouts white. Fringe of tergite 8 vestigial, medianly lost. Chaetotaxy stronger; pronotum with a pair of minor setae within the postero-marginal pair. Antennae exhibiting sexual dimorphism in structure. Size larger. *Hab.* Australia .. .. .. *P. kellyanus.*

2. Antennae brown (exhibiting sexual dimorphism in colour). Head and prothorax longer, with longer interocellar and pronotal bristles, those at posterior angles of prothorax being subequal in length. Size larger. On rubber (*Funtumia elastica*) .. .. *P. funtumiae*

   Antennae with segment 3 greyish yellow, similar in colour and structure in both sexes. Interocellar and pronotal bristles shorter, the inner of those at posterior angles of prothorax being distinctly longer than the outer. Size smaller. On various plants .. .. *P. marshalli.*

Table of Males.

1. Fore-wings uniform brown. Antennae with segment 6 not abnormally developed. Colour not wholly brown 2

   Fore-wings white basally, insect otherwise wholly brown. Segment 6 of antennae exceptionally large, more than twice as long as 5, and four times as long as the style (7+8) .. .. *P. kellyanus.*

2. Antennae not coloured as in ♀, intermediate segments varicoloured. Abdominal segments less transverse, with the depressions in sternites 3–7 roughly approximating 4 (sometimes 3) transverse rows, and usually having a longish transverse area, more or less median, in the first row (fig. 2 *b*). Specialised setae on tergite 9 as in fig. 2 *c*, stout .. .. *P. funtumiae.*

   Antennae as in ♀. Abdominal segments more strongly transverse, with the depressions in sternites 3–7 arranged in 2 rows and without any transverse area (fig. 1 *b*). Specialised setae on tergite 9 as in fig. 1 *c*, weak *P. marshalli.*

Physothrips marshalli, sp. nov. (fig. 1).

♀. Length, about 1·1 mm.

Colour brown; antenna with the two basal joints brown, joint 3 yellow and 4 to 8 yellowish brown, with extreme bases of 4 and 5 lighter. All tarsi and fore tibiae yellowish, the latter shaded to greyish brown laterally. Fore-wings uniform brown; hind-wings, excepting median vein, lighter.

Head approximately 1·5 times as broad as long; cheeks subparallel, scarcely arched; eyes moderately coarsely facetted, setose, space between them equal to the breadth of an eye; ocelli placed well back, the posterior pair approximating the interior margin of the eyes at about their posterior fourth; inter-ocellar bristles only moderately long, about as long as the breadth of an eye. Other dorsal and lateral setae minute.

Antennae approximate at base, at least 2·6 times as long as the head; form and structure as in fig. 1 *d*, segment 4 being slightly longer than 3. Long forked trichomes on 3 and 4.

Prothorax but slightly longer than the head, about 1·7 times as broad as long; the two bristles at posterior angles rather stout and long, the inner being 0·6 the length of the prothorax and distinctly longer than the outer. Pterothorax broader than the prothorax (1·25 : 1), as long as or slightly longer than broad. Fore-wings 15 to 16 times as long as broad at middle, curved (*i.e.*, sword-shaped); costa with about 27 setae; upper vein with a series of 3+5 setae in the basal two-fifths or thereabouts and then 2 in the distal seventh; lower vein with a series of 16 to 20 similar setae; all setae not stout and somewhat short. Upper cilia sparing, rather long; lower cilia close, not exceptionally long, minutely wavy. Legs of normal form.

Abdomen of usual form; posterior margin of tergite 8 with a moderately long fringe of microscopic hairs; tergite 9 with a widely spaced pair of dorsal bristles; bristles at posterior angles of segment 8 incurved. Apical bristles moderately strong, long, the longest pair being as long as the length of segments 9 and 10 together.

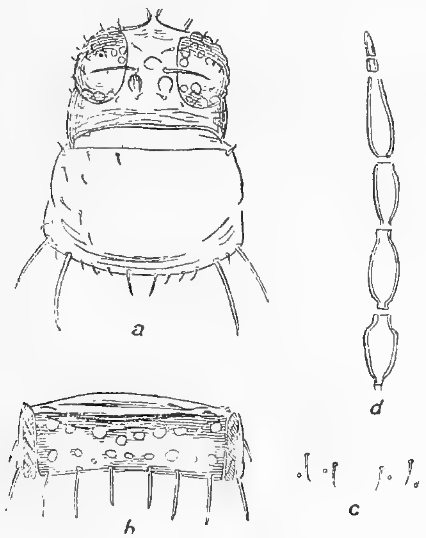

Fig. 1. *Physothrips marshall*, Bagn., sp. n.: *a*, head and prothorax of ♀, × c. 135; *b*, sternite 6 of ♂ showing areas, × c. 135; *c*, arrangement of special setae on tergite 9 of ♂, × c. 200; *d*, antennal segments 3 to 8 of ♀, × c. 200.

Measurements, approximately:—

Head, length 0·105 mm., width 0·152 mm.; interocellar bristles 0·046 mm. long; pronotum, length 0·115 mm., width 0·195 mm.; pterothorax, length 0·27 mm., width 0·25 mm.; fore-wing, length 0·68; width near middle 0·044 mm., at base 0·064 mm.; abdomen, width at segment 5, 0·3 mm.; length of tergite 5, 0·076 mm.

Antennal segments	i	ii	iii	iv	v	vi	vii	viii
length (μ)	26	34	49	54	38	55	10	16
width (μ)	31	26	22	19	16	17	6	5

Total length of antenna, 0·282 mm.

♂. Length, about 0·8 mm. Colour and structure much the same as in the ♀. Abdominal sternites 3 to 7 with two more or less regular transverse series of irregular roundish pale depressions. Antennae much as in ♀.

Measurements of antennal segments approximately as follows:—

Segments	i	ii	iii	iv	v	vi	vii	viii
length (μ)	23	30	43	45	34	47	8	12
width (μ)	24	23	17	16	15	15	6	4

Tergite 8 with longish fringe; tergite 9 with special dorsal setae weak, disposed as in fig. 1 *c*.

Types. In British Museum (Imperial Bureau of Entomology).

Gold Coast: Aburi; apparently common; females only in flowers of *Solanum tuberosum*, and *S. wendlandii*; both sexes, but chiefly females, in flowers of *Ipomoea bona-non*, and both sexes, with the males fairly plentiful in flowers of *Hibiscus sinensis*, *Thunbergia erecta*, *T. laurifolia*, *Strophanthus gratus* and *Canna*, November 1915 (*W. H. Patterson*).

Physothrips funtumiae, Bagn. (fig. 2); Ann. Mag. Nat. Hist. (8) xii, 1913, p. 292.

The female of this species approximates 1·5 mm. in length and in its general appearance and chaetotaxy it would seem to have closer relationship with *kellyanus* than with *marshalli*. It is distinguished at once by the stout specialised spines on

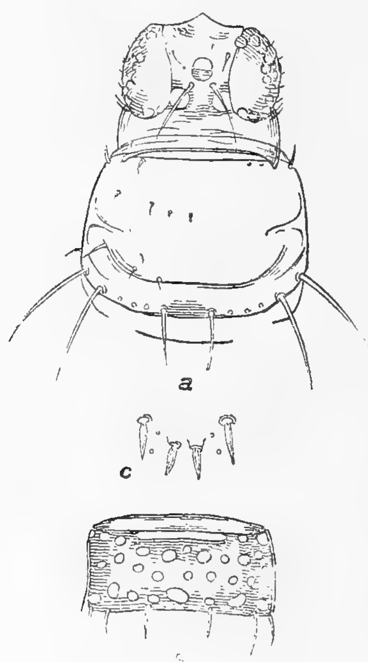

Fig. 2. *Physothrips funtumiae*, Bagn.: *a*, head and prothorax of ♀, × c.135; *b*, sternite 6 of ♂ showing areas, × c.135; *c*, arrangement of special setae on tergite 9 of ♂, × c.200.

tergite 9 of ♂, and by the depressions on sternites 3 to 7 being disposed in 3 (or more generally 4) more or less regular transverse rows, the uppermost row having, in most cases, a long transverse area medianly in the place of several isolated smaller areas. There is an interesting colour dimorphism or antigeny in the antennae. In the ♀ the antennae are coloured as in *P. kellyanus*, except that segment 3 is of a somewhat yellowish brown, lighter than the succeeding; in the ♂, however, the antennal segments 3 to 6 are pale yellowish white, 4 to 6 being light grey-brown in their distal halves or thereabouts, and 7 and 8 also grey-brown. Fringe of tergite 8 in ♀ entire, longish; apical abdominal bristles shorter than the length of segments 9 and 10 together.

Measurements approximately :—

♀. Head, length 0·125 mm., width 0·16 mm.; interocellar bristles, length 0·065 mm.; pronotum, length 0·15 mm., width 0·22 mm.; pterothorax, length 0·35 mm., width 0·35 mm.; fore-wing, length 1·0 mm., width near middle 0·067, mm., at base 0·09 mm.; abdomen, width at segment 5, 0·37 mm., length of tergite 5, 0·095 mm.

Antennal segments	iii	iv	v	vi	vii	viii
length ♀ (μ)	63	57	46	61	12	26
width ♀ (μ)	25	24	18	19	8	6
length ♂ (μ)	55	51	39	56	10	18

Known from Uganda and Southern Nigeria.

Physothrips kellyanus, Bagn. (fig. 3); Ann. Mag. Nat. Hist. (8) xvii, 1916, p. 219.

This species, measuring from 1·6 to 1·8 mm. in the ♀, was described from several examples collected by Mr. R. Kelly in North Queensland on a composite plant (? *Helianthus* sp.) and on a South African plant (*Acokeanthera spectabilis*) in the

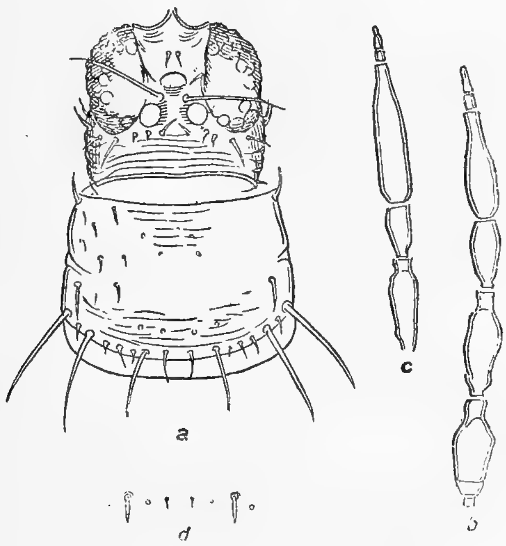

Fig. 3. *Physothrips kellyanus*, Bagn.: *a*, head and prothorax of ♀, × c.135; *b*, antennal segments 3 to 8 of ♀, × c.200; *c*, antennal segments 4 to 8 of ♂, × c.200; *d*, arrangement of special setae on tergite 9 of ♂, × c.200.

Brisbane Botanic Gardens. Mr. Kelly also took it in Victoria, on *Hypochoeris radicata.* It differs from the two African species, apart from its larger size, by the stronger chaetotaxy of the head, prothorax, etc.; the presence of a pair of minor setae between the median posterior pair of prothoracic bristles (fig. 3 *a*); the arrangement of specialised setae on tergite 9 (fig. 3 *d*) and the striking antennal antigeny, the fifth segment in the ♂ being distinctly smaller and the sixth considerably larger than in the ♀.

I amend and augment the original descriptions as follows :—

♀. Antennal segments 3, 4 and 5 narrowly yellowish basally, in addition to the distal constricted parts of 3 and 4 being colourless or faintly yellowish.

Posterior margin of pronotum with the median pair of bristles rather widely separated and having a pair of minor setae within.

Abdomen with fringe on posterior margin of tergite 8 vestigial, altogether absent medianly, and only very short and sparse for a short area at each side. Segment 8 with a widely spaced pair of dorsal bristles. Apical bristles shorter than the length of segments 9 and 10 together.

Measurements approximately :—

Head, length 0·145 mm., width 0·175 mm.; interocellar bristles, length 0·085 mm.; pronotum, length 0·155 mm., width 0·24 mm.; pterothorax, length 0·37 mm., width 0·41 mm.; fore-wing, length 0·95 mm., width near middle, 0·068 mm., at base 0·1 mm.; abdomen, width at segment 5, 0·425 mm., length of tergite 5, 0·095 mm.

Antennal segments	iii	iv	v	vi	vii	viii
length (μ)	71	70	46	67	11	16
width (μ)	28	26	20	20	8	5

♂. The irregular pale areas of sternites 3 to 7 more minute than in either *funtumiae* or *marshalli*, conforming more or less to 3 irregular transverse rows. Colour of antennae as in ♀, but with joint 5 relatively short and 6 abnormally long.

Antennal segments	iii	iv	v	vi	vii	viii
length (μ)	64	63	35	90	8	13

DESCRIPTIONS OF SOME CAPSIDÆ FROM THE BELGIAN CONGO.

By W. L. Distant.

Genus Lycidocoris.

Lycidocoris, Reut. & Popp., Trans. Ent. Soc. Lond., 1911, p. 409; Popp., Acta Soc. Scient. Fenn., xli, p. 182 (1912).

Lycidocoris mimeticus.

Lycidocoris mimeticus, Reut. & Popp., Trans. Ent. Soc. Lond. 1911, p. 410, pl. xxxii, fig. 3; Popp., Acta Soc. Scient. Fenn. xli, p. 183 (1912).

This species appears to be of a most variable character and in one respect to differ from both the original description and figure. In all the specimens now before me, both from Uganda and the Belgian Congo, the last and very short joint of the antennae is not black, as described and figured by Reuter and Poppius, but is ochraceous with the extreme base black.

Var. A. Typical form .. .. Uganda, Lubowa (*C. O. Gowdey*).

Var. B. The black fascia to the pronotum and scutellum very much reduced and abbreviated; in one specimen almost absent; the cuneus also, though always black, has that colour more or less continued on the adjacent margin of the corium proper .. .. Belgian Congo, Eala (*R. Mayné*).

Found by M. Mayné on coffee bushes.

Lycidocoris modestus, sp. nov. (fig. 1).

Brownish-castaneous; membrane fuliginous, the margins of the basal cell sanguineous; body beneath dull sanguineous; legs and rostrum ochraceous; antennae

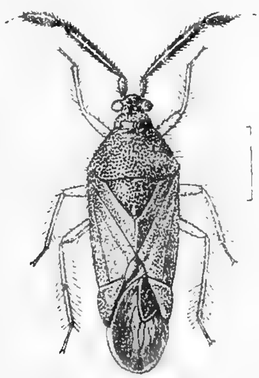

Fig. 1. *Lycidocoris modestus*, Dist., sp. n.

very robust, pilose, dull castaneous, first joint short, about as long as head, second about as long as pronotum, third stoutest, pyriform, about as long as scutellum; pronotum thickly, coarsely punctate and very finely wrinkled, the anterior collar with foveate impressions and with a central obtuse tubercle, the lateral margins with long pilosity; scutellum thickly coarsely punctate and with a distinct central longitudinal ridge; corium thickly finely punctate, the clavus more coarsely punctate; legs with thick long pilosity; membranal veins somewhat coarse.

Long. 8–9 mm.

BELGIAN CONGO: Eala, on cinchona (*R. Mayné*).

Lycidocoris thoracicus, sp. nov. (fig. 2).

In colour markings closely allied to the preceding species, *L. modestus*, but structurally distinct by the slightly longer and anteriorly broader pronotum, the

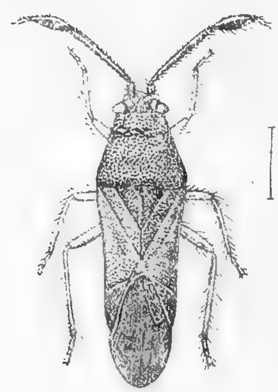

Fig. 2. *Lycidocoris thoracicus*, Dist., sp. n.

collar being much broader and longer; the central longitudinal carination on the scutellum is also somewhat less pronounced anteriorly, but distinctly tuberculate near apex; tegmina a little darker and more opaque.

Long. 9 mm.

BELGIAN CONGO: Eala, on indigenous rubiaceous plant (*R. Mayné*).

Genus CHAMUS.

Chamus, Dist., Ann. Mag. Nat. Hist. (7), xiii, p. 197 (1904); Reut. & Popp., Trans. Ent. Soc. Lond., 1911, p. 413; Popp., Acta Soc. Scient. Fenn., xli. p. 192 (1912).

Chamus bellus, sp. nov. (fig. 3).

Head and pronotum black; antennae pale stramineous, the basal joint black; scutellum black; hemelytra very pale ochraceous, basal area of clavus black, before cuneus a broad transverse dark castaneous fascia; body beneath and legs very pale ochraceous; head between the eyes, and the lateral areas of the prosternum, black; basal joints of the antennae robust, very coarsely hirsute, much attenuated at base, second joint much longer than third, fourth shortest, and in one specimen this joint is blackish; tibiae with long coarse hairs; posterior lobe of pronotum tuberculate and with a broad discal longitudinal sulcus; corium sparingly coarsely granulose.

Long. 5–6 mm.

Belgian Congo: Eala, on "lionzi" (*R. Mayné*).

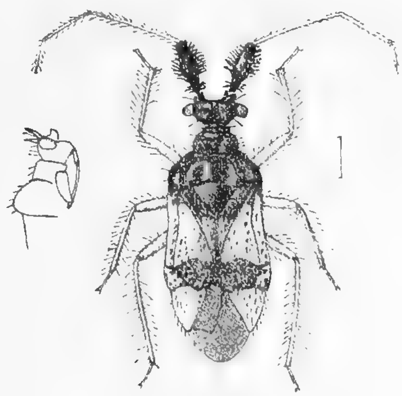

Fig. 3. *Chamus bellus*, Dist., sp. n.

Chamus tuberculatus, sp. nov.

Head, pronotum and scutellum, brownish ochraceous, lateral margins of the pronotum much darker; antennae with the basal joint castaneous, second and third joints pale stramineous, fourth joint black, its apex sanguineous; corium brownish-ochraceous, with scattered small darker tubercles, rather more thickly tuberculate on clavus, a broad dark transverse fascia before cuneus, which is pale stramineous and very finely tuberculate and with its apical margin castaneous; membrane pale stramineous with a central dark fascia, which bifurcates towards apex; body beneath and legs very pale stramineous; basal joints of antennae strongly clavate and very coarsely hirsute, second joint a little longer than third; head broadly centrally channelled; pronotum with the anterior lobe with a somewhat large and prominent tubercle on each side at base, posterior lobe sparingly finely tuberculate; scutellum broadly centrally sulcate; tibiae with long coarse hairs.

Long. 5–6 mm.

Belgian Congo: Kunnulu, on guava (*R. Mayné*).

ON A NEW METHOD OF ASCERTAINING THE PARASITES OF THE RESPECTIVE HOST-INSECTS IN A MIXED INFESTATION.

By Ivar Trägårdh.

Swedish Institute of Experimental Forestry, Entomological Department, Experimentalfältet, Sweden.

When studying the injurious insects of a plant it is, as a rule, easy when several insects occur together to isolate them and breed them separately in order to ascertain their parasites. In some instances, however, this method is unworkable, and this applies particularly to the often very complicated fauna of the cones of the coniferous trees.

During my recent investigations into the insects injurious to the spruce-cones of Sweden * this fact was very distressing. The researches were based on a material of some 14,000 cones collected from about 70 different localities distributed all over the country, and I had the hope of being able in this way to find at least in some localities cones attacked only by one species and thus to secure reliable data as to the parasites of the different species.

This did not, however, prove to be the case, all cones as a rule containing at least two or three different injurious species, which rendered it impossible to draw any conclusions as to which were the hosts of the different parasites that emerged. Moreover, it was, at least as regards the seed-eating species, out of the question to isolate the different forms, since the seeds could not be separated according to the species which attacked them.

It became therefore urgent to find another, indirect method of solving this problem, and the system employed will now be briefly described.

The cones were kept in breeding-cages of the so-called American type, and the insects emerging from them were collected daily or every second day. Diagrams were then made illustrating what percentage of each species emerged during each day.

I took as my basis the supposition that a certain relation existed between the time of emergence of the host and its parasite ; the latter being adapted both morphologically and biologically to its host and appearing invariably at the moment most suitable for its successful propagation. This relation might, of course, be different according to the instar of the host which was attacked by the parasite.

It is true that the insects were not subjected to natural conditions as regards temperature, light and humidity in the breeding-cages, their development being doubtless much accelerated. But owing to the deplorable lack of an insectarium in the Institute it was impossible to make suitable arrangements for the breeding-cases, which had to be kept in the laboratory subjected to a temperature of about +17° C.

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* Investigations into the insects injurious to spruce and vine cones.—Report of the Swedish Institute of Experimental Forestry, vol. 13–14, pp. 1141–1204, 44 figs.—Stockholm, 1913.

But, on the other hand, one might safely presume that these conditions did not alter the relation between the time of emergence of the host insect and its parasites. Further there existed certain known data as to the relation of *Nemeritis cremastoides*, Hlmg., *Ephialtes glabratus*, Ratz., and *Bracon* sp. to *Laspeyresia strobilella*, L. This greatly simplified matters. The first thing to be done was to see how these parasites grouped themselves around their host. If other parasitic species grouped themselves round one or the other of the phytophagous species, it might safely be concluded that they were the parasites of these.

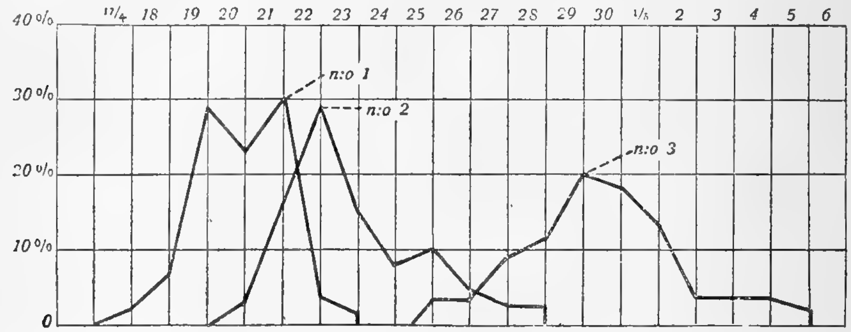


Fig. 1. Diagram showing the percentages of *Perrisia strobi*, Winn. (No. 1), *Laspeyresia strobilella*, L. (No. 2), and *Torymus azureus*, Bhn., bred from spruce-cones from 17th April to 6th May 1916; material from Kungsör, Köping.

The success of the method, however, depended on the phytophagous species not appearing contemporaneously, but in a certain succession. Fortunately the latter was the case. Figs. 1 and 2 are diagrams showing the number of *Perrisia strobi*, Winn. (No. 1), *Laspeyresia strobilella*, L. (No. 2) and *Torymus azureus*, Bhn. (No. 3), calculated as a percentage of the whole number of each species, bred from two different localities.

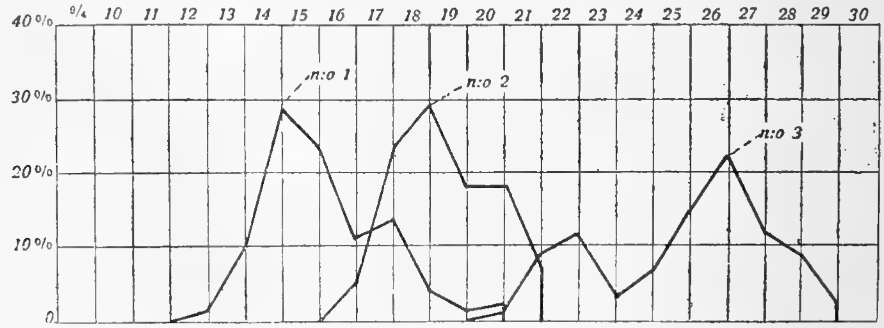


Fig. 2. Diagram of the same species bred from 3rd to 30th April 1916; material from Forshem, Kinne.

We notice in fig. 1 that the gall-midges start hatching on the 17th of April and increase rapidly in number, so that on the 19th, 30 per cent. emerged; on the 20th the number decreased, on account of the number of males rapidly diminishing before the females have reached their maximum. On the 21st also 30 per cent. emerged, the number subsequently rapidly diminishing.

Three days after the gall-midges the cone-moths make their appearance, their number increasing rapidly, attaining three days afterwards its maximum (28 per cent.) and subsequently quickly diminishing. Not before the cone-moths have nearly ceased emerging does *Torymus azureus* begin to appear, and the curve of the latter rises and falls much more slowly than that of the two other species.

The curves in fig. 2 show the same succession of the three species and almost the same shape of the curves as in fig. 1. On the 14th of April the gall-midge reaches its maximum, on the 18th the cone-moth, and not before the 26th does *Torymus* attain its maximum.

Consequently there exists a difference in the time of appearance of the phytophagous insects, and this enables us to ascertain how the parasites group themselves around their hosts.

The diagram fig. 3 shows the curves of *Perrisia strobi,* Winn. (No. 1), *Laspeyresia strobilella,* L. (No. 2), and one of the parasites of the latter, *Nemeritis cremastoides,* Hlmg. (No. 3) from another locality. We notice that the latter appears three days

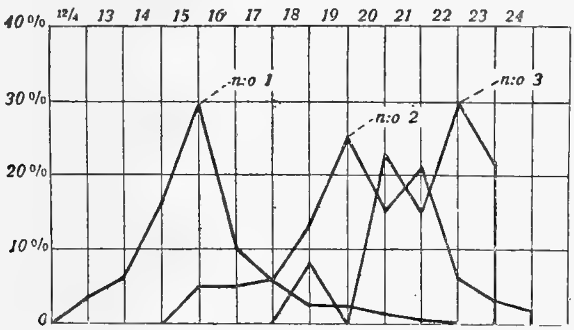


Fig. 3. Diagram of *Perrisia strobi* (No. 1), *Laspeyresia strobilella* (No. 2) and one of the parasites of the latter, *Nemeritis cremastoides,* Hlmg. (No. 1), calculated as in fig. 1, bred from spruce-cones from 12th to 24th April 1916; material from Lillögda, near Asele.

after its host and ceases emerging one day after the latter. Both the curve of the host and of the parasite have two apices, on account of the number of males, which invariably make their appearance a couple of days earlier than the females, the number decreasing more rapidly than that of the females increases. The difference between the apices of the host and the parasite is only one day. The diagram shows, as a consequence, that the curve of the parasite closely follows that of the host, with an interval of one or two days.

If we return to the diagram fig. 1 and add to it the curve of *Platygaster contorticornis,* Ratz., a species very common in spruce-cones, it is evident (fig. 4) that the curve of this species shows the same relation to that of *Perrisia strobi* as that of *Nemeritis cremastoides* to *Laspeyresia strobilella,* the only difference being that *Platygaster* appears a little earlier than *Perrisia.* The curve of the latter has two apices, which is brought about in the same way as in *Laspeyresia* and *Nemeritis.* In the curve of *Platygaster,* on the other hand, the top is cut off, because the females, which in this species are far more numerous than the males, increase in number to the same extent as the males decrease, so that the percentage of hatched insects during two days is the same.

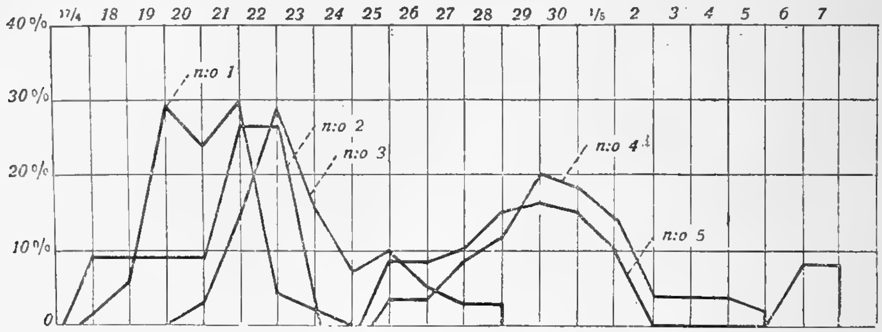


Fig. 4. Diagram of *Perrisia strobi*, Winn. (No. 1), *Platygaster contorticornis*, Ratz. (No. 2), *Laspeyresia strobilella*, L. (No. 3), *Torymus azureus*, Bhn. (No. 4), and *Aprostocetus strobilanae*, Ratz. (No. 5), bred from spruce-cones from 17th April to 7th May 1916 ; material from Kungsör, Köping.

The diagram, fig. 5, shows the same relation still more plainly, the curves of *Perrisia* and of *Laspeyresia* being more separated one from the other.

This close relation of the curves of *Platygaster* and *Perrisia* argues strongly in favour of the assumption that the former is the parasite of the latter, which was previously suspected, all other species of the genus *Platygaster* of which the food habits were known being parasites of gall-midges.

An examination of material from which a great number of both *Perrisia* and *Platygaster* had been hatched enabled me to make certain that the above conclusion as to the relation of *Platygaster* to *Perrisia* was true, a dead *Platygaster* being found in the inflated larval skin of a *Perrisia*.

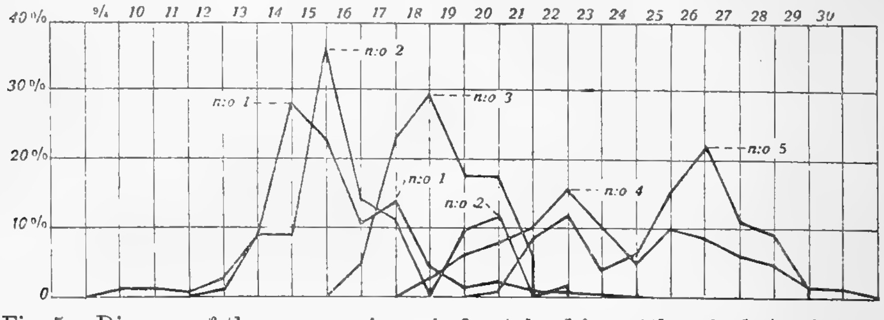


Fig. 5. Diagram of the same species as in fig. 4, bred from 9th to 30th April 1916 ; material from Forshem, Kinne.

There remain *Torymus azureus*, Bhn., and *Aprostocetus strobilanae* (Ratz.), the latter being one of the commoner insects hatched from the cones. As pointed out above, the former makes its appearence only when the majority of *Perrisia* and *Laspeyresia* have emerged, and its curve is of a quite different shape. While the curves of the two latter both rise rapidly to 30 per cent., the emergence of the majority of them taking place within a few days, the curve of the former hardly rises above

20 per cent., the emergence continuing during a considerably longer time, 10–12 days. In both these respects the curve of *Aprostocetus strobilanae* agrees entirely with that of *Torymus azureus,* and the diagrams fig. 3 *a* and *b* show how closely one curve follows the other. From this I draw the conclusion that *Aprostocetus strobilanae* is the parasite of *Torymus azureus.*

The above conclusions are of course based not only on the diagrams now published, but on the great material brought together during the investigations of the spruce-cone insects, which will be published later.

The method was invented in order to enable me to ascertain the relation of the cone insects to one another, and its usefulness seems to be proved by the fact that the conclusion drawn from it regarding *Perrisia* and *Platygaster* by examination of the cones was found to be true.

If the material could have been kept under normal conditions, the curves would evidently have been more separated from one another and the grouping of the parasites round their respective hosts, as a consequence, still more plainly discernible.

Very likely this method may also be applied with success in the investigations of other complicated biocoenoses, when direct observations regarding the relationship of the insects to each other are difficult to make, as for instance in large galls, which are often inhabited by many different species, and tree-trunks. It is therefore desirable that other entomologists should give the method a trial.

ON BRACONIDAE PARASITIC ON DIATRAEA SACCHARALIS IN DEMERARA.

By R. E. Turner.

Three species of Braconidae have now been bred in Demerara from the larva of the cane-boring moth, *Diatraea saccharalis*: *Ipobracon grenadensis*, Ashm., which I have previously mentioned (Ann. Mag. N.H. (8) xx, 1917, p. 244), and *Ipobracon saccharalis*, sp. n., both of which belong to the subfamily Braconinae; and *Microdus diatraeae*, sp. n., which belongs to the subfamily Agathinae.

Ipobracon saccharalis, sp. nov.

♂. Niger; segmentis abdominalibus 5 basalibus rufis; alis pallide fuscis, dimidio basali subhyalinis; stigmate flavo, tertio apicali fusco, cellula cubitali prima striga obliqua hyalina; venis brunneis.

Long. 8 mm.

♂. Face and front closely and finely punctured, densely clothed with close-lying grey hairs; vertex strongly convex, minutely punctured; the head strongly narrowed behind the eyes. Antennae about 63-jointed; the scape finely and closely punctured, the third joint distinctly longer than the fourth. Thorax and median segment very finely punctured, sparsely on the dorsal surface of the thorax, very closely on the mesopleurae and median segment, both of which are densely clothed with greyish pubescence, which is also present, though much more sparsely, on the dorsal surface of the thorax. Mesonotum narrowed anteriorly, the parapsidal furrows very deep. First tergite almost as broad at the apex as long, the lateral carinae well developed, the median area finely rugulose, the grooves between the median area and the lateral carinae broad and transversely rugulose. Second tergite with a smooth lanceolate area from the base reaching to the middle and prolonged by a carina to the apex; the areae at the anterior angles large and smooth, the groove separating them from the remainder of the segment shallow and narrow; on each side of the median area are short oblique striae, beyond which the segment is finely rugose; second suture broadly arched and finely crenulate. Third and fourth tergites finely punctured-rugulose; the third with a very small triangular smooth area at the base, the areae at the anterior angles large and smooth. Apical tergites very finely punctured. Nervulus interstitial; recurrent nervure received just before the first transverse cubital nervure.

British Guiana: Non Pareil Plantation, East Coast of Demerara, 6.iii.1913 (*G. E. Bodkin*).

This is a parasite on the larva of *Diatraea*. It is more nearly allied to *I. poultoni*, Szép., than to any other described species, but I do not think that it can be the male of that species owing to differences in sculpture, and in the form of the area on the second tergite. *I. dolens*, Cam., is also very nearly related, but the colour is different and the sculpture of the abdomen is finer, the fourth tergite being finely punctured, shining between the punctures, not rugulose, and there is no basal shining area on the third tergite; so that, unless the sculpture is subject to considerable variation, the two cannot belong to one species.

Microdus diatraeae, sp. nov.

♀. Nigra; segmento mediano, abdomine, segmento apicali excepto, coxis posticis, femoribusque posticis, apice excepto, rufo-ferrugineis, alis fuscis, stigmate cellulisque mediana cubitalibusque prima secundaque pallide flavis, palpis testaceis.

Long. 11 mm.; terebrae long. 12 mm.

♀. Face subopaque, finely and very closely punctured, much broader than long; vertex shining, sparsely punctured, front shining, concave, the marginal carinae of the concave area low and indistinct. Thorax strongly narrowed anteriorly, shining, the parapsidal furrows deep; the median lobe of the mesonotum almost smooth, with a distinct longitudinal carina, the lateral lobes distinctly, but rather sparsely punctured. Mesopleurae, sides of the median segment and coxae finely and very closely punctured. Median segment rather finely rugose at the base, becoming distinctly reticulate towards the apex, with two distinct, but not very strong, longitudinal carinae close to the middle, running from near the base to the apex. First tergite nearly twice as long as its apical breadth, twice as broad at the apex as at the base, irregularly obliquely rugose-striate, with a distinct longitudinal carina from the base to the middle, the apex smooth and shining. Second tergite nearly two-thirds of the length of the first, smooth and shining, with an oblique groove on either side from the base to the lateral margin, the space at the angle bounded by the grooves very small; a broad transverse groove crossing the segment near the middle, the groove closely longitudinally striated; second suture smooth. Third tergite smooth and shining, with a shallow, smooth, transverse groove which is obsolete in the middle; the remaining segments smooth and shining. Spur of hind tibia scarcely more than one-third of the length of the hind metatarsus; ungues simple. Second cubital cell triangular, not petiolate; the radius reaching the costa a little nearer to the apex of the wing than to the apex of the stigma.

British Guiana: Lusignan, Non Pareil and Ogle Plantations, East Coast of Demerara; March and April (*G. E. Bodkin*).

A parasite of *Diatraea* larvae.

In the transverse grooves of the second and third tergites this approaches the genus *Aërophilus*, Szép., but the general form and the sculpture of the median segment approach much more nearly to *Microdus*. Nearly related to this species is *Microdus maculipes*, Cam., 1911 (*Cremnops maculipes*, nec *Microdus maculipes*, Cam. 1887), which I take to be the female of *Microdus parvifasciatus*, Cam. (described as a *Cremnops*); but the sculpture of the median segment and the difference in the length of the terebra separate the two species at once. Other species described by Cameron in the same paper as *Cremnops* and really belonging to *Microdus* are *M. nigrobalteatus* and *M. punctipennis*.

THE SUGAR-CANE FROGHOPPER IN GRENADA.

By C. B. Williams, M.A., F.E.S.,

Department of Agriculture, Trinidad, B.W.I.

In the course of an investigation into the froghoppers (Cercopidae) of the genus *Tomaspis* found on sugar-cane in Trinidad and the neighbouring countries, made on behalf of the Government of Trinidad, I visited Grenada in December 1916 and spent a few days investigating a small but severe outbreak of froghoppers in that Island. The following notes seem of sufficient interest to be published without further delay.

Grenada is the most southerly of the Windward group of the Lesser Antilles, and is situated in Lat. 12° 5′ N. and Long. 61° 40′ W. It is about 90 miles in a direct line north of Trinidad, with which island there is continuous traffic both by steamer and sailing vessels. It is a mountainous volcanic island about 21 miles long and little more than half as broad.

The rainfall varies greatly in different parts of the island; from 25 inches per annum in the extreme south-west, where the country is flat, to 130 inches or over in the mountains in the centre of the island. The average rainfall for twelve years at one of the localities where the froghopper outbreak was most severe is given below, together with the actual rainfall for 1916.

Rainfall at Mount Horne, Grenada.

	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Average 12 years.	5·0	3·2	3·4	4·1	4·4	9·1	9·0	9·2	8·0	9·8	11·3	7·6	84·1
1916.	5·2	2·8	4·0	3·7	4·6	5·5	6·7	11·7	7·1	6·3	16·5	8·3	82·4

The chief dry season is from January to May, and there is a slight "Indian summer" about September. During 1916, June and July had been drier than usual—August wetter, followed by a distinctly dry period in September and October; November was unusually wet.

The sugar-cane industry of Grenada is of quite secondary importance; no sugar is exported and nearly all that is grown locally is used for the manufacture of rum, and the cane-tops for stock feeding. A pest of sugar-cane in this island, although bad, has nothing of the serious importance of a similar one in Trinidad, where the production reaches 70,000 tons of sugar per annum.

Froghoppers were first reported from Grenada by Uhler (Proc. Zool. Soc. London, 1895, p. 58) under the name of *Tomaspis pictipennis*, Stål. The specimen he described was captured by H. H. Smith in Grenada about 1890.

In 1912 several specimens found on Para grass (*Panicum barbinode*) were sent from Grenada to the Board of Agriculture of Trinidad, and Mr. Urich reported (in litt.) that they were the same species as that recorded by Uhler, which however was not *T. pictipennis* (a Mexican species), but one closely related to the Trinidad species *Tomaspis saccharina*, Distant (then known as *T. varia*, Fabr.). Mr. Urich, however, believed that the Grenada specimens were distinct from the Trinidad species.

At the beginning of December 1916, Sir Francis Watts, Imperial Commissioner of Agriculture for the West Indies, arrived in Trinidad and reported that froghoppers were severely injuring canes in one district of the island. As a result of this report I visited the island at the first opportunity and arrived there on the 12th December 1916.

Froghoppers of one species were found to be widely distributed over the island on grass, in cane-fields and by the road-side, and also on sugar-cane. The localities where they were found are indicated by crosses on the accompanying map. The north-east half of the island was not visited, but it is probable that they are there also. The wide distribution leaves little doubt that the species has been long established in the island and is not a recent introduction.

The localities where damage was reported were Plantation Mount Horne, about two miles north-west of Grenville (the chief town on the East Coast of the island), and Plantation Nainganfoix, almost in the middle of the island. At both these localities the fields were said to appear " as if fire had passed through the fields."

I was able to visit only the first of these two—Mount Horne. Three fields were attacked here, but that most severely damaged had already been burnt and cut down before my arrival. The second was still standing and was suffering from what would be called in Trinidad, a severe attack. The third field was only slightly damaged and on it was found a much smaller number of froghoppers.

Field No. 1 had been for about ten years previous alternately in canes and pasture, before that a pasture. Fields 2 and 3 had been in pasture for at least 8 years and were only put under cane in January of this year (1916).

The main features of this attack were quite similar to those found in Trinidad. The leaves of the cane were turning brown from the top downward, and in some only the top few leaves were still green. The adult froghoppers were very numerous in the axils of the leaves, and the nymphs in their froth were particularly common round the main stems of the cane about 2–3 inches below the surface of the ground.

Part of Field 2 had been heavily limed round the stools and then earthed up to the height of four or five inches. There seemed to be distinctly fewer nymphs on the canes so treated.

The most striking difference from the conditions found in Trinidad was in the situation and soil condition of the fields. In Trinidad it is usually the low-lying heavy clay soils in which the damage by froghoppers is most severe. In Grenada many fields of cane in similar conditions round the coast were examined and in some of these froghoppers were found—never however causing the slightest visible damage.

The fields at Mount Horne and Nainganfoix, on the contrary, were at an altitude of 300–400 feet and each of them situated on a steep slope facing east and exposed to the trade winds. The soil was a red volcanic ash earth, heavy when wet, but rapidly drying to a crumbly mould. From the slope of the field alone there could be no question of lack of drainage.

It seems impossible to suggest any reason for the outbreak in these particular fields.

After a very close comparison of a number of specimens from Grenada with the Trinidad species, I am unable to find any constant difference between them, either in markings, profile or in the male genitalia. The Trinidad specimens (dead) usually have a bronze tint on the prothorax which is absent in all my Grenada specimens, but as it is lacking also in some Trinidad specimens it cannot be considered as of specific value. It may even be due to the method of killing.

The specimens show the same range of variation in colour markings as the Trinidad species. There are two quite distinct forms, one with and one without a broad V-shaped light brown mark at the base of the wings (when closed).

At Mount Horne a large number of sepcimens were captured and gave proportions as follows :—

	With light basal mark.	Without mark.
Males	32	36
Females	25	23
	—	—
	57	59

It will be seen that the two varieties are in almost equal numbers. The slight excess of males is probably accidental and due to the method of capture. The species must be considered as *Tomaspis saccharina*, Distant, and is in this case the first certain record of this insect outside Trinidad.

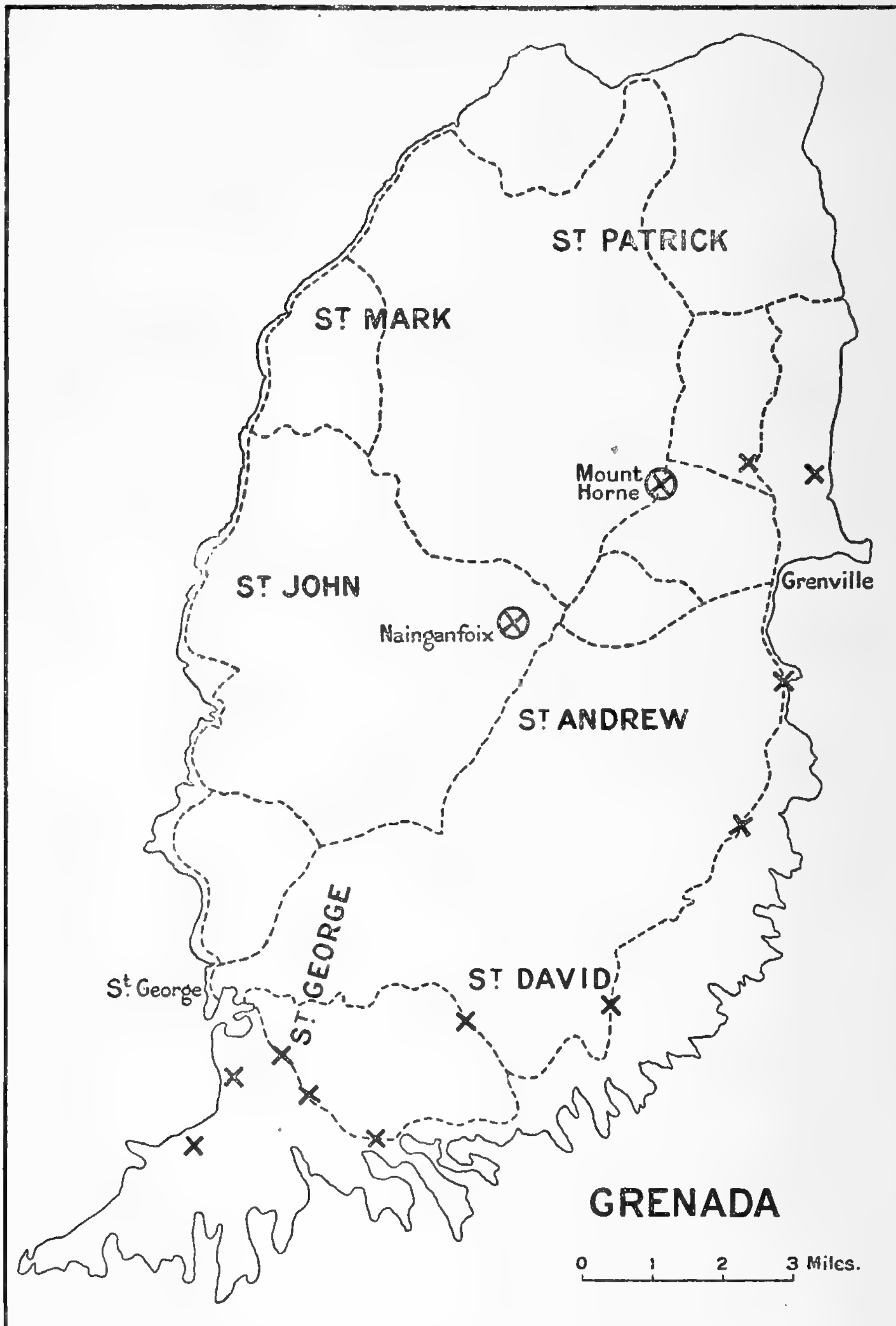
Several hundred spittle-masses were collected and examined, but no maggots of the Trinidad Syrphid fly (*Salpingogaster nigra*) were seen. If present, they must have been too rare to be of any value as a control. At this season in Trinidad they have generally become sufficiently numerous to exercise a considerable check on the numbers of the froghopper.

A single dead adult was found infested with the early white stage of the Green Muscardine Fungus (*Metarrhizium anisopliae*). This also was much too rare to be of any practical value.

Attid spiders, an important control in Trinidad, were very scarce in the canes.

A few specimens of the predaceous grasshopper, *Xiphidium fasciatum*, de G. (which is known to eat froghoppers) were found in the grass alongside the infested fields and also in other localities in Grenada. It does not, however, appear actually to enter the canes. It may on the other hand help to keep down the froghoppers in the areas between and so prevent rapid spread.

The mongoose, which is indirectly partly responsible for the depredations of insect pests by destroying birds and l zards, is generally common in Grenada, and in some localities rewards are offered for its destruction.


ST PATRICK
ST MARK
Mount Horne
ST JOHN
Nainganfoix
Grenville
ST ANDREW
ST GEORGE
St George
ST DAVID
GRENADA
0 1 2 3 Miles.

I took with me to Grenada two or three pounds of artificially prepared spores of the Green Muscardine Fungus mixed with rice flour, kindly given to me by the Usine St. Madeleine, Trinidad, from one of their recently opened culture cabinets. As the fungus was so rare naturally in Grenada, this mixture was spread over the damaged fields in the hope of infecting the froghoppers. The greater part of the material was distributed in Field 2. The spores were distributed at first by beating the bag containing the powder while carrying it through the canes. As, however, the field was exposed to a strong trade wind, and as also the supply of spores was limited, a number of stools were infected by shaking the powder from a small tube down into the axils of the upper leaves where the adults were congregated. This was much less wasteful of material, but was naturally a more expensive method and could not be recommended on a large scale.

I had to leave Grenada before any visible results could be expected from this treatment, but I was later informed by Mr. Berkeley, the Manager of Mount Horne, that a number of dead infected hoppers were found.

In 1917, I was also informed, the froghoppers appeared again in both fields but not to the same extent as in 1916.

Tomaspis saccharina was found at the following localities in the Island (see map).

St. George :—Belmont, on grass among cane ; Morne Rouge, on cane ; St. George Lower Road, on grass ; Woodlands, on cane ; Calvini, on cane.

St. Davids :—Main Road one mile North of Bailey's Bacolet, on grass ; La Sagess, on grass.

St. Andrews :—Menere, on grass ; Simon, on grass ; St. Andrews Harbour, on grass ; Lower Simon, on cane ; Mount Horne, on cane ; Nainganfoix, on cane.

St. Patrick.

St. Mark and St. John were not visited, but there is no doubt that it occurs there also.

COLLECTIONS RECEIVED.

The following collections were received by the Imperial Bureau of Entomology between 1st October and 31st December, 1917, and the thanks of the Managing Committee are tendered to the contributors for their kind assistance :—

Dr. W. M. Aders, Economic Biologist to the Zanzibar Government :—303 Culicidae, 11 *Culicoides*, and 4 *Simulium* ; from Zanzibar.

Mr. T. J. Anderson, Government Entomologist :—4 packages of Coccidae ; from British East Africa.

Mr. G. E. Bodkin, Government Economic Biologist :—5 Diptera, 20 Coleoptera, 6 Hymenoptera, 13 Rhynchota, 10 Orthoptera, and 1 Tick ; from British Guiana.

Mr. J. R. Bovell, Superintendent of Agriculture :—3 Diptera, 2 Lepidoptera, 3 Hymenoptera, 10 Coleoptera, 4 species of Coccidae, and 7 other Rhynchota ; from Barbados.

Capt. Carment, R.A.M.C. :—58 Culicidae, 14 Tabanidae, 2 Hippoboscidae, and 5 other Diptera ; from Salonica.

Capt. G. D. H. Carpenter :—135 Diptera, 1 Lepidopteron, 35 Hymenoptera, 209 Coleoptera, 2 Planipennia, and 14 Rhynchota ; from German East Africa.

Mr. D. d'Emmerez de Charmoy, Government Entomologist :—31 Lepidoptera, 25 Hymenoptera and 2 wasps' nests, 592 Coleoptera, 2 Rhynchota, 2 Orthoptera, and 9 Odonata ; from Madagascar.

The Division of Entomology, Pretoria :—10 Diptera and 42 Coleoptera ; from South Africa.

Mr. P. R. Dupont, Curator of the Botanic Stations :—5 packages of Coccidae and 8 packages of Fungi ; from the Seychelles.

Mr. C. C. Gowdey, Government Entomologist :—15 Diptera, 7 Lepidoptera, 150 Hymenoptera, 149 Coleoptera, about 30 Thysanoptera, 71 Rhynchota, 22 Orthoptera, 1 Termite, 10 Mites, and 10 Worms ; from Uganda.

Mr. E. Hargreaves :—18 Diptera, 2 Lepidoptera, 24 Hymenoptera, 138 Coleoptera, 2 Planipennia, 111 Rhynchota, 39 Orthoptera, and 3 Odonata ; from Italy.

Mr. M. E. MacGregor :—22 Mosquitos and about 20 larvae and pupae of *Anopheles maculipennis* ; from Hampshire.

Mr. N. C. Preston : —1 Dipteron, 100 Lepidoptera, 1 Trichopteron, 6 Hymenoptera, 9 Coleoptera, 5 Planipennia, 2 Rhynchota, and 3 Orthoptera ; from Macedonia.

Mr. A. H. Ritchie, Government Entomologist :—11 Lepidoptera, 6 Chalcids, 1 other Hymenopteron, 48 Coleoptera, 1 Lacewing, and 34 Rhynchota : from Jamaica.

Major H. S. Stannus :—4 Siphonaptera and 4 insect larvae ; from German East Africa.

Dr. H. Swale :—1 Braconid and 47 Coleoptera ; from Samoa.

Capt. Treadgold :—11 Rhynchota ; from Macedonia.

Mr. F. W. Urich, Government Entomologist :—17 Coleoptera ; from Trinidad.

Lieut. Jas. Waterston, R.A.M.C. :—62 Culicidae, 5 *Phlebotomus*, 9 Tabanidae, 1 Hippoboscid, 96 other Diptera, 79 Lepidoptera, 3 Trichoptera, 64 Hymenoptera, 72 Coleoptera, 19 Planipennia, type of the new Coccid *Antonina waterstoni*, Newst., 36 other Rhynchota, 22 Orthoptera, 39 Odonata, 1 Arachnid, 2 Leeches, and 31 Mollusca ; from Macedonia.

Mr. C. B. Williams :—3 Ants, 1 Bug, 1 Orthopteron, and 2 Spiders ; from Trinidad.

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IMPERIAL BUREAU OF ENTOMOLOGY.

HONORARY COMMITTEE OF MANAGEMENT

A CONTRIBUTION TO THE KNOWLEDGE OF THE BOT-FLIES, GASTROPHILUS INTESTINALIS, DeG., G. HAEMORRHOIDALIS, L., AND G. NASALIS, L.*

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(Plate II.)

The following is an account of an investigation into the life-histories and habits of the species of bot-flies (*Gastrophilus*) occurring in the western provinces of Canada. The investigation was undertaken co-operatively by the Entomological and Health of Animals Branches of the Dominion Department of Agriculture under the direction of the Dominion Entomologist and the Veterinary Director General. The greater proportion of the work, for which the authors are equally responsible, was carried out at the University of Saskatchewan, Saskatoon, Sask., during a period of about four months extending from June to September, 1917. Certain of the experiments dealing with the penetration of the larvae of *G. intestinalis* into animal tissue were commenced at Saskatoon, but were supplemented later in the same year by others carried out in the Department's laboratories at Agassiz, British Columbia.

Recognizing the scantiness of the knowledge pertaining to the early stages and habits of the three common species of bot-flies, the authors had in mind in this work the elucidation of several obscure points, more particularly relating to the hatching of the eggs, the form and behaviour of the first-stage larvae, the specific regions of the host selected by the different flies in ovipositing, and the manner in which the persistent attacks of the flies affect their hosts psychically.

When one considers how common these insects are, and that they have been known to both entomologists and veterinarians for several decades, it is surprising to find how inadequate is our knowledge of the species. Indeed, the theories regarding the hatching of the eggs and the mode of entrance of the larvae to the alimentary canal of the host have passed untested as genuine currency through the literature from the earliest times until quite recently, when the important discovery of the direct penetration of the skin of cattle by the ox-warble (*Hypoderma*), by Carpenter and Hewitt in Ireland (1) and one of the authors in Canada (2), has been almost paralleled by the significant results of Roubaud's investigations (3) in France. This last author observed in his experiments with guinea-pigs that, when the recently-emerged larva of *G. intestinalis* is brought into contact with the buccal mucosa, it promptly burrows into the mucosa and lies immediately beneath and parallel to the surface..

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The facts regarding the life-history and habits of *G. intestinalis* are much more extensive than those of *G. haemorrhoidalis* and *G. nasalis*, thanks, in great measure, to the excellent and careful work of Osborn (4), who has emphasized the importance of moisture, friction and warmth as factors necessary to the successful hatching of the eggs. His results in this direction have been in the main confirmed by Collinge (6).

The Egg.

Gastrophilus intestinalis.

The stalkless egg is generally laid at the distal end of a hair, in full view. It measures on the average about 1·25 mm. in length and about 0·379 mm. at its widest part just posterior to the operculum. General colour, greyish yellow to yellow. General shape navicular, more or less flatly oval in section. Two attaching sub-parallel flanges project on the side proximal to the supporting hair, which they encircle, commencing at a point removed about one-third from the anterior end of the egg and terminating just short of the posterior extremity; the non-flanged, anterior third

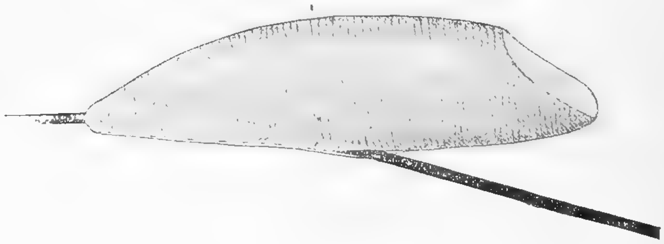

Fig. 1. Egg of *Gastrophilus intestinalis*, × 50

makes an angle of about 30 degrees with the supporting hair. Chorion traversed by a close series of very delicate, transverse, sub-parallel striae continuous with those of the flanges; some striae interrupted and broken in their course. Operculum non-striate and apparently unsculptured, more or less flat, arising and arching somewhat abruptly on the side nearer the hair, imparting a rather truncate appearance to the anterior extremity of the egg (fig. 1). Chorion closely invested internally by a delicate membrane enclosing the larva (fig. 2).

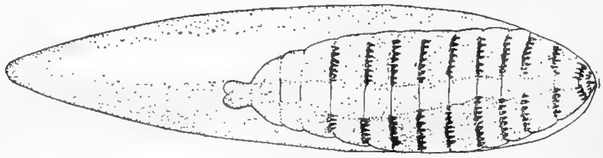

Fig. 2. Egg membrane enclosing unhatched larva of *Gastrophilus intestinalis*, × 70.

The eggs of *G. intestinalis* may be found promiscuously on the shoulders of the horse, mane, fore-legs, antero-interno-inferior part of the knee and postero-internal region of the fetlock. The long hairs which invest the inside of the fore-legs would appear to be especially favoured by the adults in ovipositing. The eggs have also been found on the hind-legs, particularly on the inside of the hocks, but here they occur only in small numbers.

In a paper by M. J. Rodhain (13), to which our attention was drawn by M. J. Bequaert, of the American Museum of Natural History, New York, the author records the finding of the eggs of the Oestrid of the rhinoceros (*Gyrostigma*), which were submitted to him from the Belgian Congo. In his description he says that the general form of the egg recalls that of *Gastrophilus intestinalis* by reason of the delicate and regular transverse striation of its walls, as well as by the oblique attachment of the apical operculum. It differs, however, from the egg of *G. intestinalis* in that it is devoid of flanges, their function being assumed by a posterior falciform appendage applied to the skin of the host. It is further suggested that the hatching of the eggs is effected in a manner similar to that which occurs in the case of *G. intestinalis*, namely, one animal licking another.

Gastrophilus nasalis.

Egg stalkless, generally laid at the proximal end of the hair near the skin, obscured externally among the overlapping hairs. Average length about 1·25 mm. Average breadth at widest part, midway between the two extremities, about 0·339 mm. General colour, whitish yellow. General shape elongate ovate, sub-circular in section. The two attaching sub-parallel flanges commence just posterior to the anterior extremity and run almost the entire length of the egg, stopping just short of the posterior extremity. The long axis of the egg almost parallel to that of the supporting hair. Chorion traversed by a close series of very delicate, transverse,

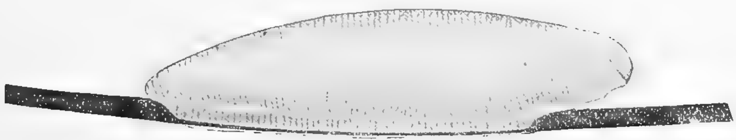

Fig. 3. Egg of *Gastrophilus nasalis*, × 50.

sub-parallel striae, continued on the flanges; some striae interrupted and broken in their course. Operculum non-striate and non-reticulate, dome-shaped, its horizontal axis at right angles with the longitudinal axis of the egg, terminally placed on the anterior end (fig. 3). Chorion with internal investing membrane enveloping the unhatched larva.

The eggs are generally laid on the hairs of the intermaxillary space between the rami of the mandibles beneath the head. Theobald (6) and other authors are of the impression that the species deposits its eggs in the nasal orifices, but in our experience, this is contrary to fact.

Gastrophilus haemorrhoidalis.

Egg stalked, the stalk a continuation of the broad chorionic flanges, hollow and open all along one side for the reception of the supporting hair. Average length 1·5 mm. Average breadth at widest part near the centre, 0·345 mm. General colour brownish black. General shape somewhat barnacle-like and compressed, flatly ellipsoidal in section. The two attaching sub-parallel flanges commence at a point removed about one-third from the anterior extremity of the egg, are continued into the stalk, which is about two-thirds the length of the egg, and taper off somewhat abruptly (fig. 4). The chorion encircled by a close series of fine striae, bearing on their anterior margins tiny, slightly recurving spinules anteriorly directed, the spinules of any one stria all but reaching the stria immediately anterior. Egg

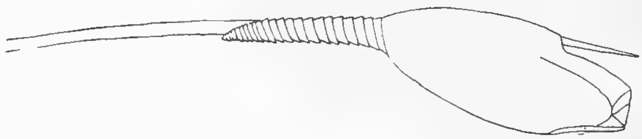

Fig. 4. Egg of *Gastrophilus haemorrhoidalis*; outline sketch to show attachment to hair and disposition of bands on stalk, × 65.

disposed parallel to the hair, with the exception of a slight outward deviation of the unflanged anterior portion. Operculum placed antero-externally, non-striate and non-reticulate, elongate-oval, slightly concave on its inner side (fig. 5).

G. haemorrhoidalis generally lays its eggs on the hairs of either of the lips of the horse, but preferably on those of the lower. Parker (7), among other authors, states that the eggs are also found in the nostrils, but it has never been our experience to find them elsewhere than on the lips.

According to Parker (7), eggs of this species were found by himself and his assistant thrust into the nose and lips of horses, sometimes to the full length of the stalk. Thus he finds a reason for the nervous and occasionally uncontrollable fear shown by horses when the fly is "striking." Further, he states that the chitinous "bands" of the stalk impart to it the appearance of a screw, and that the structure

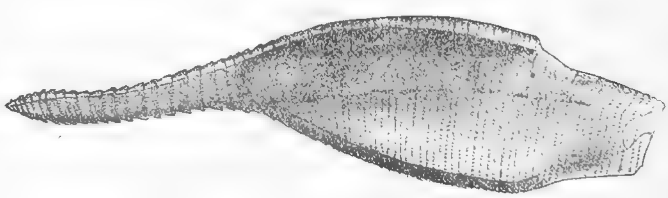

Fig. 5. Egg of *Gastrophilus haemorrhoidalis* removed from the hair to show the continuity of the flanges with the stalk, × 69.

is patently adapted to hold the egg in the skin after insertion. In no single instance did we find the egg penetrating the skin. On the contrary, we invariably found it adhering to a hair (fig. 4) and not touching the skin. Therefore, we conclude that Parker must have erred in his observations.

The recently emerged Larva.

Gastrophilus intestinalis.

Number of segments 13, hairless. Length, 0·866 mm.; greatest width, 0·217 mm. General colour translucent white; general shape strap-like and fusiform, tapering towards both extremities. Unpaired, lance-like mouth-stylet (mandible) directed anteriorly. Anterior margin of the first segment with a few recurving, small, black hooks. Anterior margin of the second segment bearing an armament of long, recurving, black hooks (head-hooks), diminishing in size posteriorly, interspersed with small hook-shaped, placoid denticles. Posterior margins of segments 2 to 10 provided with an armature of irregularly-disposed rows of similar cuticular denticles and sub-ovate, brownish-black, flat scales, the denticles predominating in segments 2 to 5 and the scales in the following segments; segments 11, 12 and 13 devoid of armature. There is a slight medio-dorsal and medio-ventral interruption in the armature of each segment. Two divaricating, cylindrical, fleshy processes arise from the 13th segment, each process containing the prolongation of the main tracheal trunk of its side and bearing at its distal end the posterior spiracle (fig. 6).

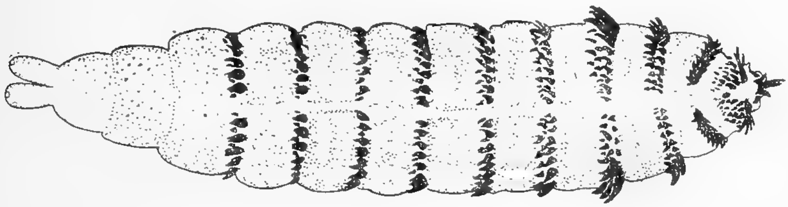

Fig 6. Larva of *Gastrophilus intestinalis*, × 120.

Raillet (8), on page 752, quotes Joly as asserting that spines similar to the crown of hooks of the head segment are present on the posterior margins of segments 2–10 inclusive, a view with which we entirely agree. In a footnote, however, this author quotes Brauer's opinion that these spines are more likely attached to the anterior margin of the segments following number 2, as is found in the mature larvae.

Gastrophilus nasalis.

Number of segments 12. Length, 0·829 mm.; greatest width, 0·116 mm. Segments 2 to 12 sparsely provided with regularly-arranged, slender, elongate hairs. General colour translucent white, with the exception of the black and brownish yellow of

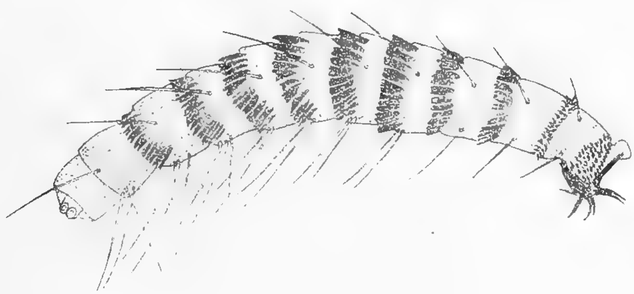

Fig. 7. Larva of *Gastrophilus nasalis*, × 114.

the hooks, denticles and scales of the segmental armature. Slender, paired mouth-stylets directed anteriorly from their articulation with the sclerites of the cephalo-pharyngeal apparatus. Anterior margin of first segment bearing an armament of recurved denticles, the ventral ones strongly developed, elongate and tapering gently to a slender, sharp, recurved point (head-hooks). Posterior margin of segment 2 provided with similar placoid denticles, but elongate ones lacking. Posterior margins of segments 3 to 10 armed with narrow, elongate, sharp-pointed, denticular scales interspersed with similar smaller ones; base of scale brownish yellow, apices and margins black and more strongly chitinised; the larger scales apparently strengthened by a median rib. Segments 11 and 12 unarmed. Posterior pair of spiracles scarcely projecting beyond the extremity of the body, sessile (fig. 7).

Raillet (8), on page 758, and Neumann (9), on page 345, state that in the recently emerged larva of *G. nasalis* there is but one row of spines on the anterior border of the segments. With this opinion we do not agree, as examination of a large number of specimens shows that the spines or scales—as we prefer to call them—arise from the posterior margins, and further, their arrangement is somewhat irregular, so that they do not assuredly form a single well-defined row.

Gastrophilus haemorrhoidalis.

Number of segments, 13; hairless. Length, 0·585 mm.; greatest width, 0·133 mm. General colour translucent white, with the exception of the brownish-black of the denticles and scales of the segmental armature. General shape fusiform, tapering to both extremities. Single pair of mouth-stylets (mandibles) directed anteriorly. Strongly developed crown of elongate, slender, recurving head-hooks arising from the anterior margin of segment 2 with numerous smaller placoid denticles and toothed

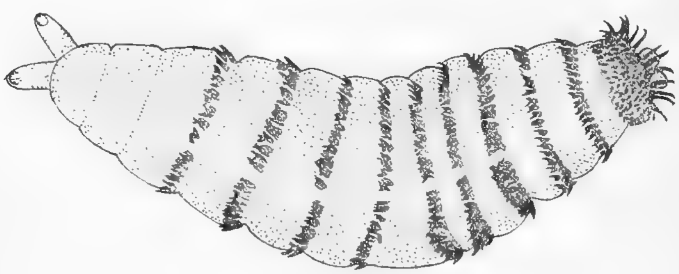

Fig. 8. Larva of *Gastrophilus haemorrhoidalis*, × 140.

scales intermingled and irregularly arranged in a row. Segments 11, 12 and 13 devoid of armature.. Ultimate segment bearing posteriorly two cylindrical processes, at the extremity of each of which is a spiracle where the main tracheal trunk of each side terminates, as is the case in the larvae of *G. intestinalis*. The armature not so strongly developed as in the larvae of *G. intestinalis* and *G. nasalis* (fig. 8).

In his description of the third-stage larva of this species, Neumann (9), on page 344, distinguishes it from *G. intestinalis* by its smaller size and its very deep red colour. The absence of spines on the mid-dorsal region of the ninth segment is mentioned and their complete absence on segments 10 and 11.

Hatching of the Eggs.

There seems to be some doubt as to whether the eggs of bot-flies require moisture and friction for their successful hatching. It has frequently been argued, notably by Osborn (4) and later confirmed by Collinge (5), that both moisture and friction are necessary factors in the hatching of the eggs of *G. intestinalis*. Whilst our experience would corroborate this statement, it can be definitely stated, as the results on Table I show, that the eggs of *G. nasalis* hatch quite freely without extraneous aid. For those of *G. haemorrhoidalis* no definite assertion can be made, as the number of eggs at our disposal was rather small. However, in one case, out of 14 eggs of this species, 8 hatched independently in a dry vial.

TABLE I.—*Experimental Hatching of Eggs of Bot-flies in Vials, unaided.*

Species.	Number of un-hatched eggs.	Date when collec-ted.	Number of eggs hatched.	Date of hatching of last egg.	Remarks.
G. intestinalis ..	7	July 28	0	—	3 alive Aug. 28, 4 dead.
	250	Aug. 5	1	Aug. 16	Larvae in eggs alive Aug. 16
	206	Aug. 20	4	Sept. 6	Remainder dead.
	13	Aug. 26	0	—	All dead in September.
	12	Aug. 27	0	—	Alive Sept. 4, died later.
	130	Aug. 27	6	Sept. 21	4 hatched only partly.
G. nasalis	40	July 11	32	July 23	Remainder died.
	69*	July 11	43	July 23	,, ,,
	29	July 18	22	July 28	,, ,,
	8	Aug. 3	0	—	Aug. 29, all dead.
	79†	Aug. 5	28	Aug. 20	Remainder died.
G. haemorrhoidalis ..	14	July 20	8	July 24	1 damaged, remainder died.

* The glass vial containing these eggs was kept slightly moist by means of a wetted piece of blotting-paper inserted between the cork and the walls of the vial.

† Includes some eggs which had hatched before they were collected from the horse, the number of which was not determined.

In the case of *G. intestinalis*, the experiments were continued until the end of September, and the eggs were frequently examined, at least three times a week. A large number of eggs in each batch were dissected after the date on which the last larva was observed to emerge. In most cases the larvae inside were alive and, when liberated, were quite active. From the results, it may be apparently deduced that the eggs of *G. intestinalis* normally require assistance in hatching in the shape of moisture and friction, and that only a very small percentage (1·7) contrive to hatch unaided. In support of this fact, it was found in frequent tests that hatching is readily promoted when the eggs are moistened and subjected to pressure by passing the blunt edge of a scalpel over them. In some, only slight pressure is required, just sufficient indeed, to cause the operculum to spring from its attachment with the egg. The length of time that moisture is applied may also determine the rate of hatching.*

From the foregoing table it would appear that the eggs of *G. nasalis* hatch most readily of the three species without artificial aid (51 per cent.), a fact which is more than interesting in view of the position where the eggs are deposited on the host, namely, the intermaxillary region. This also agrees with our theory that the larvae of *G. nasalis* may penetrate the integument of the host directly, since it is manifestly impossible that the animal could reach the eggs with its lips or tongue.

Actually, 51 is a low estimate of the percentage of hatching of *G. nasalis* eggs, for it does not take into account the fact that in the case of the batch of 79 eggs several had hatched before being collected.

It would be unwise to generalise from the results obtained in the case of the eggs of *G. haemorrhoidalis*, owing to the small number with which we dealt.

In passing, it may be observed that the eggs of *G. intestinalis* are disposed on the hairs differently from those of *G. nasalis*. On long hairs bearing a number, the eggs of the former are usually separated from each other more widely than are those of the latter, of which as many as 7 and 8 eggs are often deposited in close series, the anterior extremity of one in contact with the posterior extremity of its immediate neighbour. As already remarked, the eggs of *G. haemorrhoidalis* do not have the stalk touching the skin of the host, and generally there is but one egg on each hair.

Do the recently emerged Larvae of Bot-flies penetrate the Integument of the Host?

It is significant to note that about the time that the larvae of *G. nasalis* were hatching from the eggs in maximum numbers, numerous small scabby areas were observed in the intermaxillary region of the host. As to whether the cause could be attributed to the animal rubbing the affected part on fence-posts, is a moot point. In the animals examined, it could not be shown that the hair under the jaws had been rubbed off, as one would have naturally expected had the above been the reason. It is just possible that the newly-hatched larvae were the direct agents concerned in producing this abraded condition of the skin. Although we cannot substantiate this theory by material evidence, is it not permissible to suppose that, since it would

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* Since completing the manuscript of this paper, the authors have had the opportunity of consulting Bracy Clark's work (14) on the OESTRIDAE. In the hatching of the eggs of *G. intestinalis*, he states how he found that moisture and friction were necessary, and that these conditions were supplied when the host licked the eggs. As for the stimulus which causes the horse to lick the eggs, Clark advances the ingenious theory that the irritable biting of other flies, which he enumerates as *Conopes*, *Tabani*, and *Muscae*, is responsible, and indeed, is of the opinion that the great majority of the larvae reach the mouth in this way. It is undoubtedly true that *Stomoxys* by its attacks will furnish this stimulus. The author also mentions the liability to infestation when one horse performs the friendly operation of licking the egg-infested coat of another.

As regards the eggs of *G. haemorrhoidalis*, Clark was the first to observe that they were deposited on the lips and that they were of a darker colour than those of *G. intestinalis* or *G. nasalis*.

Up to the time of appearance of Clark's paper the three species of *Gastrophilus* had been hopelessly confused with each other and with *Hypoderma*. The author rendered a material service to entomology by giving clear descriptions of the flies, accompanied by excellent illustrations, thus enabling one to discriminate the three species readily.

be impossible for the host to lick the eggs with its tongue by reason of their inaccessibility, the young larvae, instead of being taken into the mouth, penetrate into the body directly through the integument? This would undoubtedly account in satisfactory fashion for the small lesions which were noted. This theory receives additional support from the fact that in several of our experiments many eggs hatched independently, unaided by either moisture or friction, in a glass vial.

In reviewing the literature, it is interesting to note that Brumpt (10), p. 699, quoting Henry, says that the eggs of *G. nasalis* are laid on the cheeks and intermaxillary region of the horse and are entirely adherent to the hairs, a fact with which we readily agree. This same author, in a footnote, also quotes Raillet, on page 699, as stating that the first-stage larvae of this same species are probably the cause of "creeping myiasis" on the cheeks of the horse, indicating that he found a condition similar to that already noted in our observations.

Similar scabby pimples have been diagnosed on the lips of the horse, on the hairs of which the eggs of *G. haemorrhoidalis* are generally found. In this case, however, the eruptive condition might be satisfactorily explained, in the absence of approved evidence, by the host rubbing its lips violently on the ground. At the height of the season, the adult fly was frequently observed to goad its host into behaving thus, especially when the "striking" was persistently repeated. Further, the rubbing of the lips was severe enough to cause the complete removal of the hairs.

On 20th August 1917, a piece of skin, the hairs of which bore numerous eggs of *G. intestinalis*, was removed from the umbilical region of a foal recently killed. To prevent its decay, the skin was treated with bichloride of mercury. In all, only three eggs hatched unaided, one on 25th August and the remaining two on 29th August. The larvae which emerged from these three eggs died among the hairs and apparently made no effort to burrow beneath the skin. Results of a similar kind were obtained with the eggs of the same species when another piece of skin was taken from the antero-intero-inferior region of the knee of a horse which had recently died, and likewise treated with bichloride as before. No larvae emerged of their own accord from the eggs deposited on the investing hairs. Therefore, from these two casual experiments, no evidence was forthcoming that the recently emerged larvae of *G. intestinalis* may penetrate directly beneath the integument.

On 18th September, a small piece of the buccal mucosa was removed from the inside of the lower lip of a horse and placed in a petri dish. Recently emerged larvae were obtained from the eggs mentioned in the two previous experiments and hatched by the aid of moisture and friction. In all, 9 live larvae were placed on the skin, which was kept moist by the application at intervals of a few drops of normal salt solution. The experiment was commenced at 7.30 p.m. By means of the binocular microscope, some of the larvae were observed to be actively working their mouth-parts. The head-hooks were extended and opened out in a lateral direction. This behaviour was continued for a time. Finally, the mouth-hooks were embedded in the skin as if preparatory to the larvae tunnelling beneath the surface. At 10 p.m., they were still actively engaged in the work, but no single one had made any extensive headway. The most successful had not penetrated further than the second anterior segment. Nevertheless, the fact remains that the mouth-hooks were securely fixed, so much so, indeed, that quite a little force had to be exerted in detaching them. When examined the following morning (19th Sept.) all were found to be dead, probably from the effects of the salt solution. None had made any further progress in their efforts at entrance than was observed the previous night. The experiment was again repeated on 21st September, but on this occasion two pieces of mucosa with the attached muscles, taken from a horse's tongue were used. One of the pieces was papillated, the other unpapillated. In the case of the first, 12 newly-hatched larvae of *G. intestinalis* failed to effect an entrance, but out of 4 larvae on the unpapillated portion, one succeeded in becoming completely buried in 8 hours after the experiment was commenced. After 6 hours, only the terminal spiracle-bearing processes were showing, and these were finally lost to sight.

The success of this last experiment stimulated the authors to make a further attempt, which was done in the laboratories at Agassiz, B.C., later in the season. In all, four experiments were made on 22nd October, with larvae hatched from eggs collected at Duncan, Vancouver Island, on 15th October. The larvae readily emerged when the opercula of the eggs were detached with needles. In each case the mucosa of the tongue of a calf just killed was used. For the first, the portion selected was unpapillated, taken near the tip of the tongue ; for the others, papillated.

Briefly stated, the results were as follows. In experiment No. 1, of 10 larvae placed on the skin at 12.45 p.m., 6 began burrowing and effected an entrance. In only one case did the larva succeed in completely burying itself, and this occurred 7 hours after the experiment commenced. In the other cases, only partial success attended their efforts, and the progress made varied considerably. For instance, after 6 hours, 3 larvae had 3, 5 and 7 segments respectively still revealed, and another after 7 hours, had still 4 segments visible.

In experiment No. 2, of 6 larvae, one burrowed completely beneath the surface in $2\frac{1}{4}$ hours, in close proximity to a papilla. In experiment No. 3, of 5 larvae, 2 effected an entrance and, in each case, became completely buried in about 4 hours. A third was only partly successful, all the segments being hidden except the last three, in 1 hour and 40 minutes. No further progress was, however, achieved.

In experiment No. 4, of 6 larvae, 2 burrowed beneath the surface and disappeared in $2\frac{1}{2}$ hours. In both cases they effected their entrance by means of the circumvallate fossa of a fungiform papilla. In this particular experiment, the larvae proved very restless, at times travelling aimlessly around, and at others, settling down and making an attempt to enter. Some appeared to be partly successful in their efforts, but after a while they would withdraw their mouth-hooks and wander around restlessly again. In the third case, in which entrance was successfully effected, 8 hours were occupied in the process, the larvae being finally oriented at a sharply oblique angle with the surface.

In summing up the results of these experiments, we do not wish to attach too much importance to their significance, although they are certainly suggestive. Granted the larva finds its way to the mouth of the host, there is apparently no reason why it should not penetrate the mucous tissues therein. Indeed, its structure is admirably adapted for this purpose, as is readily seen when one considers the piercing function of the mouth-hooks and the backwardly-directed segmental denticles and scales, which cannot fail to advance the efforts of the larva, once it has effected an entrance.

Since the completion of these experiments, we find that Roubaud (3) has demonstrated that a larva, hatched from eggs sharply brushed by the lips of a guinea-pig, immediately burrowed beneath the buccal mucosa in the animal's mouth and maintained itself parallel to the surface in travelling towards the throat. Its course was followed for a period of nine days, when it had then attained a size approximately equal to that of the larva just previous to the first moult. From this it is inferred that the infestation of the horse is produced when, for some reason or other, the animal rubs the eggs with the buccal membranes of its lips. The author goes on to state that in cases of "creeping myiasis" due to bot-larvae, entrance is not apparently made directly through the epiderm, but by way of the exposed mucous membranes of the eyelids and lips, or of some skin lesion. Regarding his statement that larvae are unsuccessful in penetrating the skin of the horse, wet or dry, and die very rapidly, the negative results in our own observations of the larvae on fresh skin removed from horses, bear him out.

Hall (12) has recently succeeded in obtaining some interesting results regarding incidental myiasis of bots in dogs. Bots, according to this author, have been found on a few occasions in the stomachs of dogs, the infestation probably arising from the eating of bot-infested stomachs of horses. In his experiments, 6 specimens each of *G. intestinalis* and *G. nasalis*, enclosed in gelatine capsules, were fed to each of two dogs. Three specimens of the former succeeded in establishing themselves for a period of 35 days, after which the animal was killed and examined. They were found to have settled in such diverse locations as the stomach, the caecum and the lower part of the small intestine. The specimens of *G. nasalis* did not succeed in establishing themselves, and none were found on post-mortem examination. Negative results were also obtained in another experiment with the larvae of *G. haemorrhoidalis*, although the same animal retained one of six larvae of *G. intestinalis*, fed at the same time, for as long as 13 days. The author quotes the parallel results of Raillet, who worked along similar lines.

It would be irrational to attach too much value to these experiments of Hall and Raillet. It has been our experience that the mature larva of bots will attach themselves very readily to animal tissue of various kinds, and it is only natural to suppose that they will endeavour to fix themselves temporarily to the walls of the alimentary canal of any strange mammalian host. The fact that several of the larvae in Hall's experiments were passed per anum soon after they were fed to the dogs, seems to us to prove that their unaccustomed environment did not suit them.

Distribution in Canada.

So far as our information goes, *G. intestinalis* occurs in Ontario, Alberta and Saskatchewan, as well as in British Columbia. It is more than probable that it is present throughout Canada wherever its host is found. *G. nasalis* occurs in the three western provinces, Saskatchewan, Alberta and British Columbia; while *G. haemorrhoidalis* has been taken in Manitoba, Saskatchewan and Alberta. In the opinion of F. C. Bishopp, of Dallas, Texas, who writes under the date of 12th February

1917, there is little doubt but that the last-named species will be found to occur in British Columbia, as it has been reported in neighbouring regions of the United States from Western Montana.

Professor W. Lochhead (11) quotes the opinions of two correspondents from Western Canada, one from Saskatchewan. It is the idea of the first that the " nose-flies " arrived in the western territory eight years ago and were first observed about a year after the importation of some horses from the United States, from which the parasites may have been obtained. The second states that the " nose-fly " (apparently referring to *G. haemorrhoidalis*) made its first appearance in Saskatchewan some ten or more years ago and supposes it to have been brought from the United States or Mexico.

Period of Adult Activity.

In the vicinity of Saskatoon, *G. nasalis* is on the wing from the middle of July until the middle of August, although a specimen taken by Mr. T. N. Willing, of Saskatoon, at Maple Creek, Sask., is dated 30th October 1903. Eggs of this species that were collected in the first days of August were found to have already hatched. Our first specimen of *G. haemorrhoidalis* was taken on 11th July 1917, and the last on 11th August. It is probable that the adult activities of these two species are seasonally contemporaneous. *G. intestinalis* makes its appearance somewhat later than the other two, the first capture having been made on 22nd July 1917, and the last on 22nd August. On the Pacific Coast, *G. intestinalis* is found on the wing much later in the season. On Vancouver Island, a specimen was taken on 5th October 1917, whilst on 3rd October several were observed in copula, the flies being then very numerous.

Habits of Adults.

The three species of *Gastrophilus* are most active on bright sunny days, attacking their hosts when the weather is warm. Wind has apparently but a slight restraining influence. All three are strong on the wing, although *G. intestinalis* is least rapid in its movements. As regards their effect on horses, it has been observed that the attacks of *G. nasalis* and *G. haemorrhoidalis* inspire the animals with more acute nervous apprehension than do those of *G. intestinalis*. Persistent attacks will drive horses that are grazing in the open almost frantic, and a mad stampede on a warm day is a fairly sure indication that bot-flies are in the immediate vicinity of the animals.

In an endeavour to prevent the attack of *G. nasalis* horses are often observed standing head to head, resting their jaws on each other's necks. By adopting this attitude the host can the better protect itself against the fly as it " strikes " upwards to oviposit between the rami of the mandibles. When in harness, the animals strive to ward off the fly by drawing the head back quickly towards the neck, but the action is apparently not rapid enough to prevent the insect accomplishing its purpose. An egg is generally left behind, securely fastened to a hair at each attack.

In darting at the lips, *G. haemorrhoidalis* will cause the animals to nod their heads violently, to strain them forward and to open their lips. On repeated annoyance they endeavour to rid themselves of the irritating pests by rubbing their lips vigorously on the ground or any convenient object. With this species, as with the last-mentioned, the adult makes its attacks insidiously from below and is often observed flying beneath the abdomen of the horse, near the ground, as if waiting for a favourable opportunity to push home the offensive. A Saskatchewan correspondent of Prof. Lochhead (11) relates how an adult of this species deposited an egg on the back of his hand, attaching it to a hair. He also recounts that on several occasions the flies have " struck " at the underside of the brim of his hat.

A second correspondent, also hailing from Saskatchewan, remarking on the haemorrhoidal bot-fly, observes how " it flies very swiftly back and forth, poises itself for a moment, as though to judge place and distance and then darting upward, stabs a black egg into the lip or chin of the horse, and retreats as swiftly, only to

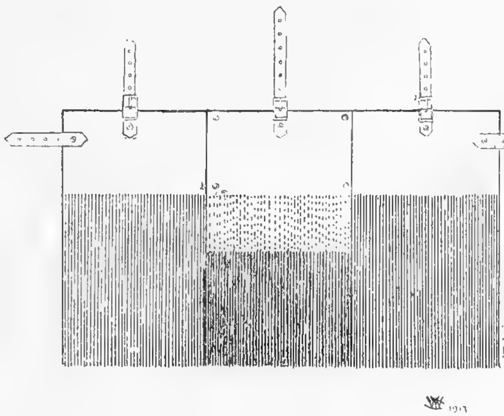

Fig. 9. Leather nose-fringe, extended, for protecting lips of horse against the attacks of *Gastrophilus haemorrhoidalis*, with central flap and fringe to cover the exposed upper lip.

return at the next suitable moment. The horse can hear it and awaits the attack with nervous apprehension. On feeling the needle-like thrust, it starts violently and rubs its lips or nose on the grass or against another horse." As we have already pointed out, the idea that the egg is inserted into the lip is a fallacy, and the actual deposition of the egg does not cause the animal any physical pain.

The adult *G. intestinalis* does not apparently inspire such terror in the animals as the other two species. In thrusting home its attack, it may be often observed to hang on the wing, both before and after the operation is completed.

Preventive Measures.

It is usual for western farmers to shield the lips of their horses from the haemorrhoidal bot-fly by means of a wire-screen muzzle of fairly close mesh. Whilst quite effective for the purpose, it is rather clumsy, besides being an impediment to natural and free respiration. In order to obviate this difficulty, a device such as is represented in figures 9 and 10 might be contrived. The principle consists in nonplussing the attack of the fly by disturbing effects produced by hanging leather strips protecting the nose and lips and agitated into motion whenever the animal moves its head.

The apparatus, as devised by the authors with the aid of Mr. C. Warburton Young, is quite simple, consisting of a leather-band cut into a series of strips, each about three-sixteenths of an inch wide and long enough to cover the lips of the horse. The band is fastened by a buckle under the chin and attached to the head-stall by a similar buckle on each side and one on the front, as shown in figure 10. In order to eliminate the possibility of the nose being unprotected when the strips fall away too sharply as the animal raises its head, it is recommended that an extra leather-flap, as figured, should be attached to the band directly over the nose and likewise cut into strips on the lower margin. To secure a more rapid attachment of the nose-band to the head-stall, spring-snaps might be used in place of straps and buckles.

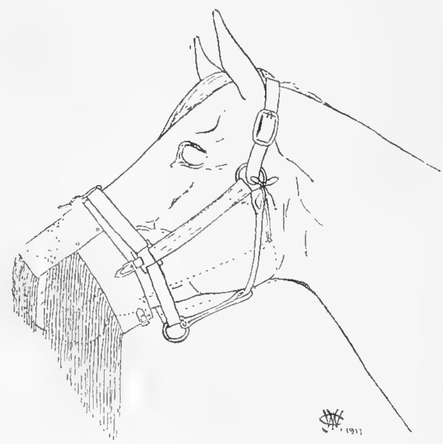

Fig. 10. Leather nose-fringe as it should be adjusted on the horse's nose. Dotted lines beneath the jaws indicate the outline of the canvas flap, attached to the head-stall and nose-fringe, for warding off the attack of *Gastrophilus nasalis.*

As a preventive measure against the attacks of *G. nasalis*, a piece of canvas extending from the nose-band to the throat is attached under the jaws. It is riveted to the posterior margin of the nose-band and fixed posteriorly to the ring of the head-stall on each side by a stout cord. The inter-maxillary region is thus completely protected.

Summary.

The eggs of the three species of bot-flies discussed in this paper are distinguished by the fact of that of *G. haemorrhoidalis* being the only one stalked. It is also longer than those of the other two species, which are of about equal length. Further, it is brownish black in colour, that of *G. intestinalis* being whitish yellow and *G. nasalis* yellow. The egg of *G. intestinalis* adheres to the hair by clasping flanges, which run only two-thirds of its length, whilst the flanges of the *G. nasalis* egg run almost the entire length.

The egg of *G. haemorrhoidalis* is not inserted nor screwed into the skin of the host. The eggs of *G. intestinalis* are laid indiscriminately on the body of the host, but preferably on the long hairs investing the inside of the foreleg. *G. nasalis* lays its eggs on the hairs of the intermaxillary space, and *G. haemorrhoidalis* on the hairs of the lips, preferably the lower.

Of the recently emerged larvae, that of *G. intestinalis* is largest in size and *G. haemorrhoidalis* smallest. In these two species there are 13 body segments, whilst *G. nasalis* has but 12 and is the only one bearing slender, elongate hairs. The larval posterior spiracles of the latter species are sessile; whereas in the others the two spiracles are borne on the distal ends of two cylindrical processes arising from the ultimate abdominal segments.

The eggs of *G. intestinalis* do not readily hatch unaided, but apparently require the application of moisture and friction or shock. A large number of *nasalis* eggs hatched spontaneously and a few of the *haemorrhoidalis* eggs also. This latter fact is regarded as supporting the theory that the newly emerged larvae of these two species may penetrate directly into the integument of the host. The lesions on the skin of the intermaxillary space and lips of the host observed at the time the eggs were hatching may be due to direct penetration of the larvae of *nasalis* and *haemorrhoidalis* respectively.

The newly emerged larvae of *intestinalis* failed to penetrate the hair-bearing integument of the host, but positive results were obtained when they were placed on portions of the buccal mucosa of a horse and calf recently killed. A larger number succeeded in penetrating the papillated portion of the calf's tongue, as compared with the unpapillated.

The three species are probably present in each of the western provinces of Canada.

As regards their seasonal appearance, *intestinalis* is somewhat later than *nasalis* and *haemorrhoidalis*, which appear simultaneously and are on the wing for about the same time. *G. intestinalis* continues to be active far into the autumn.

Of the three species, *intestinalis* causes the animal less apprehension than the other two.

The provision of leather-flaps on the lips of the horse, cut into strips, comb-wise, is advocated as likely to give good results in warding off the attack of *G. haemorrhoidalis*.

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The authors desire to render their grateful thanks to Dr. W. C. Murray, President of the University of Saskatchewan, for the laboratory accommodation which he so kindly granted. They are also indebted to Mr. T. N. Willing, Professor of Natural History in the University, for his generously allowing them to consult the specimens of Oestridae in his collection.

Ottawa, 28th November 1917.

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1. *Gastrophilus nasalis*, L. ♀

2. *Gastrophilus haemorrhoidalis*, L. ♀

3. *Gastrophilus intestinalis*, de G. ♀

CANADIAN BOT-FLIES.

THE COCCIDAE OF SOUTH AFRICA—II.*

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(PLATES III–VII).

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Four Gall Coccids.

Although a large variety of plant-galls are known in South Africa, only four have so far been determined to be caused by Coccids. These are of particular interest because no two of them are similar, and more remarkable still is the fact that no two of the insects belong to the same genus, nor apparently to the same sub-family. Under these circumstances it has been thought advisable to group them together without reference to their systematic position in this paper. The characters of the galls and insects may be seen from Plates iii and iv.

The four genera are *Grewiacoccus*, g.n., *Cissococcus*, Ckll., *Calycicoccus*, g.n., and *Amorphococcus*, Green. The first of these belongs undoubtedly to the PSEUDOCOCCINAE; the last undoubtedly to the ASTEROLECANIINAE. The remaining two, *Cissococcus* and *Calycicoccus*, are so unusual that I am unable to place them in any existing sub-family. I therefore propose sub-family names with the characters of the type genera. Cockerell in his description of the genus *Cissococcus* prefaces it by saying :—" belongs to the ERIOCOCCINI. Larva typically Eriococcine with rows of dorsal spines and prominent caudal tubercles." With this I cannot agree, as the larva has a distinct marginal series of stout conical spines but no dorsal ones.

* The numbers applied to species and to the figures on the Plates follow on from those of Part I in Trans. Roy. Soc. S. Africa, v, 2, pp. 65–194, 1915.

In *Calycicoccus* the body of the adult ♀ terminates in a distinct cone with numerous very stout conical spines. The galls of the four species may be distinguished as follows :—

Gall on stem, flatly rounded and blister-like, about 3 mm. in diameter (fig. 75) *Amorphococcus.*

Gall on leaf, normally flatly conical, about 3 mm. in diameter (fig. 73) *Calycicoccus.*

Gall on margin of leaf, pitcher-shaped, about 6 mm. long (fig. 76) .. *Grewiacoccus.*

Gall on stems, large, about 10–12 mm. long, broad, truncate pear-shaped (fig. 74) *Cissococcus.*

Sub-family Pseudococcinae.

Genus **Grewiacoccus,** g.n.

A Pseudococcine genus in which the adult ♀ is enclosed in a blunt leaf-gall (fig. 76). Two or three adult females may be found in the same gall.

Adult ♀ with legs and antennae of normal form but small, and an anal ring with six hairs which surround a short, stout, hollow cone. Anal tubercles not produced, but represented by single setae. Scattered over the body are small gland pores, many of which are furnished with spear-head-shaped spines ; on the posterior portion of the body these are extremely numerous ; the anterior part has comparatively few.

Type, *G. gregalis*, sp.n.

64. **Grewiacoccus gregalis,** sp. n. (Plate iv, figs. 76–76*d*).

Adult ♀ causing a gall on the leaf of the host-plant, in which one, two or three insects may be present. The galls may be solitary, or, as is often the case, five to twelve may be found clustered around the edge of a single leaf. The mature gall is about 6 mm. in length, broadly inflated, with the sides tapering slightly to the neck, of a scrotal shape or one very much like a pitcher (fig. 76). The galls stand nearly erect from the distorted edge, and are of the same green colour and texture as the leaf. There is no hole at the distal end, but below, on the under-side of the leaf, is a circular opening through which project two dense white filaments accompanied by a small amount of fine white cottony matter. When obtained in January numerous young were found clustered around the necks of some of the galls. All the available space in the gall is occupied by the female—or females if there are two or three—and on the inner walls there is a slight layer of white wax, which is more plentiful near the base, or where the posterior part of the insect is. On some leaves small slender galls (fig. 76) were observed, but these were always empty in cases examined.

Adult ♀, when alive, yellowish or slightly pink, about 3·2 mm. long, broadly rounded in front and tapering behind ; segmentation distinct. When stained and mounted the ♀ is long, with nearly parallel sides and has the two extremities almost equally rounded. The integument is almost clear, except that of the posterior segments ; these are richly supplied with gland-pores, from the majority of which spear-shaped and slightly pigmented spines arise (fig. 76*b*). On the anterior parts of the body the gland-pores are few in number and scattered. They are all small ; some have trilocular orifices, whilst others are simple with a slender spine or hair. The eyes are small and are situated at a distance from the bases of the antennae about equal to the length of the latter.

The antennae are 6-jointed, occasionally appearing 7-jointed owing to a pseudarticulation in segment 3. The average lengths of the segments are approximately, in μ: (1) 24, (2) 17, (3) 40, (4) 15, (5) 20, (6) 46 (fig. 76*d*).

The legs are small, the approximate measurements in μ being: femur 68, tibia 44, tarsus 34, claw 16 (fig. 76*c*).

The anal ring is recessed in a deep groove and has six stout bristles, from between which projects a short, stout, hollow cone.

Habitat: On leaves of "kruisbesje" (*Grewia occidentalis*, Linn.—Tiliaceae), Pienaar's River, Transvaal; collected by the writer and Claude Fuller, 23rd January 1917.

Collection No.: 305.

Sub-family Cissococcinae, nov.

(Characters of the type genus.)

Genus **Cissococcus,** Ckll.

Cissococcus, Ckll., Ann. Mag. N. H. (7) ix, p. 23, 1902.

Adult ♀ causing large truncate-pear-shaped galls on the stems, tendrils or leaf-stalks of the host-plant. Galls often solitary, but sometimes clustered in masses of six or eight. Gall broad; usually 10–12 mm. long; tapering to top, where there is a circular depression and perforation. Adult ♀ with small rudimentary legs and without conspicuous antennae. Anal ring with six stout bristles enclosed in a delicate fluted tube beneath a series of densely chitinised plates. Anal plates four in number, two large outer ones with outer edges fringed with dagger-like spines (fig. 78*a*); two inner ones with rounded outer edges and with rows of spines on disc. Integument with simple, scattered glands and a few long bristles.

Larva with long legs and 6-jointed antennae. Margin of body with complete series of short conical spines, about 32 on each side. Anal tubercles produced, each with one very long seta and several shorter ones. Anal ring with six hairs.

Type, *C. fulleri*, Ckll.

65. **Cissococcus fulleri,** Ckll. (Plates iii & iv, figs. 74 & 78).

Cissococcus fulleri, Ckll., Ann. Mag. N.H. (7) ix, p. 23, 1902; Fernald, Catal. Coccidae, p. 84, 1903.

Insect causing large galls on the stems, tendrils or leaf-stalks of the host-plant. The galls are normally solitary, but in many cases six to eight are clustered together and are then distorted. The normal gall averages 12 mm. long, is broad pear-shaped, almost as broad as long, broadly rounded at the base and slightly tapering to the end (fig. 74) where the orifice is situated. The galls are usually fixed by one side, so that the long axis of the gall is parallel with the stem or tendril to which it is attached. The galls apparently grow very rapidly from June to August, for in material just received (8th August 1916) Mr. Fuller writes that the galls have all developed in the last six weeks. The twigs and leaves are green, but the galls brown, and where a number are clustered together the intermediate stem is decidedly reddish. The stem beneath the normal galls remains green, but the broad attachment is half green and half brown. The outside of the gall is not smooth, but is much wrinkled and appears bark-like. The orifice of the gall is conical, the thin outer edge being brown and hard in texture, the inside appearing softer and green. At the base of the wide opening there is a minute circular pore. When opened in the fresh state the walls of the gall are hard and woody, from 1 mm. to 1·5 mm. in thickness, with the outer bark loosely attached.

Male puparium about 1·4 mm. long and 0·7 mm. broad, almost parallel-sided, with rounded extremities; margin with a fine fringe of glassy filaments about one-fourth of the width of the body in length, and the dorsum with two submarginal rows of very long white glassy filaments many times the length of the body (fig. 74*c*). The puparium itself is delicate, glass-like, not divided into definite plates as in the ♂ LECANIINAE. The posterior extremity is broadly and roundly excavated. Body of the immature male, as seen through the puparium, pinkish.

The adult female at the time the eggs are developing fills approximately half the space of the gall, being very convex, with the blunt caudal extremity fitting tightly into the conical portion near the aperture. The dorsal surface is distinctly segmented and is flat with prominent ridges, as shown in fig. 74*a*.

The colour of the body is delicate flesh-pink, slightly obscured by a thin layer of white powdery secretion. In boiling KOH the body becomes purplish red, and the liquid is deeply stained with the same colour.

Anal ring in a delicate tube beneath the two anal plates. The chitin of this tube is very delicate, but bears a few scattered hairs and simple glands and is pleated longitudinally, so that it looks like a large number of long bristles when seen in optical section. The anal ring bears 6 very stout bristles.

Legs small, rudimentary (fig. 78*b*, *c*).

Spiracles very large. Mouth-parts comparatively very small. Integument clear, with scattered simple glands and numerous long bristles. Antennae apparently entirely absent.

Larva with marginal series of short blunt, very stout spines, about 32 on each side, but no dorsal spines. Anal lobes and armature of larva reminding one of those of *Cerococcus*. Eyes darkly pigmented.

Remarks: A number of the galls of this species which contain healthy females also harbour a large coleopterous larva. I imagine that this species feeds upon the wax and other secretions of the insect. In other cases comparatively large galls were opened which showed no trace of the Coccid, but contained a small dipterous larva. In a few instances living galls were opened that contained a large body of the Coccid in which the integument was dry and brown, and this on being opened exhibited a number of maggots (8–10), also Dipterous. Dead galls, apparently of last year's growth, harboured a multitude of specimens in great variety. These include a small centipede, several species of mites, a mealy bug, and a minute honey-coloured ant, the entire nest of which seems to be in a single gall.

Habitat: On native vine (*Cissus cuneifolia*); collected by C. Fuller on Natal Coast, near Durban.

Collection No.: 40.

Sub-family CALYCICOCCINAE, nov.
(Characters of the type genus.)

Genus **Calycicoccus,** g.n.

Adult ♀ inhabiting small conical or calyx-like galls in the leaves of the host-plant. Typical galls flat on upper surface of leaf and flatly conical on lower side. The apex of the cone is perforate, and through the aperture protrude numerous strong filaments secreted from the caudal spine glands of the ♀. Inverted galls, formed from the upper tissues of the leaf, are larger and bluntly pointed.

Body of adult ♀ peg-top-shaped, wine-red in colour ; anterior end broadly rounded and the abdominal segments produced into a conspicuously annular cone, all segments bearing very stout spines. In the type species ten segments are visible, on which the stout spines decrease in size away from the posterior extremity.

Antennae and legs present. Antennae small, consisting of 4 segments. Terminal segment with several hairs.

Legs small, all three pairs usually about equally developed. Claw long ; upper and lower digitules apparently simple hairs.

Mouth-parts comparatively small. Integument of greater portion of body without glands. Posterior segment, margins and around the spiracles with long setae. Anal ring with 6 hairs.

Type, *C. merwei*, sp. n.

66. **Calycicoccus merwei,** sp. n. (Plates iii & iv , figs. 73 & 77).

Adult ♀ enclosed in galls on the leaves of host-plant. The galls are of two distinct types : one small, flat, and inconspicuous, except for the coloration of the plant tissues above them ; the other stout, blunt, horn-like.

Gall, type A (fig. 73*a*). About 3 mm. in diameter, flatly conical, only about twice the thickness of the leaf. On the upper surface of the leaf there is a flatly rounded, circular indication, the centre of which is pale yellow in colour. This is surrounded by a darker area, outside which a paler tint fades into the general grey-green of the leaf ; this is the top of the gall. On the under-side the gall is regularly raised into a flat cone, the centre of which is drawn out into a small tube, from which a tuft of glassy filaments protrudes. On dissection of the hard woody tissues it is found that the filaments are produced from the conical posterior extremity of the adult ♀.

Gall, type B (fig. 73). About 4·5 mm. in diameter and about 5 mm. long, tapering to a pointed tip, which is always curved to one side. This gall is hard and woody, and represents, I think, the inverted form of " type A " which is normal. In every case the large gall is found on the upper surface of the leaf, with a thickened edge or rounded mound on the lower side, and is often found on a leaf with as many as 30 of the normal galls, which open on the lower surface. The insects contained in the two forms are identical, but vary somewhat in size, those in the abnormal galls being usually the larger. The different types of galls appear to depend upon whether they are formed from the upper or lower tissues of the leaf, as the large type B are only produced on the upper surface.

Adult ♀ about 1·5 mm. in diameter, peg-top-shaped with the conical posterior extremity extending downward with the gall (fig. 77). The body colour is deep wine-red, with the posterior segments rendered conspicuous by the accumulation of white powdery secretion. Strong glassy filaments are produced from the pointed tip and extend through the opening of the normal gall. These have never been observed protruding from galls of type B. When cleared and mounted the insect is seen to possess both legs and antennae. The body is hyaline, except the mouth-parts, legs, antennae, and posterior extremity with the stout spines, which are more heavily chitinised.

Male puparia clustered on the lower sides of the leaves, generally around the conical parts of the galls. Male puparium about 1 mm. long and rather more than half as broad, with the dorsum densely matted with white waxy filaments. Before forming puparia the males are first of all yellow, and bright pink when older.

Habitat: Causing galls in the leaves of a native tree (*Apodytes dimidiata*, L. Mey.), Durban; collected by C. P. v. d. Merwe, 10th July 1916. Also on the stunted beach form of this plant at Illovo River, Natal; collected by Claude Fuller, 5th August 1916.

Remarks: I have pleasure in associating the collector's name with this interesting species. The insects were in the adult stage and contained well-developed embryos when collected in July.

Mr. T. R. Sim in his " Forest Flora of Cape Colony " mentions and figures " calyx-like galls " on the leaves of this tree. Since describing this species I have received galls similar to Mr. Sim's description and figure on smaller leaves said to be of the same species of host-plant, but these did not contain insects in suitable condition to determine whether they belong to this same species. They do, however, undoubtedly belong to the same genus. In reply to a query concerning the insect Mr. Sim writes (2nd February 1917) " I am under the impression that the insect gall appears wherever the tree grows, from the coast to the Drakensberg, though as the subject is not quite in my line, I made no special observations. I remember it on the East London, Durban-Coast, Mid-Natal and Amatola Ranges, but am not sure in regard to the Drakensberg, where the tree is frequent."

Collection No.: 104.

Sub-family Asterolecaniinae.

Genus **Amorphococcus,** Green.

Amorphococcus, Green, Ent. Mo. Mag. xxxviii, p. 261, 1902.

" Insect enclosed in galls. Adult female forming no test; naked or partially enveloped in the nymphal pellicle. Antennae rudimentary. Limbs wanting. Mentum monomerous, without stigmatic spines. Derm without cribriform plates or paired glands. Anal lobes minute or obsolescent. Anal ring setiferous.

" Larva with conspicuous 8-shaped glands giving rise to curling glassy filaments. The characters of the larva clearly indicate the relationship of this abnormal genus to *Asterolecanium.*

" Probably allied to Maskell's genus *Frenchia.*" (Green).

67. **Amorphoccus acaciae,** sp. n. (Plates iii & iv, figs. 75 & 79).

Adult ♀ causing flatly rounded, circular, blister-like galls on the stems of *Acacia* sp.

Gall of adult ♀ about 2·5 mm. in diameter, and 1 mm. high, circular, curving from stem to centre of gall, which is perforate with a circular orifice (figs. 75, 75*a*).

The surface of the gall may be chipped off with the point of a knife, exposing the yellow adult ♀ below (figs. 75*b*, 75*c*). The inner surface of the gall is regularly domed, and the orifice is generally closed from within by what appears to be the cast skin of the immature ♀.

Adult ♀ about 1.25 mm. in diameter, pale yellow in colour, irregular and wrinkled. When cleared and mounted the insect appears as a hyaline sac with mouth-parts and anal ring only conspicuous. The antennal tubercles are small, with 3 curved spines (fig. 79*a*). Figure-8 glands absent. Simple glands moderately numerous, chiefly in irregular transverse rows near posterior end. Anal ring small, with 6 hairs. Caudal lobes obsolete, but marked by a pair of long stout bristles, which are rather more than twice the length of those of the anal ring (fig. 79). Mouth-parts comparatively small.

Habitat: Causing flat galls in stems of *Acacia* sp.; collected by writer, Pretoria, 19th September 1914.

Collection No.: 299.

Sub-family CONCHASPINAE.

This sub-family comprises very few species, all of which belong to one of the two genera *Conchaspis* and *Fagisuga*. Only the former is represented in South Africa, and that by one species.

The characteristics of the CONCHASPINAE may be briefly stated as follows :—

Anal ring hairless; legs and antennae present; adult females beneath a separate covering scale, which is composed entirely of secretionary matter without the admixture of exuviae.

Genus **Conchaspis,** Ckll.

Conchaspis, Ckll., Gard. Chron, (3) xiii, p. 548, 1893; id., Jn. Inst. Jamaica, I, p. 256, 1893; id., Bull. Bot. Dept. Jamaica, p. 101, 1895; Green, Cocc. Ceylon, i, p. 19, 1896.

Pseudinglisia, Newst., Ent. Mo. Mag., xxix, p. 153, 1893.

Scale ± circular, moderately convex, smooth or slightly ridged. Adult ♀ retaining legs and antennae. Antennae of few (3 or 4) segments. Terminal segments of the abdomen ± united into a pseudo-pygidium, which usually has long hair-like spines but no definite plates (figs. 80 *c*,81). In the type species of the genus *Fagisuga*, *F. triloba*, Ldgr., there are several stout spines and three broad plates with saw-like margins (fig. 83).

68. **Conchaspis euphorbiae,** sp. n. (Plate v, fig. 81).

Female scale large, reaching 6·5 mm. for its greatest diameter, average size about 5 mm.; nearly circular, sometimes slightly elongate, moderately arched. Colour white, but appearing greyish owing to the presence of small dark particles incorporated in it, especially at the margins of the component lamellae. The scale is somewhat flattened on top, where it usually presents a ± irregular, central, yellowish projection surrounded by a concentric ring. In texture the scale is compact, the main dome being slightly roughened above and white and shiny beneath. The small male (?) puparia found beneath the large main scale are white, broadly oval and loose and flocculent in texture. Large numbers of scales are often aggregated into masses which entirely surround the smaller twigs of the host-plant. In one lot of material from Namaqualand the scales are dull black in colour, owing to the collection of "sooty" fungus which covers entirely both scales and twigs.

Adult ♀, when dry, dark brown in colour, larger than *C. socialis*; the average length being 1·8–2 mm. The body, when cleared, is broadly rounded in front and tapers gradually towards the posterior end. The integument is but slightly chitinised, except the mouth-parts, legs, antennae and thickened portions of the pseudo-pygidium, which appear yellowish brown. The general body surface is finely stippled, and is not rugose, as is the case in *socialis*. The antennae are 3-jointed; the basal segment long, and often appearing divided towards the base (figs. 81*b*, 81*c*). Legs stout and moderately long, extending well beyond the margin of the body, similar to those of *socialis*, *i.e.*, without tibio-tarsal articulation. The clear spaces surrounding the eyes, which are so conspicuous in the Ceylon species already mentioned (fig. 80*a*), are not noticeable in this species, but a close examination reveals two areas, similar in shape, but closer together and situated somewhat further back from the front margin, at the level of the mouth-parts. These are of about the same, or slightly intensified, density as the surrounding integument, with the eyes noticeably denser in the centre. The characters of the pseudo-pygidium are illustrated in the accompanying figures (figs. 81, 81*a*). The compound, circular, marginal glands of *socialis* are absent, and the compressed, oval gland openings are more numerous. On the margin of the anterior part of the body, between the position of legs i. and ii., there is a rounded protuberance (fig. 74*d*), and a submarginal series of long hairs.

Habitat: On melkbosch (*Euphorbia sp.*), Concordia, Namaqualand; collected by Mr. Krapohl.

Collection Nos.: 13 and 14.

Sub-family Diaspinae.

Anal ring hairless. Adult ♀ without legs and with rudimentary antennae. The terminal abdominal segments are $\pm$ united into a definite pygidium. Adult ♀ beneath a separate covering scale which is composed of secretionary matter *plus* the exuviae.

The insects comprising this sub-family show considerable variation in form, character of the scales, etc., and this accounts for the large number of genera and sub-genera which have been made to accommodate them. Several attempts have been made to classify them in a more or less natural or phylogenetic manner, as, for instance, the arrangement of Leonardi in 1898, and particularly that of Lindinger in 1907. As none of the schemes so far propounded seems entirely satisfactory, I refrain from making use of any one of them in dealing with South African Coccids only, as such a course would necessitate either many unavoidable gaps or the inclusion of a large amount of material which is undesirable in such a work as this. A really workable classification of the Coccidae must be a work of the future, when more forms have been discovered and more complete collections assembled.

The chief specific characters used for the determination of the Diaspinae are found in the pygidium of the adult female. These may be given more or less in the order of their importance in the following way:—(1) Number and character of lobes: (2) number and character of plates; (3) number and arrangement of circumgenital glands; (4) number and arrangement of marginal gland openings; (5) number and position of spines; and (6) number and position of dorsal glands.

To facilitate the comparison of species, particularly with reference to the above characters, a formula is included in many of the descriptions. The type of formula follows that used by Dr. L. Lindinger in his work on European COCCIDAE (Die Schildläuse, 1912), but it has been altered and adapted to the requirements of this work. All formulae read from the median line of the pygidium.

L indicates lobes; the position is indicated by figures placed below, as L_1, L_2, etc. Thus L_1 indicates the median lobe, L_2 the first lateral lobe or lobe in the 2nd position, etc.

ll indicates a lobe composed of two lobules.

P indicates plates with the position indicated as for lobes.

— indicates a vacant space in the margin of the pygidium.

G indicates gland openings on the margin.

S indicates spine on the margin.

N.B.—G and S are not used unless the parts indicated form a distinctive characteristic of the pygidium, and glands or spines set within the margin are not indicated. When more than one plate is present at any point the number is indicated by a figure in front of the character: thus $2P_1$ indicates two plates before the median lobe.

For example, L_1, P_2, ll_2, P_3, G, G, P_4, G, G, P_5, G, —, G, P_6. (*C. natalensis*)

In using the above characters it will be found that every species does not have a distinctive formula. Thus *Chrysomphalus aurantii*, the common Red Scale has :— P_1, L_1, $2P_2$, L_2, $3P_3$, L_3, $3P_4$, and this is also the formula for *C. ficus* and *C. dictyospermi*. Nevertheless, the value of such a formula as a means of comparison is great, and the tabulation of pygidial characters is facilitated and shortened.

The number and arrangement of the circumgenital glands are also given in tabular form. Thus in *Diaspis bromeliae* there are five groups of glands arranged in an anterior median group and two lateral groups on each side. This would be stated :— Circumgenital glands in 5 groups :—

7—11
13—21 13—21
12—18 12—18

indicating that the median group consists of from 7 to 11 glands, the anterior laterals of 13 to 21 each, and the posterior laterals of 12 to 18 each.

Synoptical Key to South African Genera of the Diaspinae.

A. ♂ puparium somewhat similar to the ♀ scale in general form and texture, being usually smaller and more elongate.

B. Exuviae of ♀ scale $\pm$ central and superposed; ♀ scale circular or nearly so.

C. Adult ♀ not enclosed in the second pellicle.

(1) ♀ scale with thin margins, not recurved to make it capsular; pygidium without elongated thickenings (paraphyses); plates absent, simple or branched; circumgenital glands absent, or, when present, usually in 4 groups.
Aspidiotus series.

(2) ♀ scale usually capsular ; pygidium with elongated paraphyses ; plates variable sometimes absent ; pygidium without embossed design on dorsum *Chrysomphalus*.

(3) Similar to *Chrysomphalus*, except that the pygidium has embossed design on dorsum ; body usually wine-red in living insect, often with deep articulation between the cephalothorax and abdomen ; plates usually simple. *Pseudaonidia*.

(4) ♀ scale with exuviae curved over to one side, giving the scale a distinct shell-like appearance ; body deep purple ; plates cleft and ± spoon-like. *Furcaspis*.

CC. Adult ♀ enclosed in second pellicle.

(5) As in *Aspidiotus* series, except that the ♀ is enclosed in 2nd pellicle but for the pygidium, which protrudes .. .. .. *Cryptaspidiotus*.

(6) ♀ scale composed almost entirely of the large second pellicle with little or no secretionary covering ; pygidium with definite lobes and plates *Aonidia*.

(7) As in *Aonidia*, except that the pygidium is without definite lobes or plates. *Gymnaspis*.

BB. Exuviae of ♀ overlapping and placed near or at the anterior end of the scale ; ♀ scale broadly elliptical or elongate and narrow.

(8) ♀ scale broadly elliptical, 2nd pellicle large with ± secretionary covering ; pygidium with a continuous marginal series of broad fimbriated plates and with wide marginal glands, whose openings are at right angles to long axis of body. .. .. *Parlatoria*.

(9) ♀ scale long and narrow ; pygidium of ♀ without embossed design on dorsum ; plates simple ; circumgenital glands usually in 5 groups ; ♂ puparium similar to ♀ scale but smaller ; the posterior part with a hinge-like flap. *Lepidosaphes*.

(10) ♀ scale very long and very narrow, thread-like ; pygidium of ♀ with a large embossed patch on dorsum ; circumgenital glands in 3 or 5 groups. *Ischnaspis*.

AA. ♂ puparium usually white and usually unlike the ♀ scale in texture ; always unlike it in form, being narrow with nearly parallel sides, in some cases uni- to tri-carinate.

B. Adult ♀ not enclosed in second pellicle.

(11) ♀ scale ± circular or slightly elongate ; circumgenital glands usually in 5 groups ; exuviae central or slightly to one side, but within the margin ; plates usually simple and dagger-like, rarely branched at tips. *Diaspis* series.

(12) ♀ scale usually buried beneath the outer layers of bark of host-plant ; pygidium strengthened by two clubbed thickenings which extend backward from median lobes ; plates few in number, simple, blunt .. *Howardia*.

(13) ♀ scale usually elongate, often broadened behind, usually white ; exuviae anterior ; circumgenital glands absent or present ; plates usually simple and dagger-like. .. .. *Chionaspis* series.

BB. Adult ♀ enclosed in second pellicle.

(14) ♀ scale completely enclosing the adult ♀, composed of large second pellicle and with little secretionary covering; plates usually absent or few in number and simple. .. .. *Fiorinia.*

Genus Aspidiotus, Bouché.

Scale of adult ♀ ± circular, flat to convex or conical. Exuviae central or subcentral, invariably occupying the highest portion of the scale; with the first exuviae superposed upon the second, and often coated with a thin secretionary covering, which sometimes gives a nipple-like effect to the scale. Ventral scale usually thin and delicate, often remaining on the plant when the insect is removed.

The puparium of the male resembles the ♀ scale to a great degree, but is usually smaller, rather more elongate, and usually more coriaceous.

The pygidium of the adult ♀ has lobes and generally branched plates, but no elongate paraphyses such as those found in *Chrysomphalus.* Circumgenital glands may be present (2 to 5 groups) or absent.

The following sub-genera are represented in South Africa:—*Aspidiotus* (*s. str.*), *Selenaspidus, Morganella, Diaspidiotus* and *Hemiberlesea.*

These may be distinguished by the following key:—

A. Pygidium without incisions having thickened edges.

(*a*) Lobes present, all normal; plates branched, normal. .. *Aspidiotus, s. str.*

(*b*) Three pairs of lobes present, of which the 3rd are usually tusk-like; scale generally flat, circular, with central exuviae, of a brown colour; cephalothorax, with one exception, distinctly separated from the abdomen at the margin; plates broad, with outer end fringed. .. .. *Selenaspidus.*

(*c*) Only median pair of lobes present; these are long and slender, closely adjacent or contiguous, with anal openings at inner bases; scale convex, black; exuviae concolorous; plates very long, numerous, and fringed on sides. *Morganella.*

B. Pygidium with incisions having thickened edges.

(*d*) ♀ scale usually dark greyish in colour, exuviae covered, often exhibiting "concentric ring and dot"; median lobes usually close together; other lobes rudimentary or at least not prominent; plates usually few in number and simple, dagger-like or but slightly branched .. *Diaspidiotus.*

(*e*) ♀ scale usually convex, light in colour, buff or yellowish, median lobes large and close together, others suppressed; plates conspicuous, crowded towards median lobes; anal ring large, set far back near median lobes *Hemiberlesea.*

Key to South African Species of Aspidiotus s. str.

A. Pygidium with three pairs of lobes.

a. L_1 projecting beyond L_2.

(1) ♀ scale brownish, ♂ puparium white, L_1 with straight sides, L_2 and L_3 smaller; ± pointed (fig. 84) .. .. *A. hederae* (Vall.)

(2) ♀ scale circular, white, with brown exuviae; L_1 with straight sides, L_2 and L_3 normal (fig. 91) .. .. .. *A. fimbriatus capensis,* Newst.

(3) ♀ scale somewhat elongate, brown ; L_1 rounded ; P_4 very long (fig. 90) *A. regius*, sp. n.

(4) ♀ scale very small, conical ; L_1 broad, rounded (fig. 87) .. *A. gowdeyi*, Newst.

(5) ♀ scale white with radial striae, exuviae yellow ; L_1 chitinous, L_2 and L_3 similar in shape but ± colourless (fig. 89). .. *A. transparens*, Green.

aa. L_1 not extended so far back as L_2.

(6) ♀ scale transparent, yellowish ; L_1 almost as long as L_2 (fig. 88) *A. destructor*, Sign.

(7) ♀ scale buff ; L_1 deeply recessed and much smaller than L_2 (fig. 86) *A. kellyi*, sp. n.

B. Pygidium with four pairs of lobes.

(8) L_2, L_3 and L_4 rudimentary ; P long, forked (fig. 85) .. *A. furcillae*, sp. n.

69. **Aspidiotus hederae** (Vall.) Sign. (Plate vi, fig. 84).

The synonymy of this species is extensive. The following list includes, perhaps, most of the different specific names which have been applied to it :—

Aspidiotus affinis, Targ., 1869 ; *A. aloes*, Sign., 1869 ; *A. bouchéi*, Bar., 1849 ; *A. capparis*, Sign., 1876 ; *A. ceratoniae*, Sign., 1869 ; *A. chamaeropis*, Sign., 1869 ; *A. denticulatus*, Sign., 1869 ; *A. epidendri*, Bouché, 1844 ; *A. ericae*, Sign., 1869 ; *A. genistae*, Westw., 1840 ; *A. gnidii*, Sign., 1869 ; *A. ilicis*, Sign., 1869 ; *A. lentisci*, Sign., 1876 ; *A. limonii*, Sign., 1869 ; *A. nerii*, Burm., 1835 ; *A. oleastri*, Colv., 1882 ; *A. osmanthi*, Sign., 1869 ; *A. transvaalensis*, Leon., 1914 ; *A. villosus*, Sign., 1869.

Chermes aloes, Boisd., 1867 ; *C. cycadicola*, Boisd., 1867 ; *C. hederae*, Vall., 1829 ; *C. osmanthi*, Vall., 1829.

Diaspis obliquus, Costa, 1835.

This may be accounted for, to some extent, by the large variety of plants upon which the insect thrives, and by the variability of the insect itself. As a general rule the scale of the adult ♀ is approximately circular, moderately robust, varying from flat to roundly arched. It is yellowish to pale brown in colour, with yellow exuviae. When young the ♀ scale is white, as is also the ♂ puparium. In some cases the ♂ and ♀ scales are intermingled, but it is commonly noticed that the majority of the ♀ scales are on the upper surfaces of the leaves and the ♂ puparia on the lower. The size of the scales varies considerably on different host-plants. Thus on oleander the ♀ scale is often 2·5 mm. in diameter ; on *Melia azedarach* the average size is probably 1·75 mm.

The living insect (♀) is ± circular to broad pear-shaped, its broadest part being at about the middle. It is yellow in colour, with the pygidial margin darker. The free abdominal segments are distinct in young forms, but obscured when the body becomes distended with ova.

When cleared and mounted the body is hyaline, and the mouth-parts and pygidium yellowish. There are three pairs of lobes, which are variable. The median lobes are typically strong, with their inner faces straight but sloping backwards, so that the space between them is slightly broader at the base than at the outer end. The length on the middle face is about equal to the width of the lobe. When not worn down, L_1 are notched on both outer and inner sides and the median extremity is rounded. The outer margins of these lobes curve slightly outward, and from each lobe a dense band of chitin extends into the pygidium for about the length of the lobes. L_2 are about as long as L_1 but narrower, and usually notched on the outer side; L_3 smaller, often $\pm$ conical. The plates are longer than the lobes (fig. 84) and are finely divided at their extremities, the longest branches being nearest the lobes. Circumgenital glands present, in four groups:—

7—13 7—13
4—10 4—10

Formula:—P_1, L_1, $2P_2$, L_2, $3P_3$, L_3, 7–$8P_4$.

Habitat:—It is commonly found on *Acacia* (Australian species), asparagus, *Grevillea*, *Hakea*, English ivy, *Melia*, mulberry, oleander and palms; and has been received on *Agave americana*, aloe, *Aralia*, *Arbutus*, *Aucuba*, *Bauhinia*, box, broom, *Callitris*, Cape gooseberry, carnation, *Ceratonia siliqua*, *Citrus* (lemon), convolvulus, *Coprosma*, croton, *Cupressus sempervirens*, *Dracaena*, *Elaeagnus*, ferns, fig, *Genista*, grape, honeysuckle, jasmine, Kei apple, lilac, mango, moonflower, New Zealand flax, oak, orchids, *Osmanthus*, *Pandanus*, pepper, *Penstemon*, pine (*P. excelsa*, *P. canariensis*), plum, poplar, privet, *Prunus pissardi*, rose, *Spiraea*, *Tecoma*, *Thuya*, *Veronica* and *Yucca*.

Collection Nos.: 192, 195, 206.

70. **Aspidiotus furcillae**, sp. n. (Plate vi, fig. 85).

Female scale small, about 1 mm. diameter, $\pm$ circular, roundly arched, sordid white in fresh material, but when older appearing dark brown to blackish brown with rich red brown exuviae. The true colour of the scale is rarely seen, as nearly all specimens are partly or wholly covered with the outer layers of bark of the host-plant. The exuviae are central or nearly so.

The adult ♀ is apparently viviparous, as mounted specimens contain many larvae. Its body is broad pear-shaped, widest a little before the middle. The body wall is thin. Antennal tubercle with one long hair and two short spurs. Extending into the pygidium are two interrupted bands of chitin, the anterior portion being a little outward from the posterior bands (fig. 85). L_1 large, strongly chitinous, with the dense portion extending into the pygidium for a distance of a little more than the length of the lobes. The median space is narrow, parallel-sided, apparently without plates or spines. The median lobes are stongly indented on the outer margin and faintly notched on the inner side; outer margin of lobes rounded, with the outer edge longer than the inner. L_2 and L_3 $\pm$ rudimentary, with a broad base from which arises a long stout spine, and the lobe proper, which is delicate and pointed. L_4 similar but generally shorter and more rudimentary. P long, broad, almost parallel-sided, with the apex drawn out into two, or occasionally three, very long prongs. The plates are apparently easily broken away, as many specimens have few left when mounted. Parastigmatic glands O. Circumgenital glands in four groups:—

2—4 2—4
1—3 1—3

Formula:—L_1, 1–$2P_2$, L_2, $2P_3$, L_3, 2–$3P_4$, L_4, $3P_5$,—, S.

Habitat: On *Acacia horrida*, Pretoria; collected by the writer, 20th September 1914.

Collection Nos.: 193 and 209.

71. **Aspidiotus transparens,** Green (Plate vi, fig. 89).

Aspidiotus transparens Green, Ind. Mus. Notes, iv, p. 4, 1896; Green, Cocc. Ceylon, i, p. 49, 1896 (*A. lataniae*, Sign., part); Green, Jl. Bomb. N. H. Soc. xiii, p. 69, 1900; Lindinger, Der Pflanzer, iii, p. 358, 1907; Lindinger, Berl. Ent. Zeits. lii, p. 105, 1908.

Scale of adult ♀ + circular to somewhat elongate, about 3 mm. in largest diameter, dense white, occasionally slightly translucent, so that the deep orange ♀ may be indicated below. Scale usually with distinct radial striae. Occasionally the ♀ scales are faintly tinged with yellow, but as a rule they are pure white with orange yellow exuviae.

Adult ♀ elongate, bright orange yellow, with pygidial margin somewhat darker. Body (when mounted) hyaline, pyriform, with the abdominal segments well indicated. Pygidium long, roundly tapering, with the median lobes dense and deeply coloured, and L_2 and L_3 much more delicate and almost colourless (cf. *A. destructor*). Antennal tubercles with a long curved spine and apparently two or three small spurs. Parastigmatic glands 0. Pygidial margin as illustrated (fig. 89). Circumgenital glands in 4 groups :—

5—12 5—12
9—18 9—18

Formula :—P_1, L_1, $2P_2$, L_2, $2P_3$, L_3, $8P_4$.

Habitat: On "umkavoti" (*Chaetachme aristata*, Planch.), Durban; collected by C. Fuller. On avocado (*Persea gratissima*, Gaerm.), Durban; collected by A. Kelly, May 1916. On reed, Simondium; collected by J. W. Hodgson, 30th January 1915.

Collection Nos.: 159, 159a.

72. **Aspidiotus destructor,** Sign. (Plate vi, fig. 88).

Aspidiotus destructor, Sign., Ann. Soc. Ent. France, ix, p. 120, 1869; Green, Jl. Bomb. Nat. Hist. Soc. xiii, p. 70, 1900.

Scale of adult ♀ about 2 mm. in diameter, circular or nearly so, thin, transparent, yellowish, without radial striations. Exuviae pale to moderately deep yellow.

Adult ♀ similar to *A. transparens*, but often with the abdominal segments somewhat withdrawn, and when mounted readily distinguished by the following characters:

A. destructor, Sign.	*A. transparens*, Green.
L_1 shorter than L_2 and appearing slightly recessed, narrow, with the inner margin somewhat concave, outer margin notched near apex (fig. 88).	L_1 longer and broader than L_2, not appearing recessed, deeply coloured, with thickened chitin extending into pygidium, ± symmetrical; notched on inner as well as outer side (fig. 89).

Circumgenital glands in 4 groups (occasionally in 5):

(0—5)
9—14 9—14
5—7 5—7

Habitat: On banana, Capetown; on sugar cane, Durban.

Collection No.: 160.

73. **Aspidiotus fimbriatus capensis,** Newst. (Plate vi, fig. 91).

Aspidiotus fimbriatus capensis, Newst., Bull. Ent. Res. vii, p. 373, 1917.

Scale of adult ♀ circular, about 2·5 to 3 mm. in diameter, moderately convex, pure opaque white. The exuviae are central and normally covered with a thin layer of secretion, through which they appear slightly brownish. When rubbed the second exuviae are dark brown or bronze in old specimens, yellow when younger, with a terminal yellow spot which represents the pygidium.

Puparium of ♂ similar in shape, but small, semi-transparent, with yellow exuviae.

The body of the adult ♀ is broad pear-shaped or almost circular, with the small pygidium protruding from the one margin. All the anterior part of the body, which is broadly and uniformly rounded, is rather densely chitinised. The free abdominal segments are hyaline. The pygidial margin is almost as dense as the anterior part of the body. The segmentation is very obscure and the segments are hardly indicated at the margin. There are three pairs of well-developed lobes. L_1 notched on both margins, the other two being notched on the outer side only. L_1 moderately long and broad, with parallel sides and slightly denser than L_2 and L_3. The dense chitin of the median lobes extends into the pygidium for a distance about equal to the length of the lobes. The space between the median lobes is broad U-shaped and contains two plates almost as wide as P_2. L_2 and L_3 are of about equal width and are slightly narrower and shorter than L_1. The plates are of about the same length as the lobes and form a distinct fringe reminding one of *Parlatoria*. They are broad and $\pm$ parallel-sided, with their outer margins comb-like. Pygidium as illustrated (fig. 91). Tubular glands present. Circumgenital glands in 4 groups, occasionally in 6:—

(0—2) 6—10 6—10 (0—2)
6—10 6—10

Formula:—P_1, L_1, $2P_2$, L_2, $3P_3$, L_3, $8\text{–}10P_4$.

Remarks: This species is more or less similar to *A. lauretorum*, Lindinger, but is readily distinguished by the pure white opaque scale of the mature ♀ and the more numerous circumgenital glands.

Habitat: On *Encephalartos* sp., Port Elizabeth, C.P., Cape No. 1268. Also collected by A. Kelly at St. George's Park, Port Elizabeth, C.P., April 1915. Mr. Butters of St. George's Park, Port Elizabeth, assures me that this is a native scale brought in with *Encephalartos* years ago.

Collection No.: 200.

74. **Aspidiotus regius,** sp. n. (Plate vi, fig. 90).

Scale of adult ♀ small, elongate, about 1·4 mm. long and 0·7 mm. broad, usually widest about the middle and narrowed to each end; buff in colour, with brownish exuviae showing through the thin layer of secretion. The scale is somewhat translucent.

Adult ♀ small, about 1 mm. long, considerably longer than broad, evenly rounded in front, hyaline, except the pygidium, which is slightly yellow. The segmentation is indistinct and the margin of the body $\pm$ regular. The antennal tubercles are small, with one very long seta, which is five times the diameter of the tubercle in length. There are three pairs of well-developed lobes, the median pair as broad as long, symmetrical, with the sides rounded and narrowing towards the pygidial margin. There is a distinct notch on each side and the apex is evenly rounded. The apical half of all the lobes is striate. L_2 somewhat similar, smaller, with the notch on the outer side more prominent than that on the inner. L_3 about half the size of L_2, similar in shape. The plates are broad, with a long terminal fringe, except P_4, which are broad at the base with a long narrow projection, which is $\pm$ toothed on its outer margin. The first two plates of P_4 are almost four times as long as L_3. Pygidium as illustrated (fig. 90). Circumgenital glands in 4 groups :—

2—5 2—5

3—4 3—4

Formula :—P_1, L_1, $2P_2$, L_2, $3P_3$, L_3, 3-$4P_4$.

Remarks : This species is similar to *A. britannicus* and *orientalis*, Newst., in some respects, but is easily distinguished by the slight difference in the size of the scale, the shape of the body, and the character of the glands and plates, especially P_4.

Habitat : On aloe, King Williamstown, C.P. ; collected by A. Kelly, March 1913.

Collection No. : B200.

75. **Aspidiotus kellyi,** sp. n. (Plate vi, fig. 86).

The scale of the adult ♀ is about 2 mm. in diameter, $\pm$ circular or slightly elongate, flat to slightly convex, rather robust, faintly buff or brownish in colour, with almost central exuviae, which are covered ; but in rubbed specimens they appear metallic yellow to bronze in colour. Seen from below the second exuviae are yellow. The ventral scale is extremely delicate and remains attached to the leaf. The tissues below, and around the scales, are of a rich purple tint.

The ♂ puparium is flat, about 1 mm. long, somewhat elongate, often with the ends slightly pointed, dull light brown in colour with paler margins. Exuviae covered yellowish.

Adult ♀ bright yellow, long, pear-shaped ; when dry, dull deep brown to blackish. When boiled and cleared the insect is small, almost 1 mm. long (containing young), regularly pyriform, with margin regular, *i.e.*, without prominent margins to the abdominal segments. The posterior extremity is rather abruptly narrowed to the pygidium. The mouth-parts are comparatively large and broad ; the antennae, situated near the anterior margin, small, each composed of a $\pm$ elongate tubercle and one long curved bristle. Parastigmatic and circumgenital glands absent. The pygidium appears truncate from the fact that the median lobes and the six adjacent plates are deeply recessed in a $\pm$ rectangular depression between the large second lobes. There is a large strong spine at the outer margin of each lobe. Beyond the third lobes the margin is $\pm$ fringed with broad, short plates, of which there are probably four or five, but the plates in this species are so delicate that out of eight insects mounted no single specimen shows them all in position. L_1 small, deeply recessed, $\pm$ parallel-sided and notched on each side. L_2 large, rounded, outer portion not conspicuously notched, but striate. L_3 smaller than L_2, roundly pointed, with the apex pointing slightly outward. P comparatively short. P_1 and P_2 not so long as L_2. P_3 fringed on the outer margins. Pygidium as illustrated (fig. 86).

Formula : P_1, L_1, $2P_2$, L_2, $2P_3$, L_3.

Adult ♂ not observed.

This insect is most like *Aspidiotus excisus*, Green, in the peculiar type of pygidium. It is readily distinguished from that species however by (*a*) the difference in the scale, (*b*) the fact that the median lobes are smaller than the second pair, and (*c*) the entire absence of circumgenital glands.

The material studied consists of a small collection of dry material from which 8 adult females were mounted.

Habitat: On grass (*Andropogon amplectens,* Nees), Meintjes Kop, Pretoria; collected by A. Kelly, October 1913 ; also in same place by Carl Rudolf, 8th April 1916.

I have much pleasure in associating the collector's name with this species as a token of appreciation for much assistance rendered in a multitude of ways.

Collection No.: B188.

76. **Aspidiotus gowdeyi,** Newstead (Plate vi, fig. 87).

Aspidiotus gowdeyi, Newst., Bull. Ent. Res. iv, p. 77, 1913.

Scale of adult ♀ " very small, obconical and suddenly truncate at the margin of the larval pellicle ; margin circular. Colour dark brown, outer margin paler, upper margin orange-brown to pale castaneous. Larval pellicle completely hidden beneath a glistening white secretion, which is perfectly flat, quite circular in outline, and not raised above the upper truncate margin of the secretionary covering of the puparium. Ventral pellicle thin. Diameter, 0·4–0·5 mm.

" Female, adult. Broadly ovate, narrowed posteriorly ; integument very thin and transparent ; presence of rudimentary antennae and parastigmatic glands doubtful. Pygidium with six lobes ; median lobes much the largest, distal margin broadly rounded ; second and third pair small and somewhat triangular, with the distal margins more or less pointed. Squamae very finely and closely fringed ; those between the median and third pair of lobes and the three succeeding ones, on either side, unusually broad, the two proximal ones small and branched. Only two spines are traceable and these are placed on opposite sides beyond the squamae. There is a very small bilateral incision near the second pair of lobes and a rather long thickening of the integument near each of the third lobes. Anal orifice large and submarginal. Position of the vaginal orifice rendered obscure by a large and somewhat tongue-shaped thickening of the integument occupying the middle area of the pygidium. Circumgenital glands absent." (Newstead).

Pygidium as illustrated (fig. 87).

Formula : P_1, L_1, $2P_2$, L_2, $3P_3$, L_3, $6–8P_4$.

Habitat: On " umkavoti " (*Chaetachme aristata,* Planch.) and other native shrubs in Natal and S.E. Cape Province.

Collection No.: 213.

Key to South African Species of Sub-Genus Diaspidiotus.

A. Pygidium of ♀ without distinct plates.

a. L_2 rudimentary.

(1) L_1 short, not touching on inner margins; circumgenital glands 0 (fig. 99) .. *africanus*, Marlatt.

aa. L_2 normal, smaller than L_1.

(2) L_1 sloping inwards and touching or nearly so; circumgenital glands present (fig. 92) .. .. *forbesi*, Johnson.

(3) Chitinous thickening to second incision reniform, L_1 not touching on inner margin; circumgenital glands 0 (fig. 98) .. .. *ehretiae*, sp. n.

B. Pygidium of ♀ with distinct plates.

b. L_2 normal, smaller than L_1.

(4) Plates short; circumgenital glands 0 (fig. 97)- .. *perniciosus*, Comst.

bb. L_2 rudimentary or apparently absent.

(5) Plates short; circumgenital glands present (fig. 94) .. *pectinatus*, Ldgr.

77. **Aspidiotus (Diaspidiotus) forbesi,** Johnson (Plate vi, fig. 92).

Aspidiotus forbesi, Johnson, Ent. News, vii, p. 151, 1896.

A. (*Diaspidiotus*) *forbesi*, Ckll., Bull. 6, U.S. Dept. Agr. pp. 5 & 21, 1897.

A. (*Aspidella*) *forbesi*, Leon., Gen. Spec. Dias. Asp. p. 49, 1900.

Aspidiotus forbesi, Fernald, Catalogue, p. 259, 1903.

Common Name: Cherry Scale.

Scale of adult ♀ ± circular, about 2 mm. in diameter, greenish or brownish grey, with the exuviae orange-red to dark red-brown and slightly covered.

Male puparium similar in colour, smaller and more elongate. In both cases the margins of the scales are often much paler than the median portions.

Adult ♀ yellow, long, pear-shaped, with the pygidial end sharply pointed. Abdominal segments distinctly rounded at the margins. L_1 rounded at apex and notched midway on lateral margin, converging and almost meeting, giving this species a decided pigeon-toed appearance. L_2 narrower, about one-half the width of L_1, obscurely pointed, and with an indefinite notch on the the outer edge. The first incision is edged by chitinous thickenings of unequal size, the mesal one being long and club-shaped, the outer one usually minute. There is a small pair of thickenings between the median lobes and the pair bounding the second incision are often of about equal size and fused at the top. Plates absent or inconspicuous. Pygidium as illustrated (fig. 92). Circumgenital glands in 5 groups:

1—4

4—7 4—7

3—5 3—5

Formula:—L_1, S, L_2, S, —, S, (1–2P?), —, S.

This species was probably introduced prior to 1900 on consignments of apple trees from the Southern States of America.

Habitat: On plum, Bethlehem, O.F.S., 6th April 1912; on plum, Potchefstroom, Transvaal, May 1912; Cradock, Cape Province; Pietermaritzburg, Natal.

Collection No.: 190.

78. **Aspidiotus (Diaspidiotus) africanus** (Marlatt) Brain (Plate vi, fig. 99).

Aspidiotus (Diaspidiotus) africanus, Marlatt (*ex parte*), Bull. U.S. Bur. Ent., T.S. 16, p. 15, 1908.

Scales of young circular, yellowish or buff, with a distinct white cap formed of the secretionary covering of the first exuviae. This white layer sometimes exhibits a faint nipple effect, owing to a depressed ring near its outer margin.

Scale of adult ♀ sometimes circular, often slightly irregular and elongate, about 1·8 mm. in diameter, creamy-, yellowish-, brownish- or greenish-buff in colour, with yellow exuviae. The scale is often roundly arched or bluntly conical. The first exuviae are small, yellow, covered with an opaque layer of white secretion as observed in the young scales. The white caps are undoubtedly one of the chief distinguishing characters of the scales of this species. Male puparia about 1 mm. long and 0·6 mm. broad, almost parallel-sided, with rounded ends and the exuviae placed just within the margin at the anterior end. Colours as in the ♀ scale. The material described by Marlatt in 1908 was undoubtedly a mixture of two species, *africanus* and *pectinatus*, q.v. These were separated and the latter described by Lindinger in 1909.

Specimens mounted in glycerine are readily distinguished, for in *pectinatus* the plates are numerous and normally branched, while in *africanus* there are very few plates and these are simple and dagger-shaped, and very short.

The adult ♀ of *A. africanus* is broad pear-shaped, and hyaline, with the pygidial margin slightly denser. There are three pairs of lobes, the median pair alone being well developed. L_2 and L_3 are rudimentary. L_1 short, with their outer edges sloping and once notched. There are no chitinous thickenings between the median lobes. Those bounding the first incision are equal and usually $\pm$ fused. Those at the second incision somewhat unequal, the inner being the larger of the two.

The formulae for the two species would be:

africanus:—$2P_1$, L_1, $2P_2$, L_2, P_3, L_3.
pectinatus:—$2P_1$, L_1, $2P_2$, L_2, $1\text{–}3P_3$, L_3, $2\text{–}3P_4$.

Pygidium as illustrated (fig. 99). Circumgenital glands 0.

Habitat: On bezemboom, Lady Grey; collected by J. C. Faure, May 1916. On *Robinia pseudacacia* and on pepper, Bloemfontein; on native bush, Meintjes Kop, Pretoria; collected by the writer, July 1915.

Collection Nos.: 188, 191, and 196.

79. **Aspidiotus (Diaspidiotus) perniciosus,** Comstock (Plate vi, fig. 97).

Aspidiotus perniciosus, Comst., Rep. U.S. Dept. Agr., p. 304, 1811.

A. (*Diaspidiotus*) *perniciosus*, Ckll., Bull. 6, U.S. Dept. Agr., p. 30, 1897.

Aonidiella perniciosa, Berl. & Leon., Annali di Agr., p. 55, 1898; Leonardi, Gen. Spec. Dias. Asp., p. 129, 1900.

Aspidiotus perniciosus, Fernald, Catalogue, p. 271, 1903.

Common Names: San José Scale, Pernicious Scale.

Scale of young flat, small, very dark blackish grey or black, with a central greyish dot surrounded by a black ring bordered on the outside again by a distinct greyish ring.

Scale of adult ♀ to 2 mm. in diameter, yellowish or buff-grey, but often obscured by fragments of bark. The yellow exuviae are covered and exhibit the greyish ring and dot of the young stages.

Male puparium smaller, narrower and darker in colour.

The nearest South African species is *A. pectinatus* , so far as the scale itself is concerned, but in this latter the ochraceous or blue-grey colour is pronounced, the exuviae show through the secretionary layer as a red-brown pellicle, and the ♀ scale is usually more conical.

Adult ♀ (mounted) about 1·2 mm. long, broad pear-shaped, but often with the abdominal segments somewhat retracted, hyaline, except the mouth-parts and median area of the pygidial margin, which are yellow. Antennal tubercle slightly shorter and broader than in *pectinatus*. Pygidium (fig. 97) pointed, with two pairs of lobes. L_1 about as long as broad, rounded at apex, notched on the outer margin as in *pectinatus*. L_2 smaller, usually rounded at apex and notched near the middle of the outer margin. P short, slightly branched. Circumgenital glands 0. Formula: P_1, L_1, $2P_2$, L_2, $3P_3$, L_3, $3P_4$, —, S.

It is practically impossible to state with any degree of certainty when this species was introduced into the Union. From its distribution at the time of discovery here it seems to me quite possible that there were two separate introductions, the one into Natal and the other to the Transvaal, possibly from Australia about 1906.

Habitat: It has been found on apple, almond, apricot, ash, chestnut, elm, hawthorn, loquat, oak, peach, pear, plum, poplar, quince, rose, pepper, walnut, and willow, and has been found at about a dozen places in the Transvaal, about an equal number in Natal, and three in the Orange Free State. It is not yet reported from the Cape Province.

Collection No.: 197.

80. **Aspidiotus (Diaspidiotus) pectinatus,** Lindinger (Plate vi, fig. 94).

Aspidiotus (*Diaspidiotus*) *africanus*, Marlatt (*ex parte*), Bull. U.S. Bur. Ent., T.S. 16, p. 15, 1908.

Aspidiotus pectinatus, Lindinger, Jahrb. Hamb. Wiss. Anst. xxvi, p. 43, 1909.

Common Name in South Africa: Grey Scale.

Scale of young circular, dark greyish, with a distinct white ring and dot. Scale of adult ♀ about 1·5 mm. in diameter, moderately convex to flattish, dark greenish grey, olivaceous, or bluish grey in colour, with the yellowish brown to reddish brown exuviae covered. The exuviae usually show distinctly through the thin secretionary layer and are surmounted by the conspicuous white ring and dot as observed in the young scales.

On oleander the scales often contain an admixture of powdery material from the bark of the plant and are light in colour, but the greenish colour is generally apparent on the under-side of the scale. The white caps which are so conspicuous in *africanus* are never found in this species. Male puparia narrow, with exuviae near the anterior rounded margins; colour as in the ♀ scale.

♀ viviparous.

Body of adult ♀ (mounted) small, about 0·75 to 1 mm. long, broad pear-shaped, hyaline, except the mouth-parts and tip of the pygidium, which are yellow. Antennal tubercle small, narrow, comparatively longer than usual, with one long spine, which is almost straight and about twice the length of the tubercle. Parastigmatic glands absent. The pygidium (fig. 94) is pointed; it has one well developed pair of lobes and two other pairs which are rudimentary. L_1 large, normally about as long as broad, median space short, parallel-sided, but the lobes appearing to converge owing to the outer margins curving slightly outward. There is always a deep outer notch at almost half their length and occasionally an obscure inner one. L_2 and L_3 rudimentary, sometimes represented by a small conical, hyaline, projection from the broad base; but most commonly this is apparently absent or lost to view in the process of mounting.

Circumgenital glands few in number, in 4 groups:

0—4	0—4	usually	1—2	1—2
0—3	0—3	„	1—2	1—2

Formula: P_1, L_1, $2P_2$, L_2, $1\text{–}3P_3$, L_3, $1\text{–}3P_4$.

Habitat: This scale is now recorded from all four Provinces of the Union. It was first described from specimens on pear, but is more commonly a privet scale. It is known to infest *Acacia horrida*, *Acer*, alder, almond, apple, apricot, ash, *Berberis*, *Ceratonia*, *Cotoneaster*, *Crataegus*, fig, *Gleditschia*, grape vine, hibiscus, ilex, lilac, pear, persimmon, plum, poplar, privet, quince, *Rhus*, pepper, and willow.

Collection No.: B.191.

81. **Aspidiotus (Diaspidiotus) ehretiae,** sp. nov. (Plate vi, fig. 98).

Scale of adult ♀ about 2 mm. in diameter, almost circular, greyish buff to brownish grey in colour, but often obscured by fragments of bark from the host-plant. The margins are depressed and the central portion raised, almost conical, with the highest portion occupied by the covered exuviae. The portion of the scale covering the second exuviae is smoother than the remainder of the secreted scale and the pale brown exuviae are slightly visible. In the centre is a small greyish or slate-coloured area, with a central white dot surrounded by a distinct shining ring of opaque white. This ring is particularly prominent in the young and male scales. Ventral scale white, extremely delicate, remaining attached to the host-plant.

Male puparium about 1 mm. long, and 0·6 mm. broad, of similar colour to that of the the ♀ scale.

Adult ♀ (from dry material) resinous brown, chitinous; when mature (mounted) large, 1·7 mm. long and 1·4 mm. broad, becoming highly chitinised from the anterior end backwards. Old females, after the eggs are laid, are entirely chitinous, of a deep yellow-brown colour. In young specimens the body is hyaline, except the mouth-parts, chitin bands of the pygidium, and the lobes and median part of the pygidium immediately behind them. Antennal tubercle with one moderately long spine. Pygidium with a basal row of transverse chitinous bands and two lateral ones, one on each side. Abdominal segments not prominently produced but broadly rounded; margin with a few hairs. Anus small, set well back from the lobes. The pygidium (fig. 98) is pointed. There are two pairs of lobes; but in specimens which have not become too generally chitinised there is an indication of a small third lobe immediately anterior to the second incision. Later, when the surrounding chitin is denser, this appears as part of the pygidial margin. L_1 large $\pm$ triangular, once notched on the outer side. L_2 similar but less than half the size. P absent. The chitinous thickenings to the first incision are large, unequal, the mesal one being the larger. The thickening to the second incision is large and reniform. Circumgenital and parastigmatic glands 0.

Formula: L_1, S, L_2, S, —, S, —, S.

The character of the lobes and the apparent absence of plates places this species very close to *A. forbesi*, but it is readily separated from this species by the characters of the scale, the median lobes being less convergent and slightly wider apart, the reniform thickenings to the second incisions and the absence of circumgenital glands.

Habitat: Apparently killing a tree of *Ehretia hottentottica*, Burch., Cookhouse, C.P.; collected by A. Kelly, 13th March 1915.

Collection No.: 189.

82. **Aspidiotus (Hemiberlesea) rapax,** Comst. (Plate vi, fig. 96).

Aspidiotus rapax, Comst., Rep. U.S. Dept. Agr., p. 307, 1881.
„ *camelliae*, Morg., Ent. Mo. Mag. xxiv, pp. 68 & 79, 1887.
„ *flavescens*, Green, Ceylon Independent, 1889.
„ *camelliae*, Lounsbury, Rep. Ent. C.G.H., p. 63, 1896.

Scale of adult ♀ strongly convex or almost conical, almost circular to elongate and one-sided, often appearing resinous, yellowish brown, with the exuviae towards one end brownish or blackish.

Professor Comstock's original description of the ♀ is as follows:—

"Female.—The body of the female is nearly circular in outline, bright yellow in color with more or less translucent blotches. The last segment presents the following characters: The group of spinnerets are wanting.

"Only one pair of well-developed lobes, the median, present. These are prominent. Each one is furnished with a notch on each side, the notch on the mesal margin is distad of that on the lateral margin. The second and third pairs of lobes are represented by the minute pointed projections of the margin of the body.

"The margin of the ventral surface of the segment is deeply incised twice on each side of the meson; once laterad of the first lobe, and again between the rudimentary second and third lobes. The parts of the body wall forming the margin of these incisions are conspicuously thickened.

"There are two simple tapering plates between the median lobes, two deeply and irregularly toothed or branched plates extending caudad of each incision, one usually simple and tapering plate between incisions of each side, and two or three of the same character laterad of the second incision.

"The first, second, and third pairs of spines of each surface are situated near the lateral bases of the first, second, and third lobes respectively; the fourth pair are situated at a little more than one-half the distance from the median lobes to the penultimate segment. In each case the spine on the ventral surface is but little laterad of the one on the dorsal surface."

Pygidium as illustrated (fig. 96). Circumgenital glands 0. Formula: $2P_1$, L_1, $2P_2$, L_2, $3P_3$, L_3, $2–3P_4$.

Habitat: This scale has been recorded on a large variety of plants, but an examination of the material reveals the fact that most of the records refer to *A. lataniae* and not *A. rapax*. It is known on *Euonymus*, *Acacia melanoxylon*, and a native tree from Johannesburg.

Collection No.: 198.

83. **Aspidiotus (Hemiberlesea) lataniae** (Sign.) Green (Plate vi, fig. 93).

Aspidiotus lataniae, Sign., Ann. Soc. Ent. Fr. (4) ix, p. 124, 1869; Green, Ent. Mo. Mag. (2) x, p. 181, 1899.

Scale of adult ♀ arched, circular to one-sided to elongate, with exuviae near one side. Whitish or greyish brown, about 2 mm. diameter, exuviae blackish. This scale is very much like that of *A. rapax*, but is usually flatter and the exuviae strike one as darker in looking over a lot of material. Pygidium as illustrated (fig. 93).

Circumgenital glands in 4 groups:

3—6	3—6
5—10	5—10

Lobes and plates as in *Aspidiotus rapax*, from which it is readily separated by the presence of circumgenital glands.

Habitat: On a large variety of plants throughout the Union, including vines, rose, box, palm, camellia, etc.

Collection Nos.: B.198, 199.

84. **Aspidiotus (Hemiberlesea) mitchelli,** Marlatt.

Aspidiotus (*Hemiberlesea*) *mitchelli*, Marlatt, Bull. U.S. Dept. Agr., T.S. 16, part 2, p. 22, 1908.

Professor Marlatt's description is as follows:—

"Scale of female: Length 1·5 mm; subcircular to broad oval, strongly convex, and of the general *camelliae* (*rapax*) type; secretionary matter rather dense, color dull yellowish, due chiefly to the extraneous matter taken up from the surface; exuviae yellowish-brown, near the anterior and usually covered. Ventral scale a distinct white flocculent patch, thinnest at the centre.

"Scale of male: Similar in general appearance to that of the female, but of the normal elongate shape.

"Adult female: Normal top-shaped, 0·75 mm. in diameter; in balsam hyaline; anal plate a little more yellowed than body, broad, not produced; three pairs of lobes; median lobes truncate, not converging, with two lateral shoulders, separated by a lobe's width, relatively much smaller than the lobes of *camelliae* (*rapax*); second lobe minute, spear-shaped, often with outer lateral shoulder; third lobe narrow, spiniform; thickenings of first and second incisions present, subequal, and together with lobes a little more yellow than the pygidium, but not strongly chitinised; plates numerous, long, filiform, central ones simply branched; spines short, inconspicuous; basal dorsal thickenings not strongly developed or chitinized; anal opening much larger than median lobes, broad oval, about one lobe's length from tip; paragenital pores wanting ; dorsal pores not numerous or conspicuous, but with very long (one-half width of pygidium) internal tubes ; ventral thickenings of integument extending from median lobes practically wanting."

This species was recorded " on thick, narrow, slightly oblanceolate leaves about 1½ inches long, collected by Mr. C. P. Lounsbury, at Mitchell's Pass, S.A., Jan. 29, 1897." This species has not been observed again nor has any of the original material been found in the collection. I have left this species in the sub-genus *Hemiberlesea*, as described, for the present, but I think, from the illustration, that it should be in *Aspidiotus s. str.*

Sub-genus **Selenaspidus,** Ckll.

The chief distinguishing characters of this sub-genus may be tabulated as follows :—

Scale of adult ♀ generally large, flat, ± circular, with central exuviae, most commonly brown in colour.

Puparium of ♂ elongate, brown, with exuviae placed towards one end.

Adult ♀ in all species (except *S. silvaticus*, Lindinger) with the cephalothorax distinctly separated at the margins from the abdomen. Pygidium with three pairs of lobes and numerous comb-like plates. The median two pairs of lobes are usually large and ± tri-lobed. The outer (3rd) pair of lobes are normal and nearly as large as the others in *S. lounsburyi* ; normal but smaller in *S. schultzei* ; reduced to a small pointed projection in *S. euphorbiae*, Newst., and strong, ± tusk-like and pointed in the other South African species. The scales of *S. lounsburyi* and *S. griqua*, sp. n., are unusual for this sub-genus. In the former it is ± buff-coloured at first, moderately convex, and usually bleached in old specimens. In *S. griqua* the scale is very convex and the hardened, chitinous body of the female is also highly convex.

The position of the scales on the host-plant, the age of the specimens, and the condition of humidity and sunlight probably influence the scales of the species of *Selenaspidus* in a more marked manner than in any other known Diaspine Coccids.

Circumgenital glands are absent in the majority of species known, but there are two groups present in *S. articulatus* and *pertusus*, sp. n., and four groups in *S. celastri*. At maturity the chitin becomes very dense, and the characters of the pygidium are often more or less obscured, and in some cases the body-wall has the appearance of being perforated by large, more or less rounded holes. These perforations are often arranged in definite order, but could never be mistaken for the tessellated designs found in *Pseudaonidia* spp.

The species known to occur in South Africa may be distinguished as follows :—

A. Cephalothorax distinctly separated at the margins from the abdomen.

I. Circumgenital glands absent.

(1) 3rd lobes normal, not much smaller than 1 and 2 (fig. 100) *lounsburyi* (Marlatt).

(2) 3rd lobes normal but much smaller than 1 and 2 (fig. 101) .. *schultzei*, Newst.

(3) 3rd lobe obsolete, not represented by lobe or definite tusk (fig. 102) *euphorbiae*, Newst.

(4) 3rd lobe strong, tusk-like ; insect small, flat, highly chitinous (fig. 107) *pumilus*, sp. n.

(5) 3rd lobe strong, tusk-like ; insect convex, conical (fig. 105) *griqua*, sp. n.

II. Circumgenital glands in two groups.

(6) Posterior lateral margins of cephalothorax rounded ; integument not perforate (fig. 104) .. .. *articulatus* (Morgan).

(7) Posterior lateral margins of cephalothorax $\pm$ acute ; integument appearing perforate (fig. 103) .. .. *pertusus*, sp. n.

III. Circumgenital glands in four groups.

(8) Anterior margin with tubercles (fig. 108) .. .. *celastri*, Mask.

B. Cephalothorax not distinctly separated at the margins from the abdomen.

(9) Circumgenital glands absent (fig. 106) .. .. .. *silvaticus*, Lindgr.

85. **Aspidiotus (Selenaspidus) lounsburyi** (Marlatt) (Plate vii, fig. 100).

Pseudaonidia (*Selenaspidus*) *lounsburyi*, Marlatt, Pr. Ent. Soc. Wash. ix, p. 139, 1908.

Professor Marlatt's description is as follows :—

" Female scale. Scale of adult female flat, subcircular, 2–2·5 mm. in longest diameter ; yellowish white but dense and opaque ; exuviae resinous to brown, covered with a slight excretion ; supplement usually three times diameter of second exuvium ; thin but distinct ventral scale present which adheres to the leaf.

" Male scale similar, oval, 1·5 mm. long ; exuvium near anterior end, brown.

" Adult female. Form oval, nearly 1·5 mm. long, strongly chitinized and brown in the case of old spent specimens ; body divided into two subequal parts by a deep cephalothoracic suture ; segments of abdomen indicated by distinct sutures but not marked by lateral incisions except in case of anal plate ; a short, stout lateral spine, distinctly annulated in the more hardened specimens, a little anterior to cephalothoracic suture.

" Anal plate. Similar in general characteristics to *articulatus* but exhibiting important differences ; lobes in three pairs, not very large, oval in shape, and often distinctly striate ; the two median subequal, the third smaller ; lateral teeth wanting or represented by the broad plates laterad of the third lobe ; incisions shallow, scarcely falling below the edge of the segment ; paraphyses indistinct or wanting ; interlobular plates narrow, two forked at tip—two median, two in first lateral and three in second lateral incision ; two obliquely truncated broad plates laterad of third lobe, with rudimentary third plate ; spines minute and inconspicuous ; anal opening narrow, oval, a little more than one third from tip ; vaginal opening very broad, more than one-third width of segment ; dorsal pores numerous in radiating rows from tip, but smaller and less abundant than in *celastri* ; basal thickenings a narrow line in four sections ; ventral thickenings not marked."

Habitat : On *Mesembryanthemum edule*, Capetown ; collected by C. P. Lounsbury, 29th June 1897 (Cape Nos. : 1263 and 1313).

Collection No. : 221.

85a. **Aspidiotus (Selenaspidus) lounsburyi,** var.

Scale of adult ♀ greenish grey, with uniform rusty-brown margins. Exuviae covered, central, appearing $\pm$ grey.

The chitin in the adult ♀ of this variety is much more dense, dark in colour and often appears perforate. The third lobe is normal as in *lounsburyi* and the other characters are similar.

In old specimens which have dried out the scales become uniformly greyish white, and the covering of the second exuviae with the first exuviae attached is generally flaked off so that the scales appear greyish white with brown centres.

Habitat: On *Mesembryanthemum edule,* Bloemfontein; collected by J. C. Faure, 3rd June 1915.

Collection No.: B.221.

86. **Aspidiotus (Selenaspidus) schultzei,** Newst. (Plate vii, fig. 101).

Aspidiotus (*Selenaspidus*) *schultzei,* Newst., Zool. Anthr. Ergeb. Westl. Zentr. Sudafr., p. 18, 1912.

Professor Newstead's description is as follows:—

" Puparium of female. Circular, smooth and rather thin; pellicles central, yellow to yellowish-brown; secretionary portion straw-coloured to ochreous white.

" Diameter, 1·50–2 mm.

" Female, adult. Strongly chitinised; thoracic articulation very distinct, constriction at sides deep; abdominal segments clearly defined by broad deep grooves terminating before reaching the margin; there are also several similar grooves on the thoracic region, but they are very short and irregular, taking the form rather of gland-tracts than true articulations. Pygidium (fig. 101) with three pairs of lobes; the second pair similar to the median pair, the third the smallest; all are distinctly striate, longitudinally. Squamae broad and rather coarsely divided. Spines very short. Tubular spinnerets long and slender, some of them reaching almost to the base of the pygidium.

" Resembles *Aspidiotus articulatus,* Morgan, but may be readily distinguished by the absence of the long serrated squamae at the margin of the pygidium.

" *Habitat*: Sudwestafrika, Klein Namaland, Kamaggas, L. Schultze. On a succulent plant." (R.N.).

87. **Aspidiotus (Selenaspidus) euphorbiae,** Newstead (Plate vii, fig. 102).

Aspidiotus (*Selenaspidus*) *euphorbiae,* Newst., Zool. Anthr. Ergeb. Westl. Zentr. Sudafr., p. 18, 1912.

Professor Newstead's description is as follows:—

" Puparium of female. Circular, thick, and opaque; exuviae central or subcentral; larval pellicle golden brown to dark golden yellow, covered with a white secretion, generally; second pellicle red-brown, covered with secretion similar to that of the larva; secretionary portion in two equal zones of pale ochreous and white, the latter marginal. Diameter, 1·75 to 2 mm.

" Female adult. With a well-marked thoracic articulation, constriction at sides great. Integument not highly chitinised. Antennae represented by an extremely minute tubercle furnished with a long spinose hair at the base. Stigmata without parastigmatic glands. Pygidium with a clearly defined lingula-shaped body of chitin on the central surface, the apex of which points towards the hind margin. Circumgenital glands obsolete. Dorsal pores small, numerous, scattered over the whole of the pygidium. Anal orifice placed a little posterior to the lingula-shaped body. Fringe of pygidium [fig. 102] with two pairs of large lobes, the third pair obsolete. Squamae broad and digitate; these organs are not, however, very clearly defined.

"Length, 1·50 mm.

"Easily distinguished by the singular tongue-shaped mass of chitin on the pygidium. It is nearly related to *Selenaspidus magnus*, Lindgr., but this species has the integument much more highly chitinised, is slightly larger, has a very wide vaginal orifice and the tongue-shaped body is entirely absent.

"*Habitat*: Sudafrika bei Riet Tinkas (sudlich von Salem am Swakop), Sept. 1903, L. Schultze. Auf *Euphorbia* aff. *virosa*, Willd."

This species is not represented in the Division collection.

88. **Aspidiotus (Selenaspidus) pumilus,** sp. n. (Plate vii, fig. 107).

Scale of adult ♀ about 1·6 mm. in diameter, almost circular, margins flat, depressed, centre roundly and flatly conical, dull, g brown, with yellow exuviae.

Puparium of ♂ smaller, narrower and elongate, of same colour and texture as the ♀ scale.

♀ viviparous.

Adult ♀ (mounted) small, largest specimen seen measuring 1·2 mm. long and 1·1 mm. broad across the angles of the cephalothorax. The body is entirely chitinous and is chitin brown in colour. The cephalothorax is flatly rounded, more than twice as wide as long, and the V-shaped sides of the articulation extend inwards for about one-tenth the width of the body. The segmentation of the body is distinct on the middle part, but does not extend to the margins. The antennal tubercles are large, disc-like, with one long hair. Before the chitinisation of the body is quite complete there are two well-defined series of hyaline patches, one in a curve in the region of the vulva (in optical section) comprising six long oval spaces, and another in the region of the mouth-parts. Parastigmatic glands 0. The vulva is wide, 180 μ, and is situated anterior to the anal opening. The pygidium as illustrated (fig. 107).

Circumgenital glands 0. Formula: P_1, L_1, $2P_2$, L_2, $3P_3$, L_3, $2\text{–}3P_5$.

Habitat: On New Zealand flax (*Phormium tenax*, Linn.), Stanger, Natal; collected by C. Fuller, 11th December 1903.

Collection No.: 224.

89. **Aspidiotus (Selenaspidus) griqua,** sp. n. (Plate vii, fig. 105).

Scale of adult ♀ about 1·5 mm. long, almost circular, but appearing elongate in the direction of the length of the twigs because it is so much arched, buff to brownish, matt, ± smooth, shell-like, with exuviae covered. The first exuviae are central and are usually covered with a small circular area of secretion which is paler, or almost white. In rubbed specimens the first exuviae are brown. The second exuviae are covered with a layer of secretion similar to that of the scale, but their outer margin is often indicated by a line of paler colour.

Puparium of ♂ similar, but smaller and more elongate, with the first exuviae near one end, covered, yellow to orange when rubbed.

Adult ♀ with body very highly chitinised when mature, and highly conical, retaining this character when boiled in KOH, so that it is impossible to mount specimens flat without splitting them. When mounted the body is highly chitinous, with the segmentation intensified by thickened ridges of chitin at the edges of the segments. In shape the body is very short in comparison with its width, being broader than long. The cephalothoracic area is larger than the abdominal region, and the pygidium is short and flat, not pointed as in *articulatus*. The articulation is distinct, but not deep at the margins, and there is no process on the lateral margin. The lobes and plates are small and comparatively delicate, as shown in the illustration (fig. 105). Circumgenital glands 0.

Habitat: On *Arthrosolen polycephalus* (*Thymeleaceae*), a small native veld bush with numerous slender branches and narrow leaves, Belmont, Griqualand East; collected by F. Thomsen, 2nd April 1915; and on the same plant at Middelburg, Cape, by the writer, November 1916.

Collection No.: 227.

90. **Aspidiotus** (**Selenaspidus**) **silvaticus** (Lindinger) (Plate vii, fig. 106).

Selenaspidus silvaticus, Lindinger, Jahrb. Hamb. Wiss. Anst., xxvi, p. 10, 1908.

The illustration shows the pygidium from a specimen collected on *Aberia caffra*.

The scales of this species vary considerably in size and colour on different host-plants. The following variations may be noted for South African material:—

(*a*) On stemfruit (Transvaal, Collection No. 246).

Scale of ♀ circular or nearly so, brown, or in old specimens pale buff or almost white, flat, to 2 mm. in diameter. First exuviae naked, metallic, brassy or bronze; second exuviae covered, brownish. Puparium of ♂ smaller, horn-brown, with yellowish or brassy exuviae.

(*b*) On *Dracaena australis* (East London, C.P., Collection No. 231).

Scale of adult ♀ large, may reach 2·7 mm. for longest diameter, ± circular or elongate oval according to position on leaf, flat, thin, dull brown with paler margins. Exuviae central, flat, greenish, yellowish or metallic and brassy. Puparium of ♂ smaller, brown.

(*c*) On *Euonymus* (Natal, Collection No. 232).

Scale of adult ♀ to 2·5 mm. in long diameter, almost circular when not against midrib or margin of leaf, flat, dull, thin, dirty brown in colour, with ± metallic, yellowish exuviae. Puparium of ♂ flat, small, brown, with yellowish exuviae.

Habitat: On *Aberia caffra*, Uitenhage, C.P.; collected by C.P. Lounsbury, 2nd August 1906. On palms, tea and citrus, Natal; collected by C. Fuller. On *Euonymus*, Natal; collected by C. Fuller. On stem-fruit (*Chrysophyllum magalies-montana*), Nelspruit; collected by T. R. Sim, January 1908. On native tree, Kei Valley, C.P. On *Berberis*, Irene, Pretoria, July 1913, and on ivy.

Collection Nos.: 203, 222, 228, 228a, 231, 232, 245, 246, 247 and 248.

91. **Aspidiotus (Selenaspidus) articulatus,** Morgan (Plate vii, fig. 104).

Aspidiotus articulatus, Morgan, Ent. Mo. Mag. xxv, p. 352, 1889.

Selenaspidus articulatus var. *simplex*, d'Emmerez, Pr. Soc. Amer. Scien. p. 20, 1889.

Aspidiotus articulatus, Newst., Mon. Brit. Coccidae, I, p. 127, 1901.

Selenaspidus articulatus, Fernald, Catalogue, p. 284, 1903; Lindinger, Jahrb. Hamb. Wiss. Anst. xxvi, p. 10, 1908.

Scale of adult ♀ about 2 mm. in diameter, circular, flat, semi-transparent, pale brown or yellowish brown or dirty smoky brown when old, sometimes with margins very pale, often shiny, with central exuviae golden yellow.

Puparia of ♂ smaller, more elongate, brownish, with lighter exuviae.

♀ second stage non-articulate.

Adult ♀ viviparous, with the cephalothorax distinctly separated from the abdomen. Body-wall yellow-brown, densely chitinised; front margin flatly rounded, very finely crenulated, but without tubercles; posterior lateral angles of cephalothorax each with one spiny process, which is usually longer than its breadth at the base. The integument is finely stippled, and there is a sub-marginal series of small hairs at wide intervals. The antennae are small, with one long curved seta and a stump which may represent a second seta which has broken away. Parastigmatic glands 0.

Circumgenital glands in two groups:

6—12 6—12

The pygidium is rapidly narrowed but rounded, the ends of the four normal lobes being almost level. Lobes and plates as illustrated (fig. 104).

Habitat: On *Carissa grandiflora*, Durban; collected by A. Kelly, 7th June 1908. On variegated ornamental plant (*Euryea*?), Pietermaritzburg; collected by C. Fuller.

Collection Nos.: 223 and 225.

92. **Aspidiotus (Selenaspidus) pertusus,** sp. n. (Plate vii, fig. 103).

Scale of adult ♀ may reach 2·6 mm. in diameter, circular, flat, dull rusty brown in colour, with margins slightly paler. Exuviae yellowish or reddish brown. Second exuviae usually somewhat sunken. In old specimens exposed to the sun the scale often becomes ± bleached.

Puparium of ♂ smaller, more elongate and paler in colour, yellowish brown.

Body of adult ♀ narrower than in *articulatus*, longer than broad (1.5 × 1mm.) with deep articulation. Posterior lateral margin of abdominal region with distinct process. The integument is very highly chitinised, appearing dark brown in mature specimens, but with distinct, transparent, hyaline perforations. These are in three series: (*a*) a loop of about 10 spaces below the position of the mouth-parts, across the cephalothorax; (*b*) an interrupted series across the abdominal segments; (*c*) the pygidial series, which comprises a band across the base, four posterior to these lying longitudinally in two pairs, and a few elongate, narrow ones between these and the margin of the pygidium. Antennal tubercles small, each with two moderately long, curved setae. Dorsal glands and tubular glands numerous.

Circumgenital glands in 2 groups:

7—10 7—10

usually 8. Occasionally 1–2 glands are separated and might indicate that 4 groups may be present. Pygidial characters as illustrated (fig. 103).

Formula: P_1, L_1, $2P_2$, L_2, $3P_3$, L_3, $6–7P_4$.

Habitat: On *Euphorbia* (tree form), East London; collected by Mr. King, 19th October 1914. On *Mimusops* sp., East London; collected by Miss Impey, 30th May 1915. On laurel, Komgha, C.P.; collected by C. P. Lounsbury, September 1909 (Cape No. 1709).

Collection Nos.: 212, 229 and 229a.

93. **Aspidiotus (Selenaspidus) celastri,** Maskell (Plate vii, fig. 108).

Aspidiotus articulatus var. *celastri*, Maskell, N.Z. Trans. xxix, p. 297, 1897.

Selenaspidus articulatus celastri, Fernald, Catalogue, p. 285, 1903.

Selenaspidus celastri (Mask.) Lindinger, l.c., p. 8.

Scale of adult ♀ to 3 mm. in diameter, almost circular, ochreous fawn to straw-colour, often paler towards the margin, semi-glassy and smooth, with a dark brown to black blotch in the centre of the second exuviae. Exuviae central, flat. First exuviae thin, pale, almost colourless and transparent. Second exuviae brown, bright coloured, central, with a black blotch in centre.

Puparium of ♂ smaller, somewhat elongate, pale buff, semi-transparent, thin and delicate, with exuviae slightly darker.

The body of the adult ♀ resembles that of *articulatus* to some extent, but when under a low power the following differences are noticeable: The sides of the articulation are less acute and form a broad V. The anterior margin usually has a series of about twenty rough chitinous tubercles. The finger-like process on the lateral margins of the cephalothorax of *articulatus* is replaced by a process which is most often irregularly forked at the extremity. Pygidium as illustrated (fig. 108).

Circumgenital glands in 4 groups:

$$\begin{matrix} 5\text{—}9 & 5\text{—}9 \\ 5\text{—}12 & 5\text{—}12 \end{matrix}$$

Habitat: On *Celastrus laurinus*, Thb., Ceres, C.P.; collected by C. P. Lounsbury (Cape No. 1261).

Collection No.: 226.

94. **Aspidiotus (Morganella) maskelli,** Cockerell (Plate vii, fig. 109).

Aspidiotus longispina, Mask. (non Morgan), N.Z. Trans. xxviii, p. 38, 1894.

Aspidiotus (*Morganella*) *maskelli*, Ckll., Bull. U.S. Dept. Agr., P.T. 6, p. 22, 1897.

Scale of ♀ small, about 1 mm. diameter, roundly arched, pitchy black, with exuviae of the same colour. Exuviae usually situated towards one side of the scale.

Adult ♀ (mounted) elliptical, broader than long (0·9 × 0·8 mm.), with the small, pointed pygidium somewhat recessed. Antennal tubercle with one very long curved spine. The pygidium (fig. 109) is acutely pointed. The median lobes are very long and narrow, with their inner faces close together and their outer margins very deeply notched. The extremity is round. There are chitinous thickenings extending back from the lobes. The plates are extremely long, ± parallel-sided, with long terminal branches, and the two edges ± plumose, the outer side being more branched than the inner. Circumgenital glands 0. Formula: $L_1 + 12–13$ long plates with outer edges fringed and 3 pairs of very long spines.

Habitat: On camellia, Botanic Gardens, Durban; collected by C. Fuller. On "Coffin tree" imported from China; collected by A. Kelly, February 1910. On *Michelia champeca,* Botanic Gardens, Pietermaritzburg; collected by A. Kelly, September 1910. On plant cuttings, Botanic Gardens, Durban; collected by A. Kelly, July 1914. On *Lagerströmia* sp., mango and orange, collected by A. Kelly in Durban, 1915. On citrus, Hillary, Natal. On papaw, Durban.

Collection No.: 210.

Genus **Furcaspis,** Lindinger.

This genus was erected by Lindinger in 1907 to accommodate the species "*biformis*" and *capensis.* The following is a translation of his diagnosis:—

"Scale of the ♀ round or elongate, thick, of differing brown colour, arched. Exuviae central or subcentral.

"Scale of the ♂ similar in colour and texture but different in shape being narrow and linear with the exuviae at the anterior end.

"Body wine-red in colour.

"Pygidium yellow, broadly rounded. Lobes, more than 3 pairs, the innermost 3 pairs almost similarly formed, those more removed differing to a greater or less degree, often toothed. Plates branched only at the end, apparently 2 to 3 toothed, the teeth united by a membrane which disappears on the dorsal side, so that the plates are really spoon-like. Design on dorsal side absent (such as found in the genus *Pseudaonidia*)."

It should be mentioned that the scale of the two South African species is more or less shell-like, with the exuviae curved over to one side, and with $\pm$ distinct concentric ridges on the upper surface of the scale.

95. **Furcaspis capensis** (Walker) Green (Plate vii, fig. 110).

Lecanium capense, Walker, Cat. Br. Mus. Homopt. p. 1079, 1852; Signoret, Essai, p. 612, 1876.

Aspidiotus cladii, Maskell (*ex parte*), N.Z. Trans. xxviii, p. 385, 1895.

Aspidiotus (*Aonidiella*) *capensis,* Green, Ann. Mag. N.H. xiv, p. 375, 1904.

Aspidiotus reticulatus, Newst., Zool. Anthr. Ergeb. Westl. Zentr. Sudafr. p. 17, 1912.

Common Name: Aloe Red Scale.

Scale of adult ♀ sub-circular or oval, moderately convex, very dense and tough, with the highest point towards one side, from which, as a centre, concentric ridges or corrugations extend to the margin. The first exuviae are laterad again of the highest point and appear as a rounded prominence, thus giving the whole scale the exact appearance of a minute shell. The colour of the scale varies with age. When young it is a rich pale brown, but becomes more reddish later. The most common colour in dry material is dry-blood colour. In living specimens the adult ♀ scale is sometimes very beautiful, with the margins and first exuviae orange brown, the second exuviae covered with deep red and the concentric ridges very dark, almost black. The average size of the adult ♀ scale is 2·5 mm. in largest diameter, but occasional specimens reach 3·5 mm. Ventral scale very dense and tough, yellowish white.

The ♂ puparium is small, linear, tapering slightly to the posterior extremity, brown, with the exuviae at the front end and the hind end paler. Length about 1.2 mm.

Body of adult ♀ dark purple, almost black when alive, deep purple brown when dry. When cleared and mounted the body is broadly oval, hyaline, except the mouth-parts and pygidium, which are yellow. The abdominal segments are not produced, and are merely indicated, being ± rounded at the margins. The antennae are represented by a low tubercle and about 5 curved spines. The anterior part of the body is supplied with a sub-marginal series of long hairs, and there is a ventral series of four to six stout conical spines on each side, each of which arises from a conspicuous circular disc. These extend at intervals from the level of the mouth-parts to the region of the pygidium, those of the thoracic area being the smaller. Circumgenital glands 0. Pygidium as illustrated (fig. 110).

Remarks: This species was first described—in a few words—as *Lecanium capense* by Walker. This description was copied by Signoret in his Essai. Nothing further was done until Mr. Green worked over the material and published his description in 1904. The bark mentioned in these descriptions must be the dry withered aloe leaf, which could be easily so mistaken.

In the New Zealand Transactions, 1890, p. 75, Mr. Maskell described a Coccid on *Cladium* from Australia under the name of *Aspidiotus cladii.* This species has a stout circular scale with central exuviae. It is rich dark brown with paler reddish margins and red exuviae. In this respect it resembles the scale of *capensis*, but here the similarity ends, for *cladii* is more like a *Chrysomphalus* from its pygidial characters (fig. 112), although the shape of the lobes and the thickened margin of the pygidium remind one slightly of *capensis.* In 1895 (Trans. N.Z. p. 385) Mr. Maskell writes as follows :—

"I have lately received from Mr. A. Cooper, of Richmond, Natal, some pieces of aloe having on them several specimens of an *Aspidiotus* which is very clearly *A. cladii.* I have never before seen this insect from any place outside Australia, in which country it seems to be widely spread, as I have had specimens from nearly every portion of the continent. The species must have been taken to South Africa (I suppose) in some ship, perhaps on decorative plants for the saloon, or in a Wardian case. Mr. Cooper tells me that the aloe in question seems to be not seriously damaged; and I have not heard that *A. cladii* is injurious in Australia, although common enough."

In 1899, d'Emmerez de Charmoy recorded *Aspidiotus cladii* on palms from Mauritius (Proc. Soc. Amic. Scien. p. 22, 1899). This insect forms a yellow-brown to dark brown scale, often tinged with a greenish colour. It is quite distinct from *cladii* and *capensis* and is usually somewhat elongate, with exuviae curved over to one side. Its pygidial characters may be seen from fig. 111 and I suggest that this insect should now be known as *Furcaspis charmoyi*, sp. n.

Habitat: On aloe (leaves) Eastern Province, Cape, common. On aloe, Rosebank, Cape; collected by the writer, July 1914. On aloe, Pretoria, Transvaal. On *Aloe rupestris*, Namaqualand, sent by I. B. Pole Evans, Chief of Division of Plant Pathology.

Collection Nos.: 194 and 235.

96. **Furcaspis proteae,** sp. n. (Plate vii, fig. 113).

Scale in large numbers on the leaves of different species of Proteaceae.

Scale of adult ♀ similar to that of *capensis,* but smaller and more brown than red. Average size 1·6 mm. in diameter.

Male puparium comparatively larger and wider than in *capensis.* In dry material the exuviae often appear whitish owing to the secretionary layer becoming detached from the pellicle.

On casual observation the insect itself is extremely like *capensis,* but differs in the following important particulars :—

(*a*) There are *four* pairs of striate lobes instead of three (Fig. 113) ; (*b*) the posterior four thick conical spines are larger and more conspicuous ; (*c*) the lobes are longer, more parallel-sided, and narrower than in *capensis* ; (*d*) the marginal lobular thickenings beyond the four pairs of lobes usually take the form of four lobules of which the second is generally the largest.

Habitat : On leaves of *Protea* sp., Henops River, Pretoria ; collected by Mr. Mogg, July 1915. On leaves of "beukenhout" (*Faurea saligna,* Han.), Buffelspoort, Rustenburg District, Transvaal ; collected by F. Thomsen, September 1909.

Collection Nos. : 241 and 241a.

EXPLANATION OF PLATE III.

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73. *Calycicoccus merwei*, sp.n., adult ♀, inverted gall; (*a*) normal gall.

74. *Cissococcus fulleri*, Ckll., galls of adult ♀; (*a*) gall of adult ♀ in section, showing ♀; (*b*) massed galls; (*c*) ♂ puparium; (*d*) adult ♀ in gall.

75. *Amorphococcus acaciae*, sp.n., adult ♀ galls; (*a*) adult ♀ galls further enlarged, showing openings; (*b*) adult ♀ galls with cover removed to expose ♀; (*c*) ♀ with eggs.

SOUTH AFRICAN COCCIDÆ.

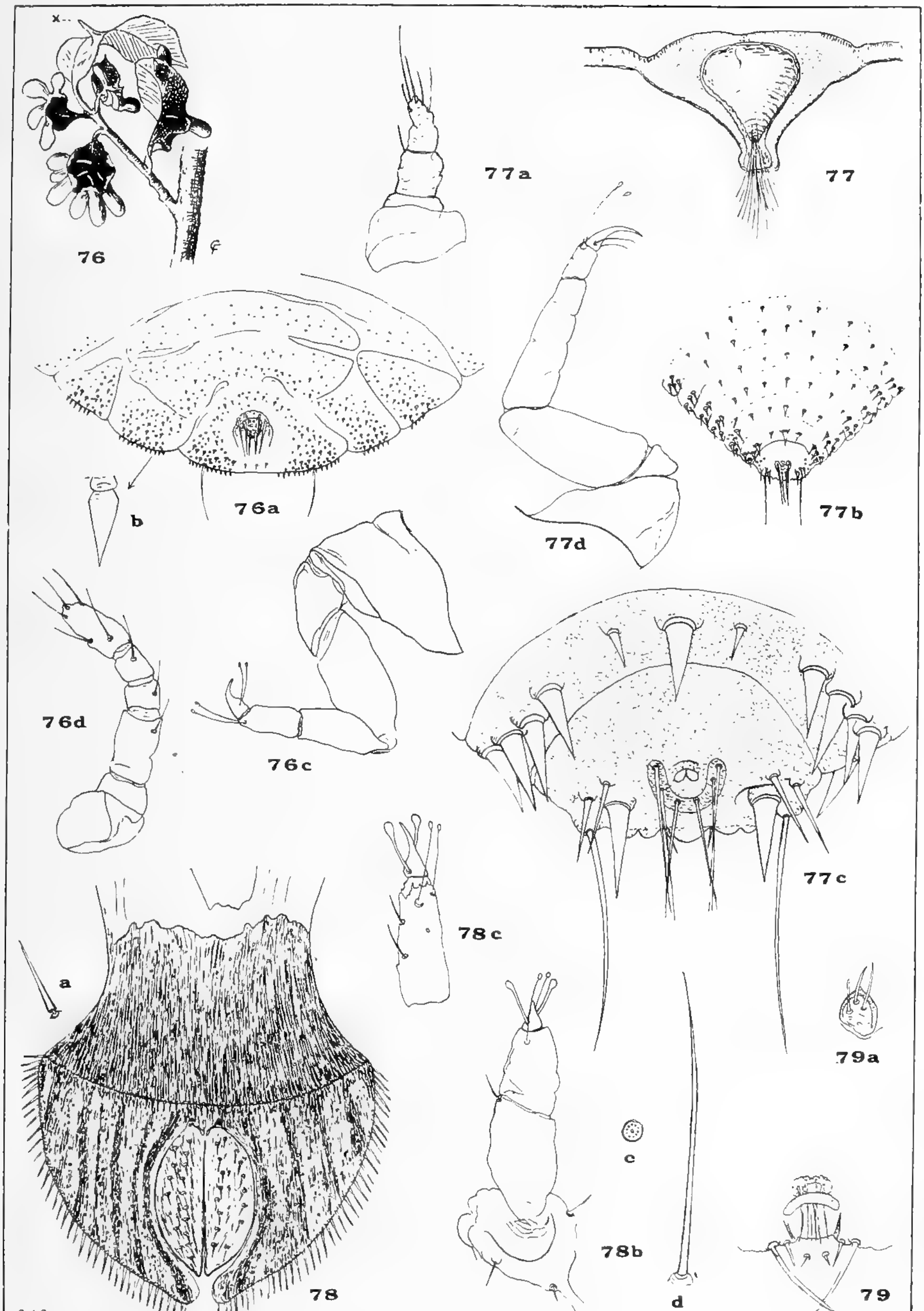
EXPLANATION OF PLATE IV.

76. *Grewiacoccus gregalis,* sp. n., galls ; (*a*) caudal extremity of adult ♀ ; (*b*) spine of adult ♀ ; (*c*) leg of adult ♀ ; (*d*) antenna.

77. *Calycicoccus merwei,* sp. n., adult ♀ in gall ; (*a*) adult ♀ antenna ; (*b*) adult ♀, caudal extremity ; (*c*) adult ♀, caudal extremity further enlarged ; (*d*) leg.

78. *Cissococcus fulleri,* Ckll., adult ♀, anal plates ; (*a*) spine from margin of plates ; (*b*) rudimentary leg ; (*c*) normal tarsus ; (*d*) spine from integument ; (*e*) dermal gland.

79. *Amorphococcus acaciae* sp. n., adult ♀, anal armature ; (*a*) antenna.



SOUTH AFRICAN COCCIDÆ.

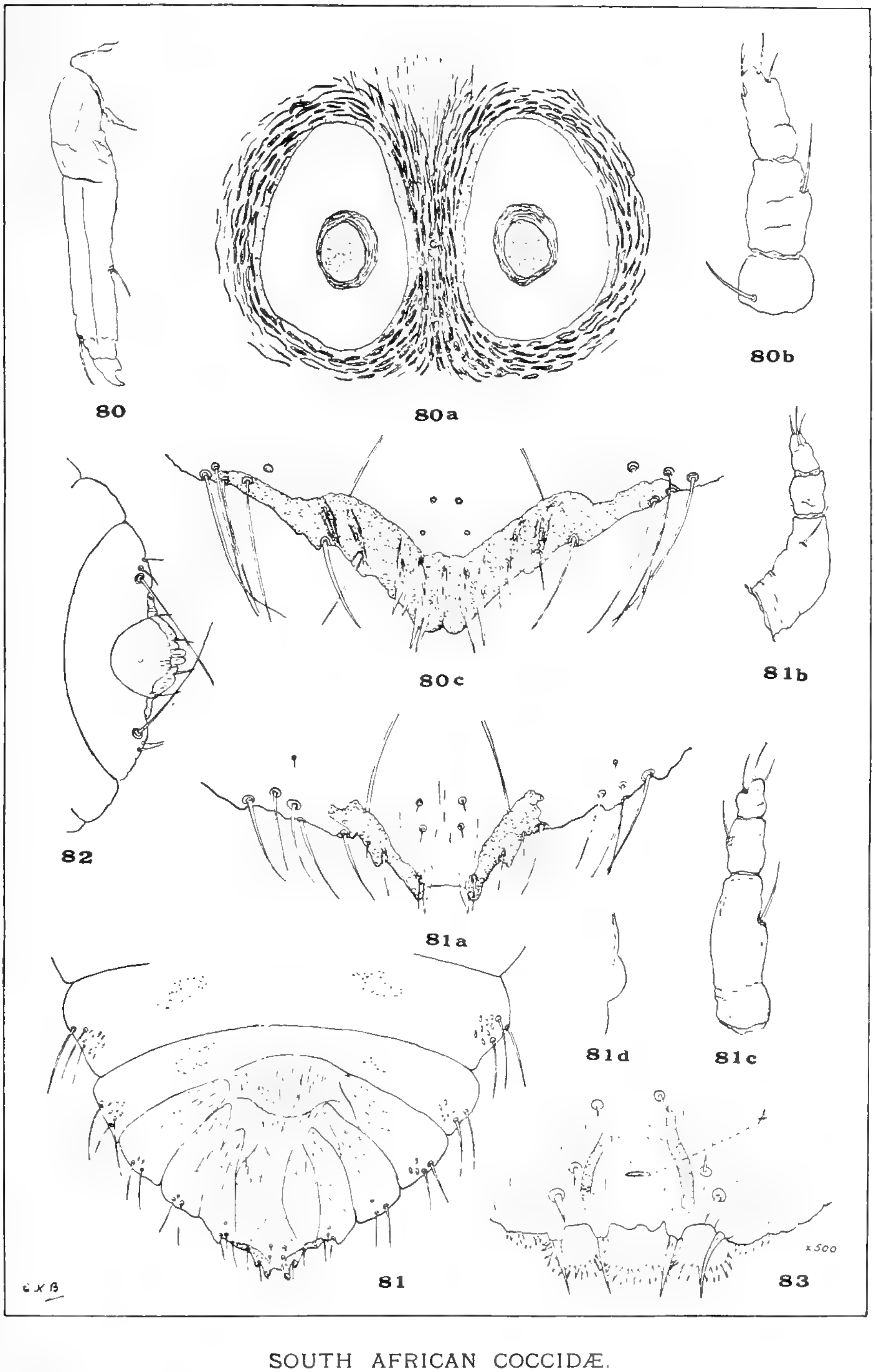
EXPLANATION OF PLATE V.

80. *Conchaspis socialis,* Green, leg of adult ♀; (*a*) eye-spot; (*b*) antenna; (*c*) pseudopygidium.

81. *Conchaspis euphorbiae,* sp. n., adult ♀, pseudopygidium; (*a*) ditto, further enlarged; (*b, c*) antenna; (*d*) lateral tubercle.

82. *Conchaspis angraeci hibisci,* Ckll., larva, caudal extremity.

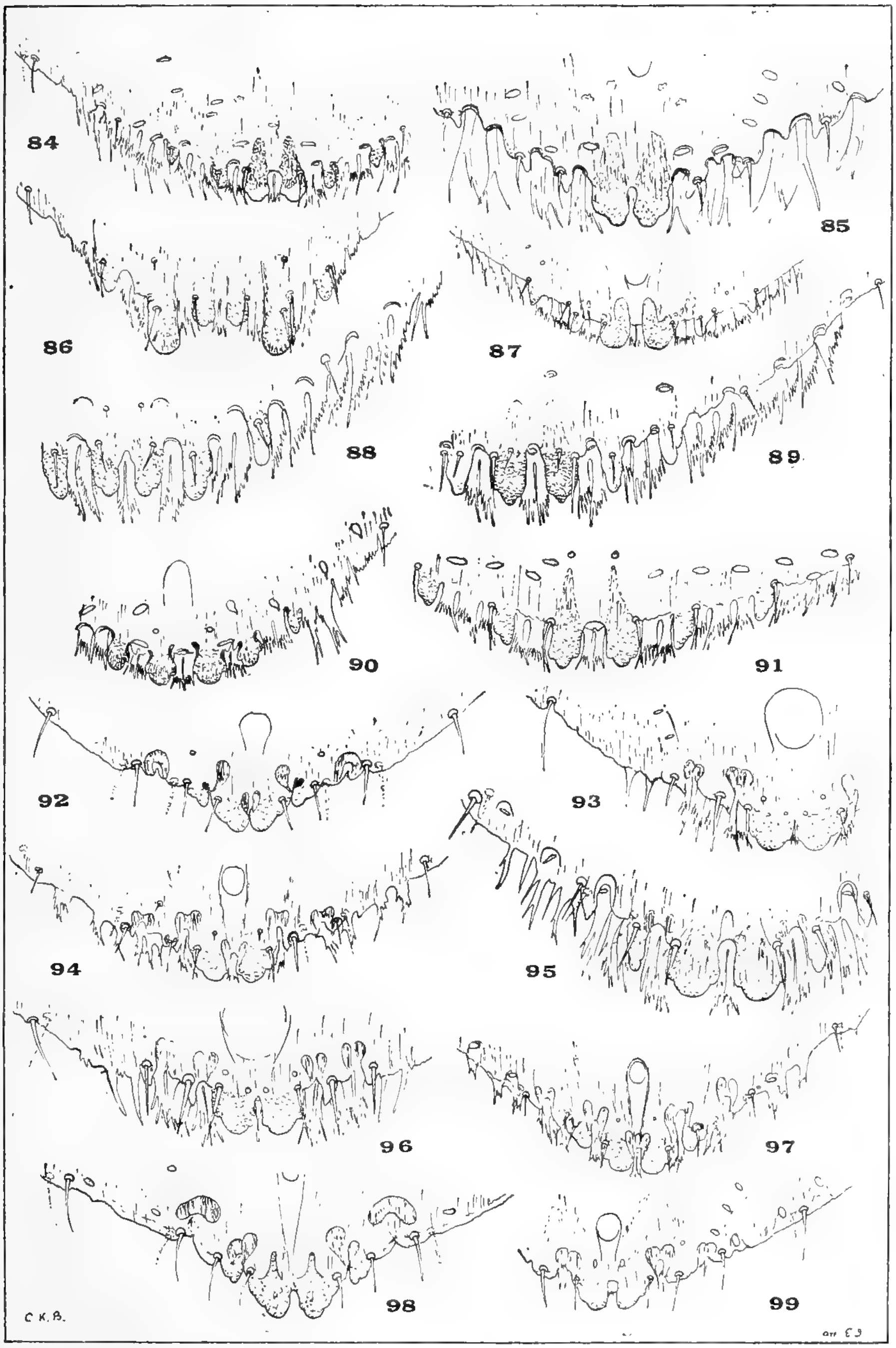
83. *Fagisuga triloba* Ldgr., ♀, caudal extremity (after Lindinger).



SOUTH AFRICAN COCCIDÆ.

EXPLANATION OF PLATE VI.

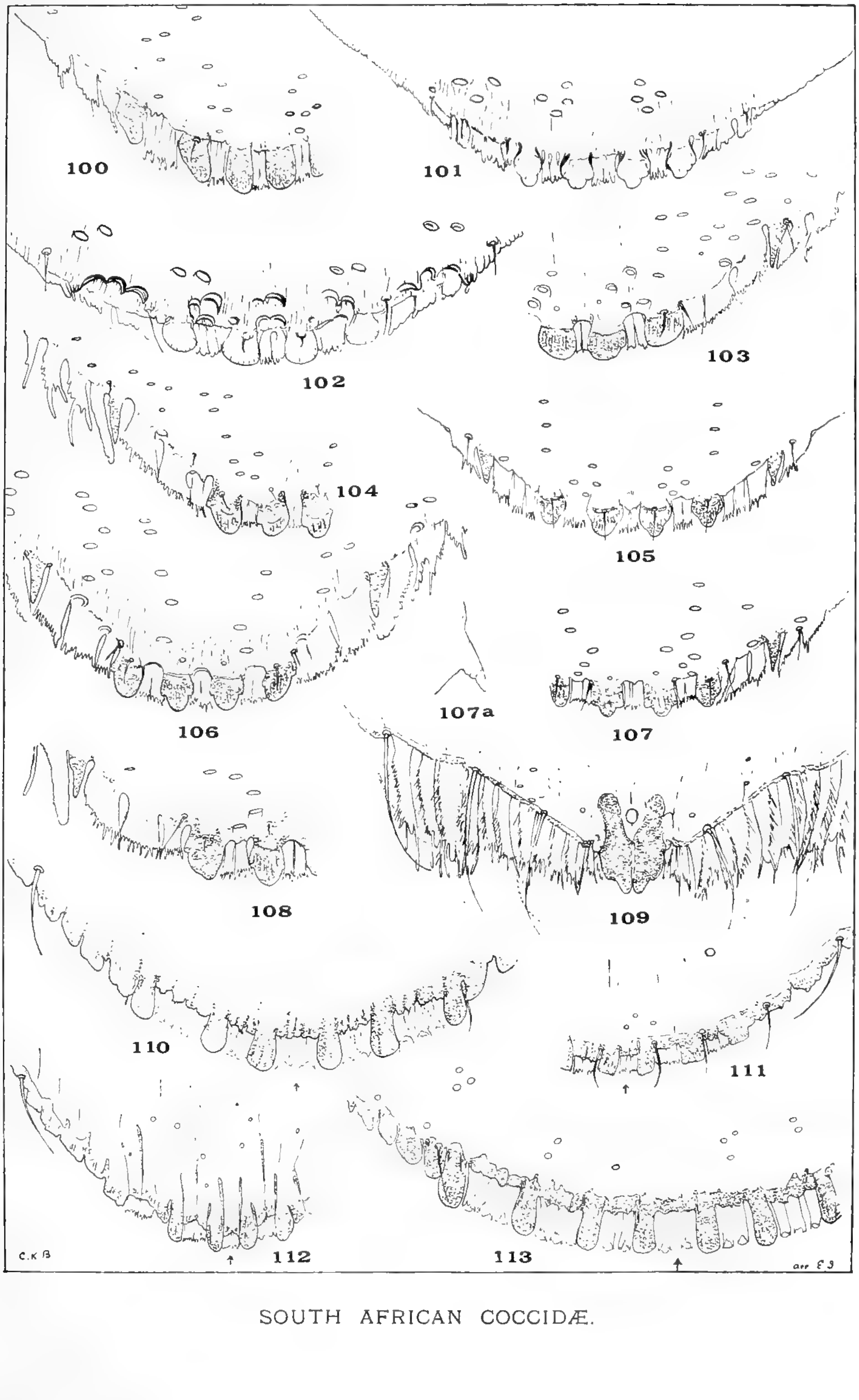
84. *Aspidiotus hederae* (Vall.) Sign.
85. ,, *furcillae*, sp. n.
86. ,, *kellyi*, sp. n.
87. ,, *gowdeyi*, Newst.
88. ,, *destructor*, Sign. (after Lindinger.).
89. ,, *transparens*, Green.
90. ,, *regius*, sp. n.
91. ,, *fimbriatus capensis*, Newst.
92. ,, (*Diaspodiotus*) *forbesi*, Johnson.
93. ,, (*Hemiberlesea*) *lataniae* (Sign.) Green.
94. ,, (*Diaspidiotus*) *pectinatus*, Ldgr.
95. ,, *cyanophylli*, Sign. (after Lindinger).
96. ,, (*Hemiberlesea*) *rapax*, Comst.
97. ,, (*Diaspidiotus*) *perniciosus*, Comst.
98. ,, (*Diaspidiotus*) *ehretiae*, sp. n.
99. ,, (*Diaspidiotus*) *africanus*, Marlatt.



SOUTH AFRICAN COCCIDÆ

EXPLANATION OF PLATE VII.

100. *Aspidiotus* (*Selenaspidus*) *lounsburyi* (Marlatt).
101. *Aspidiotus* (*Selenaspidus*) *schultzei,* Newst. (after Newstead).
102. *Aspidiotus* (*Selenaspidus*) *euphorbiae,* Newst. (after Newstead).
103. *Aspidiotus* (*Selenaspidus*) *pertusus,* sp. n.
104. *Aspidiotus* (*Selenaspidus*) *articulatus,* Morgan.
105. *Aspidiotus* (*Selenaspidus*) *griqua,* sp. n.
106. *Aspidiotus* (*Selenaspidus*) *silvaticus,* Ldgr.
107. *Aspidiotus* (*Selenaspidus*) *pumilus,* sp. n.
108. *Aspidiotus* (*Selenaspidus*) *celastri,* Mask.
109. *Aspidiotus* (*Morganella*) *maskelli,* Ckll.
110. *Furcaspis capensis* (Walker) Green.
111. *Furcaspis charmoyi,* n. n.
112. *Chrysomphalus cladii* (Mask.).
113. *Furcaspis proteae,* sp. n.



SOUTH AFRICAN COCCIDÆ.

AN EXAMINATION OF THE SENSE-REACTIONS OF FLIES.

By Olive C. Lodge.

(Plates VIII–XI.)

Comparatively little experimental work appears to have been done to determine the likes and dislikes of flies, and the ways in which the different species respond to stimuli affecting the senses of smell, sight, touch, taste, and the perception of the differences of temperature and humidity.

It is self-evident that the more completely the ways in which flies behave under different conditions are understood, the more possible it is for effective remedial and preventive measures to be devised and carried out; especially is this important in the case of those flies which are known to be agents in the spread of intestinal diseases.

One of the objects of this investigation was to test many different substances with a view to finding some which would so stimulate the senses of flies that all those approaching would be immediately attracted or repelled. If some such substances could be found, they would be of extreme economic importance, and should they be poisonous to the flies as well, their practical value would be increased.

The two obvious methods of investigating the sense-reactions of flies are:—

(1) To examine and compare the position and morphology of the sense organs, more particularly those situated on the antennae and mouth-parts; (2) to test various poisons, smells, colours, etc., on flies of different species, and to notice how they react towards them.

The second method was followed in this investigation, in which there are two main points to be considered:—(*a*) The observation of the likes and dislikes of flies, and the general way in which they react to sense-impressions; (*b*) the determination of the sense or senses involved in these reactions, and to find out whether they are due to sight, smell, etc.

To this end experiments were made to find out:—

(I) The likes and dislikes of flies, with regard to, (*a*) various foods, (*b*) various chemicals, (*c*) different colours, (*d*) variations in temperature, and (*e*) variations in humidity.

(II) Their behaviour when different substances, either freely exposed or covered in various ways, were presented to (*a*) normal flies, (*b*) flies with their antennae removed, and (*c*) flies with their eyes covered.

The behaviour of the two sexes was particularly observed, since any difference of reaction of the sexes in this respect might be of use in considering economic measures.

The work was undertaken for the Zoological Society of London, to whom my thanks are due for the facilities which they afforded me. It was carried out at the Imperial College of Science and Technology, during the summer and autumn of 1916.

The flies principally used were those which from their habits were likely to be concerned in the spread of intestinal diseases, viz.: *Musca domestica* (house-fly), *Fannia canicularis* (lesser house-fly), *Fannia scalaris* (latrine fly), *Calliphora erythrocephala* (blue-bottle), *Calliphora vomitoria* (blue-bottle), *Lucilia caesar* (green-bottle), and *Phormi azurea* (*groenlandica*).

The blow-flies were obtained for the most part from those caught in traps set in the Zoological Gardens. They were also bred for a time in a greenhouse at the Imperial College, when beef and mutton scraps were used as the principal food both for flies and maggots. The best results were obtained, both with the maggots and flies, when the air in the greenhouse, which became very hot, was kept moist; if this was not done, they—and more particularly the flies—very soon died.

The supply of house-flies was kept up by breeding from the descendants of the flies which emerged from pupae collected from a manure-heap near London, in July 1915. Breeding was carried out in the fly room (Plate VIII) and in the same way as formerly, viz., by using mixtures of casein, bread, water and banana, surrounded by a layer of dry rubbish in which the maggots could pupate, the whole being placed in very large saucers (Plate IX, fig. 1). It was thus possible to keep up a continuous supply of flies during 14 months. House-flies were found to be hardier and easier to breed than blow-flies.

Fannia were also bred in the same mixtures, and under the same conditions and for the same period of time as *Musca*; although they never bred in such large numbers as the latter.

In all experiments the different substances were as far as possible tested on free flies, and also on those confined in glass cylinders (8 in. × 9 in.) with muslin tops.

When flies were needed for the cylinders, they were generally caught in balloon traps placed over the breeding saucers. In all cases controls were set up for each series of experiments. It was thus possible to compare the behaviour of the flies under different conditions, and to obtain an idea of the relative value of the different substances tested.

Experiments to test the likes and dislikes of flies.

Foods—baits, deterrents and poisons.

A certain number of experiments of a more or less preliminary nature were made, in order to compare the proportion in which the sexes came to feed, and to find the most suitable medium to employ as a foundation to which the various chemicals, colours, etc., could be added. During the experiments the substances were watched and the numbers of flies feeding counted at intervals during the day.

The results showed that on the whole the sexes came to the baits in approximately equal numbers.* More females, however, were noticed at foods containing a few drops of ammonia; although when ammonia, or ammonia and water, were exposed alone, this was apparently not the case. When casein and honey baits were exposed, more females generally came to the former. Again larger numbers of females were always seen frequenting the breeding saucers, containing mixtures of casein, bread, water and banana. This was however to be expected, and confirms the results obtained by Gordon Hewitt for wild flies and those found in houses.†

* The sexes emerged in approximately equal numbers.
† C. Gordon Hewitt, "The House-Fly."

Some results giving percentages of the sexes coming to various baits are given below in Table I.

TABLE I.

	♂	♀		♂	♀
Potassium iodide	9	7	Boric acid	4	4
Potassium sulphate	10	2	Control (honey + water) ..	2·5	2·5
Casein control	17	14	Ammonia + honey + water	25	25
Sodium sulphate	10	4	Ammonia + sand	10	10
Sodium iodate	4	0	Ammonium sulphocyanide ..	3	3
Sodium phosphate	5	4	Ammonium sulphate	2·5	2·5
Honey + methylene blue ..	20	14	Sodium acid phosphate ..	2·5	5
Honey + cochineal	14	10	Honey + water	3	11
Honey + thiosinamine ..	3	1	Ammonia + honey	13	18
Ammonia	11	8	Casein mixture + thiosinamine	1	4
Ammonia alum	14	10	Casein mixture (control) ..	4	15
Ammonium carbonate ..	36	8	Ammonia + brown sugar ..	57	87
Ammonium tartrate	21	14	Ammonia + casein mixture ..	21	29
Sodium phosphate	5	5	Ammonium nitrate	3	5
Potash alum	2	2			

The most suitable medium for use in the experimental tests was found to be the casein mixture, since this was attractive to *Musca* and not disliked by the other species; the mixture consisted of equal parts of casein, sugar and banana, to which a solution of the substance to be tested was added, or if insoluble, it was stirred up in water and then mixed into the casein, etc.

Some experiments were also made with various flowering plants and vegetables on free flies, to see if any of them would be of practical use against flies, either to attract them or to keep them off. For this purpose 46 different kinds of plants were used, but none of them had any practical value as attractions or deterrents. The flies, however, discriminated between them, showing preferences for some and dislikes for others; this was especially marked in the case of Aaron's Rod or Golden Rod (*Solidago virga-aurea*), which attracted large numbers of blow-flies (*Lucilia, Calliphora* and *Phormia*), although to the vast majority of the plants they appeared to be indifferent. Tomato fruits, cut in half, were visited by considerable numbers of *Phormia*; and over-ripe apples and rotten carrots attracted many *Lucilia, Calliphora* and *Phormia.*

Alcoholic and water extracts, also, were made from some of these plants that seemed to be the most attractive or disliked. These were tested as baits, as well as being sprayed upon captive flies in balloon traps. But in neither case were results of any practical value obtained. The following is a list of the plants from which extracts were made :—Ragwort (*Senecio jacobaea*), flowers and leaves of sweet gale (*Myrica gale*), lettuce (*Lactuca*), flowers and leaves of tansy (*Tanacetum vulgare*), and tomato fruit (*Solanum lycopersicum*).

Experiments were also carried out with various groups of organic and inorganic compounds, to find out whether any of them would be suitable to use as baits, poisons or deterrents.

The substances to be tested were generally added to casein mixtures, or pieces of blotting paper were soaked in them. In most cases they were exposed to free flies, as well as being fed to those confined in glass cylinders or otherwise. They were kept under as continuous observation as possible for one or more days, during which time counts were made at intervals of the number of males and females which were feeding, or which had died during the experiment.

The results showed that although many of the substances attracted a certain number of flies, yet none of them were so attractive that all the flies present went to them. Sodium iodate showed the greatest possibilities of being a good poison, if it were not for the expense; for when quite small quantities were mixed with the baits and the flies fed upon them, they died very quickly—in some cases 99 per cent. were dead in 21 hours. It was found however that the flies apparently fed upon baits containing sodium iodate only when they were very hungry, or when no other more attractive foods could be obtained. The results from the experiments with sodium iodate are given below in Table II. It was also tested against similar amounts of formalin, when very many more flies died than with the latter.

The substances were mixed with 20 c.c. of water and then added to 10 grms. of a mixture containing equal parts of casein, sugar and banana. The counts of dead flies were made 21 to 22 hours after the baits had been exposed.

Table II.

Sodium iodate.		*Formaldehyde* (40 *per cent.*).	
2 grms.	90 per cent. dead.	2 c.c.	42 per cent. dead.
1 ,, ...	99 ,, ,,	1 ,, ...	19 ,, ,,
0·5 ,, ...	99 ,, ,,	0·5 ,, ...	4 ,, ,,
0·4 ,, ...	99 ,, ,,		
0·2 ,, ...	79 ,, ,,		

The results with mineral and tar oils further confirmed the importance of oils for use as repellents; they still appear to be the substances which house-flies dislike most. In the experiments made none came near any of the baits to which a few drops of these oils had been added.

The essential oils, also, were on the whole repellent to the different flies, although their degree of distastefulness varied according to the species, and also with the length of time of exposure. The distastefulness was found to be greatest at first; in many cases it had quite disappeared after the preparation had been left out for a number of hours.

The oils of cloves, geraniol, cummin, sassafras and cinnamon bark were found to be the most repellent to house-flies.

In Table III will be found a comparison of the relative attractiveness of the different substances for the different species, summarising the results obtained in the foregoing experiments.

It is seen that the tastes of the different species are not identical, though in many cases the same substances are liked or disliked by them, this is especially noticeable with regard to oils and distasteful substances.

In these experiments 2 grms. or 2 c.c. of the substances were added to 20 c.c. of water and then mixed with the control bait (equal parts of casein, brown sugar and banana) so as to make a paste, except in the case of essential oils, of which a few drops only in water were added to the bait.

Table III.

Comparison of the results of offering various baits to different species of flies.

Explanation.

1 = 1– 9 per cent. of the flies feeding when counted.
2 = 10–19 ,, ,,
3 = 20–29 ,, ,,
4 = 30–39 ,, ,,
5 = 40–49 ,, ,,
6 = 50–59 ,, ,,
7 = 60–69 ,, ,,
8 = 70–79 ,, ,,
9 = 80–89 ,, ,,
10 = 90–100 ,, ,,
A dash indicates that no test was made.

Bait.	*Musca.*	*Calliphora.*	*Lucilia.*	*Phormia*	*Sarcophaga.*	*Fannia.*
Potassium iodide	2	—	—	—	—	—
,, alum	1	—	—	—	—	—
,, sulphate	2	—	—	—	—	—
,, ferrocyanide	0	—	—	—	—	—
,, chlorate	many	—	—	—	—	—
,, permanganate	many	—	—	—	—	—
,, metabisulphite	0	1	1	1	0	1
Control bait	many	—	—	—	—	—
Sodium sulphite	2	—	—	—	2	1
,, iodate	many	—	—	—	—	—
,, sulphate	many	—	—	—	—	—
,, acid phosphate	1	—	—	—	—	—
,, phosphate	1	—	—	—	—	—
,, chloride	few	—	—	—	—	—
Pyrethrum extract	2	7	3	2	2	1
Aqueous skatol soln.	1	3	1	1	3	0
Amyl. acetate	0	1	1	0	0	1
Artificial milk	1	0	—	3	0	1
Nicotine (1 per cent.)	4	1	1	3	0	0
Balsam of Peru	1	0	0	0	0	0
Cannabis indica	1	0	0	0	1	0
Controls	2	—	—	—	—	—
Valeric acid	0	—	—	—	—	—
Ammonium butyrate	0	0	0	—	—	—
Ammonia	—	2	1	8	3	0
Ammonium nitrate	1	1	1	1	0	1
Ammonia + honey	5	—	—	—	—	—
Boric acid	1	—	—	—	—	—
Methylene blue + honey	4	—	—	—	—	—
Cochineal + honey	2	—	—	—	—	—
Water + honey	5	—	—	—	—	—
Thiosinamine + honey	1	—	—	—	—	—
Aniline hydrochloride	0	—	—	—	—	—
β Naphthol on filter paper	1	2	—	—	—	—
Piperozine on filter paper	0	1	—	—	—	0
Ammonium sulphocyanide	0·5	—	—	—	—	—
,, tartrate	2	—	—	—	—	—
,, alum	3	—	—	—	—	—
,, carbonate	5	—	—	—	—	—
,, sulphate	1	—	—	—	—	—

TABLE III.—*cont.*

Bait.	*Musca.*	*Calli-phora.*	*Lucilia.*	*Phormia*	*Sarco-phaga.*	*Fannia.*
Oil of verbena	1	0	0	2	—	—
Palma rosa	1	0	0	0	—	0
Peppermint	1	0	2	1	—	0
Control	2	—	—	—	—	—
Heliotrope	1	0		—	0	0
Citronella	1	0	3	—	1	0
Camphora	1	4	1	1	—	1
Santal	0	0	1	—	—	0
Cassia	0	0	0	2	0	0
Java citronella..	0	0	0	0	0	0
Sassafras	0·5	0	0	1	0	0
Cummin	0	1	0	—	0	—
Geraniol	0	0	0	—	0	0
Anisol	0	0	0	0	0	0
Cinnamon bark	0	0	0	0	0	0
,, leaf	0	—	—	—	—	0
Ceylon citronella	0	—	—	[9]	0	0
Lavender	0	1	4	—	—	—
Control	many	6	7	—	—	—
,, ...	2	10	10	—	—	—
,, ...	—	9	8	0	—	0
Camphor	—	4	0	0	—	2
Honey	—	4	4	3	—	2

Effects of colours on flies.

A large number of experiments were made in order to see whether the flies showed any special preference for a particular colour or colours. Their colour-preference was tested by means of coloured foods, coloured light, and coloured materials.

Amongst the various ways of colouring the baits that were tried, the most satisfactory one was to mix them with powdered chalks of different colours (*i.e.*, red, blue, orange, green, white, yellow and purple). It was thus possible to compare the effect of the different colours under the same conditions, without any complications due to the effect of the different colouring matters employed, as was the case when various stains, etc., were used as colouring agents.*

In these experiments the different coloured chalks were thoroughly mixed into the baits, which consisted of honey, or mixtures of casein, sugar, banana and water. They were then fed, singly or in pairs, in all possible permutations and combinations, to flies confined in glass cylinders, and to free flies. In some of the experiments, however, baits of all colours were introduced into the cylinders at the same time. They were kept under as continuous observation as possible, and the numbers of males and females feeding upon the different colours were counted at intervals during the day. The flies were as a rule driven off after each count.

Controls consisting of the same number of casein or honey baits, uncoloured, were fed in the same permutations and combinations. It was thus possible to compare the results, and the numbers feeding on the different colours, with those feeding

* When the baits were coloured by stains, etc., methylene blue, eosin, red lead, white lead, and lead chromate, were amongst those found to be very attractive, while cochineal and picro-nigrisin were very distasteful to house-flies.

on the similarly arranged controls ; and hence one was better able to judge whether the flies were attracted by the colour, or simply came for the food.

The number of flies coming to the differently coloured foods was approximately equal. The same was found in the controls ; showing that the flies came more or less haphazard to the baits, and were not attracted by any particular colour.

The effect of colour was further tested by means of coloured light. Wratten filters were attached to one side of a large glass cage, the other sides of which were darkened, so that light could only enter through the filters. In some of the experiments casein, and in others honey baits, reaching the whole length of the cage, were so arranged that some part of them was illuminated by light from each of the filters. Different species of flies, *i.e., Musca, Calliphora, Lucilia, Phormia, Fannia* and *Sarcophaga,* were then introduced and kept under observation, and their behaviour towards the different colours noted, as well as the numbers feeding or settling upon them. The results were negative, as in the preceding experiment.

Further experiments testing the colour-sense of flies were made with different coloured materials. These were placed in different parts of the fly-room and kept under observation, and the number of flies settling upon the various colours noted. In order to avoid error due to differences in texture, pieces of the same material were dyed different colours. The results again showed that the flies (*Musca*) had no preference for any particular colour, and that the choice of material upon which they settled was governed not by colour, but by some other factor or factors, *e.g.*, probably texture, position, temperature, or curiosity, etc.

Temperature.

It is known generally that house-flies are influenced by differences in temperature and that they prefer warm situations, but precise experiments to determine their optimum temperature, and the maximum and minimum temperature at which they will feed, appear to be lacking ; and it was to remedy this, that the following experiments were made. This liking of house-flies for warmth was well shown in the way they congregated in large numbers round the lighted Bunsen-burner, sitting round it in a very definite circle, the size of which varied according to the distribution of the heat. This was easily tested by placing larger, or smaller pieces of asbestos over the flame, when the flies arranged themselves in larger or smaller circles respectively (Plate X, fig. 1). The temperature of these circles was found to be very constant, varying between 42°–44° C. If the gas was turned off the flies ceased to sit in the ring, but came closer in to the base of the burner, up the stem of which they often crept (Plate X, fig. 2), until finally, when it was no longer warm, they dispersed and settled anywhere in the room. As soon as the gas was re-lighted, however, they formed a circle round it once more.

After a number of preliminary experiments in testing baits at different temperatures, in which however it was not possible to keep the temperature constant for any length of time and thus not possible to determine it accurately, the following apparatus was set up, in order to find the optimum, maximum and minimum temperatures at which house-flies would feed. This apparatus (Plate XI, fig. 1) was designed so that the temperatures of the baits could be regulated and kept constant for a certain time.* The baits (casein mixture or honey) were smeared in thin layers upon the outsides of the test tubes (*a-a*) which were kept at a constant temperature for a length of time, by circulating water throughout the series of vessels by means of siphons; the rate of flow being regulated by stop-cocks. The water in the flasks (*b-b*) was heated or cooled as required, and flowed into the test-tubes (*a-a*) and heated or cooled the baits. The flasks were kept filled by water from the breffits (*c-c*). In order to keep the temperature of the test-tubes as constant as possible, it was necessary to allow only water of constant temperature to enter them. This was done by regulating the amount of water flowing into the flasks from the vessels, and from them into the test-tubes. The water escaping from the test-tubes was also regulated, so that the quantity of water entering and leaving the test-tubes and flasks neutralised each other, and thus kept the temperature of the test-tubes and baits constant. In this way it was possible to keep the baits at different temperatures and to compare the numbers of flies feeding upon them with those on the control (at room temperature). They were kept under observation, and the numbers of flies feeding on each of the baits at different temperatures was recorded at short intervals during the day.

The results obtained from a number of experiments showed that the largest number of flies (*Musca*) came to feed on the baits at temperatures of 38°–48° C., while the highest and lowest temperatures at which they were seen to feed on the baits were respectively 55°–58° C.; and 10°–13° C.

Humidity.

It is generally supposed that the amount of moisture in the atmosphere makes a difference in the attractiveness of certain substances for flies and affects the numbers coming to various baits, formalin in particular being apparently so affected. A number of experiments were made to test this, which were chiefly carried out in the greenhouse. But owing to various practical difficulties and also to lack of time, it was not possible to draw any definite conclusions. The general impression was that most foods, especially when very moist, were more attractive to the house-flies on dry than on wet days.

Again flies, and more particularly blow-flies, were found to be able to stand a greater amount of moist than dry heat. The blow-flies bred in the greenhouse (which became very hot and dry in the day-time in the summer) throve if the air was kept moist, but died if it became dry. This applies to the maggots as well, but was more marked in the case of the flies. Without water house-flies were able to live only one or two days.

Experiments to discover the cause of the reactions of flies to the various sense-impressions.

Experiments were made with a view to discovering what causes flies to react as they do to sense-impressions, and whether sight or smell plays the principal part in attracting or repelling them to baits, etc.; therefore, (*a*) various foods were covered in different ways, (*b*) the eyes of the flies were painted over, and (*c*) their antennae cut off; and their behaviour was then noted when the various substances were fed to them.

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* My thanks are due to Mr. F. M. Howlett for many suggestions in the setting-up of this apparatus.

Covered foods offered to house-flies (unconfined).

In the experiments testing covered and uncovered foods a series of preliminary experiments with free *Musca* was made to find out the effect of covering food in various ways; the results obtained were further tested by several series of experiments, in which different foods were covered in the same way.

In all the experiments the behaviour of the flies was noted, and the numbers which came to feed were counted from time to time.

In the preliminary experiments sight tests were made (*a*) by using covers of transparent materials (glass, talc, mica, celluloid, and gelatine) in order to test the reactions of the flies to varying degrees of opacity, through which it was presumed the smell could not penetrate (none could be detected by me); and (*b*) by using covers of muslin, through which the smell could pass.

The following results were obtained. In the controls, with uncovered baits, very many flies came to feed.

(*a*) When the baits were covered by glass plates, a few flies settled upon them as a rule, and sometimes appeared to be trying to get at the bait, especially when it was touching the glass. They never came to these covered baits, however, in the same proportion as to the uncovered ones. They also appeared able to distinguish between dishes containing baits and empty dishes, when both were covered by glass; for when empty dishes were exposed, the flies did not, as a rule, come to them at all. Very similar results were obtained when the baits were inserted inside blown glass bulbs and placed among confined flies, and also when they were covered by talc, mica, gelatine and celluloid.

(*b*) When the baits were covered with muslin, more flies settled upon these covers than on the glass, and the flies generally appeared to be trying to get at the food inside. They seemed able to distinguish between attractive and repellent foods so covered; for in the latter case, those circling round the baits never settled.

Free blow-flies also were seen to behave in a similar way. They were strongly attracted to decaying meat covered by muslin, coming to it from a considerable distance.

In the subsequent series, various foods and other substances, covered in the same way, were exposed at the same time, to see whether the flies could distinguish between the different contents of the dishes. When the baits were covered by glass, celluloid, or gelatine, the flies settled upon all, although larger numbers came to the covers of the dishes containing attractive foods.

When muslin covers were used, the flies appeared to be able to distinguish more easily between the contents of the dishes, since many more flies settled upon the covers of those containing attractive foods, although a few settled for a short time upon all, except those containing very repellent substances, *e.g.*, oils, etc., to which none came.

Confined house-flies with painted eyes.

In these experiments the eyes of the flies were coated over so as to prevent their seeing what substances were fed to them and thus test the intensity of their sense of smell.

The varnishes used were (*a*) gelatine heated in water, which was first painted over the eyes, and when nearly dry a drop of absolute alcohol was added to coagulate it, and finally, when quite dry, this was painted over with water-proof Indian ink, to make it opaque ; or (*b*) a saturated solution of shellac in absolute alcohol in which light green stain was dissolved was painted over the eyes.*

The eyes were examined very carefully before and after each experiment, to see that they were completely covered, for the flies were sometimes able to rub up the edge of the varnish, in which case the whole cap of varnish peeled off. If this was found to have happened, the results were rejected.

In these experiments the flies in nearly all cases behaved rather abnormally, being less active than normal flies and spending a great deal of time, especially at first, in trying to rub off the varnish. They paid little attention to the baits, although they sometimes came down to feed. They appeared able to tell attractive from repellent foods, feeding upon the former, though in less numbers than normal flies, and leaving the latter alone.

Similar results were obtained when *Calliphora* and *Lucilia* were used.

Confined house-flies with antennae cut off.

The flies after their antennae were cut off appeared able to detect differences in foods, and to be able to distinguish between attractive and repellent substances, coming to feed on foods which were attractive to normal flies, although they appeared to take less interest in them than normal flies, and avoiding those which were disliked. This was particularly noticeable when a few drops of the different mineral and tar oils were added to the baits. It was also noticed that the antennae-less flies seemed to lose to a certain extent their sense of balance, falling over on their backs more frequently than normal flies ; they also experienced greater difficulties in getting up again.

Very similar results were obtained with blow-flies (*Lucilia* and *Calliphora*).

Note on the life-history of Fannia.

In order to discover the length of time of the larval and pupal stages of *Fannia*, the eggs were kept under observation ; some began to hatch after one day, and all had hatched by the 3rd day. Unfortunately oviposition was not actually observed, hence the eggs may take longer than 1–3 days to hatch out. It was noticed that if they became too dry, they did not hatch out, and that if they were moistened with a few drops of water they hatched more quickly, the longitudinal split often beginning immediately the water was applied. The larval stage lasted 11–21 days, giving an average of 14–15 days. The pupal stage lasted 13–34 days, giving an average of 21–22 days. The largest number of flies emerged, however, after 19–26 days. The total number of flies which emerged was 70–100.

* It was not at all easy to make the varnish remain on the eyes, chiefly because the flies were always trying to rub it off. However, after various trials the above two comparatively satisfactory ones were obtained. My thanks are due to Mr. F. M. Howlett for many useful suggestions in connection with these varnishes. In order to prevent the flies from rubbing off the varnish before it was dry, they were at first held in the hand, but as drying was often a long process, they were often placed in paper pillories for convenience in handling.

The experiments were carried out in a laboratory, the average temperature of which was 17·5° C. The eggs, maggots, etc., were kept in a glass cylinder covered with muslin. The maggots and flies were fed on banana, and the casein, sugar, banana and water mixtures. In many cases the maggots were isolated as soon as they had pupated, being placed in small glass bottles inside the cylinder.

The eggs were found laid on the inside of a banana skin (Plate XI, fig. 2)* on the 13th August 1916. The maggots hatched out from the 14th to 17th August. They began to pupate on the 25th and 26th August and all had pupated by 4th September. The flies began to emerge on the 7th, the largest numbers emerging together on 23rd and 24th September, while all had emerged by the 3rd October 1916.

Summary.

1. There appears to be a general similarity in the tastes of the different species with regard to various chemicals and foods; the tastes of *Musca domestica* and *Phormia azurea*, in many cases, being found to approximate most nearly. It will be interesting to discover whether there is a closer correspondence between the sense-organs of these flies than between these of other species.

2. These experiments emphasise the extreme curiosity of house-flies, and again show the catholicity of their tastes and the difficulty of finding any substances which will either attract or repel all those that come near it. The mineral and tar oils seem to be amongst the most repellent substances. With regard to poisons, good results were obtained with sodium iodate, large numbers being killed when very small amounts were used, although it did not always attract many flies. Sodium iodate has the disadvantage of being very expensive. But further experiments require to be made before any definite conclusions can be arrived at as to the importance of the iodates of sodium and other metals as poisons for general use.

3. House-flies were not found to show any colour-preference.

4. For house-flies the optimum temperature was found to be between 36°–44° C., the maximum and minimum between 55°–58° C. and 10°–13° C., respectively.

5. It appears that curiosity plays an important part in causing house-flies to come to baits and to investigate traps, etc., although the senses of smell and to a less extent that of sight are also concerned; the former, however, to a much less extent than it is with blow-flies, and it appears to be most used when the flies are close to the baits.

* The eggs of *Fannia* were invariably found laid singly on the insides of banana skins, while those of *Musca* were found either on the cut surface or sides of the banana, or in the cracks between the pulp and the skin.

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Fig. 1. A saucer containing breeding materials, maggots and pupæ of *Musca domestica*.

Fig. 2. An attractive bait, consisting of part of a banana, which is almost completely covered.

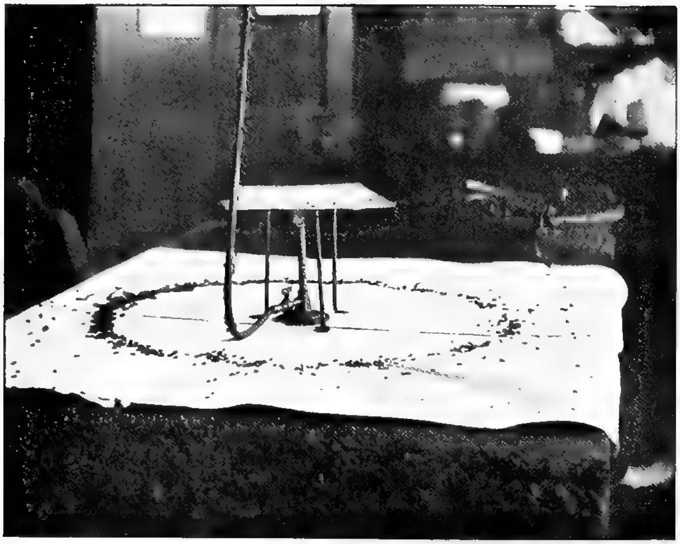

Fig. 1. Flies collected in a ring round a piece of heated asbestos.

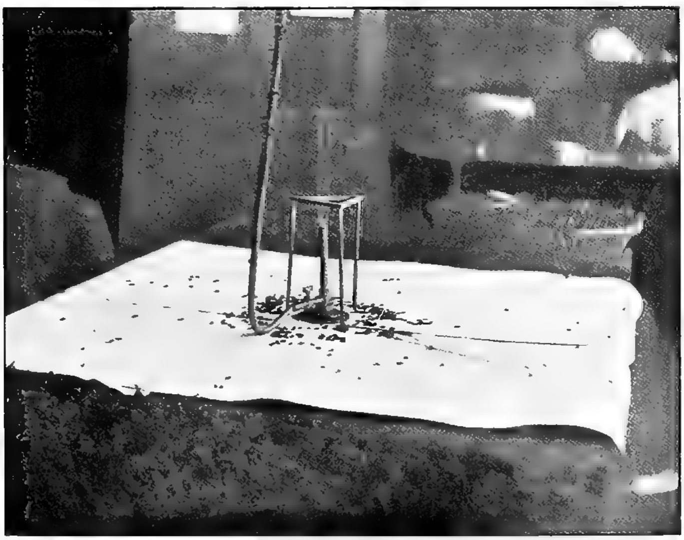

Fig. 2. Flies approaching the burner when the heat has been reduced by the removal of the asbestos.

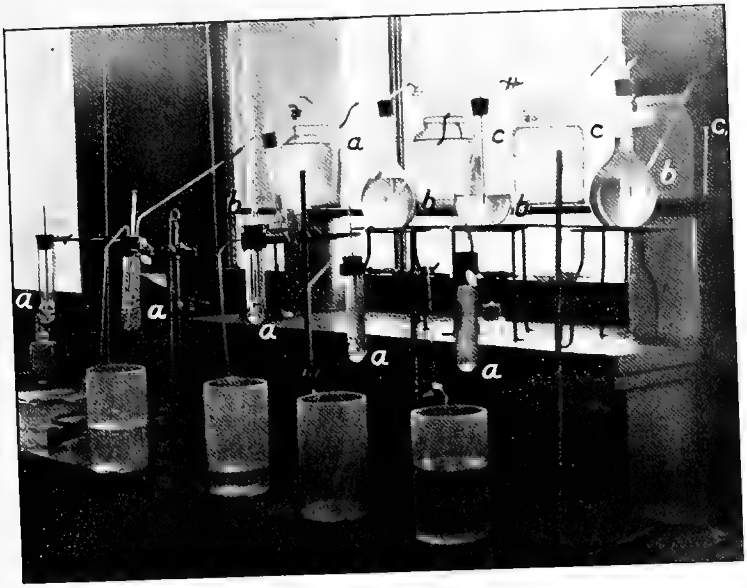

Fig. 1. Apparatus for testing variations in the temperature of the baits for flies (*Musca domestica*).

Fig. 2. *Fannia* eggs laid on a banana skin.

NOTES ON SOME BLOOD-SUCKING AND OTHER ARTHROPODS (EXCEPT CULICIDAE) COLLECTED IN MACEDONIA IN 1917.

By James Waterston, Lieut. R.A.M.C.,

Entomologist to the Malaria Commission, Salonika.

In the course of the operations for controlling mosquitos on the Macedonian front some time, necessarily limited, was devoted to collecting parasitic or noxious arthropods, and a list is here given, more particularly of those affecting man. One or two other noteworthy species are also recorded.

Anoplura.

Trichodectes subrostratus, N.

Very plentiful on a kitten, Kalamaria, 8, xii.

Pediculus capitis, De G., *P. humanus*, L., and *Phthirus pubis*, L.

All occur. The last not commonly met with.

Polyplax spinulosa, Burm.

Several on a young rat, Kalamaria.

Rhynchota.

Geocoris albipennis, F.

Twice, at widely separated places, I was bitten by individuals of this species. Fortunately, on the second occasion the insect was secured without damage. Lahana, ix.

Cimex lectularius, L.

One of the pests of Macedonia; only too common in wooden huts. This species drops on one's bed from roofs, unless prevented by mosquito netting.

Diptera.

Phlebotomus papatasii, Scop.

Common at Kalamaria round electric lamps in huts, and also at Karasouli and Cidemli; on the Struma at Sakavca, etc.

Phlebotomus perniciosus, Ann.

5 ♂ 14 ♀, Karasouli and Kalamaria, viii.

Simulium sp.

In hill streams near Lahana, Paprat and Oreovica larvae of one or more species of this genus were obtained, but attempts to rear the imago were unsuccessful.

Pangonia marginata, F.

♀ (Capt. A. G. Carment).

Pangonia sp.

♂, ♀, near *variegata*, F., but possibly representing two distinct species (Capt. Treadgold).

Chrysops coecutiens, L.

2 ♀, near Salonika, vii.

Chrysops italica, Mg.

♀, Mikra, Experimental Farm, on donkey, vii.

Chrysops perspicillaris, Lw.

♀, near Salonika, vii. Taken also by Capt. Carment.

Chrysops quadrata, Mg.

♀, Karasouli, vii.; 2 ♀, Mikra, Experimental Farm, on donkey, vii.

Tabanus ater, Rossi.

2 ♀ (Capt. Treadgold).

Tabanus autumnalis, L.

♀, Mikra, Experimental Farm, on donkey, vii.

Tabanus bovinus, L.

♀, near Salonika, vii–viii. Taken also by Captains Carment and Treadgold.

Tabanus glaucopis, Mg.

♀, Karasouli, vii.; 2 ♀, Lahana, viii.

This species frequently sheltered on the inside of our tents during the heat of the day.

Tabanus graecus, F.

♀ (Capt. Treadgold).

Gastrophilus equi, L.

2 ♀ captured and others observed on pony, Lahana (Capt. Boyle).

Stomoxys calcitrans, L.

In latrines at Lahana and Karasouli. Also not uncommon in horse and mule lines, *e.g.*, near the beach at Kalamaria.

Morellia hortorum, Fall.

2 ♀, off donkey, Mikra. Mr. Collin notes that these examples differ from typical *M. hortorum* in having the dorso-central bristles immediately behind the thoracic suture shorter and weaker than the others.

Musca sp.

♀♀, off donkey, Mikra. This undetermined species, which comes close to *M. lusoria*, Wd., occurred in numbers. Like the *Morellia*, it fed on the animal's festering sores and at wounds made by *Tabanus*, whenever the latter flew off. While a *Tabanus* was feeding the *Musca* would take up their position an inch or so below the puncture and drink up the blood that ran down.

Musca vitripennis, Mg.

♂, off donkey, Mikra.

Musca domestica, L.

During the last week of October and for the first ten days of November flies proved extremely troublesome in one area. Owing to the heat, presumably, they drank freely a 5 per cent. mixture of formalin and water, with a little sugar added. Large numbers were killed in this way, and multitudes more were accounted for by burning, swatting, trapping (both balloon and the Japanese revolving traps were used), and spraying. For the latter purpose I found that an aqueous solution of formalin 5 per cent. was in use. This certainly killed the flies, but a good deal of fluid was required, since all the flies touched were not properly wetted, and those that were knocked down crawled about for some time. For the formalin mixture the following emulsion was substituted :—$\frac{1}{4}$ lb. bar soap boiled till dissolved in $\frac{1}{2}$ gallon of water; when dissolved, $\frac{1}{2}$ gallon of paraffin was slowly added, and $\frac{1}{2}$ pint of mixed ketones [incorporated in the same way. This mixture was quite effective, but the ketones smelt rather strongly and discoloured clean wood-surfaces.

Later a second formula was tried: $\frac{1}{4}$ lb. soap, $\frac{1}{2}$ gal. water and 1 gal. paraffin. Used pure, this killed almost instantaneously, and not a fly touched escaped. Subsequently, the same emulsion, diluted to half strength, was used and worked excellently, although the flies crawled about sometimes for a minute after being knocked down. None, however, were seen to recover. The use of an emulsion was indicated because of the danger of fire had pure oil been sprayed. The formula, I may add, was purely empirical, and my only object in recording these facts now is to suggest that it may be worth while to investigate the constitution of a suitable emulsion spray for flies, and particularly to ascertain what should be the minimum oil content of such a mixture. A little clean boiling water should be passed through the nozzle of the sprayer after use, to obviate clogging with dried emulsion.

Lucilia sericata, Mg.

Abundant. Reared also from larvae found in carrion on the Struma. This species formed a considerable part of the daily catch in fly traps.

Hippobosca capensis, Olf.

♀, Lahana, off mule, ix.

Hippobosca equina, L.

♀, Kalamaria, vii; ♀, Lahana, ix, off mule. Not uncommon in horse and mule lines. Taken also by Capt. Carment.

[*Olfersia ardeae*, Macq.

A number of specimens of what I believe to be this species were observed on a young Purple Heron (*Ardea purpurea*) shot on the Giol Ajak about two miles from the top of Lake Ardzan. These flies were extremely active and all evaded capture.]

Ornitheza ?metallica, Schin.

♀, on partridge (*Perdix perdix*), Lahana, ix.

Siphonaptera.

Pulex irritans, L.

Kalamaria, Salonika, etc., on dogs.

[*Xenopsylla cheopis*, Rothsch.

Dr. Jolly informs me that this species has been identified in Paris from examples which he has forwarded from plague-stricken rats dying in Salonika.]

Ctenocephalus felis, Bouché.

Kalamaria, on dogs.

Acarina.

Laelaps echidninus, Berl.

♀, on young rat, Kalamaria.

Liponyssus saurarum, Oud.

A dozen from under the throat-scales of Green Lizard, Lahana, 27.viii.

For assistance in determining the above-mentioned species I am indebted to the following friends:—Messrs. J. E. Collin, S. Hirst, G. A. K. Marshall, and R. Newstead.

ON A PARASITIC DROSOPHILA FROM TRINIDAD.

By C. G. Lamb, M.A., B.Sc.,
Clare College, Cambridge.

The material for this paper was forwarded to the author by Dr. Guy Marshall, of the Imperial Bureau of Entomology, and was collected by Mr. C. B. Williams.

The insects were said by him to be parasitic on a Cercopid of the genus *Clastoptera*, which was found attacking cacao trees. This highly unusual habit gives much interest to the species. Unfortunately the number of individuals sent was quite inadequate to enable one to deal satisfactorily with such small and obscure insects, especially as shrivelling takes place to a different extent in various individuals, which renders the provision of a reasonably large number more necessary than in more normal forms of fly. The individuals sent included three pinned ones of a species from Trinidad (West Indies), and one pinned one of a species from Panama, together with the fragments of two others of the latter species in spirit. In spite of the paucity of material, it was felt to be desirable to put on record as fair a description as could be made under the circumstances. Two of the individuals of the Trinidad species were of one sex, and the third was apparently the other sex of the same species. The two former had all the appearance of representing the male, having

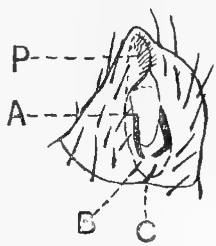

Fig. 1. Terminal segments of *Drosophila paradoxa*, ♀, viewed obliquely from below, × 70; explanation in text.

brighter eyes, darkened wings, and the general facies of that sex. The genitalia were small and hidden in a terminal hood, such as is found in *Drosophila melanogaster* and *Leucophenga maculata*, but it was smaller than in either of these, even than in the latter, in which the hood is only moderately open at the tip, while widely so in the former. In both these species the genitalia can be seen inside the hood, but in the present species only the tips of the fleshy processes are visible. Still, as far as things can be made out without destroying the specimens, they will pass for males. The desirability of having a few spare individuals available for dissection is very great, as otherwise points of this sort have often to be left in some uncertainty. Very little doubt would have been felt on this matter had it not been for the unusual characters possessed by the third specimen. On the lower surface of the abdomen are borne some truly remarkable chitinous hooks; in fig. 1 is shown a somewhat diagrammatical representation of the terminal segments viewed obliquely from beneath. The last segment is large, and is hollowed out in a shallow pocket whose boundary is shown by a dotted line. Towards the tip of the abdomen this pit is bounded by a very hairy elongate papilla (P), which is very like the similar hairy prominences so usual in females of this family. It is well marked and definite, and can be just seen projecting beyond the end of the body when the insect is viewed from above. Inside the shallow pocket lie two very stout sharply bent chitinous rods, each being L-shaped, attached by the longer arm of the L to the bottom of the pocket (A) with the pointed end (B) of the rod pressing against the ventral surface. Between the rods the floor of the pocket is somewhat arched. Forward of these rods arises a fine sharp chitinous rod, slightly curved, based as at C, with the sharp point projecting backwards. The presence of these appendages causes much difficulty. But for them, the general appearance of the insect, the points in which it differs from the other two, the external form of the abdomen, &c., are such that one would have had little hesitation in considering it to be the female of the other two specimens. Remarkable chitinous appendages occur in some male Drosophilids; for example, *D. obscura* possesses an extraordinary five-branched chitinous appendage projecting forwards from the last segment, and other species seem to possess such structures, though not so highly specialized in form. This process is apparently the penis. Most males show no signs of such external appendages, but it is possible that in such cases they are small and internal, though all that can be seen consists of various complex fleshy processes. The question is one well worthy of investigation, and the author is hopeful that Dr. Keilin (of the Quick Laboratory, Cambridge) may be able to devote a little of his unexampled skill to the elucidation of this point in some of our more common species. These chitinous processes are, as far as one knows, all median and single. The female genitalia are apparently nearly always simple in structure and of soft tissue, but exceptions occur in some cases. Thus, in *Scaptomyza graminum* the abdomen is provided with two chitinous processes which look like tiny saws, and in a mount they are seen to be truly saw-like external appendages with sharp bordering teeth. Hence the presence in the female of paired chitinous appendages is proved in certain species of the family, and thus the objection to the present insect being a female (owing to their presence) is of less weight. In fact, it is possible that they are homologous with the saws of *Scaptomyza*, and have been modified in some way to suit the parasitic habits of the present species. The median process is so inserted and so orientated that it is highly improbable that it is a male organ. It might, indeed, be argued that we have before us the males of two different species, but a close and critical comparison was made of the Trinidad specimens, and the agreement in chaetotaxy, venation, and nearly all the external characters is so very close, that nothing warranting such a conclusion is apparent. Hence, for the present, the only thing to do is to consider the two similar individuals of the Trinidad species to be males, and the third to be a highly aberrant type of female of the same species.

It may be as well to add a few words concerning the Panama species, as little can be said later on. The pinned example was rather shrivelled, and so bent as to make critical examination almost impossible, hence it can only be described in a rather superficial manner. As far as outside appearance went, both the pinned and the spirit specimens were females. Hence the latter fragments were given to

Dr. Keilin, who made a mount of them with especial reference to the genitalia. As far as can be judged, they are fairly typical females, with absolutely no sign of the external appendages found in the first species. There is evidence of paired and unpaired chitinous processes in the mount, but they are all internal. Hence the matter must, for the present, be left in abeyance pending further investigation on several forms.

The description of the Trinidad species is as follows :—

Drosophila paradoxa, sp. nov. (fig. 2).

A minute species, well under 2 mm. in length, exhibiting broadly the usual appearance of the small pale yellow species, except for having darkened wings. The whole insect is pale yellow, including the legs, except for a slight darkening of the tip of the abdomen.

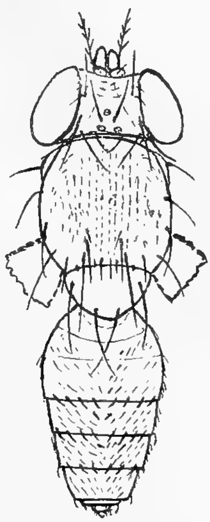

Fig. 2. *Drosophila paradoxa*, Lamb, sp. n., × 30.

♂. Head (fig. 3): frons all shining, the central triangular area (bounded by the dotted lines in fig. 2) being slightly depressed, with three pairs of small converging hairs on the boundary lines. The chaetotaxy is quite normal, as figured; the small front bristle of the outer f.o. row is just in the same line with the large inner f.o. (the position of this small f.o. bristle is a useful character in the genus). The bristles are all somewhat exceptionally stout and are golden brown in colour; the ocelli are bright red. The eyes are well rounded, as shown in fig. 3; under a power of 40 diameters a very sparse and scattered pubescence can be seen. The concave hind head is also entirely yellow. The antennae (fig. 3) have the first joint quite hidden by the lunular ridge; the second joint is globular and has a few bristles, an especially long one at the base, and another towards the front; the third joint is rounded in profile, but somewhat pointed when viewed from in front. It will be seen that the antennae are absolutely approximated at the base, there being no vestige of the facial keel so common in these small yellow species, and indeed the face is but slightly arched from eye-margin to eye-margin. The antennal joints are wholly pale yellow. The arista (fig. 3) has four upper rays, a terminal ray and one apical lower ray, but none on the basal part; under a power of 90 diameters one can just see a few of the usual inner row of tiny rays. The arista is bright yellow up to just beyond the insertion of the second upper ray; the rest, together with all the rays, is black. The mouth vibrissae are single and very strong, and the stout bristles on the jowls (lower and hind) are quite strikingly developed. The buccal opening is somewhat unusual in structure. In the normal Drosophilid mouth, if one looks straight into it from below, one will see the fulcrum in the form of an elongate arch widely separated from the actual mouth-edges by the membranous sides which join it to the same. In the present species the fulcrum follows closely and exactly the mouth-margin, so that its long axis is across the mouth, instead of axial, and in fact there appears to be no room for the membranous connections, and hence

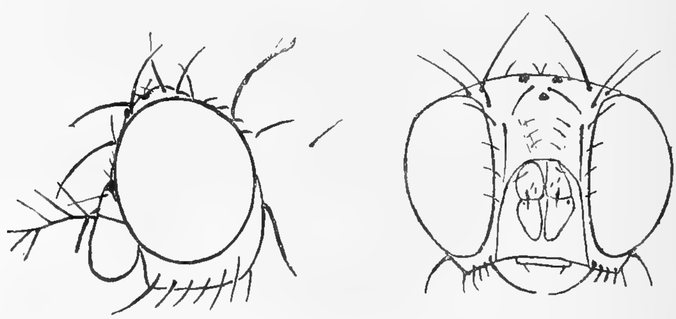

Fig. 3. Lateral and front views of head of *D. paradoxa*.

little possibility for the usual mobility of the proboscis. The tongue and palpi are inserted deeply in the buccal cavity; they are both entirely pale orange. The palpi are slightly clubbed at the tip and bear there a small black terminal bristle, and there is a single similar bristle on the lower side of the end.

The thoracic dorsum (fig. 2) is also pale, rather shiny yellow, although in certain illuminations two indistinct orange lines can be seen showing through the chitin. The surface is entirely covered with regular rows of tiny bristles, which, as usual, show black against the dorsum but golden on side view; the middle six rows of these bristles (shown as four only in the figure) form the acrostichal rows. Three pairs of post-sutural dorso-centrals are present, the first very small, the next long, and the last very long, extending over the scutellum. There are 4 small prescutellars, and the rest is as shown in the figure. The scutellum is absolutely smooth and of the same yellow colour as the dorsum, as is also the metanotum. The pleura is also all of the same colour; the large terminal humeral bristle is accompanied by an almost equally large one on the lower side of the humerus and 2 or 3 smaller ones. There are two sternopleural bristles inserted rather closely together, the hind one being very long and stout, the other about half its size.

The legs are likewise entirely pale yellow and are well clothed with tiny bristles; the coxae carry long irregular bristles, and the front femur is provided with a lower row of 6 or 7 stout bristles; there are no special adornments on the front legs.

The wings have the form and venation shown in fig. 4. The lower cross-vein is broadly clouded as indicated by the dotted lines. A darkened area extends from the costa across to the third vein, the approximate boundary of its darkest part being shown by dots; the darkening then quickly shades off into the greyish glassy surface of the rest of the wing. The basal segment of the costa is well bristled, the last bristle at the costal break being the strongest.

The abdomen is yellow and slightly shining, the last two segments being darkened with ill-defined borders extending broadly along the hind margins of the segments. The dorsum is covered with small bristles somewhat converging towards the axial line; the marginal bristles, about 4 on each side, are considerably longer and stouter and more regularly spaced. The hypopygial segments are somewhat darkened and hairy; all that is externally visible is a small terminal knob and what are possibly the tips of the side appendages; the whole apparatus gives one the impression of its being a small edition of the type of thing seen in *Leucophenga maculata*.

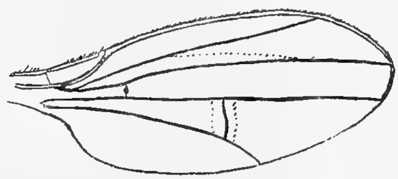

Fig. 4. Wing of *Drosophila paradoxa*, × 30.

♀. A very careful comparison was made by viewing the specimen in conjunction with the camera lucida drawings made of the male. There is practically no structural difference of any weight to be found. The lower hind quadrant of the eye boundary in side view is somewhat less rounded, but that is a matter that varies to some extent in a single species, giving a more or less pointed appearance to the lower part of the eye. A long series of *D. melanogaster* will show quite perceptible differences in this respect. The chaetotaxy, both cephalic and thoracic, and the relative size of the bristles are the same, as are the legs. The wings have exactly the same venation and relative positions of all the veins, but are very slightly shorter. The main difference is in the colour of the wings; the suffusion is almost absent, but can just be seen in a proper light. The peculiar structure of the abdomen has been described on p. 157. The central hairy ridge is pale yellow on its base. The last segments are more darkened, and the terminal one bears a crown of regularly spaced bordering bristles, which are stout and very nearly as long as the previous segment.

Length, just under 2 mm.; wing, the same.

Trinidad: St. Joseph, 3 specimens, xii. 1917 (*C. B. Williams*).

The single female from Panama is superficially very like that of the last species. The side view of the head is much the same, but it is not quite so high in proportion to its breadth, and the jowls are a little narrower. The inner row of aristal rays is very evident. The thorax was spoiled in pinning, but as far as can be seen the chaetotaxy is the same, as is that of the head, though the bristles are less stout.

The venation is different: on micrometric measurement it is found that the ratio $\frac{\text{distance from small to large cross-vein}}{\text{distance from large cross-vein to wing-margin}} = 0{\cdot}42$, while in *D. paradoxa* it is about 0·62; also as measured along the costa we have $\frac{\text{end of 1 to end of 2}}{\text{end of 2 to end of 3}} = 1{\cdot}6$, whereas in *D. paradoxa* it is a little over 2; hence the 2nd vein is proportionally much shorter. The free end of the 5th vein is also longer, and there is no darkening at all of the veins or costal border.

The pinned specimen was so badly placed for viewing that the abdomen could not be properly examined, but it was apparently very like that of the last species externally. The fragmentary specimens were mounted as slides, as before mentioned, and hence are not much help in description.

Size, as last species.

PANAMA: Changunda, xi, 1917, (*C. B. Williams*).

[In a later communication Mr. C. B. Williams states that from what he saw of the Panama *Drosophila* he concluded that it was probably not a true parasite of the *Clastoptera*, but merely an inquiline. In Trinidad, however, he collected about 30 spittle-masses of the same *Clastoptera* on *Casuarina* trees, and about half of these contained *Drosophila* larvae, most of which had their heads buried in the abdomen of the *Clastoptera* nymphs, the head being usually inserted between the dorsal abdominal plates. In a letter to Mr. Williams, Mr. A. H. Sturtevant, of Columbia University, New York, says: "Similar habits have been observed in *Drosophila inversa*, Walker, in Minnesota. C. N. Ainslie (Canad. Ent. 1916, pp. 38–44) reported this species (incorrectly determined as *D. sigmoides*, Loew) as bred from pupae found in the froth of a Cercopid."—ED.].

A FROGHOPPER ON SUGAR-CANE IN BRITISH GUIANA.

By C. B. Williams, M.A., F.E.S.,

Department of Agriculture, Trinidad.

In the course of an investigation of the froghoppers (Cercopidae) of Central America, made on behalf of the Government of Trinidad, I visited British Guiana in 1916. The object of the visit was to find, if possible, some new parasites for introduction into Trinidad in order to combat the froghopper (*Tomaspis saccharina*, Dist.), which is the most serious pest of sugar-cane in the island. Although the species of froghopper found on the sugar-cane in British Guiana is different from the species in Trinidad, yet all the parasites found were already known in that island. However, the following notes on the British Guiana insect may be of some general interest.

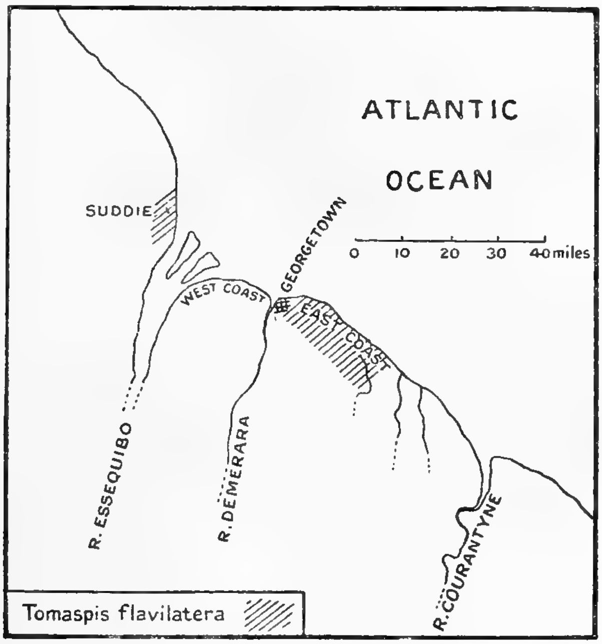

Fig. 1. Sketch-map of the coast of British Guiana, showing the distribution of the froghopper, *Tomaspis flavilatera.*

Practically all the investigation was carried out on the coast lands of what is generally known as Demerara. These were reclaimed many years ago from a flat forest swamp and are mostly below sea-level at high-tide. The soil is a deep alluvial deposit of clayey consistency. Drainage is bad and is done chiefly by sluices, which are opened by hand at low tide and closed again when the tide rises. The whole of the sugar-cane district is intersected with two systems of artificially constructed trenches or canals at different levels. The higher level is used for transport and irrigation or flooding, the lower system, usually about four feet below the other, is the drainage canal. In only one part of the coast under consideration is there any rise in the ground and this is just on the western side of the Essequibo River, where there are a few low sand ridges. The coast of Demerara proper (which extends from the Berbice to the Essequibo Rivers) (see map, fig. 1) is divided by the Demerara River into the East Coast and the West Coast; the Corentyn Coast, east of the Berbice River was not visited.

The following is the average for 32 years of the rainfall at the Botanic Gardens, Georgetown, Demerara:

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
8·4	6·8	7·5	7·3	11·5	12·1	10·6	6·3	3·1	2·4	5·3	11·5	91·3

During these 32 years the total annual rainfall has varied from 59 to 135 inches.

It will be seen that there are two dry seasons, one during February, March and April, and a second from about the middle of August to the middle of November.

The coast land is almost entirely under cultivation, that nearest the sea, immediately behind the sea defences, being largely used for rice-growing (the area under which is increasing every year), and very wet pastures for cattle, sheep and goats. Behind this, usually from about two miles to about eight miles from the sea, are the chief sugar fields. These stretch further inland up the river margins. A small area near Georgetown, once in sugar, is now used by market-gardeners. There is very little uncultivated land. Most of the wild plants are grasses and sedges, which are found in the pastures along the canal banks and roadsides, and to a lesser extent among the canes.

The British Guiana Froghopper.

The froghopper found attacking the sugar-cane along this coast is *Tomaspis flavilatera*, Urich. It has not yet done any serious damage, but is viewed with suspicion by the planters after what has been experienced in Trinidad.

They were first discovered by Mr. J. J. Quelch at Plantation Melville, East Coast, about 1909. In 1911 Mr. H. W. B. Moore reported that they were common only at Melville (Report for 1911, p. 20). They were found chiefly on grass and were preyed on largely by Attid spiders. In 1912 there was a long drought and the froghoppers almost disappeared, but in 1913 they were again seen on several estates, particularly Plantation Cane Grove, East Coast, and Plantation Ogle, East Coast. They were chiefly on the grass and less on the cane. (Moore, Report for 1913, p. 15.)

In 1914 Urich gave a short general account of froghoppers in the Journal of the Board of Agriculture of British Guiana for the use of the local planters. *T. flavilatera* is mentioned as occurring in British Guiana, but is not thought to be very serious. A list of the chief enemies of *T. saccharina* in Trinidad is given and it is suggested that most of them probably occur in British Guiana.

In 1914 " From June to August there was a fairly sharp attack. On some fields of Cane Grove over 50 nymphs of various ages. . . . . . were counted attached to the rootlets of some stools. Froghoppers were also observed at Plantation Ogle, but the attack was not of much consequence. Numbers of nymphs were destroyed here by pounding and crushing " (Moore, Report for 1914, p. 15). In June of the same year Mr. Quelch bred out the parasitic Syrphid fly, *Salpingogaster nigra*, from maggots found at Cane Grove.

In 1915, froghoppers were abundant in July and August at Plantation Ogle; 386,222 nymphs were collected by hand and destroyed. "This is the first occasion on which it has assumed alarming proportions" (Moore, Report for 1915, p. 7). The fields were also flooded for some days and the nymphs which crawled up the stems were shaken off into the water; in this way many thousands were destroyed. The Syrphid fly was also found in this locality for the first time this year.

My first observations in the field were at the end of May and the beginning of June 1916, when *Tomaspis flavilatera* was found occasionally on several estates, but was nowhere common. Females in captivity readily laid eggs on dead trash (see below). The nymphs and adults were chiefly in the short succulent grass along the narrow drainage trenches running through the canes, and the adults could be readily caught by sweeping along these with a strong net.

After two months absence I returned to the district again in August and September, when the insects were much more numerous, but were still causing practically no damage. One estate (Plantation Ogle) had already started collecting the nymphs by hand.

During my two visits I found the froghopper generally distributed along the East Coast and in small numbers on a plantation just west of the Essequibo River. Although the West Coast was visited on several occasions, none were seen there, and I understood that neither Mr. Bodkin nor Mr. Moore have any record from this Coast. In spite of this I think there is no doubt that it will be found to occur there in small numbers.

The Egg.

Eggs were first obtained in captivity on the 3rd June 1916. They were laid in the dead moist leaf-sheaths at the base of the grass stems near the ground, in a position quite similar to that adopted by *T. saccharina* in Trinidad. In cane and in grasses with thick leaves the egg is inserted between the two surface layers with the anterior end very slightly projecting. In grasses with thin leaves the egg may be passed through one or more leaves and embedded in a deeper layer. In one case in which a thin dead leaf was covering some living tissue an egg was inserted through the dead layer into the green tissue beneath. This was the only case in which an egg was found in green tissue.

The eggs are pale yellow in colour when first laid. They are 0·88 mm. long and 0·29 mm. broad; spindle-shaped, slightly more pointed at the anterior than at the posterior end. After some days a dark longitudinal streak (the hatching lid) appears at the anterior end, quite similar to that found in *Tomaspis saccharina.*

The Nymph.

Stage I. Total length, 1–2·5 mm. Pale yellowish-brown, with a slight red-brown mark on either side of the abdomen. (The young larva of *Tomaspis pubescens*, the black froghopper, which is the only other grass-feeding species found in this district, can be distinguished at this stage by its orange-red colour; although occasionally occurring on grass, it was not found on sugar-cane.) No traces of wing rudiments are noticeable at the hind margin of either the meso- or meta-thorax. Owing to the misplacement of my preserved specimens of this stage, it is not figured.

Stage II (fig. 2, A). Total length, 3–3·5 mm. Yellowish brown in colour, thorax and head slightly darker than the abdomen. Head less than one and one-half times as long as broad, longer than the prothorax. Hind angles of the meso- and meta-notum very slightly acute, indicating the wing rudiments. Antennae six-segmented; length of segments in millimetres:—1, 0·11; 2, 0·08; 3, 0·11; 4, 0·07; 5, 0·05; 6, 0·06; total length of antenna, 0·50 mm.

Stage III (fig. 2, B). Total length 4·5–5 mm. Colour as before, but the thorax and head are more distinctly darker than the abdomen. Head more than one and a half times as broad as long and about equal in length to the pronotum. Hind

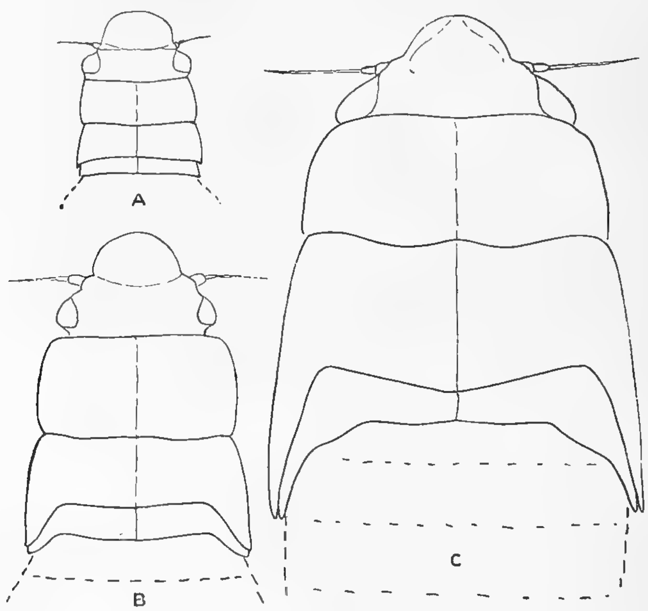

Fig. 2. Head and thorax of nymph of *Tomaspis flavilatera*: A, stage ii.; B, stage iii; C, stage iv.

angles of the meso- and meta-notum produced into wing rudiments, which are about as long as wide at the base. Antennae seven-segmented; length of segments in millimetres:—1, 0·19; 2, 0·13; 3, 0·16; 4, 0·10; 5, 0·10; 5, 0·10; 6, 0·06; 7, 0·10; total length of antenna, 0·85 mm.

Stage IV (fig. 2 C). Total length 7–8 mm. Head and thorax much darker than the abdomen, wing rudiments still darker. Head more than twice as broad as long and shorter than the pronotum. Wing-rudiments reaching to the hind magrin of the second abdominal segment. Antennae eight-segmented; lengths of segments in millimetres:—1, 0·19; 2, 0·18; 3, 0·27; 4, 0·18; 5, 0·21; 6, 0·08; 7, 0·13; 8, 0·10; total length of antenna, 1·35 mm.

The nymphs in all stages are found in their masses of frothy secretion on the roots of grasses or sugar-cane on or just beneath the surface of the ground. If the ground is loose and open, they descend lower ; usually however the great majority are within three inches of the surface. The froth of *Tomaspis flavilatera* closely resembles that of *T. saccharina* in Trinidad. It is softer and less elastic than that of *T. pubescens,* the only other froghopper found on grass in this district.

Just before emergence the full-grown nymph frequently ascends a grass stem to a height of from six to ten inches and there forms a frothy covering in which the final moult takes place. In the early morning these elevated froth masses are often seen, but it is only at this stage that the nymph is found away from the roots. This distinguishes it in habits from the froghopper (*Tomaspis tristis*, F.) at present found on sugar-cane in Surinam, which regularly forms its froth at a height of two to five feet above ground level (Williams 1916). This latter species is known to occur in British Guiana and might at any time be found on sugar-cane.

The Adult.

Tomaspis flavilatera was described by Urich in 1914 (Bull. Ent. Research, v, p. 43) from specimens taken in British Guiana ; at present it is not known elsewhere. It is dark brown in colour, with the fore wings semi-translucent. On the costa of each fore wing is a light yellowish-brown streak from the base of the wing almost to the apex. This species is quite different in the scheme of coloration from *T. saccharina* and its various relatives in Central America, all of which have as a colour pattern two more or less complete light transverse bands on a dark ground. In the minuter structure, in the profile of the face, in the structure of the male genitalia and in habits, it shows a very close relationship to this group of froghoppers and must be considered as a member of the *saccharina* series with an aberrant colour pattern.

Among a large number of specimens examined there is very little variation. The only distinct form is one in which the eyes are bright red instead of the usual black. This is rare and appears to be in a proportion of 1 : 1000, or less. A similar variety occurs in other species which will be dealt with later.

During the day-time the adults may be found in large numbers sitting on the short succulent grass growing along the drainage trenches. They are found also in the axils of the upper leaves of the cane plants, but they do not frequent this situation so exclusively as is found to be the case with *Tomaspis saccharina* in Trinidad.

In addition to sugar-cane almost any species of grass seems to be used as food by *T. flavilatera*. The following grasses on which nymphs were found have been identified :—*Cynodon dactylon* (Bermuda or Bahama grass), *Cynodon* sp., *Stipa* sp., and *Panicum lascum*. Adults were also seen in the rice plantations sucking the stems of rice. There is, however, not much danger of its becoming a pest of the wet land rice, as conditions at the root of the rice are quite unsuitable for the nymphs.

Natural Enemies.

During the months of August and September the following natural enemies were seen. Of these only the Syrphid fly (*Salpingogaster nigra*) had been previously recorded as attacking *T. flavilatera.*

Egg Parasites.

(1) The Vermilion Parasite (*Oligosita giraulti*). Several specimens of this minute Chalcid were obtained during September 1916 from grass containing froghopper

eggs collected at Plantation Ogle, East Coast, and one specimen was obtained by sweeping the grass in the same locality.

(2) *Haplothrips* sp. In one of my small breeding tubes containing only froghopper eggs in dry trash I found a larva of a thrips which, under these artificial conditions, was sucking the contents of the eggs. The larva was bred out and the adult proved to be a species of the genus *Haplothrips*, a very abundant and widely distributed genus of thrips, members of which have been previously reported to be occasionally carnivorous ;* as a general rule, however, they are vegetarians. No effort was made to introduce this insect into Trinidad, as several species of the genus are already quite abundant there and it is questionable if they are of any serious value under field conditions.

Parasite of the Nymph.

(3) The Syrphid Fly (*Salpingogaster nigra*). This was first recorded from British Guiana by Quelch in 1914. During my visit in May and June it was not seen, but by the middle of August the maggots were quite common at Plantation Ogle, and a few were seen at Cane Grove and Non Pareil, all localities on the East Coast. By the middle of September there was a Syrphid maggot on nearly every cane stool in that part of Plantation Ogle where the froghoppers were abundant.

Parasites of the Adult.

With the exception of the Green Muscardine fungus no true parasite of the adult froghopper was found, but a number of predatory insects and lizards were observed to feed on froghoppers to a greater or less extent.

(4) The Green Muscardine Fungus (*Metarrhizium anisopliae*). In the course of over two months spent in this district only a single adult froghopper infested with this fungus was found. This was on the 14th August 1916 at Plantation Ogle. No infected nymphs were observed. This was entirely unexpected, when compared with its relative abundance in Trinidad, and when one considers the moist conditions in the cane-fields, which seemed extremely favourable for its propagation. In the event of further trouble with this froghopper in Demarara, cultures should be obtained from Trinidad and an attempt made to get it well established. It could not fail to be of some value, as among its known hosts are included the smaller sugar-cane borers (*Diatraea* spp.).

(5) Dragonflies. Owing to the number of small drains with which the cane-fields of Demerera are intersected, dragonflies are extremely abundant. One large green specimen when captured readily took a froghopper adult, and as the dragonflies are continually resting on and hawking above the short grass on which the froghoppers are abundant, there is little doubt that they feed on them in the wild state.

(6) Attid Spiders of several species were common and several times were seen in the act of feeding on froghoppers.

(7) Two species of predatory ants were observed carrying away adult froghoppers, but the froth of the nymphs seems to render them immune from attack. On more than one occasion hunting ants invaded my bench and killed all adult froghoppers

* In Panama in 1917 I found another species of the same genus feeding on froghopper eggs under similar conditions.

and parasites in my breeding cages. In every case, however, the nymphs were found untouched.

(8) *Heza peramata*, Kirby. A family of nymphs of this large Reduviid was found at Ogle in the axil of a cane leaf. They readily ate froghoppers in confinement and most probably do so in the field, as the position in which they were found is that frequently sought for by the adult froghoppers. They were not introduced into Trinidad, as Mr. Urich, Entomologist to the Board of Agriculture, Trinidad, informed me that they already occurred there.

(9) *Zelus mimus*, Stål. The species is smaller and more active than the previous one and was frequently seen flying about and resting on the short grass along the drains in the cane-fields. It was observed on several occasions feeding on froghoppers in the wild state. Mr. Urich informed me that this species also is known in Trinidad.

(10) *Pflugis mantispa*, Bol. This active predaceous grasshopper was not uncommon in the traces between the cane-fields. It was already known in Trinidad as a froghopper enemy, but does not seem to frequent the cane-plots to any great extent.

(11) *Xiphidium propinquum*, Redt. This grasshopper, which is largely insectivorous, was abundant on most of the sugar-cane estates. Like the last species, however, it is mostly confined to the grass on the traces. On several occasions it was seen to eat adult froghoppers, but on the other hand the newly hatched *Xiphidium* were found to eat readily small parasitic Hymenoptera, including the vermilion egg-parasite (see above), and the same grasshopper was found damaging the flowers of rice at the Georgetown Botanic Gardens. A related species of *Xiphidium* was studied in Hawaii and found to be partly vegetarian and partly predaceous, including among its prey the sugar-cane leaf-hopper.

(12) Lizards appeared to be more abundant in the cane-fields here than in Trinidad ; this may be partly due to the scarcity of the mongoose (see below).

(13) Birds. The following birds occurring in British Guiana were seen on the sugar-cane fields there or have since been proved by dissection in Trinidad to feed on froghoppers :—

TYRANNIDAE (Tyrant Flycatchers).
Tyrannus melancholicus (Grey-headed Kiskadee).
Muscivora tyrannus (Scissors-tail Flycatcher).
Fluvicola pica (Cotton Bird, Widow).
Arundinicola leucocephala (White-headed Widow).

CUCULIDAE (Cuckoos).
Crotophaga ani (Old Witch Bird, Tick Bird).

ICTERIDAE (Mocking Birds).
Icterus xanthorous (Yellow Plaintain Bird, Carouge).
Quisqualus lugubris (Boat-tail, Black Bird, Golden Eye).

FRINGILLIDAE (Finches).
Volatina jacarina (Black Dancing Finch).

Everything possible should be done to encourage these, and all other insectivorous birds, in the cane-fields. Most of the cane districts are very bare of trees ; the planting of bushy trees along the traces would be an advantage.

(14) The Mongoose. This animal, which is sometimes considered as indirectly responsible for the abundance of the froghopper in Trinidad, has unfortunately been introduced here also. It is however not common, the general reason given for this being that the low level of the land causes any burrows that it makes to be immediately filled with water. On one estate the manager informed me that the mongoose had got over this difficulty by making its burrows in the mounds of earth heaped up to form approaches to the small bridges over the canals.

Although work at present being carried on in Trinidad shows that the mongoose is much more insectivorous in its diet than was apparently ever suggested, yet there is no doubt that on the whole it is an undesirable animal, and it is to be hoped that steps will be taken to prevent it reaching the hinterland of the Colony, where it might do very serious damage.

Artificial Control.

The means adopted for the control of this froghopper, previous to my visit, consisted in flooding the land and hand-picking the nymphs. It has been mentioned above that at Plantation Ogle in 1915 over 380,000 nymphs were collected. This was done by the regular insect gang of the estate, which at normal times is employed in collecting the grubs of the sugar-cane moth borers (*Diatraea* and *Castnia*). Flooding may be done for a few days as a temporary control measure, but in some

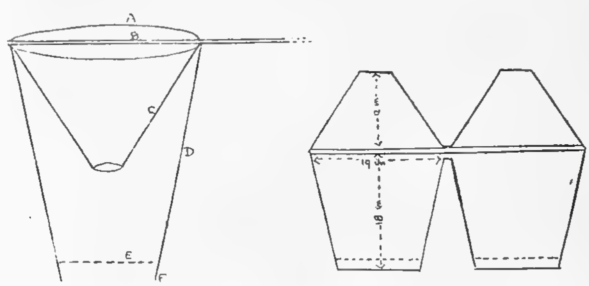

Fig. 3. Sweep-net for catching froghoppers; explanation in the text.

cases an uncultivated field is kept under water for a year or eighteen months. This treatment is found to have a beneficial effect on the soil, as well as preventing these uncultivated areas from becoming breeding grounds for insect pests.

As the adults were found so commonly sitting on the short grass in the drains, I decided to see if they could not be caught on a large scale by the use of sweep-nets. Several forms of net were tried, but the one described and figured was finally adopted and proved extremely successful.

The net (fig. 3) consisted of a bamboo handle (B) going right across a stout wire ring (A), thus giving considerably increased strength to the ring, which was about one foot in diameter. The bag, made of a light canvas, was double, the inner bag (C) in the form of a funnel open at the end to allow the insects to get into the main bag, but preventing their escape. The outer bag (D) was also not stitched across the end but instead a piece of strong mosquito netting was inserted about two inches from the end and fastened all round to the canvas. This piece of net was important for two reasons : (1) it allowed a current of air to pass through the net when in use, so that insects were not blown away from the net by the draught created ; (2) it allowed the escape of the small parasites which would be swept up by the net. The edges of the outer bag were always allowed to project for the two inches beyond the mosquito net in order to protect it from wear and tear. The inner and outer bag could be cut from one piece of canvas as shown in the second figure. The part of the net which passes round the ring is best reinforced with stout webbing. Even the strongest net bag was usually worn out after one or two week's continual use.

The boys walked down the drains through the cane-fields sweeping the grass on either hand. About every twenty minutes (usually at the end of a drain) the net was squeezed in the hand to incapacitate the contained insects, which were then removed (by putting the hand through the central funnel bag) and transferred to a tin box. In this way boys were able to catch 3,000–4,000 adult froghoppers in a very short working day of not more than 5 hours. The largest number actually brought in when I was there was 3,600 ; but supervised sweeping on one drain, which had already been swept about two hours previously, produced 500 hoppers in 20 minutes, so that an average of 1,000 an hour ought easily to be reached.

The boys were offered two cents (1d.) per hundred. During September 1916 at Plantation Ogle two to ten boys collected on twenty-two days and caught 533,540 adults. During the same period 540,000 nymphs were hand-picked, but this required a larger gang, and a higher price (4 to 5 cents per hundred) had to be paid. During the year 1916 over 4,000,000 adults and nymphs were destroyed at Plantation Ogle on an infested area of about 30 acres.

Several hundred specimens from the sweep-nets were taken at random and the sex determined ; as a result 46 per cent. were found to be females.

Two light traps were tested in comparison, one an oil lamp and one an acetylene light. The former caught 525 and the latter 651 froghoppers in one night. Five hundred of each of these were sexed and gave in each case 494 males and 6 females, or 1·2 per cent. of females. It will also be noticed that the bright light is but very little better than the oil lamp. These results agree absolutely with experiments made in Trinidad.

It will be seen that the method of sweeping is far more efficacious than the use of light traps.*

General Conclusions and Summary.

At the time of my visit (1916) the froghopper could not be considered as a very serious pest of sugar-cane. It was in some spots extremely abundant in the fields, but by far the larger number were feeding on the grass. Even at its worst the numbers nowhere approached those found in Trinidad during an attack, and the canes suffered very little visible damage. It would, however, be very difficult to distinguish the present conditions in British Guiana from those that must have prevailed in Trinidad before the insect became a regular pest. In view of this, the froghopper should always be regarded as a possible great danger in Demerara, and any reasonable precautions and preventive measures should be taken.

* This remark applies only to British Guiana. In Trinidad, owing to slight differences in habit of the insect and in cultivation, the sweep-nets are quite useless.

The following are, I believe, the chief reasons why up to the present the froghopper has done so little damage in Demerara as compared with Trinidad.

(1) The conditions of climate and cultivation in Demerara favour a continual regular existence of the froghopper and its parasites throughout the year. The absence of any long dry season together with the low level of the land makes the fields always quite damp in some spots at least. This is particularly noticeable in the narrow drains which occur at intervals of about six yards throughout the canes and which have, even in the driest season, an edging of green succulent grass. Between these drains the earth is banked up into high ridges on which the cane is planted; and these ridges are frequently too dry to attract the froghoppers from the moist drains. As a result the froghoppers may be very abundant in the drains, while the canes, except perhaps those bordering on the drains, are untouched.

(2) The lesson learnt by the planters of Demerara from the invasion of the large moth borer (*Castnia licus*) has resulted in each estate having an organised insect gang always at work, and as, in addition, they know from the unfortunate experience of Trinidad that froghoppers are capable of serious harm, the slightest trace of them in a field is reported and extremely energetic measures taken for their extermination. In this way more money is expended in destroying them than the actual damage caused, but the expenditure is more than justified as an insurance policy.

(3) One of the most effective ways of dealing with the froghopper outbreaks in Demerara is the flooding of the fields; a control measure quite impossible in Trinidad.

(4) The mongoose is still comparatively scarce.

(5) Although on some estates quite a large proportion of the canes are burnt before cutting, on account of the scarcity of labour, yet cutting is not confined to one season, as in Trinidad, and there are always standing canes forming shelters. In addition, burning, where practised, is always done at night when the ground is wet with dew, or on moist days; as a result it is not severe, the trash on the ground and the grass in the drains remain, and the eggs and their parasites survive.

(6) There is, in comparison with Trinidad, very little uncultivated land to serve as a source of infestation.

The list of enemies of the froghopper in Demerara is practically the same as in Trinidad, and with the exception of the green muscardine fungus, there is little that could be introduced. Any new parasite obtained for Trinidad should however be useful also in Demerara.

In addition to *Tomaspis flavilatera*, several other species of the genus *Tomaspis* were found in British Guiana. As in most cases the identity of these is not yet settled, particulars are reserved for a later date.

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COLLECTIONS RECEIVED.

The under-mentioned collections were received by the Imperial Bureau of Entomology between 1st January and 31st March 1918, and the thanks of the Managing Committee are tendered to the contributors for their kind assistance :—

Dr. W. M. Aders, Government Economic Biologist :—1 Moth, 8 Coleoptera, 6 fishes, and 3 mammals ; from Zanzibar.

Dr. W. Allan :—98 Mosquitos, bred at Freetown, Sierra Leone.

Mr. H. F. Baker :—1 *Saga* Grasshopper ; from Salonica.

Mr. G. E. Bodkin, Government Economic Biologist :—7 Lepidoptera, 1 Beetle, 2 Hymenoptera, 5 Rhynchota, and 13 Orthoptera ; from British Guiana.

Mr. John R. Bovell, Superintendent of Agriculture :—4 Weevils ; from Barbados.

Lieut. P. A. Buxton, R.A.M.C. :—7 Culicidae, 6 other Diptera, and 1 Wasp ; from Mesopotamia.

Capt. G. D. H. Carpenter :—2 *Tabanus*, 4 *Haematopota*, 36 other Diptera, 69 Lepidoptera, 1,468 Coleoptera, 10 Planipennia, 264 Hymenoptera, 1 Coccid, 159 other Rhynchota, 1 Embiid, 56 Orthoptera, 2 Odonata, and 3 Isopoda ; from "German" East Africa.

The Director, Royal Botanic Gardens, Kew :—1 Beetle and 3 Beetle larvae ; from New Jersey.

Mr. P. R. Dupont, Curator of the Botanic Station :—2 packets of Coccidae and 2 of vegetable pests ; from Seychelles.

The Government Entomologist, Madras :—10 Weevils ; from South India.

Mr. C. C. Gowdey, Government Entomologist :—28 Diptera, 7 Lepidoptera, 204 Coleoptera, 19 Chalcids, 115, other Hymenoptera, 35 Thrips, 1 Coccid, 110 Aphids, 114 other Rhynchota, and 1 Worm ; from Uganda.

Mr. E. Hargreaves :—328 Culicidae, 7 Tabanidae, 87 other Diptera, 1 Moth, 6 Trichoptera, 166 Coleoptera, 1 Lacewing, 27 Hymenoptera, 56 Rhynchota, 17 Orthoptera, 3 Isoptera, 1 Dragonfly, 1 Mayfly, and 2 Thysanura ; from Taranto, Italy.

Dr. W. A. Lamborn :—3 *Tabanus*, 6 *Glossina*, 52 other Diptera, 46 Coleoptera, a large number of Chalcids, 31 other Hymenoptera, and 2 packets of Coccidae ; from "German" East Africa.

Capt. A. Macdonald, R.A.M.C. :—A tube of Mosquito (*Ochlerotatus*) larvae ; from Chatham.

Mr. Chas. W. Mally, Cape Province Entomologist :—17 Diptera ; from South Africa.

M. R. Mayné, Government Entomologist :—208 Coleoptera and 40 Rhynchota ; from the Belgian Congo.

Lieut. V. I. Rigg, R.A.M.C. :—2 Larvae of *Anopheles bifurcatus*; from Lydd, Kent.

Capt. J. A. Sinton, I.M.S. :—3 Diptera, bred from ear of dog; from the N.W. Frontier Province, India.

Mr. C. B. Williams :—4 Diptera, 8 Rhynchota, and 6 Orhtoptera; from Panama, etc.

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IMPERIAL BUREAU OF ENTOMOLOGY.

HONORARY COMMITTEE OF MANAGEMENT

NEW ETHIOPIAN FRUIT-FLIES OF THE GENERA TRIDACUS AND DACUS (DIPT.).

By Prof. M. Bezzi,

Turin, Italy.

Some additional fruit-flies of the genus *Dacus* (*s.l.*) from the Ethiopian Region have been recently submitted to me for study by the Imperial Bureau of Entomology, through the kindness of Dr. G. A. K. Marshall, the Director.*

The riches of the Ethiopian Fauna in forms of this genus seem to be inexhaustible, for even a small collection of these flies always brings to light new and often very strikingly characterised species. It is interesting to note that the tendency of the wings to be adorned with bands is more frequent in Africa than was previously believed, as is shown by the discovery of *D. hamatus*, Bezzi, and of the new *D. trigonus*, here described. In both these cases, however, the imagines at present known have the wing pattern of another type and much less evolved than that of the Oriental species of *Bactrocera.*

Genus Tridacus, Bezzi, 1915.

1. **Tridacus stylifer,** sp. nov. (fig. 1).

Easily distinguished from all the other known species of the present genus on account of its very simple wing pattern, even the brown anal stripe being quite

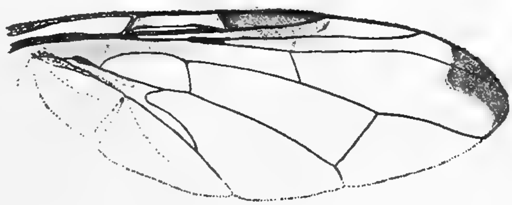

Fig. 1. *Tridacus stylifer,* Bezzi, sp. n.

wanting. Falling into section 16 of my Key (l.c., 89) with *humeralis,* which is however at once distinguished by the presence of a broad, fuscous anal stripe on the wings. In *Dacus scaber,* Loew, from Caffaria (possibly a *Tridacus*) the anal stripe seems to be wanting ; but it is described as having a very short ovipositor, and an infuscated small cross-vein.

♀. Length of body, 6–7 mm. ; length of wing, 6–7 mm. Head of a yellowish colour ; occiput rather shining, reddish in the middle and above, narrowly yellow at the eye border above and more broadly yellow below ; ocellar dot black, small ; frons about twice as long as broad, of a rather dark yellowish colour, opaque, but shining on the narrow orbits and on the brownish vertical plates ; it shows in the middle a rounded, reddish-brown spot, and is more pale in front, above the shining brown lunula ; there are only 2 pairs of lower fronto-orbital bristles. Face entirely shining yellow, quite

* For the previous papers see : Bull. Ent. Research, vi, Sept. 1915, pp. 85–101, 14 figs., and viii, Aug. 1917, pp. 63–71, 6 figs.

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unspotted; cheeks and jowls yellow, the latter with a not much developed reddish spot below the eyes. Antennae with the first joint shorter than the second; they are of a dark reddish colour, with the third joint blackened towards the tip; arista reddish on the basal part. Palpi and proboscis yellowish. All the cephalic bristles are black, only the genal bristle being dark brownish. Thorax of an opaque dark reddish colour on the disc, with a broad, rather shining, black patch on each side before the suture and above the notopleural line; along the middle line there is a narrow blackish stripe, broadening beneath the suture to form a broad patch before the scutellum; the dorsocentral lines are marked with a narrow, less distinct, more reddish stripe. The humeral calli are entirely shining yellow, with a narrow, reddish border above. The pleurae are shining reddish, with striking yellow markings, as follows: a broad, triangular, mesopleural patch, narrowly united in front with the humeral calli, and continued on the pteropleura and below with a small spot on the upper border of the sternopleura; this last spot, as well as the lower end of the mesopleural band is broadly margined with black. There is a single, rounded, hypopleural spot, which is very striking on account of the mesophragma being entirely black. Scutellum entirely yellow, with a narrow, reddish-brown, basal stripe, and with two bristles at the end. All the bristles are black; the anterior supra-alar is well developed, like the pteropleural one; the middle scapulars are not distinct, while the lateral ones are well developed; the very short pubescence of the back is more greyish, that of the pleurae longer and whitish, chiefly on the lower part of the sternopleura and on the breast. Halteres whitish yellow. Abdomen ovate, narrowed at base, convex, coloured and punctate like the disc of mesonotum; the segments are partly fused together along the middle line; the posterior border of the second segment is paler; along the middle line there is a narrow black stripe, and on the sides of the 3rd to 5th segments there is a broad black patch; but the entire lateral border is narrowly reddish, and the hind border of the last segment is more broadly reddish. The short pubescence is greyish on the disc, and longer and more whitish on the sides. Venter entirely reddish-yellow. Ovipositor very long, measuring 2·5 mm. in length, about as long as the abdomen; it is strong, cylindro-conical, shining reddish, with rather long, whitish pubescence. Legs rather slender, entirely pale yellowish and quite unspotted, only the four posterior coxae and the tarsi being a little more reddish; pubescence and hairs whitish; apical spur of middle tibiae black; claws black, with reddish base. Wings (fig. 1) long and broad, greyish hyaline, strongly iridescent, with reddish brown veins, which are blackened towards the end. The first four segments of the costa are of about the same length; the second longitudinal vein is short, the fifth segment of costa being thus longer than the preceding one; the third vein is less bent downwards at the end and is parallel with the last portion of the fourth, which is almost straight; lower end of the small cross-vein placed a little beyond the middle of the discoidal cell; the lower prolongation of the anal cell is proportionally broad and short, being only a little longer than the rest of the anal vein. The pattern is very reduced, consisting only of the yellowish stigma and a fuscous spot almost symmetrically placed across the end of the third longitudinal vein, but more developed below; the second costal cell is also slightly shaded at the base in front of the humeral cross-vein; the base of the first basal cell is broadly shaded to form a dark border around the second basal cell; the anal cell and the anal vein are quite unspotted. There is sometimes a very faintly developed greyish shading at the end of the 5th longitudinal vein, below the lower apical corner of the discoidal cell.

Type ♀, and an additional specimen of the same sex, in the British Museum from British East Africa, Kabete, 28.viii.1914 (*T. J. Anderson*).

Genus DACUS, s. str., Bezzi, 1915.

2. **Dacus trigonus,** sp. nov. (fig. 2).

Falling like *hamatus*, into section 25 of my Key (l.c., p. 90), but distinguished by the broad, triangular, fuscous patch on the middle of the wings, as well by the smal cross-vein being placed much beyond the middle of the discoidal cell.

♂. Length of body, 6·2 mm.; length of wing, 5 mm. Body entirely black, with proportionally narrow, but striking, yellow markings. Head entirely shining black, with very small yellow markings, as follows: a very narrow stripe along the ocular border of the occiput; a transverse spot on the upper border of the occiput, just beneath and below the vertex; a transverse band near the base of the frons in front of the ocelli, broadly interrupted in the middle; two narrow streaks on each side of

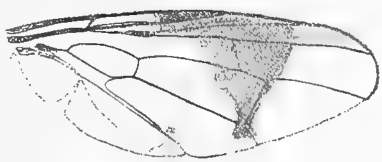

Fig. 2. *Dacus trigonus*, Bezzi, sp. n.

the frons near the eyes; a narrow border on each side of the face, in contact with the somewhat brownish cheeks. The frons on the middle is of a dark reddish-brown colour, and shining; the lunula is black; the face is quite black and glistening. Antennae very long, the first joint being porrect and about as long as the second; they are entirely blackish brown, the second joint being a little reddish below; arista black, with yellowish base. Palpi blackish brown, with a narrow yellowish border; proboscis black, with a dirty yellowish tip. The eyes are black on the hind half, with a perpendicular reddish stripe in front, and reddish on the fore half. The cephalic bristles are of a deep black colour; there are only two pairs of rather short lower orbital bristles. Thorax entirely black, punctate, rather opaque; on the disc of mesonotum there are two indistinct, broad, greyish, longitudinal stripes, enclosing a black middle stripe, which beyond the suture is divided to include a short yellow streak, ending much before the scutellum. Humeral calli shining black, with a rounded, pale yellowish, prominent spot on the hind half. Pleurae with a broad perpendicular stripe on the meso- and pteropleura, united above with a small yellow dot on sutural callus at the sides of the suture, and continued below with a small spot on the upper part of the sternopleura. The single yellow hypopleural spot is rather small, rounded, occupying only a part of the hypopleura. Scutellum yellow, with a narrow black basal stripe. Mesophragma entirely black, rather shining. The dust of the back is greyish, like the short hairs of the pleurae; the very long hairs of the lower part of the sternopleura and breast are whitish. All the macrochaetae are of a deep black colour; middle scapulars well developed, and about as strong as the lateral ones; there is no trace, as it seems, of the anterior supra-alar bristles; pteropleurals short, but strong; scutellum with the apical pair alone. Halteres whitish. Abdomen entirely black, punctate like the thorax, but distinctly more shining; it is of a characteristic shape, being narrowed at base, and gradually dilated to the end, very convex at the middle, with almost parallel sides; the segments are distinctly separate, even along the middle line, on which there is no distinct keel; the last segment is glistening, and shows distinct traces of two oval, transverse spots of a reddish brown colour on the hind half. The short pubescence is whitish, but rather long on the sides of the first two segments; the lateral cilia of the 3rd segment are darker and more numerous, but not very long. Venter entirely black, greyish dusted; male genitalia very small, black. Legs rather short and stout, the front femora being distinctly incrassate; they have black coxae and black femora, but the latter are narrowly reddish at the tips, and those of the last pair are pale yellowish on the basal two-thirds; tibiae and tarsi whitish yellow, but all the tibiae, and chiefly those of the front pair, are darkened towards the base; pubescence whitish, longer than usual; apical spur of middle tibiae black; claws whitish like the pulvilli, but with black tips. Wings (fig. 2) proportionally short, with dark brown or even black veins, which show a characteristic disposition. The costal, marginal and submarginal cells are very narrow; the second longitudinal vein is short, the fifth segment of the costa being thus much longer than the preceding one; third vein straight and parallel with the last section of the fourth; small cross-vein long and oblique, its lower end placed on the last fourth of the discoidal cell, and thus the cross-vein itself is longer than its distance from the upper end of the posterior cross-vein; lower prolongation of the anal cell very long and very narrow, being considerably longer than the terminal part of the anal vein; this last vein is less divergent from the fifth, and thus the axillary lobe is longer than usual. The wings are greyish hyaline, iridescent, and have a very characteristic pattern, consisting of a broad, fuscous patch of triangular shape, the base of which is placed along the fore border, including the stigma, the whole of the marginal, and the central part of the submarginal cell, and the vertex is on the outer lower corner of the discoidal cell, ending obtusely in the 3rd posterior cell. The terminal part of the submarginal cell is yellowish. Besides there is a greyish spot above the 6th longitudinal vein, just beyond the end of the prolongation of the anal cell. The two cross-veins are both included in the fuscous central patch, but the posterior one is nearer the hind border of the patch. The first basal cell is quite hyaline at base, even above the second basal cell.

Type ♂, a single specimen in the British Museum from S. Nigeria, Oshogbo, 9.xii.1910 (Dr. *T. F. G. Mayer*).

3. **Dacus macer,** sp. nov. (fig. 3).

Falling into section 21 *d* of my additional Key of 1917 (p. 64), and nearly allied to *D. mochii*, from which it is distinguished by the quite black abdomen, by the entirely infuscated submarginal cell and by the not infuscated base of the small cross-vein.

♀. Length of body, 6·5 mm. ; length of wing, 5·5-mm. Occiput entirely black, and very glistening ; at the middle of the upper border, just behind and below the vertex, there is a faintly developed, yellowish spot ; there is no yellow ocular border on the upper half, but a broad yellow spot near the eyes on the lower half, contiguous with the yellow jowls. Frons with more than the basal half black, while the rest is yellow ; but the black basal part has a yellowish spot on each side just in front of the vertical plates ; it is opaque, but shining at base and on sides ; lunula shining black ; it seems that two pairs of lower orbital bristles are present. Antennae with the first joint shorter than the second ; they are infuscated, almost black on the outer side, pale yellowish inwardly at end of the 2nd and at base of the 3rd joint ; arista with yellowish base. Face shining yellow, with quite unspotted antennal grooves ; cheeks more whitish ; jowls yellow, quite unspotted. Palpi and proboscis yellowish. All the cephalic bristles are black. Thorax entirely black, rather shining, even glistening in front and on sides, punctate ; the pale yellowish markings are as follows : an elongate spot, occupying about the whole of the humeral calli, except the upper anterior part ; an oblique and more whitish spot on each side of the suture, in contact with the dorsocentral line inwardly, but far apart from the sutural calli, which are shining black ; a broad, middle patch on the pleurae, including about the whole of meso- and pteropleura, continued below as a rounded spot on

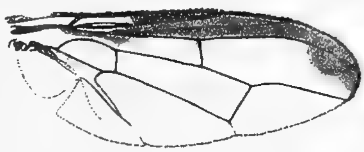

Fig. 3. *Dacus macer*, Bezzi, sp. n.

the upper border of sternopleura ; a single hypopleural spot of rounded shape. Mesophragma quite black. Scutellum yellow, with a black basal stripe. The rather long pubescence of the back is whitish, like that of the pleurae ; the long hairs on the breast are white. Macrochaetae black ; middle scapulars wanting ; no trace of anterior supra-alars ; pteropleurals well developed ; two scutellars. Halteres whitish. Abdomen rather narrow and long, of elongate-oval shape, entirely black, punctate and pubescent like the mesonotum ; it is convex, and the segments are fused together ; venter black ; ovipositor glistening black, conical, whitish pubescent, measuring not quite 1 mm. in length ; it is broad and swollen ; its apical segment is reddish. Legs rather slender and entirely pale yellowish, or even whitish ; only the four posterior coxae are darkened ; pubescence white ; tibial spur black ; claws black, with reddish base. Wings (fig. 3) hyaline, iridescent, with brownish veins, which are darkened distally. Costal, marginal and submarginal cells very narrow ; stigma long ; fifth segment of the costa considerably longer than the preceding one ; third longitudinal vein strongly curved downwards beyond the middle of its last portion ; first posterior cell very broad ; lower end of the small cross-vein placed a little after the middle of the discoidal cell ; last portion of the fourth vein almost straight, being only a little curved near the base ; prolongation of the anal cell very narrow and very short, being not longer than the rest of the anal vein. The pattern consists of a dark fore border, which leaves the costal cells hyaline but includes the whole of the submarginal cell, and is dilated at the end to form a not broad apical spot, filling obliquely the end of the first posterior cell. The stigma is of a deeper black. The small cross-vein is faintly shaded at its upper end only. The base of first basal cell above the second basal cell and the dilated part of the anal cell are a little infuscated. There is no trace of an anal stripe or of a greyish spot at the end of the sixth vein.

Type ♀, a single specimen in the British Museum from Uganda, Kampala, 24.xi.1917 (*C. C. Gowdey*).

SOME NOTES ON THE NATURAL CONTROL OF THE OYSTER-SHELL SCALE (LEPIDOSAPHES ULMI, L.).

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The oyster-shell or mussel scale (*Lepidosaphes ulmi*, L.) (fig. 1) is too well known to need any particular introduction; suffice it to say that this insect has followed its principal food-plant, the apple tree, over the world. Though usually considered a serious pest in places in which it has been long established, such as England and

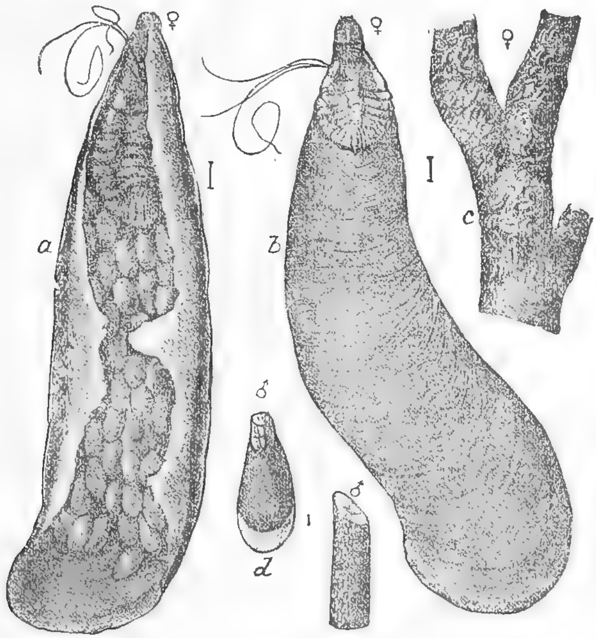

Fig. 1. Oyster-shell Scale (*Lepidosaphes ulmi*, L.); *a*, ♀ from beneath, filled with eggs; *b*, same from above; *c*, twig infested with ♀ scales; *d*, ♂ scale and twig infested therewith. (After J. B. Smith.)

Canada, it is not increasing. There must then be agencies at work destroying annually about 98 per cent. of the progeny of each pair of scales. In different countries these agencies may differ greatly. It is the purpose of the present paper to give a general outline of the principal factors operating in the control of this scale in Canada, and more especially in Eastern Canada. The study, which has been carried on under the direction of the Dominion Entomologist, Dr. C. Gordon Hewitt, is based on the literature of the subject and on the examination of about eighteen thousand egg-masses of scales collected, between September 1916 and April 1917, from representative places throughout Canada. Most of this material was gathered by the officers and friends of the Entomological Branch and mailed to the Dominion Entomological Laboratory at Fredericton, N.B., for examination. The names of these gentlemen appear in the analysis table (on page 191) opposite their respective collections and it is a pleasure to acknowledge their kindly assistance. Each 100 of these egg-masses was, so far as practicable, an average 100 selected from several twigs of one tree or bush. So far as possible, collections were made from five trees or bushes at each observation point.

From a study of the material, an analysis of which is given on page 191, it was found that a mite was by far the most important single factor in control, and most of the paper is given over to a discussion of this organism. It has been found convenient to speak first of the various agents destroying the egg stage and then of those destroying the postembryonic or summer stages.

Control in the Egg Stage.

Desiccation.

It seems to be fairly certain that desiccation of eggs in the fall occasionally plays a small part in control. In scales that are not in uniformly firm contact with the bark—owing to wrinkling or other irregularities of the surface—some or all of the eggs are exposed to an air current, and one is apt to find that they have shrivelled up and turned brown. In one case as many as 25 per cent. of the eggs on a roadside apple bush at Fredericton had shrivelled in this way. As a rule, however, one rarely finds more than 2 per cent. or 3 per cent. of such eggs. They have been found in material from New Brunswick, Quebec, Ontario, and British Columbia. That the cause of death is desiccation is indicated by the fact that healthy eggs have been induced to shrivel and turn brown when exposed on the laboratory table.

Weather.

Winter killing of eggs has been recorded in Iowa by R. L. Webster (*Jl. Econ. Ent.*, Dec. 1912 and June 1915). At Ames, on 12th January 1912, the temperature dropped to 35° F. In the spring Webster noticed " that many eggs under the oyster-shell scales were yellowish in color instead of the usual white " and infers that the low temperature in January was the cause ; he also says " it would appear that eggs might safely withstand a temperature of –31° F., and yet succumb at –32° F." A temperature of –32° F. is seldom experienced in the apple-growing sections of Canada and consequently the winter killing of eggs here is probably quite unusual.

Parasites.

The eggs of this scale appear to be free from parasites. So far as I have been able to discover there are no published accounts of true egg parasites, and in my own examinations no cases have come to hand. This freedom is not remarkable in view of the minute size of the mussel scale egg. Sometimes one finds a few healthy eggs at one end of a scale and the lemon-yellow hibernating larva of *Aphelinus mytilaspidis* at the other. This condition, as A. D. Imms points out in his interesting paper on this Chalcid (Quart Jl. Micr. Sci. lxvi, pt. 3, March 1916), is probably due to the fact that the female managed to lay a few eggs before being killed by the parasite. It is therefore not a case of egg parasitism or even of egg destruction.

Predators.

Although egg parasites play no part in the control of the insect, egg predators play an important one.

Birds. The eggs of this scale are devoured by birds to a limited extent. Forbush in his "Useful Birds and their Protection" says that "bark lice are . . . on the bill of fare" of cedar waxwings. As these birds go south soon after the eggs of the scale are laid, they cannot be of great importance here. Forbush also speaks of Weed finding in the stomachs of chickadees "remains of what appeared to be the oyster-shell bark-louse." These birds are, of course, welcome members of the Canadian fauna in winter as well as summer. Four years ago in Millville, New

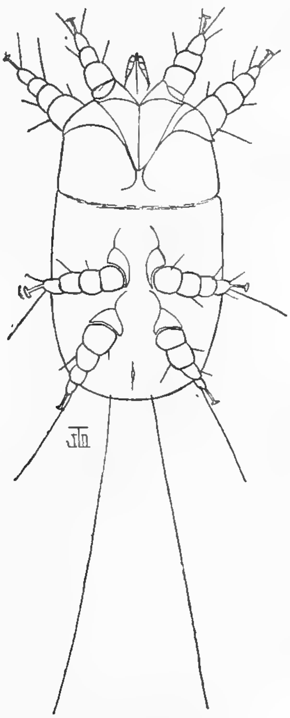

Fig. 2. *Hemisarcoptes malus,* Shimer, ventral view; in Eastern Canada this mite is the most important factor in controlling the oyster-shell scale. (Original.)

Brunswick, I had an opportunity of watching a flock of about twenty red-polls making a meal of oyster-shell eggs from a heavily infested apple tree. Afterwards it was found that the snow beneath the tree was darkened by what must have been thousands of scales dropped by the birds, and the tree was found to be covered with little whitish scars where scales had been. It was estimated that about three-fourths of the scales had been taken. In the same district other trees were found with similar scars. As a factor in control, however, even the red-poll is not abundant enough to be of much importance. An interesting note was given me by the late F. M. McKenzie, who wrote "I remember watching under a field-glass a flock of rose-breasted grosbeaks eating oyster-shell scales off the apple trees near Eagle Rock below Welsford. Some of the limbs were being cleared of them entirely. This was in the winter of 1913–14."

Insects. Coccinellid beetles or their larvae are known to feed on oyster-shell eggs, but the number destroyed in this way in Eastern Canada, where the chief predator is a mite, is probably almost negligible.

Mites. The mite, *Hemisarcoptes malus*, Shimer (fig. 2), which attacks the eggs, though apparently of European origin, was first discovered in Ohio in 1868 and described by Shimer (Trans. Amer. Ent. Soc., v, pt. 1., 1868, pp. 361–374) as *Acarus malus.* This author made a careful study of the habits of this mite and clearly recognized its importance in the control of the scale. In the same year Walsh spoke of the usefulness of what was probably this mite in Illinois (First Rept. State Ent. Ill.).

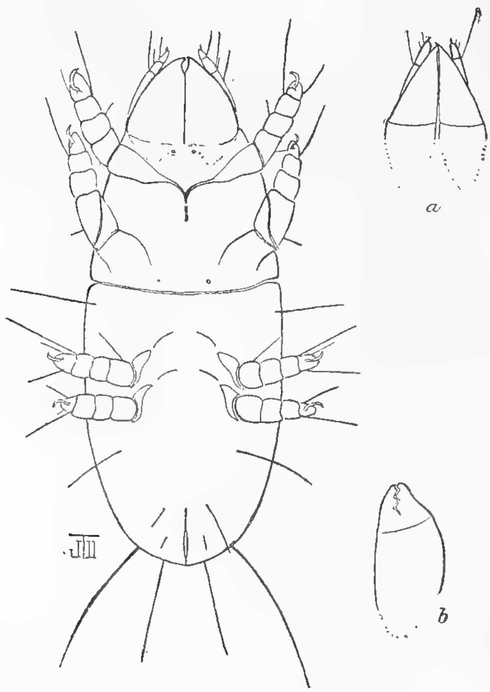

Fig. 3. *Moneziella angusta*, Banks, ventral view; a scavenging mite liable to be confused with *Hemisarcoptes*; *a*, dorsal view of head; *b*, lateral view of jaw or chelicera. (Original.)

Of a number of subsequent records of mites feeding on oyster-shell scale I shall refer only to some of the more important. Of 844 female scales examined by Le Baron in 1870 from Kane and Du Page counties, Illinois, the contents of 254 were found to be "destroyed by Acarids and unknown causes." Riley in his Fifth Report figures a mite that he found feeding on both the eggs and adults of the oyster-shell. In 1881 William Saunders (Canad. Ent. 1881) speaks of "a North American mite which is a friend to the fruit-grower since it destroys the eggs of the oyster-shell bark-louse." The species figured however is the scavenger *Monieziella* (fig. 3) that was doubtless feeding on the egg debris left by the predator *Hemisarcoptes.* Two years later, in his "Insects injurious to Fruits," the same author says "a species of mite, *Tyroglyphus malus,* Shimer, preys on the bark-louse as well as on its eggs; and this mite, so insignificant that it can scarcely be seen without the aid of a magnifying glass, has probably done more to keep this orchard pest within bounds than any other thing." Though the species figured seems once again to be *Monieziella,* the feeding was undoubtedly done by *Hemisarcoptes malus.* H. G. Hubbard, in his "Insects affecting the Orange" (1885), devoted a chapter to organisms preying upon bark-lice and found that mites "exert a constant and very powerful influence in checking their increase." Lignières, working on the oyster-shell scale in France, discovered two mites at work and recognised that one was a predator and the other a scavenger. The predator he called *Hemisarcoptes coccisugus,* but this later proved identical with the species already described by Shimer from North America. His account of the habits of this mite (Mem. Soc. Zool. France, 1893, pp. 16–25) leaves little to be desired. T. D. Jarvis, among his illuminating notes on the habits of many mites (Ann. Rept. Ont. Ent. Soc., 1910) reports this species as "attacking the eggs of oyster-shell scale . . . at St. Catherines, Ontario." He clearly recognized the usefulness of the mite, saying (l.c.) "the mites deserve a great deal of credit for their very efficient service to the fruit-grower, in that they consume large numbers of scale-insects all through the season. . . . Two species are found attacking the eggs of the oyster-shell scale. *Tyroglyphus longior* (*Monieziella*) is very common at Guelph, and *Hemisarcoptes malus* at St. Catherines, Ontario." In August 1912, H. E. Ewing and R. L. Webster (Psyche, xix, no. 4) published an excellent account of "Mites associated with the Oyster Shell Scale." As a result of making examinations of oyster-shell scales from various places in the State of Iowa, these authors say "it is quite evident that the Oyster Shell Scale is in many cases kept in check by mites . . . the most important of which is *Hemisarcoptes malus.*"

In discussing the question of distribution of this mite it seems convenient to commence with the single tree and to pass by easy transitions to the question of continental distribution.

Six collections of twigs were made from the six main branches of an unsprayed apple tree at Fredericton, N.B., that was heavily infested with scale and moderately infested with the mites. From each of the six sets of twigs a hundred scales containing 1916 eggs or egg remains were examined for the mites under a binocular. On every twig the mite was present, the lowest egg destruction being ten per cent. and the highest twenty per cent.; in no case was a scale found packed with mites and dozens were found with one or two or three mites. Thus although the mite was rather scarce on the tree, it was scattered over it in very regular fashion. Such regularity in distribution on a single tree seems to be the general condition and tends greatly to enhance the value of the organism as a factor in the control of the scale.

The mite evidently passes quite readily from tree to tree, perhaps through the medium of tree-visiting organisms. The result is a comparative evenness of distribution through orchards and districts. At Moncton, N.B., scale-infested twigs were examined from ten trees selected at random from the city and surrounding two miles of country. In the case of each twig the turning of a hundred 1916 scales revealed the mite. Seven collections out of ten from various parts of Mount Royal, Quebec, revealed mites. In twenty-one collections from trees in various places in and around the city of Fredericton the mite was found to be present in seventeen cases, in none abundant enough to be controlling the scale, but entirely absent only in four cases. This fairly regular distribution, as at Fredericton, Moncton, and Mount Royal, seems to indicate the ability of the mite to spread readily from tree to tree. The same ability was indicated by finding the mite on a young thorn bush situated rather more than a hundred yards from the nearest possible source of infestation.

In New Brunswick scaly twigs were examined from Moncton, Nerepis, St. Stephen, Woodstock, Kingsclear, Fredericton, Chipman and Chatham; the mite was found to be present at the first six places and absent at the last two. Its presence at Moncton and absence at Chipman is interesting, because these places are a little less than sixty miles apart.

Finally, as to continental distribution, the mite is known to occur in Nova Scotia, Prince Edward Island, New Brunswick, Quebec, Ontario, Massachusetts, Ohio, Illinois, and Iowa. Efforts to secure the scale from the prairie provinces have met with no success, and in those places—probably owing to the scarcity of suitable food-plants—it is evidently exceedingly scarce, if not entirely absent. A number of good collections of scale material have been examined from British Columbia, but so far the mite has not been discovered west of the Rocky Mountains. Europe seems to have been the original home of the mite. To what extent it has followed the oyster-shell scale in its now almost world-wide distribution remains to be determined.

So far as I am aware, *Hemisarcoptes* has been recorded feeding only on oyster-shell and San José scales, and my own observations are confined to its work on the former in Canada.

As soon as the eggs of the scale are deposited the mite begins to feed upon them. By glueing scales to cover-glasses and placing them over cells it was possible to observe the process of feeding. In one case a mite was noticed at 12.30 p.m. with the short proboscis partly sunk into the side of an egg; it was upside down and evidently bent on a meal. During the extremely slow, and from the spectacular point of view rather uninteresting, process of feeding the only movement noticed was a slight working of the fore legs as though to insert its mouth-parts further. At the point of contact the egg had caved in just a little. The mite disengaged itself at 2.30 p.m. and did not seem to be in a gorged condition, although I have seen some that were greatly distended after a meal. The only effect immediately noticeable on the egg was the slightly caved-in area at one side and the tiny hole made by the chelicera, but after a few days the egg began to turn brown and to collapse. In the case of a larger mite the caving in at the point of feeding was much more marked, and as early as the next day the egg had entirely collapsed. On 25th December a mite feeding on an egg had swollen up so as to give the appearance of being as tight as an average drum; and the egg had collapsed in the neighbourhood of the chelicera. In these laboratory experiments some of the mites would not feed at all and others seemed to feed ravenously; in one case six mites ate twenty-four eggs in ten days; in another a large mite ate seven eggs in eight days.

The ability to feed upside-down with apparently as great ease as when in the more normal position is due to the presence of long tarsal suckers, on the tips of which the mites walk, and to the long caudal hairs that adhere tenaciously to surfaces as slippery as polished glass. On glass slides it was found that *Monieziella,* which had no tarsal suckers and much shorter caudal hairs, could not walk at all; *Hemisarcoptes* however—perched up as it were on tip-toe—would quickly walk out of the microscopic field quite as actively on the lower surface of this slide as on the upper. In either case the long caudal hairs were invariably dragged along the surface of the slide and were never carried in the air. This ability to walk on slippery surfaces is probably of considerable assistance in climbing young apple and thorn twigs.

Scaly twigs warmed up in the laboratory were frequently found with some of the adult mites migrating from one scale to another. When the mites have not had a meal for some time they are flat enough to crawl through the very slight opening usually found between the bark and the caudal end of the scale. In a few cases mite-free scales have been encountered where the surrounding ones had all been mite-infested. It seemed that these few scales were so closely attached to the bark that the mites were deterred from entering. The eggs are evidently deposited by these wandering mites in groups of one to six in each scale; they are small, less than half the diameter of the oyster-shell eggs, fairly white, and usually to be found in the posterior end of the scale. Scales have been repeatedly found showing no trace of mite work other than a tell-tale little group of minute eggs in the caudal extremity.

In Canada, as in Iowa and in France, the mite is able to hibernate in any or all of its stages. In material collected in the winter I have found eggs, six-legged forms, and eight-legged adults, though the last have been found in far the greatest abundance. The species maintains its activity at comparatively low temperatures, and this is to a considerable extent responsible for its usefulness, as it enables the destruction of scale eggs to be continued until the days, as well as the nights, become frosty. At Fredericton the mites were found to be active on warm days even in December, although most of the pre-winter feeding was accomplished during August and September, as Shimer found in Ohio. Mites brought into the laboratory in January warmed up sufficiently to walk in a very few minutes, so that the species can evidently make use of any warm days during late autumn and early spring.

The present observations seem to show that *Hemisarcoptes* is perhaps even more useful than has been supposed. Two districts have come to notice in which the scale is evidently on the verge of total extinction on account of the immense numbers of these mites. One of these is Moncton; at this place the infestation of the scale was fairly heavy in 1916, but the mites were so abundant that by 16th October they had killed nearly all the eggs; an estimate of the ten collections itemized on the chart (page 191) indicated an egg destruction of over 90 per cent., and mites were found in all but 2·7 per cent. of the 1,400 sample scales examined; with the mites increasing and the food supply decreasing it seemed certain that by hatching time in 1917 there would be exceedingly few scale eggs left, and a field examination made in October 1917 showed this promise of enormous destruction to have been amply fulfilled (vide fig. 4). Similar conditions were found in a group of places in Huntingdon County, Quebec, including Havelock, Hemmingford, Covey Hill, and Barrington. The conditions at Havelock are typical for the four places ; in this case, of the hundred new scales turned over, nine still had a full complement of healthy eggs, and of ninety-one that were infested with *Hemisarcoptes* only four contained a few healthy eggs.

In these two districts the scale has been plentiful and the mites have had an abundant food supply. With these favourable conditions the mites have evidently increased until the scale has been almost completely destroyed. The conditions at many other places, however, were found to be quite different. In the Arboretum at Ottawa the scale is abundant and the mite is rather less so than at Moncton and the group of places in Huntingdon County (vide table). On Mount Royal, Quebec, the scale is also abundant and the mite still less abundant than at Ottawa. At the end of this series comes Chipman with the scale exceedingly scarce and difficult to find and with apparently no mites whatever.

Such a series of conditions seems capable of interpretation by supposing that when the scale is thick the optimum conditions for the mite prevail and that the mite then increases until finally, as at Moncton, it practically exhausts its food supply. The conditions in the Ottawa Arboretum and at Mount Royal would be transition stages, in which the mite is gradually increasing in proportion to its host. Chipman

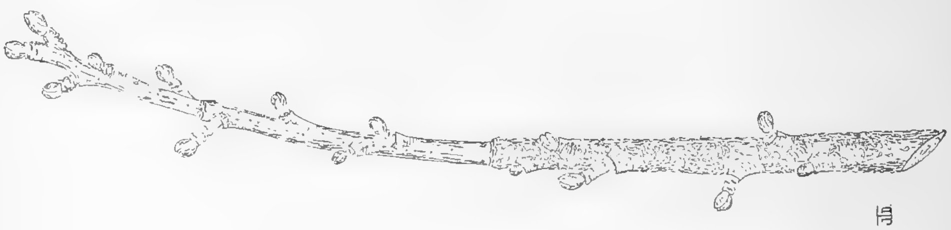

Fig. 4. An apple twig showing extermination of oyster-shell scale by the mite (*Hemisarcoptes*) ; the old (1915) wood is still covered with dead scales, which were killed between September 1915 and April 1916, none being left to infest the 1916 or 1917 wood. (Original.)

has probably been all but freed of scale in this way, as my assistant, Mr. A. B. Baird, reports that it was abundant there only a few years ago and that the elimination has come about without spraying.

Such an interpretation would explain also the almost complete absence of the scale at Campbellton, N.B., and along the St. John River in Madawaska and Victoria Counties, where its food-plants are somewhat abundant and where very little spraying has been done. It would also explain the present scarcity of scale on some derelict apple trees close to this laboratory that four years ago were heavily infested. The curious eliminations of oyster-shell noted by L. Caesar may have been due to an attack by *Hemisarcoptes* ; he says (Ont. Agric. Coll. Bull. no. 209, 1914) " I have on several occasions seen trees that were badly infested throw off the scales in some inexplicable manner and take, as it were, a new lease of life." It at least seems certain that when the scale is abundant this mite is the most important single factor operating towards control in eastern Canada. In places where the host is less abundant the mite becomes proportionately less efficient.

Before concluding this part of the discussion it may be pointed out that Fitch and his contemporaries seemed to regard this scale as a much more serious pest than

Analysis of Oyster-shell Scale Eggs, laid in 1916, *examined for* Hemisarcoptes.*

Locality		Date collected	By whom collected	Trees collected from	Scales examined	Trees with Hemisarcoptes	Scales with Hemisarcoptes	Host eggs destroyed
Moncton ..	N.B.	Oct.& Nov.	W. N. Keenan	10	1400	10	1362	90%–95%
Chatham ..	N.B.	Nov. ..	G. P. Walker ..	3	300	0	0	0
Woodstock ..	N.B.	Mar. ..	G. P. Walker ..	1	100	1	37	35%
Kingsclear ..	N.B.	Mar. ..	G. P. Walker ..	2	200	2	129	60%
Fredericton..	N.B.	Oct.& Nov.	J. D. Tothill ..	21	1600	17	483	15%–20%
Chipman ..	N.B.	Nov. ..	A. B. Baird ..	5	250	0	0	0
Nerepis ..	N.B.	Nov. ..	G. P. Walker ..	3	100	1	21	5%
St. Stephen..	N.B.	Nov. ..	G P. Walker ..	4	250	1	53	5%
Truro	N.S.	Mar. ..	W. H. Brittain	5	24	1	6	1%
Halifax ..	N.S.	Mar. ..	F. C. Gilliatt ..	5*	36	0	0	0
Kentville ..	N.S.	Mar. ..	F. C. Gilliatt ..	5†	245	0	0	0
Middleton ..	N.S.	Mar. ..	F. C. Gilliatt ..	5	435	4	173	35%
Annapolis ..	N.S.	Feb. ..	F. C. Gilliatt ..	5†	230	4	80	25%
Meteghan ..	N.S.	Mar. ..	F. C. Gilliatt ..	5	475	5	250	55%
Weymouth	N.S.	Mar. ..	F. C. Gilliatt ..	5	425	5	241	50%
Yarmouth ..	N.S.	Mar. ..	F. C. Gilliatt ..	5	500	5	319	55%
Montague ..	P.E.I.	Dec. ..	M. H. Coughlan	5	100	1	20	15%
O'Leary ..	P.E.I.	Dec. ..	M. H. Coughlan	6	32	1	5	2%
Stanstead ..	P.Q.	Nov. ..	C. E. Petch ..	13	1300	3	132	3%
Huntingdon .	P.Q.	Nov. ..	L. S. McLaine .	5	500	5	466	90%–95%
Mount Royal	P.Q.	Nov. ..	A. B. Baird ..	10	1000	7	150	10%
Ottawa 1 ..	Ont.	Nov. ..	A. B. Baird ..	5	500	2	8	5%
Ottawa 2 ..	Ont.	Nov. ..	A. B. Baird ..	4	400	4	326	50%
Guelph ..	Ont.	Nov. ..	A. B. Baird ..	10	1000	4	27	1%
Kaslo	B.C.	Feb. ..	J. W. Cockle ..	1	46	0	0	0
Grand Forks	B.C.	Dec. ..	E. C. Hunt ..	4	650	0	0	0
Vernon ..	B.C.	Mar. ..	M.H. Ruhmann	4	500	0	0	0
Lillooet ..	B.C.	Dec. ..	A. W. A. Phair	2	100	0	0	0
Agassiz ..	B.C.	Dec. ..	R. C. Treherne	5	500	0	0	0
Harrison ..	B.C.	Feb. ..	T. Wilson ..	1	400	0	0	0
N. Nicoamen	B.C.	Jan. ..	T. Wilson ..	2	515	0	0	0
N. Vancouver	B.C.	Dec. ..	T. Wilson ..	2	355	0	0	0
Kuper Island	B.C.	Mar. ..	T. Wilson ..	1	200	0	0	0
Indian Reserve	B.C.	Mar. ..	T. Wilson ..	1	300	0	0	0
Victoria ..	B.C.	Jan. ..	E. W. White ..	4	1700	0	0	0
Alberni ..	B.C.	Feb. ..	T. Wilson ..	2	500	0	0	0
Duncan ..	B.C.	Mar. ..	T. Wilson ..	1	110	0	0	0
Ithaca ..	N.Y.	April ..	R. Matheson ..	4	550	0	0	0
				181	17839	83	4288	

* Very lightly infested. † Sprayed trees.

This table shows the importance of the mite *Hemisarcoptes* as a controlling factor of the oyster-shell scale in places where the insect is abundant. It also indicates that the mite has not apparently yet found its way into British Columbia.

* Reproduced from Agric. Gaz. Canada, March 1918.

it is generally considered to-day. Writing in 1856 (First and Second Reports) Fitch says " The bark-louse is on the whole the most pernicious and destructive to the apple tree at the present time of any insect in our country. Everywhere throughout the northern States it is infesting the orchards to a grievous extent," and again (l.c.) " In those districts bordering upon Lake Michigan in particular it is at the present time making the most appalling havoc, surpassing anything which has hitherto been reported of this species." This seeming difference may be due to an absence of *Hemisarcoptes* on this continent for many years after the introduction of the scale. Harris (" Insects Injurious to Vegetation ") says " The first account that we have of the occurrence of bark-lice on apple trees in this country is a communication by Enoch Perley of Bridgetown, Maine, written in 1794." As the mite was not discovered here until seventy-four years later it seems possible that the mussel scale at first enjoyed a mite-less regime on this continent.

Control in Postembryonic or Summer Stages.

Weather.

After the eggs begin to hatch inclement weather is probably the greatest enemy until the insects come to be covered with a protecting roof. Regarding this period Franklin Sherman, Jr. (N.C. Dept. of Agr. Bull. no. 185) says " We believe that heavy showers at the time when the tiny young are crawling wash off hundreds of them and leave them to perish on the ground. Sudden gusts of wind must blow away many more, and though by this means a few may find lodgment on other trees . . . still the majority which happen to be blown off the trees must inevitably perish. But . . . the extent to which the weather aids us is uncertain."

Overcrowding.

It sometimes happens that the scales become so numerous on a tree that overcrowding and starvation take place ; this seems to act as a very important check in

Fig. 5. Showing over-crowding of oyster-shell scales on an apple twig ; the full-sized ♀ is surrounded by a number of dwarfed ♀♀, some of which did not live to lay eggs and none of which laid more than a fraction of the normal quota.

Canada. Many cases have been found in which practically all the 1916 females on a twig died from this cause before egg-laying had begun. In one case in which there was overcrowding on the upper side, there was scarcely a scale on the lower side; it seems that the inviting warmth of the sun may have been responsible for the scramble to the upper side of the twig at the time of migration. With the overcrowding carried to an extreme the twig dies and with it the scales. When the crowding is less, a result is that fewer eggs are laid per scale. Of a hundred female scales taken at random from such a twig the average number of eggs was five, whereas the normal would have been nearer fifty. Female scales dwarfed in this way by overcrowding are shown in fig. 5.

Weakened by overcrowding the scales seem more susceptible to a fungus disease that at times helps considerably in the control. L. Caesar (Ont. Agric. Coll. Bull. no. 219) speaks of "a reddish fungus disease" that occasionally does some good. On a small roadside apple at Fredericton the scales were so numerous that overcrowding had occurred and a reddish fungus disease had killed about a third of the females. A few other cases of a similar kind have come to my notice—all from New Brunswick. In one instance the overcrowded scales on an apple near Millville had nearly all been attacked. Twigs showing a similar condition have been given me by R. P. Gorham.

Parasites.

Fitch was apparently the first to observe true parasitism of the scale. In 1856 he writes "Under these scales I have also repeatedly met with a small maggot . . . of a honey-yellow color, and divided into segments by faintly impressed transverse lines. This is probably the larva of some minute Hymenopterous insect, especially designed by Providence for destroying the eggs of the bark-louse." In 1870 LeBaron described this insect as *Chalcis* (*Aphelinus*) *mytilaspidis*. Since that time its habits have become generally known and have recently formed the subject of an excellent account by A. D. Imms (Quart. Journ. Micr. Sci., vi, pt. 3, March 1916). This species and five less important parasites have been carefully studied on this continent by L. O. Howard. The five other parasites of the bark-louse are *Aspidiotiphagus citrinus*, Craw, *Aphelinus fuscipennis*, *A. abnormis*, *Anaphes gracilis*, and *Chiloneurus diaspidinarum*, all described by Howard.

In Canada *Aphelinus mytilaspidis* was reared from the scale by Alfred Eastham at Guelph, Ontario (Forty-first Ann. Rept. Ent. Soc. Ont., p. 74). It has also appeared, often in some numbers, from material gathered for the present studies from New Brunswick, Nova Scotia, Quebec, Ontario, and British Columbia. Here it is the only parasite that seems to be at all efficient in control. As is pointed out by both Dr. Howard and Dr. Imms, its effectiveness is unfortunately somewhat undermined for the reason that the parasitised scales sometimes lay from two to twenty eggs before being killed by the parasites. In England Imms found a parasitism by this species of about 7 per cent. In the Canadian material examined the percentage was usually less. In a few cases however it has been quite high. In collections from Agassiz, B.C., the percentage ranged from 10 to 40 per cent. Material from the Experimental Farm at Ottawa showed one case of 40 per cent. and one of 49 per cent. parasitism by this insect. The highest parasitism that has come to my notice was a case of 75 per cent. destruction of scales in Lake County, Illinois, in September 1914.

Predators.

Birds. As the scales grow larger a few probably become the prey of birds. In summer however other insect food is much more easily available. Forbush mentions cedar birds, chickadees, and the white-breasted nuthatch as at least occasionally feeding on this scale; and Slingerland and Crosby add the brown creeper to this list. Concerning the part played by birds in the control of scale-insects in general, Jarvis says (l.c.) " It is highly probable that these insectivorous birds rank first in the control of the larger kinds of scale-insects, such as *Eulecanium, Coccus,* and *Kermes.*" He suggests that the part played by birds in the control of smaller scales is rather inconsiderable.

Insects. Predaceous insects undoubtedly take a levy of the growing scales. Dr. Howard in " The Insect Book " remarks that " While the lice are young and before they have formed a protective scale they are avidly destroyed by the larvae of the syrphus flies, of the lace-wing flies, and by certain small predatory bugs. The most efficient of their natural enemies however are probably the ladybirds." Slingerland and Crosby say (l.c.) " Some of the ladybird beetles, the twice-stabbed especially, devour many " of these sca es. In Canada it seems that the part played by predaceous insects in the control of the pest is quite a minor one.

Mites. Mites, and more especially *Hemisarcoptes* (fig. 2), take a certain levy from the growing scales. In a letter to the editor of the Canadian Entomologist Riley in 1878 says " The *Dermaleichus* figured in my . . . Report feeds upon the eggs of *Mytilaspis pomicorticis,* as well as upon the insect proper under the scale; " the mite referred to is probably *Hemisarcoptes.* Lignières (l.c.) evidently watched these mites feeding upon young oyster-shell scales. Saunders in his " Insects Injurious to Fruits " says " A species of mite . . . preys on the louse (oyster-shell) as well as on its eggs."* Banks (U.S. Report, no. 108) says of this mite " It feeds on the eggs or on the scale." Ewing and Webster (l.c. p. 126) found one of these mites with its beak imbedded in an adult scale.

Through the summer of 1917 A. B. Baird made a series of observations at Moncton and found that although the mites did not feed to any great extent on the young scales yet they fed greedily upon the large ones. In one case five hundred scales were examined under a binocular and Baird found 85 per cent to 90 per cent. killed by *Hemisarcoptes.* The usual condition was to find in these scales one large mite and ten to fifteen little ones all in the anterior end of the scale.

My own observations, confined to examinations of material collected during the past fall and winter, have shown many instances in which females had died, and not from overcrowding, before eggs had been deposited. The explanation suggests itself that these scales had been attacked in June and early July by the mite.

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* Dearness in 1901 reports this mite feeding on San José scale in Ontario. He says " Last year (1899) I received a package of twigs, mostly San José, from Mr. John Gordon, Guilds P.O., Kent County, on some of which there were . . . mites preying on the well-grown female. . . . On some specimens received this year from the same neighbourhood these mites were very numerous . . . as many as eighteen larval mites were observed under one large scale."

Conclusion.

By way of conclusion it may be said that overcrowding, parasitism by *Aphelinus mytilaspidis*, and destruction by *Hemisarcoptes malus*, are in Canada the most important factors in the natural control of the mussel scale. Of these the last is by far the most important. As hundreds of the mites can be sent through the mail on an apple twig it should be possible to colonize it in scale-infested places and countries where it may prove to be absent from the local fauna.

Appendix.

As in the past several species of mites associated with oyster-shell scales have been confused, it seems advisable to give a brief comparative account of those most commonly found in Canada. These mites have been determined through the kindness of Mr. Nathan Banks.

The two mites most abundant are whitish or colourless and consequently somewhat resemble the pearly white eggs of the scale. Of these one is *Hemisarcoptes malus,* Shimer (fig. 2), which feeds on healthy eggs; the other *Monieziella angusta*, Banks (fig. 3), a scavenger on the carcase of the females and on the eggs killed and partly eaten by *Hemisarcoptes.* At first glance these look somewhat alike, but closer observation shows that *Hemisarcoptes* is turtle-shaped, fairly active, and supplied with conspicuous tarsal suckers; while *Monieziella* is an elongate, sluggish creature supplied with weak tarsal claws and no suckers. *Hemisarcoptes* is invariably found under scales containing at least some healthy eggs, while the scavenger is usually found under scales with no healthy eggs. The scavenging habit of *Monieziella* was first established by Lignières in France. In Canada, of several thousand scales infested with this mite only two were noted in which the Acarid was feeding on living eggs, in all other instances it was feeding on dead eggs or dead material. This scavenger was often more abundant than the predator, *Hemisarcoptes.* As many as eighteen and twenty have been found beneath a single scale, and sometimes they are present under all the scales on a twig.

The other mites found are coloured, ranging through shades of brown and red. Of these I have found four in some numbers. The smallest most active, and most abundant, *Tydeus gloveri*, Ashm., is easily recognised by the presence of a rather striking median vitta on the caudal part of the abdomen. It is more or less gregarious in habits, fifteen or twenty sometimes collecting under a single scale. Though widely distributed over the continent—I have specimens from Massachusetts, New Brunswick, Quebec, Ontario, and British Columbia—it plays little or no part in the control of this scale, as I have found it only under old scales where it had gone to hibernate. This is probably the species identified as *T. coccophagus* by Ewing and Webster. Another of these coloured mites, *Gamasus* sp. (fig. 6), also found hibernating under old scales and playing no part in control, is much larger than the above species. Of these only three or four can huddle into one scale. It can be easily distinguished by the presence of a pair of conspicuous whitish markings extending fully three-fourths of the length of the body. It has appeared in New Brunswick, Quebec, Ontario, and British Columbia. A third coloured mite, found hibernating in considerable numbers under old scales at Covey Hill, P. Q., is one of the snout mites, *Bdella brevitarsis* Banks (fig. 7), easily recognized by the snout-like beak and geniculate palpi. A few specimens of a fourth, more hairy, coloured mite of about the same size as the two preceding, were found hibernating under old scales at Covey Hill. This species is a *Galumna*.

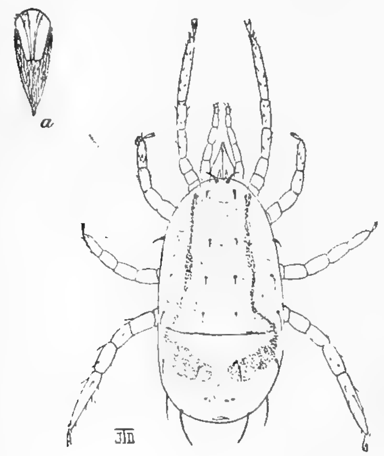

Fig. 6. Nymph of *Gamasus* sp., which sometimes hibernates under mussel scales. (Original.)

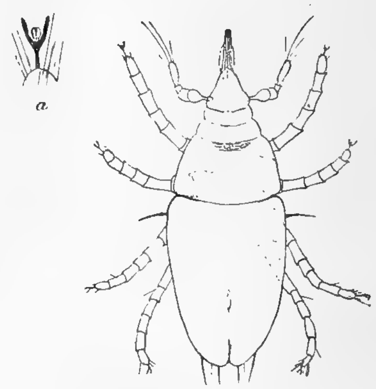

Fig. 7. Dorsal view of *Bdella brevitarsus*, Banks, a mite that sometimes hibernates under mussel scales. (Original.)

Though examination of more material would undoubtedly reveal still other species of mites using the convenient empty scales for winter shelter, none of these coloured mites seem to have more to do with the control than did a budworm larva safely housed for the winter in one of the old scales. At any rate there are no positive data that any of these mites, or the additional ones mentioned by Ewing and Webster (l.c. p. 129), ever feed on the oyster-shell scale.

In a word, then, of these half-dozen mites the red and brownish species use old scales for hibernation and are probably not factors in control. Of the uncoloured or whitish species more closely associated with this scale, one, *Monieziella*, is a scavenger and the other, *Hemisarcoptes*, a true predator on both eggs and adults.

THE COCCIDAE OF SOUTH AFRICA—III.

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(Plates XII–XVI.)

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Genus **Cryptaspidiotus**, Lindinger.

Like *Aspidiotus*, except that the adult ♀ remains enclosed in the skin of the 2nd stage, with the exception of the pygidium, which extends through the hind part of the enclosing skin, beyond the posterior margin of the 2nd stage female (fig. 114).

97. **Cryptaspidiotus austro-africanus,** Lindg. (Plate xii, fig. 114).

A. austro-africanus Lindinger, Jahrb. Hamb. Wiss. Anst., xxvii, p. 505, 1910, and xxvii (3), p. 41, 1911.

The ♀ of this species makes conical depressions in the stems of its host-plant. The body of the insect is thus below the general surface and is covered by the scale, which is generally level with, or slightly below, the surrounding plant tissue.

Female scale flat, ± circular, whitish grey or yellowish, with ± central exuviae which are darker yellow. Scale about 1 mm. in diameter.

Adult ♀ enclosed in the 2nd stage skin, pear-shaped, almost colourless, with rounded yellowish pygidium. Pygidia of 2nd stage and adult as illustrated in natural position (fig. 114). Circumgenital glands 0.

Second stage ♀: P_1, L_1, $2P_2$, L_2, $2P_3$, L_3, 3–5P_4.

Adult: P_1, L_1, P_2, L_2, L_3.

In the adult the lobes are undeveloped, and appear as irregular projections of the margin, and the plates are generally obscure or absent. There is a long stout spine immediately outside the median lobes, and a pair of shorter ones outside L_2 and L_3.

Habitat: On *Euphorbia* (tree), Mariannhill, Natal (type locality).

Collection No.: 215.

Genus **Chrysomphalus,** Ashm.

Scales $\pm$ similar to those of *Aspidiotus*, but usually darker, or more compact, robust, and capsular; generally circular, with central exuviae; sometimes $\pm$ elongate, with the exuviae towards one end. Pygidium with at least three pairs of lobes and *strong, very often long paraphyses.* Beyond the outer lobes the body margin is often thickened and $\pm$ toothed.

Three sub-genera are recognised, which may be distinguished by the following particulars :—

1. Scale neat, smooth, much like *Aspidiotus*, with bright, $\pm$ transparent, usually reddish or yellowish exuviae; pygidium with three distinct pairs of lobes and beyond these three distinct plates; e.g., *ficus*, *dictyospermi*, etc. *Chrysomphalus* (s. str.).
2. Scale with dark, usually black exuviae; plates most often fused.
   (*a*) Scale dense, slightly capsular, often partly hidden by outer layers of bark; pygidium triangular or keel-shaped, strongly pointed, with three pairs of lobes and beyond these some plates; plates all short, inconspicuous, usually forked, as if formed by two or more dagger-shaped plates fused together; e.g., *obscurus*, *corticosus* .. .. *Pseudischnaspis.*
   (*b*) Scale very dense, entirely capsular, often obscured by bark, rounded, with four pairs of lobes and beyond these no plates, or only inconspicuous ones; plates usually small; e.g., *phenax* .. .. *Melanaspis.*

Key to South African Species of Chrysomphalus.

A. Pygidium with 3 pairs of lobes.

a. Pygidium with well-defined plates.

(1) Scale transparent, showing reddish ♀ below; P_4 not much longer than L_3; circumgenital glands 0 (fig. 118) .. .. .. *C. aurantii,* Mask.

(2) Scale dark with orange red exuviae; circumgenital glands present (fig. 117). *C. ficus*, Ashm.

(3) Scale black, with greyish or brownish exuviae; circumgenital glands present (fig. 116) .. .. *C. rossi,* Mask.

(4) Scale brownish; P_4 much longer than L_3; circumgenital glands present (fig. 115) .. .. *C. dictyospermi,* Morg.

b. Pygidium without well-defined plates.

(5) Scale dark brown, greyish or blackish, usually covered by bark tissues; circumgenital glands present (fig. 119) .. .. *C. corticosus,* sp. n.

B. Pygidium with 4 pairs of lobes.

(6) Scale black, capsular ; plates inconspicuous ; circumgenital glands 0 (fig. 120) *C. phenax*, Ckll.

98. **Chrysomphalus aurantii** (Mask.) Ckll. (Plate xii, fig. 118).

Aspidiotus aurantii, Mask., N Z. Trans., xi, p. 100, 1878.

Aspidiotus citri, Comstock, Canad. Ent., xiii, p. 8, 1881.

Aonidiella aurantii, Berl., Riv. Pat. Veg., iv, p. 83, 1895.

Chrysomphalus aurantii, Ckll., Check List Sup., p. 396, 1899.

Common Name : Red Scale.

Female scale about 2mm. in diameter, nearly circular, often slightly broader than long, with thin flat margins and the central area flatly convex, generally appearing shiny or polished. The orange-red or yellowish colour is due to that of the female insect beneath the scale. The dorsal scale is thin, pale yellowish-grey, and almost transparent. Its true character is often visible only at the extreme margin of the scale. The exuviae are regularly central, orange-red or yellow, covered by a thin layer of secretion, and there is a small prominent spot with a concentric ring of whitish secretion in the centre of the larval exuviae. The ventral scale is complete, and stout at the margins, remaining attached to the dorsal scale. The adult ♀ is thus enclosed when the scale is removed and is extracted only with difficulty, except in boiling KOH.

Male puparium about 1 mm. long and 0·6 mm. broad, $\pm$ oblong, but narrowed behind, dull reddish-brown, paler at the margin. Exuviae towards the anterior end, often slightly more reddish than the scale itself, and covered with secretion as in the ♀ scale.

Adult ♀ viviparous ; when alive, orange-red, reniform, with the abdominal segments retracted and often enclosed by the sides of the thorax. The body is flat beneath and convex above, with the skin moderately hard and chitinous. When mounted the body of mature specimens retains its characteristic shape, and the average size is 1·1 mm. long and 1·3 mm. broad. In younger forms the body is broad pear-shaped.

Antennal tubercles small, set well back from the mouth-parts, with one long, slightly curved spine.

The pygidium (fig. 118) with three pairs of well-developed lobes and well-defined plates. L_1 and L_2 usually distinctly notched on both margins, the outer notch of L_2 being more pronounced ; L_3 usually only notched on the outer margin ; L_2 is a little smaller than L_1, and L_3 than L_2. P_1, P_2 and P_3 not very broad at the base, with long projections, of which the outer ones are slightly branched. L_4 wide at base, with elongate projections, of which there are normally two plates (*a*) an inner part which is simple, and (*b*) an outer which is feebly branched and whose outer edge is toothed. Paraphyses short and more delicate than in the other South African species of *Chrysomphalus*. Circumgenital glands absent ; exceptional specimens have been observed where a solitary gland has been present and Lindinger reports specimens from the tropics in which an anterior group is represented by 1–2 glands. Formula : P_1, L_1, $2P_2$, L_2, $3P_3$, L_3, $3P_4$.

Historical Note: When Mr. C. P. Lounsbury first came to South Africa as Entomologist of Cape Colony, in August 1895, *A. aurantii* was one of the first insect pests to attract his attention. In his 1896 Report, p. 48, he states :—

"The Red Scale is wide-spread and destructive in Cape Colony. I have been unable to find any clue to the time or place of its introduction into this country, but its general occurrence in nearly all parts of the Colony, as well as in the neighbouring states, would seem to be a good indication that it has been with us a long time. Aged farmers claim to have known it in their boyhood, and an observant Cape Town gentleman, who has always taken a great interest in gardening, is positive that it was present on orange trees on his father's estate at Sea Point (near Cape Town) as far back as 1857. I have seen it in all of the dozen or more districts that I have visited, and have received it from at least a dozen others. But in many isolated orchards it does not yet occur, although in a few cases known to me the trees are upward of a hundred years old."

It seems highly probable that this insect had been introduced years before, possibly with citrus trees from the East, may be Java, when trees were brought by the commanders of the old East India Company vessels as presents for the Constantia or Cape Peninsula inhabitants who entertained them. This would account for the hold the species had on the old oak trees (often far removed from citrus), on apple and pear, and on the old rose hedgerows, some of which were killed by the pest. It is now widespread throughout the Union and its list of food-plants very large and varied.

Habitat: Common throughout the Union. It is most commonly a serious pest on citrus, rose, apple, pear, oak, mulberry, camphor and privet. It has also been reported on :

Abutilon, *Acacia* spp., *Acer*, *Agave*, alder, almond, aloe, *Ampelopsis*, *Aralia*, *Aucuba*, *Araucaria* spp., asparagus, avocado pear, *Bauhinia*, belhambra (*Phytolacca dioica*), *Benthamia*, *Berberis*, *Bignonia*, *Bougainvillea*, *Bouvardia*, box, broom, *Callistemon*, *Camellia*, carob, castor-oil, *Casuarina*, *Cedrela*, *Cestrum*, chestnut, chilli, *Choisya*, *Chrysophyllum*, *Clerodendron*, clematis, *Clivia*, *Convallaria*, *Coprosma*, *Cordyline*, *Cornus* spp., *Cryptomeria*, *Cupressus* spp., currant, cycads, *Cyperus*, dahlia, *Deutzia*, *Dombeya*, *Doryanthes*, *Duranta*, *Dracaena*, *Elaeagnus*, essenwood, *Eucalyptus*, *Eugenia*, *Euonymus*, *Ficus* spp., *Forsythia*, frangipani, fuchsia, ginkgo, *Gleditschia*, grape, *Grevillea* spp., *Greyia*, guava, *Gynura*, *Hakea*, hawthorn, holly, *Hydrangea*, *Impatiens*, ivy, *Jacaranda*, jasmine, kaffirboom (*Erythrina* sp.), Kei-apple, *Kennedya*, *Libonia*, lilac, *Liriodendron*, laurel, *Lagerströmia*, *Mackaya*, mango, mangosteen, *Maranta*, *Melia*, New Zealand flax, oak, oleander, orchids, *Osmanthus*, palms, *Pandanus*, peach, poeny, *Penstemon*, persimmon, phlox, *Pinus* spp., *Pittosporum*, plane, plum, *Poinsettia*, poplar, quince, *Rhamnus* sp., *Robinia*, *Salvia*, sneezewood, *Sophora*, *Spiraea* spp., *Statice*, *Sterculia*, *Strelitzia*, *Taxodium*, *Thuya*, *Trichilia*, *Trichocladus*, *Tristania*, *Toxicophlasa*, *Veronica*, *Viburnum*, walnut, willow, wistaria, *Yucca* and *Zinnia*.

Collection No.: 234.

99. **Chrysomphalus ficus,** Ashmead (Plate xii, fig. 117).

Chrysomphalus ficus, Ashm., Am. Ent., iii, p. 267, 1880.

Aspidiotus ficus, Comst., Rept. U.S. Dept. Agr., p. 296, 1881.

Chrysomphalus aonidum, Ckll., Biol. Cent. Amer., ii, pt. 2, p. 25, 1899.

Aspidiotus ficus, Fuller, 1st Rept. Ent. Natal, p. 100, 1901.

Aspidiotus ficus, Newst., Mon. Brit. Coccidae, i, p. 104, 1901.

Chrysomphalus aonidum (Linn.) Fernald, Catalogue, p. 286, 1903.

Scale of adult ♀ circular, about 2 mm. diameter, purplish brown or blackish, with distinct reddish or orange red exuviae. In fresh specimens, especially on rose, the scale is covered by a delicate waxy bloom. In young specimens the covering of the first exuviae is white.

Male puparium dark brown, with pale margins and reddish exuviae.

Adult ♀ broadly rounded in front, broad pear-shaped and noticeably pointed behind, about 1 mm. long, yellow in colour when mature, very pale or almost colourless when young. In mounted specimens the broadest part of the body is seen to be situated a little posterior to the level of the mouth-parts. In front of this point the cephalothorax is uniformly rounded, but suddenly narrows by a slight shoulder on each side and from this point tapers gradually to the pygidial margin. Each shoulder is armed with a small sharp series of slender spines placed at wide intervals.

The pygidium (fig. 117) has three pairs of well developed lobes which are sub-equal in size: L_1 and L_2 distinctly once notched, L3 with the outer margin $\pm$ serrate, or crenulate. Plates rather deeply fringed. Beyond the lobes and plates the margin is thickened. There are five pairs of prominent paraphyses, as shown in fig. 117; occasionally there is an indication of an additional small one from the outer edge of L_3. Circumgenital glands in 4 groups:—

6—8 6—8
2—4 2—4

Formula: P_1, L_1. $2P_2$, L_2, $3P_3$, L_3, $3P_4$.

Habitat: Common, especially in the coastal area of the Union, on a large variety of plants, including avocado, camellia, citrus, palm, rose, fig, guava, ivy, mango, oleander, privet, "umbenda" (native tree), and many others.

Collection No.: 233.

100. **Chrysomphalus rossi** (Mask.) (Plate xii, fig. 116).

Aspidiotus rossi, Mask., N.Z. Trans. xxiii, p. 3, 1890.

A. (*Chrysomphalus*) *rossi,* Ckll., Bull. U.S. Dept. Agr., T.S. 6, p. 27, 1897.

Chrysomphalus rossi, Leon., Gen. e Spec. Dias. Asp., p. 157, 1900.

Scale of adult ♀ usually large, about 3 mm. in diameter, generally circular, but elongate on narrow leaves such as pine, or when against the mid-rib of a leaf; dull opaque black, with a brownish or greyish centre.

The adult ♀ is broad pyriform, purplish or deep plum-coloured, with the pygidial extremity yellowish. The abdominal segments are not produced and segmentation is obscure. The antennal tubercle is small, with one long hair and one short spur. There is a submarginal series of hairs around the body at wide intervals. Parastigmatic glands 0.

The pygidium (fig. 116) has three pairs of well-developed lobes, the outer edges of which slope backward, conforming with the curve of the pygidial margin. Each lobe is notched once on its outer edge. The plates are broad and deeply fringed. Beyond the lobes and plates the margin is thickened and has chitinous processes similar to the paraphyses but thinner and more indefinite. It is $\pm$ notched, but not roundly indented as in the variety mentioned later. There are 7 definite pairs of paraphyses, as shown in fig. 116. Circumgenital glands in 4 groups :—

7—9 7—9 8—8
3—5 3—5 usually 4—4

Formula :—P_1, L_1, $2P_2$, L_2 $3P_3$, L_3, $3P_4$.

Habitat: Cape Town, East London, Grahamstown, Queenstown, Estcourt, Dundee, Durban, Pietermaritzburg, Johannesburg, Pretoria, Krugersdorp, Pietersburg, Bloemfontein.

C. rossi is commonly found on :—*Acacia melanoxylon, Buxus* sp., *Euonymus, Hakea*, ivy, oleander, *Phormium tenax*, and *Pinus pinaster* ; and it has also been recorded on :—*Aucuba*, bottle-brush (*Callistemon*), *Camellia, Carissa, Cordyline, Ceratonia, Cupressus* spp., croton, *Dracaena, Grevillea*, hawthorn, ilex, laurel, mahogany, oak, *Pandanus*, palms, pepper, rose and *Yucca*.

Collection No. : 238.

100a. **Chrysomphalus rossi** (Mask.) var. **greeni,** Brain & Kelly.

Aspidiotus rossi, Green, Cocc. Ceylon, i, p. 35, 1896.

Chrysomphalus rossi var. *greeni*, Brain & Kelly, Bull. Ent. Res., viii, 2, p. 184, 1917.

Mr. Green's description of this insect, omitting figure references, is as follows :—

"Female puparium circular, or irregularly oblong, flattish, opaque, reddish brown or dark brown; inner surface darker, almost black. Pellicles blackish, frequently obscured by a layer of brownish secretion, with central boss and concentric ring; sometimes depressed, sometimes slightly elevated. Ventral scale obsolete, a white powdery film on surface of leaf, except at margins, where it is stouter and adheres to the dorsal scale. Diameter 2 to 3 mm.

"Male puparium stated by Maskell to be smaller and lighter in colour than that of the female. I have not found the male insect in Ceylon.

"Adult female broadly pyriform, terminal segment tapering suddenly to a point; median area tumescent; margins flattered. Colour of living insect at first milky white or ochreous, tinged with purplish, which deepens with age and extends over the greatest part of the thorax, the flattened marginal area and the abdominal segments remaining ochreous. Colour of dead and dried insect, brownish yellow. Stigmata conspicuous; no parastigmatic glands. Pygidium with six prominent, obscurely tricuspid lobes, all well developed and sub-equal in size; margin beyond the lobes with seven projecting tooth-like processes, forming a bold and regular serration; margin between the lobes squarely but not deeply incised. Squames deeply fringed, two between median lobes, two between first and second, three between second and third, and one or two in the space between the third lobe and the first marginal prominence. Circumgenital glands in four groups; upper laterals with 9 to 12 orifices, lower laterals with 8 to 9, their position indicated in the living insect by the presence of four white waxy patches. A large number of very delicate filiform tubular spinnerets, opening on the dorsal surface by small and rather inconspicuous pores arranged in definite series running upwards from the margin. Larger cylindrical or trumpet-shaped ducts nearer the extremity, opening on the margin between the lobes. Anal aperture slightly caudad of the lower spinneret groups. Length, about 1·50 mm.

"Adult male unknown.

"Eggs pale purplish. Hatched shortly after extrusion. Well-developed embryos can be seen within the body of the parent insect.

"Young larvae very pale reddish, broadly oval; caudal setae short.

"Habitat in Ceylon on under-surface of leaves of *Capparis moonii*."

I find what is undoubtedly this species on a native tree (*Chaetachme aristata*, Planch.) at Durban and also on a native shrub from East London, C.P. (Cape No. 1248). This is certainly distinct from typical *rossi*, of which I have abundant material from Australia, and is readily distinguished by the following characters :—

C. rossi, Mask.	var. *greeni*.
♀ scale black, with lighter area over exuviae.	♀ scale brown, with darker area over exuviae.
Margin of pygidium, beyond lobes and plates not deeply notched.	Margin deeply notched or bayed in.
Circumgenital glands :— 7—9 7—9 3—5 3—5	Circumgenital glands :— 9—14 9—14 7—11 7—11

The whole pygidium of the variety is wider than in *rossi*, and in a few cases, at maturity, the pygidium is retracted.

Collection Nos.: 211, 249.

101. **Chrysomphalus dictyospermi** (Morgan) (Plate xii, fig. 115).

Aspidiotus dictyospermi, Morgan, Ent. Mo. Mag., xxv, p. 352, 1889.

Aspidiotus dictyospermi var. *arecae*, Newst., Ent. Mo. Mag. xxix, p. 185, 1893.

Chrysomphalus degeneratus, Leonardi, Riv. Pat. Veg. iv, p. 345, 1896.

A. (*Chrysomphalus*) *dictyospermi*, Ckll., Bull. U.S. Dept. Agr., T.S. 6, p. 23, 1897.

Chrysomphalus minor, Leon., Riv. Pat. Veg. vii, p. 214, 1899; id., Gen. e spec. Dias. Asp. p. 169, 1900.

Chrysomphalus dictyospermi, Fernald, Catalogue, p. 289, 1903.

Scale of adult female ± circular, about 1·7 mm. in diameter, flat at margins with raised centre, reddish-greyish, to dark-brown with paler margins, often semi-transparent. Exuviae yellowish to blackish-brown from above, but bright reddish-brown and glossy from below. In one lot of material on guava from Barberton (No. 236a) the entire ♀ scale is brown, matt, with the exuviae concolorous.

Male puparium more elongate, about 1 mm. long and 0·7 mm. broad, more greyish-brown in colour.

Adult ♀ partly viviparous at least; mounted specimens usually contain many embryos. When mounted, broad pear-shaped, about 1·2 mm. long and 1 mm. broad, hyaline, margin with a sparse marginal series of spine-like hairs.

The pygidium (fig. 115) is very much like that of *C. ficus*, but can be readily distinguished by P_4. There are usually 3 of these plates, of which the first two from L_3 are divided into two parts, the inner half being small and linear, the outer much longer and broadened, reminding one of an inverted *Cupressus pyramidalis* tree. Small variations are noticeable in the lobes and paraphyses, of which the most striking are: (*a*) the lobes are normally decidedly notched on their outer margins, the notch being often absent from L_1 and L_2 in old specimens; (*b*) the fourth pair of paraphyses from the middle line are sometimes much broadened near the apex and do not appear to extend to the margin. Very thin, delicate tubular glands numerous. Circumgenital glands in 4 groups :—

4—5 4—5
1—3 1—3

Formula :—P_1, L_1, $2P_2$, L_2, $3P_3$, L_3, 2–$3P_4$.

Habitat: On guava; collected by J. W. Hodgson, Barberton, Tvl., 17th June, 1915. On palm and rose, Pretoria; collected by Miss Impey, April 1916. On umkovoti (*Chaetachme aristata*, Planch.) Durban, Natal; collected by C. Fuller. On camellia, Pietermaritzburg; collected by A. Kelly. On mango, Nelspruit; collected by J. W. Hodgson. Also on *Cupressus macrocarpa*, rose, peach, etc., from Cape Town, East London, Kingwilliamstown and Kimberley.

Collection Nos.: 236, 236a, 242, 244.

102. **Chrysomphalus (Pseudischnaspis) corticosus,** sp. n. (Plate xii, fig. 119).

Common Name: South African Obscure Scale.

Scale of adult ♀ varying greatly on different host-plants. On smooth-barked plants it is very large and flat, reaching 3·2 mm. in diameter, brownish to black in colour, with the blackish exuviae covered. As a rule, however, the scale is almost or entirely covered by the outer layers of bark of the host-plant. On *Rhus* this is usual, and it has been submitted on many occasions as a burrowing scale. On *Robinia* the scale takes the greyish appearance of the bark, but the black exuviae are very conspicuous with a greyish white concentric ring. On wild olive, on the other hand, it forms a thick crust of blackish or greyish black scales, which easily flake off. The scale itself, without any admixture of tissues, is pitchy black, with concolorous exuviae. Seen from below the scale is domed and very glossy. The ventral scale is delicate and usually remains on the host-plants.

The adult ♀, when alive, is purplish to plum-colour, but turns dull brown when old or dead. The body is broad pear-shaped, about 1·5 mm. long and 1·2 mm. broad. Antennal tubercles small, with one long, curved seta. Parastigmatic glands 0. The arrangement of lobes and plates is very similar to that of *obscurus* (fig. 121), to which this species is very close. The most striking differences in the pygidium are the longer and stouter paraphyses, the presence of two distinct paraphyses between the median lobes, and the presence of a greater number of dorsal glands. The pygidium is as illustrated (fig. 119). Circumgenital glands in 5 groups :—

6—9
17—24 17—24
9—16 9—16

Habitat: This species seems to be common throughout the Union on wild olive, keurboom (*Virgilia capensis*, Lam.), kaffirboom (*Erythrina caffra*, Thunb.) and several other native trees. It apparently takes readily to cultivated plants and has been received on apple, hawthorn, kei-apple, lilac, native plant (*Celastrus* sp.), olive, pear, poplar, plane, privet, pepper (*Schinus molle*, Linn.), *Robinia* sp., rose, peach, plum and walnut.

Collection Nos.: 240 and 240e.

103. **Chrysomphalus (Melenaspis) phenax,** Ckll. (Plate xii, fig. 120).

Chrysomphalus phenax, Ckll., The Entom. xxxiv, p. 225, 1901.

Scale of adult ♀ small, about 1·5 mm. in greatest diameter, convex, capsular, black, but covered with a secretionary layer of yellowish brown material which shows concentric markings. Exuviae nearly always nearer to one side and covered with a whitish or greyish layer. In very young scales there is a faint concentric ring and dot effect. Ventral scale dense, black.

Adult ♀ broadly oval, about 1·1 mm. long and 0·9 mm. broad, widest just about level of mouth-parts and suddenly shouldered and narrowed to the broad flattened pygidial area. Body hyaline, except the mouth-parts and pygidium, which are yellow. Antennal tubercles small, with one long, curved spine and several small processes, conspicuous because of the "corrugated" chitin surrounding them. Parastigmatic glands 0. Pygidium broad (fig. 120), with four pairs of well-developed, crenulate lobes and three lobular projections of the margin beyond them. Plates rudimentary or absent. Paraphyses stout, and very conspicuous (fig. 120). Circumgenital glands 0.

Remarks: Professor Cockerell's original description is as follows:—

"♀ scale dark grey, resembling an oyster, with the sublateral exuviae shining black. ♀ no circumgenital glands; anal orifice small, about 9μ long, oval, about 63μ from bases of median lobes; lobes four, crenulate, shaped as in *C. mimosae*, but the median lobes are broader, angular instead of sloping on the outer side; margin beyond the lobes denticulate and finely crenulate; club-shaped thickenings at inner bases of median lobes, about twice length of lobes; a pair of thickenings between first and second lobes, as in *mimosae*; three thickenings between second and third lobes, the middle one longest; two at interval between third and fourth lobes, the middle one being absent; one or two beyond the fourth."

Habitat: On *Acacia horrida*, Willd. (not *Mimosa* as stated by Cockerell), Verulam, Natal; collected by C. Fuller. Nelspruit, Tvl.; collected by C. P. Lounsbury. Pretoria; collected by B. Delport, December 1913. Grahamstown, C.P.; collected by A. Kelly, March 1915.

Collection Nos.: 237, B237, B237a, 253.

Genus **Pseudaonidia,** Ckll.

The scales are similar to those of *Aspidiotus*, and some of the ♀ insects have the cephalothorax distinctly separated from the abdomen as in the subgenus *Selenaspidus*. On the dorsal side of the abdomen, however, there is an embossed area reminding one of that of *Ischnaspis*. The body colour is usually wine-red when the insect is alive, and the plates simply or feebly branched. In some cases there are clubbed thickenings running back from the lobes, somewhat similar to those in *Howardia.*

As constituted at present this genus is entirely unsatisfactory, as it contains insects which are apparently not closely related. Thus, if *trilobitiformis* with fringed plates (fig. 126) be taken as typical, the native South African species are distinct by the absence of such, or else by the presence of simple plates. The character of the scale is different, and the *Howardia*-like paraphyses found in some species are unusual and point to a burrowing habit in the female stage. Circumgenital glands may be present or absent.

Key to South African Species of Pseudaonidia.

A. Pygidium with long, clubbed paraphyses.

(1) Scale large, flat, slightly obscured by outer layers of host-plant; pygidium with three pairs of paraphyses (fig. 123) .. *P. tesserata*, d'Emmerez.

(2) Scale large, convex, covered by outer layers of host-plant; pygidium with two strong pairs of clubbed paraphyses (fig. 125).. *P. clavigera*, Ckll.

(3) Scale of adult ♀ black, capsular, covered by bark of host-plant; anal opening covered by large forked flap (fig. 128) .. .. *P. laciniae*, sp. n.

(4) Adult ♀ small, densely chitinous, with two large clear areas; pygidial margin crenulate (fig. 122) .. .. *P. glandulosa* (Newst).

(5) Scale of adult ♀ large, black, blister-like; L_2 narrower than L_1 or L_3; pygidium with four pairs of clubbed paraphyses (fig. 127) .. .. *P. nigra*, sp. n.

B. Pygidium without distinct paraphyses.

(6) Scale of adult ♀ large, flat, brown; plates forked; circumgenital glands present (fig. 126) .. .. - *P. trilobitiformis*, Green.

(7) Scale of adult ♀ about 1·6 mm. diam., buff, moderately convex; plates simple, dagger-shaped; circumgenital glands absent (fig. 124) *P. lycii*, sp. n.

104. **Pseudaonidia tesserata** (d'Emmerez) (Plate xii, fig. 123).

Aspidiotus (*Diaspidiotus*) *tesseratus*, d'Emmerez, Pr. Soc. Amic. Scien., p. 23, 1899.

Aspidiotus (*Pseudaonidia*) *tesseratus*, Lefroy, West Indian Bull., iii, p. 247, 1902.

Scale of adult ♀ large (may reach 3·5 mm. in diameter), circular, flatly conical, completely covered by the outer flaky layers of bark, but with the central, small, brown exuviae showing through. The scale, with the bark removed, is dull red-brown, with a roughened surface. It is $\pm$ capsular, with a dense brown ventral scale. The interior is covered with a thin layer of white powdery wax, which is quite conspicuous when the dorsal scale is flaked off.

The adult ♀ is large, about 1·7 mm. long and 1·2 mm. broad, *Selenaspidus*-like in form, with a distinct articulation between the cephalothorax and abdomen, but there is no spur on the lateral margin. The integument becomes very densely chitinous at maturity, in which stage most of the pygidial characters are + obscured. The following particulars, therefore, are given from an adult ♀ prior to the stage of extreme chitinisation. The abdominal segments are distinctly indicated in the middle of the body but not at the margin. There are three well-defined regions at the margin; the cephalothorax, separated by a broad V-shaped indentation; the abdominal region; and less distinctly separated from the latter, the pygidium proper.

There is a marginal series of long (57μ) hairs at wide intervals, and a number of similar hairs scattered over both surfaces of the body. Parastigmatic glands present, 6–8 at the anterior spiracles. The pygidium (fig. 123) is broadly pointed and the pygidial area rather more highly chitinised than the remainder of the body. There are four pairs of lobes; L_1, L_2 and L_3 strongly notched on their outer margins, L_4 rudimentary. The embossed area is large, coarsely reticulate. There are apparently no plates, and the paraphyses are chiefly represented by three pairs of thickened patches, which represent the clubs of the elongate thickenings that become conspicuous when the process of chitinisation has proceeded further. Spines long, as illustrated (fig. 123). Circumgenital glands 0.

Habitat: On trunk of large native tree (sp. indet., but probably baobab), Busi (near Beira); collected by C. Fuller.

Collection No.: 319.

105. **Pseudaonidia clavigera,** Ckll. (Plate xii, fig. 125).

Pseudaonidia clavigera, Ckll., The Entom., xxxiv, p. 226, 1901; Marlatt, Proc. Ent. Soc. Wash., ix, p. 139, 1908.

Scale of adult ♀ broad oval to circular, about 2·5 mm. in longest diameter, completely covered by the outer layers of the host-plant stem, but with the brownish or resinous coloured exuviae faintly exposed. Seen from below when the scale is raised, it is flatly convex, brownish in colour.

Adult ♀, when mounted, large, about 2 mm. long, broadly rounded in front and pointed behind. The cephalothorax extends backwards one-third of the entire length and is deeply divided from the abdomen. The mouth-parts are comparatively very narrow, only occupying one-tenth of the width of the body. The abdominal segments are well defined, the two anterior ones united into a broad band, the third free segment narrow with the margins rounded. The whole body-wall is dense, and the reticulated area is well defined and distinct. The pygidium is pointed, and is made conspicuous by the two pairs of parallel thickenings with clubbed heads which extend from the margin into the pygidial area. Pygidium as illustrated (fig. 125). Circumgenital glands 0.

Habitat: On camellia, Durban; collected on several occasions by C. Fuller and A. Kelly.

Collection No.: 220.

106. **Pseudaonidia laciniae,** sp. n. (Plate xii, fig. 128).

Scale of adult ♀ circular, about 1·5 mm. diameter, hemispherical, completely covered by the bark of the host-plant, through which the black exuviae show faintly. When raised and seen from below the scale is capsular, like a *Chrysomphalus*, with a ventral layer of dense black material like the dorsal scale. The inner wall of the scale is shiny black.

The adult ♀, when alive, is dark plum-coloured, with the pygidium brown. When mounted it is transparent, with the mouth-parts and reticulated area of the pygidium yellow. Mounted specimens generally contain large numbers of well-developed embryos. The body is about 1·5 mm. long, rounded in front and pointed behind.

The cephalothorax is flatly rounded in front, deeply separated from the abdomen, and occupies about two-fifths the length of the body. The abdominal segments are not so distinctly divided as in the majority of species in this genus.

Pygidium as illustrated (fig. 128). The reticulated area is not composed of large, well-developed areas as in many species, but gives one the impression rather of fat globules. There are indications of 4 pairs of lobes. L_1 close together, uniformly rounded as illustrated, or with outer edges more sloping and slightly notched; L_2 short; L_3 longer than L_2, often rounded at apex, with outer edges sloping and once notched; L_4 similar to L_3. Beyond these the margin is thickened and severa times indentate. The first one or two projections might be looked upon as rudimentary lobes. The plates are thick, $\pm$ parallel-sided, often curved towards their tips and hyaline. The formula would be P_1, L_1, $2P_2$, L_2, $3P_3$, L_3, $3P_4$, L_4, $1–3P_5$. The spines are short and stout. There is one on each surface of the pygidium between L_2 and L_3, one between L_3 and L_4, one between L_4 and P_5, and one a little beyond the second projection. There are three pairs of divergent thickenings from the hind margin, furnished with separate $\pm$ circular knobs. The outer pair are sometimes lacking, except for the knob, which is often $\pm$ crescent-shaped (fig. 128). The anal opening is far back and appears to be protected by a pair of chitinous plates or a divided flap, which is very conspicuous and looks like a pair of lobes. Outside these the chitin is thickened and extends to the base of the median lobes as two pointed folds, the margins of which are wavy. Circumgenital glands 0.

Habitat: On stems of tree (*Acacia melanoxylon* ?) growing in streets of East London; collected by C. P. Lounsbury, 1898 (Cape No. 1,248). On stems of *Acacia melanoxylon*, R. Br., Pietermaritzburg; collected by A. Kelly, 13th June 1915. These were associated with a very large flat *Lecanium* (sp. indet.).

Collection Nos.: 219, 219a.

107. **Pseudaonidia glandulosa** (Newst.) (Plate xii, fig. 122).

Aonidia glandulosa, Newst., Bull. Ent. Res., ii, pt. 2, p. 103, 1911.

Scale of adult ♀ elongate, very occasionally almost circular, about 1·25 to 1·5 mm. in diameter, white at first, sometimes faintly buff, with dark brown or resinous exuviae.

Puparium of ♂ similar but smaller, with pale exuviae.

The body of the adult ♀ is slightly conical and often appears to be situated in a shallow pit in the stem. It is small, about 0·9 mm. long, and about as wide as long (0·82). At maturity the body-wall is very densely chitinised and is brown or blackish brown when mounted. In immature specimens the body is hyaline, colourless, except the mouth-parts and pygidium, which are yellow. The most striking feature in mounted specimens is the presence of the two large transparent areas in the anterior portion of the body, which appear as two extremely large eye-spots (fig. 122). The cephalothorax is distinctly separated at the margin from the abdominal region; the anterior margin is flatly rounded from the level of the mouth-parts, where it suddenly slopes straightly inwards, so that at the articulation it is narrower than the abdomen. The segments are not distinctly produced; the anterior two are broad at the margin, but the third, posterior, is of about equal width in the centre but scarcely represented at the margin.

The pygidium is remarkable for its even, wavy or crenulate margin. There are two pairs of low lobes and very few plates in mature specimens, but before the integument has become densely chitinised the pygidium is exceptionally beautiful. There are then two pairs of well-defined lobes and indications of at least one other pair of rudimentary lobes, but the whole margin is so deeply crenulate and regularly supplied with gland openings that it is difficult to describe precisely otherwise than as lobulate. L_1 large, broadly rounded; L_2 about half as large, with the outer edge notched. The dorsal embossed area in this stage is faintly but distinctly noticeable, the thin areas reminding one of fat globules as seen under the microscope. There are seven or eight pairs of long spines at intervals from the second pair of lobes to the base of the pygidium. The ventral surface is longitudinally rugose and, near the margin, there are numerous gland openings with their long axes perpendicular to the margin. Of dorsal glands there are five well-defined series; the first, which is short and comprises about 6–7 glands, arises from the inside of the rudimentary L_3; the second, of 2–5 glands, reaches to the level of the vulva; the third, fourth and fifth do not appear to reach the margin and consist of about 20, 10 and 5 glands respectively. Pygidium of mature, fully chitinised specimen, as figured (fig. 122). Circumgenital glands 0.

Habitat: On *Acacia horrida*, Willd., Stellenbosch, C.P.; collected by T. F. Dreyer, 23rd May 1906. On *Acacia horrida*, Willd., associated with *Asterolecanium* from S.W. Africa, 1903 (Cape No. 1,137).

Collection Nos.: 218, 218a.

108. **Pseudaonidia trilobitiformis** (Green) (Plate xii, fig. 126).

Aspidiotus trilobitiformis, Green, Ind. Mus. Notes, iv, pt. 1, p. 4, 1896; id., Cocc. Ceylon, i, p. 41, 1896; d'Emmerez, Pr. Soc. Amic. Scien. p. 26, 1899.

Scale of adult ♀ large (may reach 4 mm. in diameter), flat, sometimes circular, but more often with one side flattened against a vein of a leaf. The colour is usually brown or reddish brown, but in old exposed specimens it is commonly more or less bleached. The exuviae are flat and usually yellowish to brownish. The form and colour of this scale are very similar to those of a typical *Selenaspidus* species.

"Adult female clear brown; surface hard and horny, polished, with numerous delicate transverse striated lines. Form oblong, rounded in front, tapering to a point behind; dorsal surface flattened; ventral surface slightly tumid; segments distinct and strongly defined; a deep transverse groove on dorsal surface between the prothoracic and mesothoracic segments; a large irregular depressed space on each side of rostrum, covered with white waxy secretion, marking the position of the parastigmatic glands, of which there is a group consisting of from 12 to 20 orifices in front of each of the anterior stigmata. Pygidium with eight prominent obscurely tricuspid lobes; mesal pair stoutest, but scarcely as long as second; others rather slender. Squames deeply fringed; two in the mesal and first spaces, and three in the second and third spaces between the lobes. Lateral margin of pygidium irregularly serrulate, with two deep notches marking the position of the obliterated second and third abdominal segments. On the dorsal surface is an extensive reticulated tract completely occupying the median area of the pygidium between the base and the anal aperture, the boundaries well defined and constant, the spaces of irregular size and shape, crowded together, and forming a pattern not unlike that of crocodile leather. Circumgenital glands in four groups; orifices numerous, upper laterals with 21 to 24, lower laterals with 16 to 27; in every case the upper laterals contain the larger number of orifices; in one specimen were two single separate orifices in the place of an anterior median group. Tubular spinnerets of the filiform type, opening on the dorsal surface by large conspicuous pores arranged in definite linear series; the ducts themselves very delicate and difficult to trace. Similar pores and spinnerets on the other abdominal segments. Genital aperture between the lower lateral gland groups. Anal aperture about half-way between extremity and genital opening. Length, 1·50–1·80 mm. Breadth, about 4 mm." (Green).

Habitat: On litchi, Hillary, near Durban (probably imported from Mauritius), 5th December 1915.

Collection No.: 318.

109. **Pseudaonidia lycii,** sp. n. (Plate xii, fig. 124).

Scale of adult ♀ about 1·6 mm. in diameter, $\pm$ circular or somewhat elongate, moderately convex, sordid buff in colour, but usually obscured by the outer layers of bark of the host-plant. The exuviae are $\pm$ central, covered, and dull yellow in rubbed specimens. The ventral scale is very delicate and remains attached to the host-plant.

Puparium of male somewhat similar but smaller, more elongate, and greyish white in colour. The exuviae are at the anterior end, slightly covered, yellowish.

Living material of this species has not been seen by the writer, so the following particulars refer to mounted specimens:—

Adult ♀ viviparous, about 1 mm. long. Anterior part of body strongly chitinised, brown in colour. Pygidium slightly so, yellow. Free abdominal segments delicate, hyaline. The front margin is regularly rounded, and smooth to the level of the mouth-parts, from whence, backwards, the lateral margin usually presents three broadly rounded undulations. The four free abdominal segments are slightly produced at the sides, where they are irregularly rounded, and each bears a number of marginal gland openings, several stout spines and a few hairs. The antennae consist of the usual very low tubercle, with two short, slightly curved spines. Anterior and posterior spiracles each with two anterior glands. The vulva is wide and situated at about the same level as the anal opening. The chitin from the pygidial margin to the vulva is coarsely rugose. The dorsal "embossed" area is not strongly chitinised and the design is only seen with difficulty. The pygidial characters, especially the character of the plates, indicate the position of this insect in the genus *Pseudaonidia* more strongly than would the faint dorsal patch. There are three pairs of well developed lobes, of which L_3 is low and broad, and often nearly or quite divided into two lobules; L_1 large, with margins crenulate, inner edges more steep than outer ones, apical part uniformly rounded; L_2 and L_3 also more steep on inner margins, crenulate; L_3 apparently made up of two similar lobules; all lobes slightly striated. P simple, $\pm$ triangular or dagger-shaped. The spines at the bases of the lobes are strong (fig. 124). Circumgenital glands 0.

Formula: S, L_1, S, L_2, S, $3P_3$, L_3 (or $1l_3$), S, $5\text{–}7P_4$.

Remarks: The scale of this species is somewhat like that of *A. canariensis*, Lindinger. The two species appear to show further similarities and closer relationship in the character of the gland openings, thick spines, and simple plates, but the lobes are entirely different, *canariensis* possessing but one pair. There is also a striking similarity between the pygidium of this species and the ♀ nymph of *Howardia silvestrii*, Leon., but the size is entirely different and the specimens I examined are undoubtedly adult.

Habitat: On *Lycium afrum*, Linn. (Solanaceae), Uitenhage; collected by C. P. Lounsbury, 1st August 1906 (Cape No. 1808).

Collection No.: 155.

110. **Pseudaonidia nigra,** sp. n. (Plate xii, fig. 127).

Scale of adult ♀ almost circular, flat, about 2·8 mm. in diameter, black, sometimes with paler, brownish margins. Exuviae small, pushed to the extreme margin, appearing grey or brownish. In a few cases the position of the second exuviae is indicated by an indefinite greyish patch. The whole scale is beneath the epidermis of the leaf and appears as a black blister. For this reason it is not possible to remove the scale by rubbing, nor to pick it up with the nail as can generally be done. There is no indication of its presence on the lower side of the leaf. When the scale is broken open it is noticed that it is capsular, and that the inside is slightly dusted with white powdery wax.

The body of the ♀ is wine-red in colour. When cleared and mounted the ♀ is about 1·7 mm. long and 1·4 mm. broad, widest at about the middle, broadly rounded in front and tapering to the pygidial margin (fig. 127).

The pygidial margin, anterior to the serrated portion, is twice indented, each time having a conical, sharply pointed protuberance in front of it, from the bases of which arise short strong spines. There are four pairs of distinct, separate lobes, and beyond these the margin is strongly serrate, the first eight serrations on each side being almost as large as the lobes. The median lobes are close together, moderately strong, with both margins once strongly notched. L_2 about the same length as L_1 and L_3, but much narrower than either of these; L_3 and L_4 similar in shape to L_1, but slightly smaller and paler in colour. The plates are indistinct and appear to be simple ,with blunt ends. There are four pairs of thickenings running into the pygidium; the inner pair, arising from between L_1 are the shortest and are slightly divergent and indistinctly thickened, not clubbed as are the other three pairs. The second pair, which arise between L_1 and L_2 are the longest and are distinctly clubbed. Pairs 3 and 4 are about equal in length and thickness (fig. 127).

The antennal tubercles are small, each with one moderately long seta and perhaps a short spur. Parastigmatic glands present, about 7–9 at each anterior spiracle.

Circumgenital glands present, arranged in the form of a horse-shoe but slightly interrupted in the middle, 17–23 on each side.

Remarks. The true " mining " habit of this species is not common in leaf species. In this respect this insect is very similar to *Aspidiotus subcuticularis*, Green, which lives on *Ficus* sp. in Northern Australia.

Habitat: On leaves of an undetermined plant, Durban; collected by C. P. v. d. Merwe, August 1st 1916.

Collection No.: 257.

Genus **Parlatorea,** Targ.

In this genus the scale of the adult ♀ is variable in form and may be ± subcircular, ovoid, or elongate. The insects bear a somewhat superficial resemblance to *Fiorinia* owing to the large, usually hardened skin of the second stage, which in *Parlatorea*, however, does not enclose the adult ♀, but merely covers it.

The most striking generic character is found in the pygidium of the adult ♀, in which there are three pairs of tri-lobed lobes and a rudimentary fourth lobe, which is tooth-like in *P. pergandei* and *zizyphi* and plate-like in *P. proteus*; a fringe of finely toothed plates between them, and a series of thick-walled marginal glands which open by broad mouths placed parallel to the body margin.

The puparium of the ♂ is oblong, non-carinated, and rather narrow, with the larval exuviae placed at the anterior extremity.

So far as I can ascertain, we have only three species in this country, all of which have been introduced. These may be distinguished as follows:—

Scale of adult ♀ black, ± rectangular with rounded corners; rudimentary lobe (4th) ± tooth-like, usually pointed; dorsal gland-pores numerous. *P. zizyphi.*

Scale of adult ♀ semi-transparent, ± circular or pear-shaped; rudimentary lobe (4th) as in *zizyphi*; few dorsal gland-pores .. .. *P. pergandei.*

Scale of adult ♀ yellowish, ± egg-shaped: rudimentary lobe (4th) plate-like; few dorsal gland-pores .. .. *P. proteus.*

111. **Parlatorea pergandei,** Comst. (Plate xiii, fig. 130).

Parlatoria pergandii, Comst., Rep. U.S. Dept. Agr., p. 327, 1881; Newst., Mon. Brit. Cocc., i, p. 143, 1901; Fernald, Catalogue, p. 319, 1903.

Scale of adult ♀ about 1 to 1·75 mm. long, very variable in shape, roundish to broad pear-shaped, or sometimes ± elongate, thin, semi-transparent, smooth, the sub-lying ♀ being partly visible, smoky-white with a brownish streak and with marginal, yellowish- or orange-brown exuviae. Ventral scale complete, whitish.

The puparium of the ♂ is similar in shape to that of *P. proteus*, smoky brown to purplish brown behind the exuviae, and with the larval exuviae yellowish or straw-coloured.

When mounted the body of the adult ♀ is entirely hyaline, small, about 0·75 mm. long, broadest slightly behind the middle. The anterior part is flatly rounded and bears a small tubercle on each side at the level of the front portion of the mouth-parts. The abdominal segments are broadly rounded and wider than the cephalothorax. On their margins are a number of remarkable glandular protuberances. The antennal tubercles are flat, with one long curved spine. Parastigmatic glands 0. The pygidium is characterised by its regular, rounded appearance, with the large marginal glands, whose openings are at right angles to the long axis of the body, the broadly-trilobed L_1, L_2 and L_3, and the fringe of broad fimbriated plates; L_4 is small, sharply pointed (fig. 130). Circumgenital glands in 4 groups:—

6—10 6—10
6— 8 6— 8

Formula: $P_1, L_1, 2P_2, L_2, 3P_3, L_3, 3P_4, L_4, 3P_5$.

Habitat: On croton, Grahamstown; collected by A. Kelly, March 1915. Also at Cape Town, Port Elizabeth, Durban, Johannesburg and Pretoria (in greenhouses).

Collection No.: 281.

112. **Parlatorea proteus** (Curtis) (Plate xiii, fig. 129).

Aspidiotus proteus, Curt., Gard. Chron., p. 676, 1843.

Diaspis parlatoris, Targ., Studii sul. Cocc., p. 14, 1867.

Parlatoria proteus, Sign., Ann. Soc. Ent. France, (4) ix, p. 450, 1869; Newst., Mon. Brit. Cocc., i, p. 140, 1901; Fernald, Catalogue, p. 320, 1903.

Scale of adult ♀ about 1·2 to 2 mm. long, ± egg-shaped, yellowish, greyish or greenish yellow, with exuviae at the anterior extremity yellowish or brownish. The second exuviae in this species are not nearly so large in comparison as those of *P. zizyphi*, neither are they so rectangular or black.

The puparium of the ♂ is very elongate, with parallel sides, flatly convex until the adult emerges, when the central part becomes sunken. The secreted portion is dull, pale, with yellow exuviae, which often show a greenish dorsal area.

The adult ♀, when mounted, is small, about 0·75 mm. long, almost circular or slightly egg-shaped, widest at the free abdominal segments, hyaline, with a short, stout spine on the lateral margin of the cephalothorax nearer to the articulation than in *pergandei*. The lobes are longer and comparatively narrower than those of *pergandei*, and L_4 is represented by a plate (fig. 129). Circumgenital glands in 4 groups:—

5—7 5—7
4—6 4—6

Formula: $P_1, L_1, 2P_2, L_2, 3P_3, L_3, 7P_4$.

The middle plate of the $7P_4$ is small and rounded and has a spine at its outer edge. This represents the rudimentary L_4 of the other species.

Habitat: On orchid, Natal Coast; collected by C. Fuller.

Collection No.: 282.

113. **Parlatorea zizyphi** (Lucas) Sign. (Plate xiii, fig. 131).

Coccus zizyphus, Lucas, Bull. Soc. Ent. France, (3) i, p. 28, 1853.

Chermes aurantii, Bdv., Ent. Hort., p. 338, 1867.

Parlatoria lucasii, Targ., Catalogue, p. 42, 1869.

Parlatoria zizyphi, Sign., Ann. Soc. Ent. France, (4) ix, p. 451, 1869; Fuller, Notes on Cocc. W. Austr., pp. 4, 13, 1897; Newst. Mon. Brit. Cocc. i, p. 148, 1901.

Parlatoria ziziphus, Fernald, Catalogue, p. 322, 1903.

Parlatorea zizyphi, Lindinger, Die Schildläuse, p. 108, 1912.

The scale of the adult ♀ is about 1·4 to 2 mm. long, flat, composed almost entirely of the opaque black, hardened skin of the second stage and supplemented by a thin whitish or brownish secretion, which is most conspicuous behind. The shape therefore is ± rectangular with rounded corners, that of the 2nd exuviae with the larval exuviae extending for half its length in front and often turned to one side, opaque black. Ventral scale complete, whitish or brownish.

The puparium of the ♂ is elongate, whitish or brownish, with larval exuviae black.

The adult ♀, when mounted, is small, hyaline, readily distinguished from *P. proteus* and *pergandei* by the following particulars (fig. 131):—The margin of the cephalothorax, near the articulation, bears a *large* rounded tubercle, marginal tubercle of the abdominal segments numerous and comparatively long; L_1, L_2 and L_3 long, narrow, trilobed; L_4 pointed as in *P. pergandei*, but better developed. Circumgenital glands in 4 groups:—

$$\begin{array}{cc} 6\text{—}7 & 6\text{—}7 \\ 7\text{—}10 & 7\text{—}10 \end{array}$$

Formula: $P_1, L_1, 2P_2, L_2, 3P_3, L_3, 3P_4, L_4, 4\text{–}5P_5$.

L_4 in this species may be small and pointed as in *P. pergandei* or ± lobe-like.

Habitat: On orange, Durban and Port Elizabeth; collected by C. P. Lounsbury.

Collection No.: 283.

Genus **Aonidia,** Targ.

The genus *Aonidia* shows relationship with both *Aspidiotus* and *Parlatorea*. The second stages of some species show characters that seem to be intermediate between the two. It differs from both of these, however, in the fact that the adult ♀ is entirely enclosed within the large, hardened skin of the second stage. As is usual in cases where the second stage becomes large and hardened the dorsal scale, *i.e.*, secreted portion, is ± transparent and scant, but firm and resistant. The first exuviae are ± central. The adult ♀ is generally viviparous and without circumgenital glands, differing from that of *Gymnaspis* chiefly in the fact that the pygidium is more highly developed and possesses definite lobes and plates.

The puparium of the ♂ is somewhat similar to the scale of the female in size and shape, or, in some cases, rather elongate, and consists of secretionary matter with the larval exuviae at or near the centre.

114. **Aonidia simplex,** Leon. (Plate xiv, fig. 135).

Aonidia simplex, Leon., Boll. Lab. Zool. Portici, p. 209, 1914.

Scale of adult ♀ about 1·2 mm. long, buff, ± irregular oval, moderately convex, with yellowish or orange exuviae when young. When full-grown the colour is determined by the hardened skin of the second stage ♀, which is rich chestnut-brown. In this stage the dorsal scale is scant and appears whitish or greyish. The ventral scale is robust, whitish or greyish.

The puparium of the ♂ is more slender than the ♀ scale, buff, with paler margins; exuviae yellow or orange.

Second exuviae, which enclose the adult ♀, broad pear-shaped, about 1 mm. long and 0·7 mm. broad. They are moderately chitinised and yellow-brown when cleared. The pygidium is as illustrated in Fig. 135. The adult ♀ is smaller, about 0·8 mm. long, and 0·55 mm. broad, ± hyaline.

Habitat: On the leaves of a native plant (*Ehretia hottentottica*), Pretoria; collected by the writer, 3rd July 1915.

Collection No.: 255.

115. **Aonidia chaetachmeae,** sp. n. (Plate xiv, fig. 134).

Scale of adult ♀ small, about 1 mm. long, ± pyriform, with irregularly crenulate edges, dull pitch black in colour, with a scanty white layer of waxy secretion, which is most noticeable around the margins. The larval exuviae are central, raised, black, with dark brown margins. The hard, black, second stage skin is moderately convex, and in some cases the crinkled margins give them a shell-like appearance. The pygidial margin is often rich brown instead of black.

The puparium of the ♂ is rather elongate, about as long as the ♀ scale but with sides more parallel, buff-coloured, translucent, with exuviae nearer the anterior end. The posterior portion of the secreted substance is paler in colour. The larval exuviae are of the same size as those of the female scales, black, with brown margins. The second exuviae, which enclose the adult ♀, are very dense, blackish brown when boiled in KOH and cleared. These have a remarkable shape, with the whole margin thickened and broadly crenulate or scalloped, and with the lateral margins of the pygidial area parallel. This gives the appearance of the hind extremity being sharply cut off, as the posterior margin is more delicate. The adult ♀ is about 0·7 mm. long, broadest at about the level of the mouth-parts and tapering acutely to the pygidium. The antennal tubercles are small, with one long, curved, spine. Parastigmatic glands 0. The pygidium has two pairs of well-developed lobes. L_1 large, with the inner margins parallel, notched on each margin; L_2 smaller, close to L_1, steep on inner side and sloping outer edge. Spines, etc., as illustrated (fig. 134). Circumgenital glands 0.

Habitat: On "umkavoti" (*Chaetachme aristata*, Planch.), Durban; collected by C. Fuller, 12th October 1914.

Collection No.: 286.

116. **Aonidia rhusae,** sp. n. (Plate xiv, fig. 137).

Scale of adult ♀ about 1·5 mm. long, brown, or blackish brown, owing to the black second stage skin showing through the brownish dorsal scale. The dorsal scale is comparatively large and robust, brownish in colour, probably from the admixture of epidermal tissues. Exuviae central, dark brown.

The puparium of the male is almost circular to elongate oval, somewhat conical, smooth, parchment-like, buff, or brownish with dark brown central exuviae.

Female, second stage, from the second exuviae which enclose the adult ♀, elongate, about 1·3 mm. long, and 0·8 mm. broad, highly chitinised, brown, with the median portion blackish. It is broadly rounded in front, widest at about the middle and tapering to the hind margin, which is pointed. The margin is broadly crenulate, indicating nine regions or segments, of which the fourth from the front is the widest. The pygidial margin as illustrated (fig. 137).

The adult ♀ is about 1 mm. long, long pear-shaped, hyaline, sharply tapering behind. The antennal tubercles are small, conspicuous, with one long, straight flagellum. Parastigmatic glands 0. The pygidium has two pairs of lobes; L_1 are long and straightly notched on each side; L_2 much smaller, often slightly notched on the outer side, but in some cases quite rudimentary. Circumgenital glands 0.

Habitat: On *Rhus* sp., Cape Town; collected by C. Fuller, 1898 (Cape No. 1251).

Collection No.: 289.

117. **Aonidia mesembryanthemae,** sp. n., (Plate xiv, fig. 136).

Insects making pits in the fleshy leaves of the host-plant, around which the tissues often thicken to form rounded mounds with the scale in the central depression.

The dorsal scale of the adult ♀ is about 1·5 mm. long and 1 mm. broad, white, thin, translucent, very delicate, with the buff-coloured larval exuviae central. As the second stage ♀ develops it appears as a dark brown to black mass beneath the dorsal scale, with paler margins, ultimately reaching approximately the size of the dorsal scale. At this stage the scale appears black or greyish black, according to whether the delicate dorsal scale persists or not.

Adult ♀ pale yellow, broadly rounded, with very narrow pygidium. Posterior portion of body conical, filling the depression below the scale. Adult ♀ apparently *not* enclosed in the second exuviae, but completely covered by them. Ventral scale complete but very delicate, white.

The puparium of the ♂ is about 1 mm. long, slightly more elongate and more convex than the female scale, white to buff in colour, with yellowish larval exuviae.

The second stage ♀ attains a length of 1·3 mm. and a width of 0·9 mm. The integument becomes densely chitinous and dark brown to black. When boiled in KOH and mounted the margins are light in colour, almost hyaline, but the median area is deep brown. The margins are more regular than in any of the other five species found in this country, and the body is more regularly egg-shaped. The pygidium is delicate, and scarcely produced from the general body outline. Segmentation obscure. The pygidial characters are illustrated with those of the adult ♀ (fig. 136).

The adult ♀ is smaller, about 1·8 mm. long, pear-shaped, with the posterior extremity pointed. The whole body is delicate and hyaline when mounted. The pygidial characters as illustrated (fig. 136). Circumgenital glands 0.

Habitat: Making pits in the fleshy leaves of *Mesembryanthemum edule*, Natal Coast, Cape Province, etc.

Collection No.: 290.

118. **Aonidia marginalis,** sp. n. (Plate xiv, fig. 138).

Scale of adult ♀ about 1·5 mm. long, composed of large second exuviae, with a thin layer of buff-coloured secretion. Exuviae often showing through, black.

The shape of the scale is broad, pear-shaped, much arched, broadly rounded in front and suddenly narrowed a little behind the middle. The secretionary covering easily flakes off and exposes the dense second skin, which is dull black, except the margins and pygidial area which are deep red. When cleared and mounted the second stage varies in length from 0·9 mm. to 1·5 mm. It is clear at the margins and deep yellow to almost black in the centre, according to the degree of chitinisation. It is broad oval, with the delicate pygidium protruding from the hind end.

The adult ♀, as seen within the second skin, is almost as long and broad, but becomes narrower towards the pygidial extremity. The pygidial characters of both second stage and adult ♀ are illustrated in fig. 138. The anal opening is small, situated about twice the length of L_1 from the margin; the vulva is broad oval, rather more than twice as far back. Circumgenital glands 0.

Habitat: On *Rhus*, in association with *Aonidia badia*, sp. n. On stems of *Rhus* sp., Zeerust, Tvl., May 1915; collected by A. Kelly.

Collection No.: 292.

119. **Aonidia badia,** sp. n. (Plate xiv, fig. 139).

Insect making pits in the thin stems of *Rhus* sp.

Scale of adult ♀ almost circular, flat, about 1·2 mm. in diameter, consisting of the thickened second stage *plus* a very thin, transparent layer of secretion, which is only noticeable where it projects at the margins.

The second stage ♀ is light chestnut-coloured. First exuviae present as a small concolorous prominence near the anterior margin of the otherwise flat scale. When the scale is removed it is found to be somewhat roundly convex below, completely filling a circular depression in the bark, the scale usually lying flush with the surrounding tissue on the top. The second stage ♀ appears circular, and is uniformly chitinous to the position of the pygidial segments, where it is flatly concave. The pygidium itself is not dense and is very inconspicuous until the specimens are mounted; it is often missing, because of its delicate nature, and when present, the lobes and plates are often broken. Its typical characters are shown in fig. 139.

The adult ♀ is entirely enclosed in the second stage skin, but mounted specimens have occasionally shown the pygidium of the adult ♀ protruding beyond the split hind margin of the enclosing exuviae. The body is about 0·8 mm. long, and 0·7 mm. wide, broadly rounded, hyaline, suddenly narrowed to the two last free abdominal segments and with the pygidium narrow and pointed. The antennal tubercles are large, with one very stout spine and a short, finger-like protuberance. Parastigmatic glands 0. The pygidial margin has two pairs of well-developed lobes; L_1 large, long, tapering to the tip and once notched on the outer sides; L_2 small, steep on inner sides, but sloping backwards, with the curve of the margin on the outer edge. The spines are a little longer than L_1, and distributed as shown in fig. 139. The two conspicuous marginal openings have slightly thickened edges, reminding one of *Diaspidiotus*. Circumgenital glands 0.

Habitat: On twigs of *Rhus* sp., Kenilworth, C.P.; collected by the writer, August 1914. Also on *Rhus* sp. in association with *Aonidia marginalis*, sp. n., at Zeerust, Tvl.; collected by A. Kelly, 29th May 1915.

Collection No.: 291.

Genus **Gymnaspis,** Newst.

Scale of the adult ♀ variable, but most often reminding one of that of *Aonidia*, consisting chiefly or entirely of the black hardened second stage skin. In some cases, at maturity, the dorsal scale and first exuviae are lost, so that these hardened skins remain naked. The adult ♀ remains enclosed in this hardened cyst-like skin. In one Brazilian species (*Gymnaspis aberemoae*), described by Lindinger in 1910, there is a definite dorsal scale much like the second stage of some of the *Selenaspidus* spp.

The second stage female in *Gymnaspis* has lobes and plates, but in the adult ♀ the pygidium is rudimentary and is not provided with definite lobes or plates, but usually has ordinary spines or protuberances which are either teat-like or bottle-shaped.

It is usual for the adult ♀ to be viviparous and without circumgenital glands, but *G. aberemoae* is apparently an exception to this rule.

The males of only a few of the small number of species of *Gymnaspis* are known.

120. **Gymnaspis faurei,** sp. n. (Plate xiv, fig. 140).

Scale of adult ♀ consisting entirely of the hard, thickened, dull black second stage skin, with a thin, but hard covering, which is black and dense below and greyish and flaky above. Larval exuviae generally absent; when present, as in younger specimens, black. Skin of second stage about 1 mm. to 1·2 mm. in length, rather longer than broad and moderately convex.

The body of the second stage ♀ becomes very hard and is dull black. Even after soaking in hot KOH for hours it is entirely piceous, except the two median lobes, when they persist, and these are brown. In shape the body is broad pear-shaped, but very irregular at the anterior end. The pygidium and free abdominal segments are more constant in form. The latter are prominently rounded and bear a few stout conical projections. The characters of the posterior margin of the pygidium are illustrated in fig. 140.

The adult ♀, when mounted, often contains several well-developed larvae. The body is long, somewhat oblong in front and suddenly narrowed to the hind extremity. Segmentation is not pronounced at the margin, but a few segments are strongly indicated in the abdominal region. The pygidium is very simple, without lobes or plates, but with a few very strong stout spines. The chitin is often thickened at the extreme margin and much wrinkled posterior to the vulva, which is very wide. Its characters are illustrated in fig. 140. Circumgenital glands 0.

Habitat: Clustered on stems of "karree" bush (*Rhus* sp.), Bloemfontein, O.F.S.; collected by J. C. Faure, November 1914.

I have pleasure in associating Mr. Faure's name with this interesting species.

Collection No.: 288.

Genus **Howardia,** Berl. & Leon.

Scale of adult ♀ ± oval to elongate, with the exuviae at or near one margin of the scale. Scale usually ± covered by the outer layers of the bark of the host-plant. Pygidium with median lobes well developed and with a pair of usually clubbed paraphyses. Circumgenital glands usually absent.

121. **Howardia biclavis** (Comst.) (Plate xiii, fig. 133).

Chionaspis (?) *biclavis*, Comst., Second Rept. Dept. Agr. Cornell Univ. p. 98, 1883.

Aspidiotus theae, Green, Insect Pests, p. 13, 1890 (♀ only).

Chionaspis biclavis, Craw, Rept. Cal. Bd. Hort. p. 14, 1891

Howardia biclavis, Berl. & Leon., Riv. Pat. Veg. iv, p. 348, 1896.

Chionaspis biclavis, Green, Cocc. Ceylon, ii, p. 152, 1899; Newst., Mon. Brit. Coccidae, i, p. 190, 1901.

The original description by Comstock (l.c.), omitting figure references, is as follows :—

" This species, of which only the female is known, is remarkable on account of its habit of burrowing beneath the epidermal layer of the leaf or twig which it infests. The color of the scale is white; but this color is almost invariably obscured by the layer of vegetable tissue beneath which the scale is, and which adheres closely to the scale. . . .

" Scale of female.—The scale of the female is very nearly circular. On this account I place the species inthis genus only provisionally, until the scale of the male is found. The exuviae are marginal and project beyond the edge of the scale, giving the whole scale more nearly the form of *Chionaspis* than of any other known genus.

" Female.—The characters presented by the last segment of the female are as unusual as those presented by the scale. The pores on the dorsal surface of the segment are very small. Scattered over the ventral surface are numerous minute spines. The groups of spinnerets are wanting.

" The mesal lobes are large, oblique; nearly twice as broad as long; approximate at the base; the mesal margins diverge slightly; distal margin serrate; meso-distal angle rounded and produced into a lobule. The second lobe is very small, being simply an angular projection of the body-wall. The third lobe is about three times as wide as the second lobe, but it projects only a little beyond the margin of the segment.

" The plates are simple and spine-like. There are two minute ones between mesal lobes; two between first and second lobes; two or three between second and third lobes; a group of three or four larger ones laterad of third lobe; and another group of four or five still larger ones about midway between this group and the penultimate segment. Each of the three segments preceding the last bears on each lateral margin about seven plates.

" Two spines accompany each group of plates, one on the dorsal surface and one on the ventral. The first and second spines of each side are very small; the third, which is between the second and third lobes, is the largest; the fourth and fifth are successively smaller.

"There are two conspicuous club-shaped organs which appear like thickenings of the body-wall, but which are really within the body cephalad of the mesal lobes. These organs are about three times as long as the mesal lobes; they converge caudad; and the cephalic end of each is suddenly enlarged. This species may be distinguished from any other known American Coccid by the presence of these organs."

Habitat: In Durban only on the following plants:—*Duranthea* sp., *Trichelia* sp., *Raphiolepis* spp., star apple, *Poinsettia, Bignonia* sp., *Bauhinia* sp., honeysuckle and privet.

Collection No.: 214.

122. **Howardia moorsi** (Doane & Ferris) (Plate xiii, fig. 132).

Lepidosaphes moorsi, Doane & Ferris, Bull. Ent. Res., vi, pt. 4, p. 401, 1916.

Scales of adult ♀ entirely covered by the outer layers of bark, very long (3–4 mm.), moderately broad (0·8–1 mm.), almost parallel-sided, with the hind extremity broadly rounded and the anterior end tapering; pale, translucent brown to deep chitin brown, with thinner paler margins. The scale is flatly arched and looks like a low burrow. It is horn-like in texture and very large in comparison to the size of the body of the adult ♀. The whole horny scale—which is easily broken—is often completely covered above by a whitish layer of waxy material, with which is incorporated fragments of the loose bark of the host-plant. It is most often straight, but occasionally much curved. I am uncertain as to the colour of the exuviae, as the whole character of the material is indefinite and I possess only two small stems representing one collection of material. These bear many specimens, as they are more or less densely covered, but the scales are so inconspicuous that it is difficult to detect their presence.

Male puparium not observed.

Second stage ♀ with chitinous thickenings from median lobes similar to adult.

Body of adult ♀ elongate, broadest behind middle, front margin entire, broadly rounded, abdominal segments not produced. The pygidium has one pair of lobes, which are chitinous, with the margins very finely serrate. The other characters of the pygidium as illustrated (fig. 132). Circumgenital glands in 5 groups, with the median and anterior groups ± united into a bow.

$$\begin{array}{ccc} & 4\text{—}6 & \\ 6 & & 6 \\ 4 & & 4 \end{array}$$

Remarks. This species exhibits several remarkable characters; so much so that I am by no means certain that it belongs to the genus *Howardia* at all. The elongate, burrow-like scale is unusual, but the powerful median lobes and strong chitinous projections into the pygidium are sufficient to warrant its inclusion in this genus.

Habitat: On stems of Pride of India (*Lagerstroemia indica*), in the Botanic Gardens, Durban; collected by A. Kelly, 31st March 1915.

Collection No.: 264.

Genus **Fiorinia,** Targ.

The scale of the adult ♀ is generally extremely thin and transparent, revealing the large, hardened, second stage skin, which entirely encloses the adult ♀. The colour of the scale is thus determined chiefly by the colour of the dry second stage skin.

The adult ♀ is smaller than the enveloping skin, and gradually shrinks as eggs or young are deposited within the same hardened case.

123. **Fiorinia fioriniae** (Targ.) (Plate xiv, fig. 141).

Diaspis fioriniae, Targ., Studii sul Cocciniglie, p. 14, 1867.

Chermes arecae, Boisd., Insectologie Agricole, p. 262, 1868.

Fiorinia pellucida, Targ., Catalogue, p. 42. 1869.

Fiorinia camelliae, Comst., Rept. U.S. Dept Agr., 1880, p. 329, 1881.

Uhleria fioriniae, Comst., Second Rept. Dept. Ent. Cornell Univ., p. 111, 1883.

Fiorinia camelliae, Mask., N.Z. Trans., xxiv, p. 16, 1891.

Fiorinia fioriniae, Ckll., Can. Ent., xxvi, p. 33, 1894.

Fiorinia palmae, Green, Ind. Mus. Notes, iv, p. 5, 1896.

Fiorinia fioriniae, Green, Cocc. Ceylon, i, p. 94, 1896; Newst., Mon. Brit. Cocc., i, p. 134, 1901; Sasscer, Bull. U.S. Dept. Agr. T.S., 16, v, p. 79, 1912.

Scale of adult ♀ about 1·25 mm. long and 0·5 mm. broad, consisting almost entirely of the second pellicle covered by a thin transparent layer of colourless secretion, which extends slightly beyond its margin. Colour of the second pellicle varying from orange-yellow to rich reddish-brown. The median line is generally somewhat raised into a rounded longitudinal ridge, which appears darker. The first exuviae are small, pale in colour, and extend beyond the margin of the anterior extremity.

Male puparium white, about 1 mm. long and 0·4 mm. broad, straight, distinctly tricarinate, with pale yellow exuviae.

Adult ♀ dull orange-yellow in colour, at first elongate, later with abdominal segments somewhat retracted.

"Female thin and much contracted after oviposition, elongate, possessing rudimentary antennae, which are apparently two-jointed, the first consisting of a fleshy tubercle, which bears the second joint and a bristle, the second joint occasionally possessing a short lateral branch near the tip; anal plate triangular, 0·187 to 0·204 mm. in width, slightly truncate at tip, median notch distinct and formed by the median lobes, which are oblique and serrated along their entire free edge; second lobes prominent both in second larval exuviae and adult, incised, about twice as long as broad and followed by several indentations; margin of the pygidium exhibiting four rather conspicuous tubular pores; between the median lobes are two short spines; located on the dorsal surface situated along the lateral margin of the median lobe there are two spines, the posterior being the larger, one on the outer lobule of the second lobe and two situated between the second lobe and the penultimate segment; on ventral surface there is a spine corresponding with each dorsal spine, except on the first lobe; laterad of each lobe there is an elongate pore and two between the second lobule and the penultimate segment; anal opening twice the width of one median lobe and far removed from the tip; median and anterior lateral paragenitals contiguous, forming an arch ,21 to 23 posterior laterals 10 to 16." (Sasscer).

Habitat: On camellia and palms. Fairly common throughout the Union.

Collection No.: 187.

Genus **Diaspis,** Costa.

Scale of adult ♀ circular or nearly so, with the exuviae usually situated towards one side but entirely within the margin, occasionally almost central. Ventral scale usually delicate. The ♂ puparium differs in form and texture from that of the ♀ scale and is generally elongate, parallel-sided, small, white, and often tricarinate. This genus is readily distinguished from *Aspidiotus* by the different form of the male. The species included by some writers in the genus *Aulacaspis* seem to indicate a connecting link with insects of the *Chionaspis* type, with which *Diaspis* seems to be closely related. On the other hand insects included in the sub-genus *Epidiaspis* form a natural link with *Aspidiotus* through the sub-genus *Diaspidiotus*. These three sub-genera may be distinguished as follows:—

A. Pygidium with club-shaped glands, reminding one of *Diaspidiotus*.
   1. Dorsal glands in single rows, small inconspicuous .. .. *Epidiaspis*.

B. Pygidium without club-shaped glands.
   2. Dorsal glands appearing irregularly disposed .. .. .. *Diaspis*, s. str.
   3. Dorsal glands in regular rows .. .. *Aulacaspis*.

124. **Diaspis bromeliae** (Kerner) Sign. (Plate xv, fig. 143).

Coccus bromeliae, Kerner, Naturg. pp. 20, 52, 1778.

Chermes bromeliae, Bdv., Ent. Hort. p. 334, 1867.

Diaspis bromeliae, Sign., Ann. Soc. Ent. France, (4) ix, p. 434, 1869.

Aulacaspis bromeliae, Ckll., Can. Ent. xxvi, p. 33, 1894.

Diaspis bromeliae, Newst., Mon. Brit. Cocc. i, p. 156, 1901; Lindinger, Die Schildläuse, p. 66, 1912.

Scale of adult ♀ about 2·2–3 mm. in diameter, flat or slightly convex, ± circular, thin, ± transparent, yellowish or greenish in colour. Exuviae almost central in many specimens, but occasionally near one margin, dark yellow to pale brown.

Adult ♀, when mounted, about 0·8 mm. long and 0·6 mm. broad, moderately elongate, hyaline, with the abdominal segments moderately produced at the margins. The pygidial margin (fig. 143) has three pairs of lobes; L_1 largest, divergent, with their inner margin finely serrate and their distal extremities rounded; L_2 and L_3 each composed of two sub-equal lobules, whose distal edges are flatly rounded. Outside L_3 there is a spine and a dagger-shaped spine and beyond this what may be considered as a rudimentary L_4. About half-way up the pygidial margin there is a large gland-pore opening into a pointed process whose point turns slightly outward from the body; in some cases it is dense and appears as a stout strong spur. Circumgenital glands in 5 groups:—

$$\begin{array}{cc} \multicolumn{2}{c}{7\text{—}11} \\ 13\text{—}21 & 13\text{—}21 \\ 12\text{—}18 & 12\text{—}18 \end{array}$$

Habitat: On pineapple, Natal, and Newlands, C.P.; collected by C. Fuller and C. P. Lounsbury, 1898. Occasionally found in greenhouses at Kingwilliamstown and Pretoria.

Collection No.: 153.

125. **Diaspis boisduvali,** Sign.

Diaspis boisduvalii, Sign., Ann. Soc. Ent. France, (4) ix, p. 432, 1869.

Aulacaspis boisduvalii, Ckll., Gard. Chron. (3) xiii, p. 548, 1893.

Diaspis boisduvalii, Newst., Mon. Brit. Cocc., i, p. 153, 1901.

Diaspis boisduvali, Lndgr., Die Schildläuse, p. 75, 1912.

Scale of adult ♀ 1·3–2·2. mm. in diameter, circular or broad egg-shaped, flatly convex, thin, transparent, greenish yellow. Exuviae central or nearly so, usually pale yellow, but more seldom brownish yellow.

The body of the adult ♀ is broad egg-shaped, with narrowed pygidium, pale yellow. The anterior margin in mounted specimens is flatly rounded, with a broadly rounded, prominent tubercle on each side of the thoracic segment. This character alone forms a ready means of distinguishing this species from *D. bromeliae*, which is otherwise very similar. The pygidium is similar to that of *D. bromeliae*, but the lobes are slightly stronger, the dorsal glands are small and fewer in number, and the gland openings are shorter. The circumgenital glands are in 5 groups:—

4—12
11—25 11—25
7—20 7—20

Habitat: On Maranta, Durban; collected by A. Kelly. On palm, Pretoria, and on orchid, Pietermaritzburg.

Collection Nos.: 153a–153c.

126. **Diaspis echinocacti** (Bouché) (Plate xv, fig. 142).

Aspidiotus echinocacti, Bouché, Schadl. Gart. Ins. p. 53, 1833.

Diaspis calyptroides, Costa, Faun. Red. Nap. Cocc., p. 201, 835; Sign., Ann. Soc. Ent. France, (4) ix, pp. 99, 434, 1869; Newst., Mon. Brit. Coccidae, i, p. 159, 1901.

Scale of adult ♀ about 2·5 mm. in diameter, almost circular, convex, opaque white when young, or sometimes slightly translucent and appearing yellowish or greenish, with ± subcentral exuviae, which vary from yellowish brown to blackish brown. Old ♀ scales buff in colour, with white margin and dark brown exuviae.

Puparium of ♂ about 1·5 mm. long, narrow, yellow-buff with pale yellow-brown exuviae. The secreted portion is semi-translucent, with a distinct median keel.

Living ♀ yellow. Body of adult ♀, when mounted, broad pear-shaped, regularly rounded in front, thin, transparent and hyaline, with the mouth-parts, spiracles and pygidium slightly yellow. Abdominal segments not strongly produced, the posterior two rounded, and supplied with glands and a few hairs and plates.

Antennae consisting of low tubercles, each with one comparatively curved spine. Parastigmatic glands few in number, usually 2 or 3 at each anterior spiracle. Circumgenital glands in 5 distinct groups :—

	9—14	
12—23		12—23
11—20		11—20

Adult ♂♂ were emerging from material received from Pearston, C.P., 27th May 1916.

Adult ♂ deep orange in colour, with legs and antennae and posterior portion of abdomen paler. The wings are cloudy white and slightly iridescent. The genital sheath is very long, the comparative measurements being :—

Length of body, without antennae or spike ..	·6 mm.
Width of body	·2 ,,
Length of wings	·78 ,,
Length of antennae	·64 ,,
Length of genital spike	·26 ,,

The antennae are 10-jointed, the two basal joints very short and together forming a ± globular tubercle; the remaining 8 ± subequal, and supplied with the usual hairs.

Remarks. A recent report from Mr. Palmer of Pearston, C.P., that this species is killing off his Burbank prickly pears reminds me of a fact mentioned by Mr. Lounsbury that years ago single leaves heavily encrusted with *D. echinocacti* were sold at two shillings each to infest plants in other localities and so kill off the host-plant.

Habitat: On *Opuntia* sp., Graaff Reinet and Pearston, C.P. (Cape Accession No. 1622).

Collection No.: 156.

127. **Diaspis newsteadi,** Leonardi (Plate xxv, fig. 147).

Diaspis newsteadi, Leonardi, Boll. Lab. Zool. Portici, p. 190, 1914.

Scale of adult ♀ large, to 2·6 mm. diameter, almost circular to somewhat elongate, very convex, rounded or ± conical, white, with the sulphur-yellow exuviae forming a distinct cap at or near centre of scale. In old specimens the second exuviae are dark, often grey in colour, in which case they are generally surmounted by a small yellow prominence which represents the first exuviae. The secretionary portion of the scale is compact and dense and often has its white colour obscured by fragments of the reddish bark of its host-plant. The ♀ scales are often clustered on the stems of the host-plant in enormous numbers.

Puparium of ♂ comparatively large, white, non-carinate, with bright exuviae. The male puparia are clustered together, usually away from the ♀ and generally project from the stem amidst a large collection of fluffy white secretion.

The colour of the adult ♀ and of the ova is pale lemon or sulphur-yellow. Body broadly oval, not much narrowed to the pygidium, thin, hyaline, except the mouth-parts and a median longitudinal patch of the pygidium, which are yellow. The median lobes are very strongly chitinised, the dense area extending slightly backward into the pygidium, where it terminates in a $\pm$ crenulate arc. Only one pair of lobes present. These often appear worn in mounted specimens, the two extreme types being illustrated (figs. 147, 147*a*). Antennae each consisting of a low tubercle and *two* curved spines of moderate length. Leonardi states that there is *one* short seta, but this condition is often observed in broken specimens. The plates are very unusual and characteristic, being broadly rounded at their extremities and supplied with spiny or finger-like projections, making them spur-like. Parastigmatic glands present; anterior spiracles with 10–12, posterior with 4–6. Circumgenital glands present, very numerous, in 5 groups :—

28—60
22—32 22—32
28—40 28—40

Habitat : On *Acacia horrida*, Willd., Pretoria ; collected by the writer, 17th October 1914. On *Acacia horrida*, Willd., Grahamstown and Bathurst, C.P., and on willows, Pretoria and Johannesburg ; collected by C. P. Lounsbury. On willow, Boksburg ; collected by C. Fuller, 18th August 1914.

Collection Nos. : 154, 154*a*, 207, 207*a*.

128. **Diaspis rhusae,** sp. n. (Plate xv, fig. 146).

Scale of adult ♀ about 2 mm. in diameter, normally circular, sometimes elongate owing to position near midrib of leaf ; very convex, but rounded at top ; margins flat, sometimes slightly turned up ; colour sordid white to buff, opaque, with the median area slightly brownish. In some specimens the sides are corrugated and give the scale a shell-like appearance. Exuviae central or nearly so, yellow ; second exuviae covered.

Puparia of ♂♂ collected together on the leaves and partly obscured by numerous silky hairs ; somewhat elongate, non-carinate, with yellow exuviae.

Adult ♀ viviparous, mounted specimens containing well-developed larvae. Body pear-shaped, thin, hyaline, evenly rounded in front. Abdominal segments not produced, posterior two with glands, plates and a few hairs. Antennal tubercle small, with two short curved spines. Pygidium with 3 distinct pairs of lobes ; L_1 large, wide apart, with the inner edges serrate, vertical at first, then widely divergent (fig. 146) ; L_2 and L_3 with large inner lobule and minute outer one, both with entire margins and striate. P generally simple, occasionally forked or fully branched at the tip. Four or five oblique dorsal gland openings on each side, near the margin. Parastigmatic glands present, 2 or 3 at the anterior spiracles only. Circumgenital glands 0.

Habitat: On native bush (*Rhus* sp.) associated with *Aonidia rhusae*, sp. n., Rondebosch, C. P. ; collected by C. P. Lounsbury, 15th June 1915

Collection No. : 161.

129. **Diaspis (Aulacaspis) fulleri,** Ckll. (Plate xv, fig. 144).

Diaspis crawii var. *fulleri*, Ckll., The Entom., xxxiv, p. 225, 1901.

Aulacaspis crawii fulleri, Fernald, Catalogue, p. 233, 1903.

Scale of adult ♀ about 2 to 2·4 mm. in diameter, nearly circular or somewhat elongate, flat, white, smooth, with dark brown exuviae. The exuviae are often central, but in many specimens they are pushed to one side, near, or at the margin. The 1st exuviae are paler than the 2nd and situated at the extreme margin or slightly away from the second.

Puparium of ♂ white, strongly tricarinate, with yellow exuviae.

Body of adult ♀ elongate, almost twice as long as its greatest width. Anterior part rather more heavily chitinised than the abdominal region and the pygidium. Front margin flatly rounded, terminating on each side with a rounded prominence at the level of the mouth-parts. The three free abdominal segments are broadly rounded and well defined at the margins. The pygidium is at first rounded and then tapers suddenly and straightly to the median lobes. Circumgenital glands in 5 large groups :—

31
55 55
39 39

Formula : L_1, G, 11_2, P_3, G, 11_4, P_5, GG, –, P_6, G.

Habitat : On *Melia azedarach*, Natal (Fuller), and Pretoria, collected by the writer July 1915. On *Ricinus* sp., Durban ; collected by A. Kelly, 1910.

Collection No. : 164.

130. **Diaspis (Aulacaspis) pentagona,** Targ. (Plate xv, fig. 145).

Diaspis pentagona, Targ., Rev. di Bacch., No. 11, 1885.

Diaspis amygdali, Tryon, Rept. Insect and Fungus Pests, p. 89, 1889.

Diaspis lanatus, Morg. & Ckll., Jl. Inst. Jamaica, i, p. 137, 1892.

Diaspis patelliformis, Craw, Fifth Bien. Rept. Cal. Bd. Hort., p. 39, 1896.

Diaspis amygdali, Green, Cocc. Ceylon, i, p. 87, 1896.

Diaspis pentagona, Newst., Mon. Brit. Cocc., i, p. 173, 1901.

Diaspis amygdali, Fuller, First Rept. Ent. Natal, p. 102, 1901.

Scale of adult ♀ about 2 to 2·75 mm. in diameter, nearly circular to long, ± pyriform, flattish to convex or conical, white to greyish, the colour being chiefly due to the admixture of epidermal tissues of the host-plant, with exuviae subcentral to near one margin. The exuviae are orange-yellow to reddish brown. In young specimens the form of the scale is often elongate, with the exuviae at or near one extremity, and this form is retained in a few adult insects. The ventral scale is very thin and delicate.

Puparium of ♂ elongate, white, faintly tricarinate or feebly keeled, with pale exuviae.

Adult ♀ and ova yellowish to bright pink according to host-plant, usually pink. Body of adult ♀ short egg-shaped or broad pear-shaped, thin, hyaline. The lobes are heavily chitinised and yellow. The abdominal segments are not greatly produced and are broadly rounded. The antennae are placed close together and near the anterior margin. The antennal tubercles are bi-lobed and each bears a long curved seta. L_1 large, somewhat triangular with rounded apex, both margins ± deeply crenulate ; L_2 composed of two lobules, the inner one longer than wide, almost parallel-sided, with rounded apex, the outer lobules small, ± triangular ; L_3 composed of two ± even lobules, shorter than L_2. P strong, dagger-shaped; usually entire, but occasionally divided at their extremity (fig. 145). Parastigmatic glands numerous at the anterior spiracles, where usually about 15 are arranged in an anterior crescent-shaped group. Circumgenital glands in 5 large groups:—

	6—25	
13—49		13—49
10—41		10—41

Formula: L_1, $1P_2$, G, $1l_2$, P_3, G, L_3, P_4.

Historical Note. The following interesting note appears in Mr. Lounsbury's Annual Report for the year 1898, pp. 32–34:—

"*Strange behaviour of Peach Scale in St. Helena.*—It is possible that an efficient check for our white peach-scale (*Diaspis amygdali*) exists at St. Helena. The basis for this conjecture is the recorded statement that a century ago the peach trees of the island suffered greatly from the attacks of a white scale-insect which has since wholly disappeared from notice. Kirby and Spence, writing in 1815 (page 113, seventh edition), thus speak of the pest: 'A coccus, as it should seem from the description, imported about thirty years ago from the Mauritius or else with the Constantia vine from the Cape of Good Hope, has destroyed nearly nine-tenths of the peach trees in the Island of St. Helena, where formerly they were so abundant, that, as in North America, the swine were fed with their fruit. Various means have been employed to destroy this plague, but hitherto without success.' Reference is made to an older work, 'Description of the Island of St. Helena,' from which the information was probably derived. I have not had access to this second book, but in Melliss's 'St. Helena,' published in 1875, is a long extract from it, in which the insect is described in such terms as to leave little doubt in my mind that it was the scale now known as *Diaspis amygdali*. The pest is said to settle on the trunk of the tree and to there form a white crust, a peculiarity that at once brings our white peach scale to mind. Continuing, the old writer, as quoted by Meliss, says: 'It attacks other trees, particularly the native gum-wood trees and the mulberry, but the trunk of the peach seems to be its favourite lodgement.' Next to the peach, the mulberry suffers more than any of our other trees from the present-day scale. Melliss in his work, after relating what a severe pest the insect was formerly, goes on to state that the peach trees of his day enjoy immunity from the trouble, and expresses the belief that the pest had run its course and then naturally disappeared from the Island, a fate which he intimates had also befallen other introduced insects, notably the death's head moth, *Acherontia atropos*. It seems to me, however, that some trace of the scale must still exist, and associated with it a powerful natura check. Through the kindness of friends, the subject has been brought to the notice of his Excellency, the Governor of the Island, and he has written to say that diligent search will be made in the old gardens, and that should any insect answering the description be found, specimens will be forwarded to me. The result of the enquiries is awaited with much interest, but even should no occurrence of the insect be located, I would not think it conclusively shown that the insect is now extinct, for a few scales here and there would probably be overlooked by anyone not experienced in searching for this type of insect. It may be remarked that *Diaspis amygdali* is known both at the Cape and Mauritius, the one or the other of which countries, as stated above, is credited with having furnished St. Helena with the peach scourge. It may have been here since the early days, but I know of no evidence whatever to show that it is native. An old volume records the occurrence of a white pest on peach in Mauritius sixty years ago, and it seems to be more likely that Mauritius or some oriental country furnished St. Helena the pest than this country. St. Helena was a port of call for ships returning from the Indies in by-gone days, and the occurrence of the insect in the far east is now established. But wherever the insect may have originated and whatever place may have been responsible for St. Helena's getting the pest, we know that *Diaspis amygdali* is now and has long been a destructive enemy to the peach at the Cape, and is now also highly injurious in Mauritius. It is also coming into prominence in most of the warmer countries and threatens to prove a cosmopolitan scale pest of considerable importance. It endures a very wide range of temperature and thrives not alone on peach, mulberry, and several other common fruits, but also on many ornamental and shade trees and shrubs, on a number of worthless weeds, particularly certain shrub-like perennial Solanums and on some of the *Acacia* tribe that have been planted or sprung up along roads and in waste places in the Cape and other districts. More complaints regarding it are made to this office than about any other insect, with the exception of red scale. If nothing of value is learned from the enquiries now being prosecuted at St. Helena, it may be well worth the while for our Government to send an expert to the island to thoroughly investigate the subject; even should nothing further be learned of the scale it is possible that the agent that suppressed it—perhaps now existing at the expense of other scale-insects—may be discovered and brought to our country."

It may be mentioned that nothing came of the enquiries instituted in 1898 and nothing further was known of the occurrence of this species in St. Helena until Mr. Lounsbury's recent visit to the island (January 1916). It was by no means conspicuous in the gardens, but a careful search revealed its presence and specimens were brought for this collection. Sufficient material was collected to demonstrate the presence of a Hymenopterous parasite, but nothing has yet been done to ensure its establishment in this country.

Habitat: This scale is common on a number of nursery plants, including almond, fuchsia, geranium, kaffir-boom (*Erythrina* sp.), castor-oil plant, lilac, peach, pear, pepper, plum, poplar, mulberry, veronica, etc.

Collection Nos.: 165–165*b*.

131. **Diaspis (Epidiaspis) conspicua,** sp. n. (Plate xv, fig. 149).

Scale of adult ♀ clustered in association with those of *A. pectinatus* on twigs of privet in Pretoria. The ♂ puparia are whitish and comparatively large, with parallel sides, and are particularly conspicuous because they are attached to the stem only by their anterior end and project in all directions from between the clustered ♀ scales.

Scale of adult ♀ $\pm$ circular, convex, about 2 mm. in diameter, dark greenish to almost black, with brown exuviae. The body is broad pear-shaped, with the abdominal segments flatly rounded and only faintly indicated at the margin. The pygidium has very distinctive characters. There is an interrupted transverse band of chitin slightly posterior to the vulva and one long bar on each side at right angles to this. The vulva is wide, set about three times the distance of the anal opening from the median lobes. There is only one pair of lobes, which are large, with their inner faces in close contact with one another, the outer margins curving slightly outward and once notched at about two-fifths their length. The plates and spines are very long and unusual, as illustrated (fig. 149). Circumgenital glands 0.

Formula: L_1, P_2, S, P_3, S, $2P_4$, —, S, $2\text{–}3P_5$.

Remarks. This species is very close to *Aspidiotus spiniger*, Lindinger, but differs in the lobes and plates and the longer spines.

Habitat: On privet, Pretoria; collected by B. Delport, June 1915. On *Acacia*, Kroonstad; collected by A. Kelly, 12th December 1916. On *Gardenia fortunei*, Kabah, Uitenhage; collected by A. Kelly, 27th February 1917.

Collection No.: 217.

Genus **Chionaspis**, Sign.

Scale of ♀ elongate, often ± parallel-sided, but may be conspicuously broadened or even pyriform, and usually ± convex. Colour most commonly white. Texture varying from thin and pearly to thick and chalky or cottony. Exuviae at the anterior extremity, the first naked and partly overlapping the second, which is usually ± covered with a layer of secretion. Colour of exuviae usually yellowish or brownish. Ventral scale often but slightly developed, or strongest at the anterior end.

Adult ♀ usually elongate, and broadened posteriorly, distinctly segmented. Pygidium with usually 2 or 3 pairs of lobes and simple spine or dagger-shaped plates. Second pair of lobes, and third pair when present, often composed of two lobules. The glandular plates are usually simple, but may be slightly divided at their extremities. Dorsal glands numerous, marking the primitive segments and most variable towards the posterior end of the pygidium. Circumgenital glands absent or present.

Male puparium small, elongate, ± smooth to uni- or tri-carinate.

The following sub-genera are used, but the classification of species into them is not so easy a matter as would appear. In the present paper such a classification has not been strictly attempted.

A. Circumgenital glands in 5 groups.

(1) Median notch of pygidium not thickened; median lobes not in close contact nor fused .. .. *Chionaspis*, s. str.

(2) Median notch not thickened; median lobes in close contact or fused together *Pinnaspis* (*Hemichionaspis*).

(3) Median notch of pygidium thickened and strongly chitinised *Phenacaspis*.

B. Circumgenital glands in more than 5 groups.

(4) As in *Chionaspis* (s. str.), but with circumgenital glands usually in 8 groups, often extended into a bow .. .. *Poliaspis*.

C. Circumgenital glands absent.

(5) Ventral scale usually robust; anterior portion of body of adult ♀ generally highly chitinised .. .. *Dinaspis*.

132. **Chionaspis exalbida,** Ckll. (Plate xv, fig. 151).

Chionaspis exalbida, Ckll., The Entom., xxxv, p. 112, 1902.

The following description is made from material which I find in this collection labelled "On aloe, Howick, coll. Fuller, Part of original material submitted to Prof. Cockerell, No. 5 of second lot sent Sept 21, 1901." I am somewhat disturbed because I am satisfied that the label is correct, but the characters do not agree with the description given by Prof. Cockerell. I have an abundance of material on aloe from different parts of the country, but I have failed to find in this a species which is without circumgenital glands and which could thus agree with the description given of *exalbida.*

The scales of the adult females agree perfectly with the description given. They are massed together in large numbers so as to cover entirely large patches of the leaves. They are about 1·6 to 2 mm. long, narrow, in some cases slightly broadened and flattened behind. The secreted portion is dull white and smooth, not markedly chalky, but varying considerably in texture and in the prominence of the transverse growth lines. The exuviae are yellowish or orange-brown, the second pellicle being covered by a layer of secretion, except at the posterior end, which remains naked. In old dry specimens the anterior portion of the second pellicle often shows through the secretionary layer greyish in colour.

The male puparium is similar but smaller, with parallel sides, and usually ± distinctly tricarinated, with the median ridge well pronounced. In a few examples the margins are low, giving the impression that the puparium is uni-carinate.

The adult ♀ turns green in boiling KOH. When cleared and mounted the insect is about 1 mm. long and 0·4 mm. broad, narrowed at each end, and slightly widest behind the middle. The body is entirely transparent, the pygidium not appearing more highly chitinised than the remainder of the body. The antennae are prominent, ± oval tubercles; the margin of the abdominal segments are not produced; there appears to be one comparatively large gland-pore lateral to each of the anterior spiracles. The characters of the pygidium are very indefinite. There are probably two pairs of lobes, as indicated in the figure, but the projecting parts are very delicate, and these, as is also the case with the plates, are often bent back in mounting, and in many instances they might be considered absent (fig. 151). There are 5 well defined groups of circumgenital glands, the median with 8 to 14, the anterior laterals with 13 to 18, and the posterior laterals with 6 to 14, usually 10.

Remarks. What I consider to be a variety of this species is found on aloes in Johannesburg. The female scales appear slightly larger than normal for the species, and the secreted portion of the scale is somewhat roughened, almost felted. The first exuviae are usually yellowish brown and the secretionary layer over the second pellicle appears to extend further back than in typical *exalbida*, but in stored material it is usually flaked off. The exuviae of the male puparia are generally a little darker than in the type.

In mounted material the pygidium presents the same indefinite characters; but in looking over a number of slides it appears that the plates are possibly a little more delicate and hence more often appear to be absent, and the lobes a little longer and narrower.

Habitat: On aloe, Howick, Natal; collected by C. Fuller. On aloe, Port Elizabeth; collected by C. P. Lounsbury, April 1901. On aloe, Eshowe, Zululand; collected by C. Fuller, 17th July 1907. On aloe, Johannesburg, June 1910 (Cape No. 1520). On aloe, Barberton, Tvl.; collected by A. Kelly, Nov. 1914. On aloe, Johannesburg; collected by the writer, July 1915.

Collection No.: 141.

133. **Chionaspis margaritae,** sp. n. (Plate xv, fig. 148).

Scale of adult ♀ about 2·5 mm. long, moderately broad and convex, white, very smooth and glossy or pearly in appearance, with brownish exuviae. The second exuviae are sometimes only very slightly covered and can be seen quite easily. In the other cases the scales and also the covering of the second exuviae are much more robust. The whole scale has an extremely regular, smooth and neat appearance.

Adult ♀, when mounted, regular in outline, somewhat narrowed in front and with the anterior part of the body slightly more chitinised than the remainder. Abdominal segments not produced but broadly rounded, and conspicuous by the numerous gland openings; close to the marginal gland areas of the three anterior abdominal segments, but a little nearer the median line, is a series of carrot-shaped glands, which often appear in optical section as broad, conical spines. The pygidial margin (fig. 148) is broadly rounded and slightly but straightly notched in the middle. L_1 small, with more or less straight sides and pointed ends; L_2 consisting of two lobules, of which the inner is the larger, both lobules $\pm$ trilobed with outer end rounded. Marginal glands large and conspicuous. Plates of moderate length, simple, dagger-like. Circumgenital glands in 5 groups:—

7—8
18—23 18—23
34—40 34—40

Remarks. This species is very much like *Chionaspis capparisi* (q.v.), but may be readily distinguished by the sublateral gland area of the first three abdominal segments and the more numerous circumgenital glands.

Habitat: On aloe (Cape Accession No. 1269, of which the data have been lost).

Collection No.: 179.

134. **Chionaspis humilis,** sp. n. (Plate xv, fig. 150).

The insects are clustered on the leaves of the host-plants and large numbers of the narrow male puparia are found clustered together on the lower parts of the leaves. The scale of the adult female is about 2 mm. long, white, comparatively broad, usually robust and convex, but in some cases appearing rather loosely constructed; broadest just behind the middle, when it may terminate behind abruptly or be somewhat extended and pointed. The exuviae vary considerably; in some the first pellicle is glassy and almost colourless, but in the majority of cases it is slightly yellowish. The second exuviae are thinly covered with a layer of secretion, through which they show yellowish to brown. In old material it is a common occurrence for the anterior part of the second pellicle to appear greyish and the hind margin to look almost naked and yellow. When the scales occur singly on the leaves they are generally regular in outline, but when a large number are congregated with male scales in the axils of the leaves they are often distorted. Ventral scale delicate, adhering to the leaf. Male puparium small, linear, white, with bright pale yellow exuviae. The secreted portion usually has a very strong median keel.

Adult ♀, mounted, about 1·2 mm. long, evenly elliptical, with both ends about equally rounded; very transparent, not highly chitinised. The abdominal segments are not prominently produced but are flatly, broadly rounded. L_1 narrow, very divergent, with their outer ends free, and always a little further back than L_2; L_2 broadly rounded, rather close to L_1, with a short plate on either side. In some cases there is an indication of a rudimentary L_3 opposite the opening of the second conspicuous gland opening. P short, dagger-like, with broadened bases. The pygidium as illustrated (fig. 150). Circumgenital glands in 5 compact groups :—

8—12
14—17 14—17
12—15 12—15

Formula: L_1, P_2, L_2, P_3, G, G, L_3, P_5, G, G.

Habitat: On aloe, Grahamstown, C.P.; collected by C. P. Lounsbury, August 1906. On aloe, Pretoria; collected by the writer, November 1914. On grass, Pretoria; collected by C. P. Lounsbury and the writer, September 1914.

Collection No.: 149, 149*a*, 180.

135. **Chionaspis natalensis,** Mask. (Plate xvi, fig. 152).

Chionaspis spartinae var. *natalensis,* Mask., N.Z. Trans. xxviii, p. 390, 1896.

Chionaspis natalensis, Fernald, Catalogue, p. 220, 1903.

The scale of the adult ♀ is about 2 mm. long, narrow, slightly broadened behind, white, with yellow exuviae.

I have not been able to obtain fresh specimens of this species, but have been fortunate enough to secure two slides from Mr. Arnold W. Cooper, of Richmond, Natal. These were made in May 1895 and are apparently from part of the original material submitted to Mr. Maskell.

The male puparium is "white, elongated, cylindrical, carinated, length about $\frac{1}{30}$ inch" (Maskell).

The insect is elongate, about 1·4 mm. long, narrowed at each end. The specimens I have before me have not been treated with potash, but mounted direct with the scales into Canada balsam. They are fairly satisfactory for observing the characters of the pygidium, but other characters, such as the antennae, parastigmatic glands, etc., cannot be determined. The pygidium is as illustrated (fig. 152). The entire margin appears slightly thickened and the lobes are delicate and not always visible. The second lobes consist each of two rounded lobules. The circumgenital glands are in 5 group:—Median 8—13, anterior laterals 17—24, posterior laterals 14—20.

Habitat: On "wire-grass" Richmond, Natal; collected by A. W. Cooper, May 1895.

Collection No.: 142.

136. **Chionaspis stanotophri,** Cooley (Plate xvi, fig. 153).

Chionaspis stanotophri, Cooley, Spec. Bull. Mass. Exp. Stn., p. 35, 1899.

Professor Cooley's description, omitting plate references, is as follows :—

"Scale of Female.—Length 2·2–2·6 mm. Moderately elongated, distinctly convex, firm in texture, clear white in color. Exuviae ·8 mm. long; lemon-yellow or orange-yellow in color.

"Female.—Three pairs of lobes are present. Median pair rounded, divergent, striate, entire; separated at their bases by a distance nearly equal to the width of one of the lobes. Lobules of the second pair rounded, entire, striate. Third pair varying in degree of development; composed of two broad, short, striate, entire lobules. The lobes are very slightly, if at all, darker than the remainder of the pygidium. In general appearance the median lobes resemble those of *pinifoliae* but they are further apart. The gland-spines are arranged as follows: 1–2, 1–2, 1–2, 3. There are four distinct spines at the base of each of the median lobes, two above and two below. Second row of dorsal gland-orifices represented by the anterior group consisting of 1–4 orifices. Third row with 4 orifices in the anterior and 5–6 in the posterior group. Fourth row with 4 orifices in the anterior and 5–6 in the posterior group. Median group of circumgenital gland-orifices, 7–12; anterior laterals, 18–24; posterior laterals, 15–17.

"Scale of male.—Length, 1–1·2 mm.; distinctly tricarinate. Exuvia lemon-yellow or brownish, occupying scarcely one-third the length of the scale."

Habitat: On buffalo grass (*Stanotophrum glabrum*), Cape Town. On *Eulalia gracilis*, Maritzburg; collected by A. Kelly, April 1915. On Rhodesian lemon grass, Richmond, Natal; C. Fuller, 1899. On grass (sp. indet), Zoo, Pretoria, and on grass (sp. indet) Ceres, C.P.

Collection Nos.: 144–144d.

137. **Chionaspis capparisi,** sp. n. (Plate xvi, fig. 154).

Scales clustered on the twigs and stems of the host-plant.

The female scale is about 2·2 mm. long, comparatively wide for its length, moderately convex, widest about the middle, clean specimens appearing slightly glossy but felted. Exuviae brown. In some cases the second exuviae appear to be covered with a very slight film of whitish secretion, but as a rule they are naked.

Male puparium white, non-carinated, exuviae yellowish or yellowish brown.

Adult ♀ viviparous, mounted specimens containing numerous well-developed larvae. Adult ♀ mounted, about 1·5 mm. long, comparatively wide, widest a little behind the middle, narrowest at anterior end; margin regular; abdominal segments not produced and but faintly indicated at the margin; body faintly chitinised. Lobes small and inconspicuous, as figured (fig. 154). P long, simple, dagger-shaped. Circumgenital glands in 5 groups :—

	3—4	
4—9		4—9
8—13		8—13

Formula: L_1, P_2, G, L_2, P_3, G, --, P_4.

The scales of this species, both ♂ and ♀, are similar to those of *Dinaspis lounsburyi*, Leon., but the insect itself differs from that species in having the anterior part of the body less chitinised, in a few of the pygidial characters, and in the possession of circumgenital glands.

Habitat: On witgatboom (*Capparis albitrunca*, Burch.), Cape Peninsula ?; collected by C. Fuller, 1898.

Collection No.: 146.

138. **Chionaspis retigera,** Ckll. (Plate xvi, fig. 162).

Chionaspis retigera, Ckll., The Entom, xxxiv, p. 249, 1901.

Professor Cockerell's description is as follows:—

"Scales crowded on twigs; white, the exuviae orange-brown. ♀ scale mytiliform, about $1\frac{1}{2}$ millim. long, straight or curved, very convex, the transverse growth-lines rather conspicuous; second skin more or less covered with white secretion. ♂ scale of the usual shape, rather broad, with a barely indicated median keel; exuviae bright orange.

"♀ dark brown, subpyriform, or rather club-shaped, the anterior end being much narrowed; median lobes rounded, very low, rudimentary, but conspicuous because of their dark colour; two other lobes barely indicated by low rounded structures; spine ordinary; squames long and spine-like; anal orifice far from the hind end; five groups of circumgenital glands, the posterior laterals about 10, anterior laterals about 8, median 6; submarginal region with large reticulated patches, transversely elongate, making the five posterior segments, the last pair longitudinally elongate, and situated about the region of the lateral circumgenital glands; mouth-parts large.

"♀ second skin. Mouth-parts between the anus and the hind margin of the body; median lobes large, quadrate, separated by a rather wide interval; margin on each side of median lobes strongly serrate; squames long and spine-like. Some individuals of the third stage, presumably not quite mature, show also the large quadrate median lobes, with wavy-truncate ends."

After examining a large number of specimens I am convinced that the large quadrate median lobes are normal for this species. The typical form of pygidium is illustrated. The large reticulated patches mentioned by Professor Cockerell are the large collections of dorsal gland openings. Circumgenital glands in 5 groups:—median 6—10, anterior laterals 8—12, posterior laterals 10—14.

Habitat: On a number of native plants, including witgatboom (*Capparis albitrunca*, Burch.), Durban, Natal, and East London, C.P.

Collection No.: 143 and 143a.

139. **Chionaspis euphorbiae,** sp. n. (Plate xvi, fig. 156).

Scale of adult ♀ about 2 mm. to 2·5 mm. long, white, gradually broadening to beyond middle; posterior end ± flattened and broadly rounded, straight or slightly curved. The scale is not glossy, but shows numerous small transverse ridges, which are close together and generally greyish owing to the collection of foreign matter. First exuviae pale, brownish, second exuviae covered.

Male puparium small, white, with orange exuviae, smooth to faintly carinated.

Adult ♀ (mounted) 1·4 mm. long, broadly oval, not much narrowed at either end. Anterior two-thirds moderately chitinous, yellow, posterior third colourless, transparent. The pygidial margin is richly supplied with gland openings, which form practically a continuous row, in some places two deep. The rows of dorsal glands are interrupted, the last arising from the margin with two or three openings and then interrupted to near the anal opening, where there are 2 or 3 others. The penultimate row has 3 or 4 near the margin, then two groups of 2 to 4 on each side to just beyond the anus. The lobes and plates are small, as shown in fig. 156. Circumgenital glands in 5 groups :—

2—4
14—20 14—20
19—22 19—22

Habitat: On *Euphorbia*, in association with *Hemilecanium* sp. and *Selenaspidus pertusus*, East London, C.P.; collected by Miss Impey, 23rd June, 1915.

Collection No.: 151.

140. **Chionaspis chaetachmae,** sp. n. (Plate xvi, fig. 157).

Scale of adult ♀ large, 3 to 3·4 mm. long, elongate, white, smooth, glossy, very long and narrow. Exuviae brownish; second exuviae completely covered with secretion. Ventral scale apparently formed by the thick inturned edge of the dorsal scale. Many of the female scales are arranged around the extreme margins of the leaves. In a few cases, where holes appear in the leaves the margins of these are also edged with ♀ scales.

Male puparium about 1 mm. long, very flat, white, non-carinated; exuviae straw-coloured.

Adult ♀ about 2 mm. long, narrow in front and gradually broadening until about the posterior third or suddenly widening to region of mouth-parts and then almost parallel-sided to the rounded pygidial margin. Body integument delicate, not chitinised, except mouth-parts and lobes. The pygidium is regularly rounded. The last row of dorsal glands does not reach the margin, but consists of 7 to 9 pores sloping outward and backward from the level of the hind margin of the anal opening. The lobes and plates are as illustrated in fig. 157. Circumgenital glands in 5 groups :—

4—9
16—23 16—23
36—46 36—46

Habitat: On "umkavoto" (*Chaetachme aristata*), Durban; collected by C. Fuller, 12th October 1914.

Collection Nos.: 152 and 152a?

141. **Chionaspis (Phenacaspis) visci,** sp. n. (Plate xvi, fig. 160).

Scales massed on stems of host-plant.

Adult ♀ scale about 2·2 mm. long, elongate, ± parallel-sided, convex, usually straight, ± silky, white, with transverse ridges small, numerous, close together. First exuviae greyish or brownish; second exuviae covered, brown.

Male puparium white, moderately elongate, usually with a prominent median ridge and two lateral ones, which are especially conspicuous at the posterior end. Exuviae pale, yellowish or almost colourless.

Adult ♀ (mounted) about 1·6 mm. long, widest (0·7 mm.) some distance behind the middle; abdominal segments not produced but distinctly indicated at the margin; body not noticeably chitinised. The median notch is wide, with two short plates and two short spines. L_1 wider than long, uniformly rounded when not worn; L_2 composed of two lobules, which may be somewhat rounded, but most often pointed. Beyond these there is a plate, then two or three angular projections from the margin, a short spine and a plate. Each segment is indicated rather sharply by the hind angle being slightly produced. The last row of dorsal glands is interrupted near the margin and is somewhat doubled, 3 to 4 pores lying inside, and 2 or 3 outside; the main series, which comprises 6 or 7 pores, does not reach so far back as the anus. Circumgenital glands in 5 groups:—

3—4
5—12 5—12
13—18 13—18

Habitat: On mistletoe, N.E. Transvaal; collected by Mr. Mogg, 20th October 1914. *Collection Nos.*: 148, 148a.

142. **Chionaspis globosus,** sp. n. (Plate xvi, fig. 155).

Scale of adult ♀ small, about 1 mm. long, very convex, almost globular, shiny white, with very pale yellowish to orange-brown exuviae.

Puparium of ♂ white, with a broad median rounded ridge; pellicle pale yellow or orange.

Adult ♀ broadly oval, with the two extremities about equally rounded, thin, hyaline, with the posterior margin exhibiting a series of rounded projections. The largest represent the margins of the three abdominal segments, the remainder of the pygidium consisting of smaller round projections. No lobes. The position usually occupied by the median lobes is slightly recessed and bears two short plates. On each side of this there are two gland openings followed by a flatly rounded protuberance, then two more gland openings, another protuberance, two more glands and a rounded protuberance which terminates at the junction of the last free abdominal segment (fig. 155). Parastigmatic glands present, 4 to 5 at anterior spiracles. Circumgenital glands in 5 groups:—

3—5
4—6 4—6
4—7 4—7

Habitat: On *Euphorbia* (tree), Seymour, C.P. (Cape Accession No. 1236). *Collection No.*: 162.

143. **Chionaspis subnudata,** Newst. (Plate xvi, fig. 158).

Chionaspis subnudata, Newst., Zool. Anthr. Ergeb. Westl. Zentr. Sudafr. p. 20, 1912.

"Puparium of female, broadly pyriform, faintly and irregularly striated transversely, white, with a trace of pale slaty grey anteriorly; larval pellicle varying from yellow to dark grey or dark brown. Length, 1·75 to 2 mm.

" Puparium of male white, with a sharply defined median ridge, sides rounded.

" Female, adult. Subpyriform, widening considerably in the region of the free abdominal segments; gradually and widely rounded posteriorly; narrowest in front. Rudimentary antennae with one long curved spine and two very short ones. Anterior stigmata with 4 parastigmatic glands; posterior pair without glands. Circumgenital glands in five groups, formula of two examples :—

	9		8
14	12	12	12
14	15	13	14

Anal orifice opposite the lower lateral groups of spinnerets. Fringe of pygidium [fig. 158] almost denuded of appendages; median lobes very short, broad, with the inner margins touching, so that in some examples they appear as if fused. There is a single long spine on either side of the lobes and beyond them one or two smaller ones. Dorsal pores numerous and extending to the margin.

" Closely allied to *Chionaspis nudata*, Newst., but easily distinguished from this species by the form and position of the median lobes and also the shape of the adult female.

" *Habitat*: Sudwestafrika, Groot Namaland, Brukkarossberg, August 1905, Dr. L. Schultze. On an unknown plant called *Lobarus*." (Newstead).

144. **Chionaspis mytilaspiformis,** Newst. (Plate xvi, fig. 161).

Chionaspis mytilaspiformis, Newst., Zool. Anthr. Ergeb. Westl. Zentr, Sudafr. p. 19, 1912.

" Puparium of female. Form closely resembling that of the common *Mytilaspis pomorum*, when fixed to the slender stem of its food -plant; a few forms are, however, more or less straight, but all are highly convex. Length, 2 to 2·25 mm.

" Female, adult. Very elongate, narrowest in front. Antennae with two long, stout, curved spines and a minute central one. Anterior stigmata with 4 to 5 parastigmatic glands; posterior pair without glands. Abdominal and thoracic segments with large groups of dorsal glands. Pygidium with five groups of circumgenital glands, the anterior groups represented generally by a few isolated spinnerets. Formula of three examples :—

1		4		7	
12	10	13	11	10	8
28	29	30	30	26	23

" Anal orifice opposite the anterior group of spinnerets. Margin of pygidium [fig. 161]: median pair of lobes generally well developed, anterior edge irregularly and coarsely serrate; second pair quite rudimentary or sometimes obsolete; third pair absent. Squamae spiniform, long. Spines long, slender. Dorsal glands in large and well-marked groups or bands.

" I had, at first, thought that this insect might prove to be Maskell's *C. natalensis*. It certainly bears no resemblance to his extremely poor figure, neither does it agree with his diagnosis. It evidently belongs to the African group, and is nearly related to *C. nerii*, Newstead. The latter has, however, a much longer second pair of lobes, and the anterior group of circumgenital glands are much more numerous.

"*Habitat*: Sudwestafrika, Gross-Namaland, Chamis am Koankil, Sept. 1905, L. Schultze. On *Rhus lancea*, L.f." (Newstead).

145. **Chionaspis Africana,** Newst. (Plate, xvi, fig. 159).

Chionaspis africana, Newst., Zool. Anthr. Ergeb. Westl. Zentr. Sudafr., p. 19, 1912.

"Puparium of female. Rather elongate, widened posteriorly; secretionary portion dense, pure white and faintly but irregularly striated; pellicles yellow. Length, 2 mm.

"Female, adult. Ellipsoidal; segmentation in macerated example, very faint. Antennae with one very long apical spine and one minute sub-basal spine. Anterior pair of spiracles with 4–5 parastigmatic glands close to the anterior margin of the orifice; posterior pair similar, parastigmatic glands apparently absent. Pygidium large; circumgenital glands in five groups, formula of one example :—

14
18 19
16 18

"Anal orifice opposite the lower lateral groups of circumgenital glands; position of vaginal orifice doubtful; dorsal glands in two short series, the first the longest, reaching to the distal part of the lower lateral group of circumgenital glands. Margin of pygidium with three pairs of very short lobes, of which the second and third are duplex. There are four bilateral spines; but the squames are either entirely wanting or quite rudimentary and not traceable in the preparations. Length, 1·25 mm.

"The distinguishing morphological characters of this insect are the more or less rudimentary lobes and the relatively few dorsal glands.

"*Habitat*: Sudwestafrika, Steinkopf (Klein Namaland), 1904, L. Schultze. The food-plant is not given, but the puparia were attached to the slender stems of a grass-like plant" (Newstead).

146. **Chionaspis (Poliaspis) kiggelariae,** sp. n. (Plate xvi, fig. 163).

Scales clustered into large wart-like masses on the twigs and stems of food-plant. Majority of scales arranged around the twig, very few with the long axis along the stem.

Scale of adult ♀ large, about 3 mm. long, narrow in front, gradually widening to beyond the middle and moderately broad and rounded behind, smooth, faintly glossy, without distinct growth-lines or covered with a matt deposit which is greyish or yellowish. On willow the clusters of ♀ scales appear greyish white rather than pearly, owing to the admixture of fragments from the bark of the host-plant. Exuviae yellowish to bright reddish-brown; second exuviae faintly covered.

Male puparium comparatively small, non-carinate, with pale yellowish or brownish exuviae.

Adult ♀, dry, dark brown to black; when mounted, elongate, with the whole anterior portion and first abdominal segments uniformly highly chitinised. L_1 shorter than broad, evenly rounded, striate; L_2 similar but smaller, often apparently absent. Antennal tubercle with one long, stout flagellum. Pygidium as illustrated (fig. 163). Dorsal glands very numerous, in continuous groups. Parastigmatic glands present, 6–10 at each anterior spiracle. Circumgenital glands in 8 groups:—

4— 9	1— 6	5— 8
14—20	1—10	14—20
23—36		23—36

In one specimen the median lobe on the left side was doubled, an unusual occurrence.

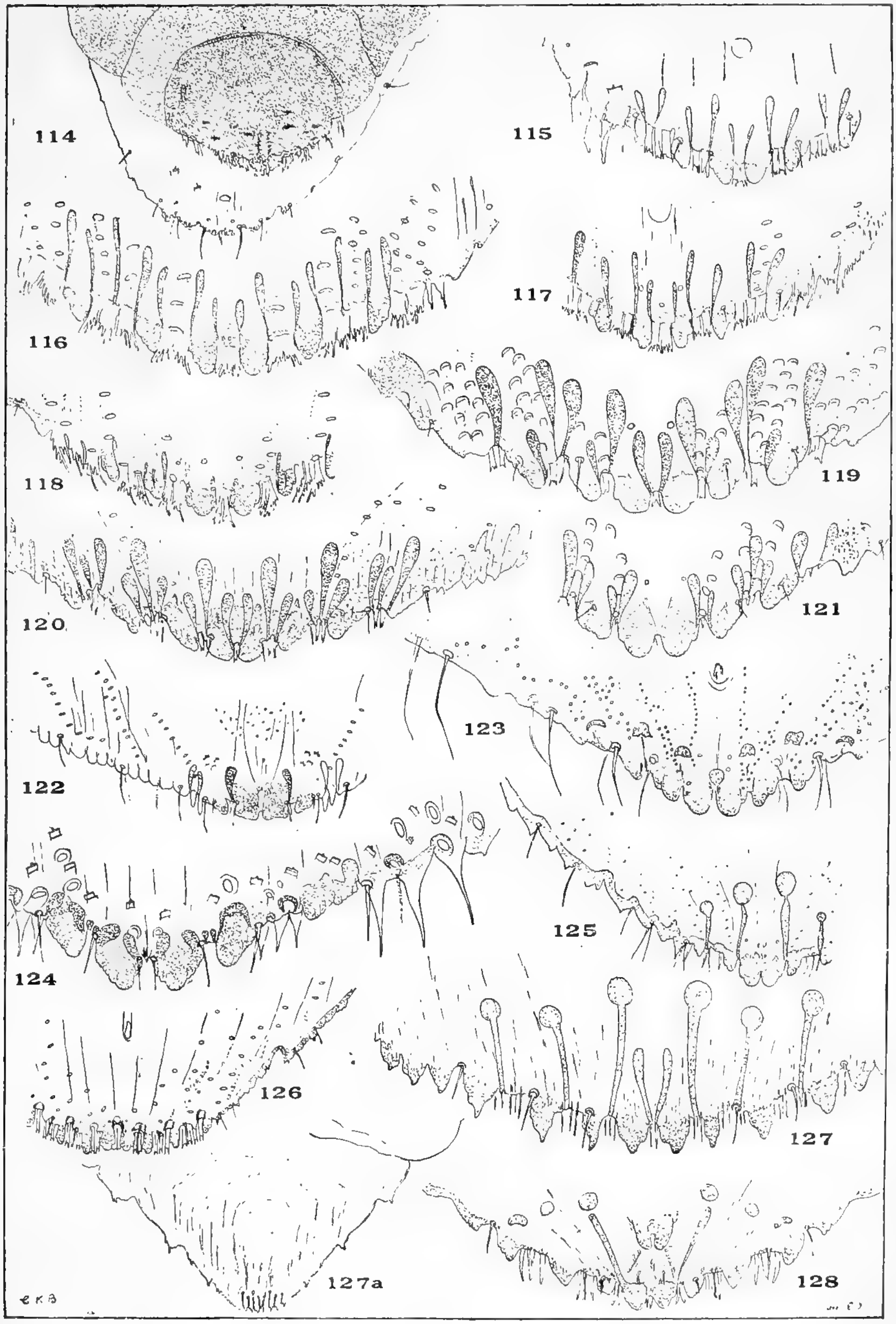
Habitat: On wild peach (*Kiggelaria africana*, Linn.), Nottingham Road, Natal. On willow, Orchard Siding, C.P.; collected by C. P. Lounsbury, 8th June 1915. On willow, Oudtshoorn (Cape No. 1235).

Collection Nos.: 169, 169*a* and 169*b*.

EXPLANATION OF PLATE XII.

Fig. 114. *Cryptaspidiotus austro-africanus*, Ldgr.; pygidium of adult ♀ projecting beyond that of second stage.

115. *Chrysomphalus dictyospermi* (Morgan).
116. *Chrysomphalus rossi* (Mask.).
117. *Chrysomphalus ficus*, Ashmead.
118. *Chrysomphalus aurantii* (Mask.).
119. *Chrysomphalus corticosus*, sp. n.
120. *Chrysomphalus phenax*, Ckll.
121. *Chrysomphalus obscurus* (Comst.).
122. *Pseudaonidia glandulosa* (Newst.).
123. *Pseudaonidia tesserata* (d'Emmerez).
124. *Pseudaonidia lycii*, sp. n.
125. *Pseudaonidia clavigera*, Ckll.
126. *Pseudaonidia trilobitiformis*, Green.
127. *Pseudaonidia nigra*, sp. n.; (*a*) whole pygidium, less enlarged.
128. *Pseudaonidia laciniae*, sp. n.



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SOUTH AFRICAN COCCIDÆ.

EXPLANATION OF PLATE XIII.

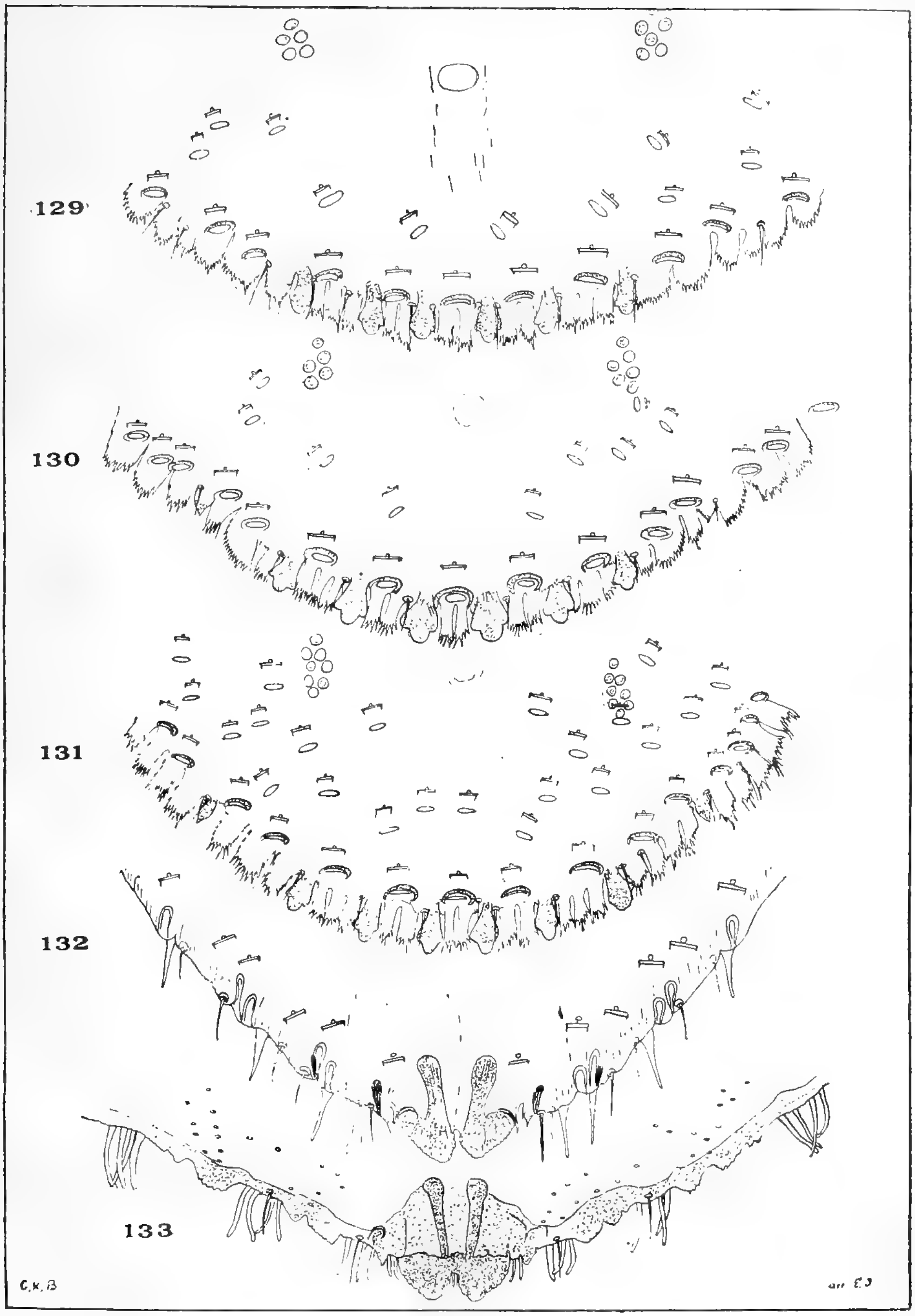
Fig. 129. *Parlatorea proteus* (Curtis).

130. *Parlatorea pergandei*, Comst.

131. *Parlatorea zizyphi* (Lucas).

132. *Howardia moorsi* (Doane & Ferris).

133. *Howardia biclavis* (Comst.).



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SOUTH AFRICAN COCCIDÆ.

EXPLANATION OF PLATE XIV.

Fig. 134. *Aonidia chaetachmae*, sp. n. ; (*a*) second stage.

135. *Aonidia simplex*, Leon. ; (*a*) second stage.

136. *Aonidia mesembryanthemi*, sp. n. ; (*a*) second stage.

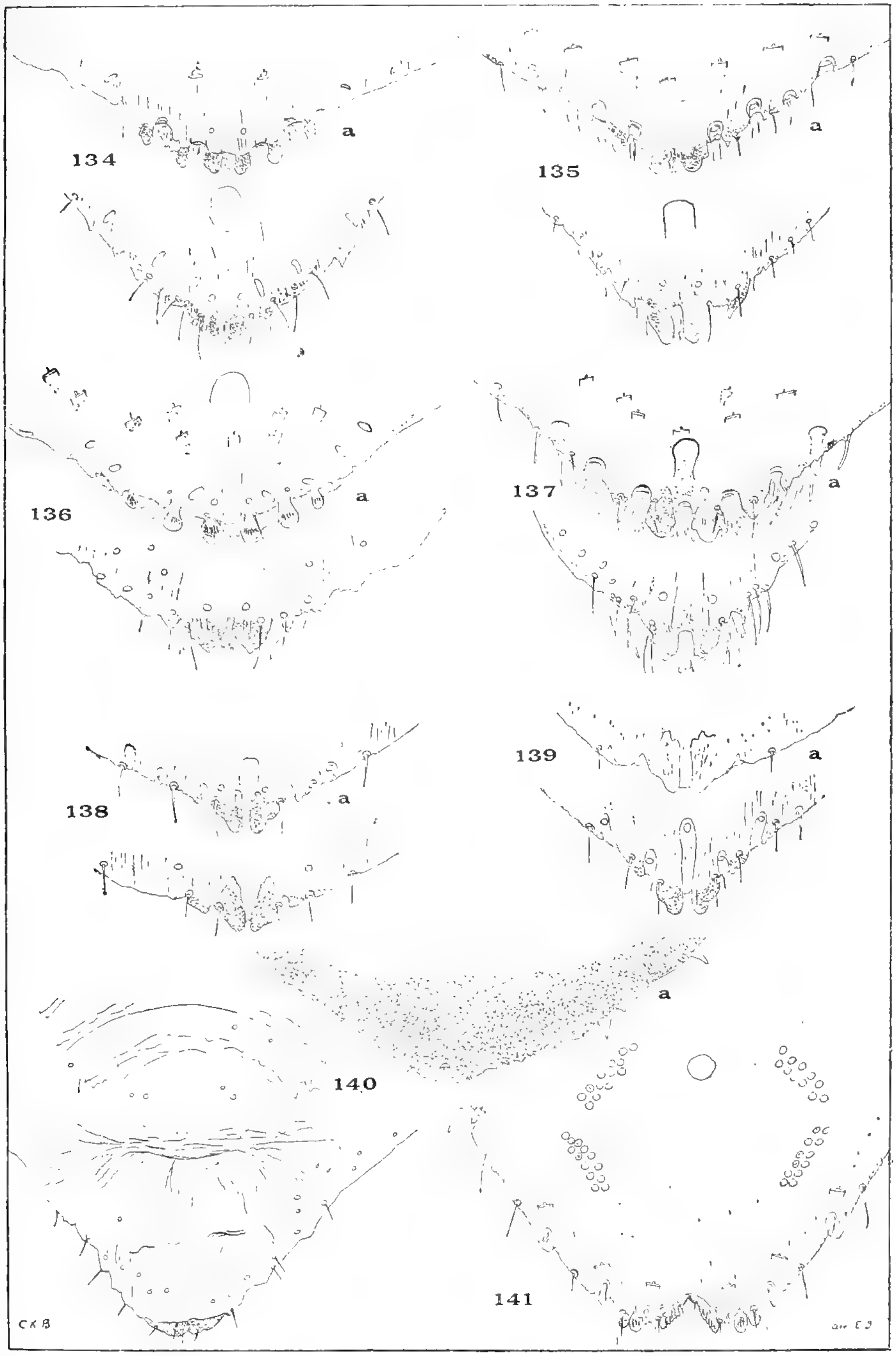
137. *Aonidia rhusae*, sp. n. ; (*a*) second stage.

138. *Aonidia marginalis*, sp. n. ; (*a*) second stage.

139. *Aonidia badia*, sp. n. ; (*a*) second stage.

140. *Gymnaspis faurei*, sp. n. ; (*a*) second stage.

141. *Fiorinia fioriniae*, Targ.



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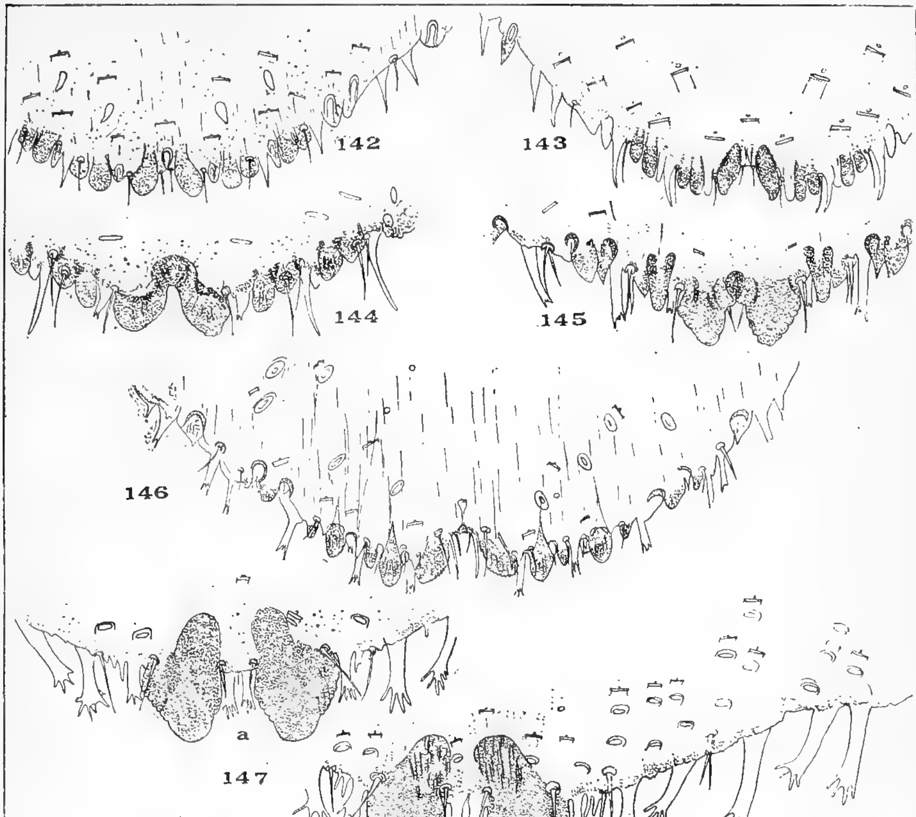
SOUTH AFRICAN COCCIDÆ.

EXPLANATION OF PLATE XV.

Fig. 142. *Diaspis echinocacti* (Bouché).
143. *Diaspis bromeliae* (Kerner) Sign.
144. *Diaspis fulleri*, Ckll.
145. *Diaspis* (*Aulacaspis*) *pentagona* (Targ.).
146. *Diaspis rhusae*, sp. n.
147. *Diaspis newsteadi*, Leon. ; (*a*) variation in L_1.
148. *Chionaspis margaritae*, sp. n.
149. *Diaspis* (*Epidiaspis*) *conspicua*, sp. n.
150. *Chionaspis humilis*, sp. n.
151. *Chionaspis exalbida*, Ckll.



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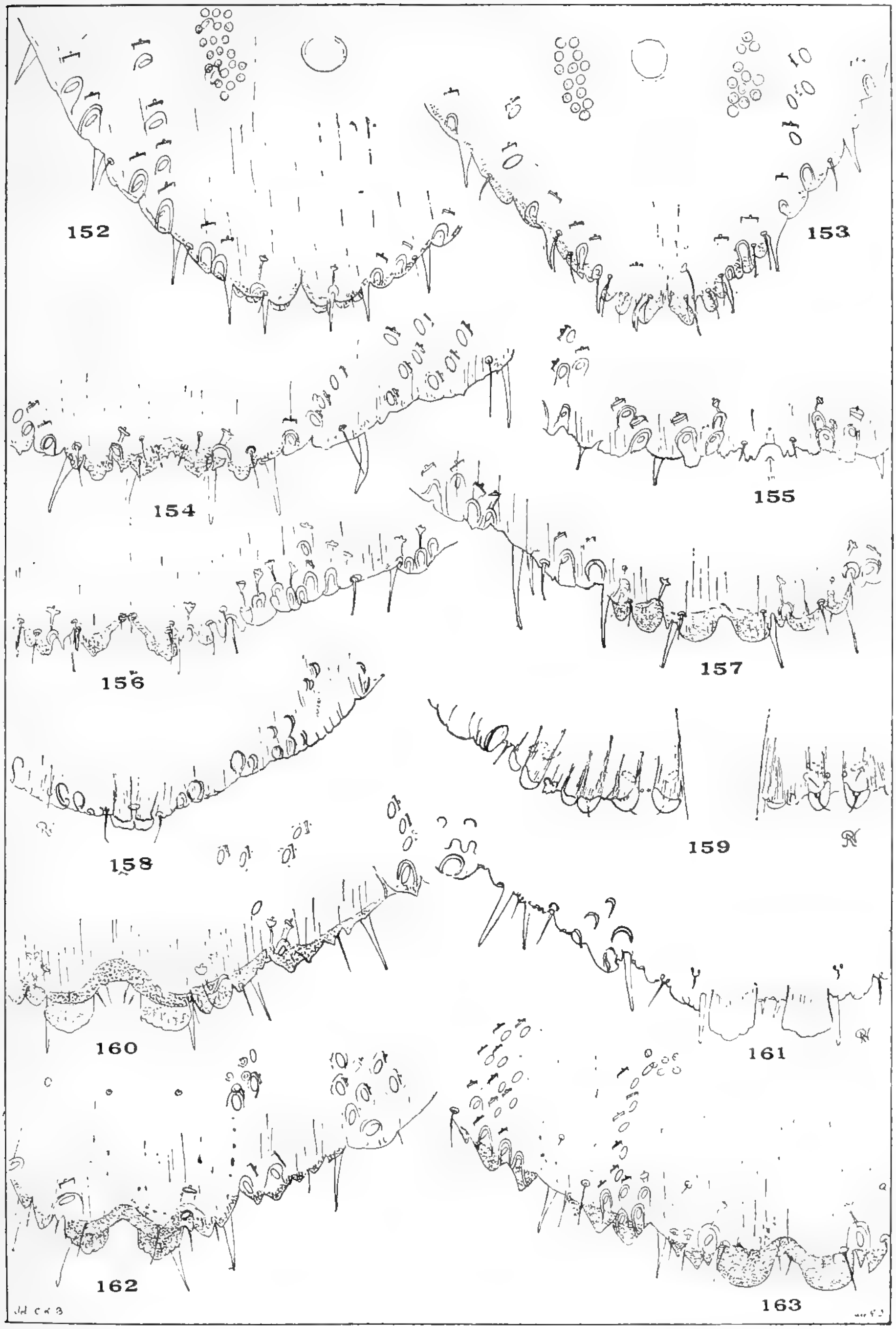
SOUTH AFRICAN COCCIDÆ

EXPLANATION OF PLATE XVI.

Fig. 152. *Chionaspis natalensis*, Mask.
153. *Chionaspis stanotophri*, Cooley.
154. *Chionaspis capparisi*, sp. n.
155. *Chionaspis globosus*, sp. n.
156. *Chionaspis euphorbiae*, sp. n.
157. *Chionaspis chaetachmae*, sp. n.
158. *Chionaspis subnudata*, Newst. (after Newstead).
159. *Chionaspis africana*, Newst. (after Newstead).
160. *Chionaspis visci*, sp. n.
161. *Chionaspis mytilaspiformis*, Newst. (after Newstead).
162. *Chionaspis retigera*, Ckll.
163. *Chionaspis* (*Poliaspis*) *kiggelariae*, sp. n.



Chas K Brain

SOUTH AFRICAN COCCIDÆ

TWO NEW ETHIOPIAN LONCHAEIDAE, WITH NOTES ON OTHER SPECIES (DIPT.).

By Prof. M. Bezzi,

Turin, Italy.

Very little is known about the Dipterous Family Lonchaeidae in the Ethiopian Region, notwithstanding the small extension of the group (almost limited to the two main genera *Lonchaea*, Fallén, and *Palloptera*, Fallén), and in spite of its economic importance. Some tropical or sub-tropical species of *Lonchaea* pass their larval stage in fruits, in which they sometimes occur in company with Trypaneids, and are often mistaken for them, being thus comprised under the same name of "fruit-flies."

The general aspect of the flies, as can be seen from the accompanying figure (fig. 1), is not unlike that of the true fruit-flies, chiefly owing to the presence of a corneous ovipositor in the female; but they may at once be distinguished by their smaller size; their dark and unicolorous bodies, which are mostly metallic; their unmarked wings, which have all the veins quite bare; and by the frons, which lacks

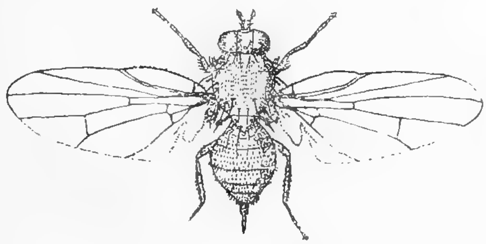


Fig. 1. *Lonchaea plumosissima*, Bezzi, sp. n., ♀.

the lower orbital bristles. Moreover it must be recognised that the species of *Lonchaea* show more resemblance to the higher Myiodaria, than to the Trypaneidae; they have been sometimes mistaken for Anthomyidae, and some care is necessary to avoid confusing them with the species of the genus *Ophyra*.

Even the maggots are very like those of the true fruit-flies, and require micro-copical examination for their discrimination; but as a rule, they are smaller and more slender, and have the posterior spiracles more prominent; the stigmal plates of these spiracles are more rounded, are often beset with ramified setae, and bear a tubercle inside; the ventral or pseudopodial protuberances are less developed, much narrower and less spinose. The puparia are also recognisable by their smaller size, and more elongate and slender shape.

Ethiopian Species of Lonchaea.

While the genus *Lonchaea* is plentiful in the warmer countries of Asia and America, from the Ethiopian Region two species only are recorded in the catalogues, both described by Macquart. One of them, *Lonchaea claripennis*, is described as a small fly of shining black colour, with short antennae and bare arista, with yellow tarsi and yellowish hyaline wings. The other, *Lonchaea aurea*, in spite of its short description, is at once recognisable as the widely spread *Lonchaea splendida*, Loew.

The third species of the family was described from West Africa, Assinia, by Bigot under the name of *Palloptera pantherina* (Bull. Soc. Ent., France, lx, 1891, p. 382); but as the genus *Palloptera* is exclusively palearctic and nearctic the species was wrongly assigned to it. Bigot was himself in doubt about its systematic position; and the insect is actually an Ortalid, recognisable by its peculiar body and wing-pattern, and now known as *Simomesia pantherina*, Big.

More recently Mr. C. G. Lamb, in dealing with the rich material collected by the Percy Sladen Trust Expedition to the Indian Ocean in 1905, under the leadership of Prof. J. Stanley Gardiner, has notably increased our knowledge of the genus *Lonchaea*. In his work, published in 1912, there are four species. The first is the well known *L. splendida*, which however must be called *aurea*, Macq. The second is described as new under the name of *L. plumata*, but is evidently the same as the Oriental *L. excisa*, Kertész (1901). The third is described under the name of *L. longicornis*; but as there is already another species of the same name described from the West Indies by Prof. Williston (Trans. Ent. Soc. Lond., 1896, d. 378), and recorded also from Porto Rico by Coquillett, a new name is necessary for it. The fourth is described as *L. vibrissifer*.

Finally, I have myself in a note in my second paper on the *Ceratitis* bred in Africa by Prof. Silvestri (Boll. Lab. Zool. Portici, vii, 1913, p. 21) recorded a species from West Africa under the name of *L. glaberrima*, Wied.

I have now before me five Ethiopian species of *Lonchaea*, two of which are to be described here as new; and adding those recorded by other authors, I propose the following table of distinction:—

1(2). Eyes hairy; head considerably broader than the thorax, with a very broad frons in the female, and with short and thin macrochaetae; lunula very broad, open and roughly hairy; antennae very short, widely separated at base, with bare arista; cheeks and jowls broad; only one strong sternopleural macrochaeta present.. .. .. .. *mochii*, sp. n.

2(1). Eyes bare; head not or only a little broader than the thorax, with less widened frons in the female and with well developed macrochaetae; lunula small. usually less visible and less or not hairy; antennae usually longer and closer together at base; cheeks and jowls narrow.

3(10). Arista bare or only microscopically pubescent; (all the species here distinguished have moreover the tarsi with yellow base and the squamulae white and with pale cilia).

4(7). Antennae short, extending only a little below the middle of the face; jowls rather broad.

5(6). Vibrissae not longer than usual; wings yellowish hyaline.. *claripennis*, Macq.

6(5). Vibrissae very long; wings brownish .. .. .. *vibrissifer*, Lamb.

7(4). Antennae long, extending much below the middle of the face; jowls narrow.

8(9). Entire body, except head, of a very glistening green, more or less golden; third antennal joint not reaching the mouth-border; only one sternopleural macrochaeta .. .. *aurea*, Macq.

9(8). Body of a shining, bluish-black colour; third antennal joint extending a little below the mouth-border .. .. *lambiana*, nom. nov.

10(3). Arista plumose or at least long-haired; antennae always extending to the mouth-border; (in all the species here comprised there are always two strong sternopleural macrochaetae, the tarsi are entirely black, and the squamulae are white and pale-haired).

11(12). Last abdominal segment of the male longer than the two preceding ones together, deeply excised at end and there with the two points clothed with dense and long, bristly hairs; plumosity of the arista of medium length *excisa*, Kert.

12(11). Last abdominal segment of the male quite simple, and not much longer than the preceding one.

13(14). Scutellum quite bare, except the usual macrochaetae; plumosity of the arista only a little longer than the breadth of the third antennal joint *gibbosa*, De Meij.

14(13). Scutellum with some hairs between the macrochaetae; plumosity of the arista nearly twice the breadth of third antennal joint .. *plumosissima*, sp. n.

1. **Lonchaea mochii,** sp. nov. (fig. 2).

A short and stout species, with a broad head, and of a more aeneous colour, closely allied to the European *parvicornis*, Mg., and *lasiophthalma*, Macq., but smaller and distinguished by the quite bare scutellum, and by the presence of a third middle keel on the face.

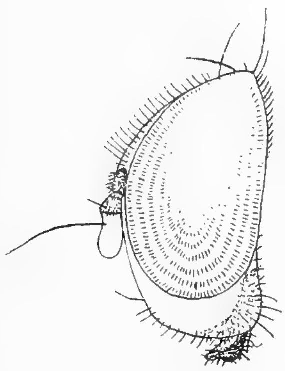


Fig. 2. Lateral view of head of *Lonchaea mochii*, Bezzi, sp. n., ♀.

♂♀. Length of the body, 3·8–4·2 mm.; of the wing, 3·7–4 mm.

Head (fig. 2) entirely black, rather shining on the occiput, with sericeous, greenish or bluish reflections on the frons, and with white shining dust on the cheeks and on the face below. It is of a large size, being distinctly broader than the thorax, chiefly in the female, which has the frons about twice as broad as that of the male. On the vertex there are no distinct shining plates. The frons is not at all prominent, and is parallel-sided in both sexes; but in the male it is twice as long as broad, while in the female it is only as long as broad; the vertical and ocellar bristles are short and thin, like the single orbital pair; all these bristles are black, like the rather long and rough hairs which cover the whole frontal stripe; these hairs in the male are irregularly disposed in four, in the female in eight rows. Lunula very broad, rounded above, clothed on the sides with hairs like those of the frontal stripe; it is moreover clothed with shining white dust, the contrast between it and the deep black frons being in certain lights very striking, chiefly in the male. Cheeks about as broad as the breadth of the third antennal joint, and clothed with greyish dust, which is chiefly shining white in the male; jowls about one-third of the height of the eye, clothed with black hairs, which are longer on the lower part of the occiput. Face flat, not at all prominent at the mouth-border, clothed with greyish dust and shining white in the male; it has along the middle a distinct, vertical keel, which is not visible in the allied species, in which the broad prominence between the antennal grooves is flat or even furrowed in the middle. Antennae widely separated at base, quite black and very short; the third joint is about as long as the previous one and is rounded at the tip, which does not extend below the middle of the face; second joint with some bristly hairs at the end above, one of which is very long; arista bare, black, thickened at the base. Eyes reddish brown, higher than broad, wholly clothed with greyish hairs, which are longer in the male. Mouth-opening rather narrow; there is a pair of distinct vibrissae, curved upwards; labium not prominent, never distinguishable; proboscis and palpi short, the latter black and broadened at the end. Thorax shining black, with more or less distinct aeneous reflections on the back, which is only very faintly dusted; the hairs of the back are rather long, black, the acrostichal ones being disposed in four rows on each side. The macrochaetae are black; there is only a pair of not very strong dorsocentrals; the mesopleura is hairy only in the middle, with some bristly hairs on the fore border, and with 3–4 long bristles at the hind border; the sternopleura has a single bristle at its upper posterior corner. Scutellum coloured like the back of mesonotum and not more dusted than it; it is quite bare, except for the usual four bristles. Postscutellum and mesophragma shining black, but with a distinct, dark greyish dust. Squamulae of proportionally greater size, whitish, with a yellowish pale-fringed border. Halteres black, with yellowish stalk. Abdomen of a broad oval shape in the female, more elongate in the male; it is shining black, with aeneous reflections and very faintly dusted; it is clothed with black hairs, and bears short thin black bristles near the sides at the hind border of the segments. The venter is entirely black, dark grey dusted and black-haired. Last abdominal segment of the male about $1\frac{1}{2}$ times as long as the preceding segment, rounded at hind border and there not specially setose; male genitalia small, rounded, black, not prominent; ovipositor shining black; if completely exserted, it is 1·5 mm. long. Legs black, black pilose and black setose; on the front pair the praetarsi are yellow with blackish tips, and the four following joints are black; on the two other pairs, the praetarsi are entirely yellow like the following joint, the three last joints only being black. Wings yellowish hyaline, with yellow veins, disposed as in *lasiophthalma*; but the first posterior cell is distinctly narrowed at the end, the 3rd and 4th longitudinal veins being slightly convergent at the apex, as in *parvicornis*. The 2nd basal segment of the costa is about straight, the 2nd costal cell being thus less widened outwardly; small cross-vein placed near the middle of the discoidal cell; 6th longitudinal vein not reaching the hind border of the wing.

Type ♂, type ♀, and numerous additional specimens of both sexes, in the writer's collection from Erythraea, Ghinda, November-December 1916, collected by *Dr. A. Mochi*, in whose honour the species is named. A couple of cotypes have been deposited in the British Museum.

Note 1. The strong resemblance that the present new species shows to *L. lasiophthalma* makes possible the supposition that it may have similar habits. The latter species is known as producing the curious, plait-shaped galls near the root of the grass *Cynodon dactylon*, L., which were first described and figured by Dr. Giraud,* but were recorded by Francesco Redi, as was pointed out by Osten Sacken,† as long ago as in 1680. These galls are very common in Central and South Europe. The allied *L. parvicornis* was observed by Perris‡ as deforming the buds of the grass *Agropyrum repens*, P.B., into spindle-shaped galls; but this deformation is much rarer than the preceding one. As the affinity of *L. mochii* is more close with *parvicornis* than with *lasiophthalma*, it may be expected that its gall will be more like that of the former. In fact Prof. De Stefani § has described and figured a gall on a grass, collected likewise near Ghinda in March 1906, which is in all probability the gall of *L. mochii*, and is more like that of *parvicornis* than that of *lasiophthalma*.

Note 2. It seems that the gall-making habit, which in the genus *Lonchaea* (s.l.) is developed only in some closely allied species, will justify the formation of a new genus for them; inasmuch as these species are distinguished by the stout body, hairy eyes, bare arista, greatly developed lunula, broader head, degenerating cephalic bristles, etc. It seems thus that the old genus *Dasyops* of Rondani (as corrected by Scudder, but Coquillett in 1910 has *Dasiopa*) must be adopted for these species, against the opinion of the monographers of the family.

This genus *Dasyops* seems to have a world-wide distribution, as *L. paulistana*, Bezzi, from Brazil, certainly belongs to it, and is very like the new species *mochii*, being distinguished by the much narrower frons of the female and by the want of the middle facial keel. From *parvicornis* it is distinguished by the bare scutellum; characteristic for the species are the bare lunula and the more dense ciliation of the front femora, in which the Brazilian species differs from all the other known species of the genus *Dasyops*, except *D. dasyops*, Mg. This last species is however very different from all the other true species (*lasiophthalma*, *parvicornis*, *paulistana*, *mochii*) on account of its prominent frons and entirely black tarsi; and moreover it is not known to make galls.‖ But as Rondani in 1856 mistook the name *dasyops* for *lasiophthalma*, this last species is the type of the genus *Dasyops*, as accepted by Coquillett.

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* Verh. Zool.-Bot. Ges. Wien, 1861, xi, p. 486, pl. xvii, fig. 6.

† Bull. Soc. Ent. Ital., 1883, xv, pp. 187–188.

‡ Ann. Soc. Ent. France, 1839 (1) viii, pp. 29–37.

§ Marcellia, 1907, vi, pp. 46–61 (*vide* p. 56 and fig. 11, gall on *Cynodon ? dactylon*, L.), and Boll. del R. Orto bot. e Giard. colon., Palermo, 1910, ix, p. 3 (sep.).

‖ Even *L. hirticeps*, Zett., does not belong to the genus *Dasyops*, on account of its long antennae; the same may be said of *L. crystallophila*, Becker. Both species have hairy eyes, thus showing that the main character of the genus is not that of the eyes.

2. **Lonchaea claripennis** Macq.

Lonchaea claripennis, Macquart, Dipt., Exot., iii, 1843, p. 407 (250), pl. 34, fig. 1

A doubtful West African species, described from Senegal, but not recognised subsequently.

3. **Lonchaea vibrissifer,** Lamb.

Lonchaea vibrissifer, Lamb. Trans. Linn. Soc. London, 1912, Zool. xv, p. 305, fig. 2, pl. 15, fig. 4.

A very distinct species from the Seychelles.

4. **Lonchaea aurea,** Macq.

Lonchaea aurea, Macquart, Dipt. Exot., Suppl. iv, 1851, p. 273 (299), pl. 28, fig. 1.

Lonchaea splendida, Loew, 1873 ; Becker, 1895, etc.

A not rare Mediterranean species of very wide distribution. Macquart described it from Africa, without precise locality ; Lamb has it from the Seychelles ; and I have it in my collection from the Cape, Willowmore (*Dr. Brauns*) and from Erythraea, Asmara, October 1916 (*Dr. A. Mochi*). The species is present also in the Oriental Region, as I have a specimen from S. India, Trichinopoly (*E. Cajus*, 1911) ;* and it has also been found in New South Wales injuring tomatoes (French, 1917).

To the characters of the species may be added : only one sternopleural macrochaeta present ; mesopleurae with macrochaetae in front and at the hind border ; scutellum with some hairs at the sides between the usual bristles ; second costal cell less dilated outwardly ; sixth longitudinal vein not reaching the hind border.

5. **Lonchaea lambiana,** nom. nov.

Lonchaea longicornis, Lamb (*nec* Williston), Trans. Linn. Soc., London, 1912, Zool. xv, p. 304, pl. 15, fig. 3.

Known only from the Seychelles.

6. **Lonchaea excisa,** Kert.

Lonchaea excisa, Kertész, Termész. Füzetek, Budapest, 1901, xxiv, p. 87 ; De Meijere, Tijdschr. voor Entom., 1910, liii, p. 118, pl. 7, fig. 50.

Lonchaea plumata, Lamb, Trans. Linn. Soc. London, 1912, Zool. xv, p. 303, fig. 1, pl. 15, fig. 1–2.

Originally described from Singapore, the species is widely spread over the Oriental Region to the Philippines, and is found in the Seychelles.

The species has two sternopleural bristles ; the mesopleura has long bristles even in front ; the scutellum is pilose.

7. **Lonchaea gibbosa,** Meij.

Lonchaea gibbosa, De Meijere, Tijdschr. voor Entom., 1910, liii, p. 119.

To this Oriental species, originally described from Java, may be provisionally referred some specimens of both sexes in the writer's collection from Erythraea Ghinda, August to December 1916 (*Dr. A. Mochi*).

* T. Broun (N. Zeal. Dept. Agric., Div. Biol. Hort., Bull. No. 4, 1905, 6 pp., 1 pl.) has described a *Lonchaea splendida* from Fiji ; the species must be re-named, if different as it seems ; I propose for it the name of *L. brouniana*, nom. nov.

The species is closely allied to the widely spread *L. setifera*, Meij., but has no special ciliation at the end of the last abdominal segment in the male. It is also very like the Mediterranean *L. aristella*, Beck., which may be distinguished by the more shortly pilose arista and by the more pilose scutellum.

8. **Lonchaea plumosissima,** sp. nov. (figs. 1 and 3).

A shining black species with quite black legs, white squamulae and hyaline wings erroneously referred by me in 1913 to the Brazilian *L. glaberrima*, but distinguished by the very long plumosity of its arista, this being longer than in any other species at present known.

♂♀. Length of the body, 3·6–4 mm.; of the wing, 3·7–4·2 mm. Head (fig. 3) entirely black, as broad as the thorax, broader than high in front view, narrow in profile. Frons dullish, but with shining upper orbital and ocellar plates; the middle stripe is clothed with short and dense black hairs; that of the female is only a little broader than that of the male, being in both parallel-sided and longer than broad. Lunula small, hardly visible and apparently bare. Cheeks linear,

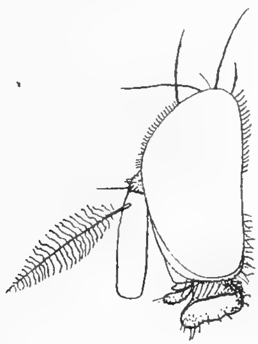

Fig. 3. Lateral view of head of *Lonchaea plumosissima*, Bezzi, ♀.

nearly indistinct above, with a faint greyish dust; jowls narrow; vibrissae less developed, but the sides of the mouth with some long hairs; lower part of occiput with short stout hairs, all black. Face shining black, faintly dusted, distinctly though not very deeply concave towards its middle, and therefore the upper mouth-border slightly prominent. Eyes reddish brown, unicolorous, bare; in profile they are much narrower than high. Antennae inserted about at middle of eyes; they are entirely black, but with a faint grey dust on the third joint; the first two joints are very short, the second bearing above a long bristly hair; third joint very long, its apex extending below the oral margin; arista black, with very long plumules, about 17–18 on each side; the breadth of the feathering is about twice as broad as the breadth of the third antennal joint. Mouth-opening broad; palpi deep black, dilated at end, with short bristly hairs, one of which at the apex is longer than the others; proboscis thick and short, of a deep black colour; labium shining black, about as prominent as the palpi. Cephalic bristles black, strongly developed and normal. Thorax shining black, with more or less developed bluish reflections, very glistening, devoid of distinct dust; hairs and macrochaetae black; chaetotaxy normal;

acrostichal hairs disposed in many rows; two strong sternopleurals; mesopleurae with 4–5 bristles at hind border, and with 2–3 at fore border. Scutellum, if viewed from in front, clothed with greyish dust, and thus appearing somewhat different in coloration from the back of the mesonotum; it bears the usual four strong bristles, and moreover 3–4 hairs on each side between the basal and the apical macrochaetae, and a pair of apical and decussate hairs at the end. Postscutellum and mesophragma shining black, the former as well as the upper half of the latter being clothed with a faint greyish dust. Squamulae whitish, with yellowish border and with pale cilia; halteres black, with yellowish stalk. Abdomen of elongate-oval shape, narrower than the thorax and likewise bluish black, not dusted; it is clothed with short black hairs, and on the sides and behind with short black bristles; last segment of the male $1\frac{1}{2}$ times as long as the previous one, obtuse and not specially ciliate at the end; male genitalia small and black; ovipositor black, with the penultimate segment dirty yellowish at the end. Venter black, black pilose and with faint, dark grey dust. Legs rather short, quite black, even at base of tarsi; hairs and bristles black; front femora with no special ciliation outside. Wings hyaline, with slightly yellowish base, of typical form and venation; all the veins are pale yellowish. Second costal cell dilated outwardly and thus the costa curved outside at base; 3rd and 4th longitudinal veins parallel at the apex; 6th vein long and reaching the hind border with its spurious end; axillary lobe much produced; alula rather narrow and acute. Small cross-vein before the middle of the discoidal cell.

Type ♂ and type ♀ in the British Museum from Gold Coast, Aburi, May 1911, "bred from vegetable marrow" (*L. Armstrong*). Besides there are in my collection the specimens from French Guinea, Conakry, bred by Prof. Silvestri from fruits of *Sarcocephalus esculentus* infested by the true fruit-fly, *Ceratitis cosyra* (=*giffardi*); and others from Dahomey, Cotonou, likewise taken by Prof. Silvestri.

Synonymical Note on the so-called "*L. glaberrima*, Wied." or "*L. aenea*, Wied."

As above stated, I have previously referred African specimens to the Brazilian *L. glaberrima*. Owing to the bad state of preservation of these bred specimens, which had almost entirely shrunk up in drying, it was not possible to discover any difference between the African and the American species, which are very similar in appearance. The only appreciable differences that I can now discover with the good specimens at hand, are that the American species is more robust and distinctly though slightly larger; that it has the pleurae more bristly; and chiefly that the arista (fig. 4) is more shortly plumose, the breadth of the feathering being about equal to the breadth of the third antennal joint. I think that this last character alone indicates a specific difference, inasmuch as some minor characters may be found in the venation. In the American species the discoidal cell is distinctly longer, the hind cross-vein being placed nearer the hind border of the wing, as can be seen from the fact that the last segment of the 4th longitudinal vein is equal in length to the preceding one (while in *plumosissima* it is distinctly longer); and that the cross-vein itself is twice as long as the portion of the 5th longitudinal vein beyond it (while in *plumosissima* it is only a little longer).

Concerning the name which must be used for the American species there is some confusion. *L. glaberrima* was described in 1830 by Wiedemann from the West Indies on a type *without the antennae*, as stated in the original description. The name was subsequently referred to a species from Florida, after Coquillett's determination, by Johnson (Proc. Ac. N. S. Philadelphia, 1895, p. 338, and Bull. Amer. Mus. N. H. 1913, xxxii, p. 80). In 1905 the name made its appearance in Brazilian literature (still based on the determination of Coquillett) in works of Hempel,* and of R. von Ihering†; and in 1910 I accepted it in my paper on the Brazilian species of *Lonchaea*. Prof. Melander in his recent synopsis of the genus has also conserved the name on hypothetical characters.

In 1912 R. von Ihering‡ used for the species the name of *L. aenea*, Wied., which was accepted also by Prof. Tavares (Broteria, Zool., xiii, 1915, p. 52). But as Wiedemann never described a species of this name, it was evidently proposed as new by Dr. Lutz, according to the indication of R. von Ihering himself (*l.c.*, p. 13).

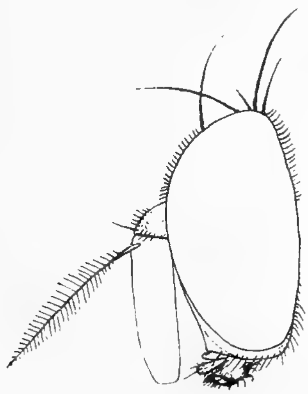

Fig. 4. Lateral view of head of *Lonchaea pendula*, Bezzi, nom. nov., ♂.

However, this latter name also cannot be accepted, because there is already a *L. aenea*, Meigen 1926, from Europe; a new name is therefore necessary, and I propose to call the important neotropical species *L. pendula*, in allusion to its very long antennae. The synonymy of the species is as follows:—

Lonchaea pendula, nom. nov. (fig. 4).

L. glaberrima (not of Wiedemann), Hempel, 1905 and 1906; R. von Ihering, 1905; Bezzi, 1910 (not 1913).

L. aenea (not of Meigen), Lutz apud R. von Ihering, 1912; Tavares, 1915.

The species seems to be widely spread in South America and Mexico, as I have it from Brazil, Campinas (*Hempel*) and S. Paulo (*Barbiellini*); from British Guiana, Bartica (*Rolle*); from Peru, Piura (*Tyler Townsend*); from Mexico, Cordoba, Yalapa, Dona Maria (Chiapas), Vera Cruz, Oaxaca (*Crawford*).

* *Contribuição à Biologia do Ceratitis capitata, Wied.*, Bol. da Agric., São Paulo, 1905, p. 352–354 (*vide* p. 353).
O bicho dos fructos e suas parasitas, l.c., 1906, p. 206–214 (*vide* p. 353).

† *As moscas das fructas e sua destruição.* São Paulo, 1905, 21 pp., 6 figs. (*vide* p. 4, fig. 3).

‡ *As moscas das fructas e sua destruição.* 2nd Edição, 48 pp., 1 pl., 10 figs. (*vide* pl. 1, fig. 3, and p. 13).

Ethological Groups and Economic Importance of the Genus Lonchaea.

We have now a sufficient knowledge of the first stages of the genus *Lonchaea*. It is curious to note that, as in many other cases, the principal observations have been made as a result of the study of the damage caused by them to fruit crops. Thus, in addition to the old general work by Bouché,* or to the short notes by Perris (of 1839, 1849 and 1870), we can find complete descriptions only in the paper by Farsky,† or in the more recent ones by Cameron‡ and Prof. Silvestri.§

It is now quite certain that the larvae of *Lonchaea* feed only on vegetable matter, whether decaying or not. This fact, already inferable from the compilations by Scholtz|| and Brauer,¶ is contradicted only by a few observations, which appear to be probably erroneous. Thus Mégnin ("Faune des cadavres"; quoted also by Howard, Proc. Wash. Acad. Sci., ii, 1900, p. 586) says that a species was found on the dead body of a child; but it is almost certain that in this case some confusion has arisen with a fly of the genus *Ophyra*. And again Perris** has advanced the supposition that the larvae of *Lonchaea laticornis* feed on the larvae of the xylophagous Coleoptera of the genus *Ips* (*Bostrychus*) (with which they live under bark of trees), and even on the larvae of their own kind; but he has made no real observations of these predaceous habits, such as he has made of their cannibalism.

The primitive larval habit of the genus *Lonchaea* seems to have been that of feeding on decaying vegetable matter or in excrement on the ground or under the bark of trees. This habit is the more usual one, occurring in all the regions of the globe, both in cold and hot countries; and it is that prevalent among the Sapromyzidae, a family with which *Lonchaea* is often united, and to which it is at any rate closely allied. This habit is confirmed by numerous observations. Thus larvae and puparia of *L. chorea*, Fabr. (*vaginalis*, Fall.), *L. tarsata*, Fall., *L. laticornis*, Meig. (*albitarsis*, Zett.), *L. palposa*, Zett., *L. lucidiventris*, Beck. (*deutschi*, Schin.) have been found in Europe under bark or in decaying wood of various trees (of the genera *Pinus*, *Abies*, *Quercus*, *Populus*, *Salix*, *Acer*, *Robinia*, etc.) by Bouché (1834), Perris (1839 and 1870), Zetterstedt (1847), Schiner (1864), De Meijere (1898), Kleine (1907); and those of *L. ploita*, Say (*rufitarsis*, Macq.) in North America by Smith (1899).

It is very interesting to note that the species living under bark of trees have been twice observed in connection with xylophagous Coleoptera of the family Scolytidae (Ipidae). Thus Perris (see the above-quoted paper of 1870, p. 343) has observed

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* Naturgeschichte der Insekten. Berlin, 1834, p. 94, pl. vi, fig. 1.

† Verh. Zool.-Bot. Ges. Wien, xxix, 1879, pp. 101-107, pl. iii, figs. 1-7.

‡ Trans. Ent. Soc., London, 1913, pp. 314-322, pl. xi.

§ Boll. Labor. Zool. Gen. e Agr., Portici; xii, 1917, pp. 123-146, 19 figs.

|| Zeitschr. f. Entom., Breslau, 1848-1850, pp. 1-34. In this little-known paper there is one of the first attempts to divide the Diptera into ethological groups, in relation to the habits of the larvae. The notices regarding *Lonchaea* are to be found on pp. 10, 15, 19 and 30; the genus is improperly comprised also in those living on animal substances, on account of its excrement-feeding habit.

¶ Denkschr. K. Akad. Wiss., Wien, xlvii, 1883, pp. 100, 5 pl.

** Ann. Soc. Ent. France, (4) x, 1870, pp. 342-344, pl. v, figs. 138-145. It is interesting to note that on this occasion Perris has made the following remark: "Elles se dévorent entre elles, ce qui, du reste, n'est pas nouveau pour moi; j'ai frequemment observé le même fait de la part de larves voraces de Muscides vivant dans les bouses et les champignons." It seems that Perris has confused the larvae of carnivorous species of Anthomyiidae with those of saprophagous ones.

larvae of *L. laticornis*, Meig., with *Ips sexdentatus*, Boern. (*Bostrychus stenographus*, Duft.) and with *Ips erosus*, Woll. (*Bostrychus laricis*, Perr.); and Kleine* has found puparia of *L. chorea* (*vaginalis*) with *Myelophilus piniperda*, L.

Other observations have shown that the larvae of *Lonchaea* feed frequently on the excrement of herbivorous mammals, as found in Europe for *L. chorea* by Scholtz (1849) and by Cameron (1913); or even in human excrement, as found in North America for *L. polita* by Howard (1900). When in Europe in search of parasites of the horn-fly (*Lyperosia irritans*) to send to the Hawaiian Islands, Koebele bred *L. lucidiventris*, Beck., from cow-dung in Germany, and sent me specimens for determination. These three species (*chorea*, *lucidiventris* and *polita*) have been found also under bark of trees, as above stated.

From these general and not specialised habits, which from an economical standpoint may be considered as indifferent, the larvae of *Lonchaea* have evolved in different directions, but always connected with vegetable matter. The presence of a well-developed, corneous ovipositor in the females of all the species alone proves the capacity of the adult flies for laying their eggs in the living vegetable tissues. Hence the economic importance of the genus.

From the ground the larvae of *Lonchaea* enter frequently, as "followers of decay," into subterranean parts of plants, which have been previously attacked by other insects or fungi or other destructive agencies. This is the case with beetroots, in which *L. chorea* causes a disease made known by the studies of Farsky and Cameron (see the above-quoted papers of these authors). Larvae of other species have been observed damaging the rootlets of wheat; and Chittenden† considers *L. longicornis* as a serious pest of truck-crops in North America. But from the subterranean parts they proceed to attack the stems and other parts of various herbaceous plants (of the genera *Verbascum, Angelica, Carduus, Cirsium, Oncidium*, etc.) as observed in Europe for *L. nigra*, Meig. (*inaequalis*, Loew) and *tarsata*, Fall. by Perris‡ and by Weyenberg (1874), and for *L. orchidearum*, Towns., by Tyler Townsend (1895) in Jamaica. More rarely they can ascend trees, as observed by Prof. Cecconi, who at Vallombrosa has bred *L. viridana*, Meig., from larvae living in the cones of *Abies pectinata* (writer's coll.). Perris has noted (1849, p. 62) that the mandibles or buccal hooks of these larvae that feed on living vegetable tissues are shorter and stouter than those of the species that feed on decaying matter. Some of the species with these habits become very dangerous pests to cultivated plants. Thus in the West Indies the "bud-maggot" is the larva of *Lonchaea chalybaea*, Wied.,§ which in Jamaica, Trinidad and Cuba does great damage to cassava, boring into the soft tissues of the growing plant, which it completely destroys.

But a more remarkable habit of these grass-inhabiting species is that which has evolved in the well-characterised group of the gall-making species, belonging to the genus *Dasyops*, Rondani. Their larvae produce acro-cecidia of stems or of buds on grasses (*Cynodon* and *Agropyrum*), and possibly on species of the allied family

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* Berl. Ent. Zeits., vii, 1907, pp. 109–113.
† Bull. No. 82, U.S. Dept. Agric. Bur. Ent., 1911, pp. 85–93.
‡ Ann. Soc. Ent., France (2) vii, 1849, pp. 62–65, pl. iii, figs. 1–6.
§ Urich, F. V.—Cassava Insects, Bull. Trinidad, 1915.
Ritchie, A. H.—Report of Entomologist for year 1915–16. Ann. Rept. Jamaica Dept. Agric., Kingston, 1916, pp. 31–34.

Cyperaceae.* We have already shown the wide distribution of these gall-making species, which however are not of economic importance; they attack only weeds, thus differing from the CHLOROPIDAE, which share with *Lonchaea* the peculiarity of attacking Graminaceae and making galls on them. It is at any rate notable that the gall-making power of the genus *Lonchaea* is exercised exclusively at the expense of a single family of Monocotyledonous plants.†

The adult flies of all the above-enumerated ethological groups of the larvae have the arista bare or only microscopically pubescent.

The last feeding habit of the larvae of *Lonchaea* has evolved chiefly in warmer, tropical or subtropical countries, and is more important from an economic point of view. This habit is that of feeding on fruits. It is probable that this mode of life arose from larvae entering decayed fruits lying on the ground; the adults would have been subsequently attracted to deposit their eggs on decaying fruits on the trees themselves, and finally on uninjured mature fruits. Thus the species of *Lonchaea* have become fruit-flies.

It is probable that some species are not primary hosts of the fruits in which they are found; but that they enter those that have decayed owing to the attacks of the true fruit-flies. The researches of Dr. Keilin‡ have shown that the larvae of the true fruit-flies, like those of *Dacus* and *Anastrepha*, do not feed on living tissues, but causes the decomposition of the fruits for their nutrition; in other words, they are saprophagous and not parasitic; and indeed they show in their pharyngeal skeleton the characters of the saprophagous and not of the parasitic larvae, contrary to what is observed in the larvae of TRYPANEIDAE, which are parasitic on stems, leaves, etc., or even gall-makers. It would be interesting to study the larvae of *Lonchaea* from this standpoint to see if the carpophilous species have the "côtes pharyngéennes" characteristic of the saprophagous forms; and if these "côtes" are present also in those living on decayed matter, as is the rule; and if those attacking living tissues, or gall-making, have no "côtes," like all the parasitic larvae.

The observations on the species of *Lonchaea* as fruit-flies are more recent. For the first time they appeared in South America in the above-cited papers by Hempel (1905 and 1906), and R. von Ihering (1905 and 1912), dealing with *Lonchaea pendula*, Bezzi (*glaberrima* or *aenea*), which is very widely distributed in Brazil and causes damage to fruits of various kind, chiefly those infested by *Ceratitis capitata* or by *Anastrepha fraterculus*. In the same year (1905) Broun (see the above-quoted paper) recorded *Lonchaea brouniana*, Bezzi (*splendida*) as having been bred in New Zealand from fruits of various kinds infested by *Dacus xanthodes*, Broun, brought from Fiji.

In 1913 Prof. Silvestri bred in West Africa *Lonchaea plumosissima*, Bezzi (*glaberrima*) from fruits of *Sarcocephalus esculentus* infested by *Pardalaspis cosyra* (*giffardi*).

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*There is only the old and very doubtful observation of Cestoni, reported by Redi in 1680 and recorded by Osten Sacken in the above-quoted paper of 1883. Even Howard in 1908, i, p. 92, no. 352, does not know other cases.

† It is very doubtful if the ?*Lonchaea* sp. of Packard (*Guide to the Study of Insects*, Ninth Edition, 1888, p. 412 and *Forest Insects*, 1890, p. 598), the larva of which "raises large blisters on the twigs of the willow," is a *Lonchaea* at all.

‡ C.R. Soc. Biol., lxxiv, 1913, p. 24.

In the same year I described two species bred in the Philippines by Prof. C. F. Baker; one of them, *L. citricola*, Bezzi, from *Citrus* fruits infested by *Monacrostichus citricola*, Bezzi; the other, *L. ficiperda*, Bezzi, from fruits of *Ficus megacarpa*, Merril.

In the Mediterranean Region there is a common species, *L. aristella*, Beck., which attacks the inflorescences and fruits of *Ficus carica*, causing serious damage; it was first recorded by Prof. Savastano* and was the subject of the above-quoted important paper by Prof. Silvestri. The species is a primary parasite of the fig, and causes the failure of the inflorescences; the maggots feed on the flowers, the tissues of the receptacle and on the true fruits. There is here no connection with species of Trypaneids, as seems also to be the case with the Philippine species. Prof. Silvestri has even observed that inflorescences well infested by the Hymenopterous parasite, *Blastophaga*, are not damaged by the *Lonchaea*, the larvae of which are killed by the pressure produced by the inflated flowers. In some figs infestation by *Ceratitis capitata* has been observed, but the attacks of *Lonchaea* seem to be independent of this. It is interesting to note that, as the infestation of certain fruits by fruit-flies causes the intervention of the *Lonchaea*, so the infestation of figs by *L. aristella* causes the intervention of another fly on the decaying parts, namely, *Drosophila melanogaster*, Meig. (*ampelophila*, Loew).

It must be recorded finally that Quayle† has bred *Lonchaea aurea*, Macq. (*splendida*, Loew) in Sicily from decayed oranges and lemons infested by *Ceratitis capitata*.

A special case, which perhaps may be referred to the carpophilous series, is that observed in Java by Roepke and reported by Prof. De Meijere (Tijdschr. Ent., lx, 1918, p. 357); it concerns *Lonchaea gibbosa*, De Meij., the larvae of which live in the large fleshy flowers of a leguminous plant, *Sesbania grandiflora*, causing their destruction. The adult fly has a plumose arista, like the fruit-inhabiting species.

To these special lines of evolution in the ethological habits of *Lonchaea* must certainly correspond a morphological differentiation in the adult flies (and without doubt in the larvae also). It seems that at least the three following cases may be recognised:

1. The saprophagous species living in decaying vegetable matter or in excrement, and those apparently parasitic on various parts of vegetables. They have a bare or only microscopically pubescent arista; rather long antennae, which reach at least to the middle of the face; and well developed chaetotaxy. They form the typical genus *Lonchaea*, s. str.

2. The gall-making species, which have a bare arista; very short antennae, not reaching the middle of the face; and an inflated head, with less developed chaetotaxy. They must form the genus *Dasyops*, Rond.

3. The fruit-inhabitating species, which have a more or less plumose arista (with the exception of *L. aurea*); very long antennae, reaching or even extending below the mouth-border; and a much developed chaetotaxy. These species are chiefly tropical or subtropical, and will require the formation of a new genus for

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* R. Staz. Sper. Agrumic. Fruttic. Acireale, Boll. No. 17, 1915, 4 pp.
Ann. R. Staz. Agrumic. Fruttic. Acireale, iv, 1917, pp. 113–146, pl. iv–v.

† Citrus fruit insects in the Mediterranean Countries.—U.S. Dept. Agric., Bull No. 134, Washington, D.C., 1914.

them. It is interesting to note that the long and scattered plumosity of the arista, characteristic for the species of the present section, is likewise developed in other Myiodaria which are attracted by mature fruits, as some ANTHOMYIDAE and DROSOPHILIDAE, in relation to olfactory tropisms.

The second and third of the above-named groups can be derived from the first, the former by reduction and the latter by addition of corresponding characters. This is chiefly evident on comparing the very reduced antennae of the sedentary, gall-forming species, with the highly developed ones of the wandering, fruit-searching species.

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4. BEZZI, M. *Brasilianische Lonchaeiden gesammelt von A. A. Barbiellini.* O Entomol. Brasil., S. Paulo, 1910, iii, pp. 20–25.*

5. COLLIN, J. E., *Additions and Corrections to the British List of Muscidae Acalyptratae.* Ent. Monthly Mag., 1910, (2) xxi, pp. 171–172.

6. DE MEIJERE, J. C. H. *Studien über südostasiatische Dipteren.* IV. *Die neue Dipteren fauna von Krakatau.* Tijdschr. voor Entom., 1910, liii, pp. 115–120, pl. vii, figs. 47–52.

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8. MELANDER, A. L. *A Synopsis of the Sapromyzidae.* Psyche, 1913, xx, pp. 79–80.

9. MALLOCH, J. R. *Some undescribed North American Sapromyzidae.* Proc. Biol. Soc. Washington, 1914. xxvii, pp. 37–40, figs.

* The three new species described in this paper (*L. paulistana*, *L. barbiellinii*, and *L. aculeata*) are not included in the Zoological Record for 1910, or subsequent years.

A NOTE ON THE OCCURRENCE OF A COLEOPTEROUS LARVA IN THE URINARY TRACT OF MAN IN THE ANGLO-EGYPTIAN SUDAN.

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and
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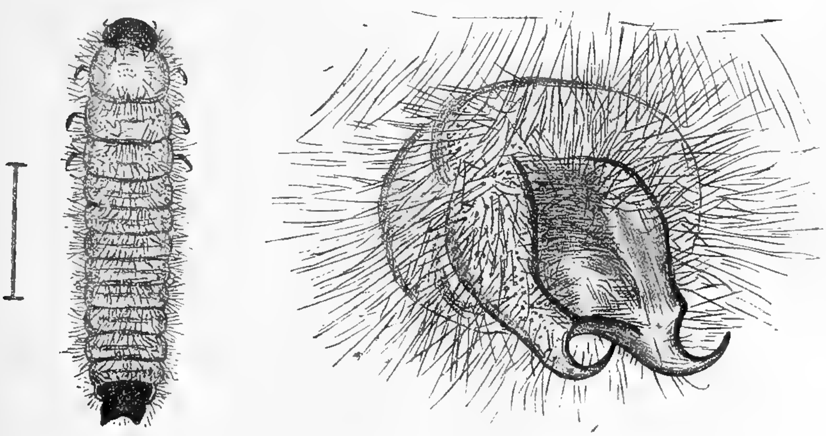
The larva figured in the accompanying illustration was obtained from the urinary tract of a native of Mongalla Province, Anglo-Egyptian Sudan. A careful search through the literature at our disposal has failed to reveal any reference to a similar case of parasitism of a Coleopterous larva in the urinary tract.

The history of the case was as follows :—

The patient, for some time, had suffered from debility, difficult and painful micturition and haematuria. He was examined at Yei Hospital by Captain Simson,



R.A.M.C., who formed the opinion that the patient was suffering either from a stone in the bladder or urinary bilharziosis. A sound was passed but no stone was detected in either the patient's urethra or bladder. Microscopical examination of the urine, however, showed that the ova of *Schistosomum haematobium* were present. He was kept under observation in hospital, but the symptoms, instead of abating, became worse, the patient complaining of severe strangury, apparently due to some obstruction in the genito-urinary tract. His urethra was then douched out with a weak solution of potassium permanganate and, after considerable straining, numerous Coleopterous larvae were ejected from the urethral meatus. The next day another urethral douch was administered with similar results. This was followed by total relief of the symptoms, and the patient left hospital apparently cured.

No explanation can be offered as to how the larvae reached their position in the urinary tract. Comparatively little medical work has yet been done in the district in which this case occurred, and it is possible that other similar cases may be met with in the future and opportunities obtained of studying the bionomics of the beetle.

Dr. C. J. Gahan, to whom one of these specimens was submitted by Dr. G. A. K. Marshall, Director of the Imperial Bureau of Entomology, stated that, while it resembled a Clerid, he was unable to determine with certainty even the family to which it belonged.

We are indebted to Mrs. H. H. King for the preparation of the accompanying illustrations.

Khartoum, 22nd May, 1918.

AN ECONOMIC STUDY OF NASONIA BREVICORNIS, A HYMENOPTEROUS PARASITE OF MUSCID DIPTERA.

By John L. Froggatt, B.Sc.

In considering the methods of coping with any group of injurious insects, the study of natural enemies must occupy an important place in any laboratory or field investigations that are carried out in connection with such pests.

When investigations concerning the sheep-maggot fly pest were commenced in New South Wales in 1913, careful search was made for any natural enemies in the field, and in November of that year pupae of *Pycnosoma* (*Calliphora*) *rufifacies* were found heavily parasitised by a small Chalcid wasp. This discovery was made on Yarrawin Station (Messrs. Dickson Bros.) in the Brewarrina district, under the remains of a dead foal. The carcase was lying on the edge of a patch of scalded ground, with a little timber about 100 yards away. On pulling the remains apart, a large number of pupae of *Pycnosoma rufifacies* were exposed; from some the flies had already emerged, many others were intact. Some of the intact pupae were carefully opened with the point of a penknife, and were found to contain a number of small, white, creamy, brown or black objects, these being the larvae, early pupal, and late pupal stages of the parasite wasps. A few of the intact pupae that could be found were collected for further study and observation; some were retained at the Experiment Station, and the remainder taken to the Entomological Department, Sydney. An average count of a number of these parasitised pupae gave the result of about 20 wasps per pupa.

Before proceeding further, a consideration of the distribution of this wasp should prove of interest. Within a few days of the above-mentioned discovery this parasite was found under similar circumstances at Longreach, Central Queensland. Specimens of the wasp sent to Dr. Howard, Chief of the Bureau of Entomology, Washington, U.S.A., by the Government Entomologist of New South Wales were identified as *Nasonia brevicornis*, a Hymenopterous parasite that had been originally described by Messrs. Girault & Saunders, who bred it from the pupae of the common house-fly (*Musca domestica*) at the Illinois Entomological Station at Urbana in 1908. It has also been reported from Chili; and the British Museum has received specimens of it from India. Future researches may reveal that its range is only restricted by the distribution of the Muscid flies.

Further observations in New South Wales have shown that it is only scattered thinly over most parts of this State and is doing valuable work in preventing the breeding of the flies by their destruction in the pupal condition. Probably it is to be found over the greater part of Australia.

The breeding of these wasps has been carried on continuously and systematically from those bred from the parasitised pupae in November 1913, the wasps now being used in the cages for the purposes of propagation being the direct progeny of those obtained from the original lot of pupae. On a few occasions additions have been made by introducing fresh specimens of *Nasonia brevicornis* collected in the field. (See paper in the Agricultural Gazette of N. S. Wales, September 1914, McCarthy's observations).

The economic value of this parasite has proved to be so great, where found actively at work in the field, that a more extensive means of artificially propagating the wasps on a large scale—by laboratory breeding and subsequent distribution—has been undertaken. This work has now assumed large proportions and is still extending. Under present arrangements, fifty thousand fresh pupae can be parasitised per week. Some idea of the extent of the work may be gathered from the following facts :—

Between November 1917 and 14th February 1918, 164 packets of parasitised pupae, averaging approximately 10,000 parasites per packet, have been distributed; while fully as many have been liberated (i.e., approximately 1,500,000 live parasites) on Kooroogama Station, Moree. Large numbers of parasitised pupae have also been held back for work in the breeding cages. Over 200 fresh requests from all parts of Australia are now waiting to be fulfilled and other requests are being received daily.

In view of the importance of this work from an economic point of view, an account of the operations, with a few notes on the habits of the wasp observed in both the field and laboratory, are herewith recorded.

The work of breeding the parasites is completely carried out in cages 12 inches long, 12 inches high and $8\frac{1}{2}$ inches wide. The bottom and one side of the cage are made of wood, the other side and one end of glass, while the top and the other end are covered with very fine mesh copper gauze; the door occupies the whole wire gauze end and is hinged to open outwards. Around the door, inside the cage, a light beading is fixed, and so prevents the tiny wasps from escaping through any crack between the door and the cage. If the beading is not present, paper must be pasted round the door. Any cracks or spaces must, of course, be also pasted over.

A tray of one-tenth inch mesh wire gauze is placed in the bottom of the cage; and, on this, a light paper tray is placed, upon which the unparasitised pupae are spread. The wire gauze tray should be made of such a size as to admit of its easy removal from the cage. From a tack driven into the upper part of the wooden side, a bag of mosquito net containing parasitised pupae, from which the wasps are just emerging, is suspended. Through the mosquito netting the wasps escape into the cage and find the unparasitised pupae.

When the freshly parasitised pupae are ready to be removed from the cage, they are tilted from the paper into the wire gauze tray, upon which they are gently rolled in order to shake all the live wasps into the bottom of the cage, this being done wholly inside the cage. The tray is then removed from the cage and the parasitised pupae set aside, after which the wire gauze and paper trays are replaced in the cage and fresh pupae added. The freshly parasitised pupae, when removed from the breeding cage, are placed in shallow trays for 2 or 3 days to allow them to dry before being either placed in jars or distributed. If placed in jars immediately, the moisture given off is sufficient to saturate them with the accumulated water and so to kill the immature wasps within the pupal shell.

The whole of the operation of transferring and changing the pupae should be done in front of a window and with the glass end of the cage placed towards the light. The wasps are strongly attracted to light and so will make toward the end of the cage farthest from the door, thus obviating any loss of parasites.

The separation of the pupae from the live parasites inside the cage prevents any loss of the wasps and also prevents any unnecessary handling and knocking about; for they would otherwise have to be recaptured from off the windows.

Feeding the parasites in the cages is effected by placing small strips of calico damped with honey on the glass end and sides to which they will readily adhere. The wasps feed greedily from these strips, which are damped with honey and water at least once a day, and in hot weather two or three times. The strips should be removed every few days and fresh ones used. The old strips can be washed and used again, but they need to be boiled.

The cages, particularly during the hotter months of the year, must be kept in as cool a place as possible and must never be shut out of a free current of air. Moreover, they should be placed in a bright situation, the wasps working much better when the cages are in a good light.

The parasitised pupae are always held for a few days before being distributed, in order to make certain that no flies will develop from the material; as a rule not ½ per cent. of flies breed out from pupae put through the breeding cage. The pupae to be kept for cage breeding work are then placed in jars and the remainder distributed.

About 400 parasitised pupae are placed in the cage for breeding purposes at each addition; and the approximate average number of parasites per pupa is 20, this gives about 8,000 parasites per cage.

The length of time in which the pupae to be parasitised are kept in the breeding cages varies considerably with climatic conditions. A period of three days is generally sufficient in warm weather, but in cool weather the time is much extended. With experience it is not necessary to examine the pupae to make sure that they are parasitised; the behaviour of the live wasps themselves shows when they have finished with any one lot of pupae.

More work is entailed in breeding fly larvae, in separating them from the breeding material, and in sorting out the fresh pupae. The principal source of supply is from the larvae of the four species, *Anastellorhina* (*Calliphora*) *augur*, *Pollenia stygia* (*Calliphora villosa*), *Pycnosoma* (*Calliphora*) *rufifacies*, *Lucilia sericata*, and also to a lesser extent, *Sarcophaga aurifrons*. The larvae of *Ophyra nigra* and *Pycnosoma* (*Calliphora*) *varipes* are also used in an emergency; but it has been found that the pupae of these two species are not selected for parasitism so readily by the wasps as the former species. The larvae of all the first four species breed only in animal material. After extensive trials liver has proved to breed the greatest number of fly larvae per unit weight as compared with other portions of a carcase; and when well "blown" there is little or no waste with it; and furthermore, the larvae are always well grown. From a single bullock's liver over 14,000 larvae of *Anastellorhina augur* and *Pollenia stygia* have been obtained at the Experiment Station.

One fact that should always be borne in mind when sorting the larvae is, that the "smooth" larvae (*Anastellorhina augur*, *Pollenia stygia*, *Lucilia sericata*) must be kept in separate receptacles from the "hairy" larvae (*Pycnosoma rufifacies* and *P. varipes*), and the larvae of *Ophyra nigra* must be kept apart from all the above, for the hairy larvae will attack and devour the "smooth" larvae, and the larvae of *Ophyra nigra* will attack all species.

Kerosene tins have been used as receptacles for containing the liver during the development of the fly larvae, as these are easily procurable and also cheap. About 4 to 5 inches of fine earth sifted through one-tenth inch mesh wire gauze are placed in the bottom of the tin, and the liver, well slashed with a knife, is then placed on the earth. The earth in the tin serves two purposes :—It absorbs the putrefactive juices from the liver which, if allowed to accumulate, would drown the maggots ; and it also forms a clean dry place for the larvae to crawl into when they have finished feeding and have left the remains of the liver. Should the liver appear to be becoming moist on the top, or should the earth underneath become wet before the larvae have reached maturity, more dry sifted earth must be added. The greatest care and attention is paid to this portion of the work ; otherwise the mortality amongst the larvae would be very high. As soon as the majority of the larvae have crawled into the dry earth the remains of the liver are transferred to another tin and the larvae are separated from the more or less damp earth. It is here that the value of the sifted earth is seen, for it affords a rapid separation by allowing the maggots to be sifted without too much knocking about, a happening to be most carefully avoided at all times. The larvae, together with any dirt that will not pass through the sieve, are then placed in a flat shallow pentagonal tray, the apex of the pentagon being cut off to form a narrow opening. The trays are made of tin. The open end should be placed away from the light and the material in the tray stirred about or spread out in a thin layer. The larvae will crawl out and away from the light, falling into oblong tins containing dry sifted earth which are placed under the open end of the tray. These oblong tins (about 12 inches by 8 inches by $3\frac{1}{2}$ inches high) should be kept covered with wire gauze, to prevent insects and mice from destroying the larvae or pupae. Amongst the insects that have to be thus contended with are :—*Dermestes cadaverinus* (skin beetle), *Creophilus erythrocephalus* (devil's coach-horse), *Saprinus laetus* (shining histerid) and *Necrobia rufipes* (red-legged ham beetle).

The method of separating the pupae from the larvae is similar to that for separating the larvae from the earth in the breeding tins. The larvae and pupae are sifted out and placed in the sorting trays ; the larvae will crawl away and the pupae will be left behind. By using the trays several lots can be separated at the same time and with little or no rough handling of either the larvae or pupae.

A matter which is most important, but for which as yet no reason can be assigned, is the fact that occasionally a very large percentage of the fly pupae atrophy, the pupal fly rotting and finally drying up. It was thought in the early stages of these investigations that this might have been caused by damage done to the maggots or pupae during sorting, for our methods were not so much simplified as they are now ; but still even now it is found to occur. Furthermore, on a number of occasions deaths of pupae from this cause have been observed in the field where the carcases have never been disturbed.

It is generally amongst the pupae of *Pycnosoma rufifacies*, and to a lesser extent *P. varipes*, that this species of Chalcid wasp is found actually at work in the field. This is largely due to the habits of the larvae of these two species, which do not crawl away from a carcase to pupate unless the remains have been much disturbed, but pupate either just under the edge of the remains or else affix themselves to the bones, wool or other portions of the carcase, and thus they are more easily found than the other species, all of which generally crawl a considerable distance from the carcase and scatter. Where the pupae of these species have been taken while radiating away from carcases, during February to April and during August to October or even into November, they have often been found heavily parasitised by *Nasonia brevicornis.*

In the laboratory, it has been found that the pupae of *Anastellorhina augur*, *Pollenia stygia*, *Lucilia sericata*, and, when obtainable, *Calliphora erythrocephala* and *Sarcophaga aurifrons* (*i.e.*, the " smooth " pupae) are attacked by the wasps before the pupae of *Pycnosoma rufifacies.* This is probably due to the shell of the pupa being thinner in the former five species than in the latter and thus more easily perforated.

No definite reason can yet be assigned to the apparent distaste of the wasps for the pupae of *Ophyra nigra* and *Pycnosoma varipes* in the laboratory. In the field the pupae of the latter species are practically always found to be parasitised.

The actions of the female wasp when placed with the pupae are very interesting. She first crawls over and over them, her body and antennae twitching constantly. She continually touches the pupae with her antennae, as if seeking for the thinnest part of the shell to puncture. When she has finally decided on the spot to be punctured, the tip of the body is curved downwards and the point of the ovipositor is inserted. The apex of the abdomen is then brought back almost to its normal position, and by so doing the whole length of the ovipositor is exposed, its normal position being in a groove along the ventral plates of the abdomen. From this time the body, except for a slight twitching, remains practically motionless, although the antennae are waving continuously. The ovipositor is gradually inserted, apparently by an upward and downward movement of the styles within the sheath. When fully inserted it remains in that position for perhaps a minute, when it is withdrawn about half its length and is again pushed in. This may occur several times, until at last the whole ovipositor is withdrawn and springs back to its normal position.

After the ovipositor is withdrawn a small globule of liquid is observed where the puncture had been made. The liquid is either a fluid resembling in its nature a synovial fluid, or else it had been acting as a lubricant for the styles ; the former is the more probable. The female almost immediately turns round and sucks up this liquid and after this there is practically no visible sign of the pupa having been perforated, until the spot dries, when a tiny white dot on the pupal shell is seen where the puncture had been made.

The time occupied for the whole process of insertion, deposition and withdrawal is very variable. The two extremes which have been noted are 4 minutes and 25 minutes. Although the female may attempt to puncture the shell in one spot, she may leave it and make more than one choice of a fresh point before beginning definitely to pierce the pupal shell.

The position of the body during the process of oviposition is characteristic, being arched from the head to the tip of the abdomen with the ovipositor projecting straight down from the mid-ventral surface of the abdomen.

In considering the economic value of these parasites when bred in centres for distribution, the length of time they live under certain conditions becomes a most important point. It is already known that the life-cycle is 11 to 14 days under normal conditions. This allows about 8 days from the date of despatch before they hatch out. Therefore the length of time that the wasps will live, after emerging from the pupae, in a closed space (1) without food, (2) with food, become important factors.

(1) As the work of breeding the parasite for distribution will always be more or less localised in centres, from which the parasitised pupae will be sent out, a greater or less time will be occupied in transit of each packet of pupae to its destination, possibly resulting in some cases in the wasps hatching out before completing their journey. In order to determine how long the wasps could live in a confined space without food, a number of parasitised pupae were placed in glass cylinders, the tops of which were covered with muslin. The dates of first emergence and of first deaths were noted, as also the dates when the greatest number of the wasps had hatched out and of the last deaths. This is not strictly identical with the conditions in which the parasitised pupae are sent out, but it at least gives some idea of an answer to this point of investigation. Under these conditions the wasps were found to live from 4 to 6 days.

(2) This is important, owing to the fact that the pastoralists, to whom parasites are sent, are directed to feed the wasps for some days in bottles if no suitable carcase is available on the emergence of the wasps from the pupae. To investigate this point, a number of parasitised pupae were placed in glass cylinders similar to those used above, the tops of the cylinders being covered with muslin. As soon as the wasps emerged, the muslin coverings were damped with honey and water as required. The dates of first emergence, maximum number of parasites bred out, and of first and last deaths were noted. The life of the wasps under these conditions was found to be from 18 to 20 days.

When kept actively parasitising in the breeding cages, the wasps live and work for from 4 to 6 weeks, living longer in the cooler weather. The difference in the length of the life of the wasps kept in a confined space, and of those actively at work in the cages may be due partly to the direct effects of confinement; but in the writer's opinion, it is due more to overcopulation of the females in the confined spaces.

The imago and life-history of this wasp have been previously described by Girault & Saunders (Psyche, Dec. 1909), and again by W. W. Froggatt and T. McCarthy, in the Agricultural Gazette of N.S.W., and re-published in Farmer's Bulletin No. 95 (Dept. of Agriculture N.S.W.), so that no further account is necessary here.

In conclusion, it might be pointed out that it is seldom that such a hardy and easily bred parasite as *Nasonia brevicornis* has been found. As has been shown in these notes, given a plentiful supply of fly pupae, unlimited numbers of these little parasites can be artificially bred and distributed. As they remain in the pupae a considerable time, they can be despatched long distances without very much danger of premature emergence, and with ordinary care they can be fed and kept for days before liberation; also while actively parasitising in captivity, they will live for weeks. It is therefore reasonable to expect that this parasite should prove a very important factor in the control and reduction of blowflies and even other species of Diptera.

SOME OBSERVATIONS ON THE BIONOMICS OF *GLOSSINA PALPALIS* ON THE ISLANDS OF VICTORIA NYANZA.

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On arriving at Nsazi Island on Victoria Nyanza in July 1918 to carry out some experiments with *Glossina palpalis* and rinderpest, I was at once struck by a marked diminution in the numbers of the fly on this and the neighbouring islands. Since the days of the first Commission of the Royal Society, the small island of Kimmi, about three-quarters of a mile N.E. of Nsazi, has been noted for the numbers of its tsetse. I had with me some of the original Mpumu fly boys and others who had worked on these islands with Fiske and Carpenter from 1911 to 1916. Their evidence on such matters is reliable, as they receive a bonus for their catches. They were all unanimous that the fly on Kimmi, Nsazi, and Tavu Islands had decreased very markedly in numbers. My own observations confirmed this in each case.

On looking around to discover the cause for the diminution, one outstanding fact was at once apparent. During the recent rise in level, which attained its maximum in June 1917, the Lake invaded, and in places completely covered, the great majority of the sandy beaches especially favoured by the fly for the deposition of larvae.

The requirements given by Carpenter in his Progress Report (1) as constituting the favourite sites of *G. palpalis* pupae are :—(*a*) shade and free air circulation; (*b*) dry and loose soil, commonly gravel or coarse sand.

The most favoured breeding grounds of the fly in this northern group of the Sesse Islands were those of Damba and Tavu Islands. Although Carpenter's latest Progress Report is not available, I believe he refers therein to the Tavu pupa ground as second only to that of Damba. Pupae had also been found on Kimmi, Nsazi and Bulago Islands, though in no great numbers.

In the course of July 1918 I visited all these islands and in each case, except perhaps that of Bulago Island, found that the rise in the level of the lake had materially curtailed the extent of suitable sandy breeding area.

Tavu Island.

The greater part of the sandy area patronised by the fly in former years is now covered with a thick layer of black mud, dotted here and there with floating water-weeds. The "byansambwe" bushes (*Triumfetta macrophylla*), which were formerly plentiful on this beach, have been largely washed away by the water. The "nzibaziba" (*Acalypha*)* shrubs, hardy though they are, have also suffered. Both these plants are commonly found associated with the favourite pupa grounds of the fly. At this breeding ground, the water's edge in July 1918 was still some 40 yards landward of the high-water level of 1911; and much of the zone exposed by the receding of the water since November 1917 is covered by a boggy mixture of black mud and the remains of the old sand.

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* Mr. R. Fyffe, Chief Forestry Officer, kindly identified these plants.

On Tavu, therefore, the breeding accommodation for the fly is reduced to a mere fraction of what existed formerly. The shrubs limiting the old breeding area on either side are growing on sand ridges above the present water-level; among their roots a few pupae were found. Even here, however, the places where the sand is sufficiently dry for the requirements of the pupae are rare. During a period of 55 minutes, 10 boys obtained 79 pupae working hard under my supervision and encouraged by a bonus according to the numbers found. Coincident with and presumably as a result of this temporary destruction of their breeding ground, the number of flies has been greatly reduced, and during this spell of pupa-hunting only a very few were seen. On a sunny day 3 boys working for 5 hours caught 140 flies, although offered every inducement to obtain as many as possible in the time at their disposal.

The most striking deficiency from the fly point of view at the present moment on Tavu Island seems to be *dry* sand.

Bulago Island.

On this island Fiske found pupae in fair, though not very large, numbers in 1915. Here the shore line is somewhat steeper than on the more favoured pupa islands such as Tavu and Damba. As a result, the lake rise has produced relatively less detrimental effect on the sandy breeding areas. From the strip of shore to the North-West, where pupae were formerly most numerous, 5 boys working under my supervision for 5 hours obtained 214 pupae. On another occasion 7 boys obtained 141 in 1½ hours from same area. These were, as usual, in the sand among the roots of the "nzibaziba" and "byansambwe" bushes, and were only found where the soil, either sand or dusty humus, was dry to a depth of 2 inches below the surface. The great majority of the pupae were found below the high-water mark, which, as will be seen later, corresponds to the lake level of June 1917. Often the sand under the bushes appeared at first suitable for pupae, but on investigation proved to be distinctly moist immediately below the surface, and no pupae were found. Occasional pupae or empty cases were found in the zone immediately above the 1917 high-water level, either in sand or in dry dusty earth in the forest belt at the bases of the trees. As Carpenter points out, ant-lion larvae are found in the same type of soil.

The flies on this island, in my experience never very numerous, are perhaps less reduced in numbers than on other neighbouring islands. In all 196 flies were caught in Bulago the sex proportions being males 84·70 per cent., females 15·30 per cent.

Nsazi and Kimmi Islands.

Carpenter (1) writes of Nsazi: "At only one place along its coast are flies at all numerous." This is along the sandy shore of a bay on the S.W. side of the island, where a fine stretch of dazzling white sand fringed with bushes is backed by a zone of forest which runs up to the base of a steep cliff. Pupae were formerly found here in small numbers. Between 22nd January and 10th February 1911, Fraser and I carried out experiments with the wild fly of these two islands. The figures of the catches made by 6 fly boys during this period, two of whom accompanied me in July 1918, were 5,765 from Nsazi and 8,444 from Kimmi. On Kimmi, where the fly used to be exceedingly numerous. the boys were limited to 1,200 flies per diem, as the available experimental monkeys on which they were fed could not stand a greater strain. On Nsazi the flies were less numerous, but the average daily number obtained by the 6 boys together when all were working was a little over 700. These flies were caught in the height of the dry season, of which Carpenter (1) writes: "A decrease in the relative humidity of the atmosphere is therefore responsible for a large drop in the number of flies . . . it appears that flies can live several months, but are killed off in large numbers at the onset of the dry weather."

The diminution in the numbers of fly on Kimmi is very marked. One of my original fly boys spent 6 hours on the island which he knows well and caught 100 flies, and this represents a fair average day's catch in July 1918. The pupa grounds are also diminished, though on this island there was no single extensive breeding ground. On Nsazi fly-beach in July 1918, 12 boys searching for 20 minutes under my supervision obtained 33 shells and 8 full pupae. Fly were rare, the most expert fly boy catching only 60 in the course of a whole day's search; of these, 40 were from this beach and 20 from neighbouring parts of the shore. The sex proportions of the flies caught on these two islands during this 1918 visit are: Nsazi 63 flies, males 84·13 per cent., females 15·87 per cent.: Kimmi 1,289 flies, males 82·32 per cent., females 17·68 per cent.

Damba Island.

Carpenter (1) in 1911 described the Damba breeding ground as follows: "Formed of small pebbles mixed with coarse sand left by subsidence of the lake 4 or 5 feet above its present level, and about the same number of yards away from the present water's edge." The high level here referred to was that of 1906. This famous beach, owing to its very gradual slope, is peculiarly subject to the encroaching effects of any rise in the lake level. From end to end of the beach the highest high-water mark is clearly indicated by a tangled accumulation of branches of trees, sticks, reed stems, and all kinds of vegetable débris. This line represents a lake level about 18–20 inches above the water line of July 1918. The distance of this high-water line from the water's edge (July 1918) at that part of the beach where most pupae are found is about 8–10 yards. In steeper parts of the beach only a few yards or feet separate the two levels.

This high-water line, as will be seen, marks the level of June 1917. Up to July 1918 the lake level has sunk some 17–18 inches. This 1917 line also coincides roughly with the lowest level of forest vegetation. In former days, as is well shown by Carpenter's photographs (1), there was a certain amount of *Triumfetta* and *Acalypha* growth outside the actual forest zone along this Damba beach. Under these bushes large numbers of pupae were found in the dry white sand. It was possible to walk practically dry-shod from end to end along the beach. In July 1918 this was no longer possible, except in the southern half, and much of the *Triumfetta* had disappeared. The fringe of grass and trailing plants which, in Carpenter's photograph, extends beyond the forest nearly to the zone of coarser pebbles, has been pushed back until it coincides roughly with the line of the big trees.

At lower lake levels, such as those of 1911–12, part of the space between the edge of the forest and the water line was often occupied by the two shrubs mentioned above, which flourish on a sandy soil. Under these shrubs the fly like to deposit their pupae. Any fallen tree-trunks are especially patronised, likewise the angles among the roots of trees near the forest edge. With the rise of the lake in May and June 1917 a large area of sand was submerged, and of that remaining much was kept constantly damp by percolation or direct exposure to the spray.

The *Triumfetta* shrubs have suffered severely or totally disappeared in these invaded areas. As a result, with the fall of the lake, some of the reappearing sand is exposed to the full glare of the sun and is useless, for the time at any rate, as a pupa ground. Among other changes the old tree-trunk photographed by Carpenter, from under which so many pupae were formerly obtained for the Mpumu laboratory, has disappeared. In November 1911, the year of Carpenter's visit to Damba, the lake reached its lowest recorded level. The highest record was touched during June 1917. The difference between these two extreme levels is 5·19 feet vertical measurement. As already stated, the 17–18 inches fall which has occurred between June 1917 and July 1918 has laid bare in places along the beach some 10 yards of ground, comprising an upper zone of fine white sand blending below with coarser pebbles.

As regards the number of pupae found on this Damba beach in 1910–11, several thousands were obtained monthly for the laboratory at Mpumu. All the old records are not available, but the following extracts give a good idea of the quantity found:— March 1911, 5,500; June 1911, 3,700; July 1911, 7,380; August 1911, 2,600; September 1911, 8,000; February 1912, 4,620. I also recollect one month receiving 11,000. These numbers were obtained by 10 or 12 men working unsupervised during a stay of a day, or perhaps 2 days, on the island, at intervals of a month or 5 weeks.

In July 1918, 10 men working for 4 hours under my supervision obtained 1,680 pupae from the southern part of the beach where pupae were always most numerous in former years. Of these, 514 came from around the roots of a single large tree growing at the edge of the forest belt, its trunk being just above the 1917 high-water level and at the edge of the grass and trailing-plant growth. On either side of this tree were scraggy *Acalypha* bushes, and among their roots the bulk of the remaining pupae were found. The whole area is in the shade of a large tree practically the whole day long. No other sector of the beach produced pupae in anything like such numbers. This particular pupa tree, together with the old trunk which has now disappeared, was always specially patronised by the fly for larval deposition. On the eastern part of the beach pupae were found only in small numbers and in isolated situations, almost always in connection with *Acalypha* bushes or the roots of larger trees. For several years no one has collected pupae from this beach. Two features common to all places where pupae were found in July 1918 are dry, finely divided soil, generally white sand or a varying mixture of sand and dry humus, and shade.

The roots of the big tree which yielded the 514 pupae are surrounded by finely divided, perfectly dry earth with a small admixture of sand. Wherever dry sand and shade were found pupae also occurred. Dry, finely divided earth at tree roots did not necessarily carry pupae, even though ant-lion larvae had established themselves hard by. The vast majority of the pupae were within a few yards of the high-water mark. Two pupa-cases were found at the base of a tree some 30 feet within the forest zone and 60 feet from the water's edge. At the part of the beach where most of the pupae are found, the 1917 high-water mark is at its farthest from the present water level. The forest zone at this point is narrow, scanty, and backed by an abrupt low cliff some 40 yards inland. The soil here is poor in humus and tends to be finely divided, as the sandy elements of an ancient lake level persist to an unusual extent. The fly are thus still able, in this particular locality, to find the requisite conditions.

Discussing the breeding grounds of *G. palpalis* on Victoria Nyanza, Fiske (2) notes that the vast majority of the regular pupa grounds of the fly occur between the high-water level of 1906 and the then (1913–14) lake level. Since his visit the lake has risen to a level ·79 feet above that reached in 1906. The highest record was touched in June 1917, but on 20th November 1917 the lake was only $1\frac{1}{2}$ inches below this record level, and it remained high all through December. Thus for a relatively long period the greater part of all the principal pupa grounds of the fly was under water. This rise in the lake level did not, however, lay bare proportional new areas of sand to make good those submerged. The level of June 1917 corresponds roughly with the limit of forest along the lake shore, which itself probably indicates a more permanent and still higher level of long years ago. All along the shores of the Lake there is ample evidence of ancient levels many feet above those of more recent times.

The soil of the forest zone consists of tough humus, often hard on the surface, and apparently unsuited to the requirements of the larvae.

Conclusions.

There has been, without doubt, a marked reduction in the numbers of fly on the islands visited. The only factor that offers a reasonable explanation of this decrease is the destruction of breeding grounds by the rising water. The rainfall and humidity figures are given below, but do not suggest any probable explanation.

On this subject Fiske (2) writes, as a deduction from his studies of *G. palpalis* on the islands, " Restrict the breeding grounds and there is a corresponding decrease in abundance of fly " ; again, " I believe it is a very conservative estimate that 90 per cent. of the flies on the islands are from puparia deposited on these beaches " (i.e., of sand and gravel). He recognised, however, other types of breeding places which the fly appeared to frequent by deliberate choice rather than by force of necessity : " On four separate occasions considerable deposits of puparia have been found in vegetable débris, fairly compact, not fine and, of course, well shaded."

These tentative conclusions put forward by Fiske in April 1914 are strikingly borne out by the events of 1917–18. It is of interest to note that, in considering the effect of another big rise of the lake to the then record level of 1906, Fiske anticipates that " The recurrence of the high-water will open up the sand and gravel deposits, newly washed and clean of vegetable débris, to reoccupation." This will, undoubtedly, be the eventual result of the 1917 rise. But, meantime, and until a further fall in the lake level, any such beneficial effect is vastly counterbalanced by the wholesale dampening of the favourite and almost exclusive breeding areas ; though it is conceivable that in certain cases abandoned breeding grounds at the 1906 level may be again rendered useful to the fly.

I will not presume, on so short an investigation into a difficult entomological problem, to dogmatise as to the cause and effect of the present marked diminution of *G. palpalis* on the islands visited. But, as a working hypothesis, it is justifiable, after due consideration of the facts, to assume that the invasion of the favourite

ENTEBBE RAINFALL STATISTICS FROM 1896 TO JULY, 1918.

MONTH	1896.	Days	1897	Days	1898	Days	1899	Days	1900	Days	1901	Days	1902	Days	1903	Days	1904	Days	1905	Days	1906	Days	1907	Days
	In.	*No.*	*In.*	*No.*	*In.*	*No.*	*In.*	*No.*	*In.*	*No.*	*In.*	*No.*	*In.*	*No.*	*In.*	*No.*	*In.*	*No.*	*In.*	*No.*	*In.*	*No.*	*In.*	*No.*
Jan. ..	*No*		1·74	5	*No*		0·61	4	2·26	..	3·88	9	2·96	7	6·53	10	1·66	6	2·16	9	2·83	4	3·43	10
Feb. ..			3·62	15	*record*		3·46	7	4·23	..	4·11	7	7·35	10	0·70	4	3·60	9	0·70	3	4·98	13	2·42	8
March ..	*record*		3·97	16	*Mutiny*		3·45	9	6·10	..	4·33	16	3·65	9	7·10	17	9·85	24	9·39	18	5·19	18	0·83	4
April ..	8·61	18	13·73	26	6·83	19	9·15	12	13·54	..	8·40	19	5·78	12	8·69	19	6·77	20	5·43	13	14·62	22	15·79	23
May ..	4·45	15	10·55	22	6·08	14	8·56	14	2·70	..	7·94	20	4·15	14	6·90	17	9·52	21	8·24	22	4·80	13	10·00	17
June ..	3·18	8	4·53	11	4·29	10	2·02	5	5·81	..	5·57	..	1·09	3	10·26	17	5·38	13	6·66	12	5·08	21	6·26	6
July ..	0·31	5	2·89	10	0·65	7	3·32	4	0·43	..	4·01	7	3·35	9	4·23	18	1·79	5	5·67	11	1·66	5	5·72	11
August	4·10	12	5·86	10	4·47	7	1·36	2	2·91	..	0·18	2	2·85	8	1·18	6	4·17	12	1·73	4	6·04	11	0·55	3
Sept. ..	2·37	5	4·74	7	5·62	10	0·64	4	3·43	..	0·66	6	5·61	8	4·45	15	2·34	8	4·27	4	2·50	10	2·45	3
October	4·59	11	*No*		4·53	16	*No*		1·53	..	1·94	12	4·98	18	3·63	10	2·58	11	6·50	13	4·86	10	2·70	15
Nov. ..	12·05	25	*record*		7·64	15			5·99	..	2·28	8	7·76	14	3·74	8	8·01	22	7·63	19	2·25	8	3·43	10
Dec. ..	4·69	10	*Mutiny*		1·63	6	*record*		12·51	..	3·72	9	3·77	14	5·47	6	7·34	13	7·36	17	4·61	12	4·67	5
Total	44·35	109	51·63	122	41·74	104	32·57	61	61·44	..	47·02	115	53·30	121	62·88	142	63·01	164	65·74	145	59·42	147	58·25	115

MONTH	1908	Days	1909	Days	1910	Days	1911	Days	1912	Days	1913	Days	1914	Days	1915	Days	1916	Days	1917	Days	1918	Days		
	In.	*No.*	*In.*	*No.*	*In.*	*No.*	*In.*	*No*	*In.*	*No.*	*In.*	*No.*	*In.*	*No.*	*In.*	*No.*	*In.*	*No.*	*In.*	*No.*	*In.*	*No.*		
Jan. ..	1·17	4	1·89	7	7·99	11	2·66	8	3·55	8	0·63	7	2·02	10	2·56	7	0·74	8	2·86	8	2·07	10	..	..
Feb. ..	3·41	10	1·44	6	0·86	4	0·26	2	3·59	10	7·32	15	3·19	10	3·40	8	5·95	12	8·31	14	1·07	7	..	..
March ..	2·32	6	5·60	10	7·34	17	5·98	19	8·61	18	9·51	15	6·63	21	9·87	17	5·63	11	2·19	3	3·59	15	..	..
April ..	11·82	18	12·09	19	8·85	19	12·38	21	7·55	18	12·71	25	9·31	16	10·30	17	5·92	15	13·30	23	10·88	23	..	..
May ..	10·34	18	5·96	9	15·80	21	10·86	15	12·03	18	10·64	26	7·71	19	7·85	24	3·96	11	9·90	19	9·05	11	..	..
June ..	3·63	11	2·67	6	4·70	4	1·34	7	9·81	15	0·97	10	5·28	15	6·84	13	9·78	15	2·85	7	5·17	18	..	..
July ..	5·04	9	2·86	7	2·06	8	2·95	6	2·61	9	3·22	6	2·85	8	2·88	6	3·16	7	0·02	1	1·89	7	..	..
August	2·90	8	3·36	11	2·27	6	6·60	7	6·75	17	1·41	6	3·10	8	1·68	6	4·53	12	1·50	13	..	..	..	..
Sept. ..	0·93	3	2·49	8	1·08	10	1·93	7	2·08	7	1·71	5	4·58	8	5·22	12	4·44	12	5·32	12	..	..	..	..
October	3·52	13	4·47	11	1·51	5	2·07	8	0·96	14	4·42	13	3·42	12	5·38	10	3·04	7	5·56	10	..	..	..	..
Nov. ..	2·42	12	3·91	6	3·39	9	4·02	14	8·22	18	0·90	11	8·53	20	4·45	14	3·50	9	2·71	6	..	..	..	..
Dec. ..	4·27	11	8·69	16	6·42	13	1·86	6	9·95	20	2·98	10	3·15	10	9·42	13	3·68	8	1·06	6	..	..	..	..
Total	51·77	123	55·43	116	62·27	127	52·91	120	75·71	172	56·42	149	59·77	157	69·85	147	54·33	127	55·58	122				

Humidity Figures :—The following are the average differences between the dry and wet Bulbs of 3 daily readings, *i.e.*, 7 a.m., 2 p.m., and 9 p.m., for the first 6 months of the last three years :—

1916.	1917.	1918.
4·2°	3·00°	4·3°

[These particulars were kindly furnished by Mr. T. D. Maitland, Curator, Botanic Gardens, Entebbe.

sandy breeding grounds by the lake has exerted a powerful adverse effect on the fly of the northern shores and islands of Victoria Nyanza. As the lake falls, on this hypothesis, the fly will again increase in numbers. The level is already some 18 inches lower than it was in June 1917, and the fall will probably continue steadily. Much valuable time has thus already been lost. I strongly recommend, therefore, that an endeavour be made immediately to accentuate the work of the lake by systematically clearing away the sheltering *Acalypha* and *Triumfetta* shrubs from certain known breeding areas. In this way the sun will succeed where the lake has failed, and there will be a still further reduction of suitable breeding accommodation at a time when the fly are still much reduced in numbers. Such measures will entail a relatively small expenditure of labour, and should be applied primarily, indeed solely, to certain carefully selected islands. Nsazi, Lwagi and Bulago Islands carry few or no situtunga, and their fly are confined to limited stretches. All these islands would be suitable for cattle. By judicious treatment of the fly shores and of the breeding grounds on the islets Kimmi, Tavu, and Ngamba, I consider that the three first mentioned islands, all of which are of fair size, could be reopened to a properly controlled native population. The fly on Nsazi and Lwagi were tested by Fraser and myself in 1911, and proved negative to *T. gambiense*. Carpenter, in an unpublished report which I regret is not available, found the Nsazi fly infective to monkeys in 1914, by which time a few situtunga had established themselves on the island. As regards the trypanosome reservoir, however, none of these islands present any serious difficulty. Bulago will be the most difficult of these islands to deal with, but its treatment is, none the less, quite a feasible undertaking. Trained fly boys should be included in the population, and their work will be diligently to catch the persisting fly, and to search for their pupae. A simple arrangement of bonuses will ensure the efficiency of this measure. Islands such as Damba, Kome, and Bugalla, thickly forested and teeming with situtunga, must be deemed beyond the pale, and every administrative effort must be used to prevent indiscriminate visiting of their shores should the above-mentioned islands be re-opened.

There are, doubtless, other islands of the great and fertile Sesse and Buvuma groups which could, with relatively little expense and labour, be opened once again. The control of these distant islands would, however, be a very much more difficult proposition.

There is good reason to hope that properly organised measures on the lines suggested and applied immediately, before the falling lake permits of an extensive recovery on the part of the fly, will result in the permanent recovery of a valuable tick-free grazing area within 20 miles of headquarters. At a rough estimate the area of the three islands concerned is 8 square miles; Lwagi 3, Bulago 2, and Nsazi 3 square miles approximately.

The above recommendations are based upon the assumption that the variations in the level of the lake are phenomena over which we have no control. Were it feasible to secure a rise in level by some engineering device, it might be possible to eliminate *G. palpalis* from Victoria Nyanza. A rise of 3 feet above the level of July 1918 would ensure the submergence of the greater part of the present breeding area of the fly, without affording it any corresponding compensation. I believe that the fly would be reduced to such an extent by this procedure that, even if the rise in level were maintained for only 6 months, the remnant could be dealt with by limited measures such as trapping, attention to possible remaining breeding grounds, etc.

After a temporary rise in level, subsequent falling of the lake will, of course, lead to exposure of the breeding area in a particularly favourable state. The progeny of the fly that survive, if left alone, will in course of time re-establish themselves. To ensure success, therefore, with a temporary raising of the lake level, the islands and shore line that it is especially desired to reclaim must first be carefully studied with a view to the proper organisation of coincident clearing of potential breeding grounds. A permanent rise in level will, I think, have a more serious effect on the fly and some time will elapse before new breeding grounds can be found at the new level.

There is only one known outlet to Lake Victoria, namely at the Ripon Falls, Jinja. The Falls are about 300 yards wide, divided into 3 parts by two islets. If a permanent dam were erected at this spot the level of the lake could be raised. Further, such a dam would prevent the falling of the lake, which sooner or later follows high levels such as those of 1906 and 1917.

I have discussed the construction of such a dam with Mr. C. V. Espeut, the Director of Public Works, Uganda, who tells me that the undertaking is quite feasible. He is, however, unable without careful consideration to estimate the cost of the structure.

Considerable time, possibly 12 months, would elapse after the erection of the dam before the lake level became once again constant.

If the contentions advanced in this paper be correct, the result of the dam will be either the practical extermination of the fly on Victoria Nyanza, or so marked a reduction in their numbers that survivors will be easily controlled.

Confirmation of my observations will, I fear, be difficult. Capt. Carpenter, who has for years studied *G. palpalis* in Uganda, is still detained on active service. The lake level is dropping steadily and the fly are in consequence doubtless once again increasing in numbers; and it is highly probable that before very long the fly popultion may reaach its former density. But the results of this 1917 rise of the lake appear to be in perfect accord with the deductions made by Fiske as a result of months of careful study in 1912--13.

References.

(1) G. D. H. Carpenter, Reports S.S. Commission of Roy. Socy. XII.

(2) W. F. Fiske, Progress Report XIV.

COLLECTIONS RECEIVED.

The following collections were received by the Imperial Bureau of Entomology between 1st April and 30th June, 1918, and the thanks of the Managing Committee are tendered to the contributors for their kind assistance:—

Dr. W. M. Aders, Government Economic Biologist:—7 Culicidae, 1 Tabanid, and 1 Fish (*Fundulus melanospilus*, Pfeffer) destroying Mosquitos.

Agricultural Research Institute, Pusa:—324 Bruchid Beetles; from India.

Mr. G. E. Bodkin, Government Economic Biologist:—3 Diptera, 7 Siphonaptera, 67 Coleoptera, 40 Hymenoptera, 15 Rhynchota, 13 Orthoptera, 24 Odonata, 32 Ticks, and 1 Scorpion; from British Guiana.

Mr. John R. Bovell, Superintendent of Agriculture:—4 Diptera, 4 Lepidoptera, 1 Bee, 8 Coleoptera, and 1 Bug; from Barbados.

Lieut. P. A. Buxton:—3 *Stomoxys calcitrans* and 3 Weevils; from Mesopotamia.

Division of Entomology, Pretoria:—1 *Chrysops*, 41 other Diptera, 5 Lepidoptera, 105 Coleoptera, 2 Planipennia, 6 Hymenoptera, 36 Rhynchota, and 5 Orthoptera; from South Africa.

Mr. P. R. Dupont, Curator of the Botanic Station:—21 Coleoptera aud 3 packages of Coccidae, &c.; from Seychelles.

Mr. C. C. Gowdey, Government Entomologist:—75 Diptera, 104 Coleoptera, 5 Planipennia, 304 Hymenoptera, 5 tubes of Thysanoptera, 3 tubes of Aphids, 89 other Rhynchota, 50 Orthoptera, and 4 Ticks; from Uganda.

Mr. P. L. Guppy:—30 specimens of the Froghopper *Tomaspis carmodyi*; from Tobago.

Dr. Van Hall, Director of the Instituut voor Plantenziekten, Buitenzorg:—16 Coleoptera; from Java.

Mr. E. Hargreaves:—85 Culicidae, 15 tubes of Culicid exuviae, 11 Tabanidae, 88 other Diptera, 3 Trichoptera, 83 Coleoptera, 1 Chrysopid, 71 Hymenoptera, 26 Rhynchota, and 11 Orthoptera; from Italy.

Mr. Harold H. King, Government Entomologist:—11 imagines, 2 puparia, and 9 preparations of *Glossina fuscipes*; from Khartoum.

Mr. S. Leefmans, Instituut voor Plantenziekten, Buitenzorg:—10 Coleoptera; from Java.

Capt. Angus Macdonald, R.A.M.C.:—26 Culicidae; from Kent.

Monsieur R. Mayné, Government Entomologist:—9 Moths and 3 larvae of *Brithys pancratii*; from the Belgian Congo.

Mr. A. D. Poestkoke:—6 Tabanidae; from the Kafu River, Uganda.

Major H. S. Stannus, Senior Medical Officer:—9 Culicidae, 1 *Tabanus*, 12 other Diptera, 17 Siphonaptera, 5 Lepidoptera, 3 Coleoptera, 4 Hymenoptera, 3 Mallophaga, 2 Rhynchota, 1 Mantid, with ootheca, and 4 Mites; from "German" East Africa.

Mr. F. W. Urich, Government Entomologist:—1 packet of Coccidae; from Grenada.

Capt. Jas. Waterston, R.A.M.C. :—4 Culicidae, 1 *Chrysops*, 3 *Haematopota*, 574 other Diptera, 5 Lepidoptera, 5 Trichoptera, 287 Coleoptera, 12 Planipennia, 199 Hymenoptera, 126 Rhynchota, 17 Orthoptera, 183 Odonata, 1 Mayfly, 21 Mollusca 1 Crab, 4 Fishes, and 4 Bats ; from Macedonia.

Dr. A. G. Wilkins :—7 Tabanidae, 142 *Glossina*, 2 Hippoboscidae, 183 other Diptera, 51 Coleoptera, 47 Hymenoptera, 6 Rhynchota, and 15 Orthoptera ; from Uluguru, "German" East Africa.

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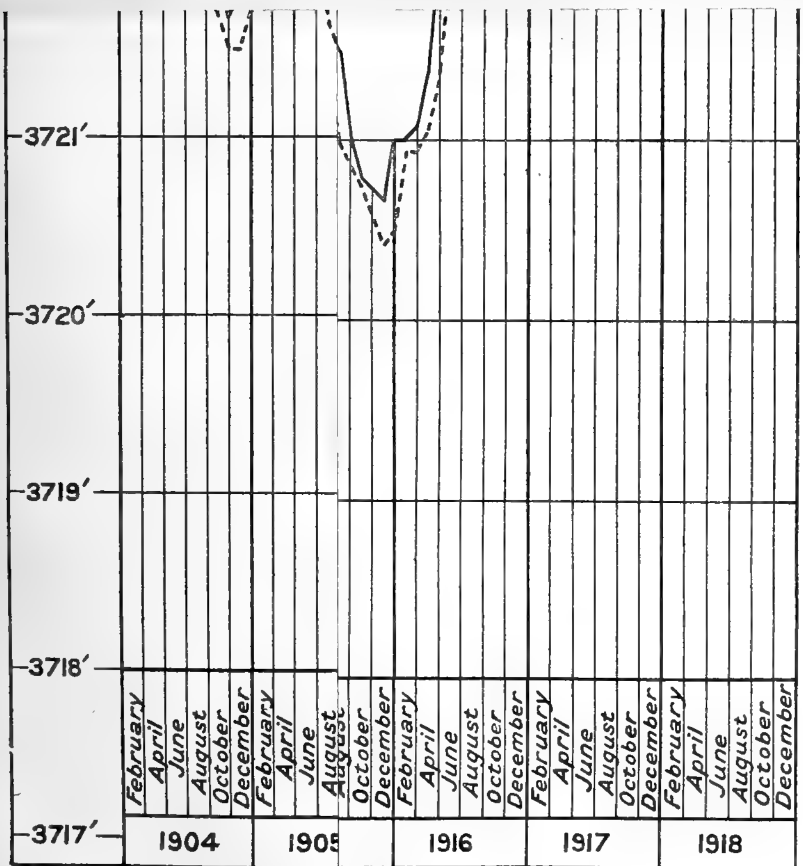
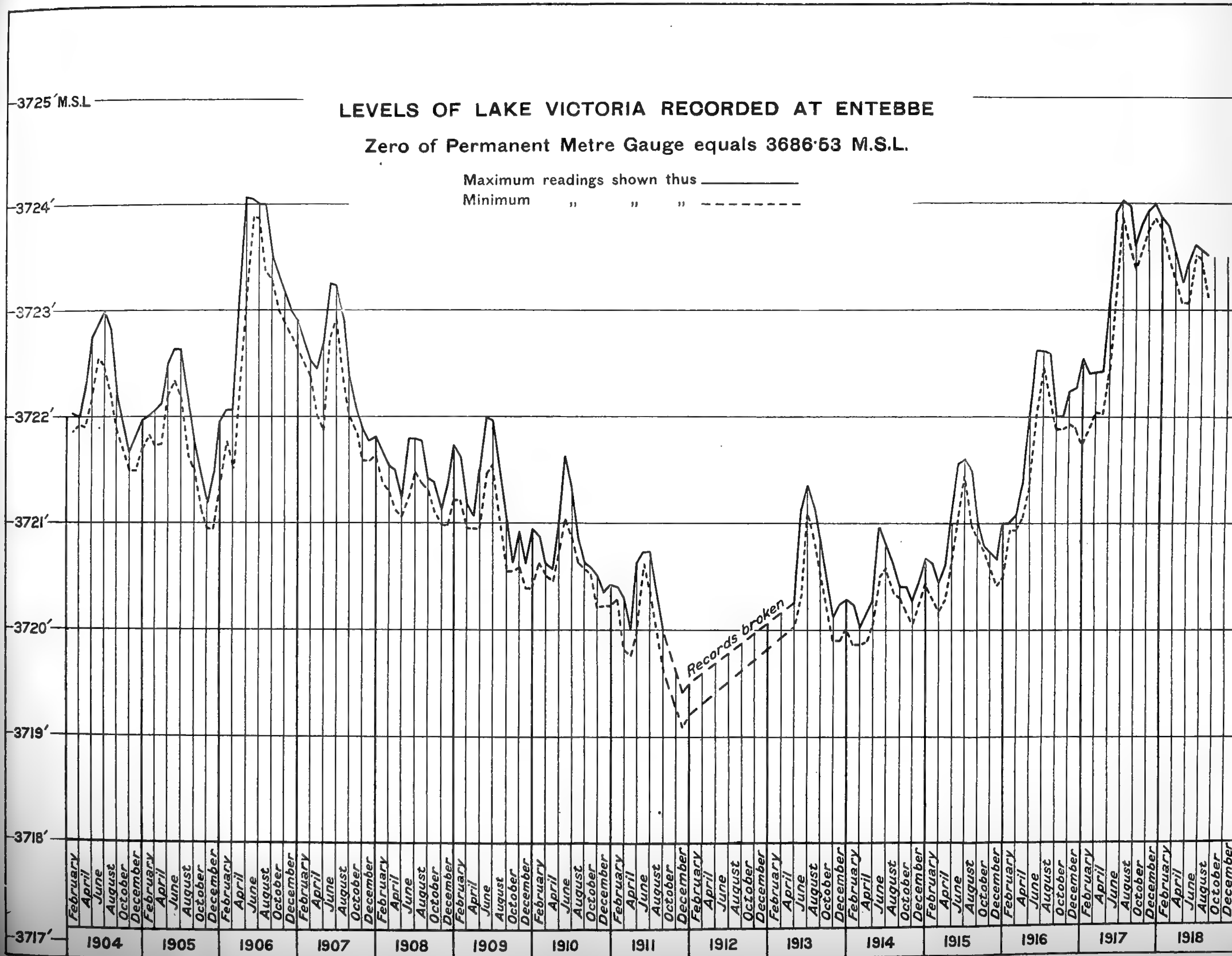
To face page 270.

NOTICE TO BINDER.

This graph should be inserted facing p. 270.




LEVELS OF LAKE VICTORIA RECORDED AT ENTEBBE
Zero of Permanent Metre Gauge equals 3686·53 M.S.L.
Maximum readings shown thus
Minimum " " "
3725' M.S.L.
3724'
3723'
3722'
3721'
3720'
3719'
3718'
3717'
Records broken
February
April
June
August
October
December
1904
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1906
1907
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1910
1911
1912
1913
1914
1915
1916
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1918

SOME NEW INJURIOUS WEEVILS FROM ASIA.

By Guy A. K. Marshall, D.Sc.

(Plate XVII.)

Among some insects recently sent for identification to the Imperial Bureau of Entomology by Mr. T. Bainbrigge Fletcher, Imperial Entomologist for India, and Dr. K. Dammerman, Government Entomologist for Java, there were four undescribed species of Curculionidae, all of which are recorded as attacking cultivated plants, though the extent of the injury inflicted is not indicated.

Subfamily Brachyderinae.

Genus **Antinia**, Pasc.

Head with the eyes lateral, moderately convex and almost circular. *Rostrum* separated from the forehead by a straight transverse impression, deflected, scarcely curved, and the lower surface parallel with the upper in profile; the epistome shiny and prominent, the sides strongly carinate, forming an acute angle behind and each bearing three (occasionally four) setae, the apical margin broadly sinuate and about as long as one of the sides; the mandibles smooth and shiny, with a strong apical tooth and each bearing four setae, the scar rather prominent and sub-triangular; the mentum filling the buccal cavity, smooth, shiny and bare; the edge of the submentum with two long, obliquely raised setae; the scrobes curving downwards close in front of the eye, their upper edge obtusely angulate. *Antennae* moderately stout and squamose, the scape cylindrical, rather abruptly clavate and reaching the middle of the eye; the funicle with the two basal joints short, 1 either longer or shorter than 2, joints 3–6 subequal and bead-like, 7 broader; the club short and ovate, the first joint as long as the rest. *Prothorax* subcylindrical, truncate at base and apex, without postocular lobes or vibrissae; the dorsal outline only slightly convex, the apex not lower than the base. *Scutellum* small or invisible. *Elytra* ovate, narrow and separately rounded at the base, the shoulders very oblique and without any prominence, the dorsal outline strongly convex and much higher than the prothorax, the tenth stria complete, and no posterior callus. *Sternum* with the gular margin very shallow, the coxae in the middle of the prosternum; the mesepisternum meeting the base of the elytron; the metepisternum almost covered by the elytron and the episternal furrow complete, the metasternum between the coxae as long as the mid coxae and without any antecoxal fold, the hind coxae touching the elytra. *Venter* with the intercoxal process obtusely angulated and as broad as the coxa, segment 2 a little longer than 3 or 4, but shorter than both together, the first segmental incision straight and deep. *Legs*: trochanters without the usual elongate seta; femora only slightly clavate, unarmed, the hind pair hardly reaching the apex of the elytra; tibiae cylindrical, with a strong apical mucro, the anterior pairs slightly curved, the hind corbels broadly enclosed and partly squamose; the tarsal claws connate at the base.

(C541) Wt. P3/130. 1,000. 5.19. B.&F.,Ltd. G.11/14. A

Pascoe erroneously placed this genus in the OTIORRHYNCHINAE, but according to Lacordaire's arrangement it would come in the BARYNOTIDES. In all its essential characters it agrees remarkably closely with the Malayan genus *Epilaris*, Pasc. (CYPHIDES), apart from the fact that the latter possesses wings. a distinct scutellum and well-marked humeral angles to the elytra.

Antinia theivora, sp. nov. (Pl. xvii, fig. 3).

♂ ♀. Dark red-brown, with dense scaling, which is usually dark brown above and pale sand-colour, with a slight metallic sheen, on the sides and beneath ; the pronotum usually with a narrow central and a broader lateral paler stripe on each side ; the elytra, in dark specimens, with the following pale markings : a short stripe at the base of interval 1, another at the shoulder occupying the base of intervals 5, 6 and 7, and a large quadrate patch behind the middle on 5–8, which unites with the pale lateral border ; the dorsal dark scales may be more or less completely replaced by sandy ones, but there always remains a large oblique dark patch about the middle on intervals 5–8.

Head with a very faint transverse impression behind the eyes and a central stria that is almost obliterated by the scaling ; above each eye a row of 4 or 5 stout erect setae and one or two pairs in the middle of the forehead. *Rostrum* a little longer than broad, gradually widening from base to apex, the sides almost vertical, and the dorsal edges rounded ; the rugose sculpture is completely hidden by the dense erect scales. *Antennae* with joint 1 of the funicle a little longer than 2. *Prothorax* as long as broad, the sides gently rounded, broadest at or a little before the middle ; the sculpturing very coarse and rugose, the inequalities being evident even through the dense overlapping scales, the elevations on the disk each bearing a stout spatulate seta, and on the sides a few minute shiny granules are visible through the scaling. *Elytra* ovate, the sides moderately rounded, broadest a little before the middle, the apex obtusely pointed and not visible directly from above as the posterior declivity is perpendicular ; the dorsal outline very convex, rising steeply from the base and slightly flattened on the highest part ; owing to the dense scaling the rather broad striae appear quite narrow and the punctures in them are entirely concealed ; the intervals slightly convex (on ints. 3–5 the greatest convexity is nearer the outer edge), the dorsal ones bearing widely spaced rows of very broad dark erect setae, which are replaced in the apical area by much smaller pale ones ; the lateral interval are almost without setae, but bear scattered minute shiny granules ; similar granules are visible at the base of the dorsal intervals, just in front of each seta ; the scales are dense and overlapping, and at the base is a projecting fringe of much larger flat pointed scales. *Legs* with uniform pale scales and stiff erect white setae.

Length, $3\frac{1}{2}$–4 mm. ; breadth, $1\frac{1}{2}$–2 mm.

W. JAVA (*Dr. K. Dammerman*).

The beetles were found feeding on tea-plants.

Subfamily HYLOBIINAE.

Dyscerus fletcheri, sp. nov. (Pl. xvii, fig. 1).

♀. Colour dark reddish-brown ; the elytra with a broad ill-defined transverse blackish band, not quite reaching the lateral margins and much deeper externally than on the disk, and a small blackish patch on the shoulder, which sometimes spreads backwards almost to the middle; on the elytra there are also the following small spots, formed of narrow yellowish scales: one a little before the middle on interval 6 and another on interval 4 on a line with it, along the posterior edge of the blackish band one each on intervals 1, 2, 3, 4, 5, and 7, that on 1 being behind the others, some of which may be absent; scutellum black; the legs red-brown, with the apices of the femora blackish; the sternum red-brown and the abdomen blackish.

Head with strong and close, but not confluent, punctures; a deep stria close round the margin of the eyes and a deep fovea between them. *Rostrum* almost as long as the prothorax, with two median rows of coarse punctures, a narrow indistinct carina between them, and two coarsely punctate sulci on each side; the interspaces with scattered fine punctures. *Antennae* with joint 1 of the funicle much longer than 2, joint 3 as long as broad, 4 to 6 gradually becoming shorter, and 7 much broader than 6 and with denser silky pubescence. *Prothorax* as long as or slightly longer than broad, the sides subparallel from the base to rather beyond the middle, thence narrowing to the apex; the base shallowly bisinuate, the dorsal apical margin arcuate, the post-ocular lobes feeble; the surface very coarsely and rugosely punctate, except on the apical fourth, the punctures partly confluent in oblique lines, and with a very short central costa in the anterior part of the rugose area; the apical area smooth, with numerous separated punctures of unequal size. *Scutellum* about as long as broad, almost flat, indistinctly punctate. *Elytra* parallel-sided to beyond the middle, the shoulders roundly rectangular, the apices separately pointed; the surface with regular rows of large subquadrate foveae to the top of the declivity, the apical area with deep striae containing shallow punctures, the three lateral rows shallowly sulcate throughout; the foveae not regularly aligned transversely, the longitudinal intervals between them about as broad as the transverse interspaces, for the most part smooth and rather shiny, but here and there with flattened, scarcely raised granules, and set with sparse minute recumbent white setae; interval 10 with a rounded impression a little before the middle. *Sternum* finely coriaceous, the metasternum with large shallow separated punctures at the sides and sparse minute ones in the middle.

Length, 9–10½ mm.; breadth, 3–4 mm.

Assam: Shillong, 5,000 ft., vi.–vii. 1918 (*T. Bainbrigge Fletcher*); United Provinces: Almora, vi–viii. 1916 (*H. G. Champion*).

Most nearly allied to *D.* (*Hylobius*) *notatus*, Pasc., from Java, of which it has quite the general form, but the latter, apart from its entirely black ground-colour, differs in having the rostrum narrowly 5-carinate, the central carina being the highest; the punctures on the forehead are coarse and confluent; the two basal joints of the funicle are equal; the prothorax is less rugosely punctate, but the apical area is coarsely and confluently punctate like the disk; the scale-like setae are much more numerous and conspicuous, etc.

The weevils were found by Mr. Fletcher boring into growing apple fruits, and Mr. Champion found them breeding in logs of chir pine (*Pinus longifolia*).

Dyscerus malignus, sp. nov. (Pl. xvii, fig. 4).

♂♀. Colour dull black, with sparse small hair-like scales, the posterior declivity of the elytra tinged with red-brown, and the yellowish hair-like scales here much larger and more numerous than on the rest of the elytra, forming a large thin apical patch; a small spot of similar scales before the middle on interval 6; the lower surface with the yellowish scales rather more numerous than above and mingled with larger white scales that are bifid at the apex.

Head with coarse confluent punctation, without a fovea on the forehead, the supra-ocular furrow immediately adjoining the margin of the eye. *Rostrum* a trifle shorter than the prothorax, with large, longitudinally confluent punctures and finely tricarinate, the median carina being slightly higher, the lateral sulcus deep. *Antennae* with the two basal joints of the funicle subequal, joints 3 and 4 about as long as broad, 5–7 transverse. *Prothorax* as long as broad, the sides subparallel from the base to the middle, thence roundly narrowed, and constricted at the apex; base shallowly bisinuate, the dorsal apical margin slightly arcuate, and the post-ocular lobes feeble; upper surface uneven, irregularly and unevenly granulate in the middle, some of the granules coalescing to form larger elevations, and with a short prominent carina in the middle of the central line; the apical area with shallow confluent punctures and scattered irregular granules; the sides confluently reticulate, the ridges between the foveae bearing small setigerous granules. *Scutellum* as long as broad, strongly convex, with shallow confluent punctures and thinly pubescent. *Elytra* broadest at the roundly rectangular shoulders and thence very gradually narrowed to beyond the middle, with a very prominent posterior callus and the apices separately pointed; the disk with slightly irregular rows of large subquadrate foveae as far as the declivity, where these are replaced by shallowly punctate sulci; the intervals uneven and irregularly granulate, interval 3 having an elongate granular elevation near the base and a less conspicuous one about the middle. *Sternum* finely coriaceous, the metasternum laterally with large, moderately close, shallow punctures with raised edges, the punctures in the middle small and scattered, and a longitudinal lance-shaped smooth area in the middle of the base.

Length, 7½–9 mm.; breadth, 3½–4½ mm.

ASSAM: Shillong, 5,000 ft., vi.–vii. 1918 (*T. Bainbrigge Fletcher*).

Very like a small *D.* (*Hylobius*) *clathratus*, Pasc.; but in that species the rostrum is 7-carinate and the central carina is not more raised than the others; the forehead bears a deep fovea; the prothorax is closely set with regular rounded tubercles and the post-ocular lobes are strongly developed; the scutellum is flat; and interval 3 of the elytra is regularly costate and without granular elevations.

The adults of this species were also observed to be puncturing apple fruits.

Subfamily ALCIDINAE.

Alcides mali, sp. nov. (Pl. xvii, fig. 3).

♀. Colour shiny dark reddish-brown; the head, rostrum, apices of the femora and all the tarsi black; the elytra with the following slightly paler markings: a narrow transverse band across the top of the declivity, a similar oblique band from behind the shoulder to the middle of the suture, and an indistinct apical patch, all these markings with a thin covering of pale plumose scales; the lower surface reddish brown, with the prosternum, mesosternum and coxae blackish.

Head with coarse confluent punctation and an impunctate curved furrow at a little distance from the hind margin of the eye, the forehead flattened. *Rostrum* (♀)

long and slender, cylindrical from the base to the antennae (about the middle), then very slightly narrowed and again widening to the apex ; closely punctate throughout, but the punctures on the basal half larger than those on the apical, those at the sides scarcely larger than the dorsal ones, the basal half with no definite smooth central line. *Antennae* with the basal joint of the funicle longer than joint 2, 4–6 nearly equal and a little longer than broad, 3 distinctly longer, and 7 longer than its apical width. *Prothorax* as long (in the middle) as broad, subparallel-sided near the base (sometimes as far as the middle), then roundly narrowing, the apical constriction well marked ; the surface closely set with low rounded granules of unequal size, which become larger and flatter on the sides, the apical area rugosely punctate. *Scutellum* not enclosed in front, obtusely angulate behind. *Elytra* cylindrical, a little broader at the shoulders than the thorax, with regular rows of large oblong foveae, which turn into shallowly punctate striae at the top of the declivity ; the intervals not broader than the septa between the foveae, and bearing scattered low rounded granules and sparse minute recumbent setae. *Sternum* fairly closely covered with pale plumose scales, the metasternum rugose, with low confluent granules. *Legs* clothed almost entirely with plumose or bifid scales on the femora, but only simple setae on the tibiae ; the two anterior pairs very long, their femoral teeth with 2–4 denticles on the outer edge ; the front tibiae rather shallowly bisinuate on the inner edge and with no median tooth, the middle tibiae rather strongly curved.

Length, $7\frac{1}{2}$ mm. ; breadth, $2\frac{3}{4}$ mm.

ASSAM : Shillong, 5,000 ft., vi.–vii. 1918 (*T. Bainbrigge Fletcher*).

Most nearly allied to *A. ludificator*, Fst., which attacks teak in Burma ; but in that species the elytra are uniformly reddish, with an indistinct posterior band of yellowish plumose scales ; the granules on the pronotum are flattened, with their apices directed forwards, and the apical area is smooth, with small distant punctures ; the foveae on the elytra are smaller and each contains two minute blackish granules, one on each side ; the front tibiae are much shorter and rather broader, and the middle pair much less curved.

This weevil was found boring in the shoots of apple trees.

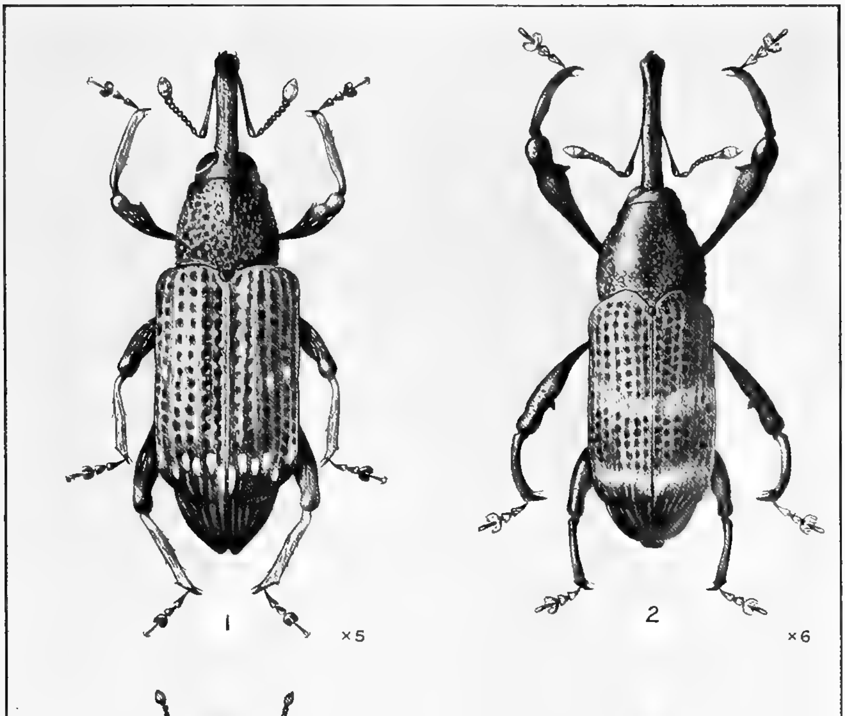
EXPLANATION OF PLATE XVII.

Fig. 1. *Dyscerus fletcheri*, sp. nov.

2. *Alcides mali*, sp. nov.

3. *Antinia theivora*, sp. nov.

4. *Dyscerus malignus*, sp. nov.



Injurious Asiatic *Curculionidæ.*

ON THE EFFECTS PRODUCED BY THE ATTACKS OF THE PINK BOLLWORM ON THE YIELD OF COTTON SEED AND LINT IN EGYPT.

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(Plate XVIII.)

Summary of the Established Facts Concerning the Life-History of the Pink Bollworm.

The history of but few insects can be compared with that of *Pectinophora* (*Gelechia*) *gossypiella*, which, having started as a minor pest in its native country and having been transported by human agency to a new country, has there suddenly leapt to the most important position as a major pest of the crop it attacks. In this respect it may be placed with the *Phylloxera* and the gipsy moth.

Although the chief object of this paper is to consider certain aspects of the damage done by the pink bollworm to the cotton crop, the following short summary of the established facts concerning the life-history of the insect may be useful to readers not familiar with its habits.

Food-Plants. The pink bollworm feeds on cotton (*Gossypium*, various species), okra (*Hibiscus esculentus*; Arabic: *bamia*; Hindustani: *bhindi*), Deccan hemp (*Hibiscus cannabinus*; Arabic: *til*), hollyhock (*Althaea rosea*), mallow (*Malva* sp., probably *silvestris*), *Thespesia populnea* (*fide* Fullaway; this record is considered doubtful by Busck), and *Abutilon* sp. (Arabic: *hanbuk*; *fide* King).

It will be noticed that all these plants belong to the Malvaceae. The record for pomegranates given by Dudgeon and Gough is without doubt due to error.

Of all these food-plants cotton is preferred. The larvae attack the stems (feeding in the cambium and boring a tunnel which encircles the stem), flowers, flower-buds, bolls and seeds. The order of preference is the inverse of that given above; stems are very rarely attacked, maturing seeds are the favourite food. Attacked buds almost invariably fail to mature into flowers. Bolls attacked during the first weeks of their development are entirely eaten out, or dry up and fall.

The pink bollworm is now known to occur in India, Palestine, Mesopotamia, Ceylon, Burma, Straits Settlements, China, Japan, the Philippine and Hawaiian Islands, East Africa, Zanzibar, Egypt, Sudan, West Africa (S. Nigeria, Sierra Leone), Brazil, Mexico, and Texas in the United States. Palestine and Mesopotamia constitute new locality records, seed showing typical damage having been received by us from both places.

The *eggs* are minute and are laid singly, or in small groups up to ten. They are to be found on the bolls, involucres, leaves and axils of leaves. The egg-stage in Egypt is known to last from 3 to 7 days. Busck gives the period as 4 to 12 days. Owing to the small size of the eggs, the insect cannot be controlled at this stage.

The *larval* stage is passed, almost entirely, inside the part of the plant attacked. The time required for this stage as given by Willcocks is 9–19 days; Busck gives 20–30 days. The feeding period is immediately followed in summer by spinning up and pupation; but in the case of larvae whose feeding period closes in the late autumn or winter it is followed by a resting period, which can last as long as two and a half years, and perhaps longer. We apply the terms "short cycle" larvae to those which pupate immediately after feeding and "long cycle" or "resting" larvae to such as intercalate a long period of rest between feeding and pupating. Resting larvae are usually found spun up inside hollow seeds, or "double" seeds. A "double" seed is produced in the following manner. The larva having hollowed out a seed, attaches another seed to the hollow one, uniting the edges of the opening of the hollow seed to the new seed by silk threads. The attachment of the two seeds to each other is very firm and resists the action of the gins. The second seed is usually eaten into. When no second seed is used, resting larvae spin up the opening of the seed they inhabit; double seeds often contain two caterpillars. It is not an infrequent occurrence for larvae to use more than two seeds for their resting shelter; as many as six seeds have been found utilised in this way. The seeds composing "double" seeds usually vary in their state of maturity. The original hollow one is generally in the red unripe stage of development, the next seed or seeds being black or ripe.

The presence of *Gelechia** larvae in attacked green bolls cannot be noticed without cutting open the boll, as the entrance hole made by the larva is very minute, and the larva does not keep it open or enlarge it in order to void the frass as *Earias* larvae do. For this reason it is not possible to control the pink bollworm by collecting attacked green bolls. When full-fed, short-cycle larvae leave the bolls by a hole which might be mistaken for the work of an *Earias* larva, but that the frass left by such larvae is wanting.

The resting stage does not appear to be entered into by many larvae (in Egypt) at the time of the first picking; on the other hand many, if not most, of the larvae present at the time of the second picking are either already resting, or intercalate a resting period between feeding and pupating. This stage, as already mentioned, may last as long as two and a half years.

It is the resting stage larvae which (in Egypt) serve to carry the species over from one year to the other. They are found almost exclusively in seed, whether in seed cotton, ginned seed or in abandoned bolls in the field. Resting larvae probably do not feed, as they lose weight continuously from February to June (see below).

The resting stage is the only period of the life-cycle of the pink bollworm during which it can be controlled, and acting on the advice of the Entomological Section of the Ministry of Agriculture, the Egyptian legislator has seized the opportunity afforded by the insect to ensure its destruction, (*a*) in the cotton field, by ordering the pulling up of the cotton-sticks and the destruction of the remaining bolls after the last picking, and consequently ensuring the elimination of the larvae left in the field; (*b*) by the treatment by heat or fumigation of the seed in the ginneries; and (*c*) by

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* The generic name *Gelechia* has been retained throughout, as being more familiar, especially to Egyptian readers.

compulsory screening of all stores where seed cotton or cotton-seed is kept in the period May to August.

The *pupa* is enclosed in a silken cocoon, and is found sometimes in the lint of an open boll, on the soil, under refuse in the fields or between dead leaves. Larvae inhabiting green bolls almost invariably leave the bolls before pupating. During the examination of several hundred thousand bolls in 1916 and 1917 only 2 or 3 pupae have been found in green bolls. Larvae which have arrived in a seed store with the seed almost invariably leave the seed-sacks, and pupate in the angle between the line of contact of two sacks or in crevices of the masonry of the walls, or between the floor-boards. The pupal period has been observed to vary from 10 days to 2 weeks; Busck gives it 10 to 20 days. Control of the insect at this stage is not feasible, as pupae are not easily found in seed stores, even when abundant, and are practically unfindable outside. Before pupating, the caterpillar spins its cocoon, and requires a few days for its transformation.

Thus short-cycle larvae spin only one cocoon, that in which the pupation takes place, whilst long-cycle larvae spin up inside hollow seeds for their resting period and leave their resting place to spin their pupal cocoon.

The *moth* is crepuscular or nocturnal in its habits. During the day it is very difficult to find in fields, or in seed stores, where one knows it to be present; if disturbed, it escapes by running swiftly and hiding under any shelter it can find.

During the day-time the moth very rarely takes wing; but at night it can fly long distances when circumstances are favourable, and is readily attracted to artificial light. Unfortunately light-traps do not form a reliable method of control, and no satisfactory measure against the adults seems possible.

The pink bollworm breeds continuously from April onwards, as long as there are cotton plants, and especially cotton bolls, for it to feed on. The generations overlap each other, so that one cannot separate the broods. In this respect it resembles *Earias*. A possible cause for this is the straggling way in which the long-cycle larvae complete their resting stage. At Cairo the emergence of moths from the resting larvae never absolutely ceases, and begins to rise in April, reaching its maximum intensity in June after a gradual and continuous increase. At Alexandria the maximum emergence of moths from resting larvae appears to take place in July. The maximum emergence of moths belonging to short-cycle larvae takes place in the autumn.

The following general remarks concerning the control of *Gelechia* may be of use or of interest.

The campaign as planned in Egypt is directed entirely towards the destruction of resting larvae. To be efficient it must be carried out thoroughly over the whole country. The campaign could be much simplified by changes in cultural methods tending to the production of an earlier crop, or by the introduction of earlier maturing varieties. Should it be possible to force total ripening before the last week of September, or to obtain a plant giving its crop before that date, then the long-cycle larvae could be destroyed by pulling up the plants in the last week of September. A further advantage of an early crop would lie in the fact that the damage due to the attack is to some extent proportionate to the lateness of the harvest, and consequently an early crop would be less likely to be badly damaged.

Egyptian cultivators have not yet quite realised that conditions have been changed by the advent of the pink bollworm, and that they will have to reckon with it in the future as a constantly recurring factor. On account of this pest the days are past when, given suitable weather, pickings could be obtained in December or January. Nowadays after October practically all the bolls matured are infested by the insect in its most dangerous form, the long-cycle larva; on account of this the longer the crop is left standing, the greater the number of "resting" larvae produced and the greater the probable attack in the next season. Given the same efficiency of the campaign in the middle of October or the middle of December, the probable attack of the next year's crop may be slight in the first case or intense in the second.

To sum up, it appears to us that in addition to the thoroughness in cleaning up the land and destruction of resting larvae, earliness in the production and removal of the crop and earliness in the application of the control measures are essential.

Problems Connected with the Pink Bollworm.

It is extremely difficult when dealing with an insect which, like the pink bollworm, passes its whole larval existence safely hidden away in the interior of a green cotton-boll or of a cotton seed, to produce much direct evidence of its life-history or habits. The larva of *Gelechia* resents any interference with itself or with its habitation. Removed from its boll or seed it immediately reacts in some way, probably normal to the circumstances, but not normal to the insect if left alone. The conviction is gaining on the writer that the length of a life-cycle is materially altered by such interrruptions as the picking of a green boll containing a *Gelechia* larva, the breaking open of a "double" seed containing a larva, and by the operations of ginning and even by the transport of seeds or bolls containing pink bollworm.

In these circumstances one is forced to obtain evidence to a great extent by indirect methods, which are not very frequently used in Entomology, hoping later on to verify by direct observation the theories that massed figures have led one to adopt.

In this paper an attempt has been made to apply statistical methods to various problems connected with *Gelechia*, the principle ones being the rate of increase, the amount and nature of the damage done by the insect to the crop, and certain features of the life-history which are best studied in this way.

The Rate of Increase of Gelechia damage in Egypt since 1911.

Prior to 1910 no records are available of the existence of *Gelechia gossypiella* in Egypt. The first specimens taken appear to have been those collected by Mr. F. C. Willcocks, in bolls received from Damanhur and Mansura, and by Mr. Adolf Andrès, near Mansura, in the autumn of 1910. In the autumn of 1911 a few were bred by the present writer from cotton bolls collected at Fua and Dekernes, and in March 1912 a few specimens of larvae and pupae were received by him in cotton seed sent from Damanhur by Mr. Pappis (see also Willcocks, "The Pink Bollworm," p. 8).

The first serious outbreak of *Gelechia* took place on Abu Kir Estate, near Alexandria, in the autumn of 1912; since then the insect has established itself as a major pest throughout Egypt.

Examination by us of some bales of Indian cotton imported by the Filature Nationale of Alexandria in December 1914 showed by the presence of appreciable numbers of pink bollworm the probable route by which *Gelechia* reached Egypt. This led to an enquiry on the part of the Entomological Section with respect to the period during which Indian cotton had been imported into Egypt, and of the quantities introduced. The following table, which was presented to the International Tropical Agricultural Congress in 1914 and later republished by Mr. Willcocks (*loc. cit.* p. 6), was supplied to the Ministry of Agriculture by the Customs Administration.

TABLE I. *The Quantities of Indian Cotton imported into Egypt.*

Year.	Quantity in kilograms.	Year.	Quantity in kilograms.
Prior to 1903	None	1908	21,460
1903	20,510	1909	31,206
1904	25,827	1910	13,353
1905	9,150	1911	None
1906	81,240	1912	10,998
1907	162,000	1913	90,012

Indian cotton was required for spinning yarns suitable for muslin weaving, and was specially desired on account of its white colour, which according to the Director of the Filature Nationale was preferable for dyeing. These yarns were exported to Turkey.

Gelechia must consequently have been brought into the country between 1903 and 1910, if its introduction really took place in imported cotton in the manner suggested. At this time unfortunately the importation of vegetable produce was not controlled by Government.

In this connection it might be remarked that the introduction might have come over-land from Palestine, the intervening desert probably not being a sufficient barrier. But there is no evidence at hand to show that *Gelechia* either existed or did not exist at that date in Palestine. The capture of moths of this species at Romani in the Sinai Peninsula might be mentioned in support of the possibility of *Gelechia* crossing the desert; but on the other hand very little cotton is or was grown in Palestine, and examination of cotton seed obtained from Jaffa in 1917 shows infestation varying from 4·0 per cent. to only 0·5 per cent. From this fact it might be urged that the pink bollworm was of more recent introduction into Palestine than into Egypt.

At all events it may be accepted that prior to 1910 *Gelechia gossypiella* was not yet known from Egypt, that it was still decidedly rare in 1911, and that it has since become the major pest of cotton. Dudgeon (1907) and Willcocks (1910) do not list *Gelechia gossypiella* amongst the cotton insects observed by them in Egypt.

In 1910 and 1911 no importance was attached to the insect, which was merely supposed to be a rare, indigenous species that might be a very minor cotton feeder, as it appears to be in many places in India, and its extraordinarily rapid extension could not then be anticipated.

A question that is frequently asked is, what has been the annual increase of the pink bollworm since the year of its discovery ? It has been possible to estimate the annual increase of *Gelechia* attack in good tagawi,* as, since the autumn of 1911, the Department (and later the Ministry of Agriculture) has supplied seed for sowing to the fellahin. Samples of this seed, as obtained from the ginneries, have been kept more or less completely since 1912, and a few samples from 1911. This seed is specially selected by the Inspectors of the Ministry of Agriculture, and is somewhat above the average quality. It therefore probably contains less damaged and immature seed than the average.† Seed purchased in any one year is probably of about the same quality in these respects as that bought in any other year ; thus the samples are comparable *inter se* within given limits.

In Table II will be found the results of the examination of this seed. In working it up, the gin-broken seed and refuse has been ignored, and only the good seed and the evidently attacked seed counted and weighed. Germination tests have been made only with apparently sound seeds. No " double " seeds were found in the samples saved from the 1911 crop ; some of the seeds had, however, been damaged by insects. Although the absence of " double " seeds suggests the need of caution in ascribing the damage to *Gelechia*, more especially as the seed was Ashmuni, some of which is known to have been ginned at Maghagha, in Upper Egypt, whence at this time the pest had not been recorded, it appears to be most probable that the pink bollworm had already reached Upper Egypt in that year. The absence of records need not weigh heavily in balancing the evidence, as no system of recording existed at that time, and even single stray contemporary observations, whether positive or negative, are not available now. From 1912 onwards no possible doubt exists, as typical " double " seeds are found in all the samples.

At the end of Table II all the seed of varieties grown in Lower Egypt has been calculated together in order to facilitate comparison with the figures for Ashmuni, which is the only cotton grown in Upper Egypt.

Taking the Lower Egypt varieties first, it will be seen that the difference in the extent of the attack, as shown in the Ministry's seed, was much the same in each year for all varieties. It will therefore be more convenient to deal with the combined figures found near the bottom of the table.

There was a steady increase in the infestation of the cotton seed from 1912 to 1915, and a distinct drop in 1917. A little examination of the figures shows that the percentage had in 1916 not reached the expected level, and that improvement had already set in, although the highest point was reached in that year. The rate of increase from 1912 to 1913 was 1 per cent. ; from 1913 to 1914, 2 per cent. ; from 1914 to 1915, 4 per cent. ; in these three years the increase each year had been double that of the year before. In 1916, if this rate of increase had been maintained, 8 per cent. increase could have been expected, whereas only 4 per cent. was found, which in itself amounts to evidence of reduction in the free breeding of the pink bollworm. The figures for the last year of the series are particularly encouraging, as there is an actual fall of 4 per cent. on the figures of the year before.

* *Tagawi*=seed intended for sowing, as opposed to *tugari*=commercial seed.

† Ashmuni tugari of 1916 averaged 9·7 per cent. against 3·2 per cent. in the tagawi. Sakellarides tugari 1916 averaged 16·3 per cent. against 15·4 per cent. tagawi. Both varieties of tugari were " buono mercantile " or good average commercial seed.

n for sowing.

›f Germination Tests.

Varie	Number Germinated.	Percentage Germinated.
Sakellarides	2,507	90 ± 1·01
	10,677	89 ± 0·50
	3,113	89 ± 0·93
	14,635	89 ± 0·43
	11,477	86 ± 0·48
	108,683	86 ± 0·15
Affifi ..	4,894	87 ± 0·66
	16,052	88 ± 0·40
	1,123	87 ± 1·43
	6,735	84 ± 0·61
	3,080	89 ± 0·93
	9,065	84 ± 0·53
Assili ..	1,184	87 ± 1·43
	7,480	89 ± 0·60
	459	93 ± 2·47
	2,212	89 ± 1·11
	—	—
Nubari ..	5,620	89 ± 0·66
	13,999	88 ± 0·41
	1,316	88 ± 1·43
	3,141	90 ± 0·93
	8,323	85 ± 0·53
Jannovitch	253	86 ± 2·47
	3,013	87 ± 1·13
	449	90 ± 2·47
Voltos ..	862	87 ± 1·75
Abbassi ..	834	93 ± 1·75
All the abov varieties combined	14,458	88 ± 0·40
	52,917	88 ± 0·22
	6,011	89 ± 0·66
	23,582	88 ± 0·34
	18,147	87 ± 0·38
	126,071	86 ± 0·13
Ashmouni	1,851	93 ± 1·23
	1,170	92 ± 1·43
	3,471	90 ± 0·87
	1,332	90 ± 1·43
	3,301	94 ± 1·13
	20,383	90 ± 0·38

Table II. *Results of the Examination of the Cotton Seed distributed by the Ministry of Agriculture to the Fellahin for sowing.*

Variety.	Crop Year.	Number of Samples.	Number of Seeds. Examined.	Number of Seeds. Found to be Sound.	Percentage Damaged.	Total Weight of Sound Seeds.	Weight in grammes of 1,000 Sound Seeds.	Results of Germination Tests. Number of Samples Used.	Results of Germination Tests. Total Number of Seeds Used.	Results of Germination Tests. Number Germinated.	Results of Germination Tests. Percentage Germinated.
Sakellarides	1912	7	6,563	6,331	3·5 ± 0·72	681·1	107·6 ± 1·05	6	2,790	2,507	90 ± 1·01
	1913	37	34,449	32,939	4·4 ± 0·32	3,454·4	104·9 ± 0·45	24	12,022	10,677	89 ± 0·50
	1914	11	10,486	9,817	6·4 ± 0·58	1,036·4	105·6 ± 0·83	7	3,482	3,113	89 ± 0·93
	1915	79	80,737	72,438	10·3 ± 0·22	7,247·9	100·1 ± 0·31	33	16,455	14,635	89 ± 0·43
	1916	57	58,400	49,382	15·4 ± 0·25	5,053·7	102·3 ± 0·37	27	13,404	11,477	86 ± 0·48
	1917	298	164,385	145,768	11·3 ± 0·11	14,728·7	101·0 ± 0·16	275	125,960	108,683	86 ± 0·15
Affifi	1912	14	13,757	13,219	3·9 ± 0·51	1,353·3	102·4 ± 0·75	14	5,653	4,894	87 ± 0·66
	1913	58	56,099	53,201	5·2 ± 0·25	5,440·6	102·3 ± 0·36	39	18,200	16,052	88 ± 0·40
	1914	3	2,934	2,663	9·2 ± 1·11	275·0	103·3 ± 1·59	3	1,295	1,123	87 ± 1·43
	1915	16	16,872	14,716	12·8 ± 0·48	1,462·6	99·4 ± 0·69	16	7,971	6,735	84 ± 0·61
	1916	12	12,361	10,483	15·2 ± 0·55	1,062·3	101·3 ± 0·79	7	3,478	3,080	89 ± 0·93
	1917	24	21,993	19,794	11·1 ± 0·39	1,695·8	97·1 ± 0·56	22	10,852	9,065	84 ± 0·53
Assili	1912	3	2,910	2,809	3·5 ± 1·11	292·2	104·0 ± 1·59	3	1,366	1,184	87 ± 1·43
	1913	27	25,704	24,677	4·0 ± 0·37	2,547·0	103·2 ± 0·53	17	8,373	7,480	89 ± 0·60
	1914	1	955	943	1·3 ± 1·98	97·0	102·9 ± 2·76	1	494	459	93 ± 2·47
	1915	5	5,606	5,042	10·1 ± 0·86	464·9	92·2 ± 1·23	5	2,494	2,212	89 ± 1·11
	1916	1	1,035	854	17·5 ± 1·98	85·6	100·2 ± 2·76	—	—	—	—
Nubari	1912	14	13,292	12,738	4·2 ± 0·51	1,350·6	106·0 ± 0·75	14	6,346	5,620	89 ± 0·66
	1913	41	36,886	35,158	4·7 ± 0·27	3,639·8	103·5 ± 0·43	35	15,920	13,999	88 ± 0·41
	1914	3	2,773	2,574	7·2 ± 1·11	280·0	108·8 ± 1·59	3	1,488	1,316	88 ± 1·43
	1916	10	10,492	9,154	12·8 ± 0·61	901·1	98·4 ± 0·87	7	3,483	3,141	90 ± 0·93
	1917	20	19,535	17,184	12·0 ± 0·43	1,664·6	99·1 ± 0·62	19	9,766	8,323	85 ± 0·53
Jannovitch	1912	1	933	900	3·5 ± 1·98	98·0	108·9 ± 2·76	1	295	253	86 ± 2·47
	1913	11	10,590	10,026	5·3 ± 0·58	1,045·3	104·3 ± 0·83	7	3,463	3,013	87 ± 1·13
	1916	1	992	849	14·4 ± 1·98	89·0	104·8 ± 2·76	1	497	449	90 ± 2·47
Voltos	1913	3	2,889	2,798	3·1 ± 1·11	288·0	102·9 ± 1·59	2	995	862	87 ± 1·75
Abbassi	1913	2	1,442	1,361	5·6 ± 1·35	143·1	105·1 ± 1·95	2	897	834	93 ± 1·75
All the above varieties combined	1912	39	37,455	35,997	3·9 ± 0 31	3,775·2	104·9 ± 0·44	38	16,450	14,458	88 ± 0·40
	1913	179	168,059	60,160	4·7 ± 0·14	16,558·2	103·4 ± 0·21	126	59,870	52,917	88 ± 0·22
	1914	18	17,148	15,997	6·7 ± 0·45	1,688·4	105·5 ± 0·65	14	6,759	6,011	89 ± 0·66
	1915	100	103,215	92,196	10·7 ± 0·19	9,175·4	99·5 ± 0·27	54	26,920	23,582	88 ± 0·34
	1916	81	83,280	70,722	15·1 ± 0·21	7,191·7	101·7 ± 0·31	42	20,862	18,147	87 ± 0·38
	1917	342	205,913	182,746	11·2 ± 0·10	18,089·1	99·0 ± 0·15	316	146,578	126,071	86 ± 0·13
Ashmouni	1911	5	4,964	4,941	0·5 ± 0·86	491·4	99·5 ± 1·23	4	1,981	1,851	93 ± 1·23
	1912	3	3,088	3,009	2·6 ± 1·11	291·7	96·9 ± 1·59	3	1,277	1,170	92 ± 1·43
	1913	9	8,469	8,336	1·6 ± 0·64	826·2	99·1 ± 0·92	8	3,844	3,471	90 ± 0·87
	1914	3	3,184	3,105	2·5 ± 1·11	291·6	93·9 ± 1·59	3	1,485	1,332	90 ± 1·43
	1916	19	19,129	18,525	3·2 ± 0·44	1,835·7	99·1 ± 0.63	7	3,500	3,301	94 ± 1·13
	1917	41	41,321	40,162	2·8 ± 0·27	3,535·2	90·6 ± 0·43	42	22,724	20,383	90 ± 0·38

Probably part of this improvement was due to the season having favoured the cotton, and to the crop having been, on an average, two weeks earlier than usual. But there can be little doubt that the effects of the Bollworm Campaign of 1915, and more especially of the very thorough one of 1916, were making themselves evident. Writing in May 1918, it seems probable that no further reduction need be expected this season, as the campaign of 1917 was handicapped by the fuel famine, which hindered the enforcement of the law in respect to the wholesale destruction of insufficiently cleaned cotton-sticks (the fear of which is the only driving force behind the fellahin), and further because the scarcity of shipping has upset the normal outflow from Egypt of the cotton seed, much of which, owing to the congestion caused, has had to stand in the ginneries, unprotected from disseminating the pest at a time when in normal years it would already have been exported.

The pink bollworm certainly reached Upper Egypt in 1912, and probably already in 1911. The figures given show that the infestation has constantly been much lower than in Lower Egypt. It is not yet evident how far this is due to the special conditions obtaining there, and how far to the first invasion being of more recent date. (It appears to be nearly certain that the first introduction must have taken place near Alexandria.)

The table further shows that provided it is suitably stored, cotton seed retains its power to germinate unimpared for six years under Egyptian conditions, as all the germination tests for seed from the years 1911 to 1916 inclusive were made in 1917; the 1917 seed has been germinated in 1918.

The Nature and Amount of Damage Done by the Pink Bollworm.

In the following chapters it is intended to show the nature of the damage done by *Gelechia*, as far as has been ascertained up to the present, and to examine the possibility of estimating its extent. No attempt has been made to show the damage to the quality of the lint or seed; only the total quantities lost have been traced.

As will be seen later, calculation of the total quantities of the crop lost annually is possible, and, provided a sufficient number of specimens are taken and care is exercised to avoid errors of sampling, it should further be possible to estimate this loss with a reasonable degree of accuracy. Such calculations are likely to prove useful, both for crop estimation, and in order to ascertain whether the pest is on the increase or decrease, thus affording a means of computing the usefulness or otherwise of the pest campaigns.

A. **The Weight of Sound Seeds from Attacked Bolls.**

It is probably well known that the weight of cotton seed is a very variable factor, and that the same seed weighed on different days gives different values. The fluctuations are without doubt due to the capacity of the seed to take up moisture from the atmosphere and can equal as much as 1 per cent. of the weight in a few days.

The normal loss of moisture immediately after picking appears to be considerable, as can be seen by comparing the first column of Sakellarides in Table III with the rest of the table; no such loss was shown in the case of the Ashmuni seed recorded in the same place, which was ginned a considerable time after picking. Seed

TABLE III. *Showing the Daily Fluctuations of Weight of 19 samples (100 Seeds in each) of Cotton Seed and their Weight some Months later.*

	September 1916.					October 1916.						Feb. 1917.	May 1917.	Nov. 1917.	Remarks.
	25th	26th	27th	28th	30th	1st	5th	8th	10th	11th	20th	19th	26th	20th	
Sakellarides															
1	10·122	10·080	10·072	10·068	10·035	—	10·055	10·045	10·070	10·072	10·080	10·077	9·915	10·052	Picked 23.ix.16
2	10·124	10·085	10·079	10·073	10·037	—	10·057	10·048	10·072	10·075	10·082	10·079	9·920	10·057	Ginned 25.ix.16
3	10·059	10·015	10·000	10·000	9·960	—	9·985	9·975	10·007	10·007	10·006	10·004	9·850	9·970	
4	9·967	9·918	9·906	9·906	9·870	—	9·885	9·882	9·915	9·915	9·915	9·912	9·765	9·910	
5	9·924	9·880	9·870	9·869	9·840	—	9·850	9·847	9·879	9·880	9·880	9·875	9·730	9·875	
6	9·867	9·827	9·816	9·815	9·785	—	9·800	9·790	9·825	9·825	9·825	9·818	9·665	9·815	
7	9·801	9·756	9·753	9·748	9·710	—	9·750	9·720	9·750	9·750	9·740	9·735	9·575	9·705	Contained a grain beetle
8	9·703	9·660	9·646	9·646	9·610	—	9·625	9·620	9·648	9·650	9·650	9·624	9·465	9·610	
9	9·379	9·337	9·330	9·328	9·285	—	9·295	9·300	9·325	9·327	9·327	9·322	9·170	9·290	
Ashmuni															
10	—	—	—	—	9·870	9·870	9·890	9·888	9·919	9·920	9·925	9·934	9·795	9·925	Picked 8.viii.16
11	—	—	—	—	9·407	9·402	9·434	9·432	9·455	9·452	9·462	9·467	9·215	9·370	Ginned 30.ix.16
12	—	—	—	—	9·750	9·745	9·780	9·767	9·798	9·798	9·810	9·810	9·670	9·815	
13	—	—	—	—	9·840	9·833	9·870	9·857	9·886	9·887	9·895	9·899	9·760	9·905	
14	—	—	—	—	9·670	9·665	9·695	9·690	9·715	9·715	9·725	9·730	9·590	9·740	
15	—	—	—	—	9·653	9·650	9·685	9·669	9·695	one seed lost		—	—	—	
16	—	—	—	—	9·185	9·180	9·217	9·212	9·226	9·234	9·242	9·252	9·120	9·205	
17	—	—	—	—	9·445	9·438	9·475	9·462	9·490	9·492	9·498	9·507	9·360	9·520	
18	—	—	—	—	9·475	9·470	9·505	9·498	9·525	9·526	9·534	9·540	9·400	9·435	
19	—	—	—	—	9·570	9·563	9·598	9·590	9·615	9·620	9·627	9·632	9·490	9·645	

weight evidently decreases considerably just after picking; whether it decreases further in consequence of ginning has not been examined.

Seed that has been kept several years responds in exactly the same way to humidity as seed belonging to a recent crop, as can be seen from Table IV. In this case approximately equal quantities (1,000 seeds) of Sakellarides seed fiom the 1912, 1913, 1914, 1915, 1916 and 1917 crops were weighed daily. It will be seen that during the ten days over which the expeiiment ran, considerable fluctuations took place. The irregularities observed on 12th January were traced to the fact that some of the samples had been exposed for a short time to the sunlight before being weighed.

Sound seed and damaged seed both behave in the same manner, as can be seen from Table V, the only difference being in the extent of the fluctuations. In these last weighings a progressive decrease of weight is noticeable, owing to the weather becoming warmer. No loss of material was possible, as the samples were enclosed in muslin bags whose weight and weight fluctuations have been allowed for. In order to ascertain the limits of possible fluctuation, two sets of 100 sound Sakellarides seeds were placed in desiccating dishes. With one set a beaker was enclosed containing water, with the otheı set a beaker containing sulphuric acid. Both sets were weighed daily, and the results are given in Table VI.

TABLE IV. *Weighings of Sakellarides Seeds from the Crops of* 1912–1917.

Date.	Time.	1912.	1913.	1914.	1915.	1916.	1917.	Combined.
1918. Jan.								
10	10 a.m.	106·12	107·61	105·10	99·06	102·57	118·51	638·97
	1 p.m.	106·08	107·57	105·11	98·94	102·57	118·36	638·63
11	11 a.m	106·07	107·56	105·10	98·90	102·55	118·20	638·38
12	9.15 a.m.	105·74	107·28	104·78	98·44	102·20	117·75	636·19
	12.55p.m.	105·61	107·27	104·75	98·51	102·22	117·75	636·11
13	9.25 a.m.	105·47	107·06	104·54	98·23	101·94	117·36	634·60
14	9.0 a.m.	105·60	107·23	104·77	98·32	102·08	117·55	635·55
	5.15 p.m.	105·76	107·35	104·85	98·45	102·22	117·66	636·29
15	9.15 a.m.	105·94	107·46	104·95	98·58	102·36	117·78	637·07
	4.15 p.m.	105·89	107·45	104·92	98·55	102·30	117·70	636·81
16	9.0 a.m.	106·08	107·62	105·06	98·66	102·45	117·91	637·78
	4.0 p.m.	106·13	107·65	105·10	98·73	102·50	117·92	638·03
17	9.0 a.m.	106·40	107·98	105·54	99·19	102·93	118·32	640·36
	1.15 p.m.	106·51	108·07	105·61	99·26	103·06	118·48	640·99
19	8.50 a.m.	106·67	108·20	105·68	99·35	103·15	118·58	641·63
20	9.15 a.m.	106·47	108·00	105·49	99·10	102·90	118·31	640·27
21	9.10 a.m.	106·28	107·75	105·29	99·01	102·72	118·16	639·21

After having been submitted to this treatment, the desiccated seed gave 57 per cent. germination, the moist seed 0 per cent. Desiccated seed takes up moisture very quickly and requires quick handling in weighing if approximately correct results are to be obtained.

The fluctuations of the weight of the samples considered above had been compared with humidity records, partly with those of the Meteorological Service, partly with records taken at the time of weighing, in order to be sure that changes in the atmospheric humidity were the cause of the fluctuations in the weight of the

TABLE V. *To show Fluctuations in Percentage of Lint, due to Absorption of Moisture from the Air.*

1917.	Weight of Lint.	Weight of Good Seed.	Weight of Damaged Seed.	Total Seed.	Percentage Lint.	Percentage Humidity.
Feb.						
11	27·475	35·415	35·520	70·935	27·9	88
12	27·305	35·165	35·270	70·435	27·9	80
13	27·273	35·005	35·140	70·145	28·0	82
14	27·208	34·877	34·977	69·854	28·0	65
15	27·172	34·729	34·791	69·520	28·1	69
16	27·204	34·652	34·751	69·403	28·2	91*
17	27·165	34·714	34·786	69·500	28·1	74
18	27·126	34·620	34·646	69·266	28·1	75
19	27·076	34·551	34·565	69·116	28·1	75
20	27·056	34·519	34·517	69·036	28·2	66
21	27·029	34·417	34·391	68·808	28·2	78
22	26·890	34·344	34·238	68·572	28·2	54
24	27·095	34·406	34·417	68·823	28·1	77
25	27·070	34·408	34·382	68·790	28·2	80
26	27·063	34·441	34·386	68·827	28·2	75
27	27·044	34·427	34·350	68·777	28·2	76
28	27·073	34·437	34·337	68·774	28·2	82
March						
1	27·029	34·423	34·289	68·712	28·2	70
3	26·908	34·293	34·117	68·400	28·2	58
8	27·051	34·411	34·230	68·641	28·3	79
9	26·876	34·220	33·984	68·204	28·3	47
10	26·898	34·163	33·922	68·085	28·3	70
11	26·835	34·128	33·880	68·008	28·3	58
16	26·797	34·095	33·795	67·890	28·3	48
17	26·788	34·086	33·793	67·879	28·3	41
18	27·123	34·164	34·011	68·175	28·5	79
19	26·934	34·174	33·913	68·087	28·3	79
20	26·882	34·046	33·727	67·773	28·4	80
21	26·788	34·051	33·662	67·713	28·3	61
23	26·835	34·063	33·670	67·733	28·4	75
24	26·945	34·174	33·783	67·957	28·4	74

The humidity is taken from the Daily Weather Report, issued by the Physical Service, P.W.M., Cairo. The figures given for Ezbekieh, Cairo, are used.
* Rain.

seed. The results obtained were however disappointing. In the light of more complete knowledge the reason lay in the insufficiency of observations both of weighings and of humidity. As it was suspected that more continuous records would solve the problem, recourse was had to a self-recording hygrometer and to a self-recording chemical balance. At the suggestion of Mr. Hurst, Director of the Physical Service, to whom our thanks are due, the balance was made self-recording by fitting a small mirror on the pointer, close to the knife-blade. This attachment was made by the Physical Service. The actual record was made by a ray of light reflected from the mirror on to a sheet of gaslight paper carried on the drum of the self-recording hygrometer. The synchronisation of the hygrometer and the weight records is thus perfect.

TABLE VI. *Showing the Fluctuation of Weight of Cotton Seed under Extreme Conditions.*

Days of exposure to experiment.	Weight of seed desiccated over sulphuric acid.	Days of exposure to experiment.	Weight of seed kept in moist chamber.
0	10·020 grs.	0	10·250
1	9·797 „	1	10·750
2	9·735 „	2	10·812
3	9·692 „	3	11·112
4	9·672 „	4	11·280
5	9·670 „	5	11·350
7	*9·865 „	7	11·785
8	9 739 „	8	*10·470
9	9·685 „	9	*10·450
14	9·535 „	14	11·648
16	9·435 „	16	11·750
17	9·422 „	17	12·470

* The lid of the desiccator was found to have slid open.

The first record extended over a period of three days. Unfortunately in two places the weight record is broken. This is due to the weight of the seed having increased so much as to make the beam of the balance rest on its support. On the graph the weight curve has been redrawn, as for two grammes of seed ; as ten grammes were actually used, the vertical component of the curve has been reduced five times. It will be seen that the seed-weight curve followed the humidity curve very closely, but with a lag of about two or three hours. Minor changes of humidity were not recorded by the seed. The actual variation in weight of two grammes of seed was found to be about 4 mg. per 10 degrees of

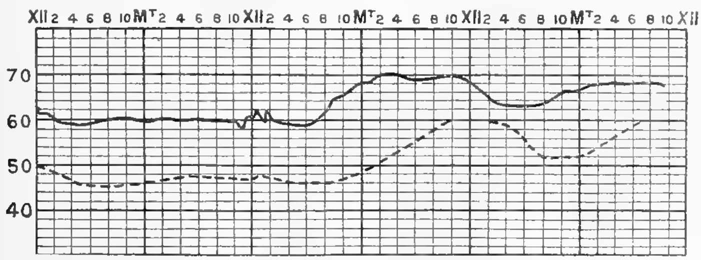

Fig. 1. Fluctuations in humidity (solid line) and simultaneous fluctuations in weight of two grammes of cotton-seed (broken line).

humidity, when the humidity itself varied from about 46 to 50 degrees. A rise in temperature is accompanied by fall in weight. The quick, short variations in the humidity record at 24 hours were due to the floor of the dark-room having been watered in the hope of inducing fluctuations in the records. As will be seen, the influence of the evaporation of water in the room was quite small as compared with the general climatic changes which made themselves noticed. It was the lag that made it previously so difficult to obtain agreement between the changes in the weight of the seed and the fluctuations of the hygrometer. We shall have to return to this subject later on when discussing the percentage of lint. The second record was made during April, and shows the effect of rising temperature caused by the setting in of a spell of hot weather accompanied by a "Khamsin" wind.

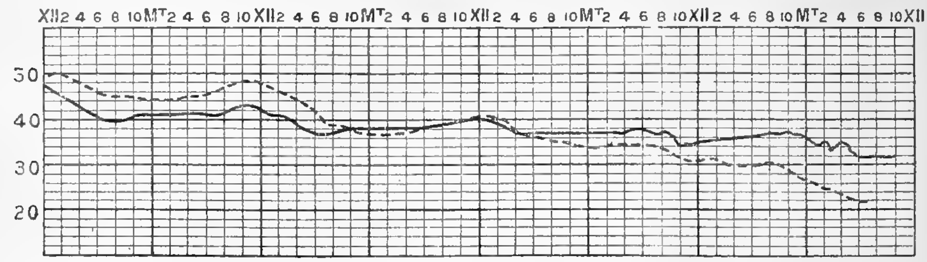

Fig. 2. **Fall in humidity (solid line) and consequent fall in weight of the cotton-seed (broken line) due to the effects of "Khamsin" wind.**

Having shown that the weight of cotton seed is relative to the temperature and to atmospheric humidity of a few hours previous to the time of weighing, it only remains to remark that when the results of several weighings made over an extended period of time and from different samples are combined together, it may be assumed that the deviation of the combined figures will be smaller than that of any one weighing; and as the errors introduced by the varying conditions are unbiassed, the figures will then be more nearly correct for average humidity and temperatures. The more numerous the samples combined, therefore, the smaller the resultant probable error for average conditions.

Examining Table VII we find that the average weight of a given number of sound seeds (in this case 1,000) falls steadily as the percentage of *Gelechia* attack

TABLE VII. *Comparing Intensity of* Gelechia *Attack with Weight of Sound Seeds.*

Number of samples used.	Percentage of sound seeds in sample.	Total number of sound seeds.	Total weight of sound seeds.	Average weight of 1,000 sound seeds.
1	100·0	1,499	178·0	118·7
56	97·0	83,872	9,631·9	114·8
28	92·1	36,407	4,037·5	110·9
44	86·9	45,338	4,820·6	106·3
22	81·9	19,106	1,947·8	101·9
26	77·5	27,384	2,774·6	101·3
28	72·2	27,137	2,744·2	101·1
13	66·6	12,438	1,249·5	100·5
20	62·2	14,112	1,390·9	98·6
15	56·5	7,989	746·0	93·4
8	51·5	5,439	452·7	83·2
8	47·4	4,745	412·7	87·0
4	41·5	1,989	161·4	81·1
5	37·4	1,955	171·6	87·8
2	32·2	504	41·9	83·1
2	27·7	480	37·7	78·5

The samples each consisted of 100 bolls of Sakellarides.
Each pair of variates weighted according to the number of samples composing it.
In the computation of the probable error, n in the formula $\text{P.E.} = \frac{2}{3}\frac{1 - r^2}{\sqrt{n}}$ has not been weighted; correlation $r = 0·976 \pm 0·008$.

rises. Irregularities only occur when the samples combined to obtain an average have been reduced to too small a number; this is doubtless due to the resultant greater chance of including non-representative samples and for changes in humidity to make themselves noticed in such cases. The correlation between fall in the percentage of sound seed in a sample (increase of *Gelechia* attack) and fall in the average weight of a given number of sound seed is very high, having been found to be 0·976 ($\pm$ 0·008), leaving no possible doubt as to the connection between the two sets of observations.

TABLE VIII. *Showing Number of Seeds of each* 0·01 *gramme difference in weight in sound and attacked samples.*

Weight in mg.	Sound samples.	Intensity of attack.			
		8 per cent.	21 per cent.	34 per cent.	46 per cent.
140–150	—	—	2	—	—
130–140	168	76	6	11	—
120–130	151	92	14	31	1
110–120	152	360	19	—	8
100–110	60	159	33	19	14
90–100	40	62	25	8	17
80–90	25	10	46	71	29
70–80	20	12	28	188	57
60–70	14	5	38	18	24
50–60	6	9	21	9	31
40–50	7	1	8	39	10
30–40	5	2	5	16	4
20–30	1	—	—	10	1
10–20	—	—	—	10	1
The same as above, but with the Numbers of Seeds replaced by the Percentage for the Sample for convenience in comparison.					
140–150	—	—	1	—	—
130–140	26	10	2	3	—
120–130	23	12	6	7	1
110–120	23	46	8	—	4
100–110	9	20	13	4	7
90–100	6	8	10	2	9
80–90	4	1	19	17	15
70–80	3	2	11	44	29
60–70	2	1	16	4	12
50–60	1	1	9	2	16
40–50	1	0	3	9	5
30–40	1	0	2	4	2
20–30	0	—	—	2	1
10–20	—	—	—	2	1

However, on comparing this table with Table II, in which the average weight of many samples of seed are recorded, it will be observed that there the weight of the seed is not so evidently influenced by the severity of the attack. This is due to sampling, the material used for the two sets of samples not having received similar previous treatment. The Ministry's selected seed was of course all ginned in commercial ginneries, and was sifted in the usual course of events. During this sifting all small seeds and most of the broken fragments are removed. The seed we have just been discussing was ginned in the laboratory, special precautions being taken to retain every single one, whatever its size or condition.

Part of the fluctuations shown in Table II appears to be the same for all samples taken in any one year as contrasted with any other year, and is probably annual, due to climatic variations.

The reduction of the average weight of sound seeds derived from attacked bolls is not due to a general reduction in weight of all the individual seeds in the sample, but to an increase in the percentage of the smaller weight seeds at the cost of the heavier grades. This is fairly evident from Table VIII, in which a number of samples are recorded that have been weighed out seed by seed.

It is thus obvious that in some manner Gelechia *causes some of the sound seeds developing in attacked bolls to lose weight.*

Table IX has been prepared to show the same facts, but from a different point of view. It is compiled from the results of the examination of 31 bolls; in this case every sound seed (352 in all) has been weighed separately. Of the 139 seeds

TABLE IX. *Gelechia Attack and Abnormal Seed Weight.*

Number of attacked seeds per boll.	Number of bolls examined.	Total number of sound seeds.	Percentage of sound seeds whose weight compared to the heaviest seed of the same boll is less than		
			$\frac{2}{3}$	$\frac{1}{2}$	$\frac{1}{3}$
0	10	139	6	3	2
1	3	36	22	19	6
2	4	49	12	6	4
3	3	35	0	0	0
4	4	39	5	3	0
5	1	8	38	13	13
6	3	29	7	7	7
7	1	8	0	0	0
8	1	6	17	0	0
10	1	3*	100	100	67
		Actual Numbers.			
Totals Sound Bolls	10	139	8	4	2
Attacked Bolls ..	21	213	25	17	9
Average per 10 Bolls					
Sound Bolls ..		139	8	4	2
Attacked Bolls		101	12	8	4
Expressed as percentage of abnormally small to total sound seeds.					
		100	6	3	1
		100	12	8	4

Standard deviation calculated from the 139 seeds from 10 sound bolls only, the heaviest seed in each boll being calculated as 100 = 18. Probable Error Mean = 0·936.

* All 3 seeds have been considered as undersized; the heaviest only weighed 29 mg. Damage being obvious, comparison was made with the boll whose heaviest seed was lightest.

from 10 sound bolls, 8 were found to weigh just two-thirds, or less than two-thirds, the weight of the heaviest seed from the same boll, 4 weighed half and 2 weighed only one-third the weight of the heaviest related seed. The standard deviation was found to be 18 per cent. of the weight of the heaviest related seed. Thus, expressed as percentages, 8 per cent. of the seeds from sound bolls differ by minus more than twice the standard deviation from the weight of the heaviest seed in the boll in which they matured, 3 per cent. three times that amount and 1 per cent. four times that amount. In the case of seed matured in damaged bolls the figures are, 12 per cent. vary by more than twice, 8 per cent. more than 3 times, and 4 per cent more than 4 times the standard deviation from the weight of the heaviest related seed.

This increase in proportion of light weight sound seeds from damaged bolls, as compared with sound seed from sound bolls, is most probably significant.

B. **The Germination of Sound Seeds from Attacked Bolls.**

In Table X are summarised the Tables for the germination of some of the samples recorded in Table VII, arranged in groups of intensity of infestation from 5 to 65 per cent. (95 to 35 per cent. sound).

TABLE X. *To show the Correlation between the Intensity of* Gelechia *Attack and the Germination of the Sound Seeds.*

Intensity of attack. / Percentage of sound bolls.	Number of samples examined.	Total number of seeds.		Percentage of germination.
		Used.	Germinated.	
91–100 (95)	64	34,062	31,654	93
81– 90 (85)	28	16,354	13,374	82
71– 80 (75)	38	20,780	17,033	82
61– 70 (65)	20	11,674	9,329	80
51– 60 (55)	7	3,698	2,184	59
41– 50 (45)	9	3,638	2,293	63
31– 40 (35)	2	612	255	42

Weighting as in Table VII ; $r = 0{\cdot}965 \pm 0{\cdot}017$.

The results show beyond possibility of doubt that the attack by *Gelechia* has an effect on the germination of sound seeds from attacked bolls ; the correlation being $r = 0{\cdot}965 \pm 0{\cdot}017$. However, no such effect was recognisable from the figures given in Table II. The reason for this apparent discrepancy is the same as that given above, when discussing the progressive reduction of average weight of the seeds that accompanies increasing *Gelechia* infestation. In both cases it is the small seeds (which in ginnery *tagawi* are sifted out), that are the carriers of reduced weight as well as of reduced germination. Besides this, the germination is not seriously affected until about 45 per cent. of the seed has been attacked, a degree of infestation not reached by the samples used in compiling Table II.

This becomes most evident on examining Table XI, in which the sound seeds derived from five samples have been arranged in 10 mg. weight groups and their germination worked out. As was to be expected, the heaviest seeds gave the most perfect germination.* Complete germination was obtained in all seeds above 120 mg. in weight; satisfactory growth was obtained from those ranging from 100–119 mg. Seeds lighter than 90 mg. gave increasingly unsatisfactory results in proportion to their decreases in weight. The correlation between seed-weight and germination is 0·958 ± 0·014.

TABLE XI. *To show Correlation between the Weight of Cotton Seeds and their Power of Germination, being the Germination of all the Sound Seeds from 300 Bolls.*

Weight groups in milligrams.	Number of seeds.		Percentage of germination.
	Total.	Germinated.	
160–169 (165)	1	1	100
150–159 (155)	2	2	100
140–149 (145)	3	3	100
130–139 (135)	14	14	100
120–129 (125)	67	67	100
111–119 (115)	122	113	93
100–109 (105)	271	221	82
90–99 (95)	196	150	77
80– 89 (85)	255	130	58
70– 79 (75)	207	73	35
60– 69 (65	189	51	27
50– 59 (55)	83	16	19
40– 49 (45)	63	5	8
30– 39 (35)	22	3	14
20– 29 (25)	17	1	6
10– 19 (15)	1	0	0
0– 9 (5)	—	—	—

Weighting as in Table VII; r = 0·958 ± 0.014.

There can consequently be no doubt that *Gelechia* indirectly affects the germination of sound seeds which have developed in attacked bolls, by reducing their

* See Balls W. L. The effect of Seed-Weight on the Field Germination of Cotton Seed. — Cairo Scientific Journal, No, 47, Aug. 1910.

weight. There is no reason to suppose that this reduction in germination is in consequence of any poisoning of the seeds; it is merely an outcome of starvation during the early stage of development of the seed in the capsule. Any other cause which reduced the weight of the seed produced would probably have the same effect. Balls writing in 1910, at a time when *Gelechia* was rare, already remarked on the better germination results of heavier seed.

C. The Number of Seeds, sound or attacked, developed in Attacked Bolls.

The number of seeds normally set in a sound boll appears to be subject to considerable variation. Sound bolls of Sakellarides produce on an average 15 to 16 seeds per boll, the limits actually observed by the present writer being from 4 to 24. The three divisions of a boll do not necessarily each produce the same number of seeds; asymmetry in this respect appears to be very frequent, if not indeed the rule.

It has been found that errors in sampling in the field spoilt the material taken in 1916 for the purpose of an investigation into this question. Thus it is doubtful whether the samples on which Tables VII and X are based actually consisted of 100 bolls each, as it was intended that they should do. The discussion of this point is consequently based on material collected with greater accuracy in 1917.

The main difficulty that prevents one (in Egypt) from establishing the normal number of seeds in a sound boll is the probability of including, by an oversight, attacked bolls, when trying to obtain perfect samples. Sampling in the field leads instantly to such inclusion of attacked bolls, as the external appearance of the least damaged ones is very deceptive. For this reason the apparently sound bolls taken in the field for this work were each packed separately at the time of picking, and were examined seed by seed in the laboratory. Even with this precaution it was found impossible to obtain many samples with less than two or three per cent. of attacked seeds.

Supposing these best samples, which exteriorly showed no sign of attack, which contained no double seeds, and in which very few damaged seeds were ultimately discovered after ginning, to be normal, and contrasting them with samples consisting of material taken from damaged bolls, the following conclusions appear to be justified :—

(1) The ripe boll cannot be taken as the unit when estimating the severity of the attack, as ripe bolls vary in the degree of attack from being almost perfect, to being totally destroyed.

(2) The intensity of the attack is better gauged from the proportion of sound to attacked seeds. This proportion has been shown in the two preceeding chapters to be correlated to seed weight and germination.

(3) The intensity of attack appears further to be correlated to the number of seeds produced in a given number of bolls. The correlation is as high as $0{\cdot}889 \pm 0{\cdot}063$ (see Table XII). There are very distinct indications that progressive increase of intensity of attack is accompanied by progressive decrease in the number of seeds present at the time of ripening.

If it be permitted to put forward a theory to explain the figures, it may be supposed that the actual loss of seeds occurs only in such bolls as are attacked at an early stage of their development, and that the loss in numbers is actually due to entire seeds having been eaten up, shell and all. Loss of seeds will consequently be greater when the bolls are attacked at an earlier stage. Very young bolls are usually not infested, until the attack has become more or less general. The average number of seeds produced per 100 bolls can consequently be taken as an index to the severity of the attack in the same way as seed weight of sound seeds, or germination of sound seeds.

TABLE XII. *To show Correlation between the Intensity of* Gelechia *Attack and Reduction in the Number of Seeds found per* 100 *Ripe Bolls of Sakellarides,* 1917 *Crop.*

Percentage of sound seeds.	Number of bolls used.	Average number of seeds per 100 bolls.	Total number of seeds in sample.
100	180	1,637	2,946
94	1,723	1,509	25,991
81	1,341	1,459	19,562
74	4,404	1,335	58,790
68	686	1,473	10,107
	98 samples		

Weighting as in Table VII: $r = 0{\cdot}889 \pm 0{\cdot}063$.

D. The Effect of Gelechia Attack on the Amount of Lint produced.

The effect of *Gelechia* attack on the amount of lint produced is more difficult to estimate than the damage done to the seed by the same cause. This is chiefly due to the lint becoming inseparably mixed during ginning. For this reason we have to rely on indirect information in estimating loss of lint. The amount of lint produced per sound boll varies very considerably, the quantity depending largely both on the number of seeds produced and on their weight; the amount produced per seed is to a very great extent proportionate to the weight of the seed.

Any factor that can affect a developing seed can also affect the quantity of lint produced by that seed. *Thus it is obvious that* Gelechia *attack must affect the amount of lint produced* (1) *by reducing the number of seeds matured per boll,* (2) *by reducing the average weight of the sound seeds produced in attacked bolls, and* (3) *by disturbing the development of immature attacked seeds.*

The loss of lint-weight can consequently to some extent be calculated from the damage done to the seed, provided that the proportion lint-weight to seed-weight is not seriously upset. As it is more usual to use the "percentage lint" than the proportion of lint-weight to seed-weight, that method of expressing the proportion of lint in a given weight of seed cotton will be used in the following discussion.

Before considering the effect of *Gelechia* attack on the "percentage lint," some general observations on factors which cause the percentage to fluctuate in normal seed cotton require notice.

In the first place, it must be stated that there is considerable difficulty in sampling. The true percentage of lint for any given quantity of seed and lint can only be found by examining the whole quantity, and even then it will be correct only for the conditions of atmospheric humidity and temperature under which the examination was made. The smaller the unit taken as a sample, the greater the probable difference of the percentage lint found from the true percentage for the whole. The smallest unit possible for a "percentage lint" is a single seed with its lint. Table XIII shows how enormously the percentages found for single seeds vary; the extreme found for any one boll being from 26 per cent. to 62 per cent. As against this, the single locks of any one of the seven bolls examined have not varied amongst themselves more than 6 per cent., and the bolls only 4 per cent.

It is of interest to remark that the examples with "freak" percentages recorded in this table are all seeds which have not been injured by pink bollworm, but whose growth has been arrested at an early stage from some other cause. The seeds giving 57 per cent., 62 per cent., and 58 per cent., weighed, without lint, 26, 44, and 38 milligrammes respectively, the average weight of a seed from the three bolls being 106 milligrammes. Stunted seeds do not however invariably give extreme percentages of lint, as can be seen from the same table. Their influence on the average for the whole boll is necessarily small, and of little practical importance.

Incidentally it may be mentioned that there appears to be no correlation between seed-weight and percentage lint; as worked out from 80 samples of Sakellarides the correlation was only $0{\cdot}009 \pm 0{\cdot}074$. This is a much lower figure than that found by Craig (Notes on Cotton Statistics in Egypt, L'Egypte Contemporaine, 1911, p. 188) for seed-weight and percentage lint. Nevertheless the figure given by that author, $0{\cdot}220 \pm 0{\cdot}094$, was already a very low one. It appears, moreover, very unlikely that there should be any correlation between seed-weight and high percentage of lint. The percentage of lint must rise (1) if the lint-weight per seed remains constant and the seed-weight falls, or (2) if the seed-weight remains constant and the lint-weight rises. A rise of both factors simultaneously would only produce a rise or fall in percentage lint if the two rises were not proportionate to each other. That this happens constantly in all samples of cotton, humidity being the driving force, will be shown later.

The correlation between lint produced per seed and percentage lint is very high, working out at $0{\cdot}906 \pm 0{\cdot}013$. This high correlation was to be expected, seeing that seed-weight and percentage lint are not correlated and remembering that seed-weight and lint-weight are the only factors used for finding the percentage lint.

The correlation between the lint produced per boll and percentage lint is much lower, working out for the same samples as used for the above at only $0{\cdot}367 \pm 0{\cdot}064$. Craig found for the same two factors $r = 0{\cdot}316$, which is fairly close to the present figures. The reason why the correlation is so much lower when made per boll instead of per seed is that the number of seeds per boll enters as a disturbing factor. The very high correlation ($r = 0{\cdot}810 \pm 0{\cdot}035$) found by Craig for seed-weight and lint-weight was to be expected, owing to the relatively small limits within which ginning outputs or percentages of lint vary in Egyptian cotton.

To test the amount of variation in the percentage lint of a single sample of seed cotton, 8,000 bolls of Sakellarides cotton were collected in 1916 at Giza. They all came from the same field, and were taken on the same day, obviously-damaged ones being excluded. These bolls were divided up into 80 samples of 100 bolls each. The percentage lint for the entire sample of 8,000 bolls was found at 31·1 ± 0·04, the standard deviation being ± 0.6. The highest percentage found for any sample was 32·2, the lowest 29·5. The total weight of the entire sample was 17,782 grammes, the average weight of the sub-samples being 222·3 grammes.

With a standard deviation of ± 0·6 on samples weighing over 200 grammes, and a range of 2·7 per cent. between the lowest and the highest sample, it is obviously not safe to quote percentages obtained from such small samples to beyond the nearest unit, unless, of course, the sample is at the same time the entire quantity whose percentage it is desired to estimate.

Contrary to Mr. Balls' practice ("The Development of Raw Cotton," p. 181) all the samples used in this paper for ginning output were ginned first and weighed afterwards. The gin used was a four inch one, and was fitted with covers to prevent the loss of seeds. The samples were not weighed until, on an average, over two weeks after ginning. It is believed that part at least of the reduction in weight said to be observed after ginning is not due to loss of seeds, but rather to loss of moisture from the seeds and more especially from the lint, as considerable heat is generated during the ginning process. The delay of two weeks, mentioned above, is more than ample to restore seed and lint to their normal conditions of humidity for the temperature and atmospheric humidity of the moment of examination.

Lint-weight is to a great extent influenced by the atmospheric humidity, the fluctuations taking place very quickly. Figure 3 shows two graphs, one made by a self-recording hygrometer, the other by the weight of one gramme of lint, under the same experimental conditions as in the weight record for seed. It will be seen that in this case the record traced by the light ray on the sensitive paper is in perfect agreement with the hygrometer record, and is synchronous in all its changes.

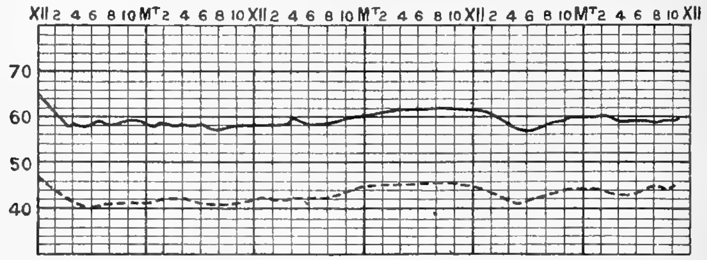

Fig. 3. Coincident fluctuations in humidity (solid line), and lint weight (broken line); increasing weight is indicated by a rising curve.

With seed-weight, as shown in figures 1 and 2, the influence of atmospheric humidity is felt, but is subject to a lag of a few hours, whereas in the case of lint-weight it corresponds simultaneously with the movements of the hygrograph. It is therefore obvious that the percentage lint will also constantly be changing, especially on account of the lag. That this is actually the case can be seen from figure 4, which was obtained in the same way as figures 1, 2 and 3, but with 2 grammes of seed on one pan of the balance, equilibrated by one gramme of lint and a gramme weight on the other. In this case the hygrograph record is obviously very different from the record of the variations of the percentage of lint.

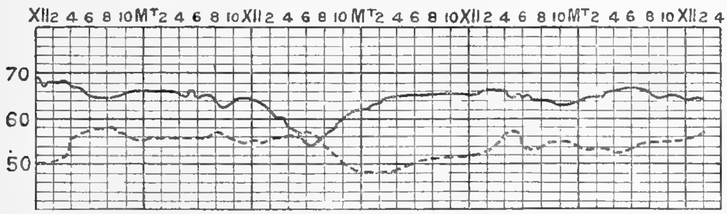

Fig. 4. Simultaneous fluctuations in humidity (solid line) and percentage lint (broken line); rising percentage lint is shown by fall in curve.

From the figures given for the fluctuations in the weight of seed, it would appear that the fluctuations increase with increasing temperatures. This is probably the meaning of the steady fall of seed-weight shown in Table V. In this case a sample of seed and its lint were weighed on 31 occasions between 11th February and 24th March 1917. The lint showed correlation ($r = 0{\cdot}46$) with the atmospheric humidity recorded at Gizeh (according to Mr. Hurst, who kindly had the calculation made), but the seed could not be correlated either with the humidity of the same morning, or with a lag of 24 hours. The reason for this is obvious now that we know that seed-weight and atmospheric humidity are correlated but with a lag of about three hours. The steady fall of the seed-weight produced a total rise of the percentage lint of 0·5 per cent. due to climatic changes alone, probably in part to temperature and in part to humidity.

The effect of *Gelechia* attack on seed cotton is to decrease the production of seed and of lint. For the seed we have already shown a decrease (1) in numbers matured, (2) in weight of the sound seed matured, and (3) actual loss of substance produced in attacked seeds. The effect on the quantities of lint produced has been studied indirectly by examination of the percentages of lint.

Obviously the suppressed seeds mature no lint, and are pure loss. It has not been possible to find any evidence that the reduction in weight of sound seeds from attacked bolls is accompanied by any change in the percentage of lint produced by such seeds. The loss of lint in such sound seeds may be considered proportionate to their loss of weight.

The changes in the percentage of lint produced by damaged seeds are more difficult to summarise, and depend to some extent on the age of the seed at the time of the attack.

(1) If the seed is attacked at a very early stage, it disappears entirely, thus causing the reduction observed in the average number of seeds set.

(2) Attacked slightly later, part of the seed remains but sets no lint, thus causing the percentage to fall to 0 per cent.

(3) Attacked when nearing complete maturity, no damage is caused to the lint, but the seed loses substance, thus causing a rise in the percentage of lint observed.

Thus Gelechia *attack can produce results ranging from total suppression of the production of lint to an apparent rise in the percentage of lint produced.*

TABLE XIII. *To show Fluctuations of the Percentage of Lint within Single Bolls.*

Boll Number.	1	2	3	4	5	6	7
Lock A.							
Seed 1	57†	37	58†	32	39*	33	38
2	35	31 }	42*	32	31	32	38
3	34	29 }		30	28	29	35
4	32	26	35	29	27*	29	34
5	30		35	27			31
6			34				30
Total Lock A.	34	31	39	30	30	30	34
Lock B.							
‡Seed 1	44	62†	35	33	45*	34	38
2	37	39	34	32	32	33	35
3	36	38	33	30	32	31	35
4	34	32	33	30	30	29	32
5	29	32	30	27*	28	27	31
6		28					31
Total Lock B.	36	37	33	30	32	31	34
Lock C.							
Seed 1	38	36	35	39*	42*	42†	43
2	37	35	34	32	33*	36	38
3	33	34	33	32	33*	34	35
4	31	34	33	30*	33	30	32
5	28	32	32	30	30	26	32†
6		30			26*		27
Total Lock C.	34	33	33	31	32	31	35
§ Total Boll.	34	34	35	31	31	31	34

* Attacked by pink bollworm.

† Seed development arrested for other causes than pink bollworm.

‡ Attacked seeds were weighed without the pink bollworm.

§ Total for all bolls 33.

Table XIV has been prepared to show the limits within which fluctuations may, under the present conditions (crop 1917), be most frequently expected to lie. All the samples came from the same crop, being Sakellarides grown on one feddan of land at Gemmaiza * in 1917. For the purposes of this examination 30 sets of 100 sound seeds were selected as a control, with 30 sets of 100 damaged seeds and 30 sets of 50 "double" seeds (=100 seeds per set) for comparison. As additional control 30 random samples each of about 150 grammes weight were taken from the same material.

* Ministry of Agriculture's Experiment Farm.

TABLE XIV. *Showing Comparison of Sound and Attacked Samples.*
Weights in Grammes.

Description of Sample.	Total weight with larvae.	Total weight without larvae.	Percentage Lint with larvae.	σ	Percentage Lint without larvae.	σ
30 sets of 100 sound seeds		449·69			34·2 ± 0·08	0·65
30 random samples of about 150 grs. each..	4,319·4*	4,287·6	34·7 ± 0·09	0·7	34·9 ± 0·09	0·7
30 sets of 100 damaged seeds other than "double" ones ..	282·93	269·93	35·6 ± 0·19	1·5	37·3 ± 0·18	1·5
30 sets of 50 double seeds (= 100 seeds per set)	313·79	284 66	30·3 ± 0·28	2·3	33·3 ± 0·26	2·15
Gemmaiza crop ; sound bolls	4,777·4†		34·0 ± 0·02	0·529		
Gemmaiza crop ; damaged bolls	15,226·0		34·0 ± 0·01	0·492		
Gemmaiza crop ; entire yield	20,003·4‡		34·0 ± 0·01	0·478		

* The total weight of 3,000 seeds with their lint would average 438·37.
† The total weight of 3,000 seeds with their lint would average 496·28.
‡ The total weight of 3,000 seeds with their lint would average 439·49.

Note.—The first four samples were taken from a piece of land set aside for experimental testing in this connection ; the last three refer to the ordinary field crop on the same farm.—G. C. D.

It may be stated at once that all of these samples, with the exception of the random ones, may be seriously biassed on account of sampling. In picking out the sound seeds the operator may have unintentionally selected the largest, and in selecting the damaged seeds a rather more than the average damage may be expected as the standard. The "double" seeds are on the other hand probably quite representative ; as, being rare, every one found would be retained, and as they are fairly easy to recognise by feeling before ginning, all those encountered would be kept. The only test we can apply for unbiassed sampling is by comparing the total weight of the 3,000 seeds in question, with the average weight of 3,000, seeds as calculated from the "Gemmaiza crop" figures, which may be accepted as being quite free from bias, as will be seen later. The "Gemmaiza crop" samples came from the same field as the others, but do not include them.

From the comparison it would appear that the sound seeds selected were below the average for "Gemmaiza crop" sound bolls. This was to be expected, if the sampling was unbiassed, as in the seed cotton from which the seeds were selected sound and attacked bolls were inextricably mixed together. In any case it may be accepted that the good seeds selected were not above the average in weight. Similarly it will be seen that the random sample varied very little (about 1·5 per cent. only) in weight from corresponding quantities of "Gemmaiza crop" of the same quality. This was expected in this case, as there was no reason for any bias to be introduced.

The "Gemmaiza crop" figures have a greater claim to be accepted as accurate. There is no possibility of errors in sampling; the entire yield has been taken under circumstances which exclude error as far as is possible; the sound and the damaged bolls were separated from each other carefully, and although a small percentage of attacked bolls were included under the sound ones, the proportion of attacked seeds wrongly included is less than 2 per cent. The damaged bolls and the sound bolls together make up the entire yield of all the trees from which they were taken.

It will be seen that the only set of samples needing control and for whose sampling no check can be found are the damaged seeds other than double ones.

The following conclusions appear to be justifiable on comparing the percentages of lint of all the samples together before removal of the larvae.

The 30 sets of sound seeds approach very closely in their percentage lint to that found for the entire crop, the difference being only 0·2 per cent.; the closeness of results, in view of the small size of the sample, may in part be due to chance.

The 30 sets of random samples are also not very far out in percentage lint, being 0·7 per cent. in excess.

The "damaged" seeds and the "double" seeds varied most from the normal, as was to be expected, but it is almost surprising that they varied so little. The "damaged" seeds were only $1\frac{1}{2}$ per cent. above the normal. Remembering that the sound seeds varied to half this extent from the normal, and the entire bulk of the 30 samples was in itself small, it is questionable how much significance should be attributed to the figures. On the other hand, the "double" seeds are $3\frac{3}{4}$ per cent. below the normal. In their case, part at least of the difference may be real, especially as a certain amount of the lint on both components is probably destroyed by the bollworm when attaching the seeds together. Hitherto, we have been reckoning the weight of the larvae in with the seed-weight, as would happen at a ginnery when calculating ginning output. Obviously the weight of the larva compensates to a large extent for the lost seed-weight in the percentage lint calculations. However, on comparing the total weights produced by damaged seeds and double seeds with that of the sound seeds, it is very obvious that a considerable loss of substance has occurred, which strangely enough is distributed in such a manner that lint and seed plus larva are in very nearly the same proportions as lint and seed in normal seeds. Removing the larvae from these samples, the percentage lint rises two to three per cent.

The "Gemmaiza crop" samples are much bigger individually and together than the sets just under consideration. Here, as was normal, the component samples varied in percentage lint, the standard deviation being approximately 0·5 per cent. The entire samples on the other hand all worked out to 34·0 per cent. lint (seed weighed including larvae).

Even supposing the sets of 30 samples of "damaged" and "double" seeds to be absolutely representative of the change produced in the percentage lint of such seed, it may be remembered that changes of such magnitude would not occur in ordinary samples, a 100 per cent. infestation of seed being very exceptional; for 100 *per cent. infestation of bolls does not necessarily mean more than* 6·6 *per cent. infestation of the* *seed, and rarely more than about* 20 *per cent. loss in weight* (*crop conditions* 1917). The alteration to the ultimate percentage lint would also not be in the ratio, percentage infestation : abnormal percentage lint :: percentage sound seeds : normal percentage lint, but would be altered in the direction of the normal percentage lint by the less weight produced by the damaged seeds.

The differences in direction of variation of percentage lint of double and ordinary damaged seeds would also tend to eliminate each other. All these factors together help to keep the percentage lint close to what would have been the normal, if the pink bollworm had been absent.

In passing it may be remarked that the ginning outputs published for the last few years have not shown any fluctuations which can be traced to damage done by *Gelechia.*

Tables XV and XVI have been compiled (from figures supplied by the State Domains Administration, to whom our thanks are due), to show how far the percentage lint in Mitaffifi and Affifi has varied during the period 1891–1917 and in Affifi, Assili and Sakellarides in the period 1911–1917.

TABLE XV. *Variation in the Percentage of Lint of Sakellarides, Assili and Affifi Cottons ginned by the State Domains during the years* 1911–1917, *calculated from figures supplied by the State Domains Administration.*

Year.	Sakellarides.	Assili Sakha.	Assili Qorashia	Affifi.
1911	33·8	35·6	35·6	33·9
1912	32·7	35·4	35·7	33·9
1913	33·5	36·4	36·2	34·5
1914	33·8	36·2	36·2	34·0
1915	32·8	35·7	35·5	34·0
1916	31·5	36·0	34·7	33·0
1917	34·1	36·4	36·7	34·5
Mean	33·2	36·0	35·8	34·0

Sakellarides, σ=0·8 ; Assili, σ=0·5 ; Affifi, σ=0·5 ; for all varieties combined, σ=0·6.

The figures for Mitaffifi and Affifi can be considered comparable to a great extent.* The mean percentage lint for Mitaffifi is 34·0, for Affifi 34·1 ; the two series are consequently extremely suitable for comparison and can be considered as forming one unbroken series.

The first point that calls for remark is, that for every year during the whole period Qorashia ginnery has never given a lower percentage lint than Sakha ginnery, and in all but two years it has given a higher percentage.

The second point is that the simultaneous difference between the percentages obtained by the two ginneries is often quite as large as or larger than the yearly fluctuations from the mean percentage.

The third point is that the standard deviation for Mitaffifi (period 1891–1912) is twice as great as that for Affifi (period 1911–1917). As Mitaffifi was grown previous to the introduction of *Gelechia,* and Affifi is contemporaneous with that pest, it is

* See note at foot of Table XVI.—G.C.D.

evident that percentage lint has not been greatly influenced, if at all, by the pink bollworm. The reduction of the magnitude of the standard deviation, however, may be considered to be connected with the greater purity of Affifi as compared with Mitaffifi.*

TABLE XVI. *Variations of the Percentages of Lint in Mitaffifi and Affifi Cottons ginned by the State Domains during the years* 1891–1917, *calculated from figures supplied by the State Domains Administration.*

Year.	Mitaffifi Sakha Ginnery.	Qorashia Ginnery.	Year.	Mitaffifi Sakha Ginnery.	Qorashia Ginnery.
1891	33·0	33·7	1908	34·0	35·9
1892	—	—	1909	33·0	34·2
1893	34·0	35·5	1910	33·0	34·9
1894	33·3	34·9	1911	33·7	34·9
1895	33·3	35·2	1912	34·9	—
1896	33·3	35·5	Mean	34·0	35·3
1897	34·9	35·2		σ =	0·74
1898	35·5	35·9	*Affifi*	33·9	34·1
1899	34·9	36·2	1911	33·9	—
1900	34·9	34·9	1912	34·5	34·5
1901	34·6	34·9	1913	34·0	—
1902	34·6	35·9	1914	34·0	—
1903	34·9	37·1	1915	33·3	—
1904	33·3	35·5	1916	34·5	—
1905	33·7	34·9	1917	33·7	—
1906	34·0	35·5	1917*	34·1	34·3
1907	33·7	35·2	Mean	σ =	0·36

* Special experimental cotton.

Note.—It is not explained what difference is supposed to exist between Mitaffifi and Affifi; the names are in general application synonymous.—G. C. Dudgeon.

Finally, nowhere do the deviations observed reach three times the standard deviation and perhaps they may not have any real significance.

Table XV, in which the percentages of lint for various varieties for the period 1911–1917 are recorded, just covers the period during which *Gelechia* has risen from insignificance to importance. It can here again be pointed out that none of the fluctuations shown is sufficiently large to be significant.

Finally, comparing the standard deviations for the annual variations in the percentage lint, as shown in the two tables under discussion, with the standard deviation found for the samples composing the crop of a single field, shown in Table XIV (comparison of sound and attacked samples), it will be seen that the standard deviation of the annual variation is nearly the same as the standard deviation of the variation of the percentage lint of various parts of a single crop.

E. **Calculation of the Damage done by the Pink Bollworm.**

The damage done to the cotton crop can be estimated, in view of what has been said above, and the quantity lost can be distributed with considerable accuracy to each of the sources of loss described.

* See note at foot of Table XVI.—G.C.D.

Dat 1917	lost per 1(and seed: Owing to estruction seed substance.
Augus	
14–23	18·1
25–30	14·1
Septen	
1– 6	17·0
8–13	15·6
First	
15–20	29·0
22–27	19·3
Octob	
29– 4	14·4
6–11	18·6
13–16	16·4
Second	

Table XVII. *Calculation of Damage due to* Gelechia *Attack.*

Date 1917.	Total quantity examined.		Average weight of 1,000 seeds without lint in grammes.		Calculated as from 100 bolls.				Seed cotton.		Amount lost per 100 average bolls, lint and seed combined.			Total of the four previous columns	Intensity of Attack.		Percentage Loss.				
					Total number of seeds found.		Number of damaged seeds found.														
	Total number of bolls.	Number of sound bolls.	From sound bolls.	From all bolls.	In sound bolls.	In all bolls.	In sound bolls.	In all bolls.	Corrected weight of seed cotton of 100 sound bolls in grammes.	Actual weight of seed cotton of 100 sound bolls in grammes.	Owing to reduction in average seed weight.	Owing to destruction of seed substance.	Owing to disappearance of seeds.		Per cent. bolls attacked.	Per cent. seed attacked.	In weight of unselected bolls as compared with sound bolls.	Due to the reduced weight of sound seeds.	Due to the destruction of seed substance.	Due to the disappearance of seeds.	Total of the last three columns.
August																					
14–23	107	60	126·3	126·0	1,650	1,558	27	202	308·4	271·6	0·8	18·1	17·4	307·9	44	13	11·9	0·3	5·9	5·6	11·8
25–30	443	180	121·7	119·4	1,654	1,583	11	176	301·0	268·7	4·8	14·1	13·0	300·6	59	11	10·7	1·6	4·7	4·3	10·6
September																					
1– 6	643	153	121·3	113·8	1,622	1,534	23	221	296·6	248·5	14·8	17·0	16·0	296·3	76	14	16·2	5·0	5·7	5·4	16·1
8–13	907	319	110·8	103·0	1,585	1,512	43	197	266·6	224·0	15·4	15·6	12·1	266·1	65	13	16·0	5·8	5·9	4·3	16·0
First picking took place.																					
15–20	724	75	112·3	107·2	1,644	1,537	28	420	277·3	222·9	8·4	29·0	18·0	278·3	90	27	19·6	3·0	10·4	6·5	19·9
22–27	1,212	186	106·3	101·3	1,607	1,467	17	312	260·0	210·1	8·4	19·3	22·3	260·1	85	21	18·8	3·2	7·4	8·6	19·2
October																					
29– 4	1,703	281	101·0	94·6	1,510	1,437	20	235	231·8	193·9	11·6	14·4	11·1	231·0	84	16	17·7	5·4	6·7	5·2	17·3
6–11	2,281	325	103·1	95·2	1,491	1,400	20	330	233·9	185·9	12·6	18·6	14·2	231·3	86	24	20·5	5·4	8·0	6·1	19·5
13–16	1,707	288	97·6	92·2	1,518	1,432	33	318	226·0	186·8	9·0	16·4	12·6	224·8	83	22	17·3	4·0	7·3	5·6	16·9
Second picking took place.																					

Provided that the samples at one's disposal are sufficiently large and sufficiently accurately taken, the loss can be estimated in the following manner.

A large number of sound bolls must be taken from the field for which the loss is being estimated. The number of sound bolls being known, their total weight divided by their number gives an average weight for sound bolls. The total yield in sound and attacked bolls of a sufficient number of plants is further required to be known, both as regards number of bolls and weight. This gives the average crop. The theoretical true crop for that number of trees can be calculated by multiplying the number of bolls found by the average weight of sound bolls. The difference of the weight thus found from the weight actually observed is the probable actual loss.

If the statements made in sections A, C and D are correct, the probable actual loss as found above must also equal the sum of the following partial losses.

(1) From number of seeds developed in sound bolls divided by the number of sound bolls is subtracted the total number of seeds developed in all bolls of the crop divided by the total number of bolls forming the crop. The remainder is multiplied by the number of bolls forming the total crop. This gives the number of seeds which should have been produced, but were not. Their average probable weight can be estimated by multiplying them by the total weight of the seeds from the sound bolls divided by the number of seeds found in the sound bolls.

(2) From the weight of the seeds found in the sound bolls divided by the number of seeds set in the sound bolls is subtracted the weight of the sound seeds set in all the bolls forming the crop, divided by the number of sound seeds found in those bolls. The remainder multiplied by the number of sound seeds found in the entire crop gives the loss due to reduction of average weight of the sound seeds in consequence of *Gelechia* attack.

(3) The weight of the attacked and double seeds is subtracted from the average weight of the same number of sound seeds from the sound bolls. This gives the probable actual loss due to seed substance being destroyed by the insect.

The result obtained by adding to the actual weight of crop observed (1) the probable weight of the seeds which did not develop,(2) the weight calculated as the reduction in weight of sound seeds in consequence of *Gelechia* attack, and (3) the actual loss due to seed substance having been destroyed by the larvae, should give the same sum as was obtained by multiplying the entire number of bolls observed by the average observed weight of the sound bolls from the same sample. It is to be shown now, that where the samples are of sufficient size to be reliable these conditions are very nearly realised, thus proving the triple nature of the damage. It is for this purpose immaterial whether the weights used throughout are those of the seed alone, or of the seed plus lint, confirming what we have said about the small degree to which the percentage of lint is affected.

In Table XVII the calculations sketched above have been made, and the results can be briefly summarised as follows :—

The average total weight found for 100 sound bolls in any one set of the samples under examination very closely agrees with the average total weight found for 100 random bolls of the same set plus the amounts found for reduction in average seed-weight, plus the amount of the difference in actual weight of the damaged seeds from the weight of the same number of sound seeds, plus the amount of weight of the missing seeds after these three amounts have each had added to them 50 per cent. to correspond to their lint-weight, at 33·3 per cent. lint. It will be seen that the calculation is only once wrong to as much as 1 per cent. (which in this case is due to differences in the percentage lint of the average sample and of the sound sample, which were here greater than in the other pairs of samples, but to which no special importance need be attached in view of what has been said earlier).

From the close correspondence of the calculated totals of loss to the amount found by weighing, it appears reasonable to believe that the percentage lint is not greatly altered on account of the attack. Damaged seeds apparently produce lint on the average in the same proportion to their remaining seed-weight (plus worm-weight) as sound seeds from the same samples do, or else the differences between calculated and actual weights would have to have been greater than found. (All seed-weight is here given with the weight of the larvae included.)

It is of importance to note that, as a general rule, the damage done to the attacked seeds is only about half (or even less) of the total damage, and that it is often equalled, and in some cases even exceeded, by the loss caused by the diminution of weight of the sound seeds or the non-development of other seeds.

It is further of interest that in these samples the average damage done has been roughly proportionate to the percentage of bolls attacked, the loss being somewhere about one-fifth of the total amount which could have been produced by the attacked bolls. This would give about 20 per cent. loss if all the bolls in a sample were attacked. However, it is necessary to remember that the total loss might be much greater when 100 per cent. of the bolls are attacked, as then the extra damage due to multiple attack would make itself still more felt than it does in the figures under examination. Some at least of the irregularities of the percentage loss figures are due to this cause; with reference to which it may here be mentioned that the higher the percentage of attacked bolls, the greater the probability of multiple infestation of single bolls.

Finally, it may be stated that the damage done in this one experimental field was between 11 and 16 per cent. on the first picking, and between 17 and 20 per cent. on the second picking. It must also be observed that all this quantity would not have been saved if the conditions existing previous to 1912 had obtained. In those days *Earias insulana* did a certain amount of damage annually, an amount which is stated to have been subject to considerable seasonal fluctuations. Balls mentions 18 per cent. damage as having occurred (Evading the Bollworm, Near East, 1915, p. 332) in a bad bollworm year. As *Gelechia* had not become a major pest in his time, and as Balls writes of bollworm and not of pink bollworm, he was presumably referring to *Earias*. *Now since the advent of* Gelechia *it has been very noticeable that* Earias *has very nearly disappeared altogether as major pest.* (In the samples under discussion it was not found to have done any damage.) It is not supposed that *Earias* has been suppressed by *Gelechia*, but the spread of the latter in Egypt has merely happened to coincide with legislation which has made conditions unfavourable to *Earias*. Further, it must be remembered that bolls attacked by *Earias* were destroyed to a much greater extent than those attacked by *Gelechia*. *A considerable* *part of the damage now found to be due to* Gelechia *would in former days have been equalled and in some years even surpassed by damage done by* Earias. It is true that *Gelechia* has compelled earlier cleaning up of the fields, and has nearly done away with the possibility of a third picking. This condition of things was, however, quite independently of bollworm or pink bollworm, bound to follow the introduction of Sakellarides cotton, which is an early maturing variety. Under former conditions bollworm attack was principally on the second and third pickings, and called for early maturing cottons as a remedy. *Gelechia* has greatly accentuated this demand for earliness in ripening and is forcing the cultivators, with or without their knowledge, in that direction in their seed selection. A still earlier maturing cotton is however required, and any such, if developed, will by reason of this character alone be able to compete advantageously with all otherwise equally good but later maturing varieties.

Notes on Observations made in 1917–1918.

A. **The Rate of Increase of Gelechia in 1917.**

During the summer of 1917 a considerable amount of information was gathered on the infestation of cotton-plants by *Gelechia*. An experiment was carried out at the Government farm at Gemmaiza, in which at first one hundred and later fifty cotton-plants were uprooted and examined daily for pink bollworm.

That the material collected in this manner was really representative for the conditions in the field can be seen from figure 5, which illustrates the budding,

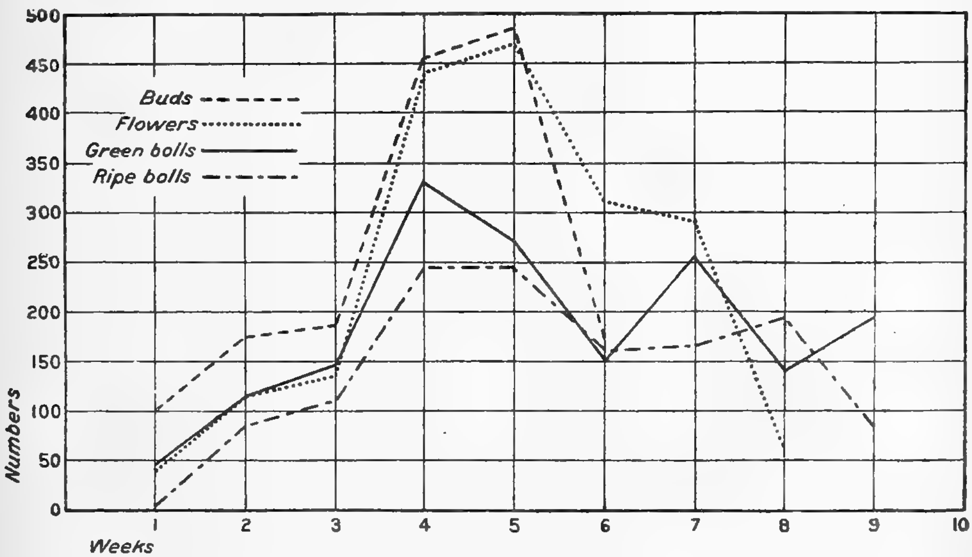

Fig. 5. Bud, flower, green boll and ripe boll curves for the Gemmeiza experimental field.

flowering, bolling and ripening curves calculated from the data collected. As this represents purely botanical work, and was only examined by way of control, there is no need to enter into details of the manner by which the weekly accessions of buds, flowers and bolls were calculated. It is enough to point out that the curves obtained show remarkable agreement, seeing that each position fixed has been worked out with the spoils of plants used for that date only.

Part of the data collected in this experiment has been utilised in a previous chapter, when studying the damage done to the crop. This material has in addition been studied for the progressive and comparative frequence of attack on buds, flowers and bolls during the season. It will be found tabulated in Table XVIII.

It has been found that buds and flowers are not normally atacked, until or unless the supply of bolls has become insufficient for the needs of the *Gelechia* population. This occurred at Gemmaiza in 1917, chiefly from September onwards. It commenced (if we ignore a few sporadic records) at the time when the pink bollworm had nearly reached its highest numbers and continued when, owing to decrease in the number of bolls set, the highest percentage of attacked bolls was registered. It is worthy of remark that it was during the same period that the most frequent and significant figures for multiple infestation of bolls were obtained. (Under multiple infestation I here refer to records showing the observation both of larvae and of damage done during the previous occupation by larvae that had left the boll—" traces.")

In point of selection of food, bolls are greatly preferred to buds or flowers. Larvae recorded from flowers cannot mature in a single flower, and probably have previously fed in a bud, or will have to wander to another flower, bud or boll for food.

The greatest interest however centres in the records for the green bolls. It must be remembered that the bolls figuring in each week's records may be from less than one to as much as eight or nine weeks old. Further, in the table under consideration " attacked " bolls denote bolls in which living worms were actually found. No attempt was made in 1917 either to judge the age of the bolls, or to count the number of larvae per boll. It is, however, a matter of general knowledge that an attacked boll frequently holds more than one larva, and that the larvae present may be of different ages, derived from different layings. Eggs being laid in groups of about six, one would *a priori* expect to find more than one larva in each attacked boll. Attention was however given to recording the traces of previous occupation of a boll by larvae which had left it, and in many cases it was found that a boll containing larvae had previously been attacked by others. Traces of previous occupation begin to be recorded about one week after the first larvae had been seen, and there is a very strong correlation between the attack of one week and the " traces " of the next week, especially for the period of eight weeks commencing 7th July and ending 31st August and commencing 14th July and ending 7th September. This period is selected for remark, as after that date part of the bolls showing " traces " would have ripened and no longer be recorded. (The correlation was found to be 0·968 ± 0·015.) For the whole period over which our observations extend, the attacked bolls are about double the number of those showing " traces," doubtless on account of part of the latter class disappearing unrecorded on the ripening of the bolls.

It further seems fairly reasonable to infer from the table that the infestation of the bolls takes place principally during the last two or three weeks before ripening. Should the attack on the average take place much before that time one would expect to find a much greater number of bolls showing traces of attack than is actually found. Late in the season very many of the bolls contain living larvae during the last week before ripening, many of these persisting unchanged as resting larvae in the seeds of the ripe bolls or of the picked and stored seed-cotton.

That the percentage of attack is no index of the numbers of *Gelechia* larvae present at any moment, was indicated in a previous paper. From Table XVIII, it can be seen that in 1917 at Gemmaiza the highest figure for population (580 attacked bolls per 100 plants) was obtained at a time when only 64 per cent. of the bolls were attacked. The highest percentage (94 per cent.) was found after the population had been reduced to one-quarter of the previous figure (142). It may also be noted that there were comparatively few green bolls at the time when the highest percentages of infestation were observed. This can readily be gathered from the columns showing the items dealing with the vegetative characters.

A factor of considerable importance in forecasting the damage is to know how evenly the attack is distributed amongst the green bolls in a field. Apparently the moths do not exert much trouble in selecting bolls, and do not hesitate to lay on such as have already been injured by earlier broods. This in itself ought to lead to quite a simple and fairly even distribution of the damage; and in fact we find that, as was expected, the standard deviation is low when most of the bolls are sound (4 per cent.) or damaged (7 per cent.), that is, at the beginning and the end* of the season, but that it rises to a quite considerable figure (11 per cent.) when the infestation has reached about 50 per cent. (The figures given are for samples of 100 bolls each). However, the problem is not merely a simple one of binominal distribution, as it is disturbed to some extent by the fact that the supply of bolls to infest is subject to considerable fluctuation, and that the quantities of young bolls produced after the middle of the season are very restricted. Thus the average age of the boll population is also undergoing considerable variation. It seems fairly evident, in the light of the examination of large numbers of sets of 100 green bolls during 1917, that it is not safe to rely on percentages obtained from 100 bolls; ten such samples are required to produce a sufficiently low probable error.

The sets of 100 green bolls examined during 1917 were derived from two sources. One part was collected by the Inspectors of Agriculture, who sent in 120 bolls weekly from each Markaz in their province; these bolls were supposed to be taken a few here and a few there. No selection was to be exercised, but the collectors may have been biased to take the older bolls; if this happened, too high percentages might be expected. The other part consisted of all the green bolls found on the 100 cotton-plants which were examined weekly at Gemmaiza. This lot may be considered to have been taken entirely without bias.

In addition to these two lots, special sets of samples were taken in the Wadi Tumulat (Tel el Kebir) and at Armant; 900 bolls were received weekly from the former, 1000 from the latter, place. These figures and the Gemmaiza figures have not been used in obtaining the provincial figures.

In analysing all these sets of samples, we find considerable agreement in the proportion of samples whose percentages of sound bolls lie between 100–76 per cent., 75–51 per cent., 50–25 per cent. and 24–0 per cent. The period required for the infestation to spread from less than 25 per cent. to over 75 per cent. appears to be a relatively short one. The ultimate damage to the crop depends greatly

* At the end of the season the numbers of samples available are insufficient for the purpose of calculating the standard deviation with accuracy.

on the moment when this transition sets in. In 1917 it started earliest in Menufia, Galiubia, Gizeh and Beni-Suef. Average percentages of 25 per cent. sound bolls or under were first recorded from Sharqia, Menufia, Galiubia, Gizeh and Beni-Suef. They were reached latest in Keneh and Girga, and never by Aswan. The damage done to the crop depends to a considerable extent on the time (which can be gauged

TABLE XIX. *Showing Comparison of Grouping of Samples of Green Bolls.*

Locality.	Percentage of Observed Samples with Sound Bolls.			
	100–76%.	75–51%.	50–26%.	25–0%.
Delta	52	13	8	27
Gemmaiza	46	19	12	23
Wadi Tumulat ..	44	15	6	35
Middle Egypt	52	7	10	32
Upper Egypt	65	6	9	20
Armant	66	11	6	17

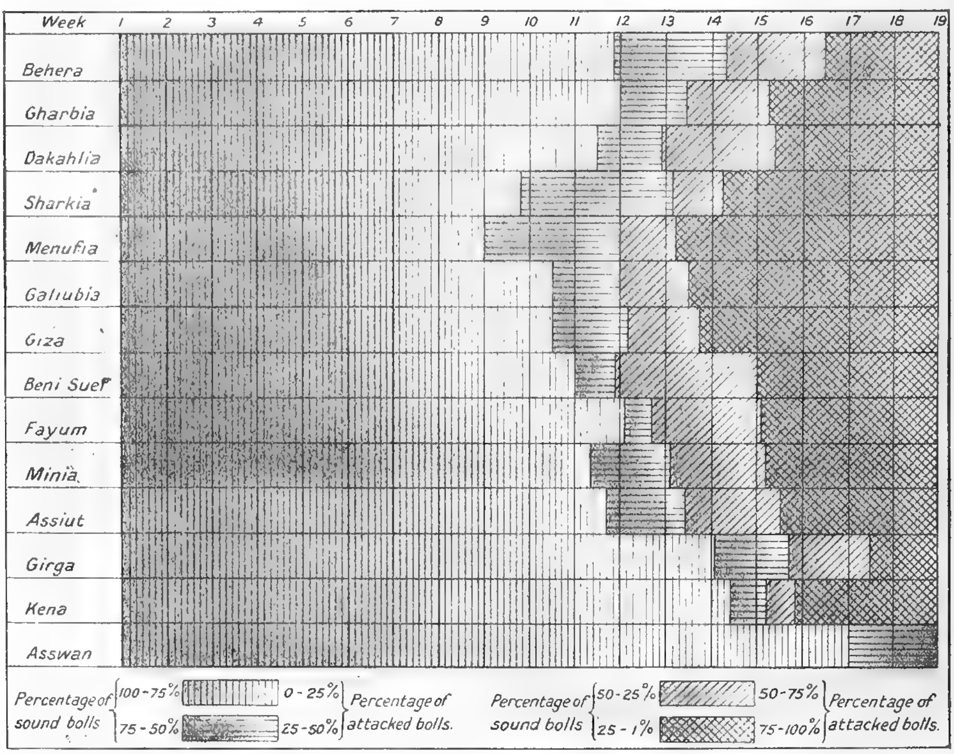

Fig. 6. Diagram to show the progressive increase of *Gelechia* attack per province (Mudirieh); week 1 commenced on 2nd June, 1917.

by the number of observed percentages) spent on the average in any of these groups. For example Table XIX shows that the damage done in the Delta was very nearly the same as that done in Middle Egypt (Giza, Beni-Suef, Fayum). Further that both were considerably worse than Upper Egypt.

Week commencing on	ugh 10,000 buds, flowers or oduced during the season.						Multiple Infestation.
			Green bolls.				
	Tota	tacked.	Weekly total.	Sound.	Larvae present.	Traces ; larvae absent	
June							
9th	271	0	0	0	0	0	0
16th	171	0	0	0	0	0	0
23rd	532	0	6	6	0	0	0
30th	491	0	46	46	0 (·25)	0	0
July							
7th	690	0	93	90	3	0	0
14th	1245	0	206	195	11	1	1
21st	1178	0	350	327	15	8	0
28th	1221	0	686	631	36	17	2
August							
4th	818	2	946	821	79	46	0
11th	475	0	1054	901	96	58	1
18th	195	3	1260	915	203	146	4
25th	89	0	1283	813	275	218	23
September							
1st	82	7	1330	681	410	287	48
8th	33	3	844	365	320	206	47
	First						
15th	88	0	894	200	571	294	171
22nd	98	0	555	80	430	142	97
29th	107	7	237	21	201	41	26
October							
6th	59	10	149	4	140	24	19
13th	68	10	58	4	44	23	7
		2	9997	6100	2834	1512	446

Table XVIII. *Showing the Distribution of* Gelechia *Attack on Buds, Flowers and Green Bolls.*

Week commencing on	Actual number observed per 100 plants. Buds. Total.	Buds. Attacked.	Flowers. Total.	Flowers. Attacked.	Green bolls. Total.	Green bolls. Attacked (larvae present or absent).	Percentage attacked. Buds.	Percentage attacked. Flowers.	Green bolls attacked (larvae present).	Green bolls showing traces of previous attack (larvae absent).	Multiple infestation.	Recombined as though 10,000 buds, flowers or bolls had been produced during the season. Buds. Weekly total.	Buds. Attacked.	Flowers. Weekly total.	Flowers. Attacked.	Green bolls. Weekly total.	Green bolls. Sound.	Green bolls. Larvae present.	Green bolls. Traces; larvae absent.	Multiple Infestation.
June																				
9th	271	0	0	0	0	0	0	0	0	0	0	342	0	0	0	0	0	0	0	0
16th	171	0	0	0	0	0	0	0	0	0	0	216	0	0	0	0	0	0	0	0
23rd	532	1	4	0	6	0	0	0	0	0	0	672	1	43	0	6	6	0	0	0
30th	491	0	24	0	47	0	0	0	0	0	0	621	0	242	0	46	46	0 (25)	0	0
July																				
7th	690	0	21	0	95	3	0	0	3	0	0	872	0	212	0	93	90	3	0	0
14th	1245	0 (·3)	58	0	209	11	0	0	5	0	0	1573	0	585	0	206	195	11	1	1
21st	1178	0	68	0	355	15	0	0	4	2	0	1489	0	695	0	350	327	15	8	0
28th	1221	0	219	0	697	37	0	0	5	2	0	1543	0	2208	0	686	631	36	17	2
August																				
4th	818	1	236	0	961	80	0	0	8	5	0	1033	1	2379	2	946	821	79	46	0
11th	475	1	152	0	1071	97	0	0	9	5	0	600	1	1532	0	1054	901	96	58	1
18th	195	2	144	0	1279	206	1	0	16	12	0	249	2	1452	3	1260	915	203	146	4
25th	89	1	31	0	1303	279	1	0	21	17	2	113	1	313	0	1283	813	275	218	23
September																				
1st	82	0 (·3)	8	1	1351	416	0	8	31	21	4	104	0	81	7	1330	681	410	287	48
8th	33	2	5	0 (·3)	857	325	3	7	38	24	6	142	3	50	3	844	365	320	206	47
	First picking took place.																			
15th	88	8	7	0	908	580	9	0	64	33	19	111	10	71	0	894	200	571	294	171
22nd	98	9	3	0	564	437	9	0	77	25	17	124	11	33	0	555	80	430	142	97
29th	107	7	4	1	241	204	7	15	85	18	11	135	9	43	7	237	21	201	41	26
October																				
6th	59	8	5	1	152	142	14	19	94	16	13	75	10	53	10	149	4	140	24	19
13th	68	14	3	1	59	45	21	40	75	39	12	86	18	25	10	58	4	44	23	7
												10000	67	10013	42	9997	6100	2834	1512	446

From this table we can also conclude that the damage done to the crop at Gemmaiza was rather worse than the average for the Delta; this is important, as it shows us that the damage to the crop as estimated from the Gemmaiza figures would be rather too high to use as an average for the Delta. The Wadi Tumulat again was considerably worse than Gemmaiza. On the other hand, the Armant samples were very near to the average for the whole of Upper Egypt.

TABLE XX. *Showing Percentage of Sound Green Bolls in the period June to November 1917.*

Muderia	June.					July.				August.				September.					Oct.
	2	9	16	23	30	7	14	21	28	4	11	18	25	1	8	15	22	29	6
Behera						82	86	87	88	82	81	74	61	56	34	37	14	11	7
Gharbia.. ..						84	88	87	87	86	75	75	65	37	28	17	11	4	3
Dakahlia ..		99	100	89	89	88	85	—	83	80	76	73	49	39	36	15	8	3	1
Sharkia ..			83	93	90	88	92	89	85	73	70	66	54	27	13	2	4	5	5
Menufia ..		97	99	91	90	90	82	78	75	72	48	50	27	16	7	1	2	1	3
Qaliubia ..			96	90	91	92	93	92	85	80	70	50	38	15	10	2	0	4	5
Giza	98	99	99	94	93	95	88	90	91	83	66	53	36	20	9	6	4	0	0
Beni-Suef ..			98	92	94	87	92	88	86	88	74	48	46	14	25	10	2	10	4
Fayum				98	92	96	98	99	87	80	78	77	40	40	24	14	8	2	0
Minia	97	99	95	97	94	93	89	91	85	85	90	51	44	35	23	5	16	13	4
Assiut	98	99	90	93	99	97	99	94	98	94	86	71	68	29	31	22	10	10	7
Girga	100	100	99	98	99	99	99	99	97	98	96	94	79	74	84	37	30	22	5
Qena				97	100	100	98	99	96	100	93	52	87	85	58	22	9	22	0
Aswan				100	94	100	100	98	99	99	98	97	95	90	93	—	—	—	55
Lower Egypt	—	98	95	91	90	87	87	87	85	80	72	67	51	35	22	16	8	5	4
Middle Egypt	98	99	99	95	93	93	92	92	88	84	72	59	40	24	20	10	4	4	1
Upper Egypt	98	99	94	96	97	97	96	95	94	93	91	71	65	48	47	20	17	15	8
Tel el Kebir Wadi Tumulat				98	95	95	95	82	89	80	74	73	49	14	8	8	12	5	6
Armant ..						99	99	99	95	100	95	72	92	83	62	28	—	15	4
Gemmaiza ..		100	100	97	94	94	92	87	86	73	63	61	43	22	14	9	2	—	—

Table XX has been prepared to show the average weekly percentage of sound bolls obtained at Gemmaiza, Wadi Tumulat and Armant in each Muderieh, and in Lower, Middle and Upper Egypt. In figure 6 this information has been used to show diagramatically the comparative moment when the 75 per cent., the 50 per cent. and the 25 per cent. sound boll positions were passed.

The following Table (XXI) shows how closely the figures for Gemmaiza agree with those for the whole Delta.

TABLE XXI. *Comparison of Percentage of Sound Bolls from Gemmaiza and from the whole Delta.*

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Delta	98	95	91	90	87	87	87	85	80	72	67	51	35	22	16	8	5	
Gemmaiza	100	100	97	94	94	92	87	86	73	63	61	43	22	14	9	2	—	—

Week 1 commenced 9th June.

B. **Observations on Resting Larvae.**

An attempt has been made to solve the problem whether " resting " larvae feed. Obviously this cannot be done by direct observation. For this reason sets of samples of 100 larvae were weighed at various dates during 1917. The results are shown in Table XXII, from which it will be seen that the weight has been found constantly falling from February to July. The difference between the samples of the 2nd and 10th June is not significant. The fall in weight does not necessarily demand the explanation that the larvae were fasting,but taken along with the known fact that many hibernating or aestivating larvae do not feed, it lends considerable weight to the probability of the larvae not feeding during their resting period.

TABLE XXII. *Weight of Sets of* 100 *Hibernating* Gelechia *Larvae.*

1917.	Number of Sets.	Average Weight.
January 3	6	2·483 ± 0·068
February 3	10	2·510 ± 0·019
March 8	6	2·457 ± 0·068
April 2	10	2·403 ± 0·019
" 7	10	2·369 ± 0·019
" 28	10	2·309 ± 0·019
May 8	10	2·286 ± 0·019
" 12	10	2·295 ± 0·019
" 19	10	2·304 ± 0·019
" 26	10	2·262 ± 0·019
June 2	10	2·245 ± 0·019
" 10	10	2·247 ± 0·019
" 16	10	2·099 ± 0·019
" 24	10	2·093 ± 0·019
July 2	8	2·017 ± 0·021

The agreement between the two sets of percentages is extremely close; the Gemmaiza figures begin a trifle higher and fall a trifle lower (perhaps not significantly) than the combined Delta figures. The table shows that the bias in sampling for the provincial samples was not great. The shortened crop season as compared with that of the whole Delta requires no comment.

It occasionally happens that cotton grown in basin lands in Upper Egypt becomes submerged at the end of the season. In 1917 some samples of bolls which had been submerged one week were examined. Forty-three *Gelechia* larvae were found, of which five were still living. The same bolls contained two dead *Earias* larvae. Another sample, submerged for two weeks, contained forty-three *Gelechia* and three *Earias* larvae, all of which were dead.

C. Gelechia in Seed Stores.

During the summer of 1917 we have had the opportunity of making some observations on *Gelechia* moths in seed-stores at Alexandria.

On entering a seed-store in the day-time and examining it for *Gelechia* moths, one never or only very rarely sees moths flying. In order to find living moths it is necessary to look in the darkest places, as the moths hide away during the day-time. If there is a plank or similar object lying on the floor, one almost certainly finds them hiding under it. On being disturbed, they make no attempt to fly, but hurry away, running to find shelter again under some suitable object, such as a board or in a crack in the wall or floor.

Dead moths may frequently be found by examining under a closed sky-light. In such places the floor is usually littered with them. Other places in the same store may be examined carefully without finding any trace of them. In one store the inner window-sills, which are nearly one metre wide, were found in June to be covered several layers deep with dead *Gelechia* moths. These windows had the regulation wire screens on their outer aspect, not being closed by glass.

Where seed was stored in sacks, the angle between two sacks resting on each other appeared to be the favourite place for the larvae to pupate.

A serious outbreak of *Pediculoides ventricosus* was raging amongst the *Gelechia* larvae in Alexandria in June, with unpleasant results to workmen and others whose duties led them into the seed-stores at that period.

Through the kindness of Messrs. Carver Brothers, Ltd., we were permitted to carry out a trapping experiment in one of their stores at Alexandria during the year June 1917 to June 1918. I take this opportunity of thanking this firm for their valuable aid. In this experiment a twenty-five candle-power electric lamp was suspended about 15 cm. above a basin of water, on the surface of which a few spoonfuls of paraffin oil was poured. The basin was about 90 cm. above the ground. The light was allowed to burn all night. Its position was such that only a part of the store was illuminated. Table XXIII gives the details of the weekly catches made by this light, which however do not represent the total numbers of moths present in the store on any day, and must only be taken to represent the comparative frequency.

The greatest numbers were taken in September, October and November. These constituted almost exclusively short generation moths, whose larvae had been introduced into the store along with the seed. The sudden increase observed during the last week of August and the first week of September was preceded three weeks before by the filling of the store with fresh crop seed from the Fayum. One week before that the store had been quite empty, but had yet given 19 moths in the seven days during which it contained no seed. It will be seen that in the period December to April very few were observed. The quantities of seed in the stores were constantly varying.

These observations make it advisable, if borne out by another season's records, to reconsider the final date up to which screening is compulsory. Moths emerging in September might, if left to find their way back to the fields, effect serious damage on the later part of the crop. The cotton of Northern Behera, which by reason of its position in the north is late, is on account of its vicinity to Alexandria liable to become attacked by part at least of the millions of moths emerging in the seed-stores of that town, given suitable weather conditions.

This record of 54,000 moths caught by traplights during the year ought to be sufficient to disprove Busck's* statement that the moths are not attracted to light; the evidence yielded by Table XXIV, which is a copy of the daily records composing part of the series whose summary in weeks has been given in Table XXIII, is however

TABLE XXIII. *Showing the Weekly Numbers of* Gelechia *Moths caught by a Trap-light in a Cotton-seed Store at Alexandria.*

Week commencing.	Number of moths caught.	Week commencing.	Number of moths caught.
1917		1917	
June 21	176	Dec. 20	12
,, 28	187	,, 27	0
		1918	
July 5	248	Jan. 3	1
,, 12	837	,, 10	2
,, 19	1120	,, 17	3
,, 26	144	,, 24	0
Aug. 1	41	,, 31	4
,, 9	123	Feb. 7	6
,, 16	69	,, 14	7
,, 23	19	,, 21	4
,, 30	691	,, 28	2
Sept. 6	21699	March 7	5
,, 13	16843	,, 14	2
,, 20	7340	,, 21	5
,, 27	232	,, 28	10
Oct. 4	194	April 4	20
,, 11	416	,, 11	38
,, 18	235	,, 18	39
,, 25	737	,, 25	20
Nov. 1	212	May 2	29
,, 8	1128	,, 9	45
,, 15	1166	,, 16	58
,, 22	26	,, 23	40
,, 29	25	,, 30	56
Dec. 6	14	June 6	
,, 13	5	,, 13	

conclusive. It will be observed that during the three weeks in question the light was not burning on two nights, and that in consequence the catch fell from several hundreds or even thousands to 8 on the first and to 1 on the second occasion, thus supplying the necessary controls to prove that the attraction to the trap was the light and not the smell of the paraffin. Whether the windows of the store were left open

*Jour. Agric. Research, Washington, 1917.

or shut appears to have made but little difference to the catch, the light evidently being a superior attraction to the draught.

The objections which were urged against the screening of the windows, before legislation in the matter was introduced, do not appear to have been realised during the summer of 1917.

TABLE XXIV.—*Showing the Daily Numbers of* Gelechia *Moths caught during the period 6th to 26th September,* 1917.

SEPTEMBER.

	6	7	8	9	10	11	12	13	14	15
Moths caught	318	943	2470	4500	7960	5500	8	6060	5670	2800
Windows	open	closed	closed	closed	closed	closed	closed; light not burning	closed	open	closed

SEPTEMBER—*cont.*

	16 17	18	19	20	21	22	23	24	25	26
Moths caught	5500	2222	1	821	1403	1524	1610	985	710	227
Windows	open	closed	open; light not burning	closed	open	open	open	open	open	open

D. **The Destruction of Gelechia Larvae in Seed as carried out on a Commercial Scale in Ginneries.**

During the winter 1917–1918 six of the ginneries in Upper Egypt secured the necessary machinery to treat by heat the seed ginned in order to kill the pink bollworm, in conformity with Law No. 29 of 1916. Although the Law was not yet in force, a large quantity of seed intended for sowing was treated in the machines. Thus all the Ashmuni seed distributed by the Ministry of Agriculture was disinfected, together with a considerable further quantity intended for private clients of the firms in whose ginneries machines were installed.

The working of the machines was tested by the Entomological Section, submission to the control being voluntary on the part of the ginners, owing to the fact that the Law was not being enforced. Two types of machine were being used; five of the factories working the Simon's malt-drying machine, made by Messrs. Richard Simon & Sons of Nottingham, and the sixth a machine known as the "Delta," made in Egypt (for description see Storey, Bulletin Min. of Agric., Egypt, No. 14).

TABLE XXV.—*Germination of Cotton-seed received from Upper Egypt Ginneries for testing after having been treated by Heat to kill the Pink Bollworm contained in it.*

Type of machine used.	Ginnery.	Treated Seed.			Number of Samples.		Untreated Seed.			
		Total number of seeds. used.	Number germi-ated.	Per-centage germi-ated.	Tested.	Found to be injured.	Total number of seeds used.	Number germi-nated.	Per-centage germi-nated.	Number of samples tested.
Simon ..	Minia	61,015	54,722	90	110	0	33,423	29,993	90	60
Simon ..	Mallawi ..	59,340	53,984	91	106	1	21,930	19,825	90	39
Simon ..	Maghagha ..	73,620	65,164	89	126	2	6,545	5,693	87	12
Simon ..	Abu Kerkas ..	56,297	52,844	94	105	0	24,100	22,811	95	45
Simon ..	Beni-Suef ..	10,235	9,839	96	20	1	5,080	4,903	97	10
Delta ..	Beni-Suef ..	18,682	16,042	86	34	1	2,737	2,391	87	5
Total		279,289	252,595	90	501	5	93,815	85,616	91	171

Note.—The difference shown in the percentage germinated is nowhere significant. For significant figures recourse would have to be had to the component samples from which these totals were calculated.

The machines were run to give 55° C. temperature to the seed by the time it was discharged with the sacks, this being the lowest safe temperature to control *Gelechia,* although considerably under the maximum safe temperature for seed germination.

Table XXV shows the results of the germination tests. Of the 501 samples tested only 5 had been damaged to a significant extent in their germination, but the damage in these five cases was not serious,—over 70 per cent. germinating. Little can be said definitely about the destruction of the larvae, as the samples were singularly free from them, 3 or 4 on an average being found per kilogram of seed. As far as could be seen under these conditions the machines were working efficiently in this respect also.

Cotton-seed is germinated in the Entomological Section under the following conditions, which have been found to give very regular results. Germination takes place in the germination room, which has a capacity of about 27 cubic metres. This room is kept at a constant temperature of 30° C. by a small hot-water radiator heated by gas, the gas-supply being regulated by a Hearson's capsule, which operates a locally-made regulating valve. The whole of the heating apparatus and the regulator are inside the room. Double doors, enclosing an air-lock, prevent undue changes of temperature when workers enter or leave the room. The window is double, enclosing an air-space. The ceiling is also double. Combustion gases are led out from the burner of the radiator by a flue. The construction of this room has been found so satisfactory as regards temperature control, that thermograph records running over several weeks show fluctuations of only half a degree above or below the desired temperature.

The seed is germinated in samples of 50 grammes each, equivalent to about 500 seeds. The standard deviation for samples of this size has been found to be 4 per cent. Worm-eaten seeds are not counted, all other seeds are recorded after 48 hours as germinated or failed. The germination actually takes place in glazed earthenware dishes, 20 cm. across by 7 cm. deep. The seed is placed in a single layer on a circle of felt which covers the bottom of the dish, and covered by a second sheet of felt, 100 cc. of water of 30° C. being given to start the germination; after 24 hours more water of the same temperature is given to each sample. The felt is washed in copper sulphate solution after each use, and then dried. The room is calculated to take up to 4,000 dishes at a time, if all the shelf space is occupied.

This system of germination has given perfect satisfaction. Formerly when working with Petri dishes in Hearson incubators a very large number of putrefying samples were obtained, which had to be repeated; under the present system no putrefying sample has been observed, and it has not been necessary to repeat germinations on this account. The few "repeat" samples made, due to extreme figures being obtained, have proved on retesting to be significant.

During the early part of 1918, 2,000 ardebs* of seed were fumigated at the State Domains ginnery at Sakha, under the supervision of Mr. Storey, Entomologist in the Ministry of Agriculture. These samples are mentioned here, as they were treated at higher temperatures than the seed just discussed, being destined for

* About 11,000 bushels, or 235 tons.

exportation abroad, for planting. Table XXVI, taken from Mr. Storey's report, shows that temperatures of from 60° to 70° C., and in most cases up to 73° C., are not fatal to the germination of the seed. The only significant decrease of germination shown in this table was found in samples 8 and 23.

TABLE XXVI.—*Tests of Samples treated at Temperatures varying between 53°C. and 73°C.*

Serial number of sample.	Temperature reached after treatment.	Percentage mortality of Gelechia larvae.	Percentage germination of the seed.
1	73° (rejected)	100	88·6
2	54° (retreated)	100	93·0
3	Control	19	93·0
4	70° (rejected)	100	88·8
5	65° (treated for second time)	100	91·3
6	70° (rejected)	100	87 5
7	69° (treated for second time)	100	89·5
8	71° (rejected)	100	65·0
9	63°	100	95·6
10	61°	100	94·2
11	65° (treated for second time)	100	93·0
12	64°	100	96·0
13	65°	100	95·8
14	67°	100	90·2
15	59° (treated for second time)	100	93·9
16	72° (rejected)	100	91·4
17	Control	50	97·4
18	Control	33	88·1
19	64°	100	87 5
20	73° (rejected)	100	88·6
21	66°	100	96·3
22	64°	100	91·4
23	73° (rejected)	100	30·1
24	Control	0	93·2
25	60°	100	95·6
26	67°	100	94·1
27	68°	100	91·7
28	66°	100	96·1
29	64°	100	88·4
30	72° (rejected)	100	86·9
31	59°	100	93·1
32	66°	100	92·9
33	68°	100	85·9
34	63° (treated for second time)	100	90·4
35	73° (treated for nth time)	100	79·9
36	Control	30	92·7

There appears to have been no difficulty in controlling the machines at any of the seven ginneries which treated seed last winter. Temperature regulation was fairly easy, and the difficulties anticipated by some people did not materialise. *In view of the perfect results obtained with the seed treated at* 65°–69° *as to germination, and more especially as to the greater safety in worm-killing, it will be advisable in future for ginners employing heat treatment to work their machines for temperatures of* 60° C. to 65° C., *rather than for* 55° C. to 60° C.

As the treatment of seed intended for exportation abroad to cotton-growing countries where the pink bollworm is not yet established has been mentioned, it is desirable to place on record our opinion of the undesirability of such a procedure on a large scale. Cotton-seed for exportation to such countries ought to be sent in small quantities only, and consigned in such a way that subsequent re-infestation of the seed is made impossible. For instance, properly fumigated postal samples are probably quite safe. Large quantities if sealed in tin boxes are equally unobjectionable. Samples such as the 2,000 ardebs mentioned above are much too large for safety. In the first place such samples must be treated in a ginnery and the sacks containing the seed will be exposed to all wandering larvae from the time of treatment up to the time of dispatch by rail—a period of several hours or even days. After this the sacks will be transported by railway trucks, which may have recently conveyed untreated cotton-seed or seed-cotton, thus exposing the sacks to further danger. Postal parcels and tin cases are not likely to come into contact with wandering larvae. Mr. Storey's comments on this point are here quoted.

" In conclusion I should like to make a few remarks on the subject of the treatment of so large a consignment of seed for a foreign country. Every effort has been made to ensure that all the worms were killed, but as there were probably not less than 5,000,000 worms in the consignment, and 50 are more than enough to start the infection of a whole country, the survival of 0·001 per cent. must be viewed with alarm if the seed is destined for a country where the pink bollworm does not yet exist. To guarantee that there is not a single worm left alive in 10,000 is humanly impossible. In the first place, whenever the machine is started a certain amount of seed—probably about a *kela**—finds its way into the seed-chute before it is properly heated up. Here it remains while the machine is filling up until the seed-chute is opened. In order to avoid this source of danger as far as possible the first two sacks to come through the machine after starting were re-treated, but this does not eliminate the danger entirely. Secondly, after treatment the seed was frequently in comparatively close contact with untreated seed in the store and on the station platform, and a slight reinfection from that source was quite within the bounds of possibility. Thirdly, I found when I got down there that it was proposed to double sack the seed, using new sacks inside and old sacks outside. Old sacks may contain literally hundreds of living worms and pupae. Fortunately it was not too late to eliminate this source of danger by using only new sacks.

" From this I think it is clear that even in spite of the most careful fumigation the importation of a large consignment of seed, such as the present one, is an extremely dangerous thing."

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*Approximately 20 lb.

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EXPLANATION OF PLATE XVIII.

Gelechia gossypiella, Saunders.

Fig. 1. Egg on a cotton involucre.

2. Larva on " double " seed.

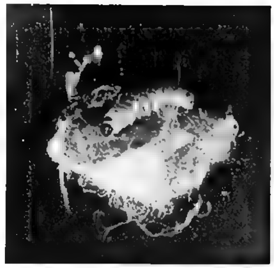
3. Resting stage larva, dorsal view.

4. Pupa, ventral view.

5. Resting stage larva, lateral view.

6. Moth.

1.



2.

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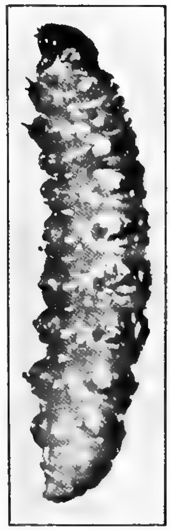

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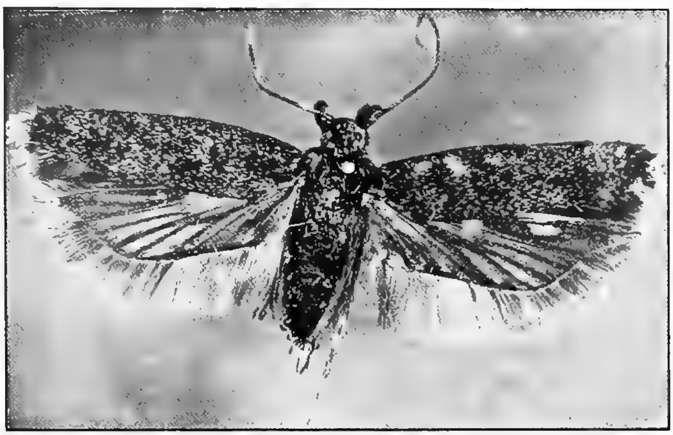


6.

Gelechia gossypiella and its early stages.

DOMESTIC MOSQUITOS OF THE NORTHERN PROVINCES OF NIGERIA.

By W. B. Johnson, M.B., B.S., F.R.C.S.,

West African Medical Staff.

During six years medical work in the northern provinces of Nigeria I have caught and examined every morning all the mosquitos I could find in my own bungalow. I have done this with a view to finding out which are the common domestic species in this region of West Africa, and their seasonal variation throughout the year.

The results are shown in the first four tables appended, and Table V shows a combination of the totals of all these tables.

The work has been done at Kaduna Junction (1917–1918), Katagum (1916), Zungeru (1915–1916), and Zungeru (1912); and the four series of figures show marked similarity. Kaduna Junction is placed on the left bank of the Kaduna River in Zaria Province. It is on laterite, hilly ground sloping towards the river, which forms a half circle round the station. An extensive marsh in the rains lies to the east of the station, and partly flooded marshy ground lies along the river banks at high water. A series of thickly-wooded gullies traverse part of the station towards the river, and afford additional mosquito breeding-grounds. Katagum is a small bush station on sandy soil on the left bank of the Katagum river in Kana Province. In the dry season the river ceases to flow, and remains as a series of pools in the sandy river bed, but in the rains it floods the surrounding country, and the station is merely an island surrounded on all sides by marsh. Zungeru is placed in the angle of junction of the river Dago with the river Kaduna in Niger Province. It is built on three laterite ridges, between two of which flows the Dago River; between the other two ridges is marshy ground during the rains, and rocky pools and marsh lie along the banks of both rivers, except during very high water.

Before commenting upon the figures given in the tables it must be pointed out that inexpensive anti-mosquito measures are energetically carried out in the stations referred to. Thus water-tanks when present are screened, gutters pierced, and compounds visited frequently by the medical officer; the occupant of any compound is fined if larvae are found. These measures diminish enormously the numbers of such domestic-breeding mosquitos as *Stegomyia fasciata* and *Culex duttoni*, which occur in great numbers if the work is neglected. Grass and bush is cleared by prison labour or by labour paid out of the sanitary vote; but extensive anti-mosquito measures, such as drainage of swamps, are not possible owing to lack of funds for the purpose.

During the periods recorded, which extended over $40+7+27+15=89$ weeks, I have caught in my own bungalow 11,514 mosquitos. Referring to Tables I-VI, the following points appear worthy of notice :—

1. **High percentage of Anopheles obtained.**

The percentage of *Anopheles* to total mosquitos caught was 88·7 (83·4 per cent., 99·6 per cent., 75·7 per cent., 89·5 per cent.). Even if Katagum (Table II) be excluded—the station being exceptional owing to the marshy nature of the country—the percentage is still high, viz., 82·9 per cent.

2. **Preponderance of certain species of Anopheles.**

In all, 10 species of *Anopheles* were obtained (including one new species). *A. costalis* and *A. funestus* show an overwhelming preponderance, forming 92·9 per cent. of all the *Anopheles* obtained.

	Table I Kaduna.	Table II Katagum.	Table III Zungeru.	Table IV Zungeru.	Combined tables.
A. costalis	81·1%	25·1%	42·6%	61·7%	54·3%
A. funestus	16·6%	66·5%	38·6%	23·0%	38·6%
Other species of *Anopheles*	2·3%	8·4%	18·8%	15·3%	7·1%

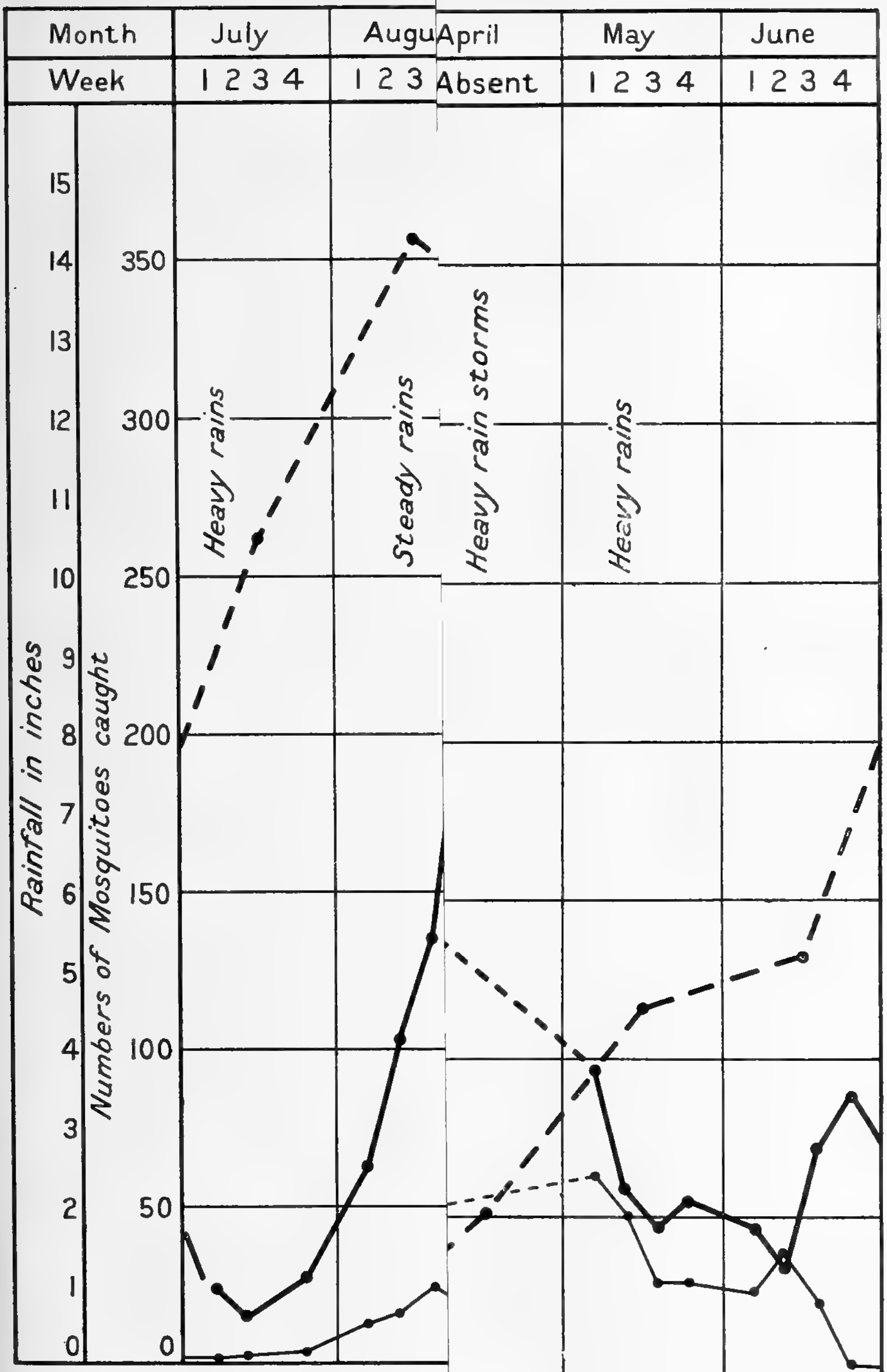
If *A. rufipes* is included with *A. costalis* and *A. funestus* these three species form 98·4 per cent. of all the *Anopheles* obtained :—

	Table I Kaduna.	Table II Katagum.	Table III Zungeru.	Table IV Zungeru.	Combined tables.
A. costalis, A. funestus and *A. rufipes*	98·7%	98·8%	96·5%	96·5%	98·4%
Other species of *Anopheles*	1·3%	1·2%	3·5%	3·5%	1·6%

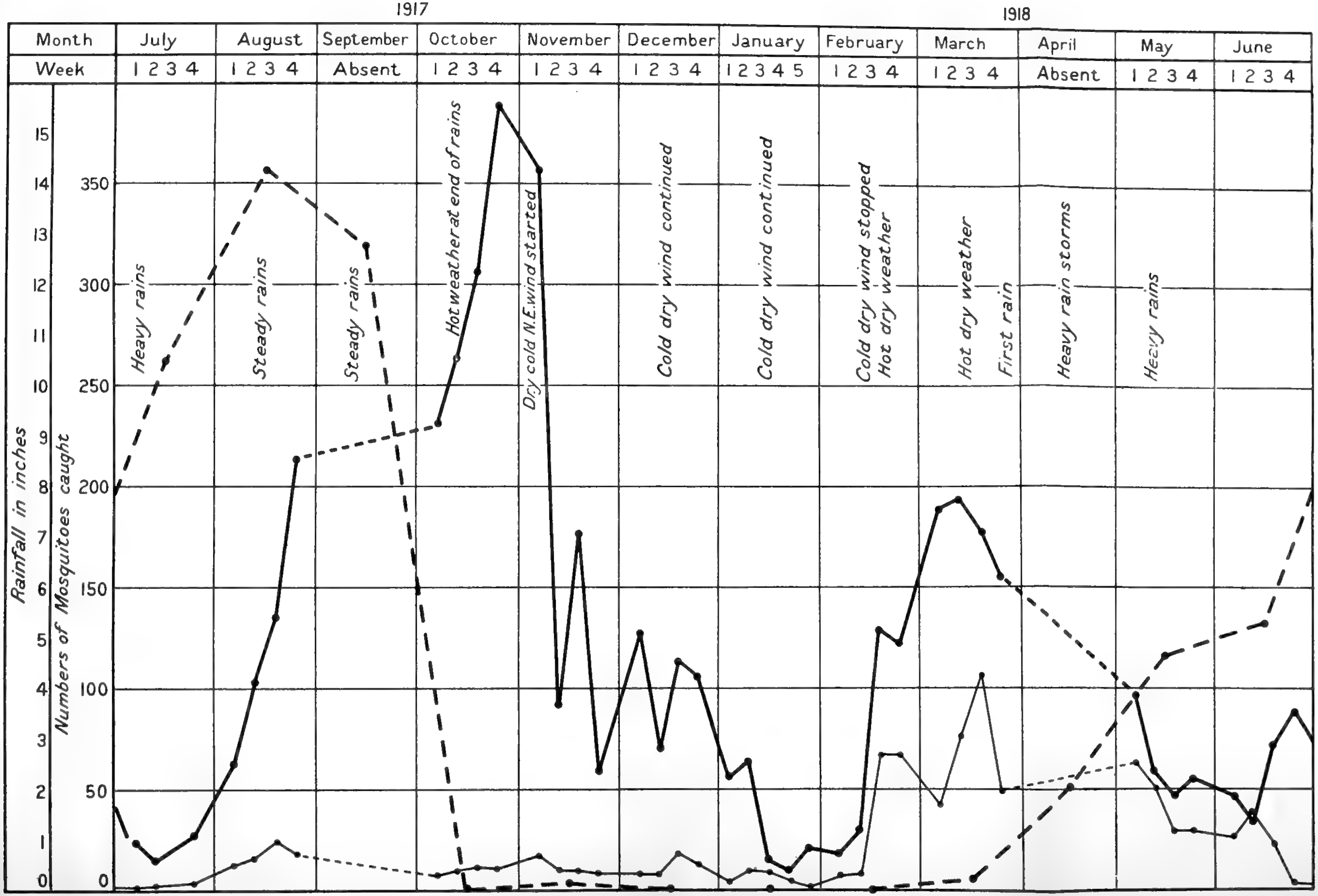
This high proportion of *A. costalis* and *A. funestus* as domestic pests appears to hold good all over the country. As a further example I may quote the following—a short experience at Ibi station on the river Benue compared with two journeys upon the same river by steamer :—

	A. costalis and *A. funestus* (combined).	Other *Anopheles*.	Other Mosquitos.	% of *A. costalis* and *A. funestus* to total *Anopheles*.
At Ibi station :— 3 weeks in Aug., 1918	249	2	4	99·2%
On boat on R. Benue 29 days, Sept. 1917 and July 1918 ..	180	105*	82	63·1%

* *A. wellcomei* and *A. nili.*



Rainfall in inches per mont-*oup caught per week* ——— .



Rainfall in inches per month — — — —. Number of Anopheles caught per week ———. Number of Culex group caught per week ———.

The new species, *A. domicolus*, was described by Mr. F. W. Edwards (Bull. Ent. Res. vi, p. 363) from specimens caught in my house at Zungeru, and I have since obtained it at Kaduna Junction.

3. **Stegomyia group.**

Stegomyia formed only 0·2 per cent. of all mosquitos obtained. This is largely due to active measures of sanitation, as *Stegomyia fasciata* swarms in neglected stations. It is an interesting fact that although *Stegomyia vittata* (*sugens*) breeds by thousands in rocky holes filled with clear water in the river beds at Kaduna and Zungeru during low water, I have never caught this mosquito in my house, and have only once obtained its larvae from a domestic water-pot. A further point of interest is that although I frequently obtained the larvae of *Stegomyia unilineata*—the African representative of the Oriental *Stegomyia variegata* (*scutellaris*)—from hollow trees at Kaduna, I never obtained this mosquito in my house. The presence of *S. unilineata* should, however, be remembered in view of the fact that yellow fever has occurred at Kaduna.

4. **Culex group.**

The species of Culex are most numerous during the hot dry season before the rains and during the early rains. *Culex decens* and *C. invidiosus* formed an overwhelming majority of the Culicines caught in my house. Thus of 1,277 Culicines examined these two species together formed 1,133 or 88·8 per cent. of the total obtained. *Culex duttoni*, which is a common domestic mosquito in Nigeria, N.P., does not form a high proportion of the *Culex* obtained, probably for the same reason that the *Stegomyia* figure is so low. In Northern Nigerian stations closely surrounded by marsh *Mansonioides uniformis* forms a high percentage of this group as a domestic pest.

5. **Seasonal Variation.**

The seasonal variation of *Anopheles* and *Culex* during one year is shown in a graph (fig. 1) taken from Table I. The figures are lowest in January, during the dry season when the cold dry " harmattan " wind is blowing and the nights are cold. There is an immediate rise on the cessation of the harmattan wind (February on the graph), which is maintained during the hot dry weather preceding the rains. Early heavy rains cause a fall in the numbers obtained (May to July on the graph), but during the steady rains of August the figure rises rapidly, reaching a maximum in October, the month after cessation of the rains. The commencement of the cold " harmattan " wind in early November causes an immediate large fall in the numbers obtained, and the numbers steadily decrease during the cold dry months of December and January.

6. **Relative Domesticity of various Species.**

To form some idea of the real mosquito pests to man I think there is some value in obtaining the adult mosquitos caught in a house over a prolonged period. A totally false idea is obtained from a " larval or mosquito survey " of a station, as the common mosquito larvae obtained may not be the common domestic mosquitos. At Zungeru I have bred out large numbers of mosquitos, and would have come to the conclusion from that alone that *Stegomyia vittata* (*sugens*), *Uranotaenia ?coeruleocephala* and *Culiciomyia nebulosa* were the common mosquitos of the station, whereas only the latter was obtained in my house, and that only rarely. Next in order of frequency I bred out *A. costalis, A. funestus, Culex decens, C. invidiosus* and *C. ager*. The list given below shows (1) mosquitos obtained from larvae at Kaduna, Zungeru, and Katagum, but not caught as adults in my house, and (2) adult mosquitos caught in these stations but not in houses :—

Bred from larvae, not caught in house.	Caught as adults in station, but not in house.
Stegomyia vittata	*Stegomyia vittata*
,, *unilineata*	,, *apicoargentea*
Ochlerotatus ?wellmani	,, *africana**
,, *?quasiunivittatus*	,, *simpsoni**
,, *?punctothoracis*	*Ochlerotatus cumminsi**
Taeniorhynchus annetti	*Culex annulioris*
Uranotaenia ?coeruleocephala	

* Caught by the late Dr. J. E. L. Johnston in 1914 at Kaduna.

7. **Conclusion.**

(a) The common mosquitos which infest houses in certain stations in Nigeria, N.P., are *Anopheles costalis*, Theo., *A. funestus*, Giles, *A. rufipes*, Gough, *Culex decens*, Theo., and *C. invidiosus*, Theo. These five species together formed 97·1 per cent. of 11,514 mosquitos caught in the medical officer's house at Kaduna, Katagum, and Zungeru, during a period of 89 weeks, whereas the remaining 17 species obtained formed only 2·9 per cent. of the total. It is tempting to state that for purposes of parasitological work these five species alone need be considered, but there is an obvious fallacy in such a statement in that certain other species are really common, but are kept under control by anti-mosquito measures, to which they are especially vulnerable owing to their selection of breeding places. Amongst this latter class must be placed *Stegomyia fasciata*, F., *Culex duttoni*, Theo., and *Culiciomyia nebulosa*, Theo. It should also be remembered that in certain stations *Mansonioides uniformis*, Theo., is numerous and may also be a house-infesting mosquito.

(b) Other species of mosquitos may be breeding freely in a station but may not be domestic pests—e.g., *Stegomyia vittata*, Big., *S. unilineata*, Theo., *Uranotaenia ?coeruleocephala*, Theo.

(c) The seasonal variation of mosquitos as domestic pests, which is well shown in the graph (fig. 1), is, I think, typical of what occurs generally in stations in Nigeria, N.P. This may be usefully remembered in comparing seasonal sickness returns for this country, especially returns of "pyrexia of uncertain origin."

In conclusion I wish to express my deep obligation to Col. A. Alcock, F.R.S., Mr. F. W. Edwards, and Dr. and Mrs. Connal, of the Medical Research Institute, Yaba, for kindly confirming my identification of species from time to time.

	1918. Iay.				1918. June.				Total for 40 weeks.		Percentages.
	5 1	12 18	19 26	27 2	3 9	10 16	17 23	24 30			
Anopheles-											
A. costa	2	37	33	37	31	23	45	42	2,695	3,685	81·1% of total *Anopheles*
	5	16	11	9	7	3	20	28	990		
A. funes	5	4	1	7	6	3	5	7	509	756	16·6% ,, ,, ,,
	3	2	1	1	1	3	1	11	247		
A. rufip	1			1					23	45	1·0% ,, ,, ,,
	1								22		
A. preto									10	21	0·5% ,, ,, ,,
									11		
A. domi									*8	20	0·4% ,, ,, ,,
									12		
A. flavic									6	11	0·2% ,, ,, ,,
									5		
A. nili									—	3	0·1% ,, ,, ,,
									3		
Stegomy		1							6	15	
		1				1			9		
Culex Grou											
Culex de	30	23	4	13	15	15	11		334	760	85·7% of total *Culex* group
	30	18	9	6	5	21	9		426		
Culex in		4	2			1			10	49	5·5% ,, ,, ,,
		1	3	3					39		
Culex du	1	1							5	38	4·3% ,, ,, ,,
	1	3	6	1	2	1	1	1	33		
Culex ag					2		1		4	9	1·0% ,, ,, ,,
	1								5		
Culex fa									—	2	0·2% ,, ,, ,,
									2		
Culex tig									—	3	0·3% ,, ,, ,,
									3		
Culiciom									2	23	2·6% ,, ,, ,,
					1			1	21		
Mansoni									—	3	0·3% ,, ,, ,,
									3		
Total *An*	97	59	46	55	45	32	71	88	4,541		83·4% of total Mosquitos
Total *Ste*		2				1			15		0·3% ,, ,,
Total *Cu*	63	50	24	23	25	38	22	2	887		16·3% ,, ,,

TABLE I.—*Mosquitos caught in Daily Examination of the Medical Officer's Bungalow at Kaduna Junction*, 1917-18.

WEEKLY TOTALS.

	Year.	1917.			1917.						1917.			1917.				
	Month.	July.			August.						October.			November.				
	From / To	1 / 7	8 / 14		29 / 4	5 / 11	12 / 18	19 / 25	26 / 1		8 / 14	15 / 21	22 / 28	29 / 4	5 / 11	12 / 18	19 / 25	26 / 2
Anopheles—	Sex.			Absent from Station for two weeks.						Absent from Station for five weeks.								
A. costalis	♂	10	10		16	45	69	76	147		92	130	158	206	155	53	97	40
	♀	7	3		5	2	18	33	34		73	92	87	110	99	16	29	12
A. funestus	♂	7	1		5	9	10	13	32		36	24	39	42	55	10	30	3
	♀					8	7	13	11		24	13	16	19	24	7	14	3
A. rufipes	♂										2		1	1	4			
	♀										1	1		4	9	1		
A. pretoriensis	♂										1	1	3	1	2		1	
	♀										1	1		5	1			
A. domicolus	♂											2	1		1		1	
	♀												1	2	7		2	
A. flavicosta	♂															3		1
	♀															1	1	
A. nili	♂																	
	♀											1					1	
Stegomyia fasciata ..	♂																3	1
	♀																3	
Culex Group— *Culex decens*	♂				1	1	3	6	8		2	2	2	2	2	1		1
	♀	1	1		2	3	10	12	2		2	5	4	7	8	5	5	3
Culex invidiosus ..	♂								2									
	♀								2				1		3	2	1	3
Culex duttoni	♂																	
	♀					2		3	1			1			1			
Culex ager	♂															1		
	♀														1			
Culex fatigans	♂																	
	♀																1	
Culex tigripes	♂																	
	♀																1	
Culiciomyia nebulosa ..	♂													1				
	♀		1			5	2	3	2		1	1	2		1		1	
Mansonioides uniformis	♂																	
	♀										1		2					
Total *Anopheles* ..		24	14		26	64	104	135	224		230	265	306	390	357	91	176	59
Total *Stegomyia* ..																	6	1
Total *Culex* group ..		1	2		3	11	15	24	17		6	9	11	10	16	9	9	7

	Year.	1917.				1918.				1918.					1918.				
	Month.	December.				January.				February.					March.				
	From / To	3 / 8	9 / 15	16 / 22	23 / 29	30 / 5	6 / 12	13 / 19	20 / 26	27 / 2	3 / 9	10 / 16	17 / 23	24 / 2	3 / 9	10 / 16	17 / 23	24 / 30	
Anopheles—	Sex.																		Absent from Station for five weeks.
A. costalis	♂	80	40	78	68	38	37	8	2	8	10	19	84	81	140	146	131	101	
	♀	16	15	23	24	11	11	3	4	9	3	6	32	24	25	19	16	20	
A. funestus	♂	20	11	7	10	4	8	1	2	2	2	2	10	12	18	16	15	15	
	♀	8	2	1	3	2	7	1		1	2	1	1	4	4	9	9	10	
A. rufipes	♂	2					1								1	1	5	3	
	♀			1											1	1	1	1	
A. pretoriensis	♂																		
	♀															1		2	
A. domicolus	♂		2	1															
	♀																		
A. flavicosta	♂			1									1						
	♀	1		1										1					
A. nili	♂																		
	♀															1			
Stegomyia fasciata ..	♂																	1	
	♀	1					2										1		
Culex Group— *Culex decens*	♂	2	2	8	3		2	3			3	3	37	22	21	34	41	11	
	♀	5	3	8	8	1	7	4	3	1	2	5	27	43	19	37	53	32	
Culex invidiosus ..	♂																1		
	♀			1			2				2		1	2		3	6	3	
Culex duttoni	♂															2	1		
	♀					1		1	1				1				4	1	
Culex ager	♂																		
	♀					1							1					1	
Culex fatigans	♂																		
	♀		1																
Culex tigripes	♂																		
	♀		1															1	
Culiciomyia nebulosa ..	♂														1				
	♀																		
Mansonioides uniformis	♂																		
	♀																		
Total *Anopheles* ..		127	70	113	105	55	64	13	8	20	17	28	128	122	189	194	177	153	
Total *Stegomyia* ..		1					2										1	1	
Total *Culex* group ..		7	7	17	11	3	11	8	4	1	7	8	67	67	41	76	106	49	

	Year.	1918.				1918.				Total for 40 weeks.		Percentages.
	Month.	May.				June.						
	From / To	5 / 11	12 / 18	19 / 26	27 / 2	3 / 9	10 / 16	17 / 23	24 / 30			
Anopheles—	Sex.											
A. costalis	♂	72	37	33	37	31	23	45	42	2,695	3,685	81·1% of total *Anopheles*
	♀	15	16	11	9	7	3	20	28	990		
A. funestus	♂	5	4	1	7	6	3	5	7	509	756	16·6% ,, ,, ,,
	♀	3	2	1	1	1	3	1	11	247		
A. rufipes	♂	1			1					23	45	1·0% ,, ,, ,,
	♀	1								22		
A. pretoriensis	♂									10	21	0·5% ,, ,, ,,
	♀									11		
A. domicolus	♂									·8	20	0·4% ,, ,, ,,
	♀									12		
A. flavicosta	♂									6	11	0·2% ,, ,, ,,
	♀									5		
A. nili	♂									—	3	0·1% ,, ,, ,,
	♀									3		
Stegomyia fasciata ..	♂		1							6	15	
	♀		1				1			9		
Culex Group— *Culex decens*	♂	30	23	4	13	15	15	11		334	760	85·7% of total *Culex* group
	♀	30	18	9	6	5	21	9		426		
Culex invidiosus ..	♂		4	2			1			10	49	5·5% ,, ,, ,,
	♀		1	3	3					39		
Culex duttoni	♂	1	1							5	38	4·3% ,, ,, ,,
	♀	1	3	6	1	2	1	1	1	33		
Culex ager	♂					2		1		4	9	1·0% ,, ,, ,,
	♀	1								5		
Culex fatigans	♂									—	2	0·2% ,, ,, ,,
	♀									2		
Culex tigripes	♂									—	3	0·3% ,, ,, ,,
	♀									3		
Culiciomyia nebulosa ..	♂									2	23	2·6% ,, ,, ,,
	♀					1			1	21		
Mansonioides uniformis	♂									—	3	0·3% ,, ,, ,,
	♀									3		
Total *Anopheles* ..		97	59	46	55	45	32	71	88	4,541		83·4% of total Mosquitos
Total *Stegomyia* ..			2				1			15		0·3% ,, ,,
Total *Culex* group ..		63	50	24	23	25	38	22	2	887		16·3% ,, ,,

Rainfall 1917 (July to November) = 37·7 ins. ; 1918 (March to June) = 12·2 ins.
Total mosquitos examined in 40 weeks =5,443 of which 83·4 % were *Anopheles*.
Anopheles—♂ 3,251 to ♀ 1,290 ; i.e., ♂ : ♀ : : 2·5 : 1.
Culex— ♂ 355 to ♀ 532 : i.e., ♂ : ♀ : : 2 : 3.

TABLE II.—*Mosquitos Caught in Daily Examination of M.O.'s Bungalow at Katagum in* 1916.

WEEKLY TOTALS.

Species.	From / To	October 6–12	13–19	20–26	27–31	November 1–8	9–15	16–22	Total for Seven Weeks.		Percentages.
Anopheles—	Sex										
A. costalis	M	96	47	46	33	3	4	25	254	1002	25·1 % of total *Anopheles*
	♀	132	59	92	192	163	37	73	748		
A. funestus	♂	45	53	56	52	6	10	84	306	2657	66·5 % ,, ,, ,,
	♀	105	71	100	703	915	177	280	2351		
A. rufipes	♂	8	11	17	19	7	7	34	103	286	7·2 % ,, ,, ,,
	♀	10	10	32	20	9	9	93	183		
A. pharoensis	♂	–	–	–	–	–	–	–	–	42	1·1 % ,, ,, ,,
	♀	–	2	10	14	7	3	6	42		
A. mauritianus	♂	–	–	–	–	–	–	–	–	5	0·1 % ,, ,, ,,
	♀	–	–	2	1	–	–	2	5		
A. squamosus	♂	–	–	–	–	–	–	–	–	2	0·05 % ,, ,, ,,
	♀	–	–	–	–	2	–	–	2		
A. flavicosta	♂	–	–	–	–	–	–	–	–	1	0·02 % ,, ,, ,,
	♀	–	–	–	–	–	–	1	1		
Stegomyia Group											
Steg. fasciata	♂	–	–	–	–	–	–	–	–	1	
	♀	–	–	–	–	–	1	–	1		
Ochlerotatus ochraceus	♂	–	–	–	–	–	–	–	–	1	
	♀	–	–	–	1	–	–	–	1		
Culex Group											
Culex decens	♂	–	–	–	–	–	–	–	–	1	
	♀	1	–	–	–	–	–	–	1		
Culex grahami	♂	–	–	–	–	–	–	–	–	2	
	♀	2	–	–	–	–	–	–	2		
Mansonioides uniformis	♂	–	–	–	–	–	–	–	–	10	
	♀	1	2	–	1	–	5	1	10		
Total *Anopheles*		396	253	355	1034	1112	247	598	3995		99·6 % of total Mosquitos
Total *Stegomyia* Group		–	–	–	1	–	1	–	2		0·05 % ,, ,, ,,
Total *Culex* Group		4	2	–	1	–	5	1	13		0·3 % ,, ,, ,,

Rainfall at Katagum for 1916 = 21·15 ins.
Total mosquitos examined in seven weeks = 4,010, of which 99·6% were *Anopheles.*
Relation of males to females :—*Anopheles* ♂ 663, ♀ 3,332 ; i.e., ♂ : ♀ : : 1 : 5.

TABLE III.—*Mosquitos caught in Daily Examination of M.O.'s Bungalow at Zungeru*, 1915-1916.

Species	Month	1915						WEEKLY TOTALS.													1916								Total for 27 weeks.	Percentages.
		Oct.		November				December					January				Feb.				March				April					
	From	20	27	3	10	17	24	1	8	15	22	29	5	12	19	26	2	9	16	23	1	8	15	22	29	5	12	19		
	To	26	2	9	16	23	30	7	14	21	28	4	11	18	25	1	8	15	22	29	7	14	21	28	4	11	18	25		
Anopheles—																														
A. costalis		94	93	55	51	25	25	2		-	-	-	-	-	-	3	-	1	-	-	3	5	3	3	2	12	7	3	387	42·6% of total *Anopheles*
A. funestus		96	143	48	28	18	12	3	1	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	351	38·6% ,, ,,
A. rufipes		14	16	38	28	15	10	1	1	4	1	-	-	-	-	2	1	-	-	-	-	1	-	-	-	3	3	1	139	15·3% ,, ,,
A. pretoriensis			-	3	-	2	-	1		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	7	0·8% ,, ,,
A. flavicosta		1	5	6	3	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19	2·1% ,, ,,
A. domicolus		-	1	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	0·6% ,, ,,
Stegomyia Group		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	—	
Culex Group																														
Culex decens		1	-	1	-	1	2	-	-	1	2	-	-	-	-	19	5	1	-	-	16	13	5	6	13	37	19	38	180	61·6% of total *Culex* group
Culex invidiosus		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19	29	31	79	27·1% ,, ,,
Culex tigripes		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4	5	13	4·4% ,, ,,
Culex quasigelidus		-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	2	0·7% ,, ,,
Culex ager		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	4	1·4% ,, ,,
Culiciomyia nebulosa		2	-	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	10	3·4% ,, ,,
Mansonioides uniformis		-	3	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	4	1·4% ,, ,,
Total *Anopheles*		205	258	153	112	63	48	7	2	4	2	-	-	-	-	5	1	1	-	-	4	6	3	3	2	15	11	4	909	75·7% of total mosquitos
Total *Stegomyia* group		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	—	
Total *Culex* group		3	3	4	2	1	2	-	1	1	2	-	-	-	-	20	5	1	-	-	16	13	6	6	13	60	56	77	292	24·3% ,,

Rainfall 1915 (April to October) = 54·61ins. 1916 (March and April) 2·26ins.
Total mosquitos examined in 27 weeks = 1,201, of which 75·7% were *Anopheles*.

TABLE IV.—*Mosquitos caught in Daily Examination of M.O.'s Bungalow at Zungeru,* 1912.

Species. Month: / Period in days:	June and July (60)	Oct. (15)	Nov. (15)	Dec. (15)	Total for 15 weeks	Percentages.
Anopheles						
A. costalis	45	407	21	2	475	61·7% of total *Anopheles*
A. funestus	5	165	4	3	177	23·0% ,, ,,
A. rufipes	7	49	31	4	91	11·8% ,, ,,
A. pretoriensis	2	20	4	–	26	3·4% ,, ,,
A. pharoensis	–	1	–	–	1	0·1% ,, ,,
Stegomyia fasciata	5	–	–	–	5	
Culex group						
Culex decens	30	3	–	1	34	40·0% of total *Culex* group
Culex invidiosus	25	5	–	–	30	35·3% ,, ,,
Culex tigripes	5	5	–	–	10	11·8% ,, ,,
Culex ager	3	1	–	–	4	4·7% ,, ,,
Culex duttoni	3	–	–	–	3	3·5% ,, ,,
Culiciomyia nebulosa	–	3	–	–	3	3·5% ,, ,,
Mansonioides uniformis	–	1	–	–	1	1·2% ,, ,,
Total *Anopheles*	59	642	60	9	770	89·5% of total mosquitos
Total *Stegomyia*	5	–	–	–	5	0·6% ,, ,,
Total *Culex* group	66	18	–	1	85	9·9% ,, ,,

Rainfall in 1912 (May to September) = 29·93ins.
Total mosquitos examined in 15 weeks = 860, of which 89·5% were *Anopheles*.

TABLE V.

COMBINATION OF TABLES I.–IV.—*Mosquitos caught in M.O.'s Bungalow.*

Species.	From Table I. Kaduna 1917–18. 40 weeks.	From Table II. Katagum 1916. 7 weeks.	From Table III. Zungeru 1915–16. 27 weeks.	From Table IV. Zungeru 1912. 15 weeks.	Total for 89 weeks.	Percentages.
Anopheles—						
A. costalis	3685	1,002	387	475	5,549	54·3 % of total *Anopheles*
A. funestus	756	2,657	351	177	3,941	38·6 % ,, ,,
A. rufipes	45	286	139	91	561	5·5 % ,, ,,
A. pretoriensis	21	—	7	26	54	0·5 % ,, ,,
A. pharoensis	—	42	—	1	43	0·4 % ,, ,,
A. flavicosta	11	1	19	—	31	0·35 % ,, ,,
A. domicolus	20	—	6	—	26	0·25 % ,, ,,
A. mauritianus	—	5	—	—	5	0·05 % ,, ,,
A. nili	3	—	—	—	3	0·03 % ,, ,,
A. squamosus	—	2	—	—	2	0·02 % ,, ,,
Stegomyia fasciata	15	1	—	5	21	
Ochlerotatus ochraceus	—	1	—	—	1	
Culex group—						
Culex decens	760	1	180	34	975	76·4 % of total *Culex* group
Culex invidiosus	49	—	79	30	158	12·4 % ,, ,,
Culex duttoni	38	—	—	3	41	3·2 % ,, ,,
Culex tigripes	3	—	13	10	26	2·0 % ,, ,,
Culex ager	9	—	4	4	17	1·3 % ,, ,,
Culex fatigans	2	—	—	—	2	0·16 % ,, ,,
Culex grahami	—	2	—	—	2	0·16 % ,, ,,
Culex quasigelidus	—	—	2	—	2	0·16 % ,, ,,
Culiciomyia nebulosa	23	—	10	3	36	2·8 % ,, ,,
Mansonioides uniformis	3	10	4	1	18	1·4 % ,, ,,
Total *Anopheles*	4,541	3,995	909	770	10,215	88·7 % of total Mosquitos
Total *Stegomyia* group	15	2	—	5	22	0·2 % ,, ,,
Total *Culex* group	887	13	292	85	1,277	11·1 % ,, ,,

Total number of Mosquitos examined = 11·514.

INVENTAIRE D'UNE COLLECTION D'OESTRIDES AFRICAINS.

Par L. GEDOELST.

Les larves d'Oestrides qui font l'objet de la présente note ont été récoltées sur le continent africain et nous ont été soumises pour détermination par Monsieur Guy A. K. Marshall, Directeur du Bureau Impérial d'Entomologie de Londres. Elles appartiennent à quatre des sous-familles auxquelles on rapporte les diptères que l'on convient de désigner communément sous le nom d'Oestrides : les GASTEROPHILINAE, les OESTRINAE, les HYPODERMINAE et les COBBOLDIINAE.

Fam. MUSCIDAE.
Subfam. GASTEROPHILINAE.
Gyrostigma, Brauer, 1884.
(Syn. : *Spathicera,* Corti, 1895.)

1. **Gyrostigma meruense,** Sjöstedt, 1908.

Syn. : *Spathicera meruensis,* Sjöstedt, 1908 ; *Gyrostigma meruense,* Enderlein, 1911.

Quatre exemplaires récoltés dans le Nord-Nyasa par Dr. J. B. Davey. Cette belle espèce a été décrite par Sjöstedt, qui l'avait trouvée dans l'estomac du *Diceros bicornis,* L., en Afrique orientale allemande.

Gasterophilus, Leach, 1817.

(Syn. : *Gastrus,* Meigen, 1824 ; *Enteromyza,* Rondani, 1857 ; *Gastrophilus,* auct.)

2. **Gasterophilus ternicinctus,** Gedoelst, 1912.

Exemplaires recueillis par Dr. J. E. S. Old au Nyasaland, Muona, Ruo District. Cette espèce est connue comme parasite d'un zèbre, probablement *Equus chapmani crawshayi,* De Winton, au Katanga.

Fam. LARVEVORIDAE.
Subfam. OESTRINAE.
Oestrus, Linné, 1758.
(Syn. : *Cephalemyia,* Latreille, 1818.)

3. **Oestrus interruptus,** sp. nov.

Syn. : *Oestrus* No. 1, Brauer, 1896 ; larve d'*Oestrus variolosus,* King, 1911 (non Roubaud, 1914).

Longueur, 22 à 27 mm. ; largeur, 10 à 11 mm.

La forme du corps est ellipsoïdale allongée, à extrémité antérieure régulièrement arrondie, à extrémité postérieure légèrement tronquée ; la face ventrale est plane, la face dorsale convexe. La largeur des anneaux augmente d'avant en arrière et atteint son maximum au niveau des segments 7 et 8, au delà desquels elle diminue progressivement. La longueur croît jusqu'au 6e anneau, reste sensiblement invariable du 6e au 9e, diminue légèrement sur les 10e et 11e et présente son maximum sur le 12e par suite du développement du prolongement ventral postérieur. A la face ventrale, on peut observer des tubercules vers le milieu des anneaux, mais ils sont peu apparents, étant dépourvus de toute saillie; des champs intermédiaires au nombre de 5 y sont régulièrement disposés, entre les anneaux 5 à 10. A la face dorsale existent 7 à 8 champs intermédiaires fort développés interposés entre les segments 3 ou 4 à 11.

La spinulation est répartie exclusivement sur la face ventrale. Sur le segment céphalique, on n'observe des épines que sur le bourrelet labial qui délimite inférieurement l'atrium buccal ; elles sont minuscules et disposées sur plusieurs rangées. Le 3me segment porte deux rangées d'épines largement interrompues sur la ligne médiane ; cette interruption comporte au moins le tiers de la largeur de l'anneau ; parfois une 3e rangée se trouve amorcée latéralement ; exceptionnellement on peut observer une rangée de petites épines qui unit sur la ligne médiane les deux moitiés latérales. Les anneaux 4, 5 et 11 portent trois rangées avec parfois l'indication d'une 4e rangée sur les anneaux 5 et 11. Les anneaux 6 à 10 sont pourvus de quatre rangées ; ces rangées sont assez régulières et sur un même anneau, les épines des rangées moyennes l'emportent en général de dimensions sur celles des rangées antérieure et postérieure. L'anneau 12 est armé de 2 à 3 rangées ; enfin on observe encore des épines disposées plus ou moins régulièrement sur 3 à 4 rangées à la face supérieure du bourrelet qui termine en arrière le segment postérieur.

Par la formule numérique de sa spinulation, *Oestrus interruptus* se rapproche d'*Oestrus disjunctus* et d'*Oestrus variolosus*, comme le montre le tableau comparatif suivant, où les chiffres pour chaque segment indiquent le nombre des rangées d'épines:

Segments.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Oestrus interruptus	2	3	3–4	4	4	4	4	4	3–4	2–3
Oestrus disjunctus	2	3	3	4	4	4	4	4	4	3
Oestrus variolosus	1–2	2–3	3	3–4	4	4	4–5	4–5	3	2

On différenciera toujours aisément *Oestrus interruptus* des deux autres espèces, non seulement par l'armature interrompue du 3e anneau, mais aussi par certains caractères des épines, qui sont surtout évidents sur les anneaux 6 à 10 : Sur les rangées moyennes les épines sont serrées les unes contre les autres et leurs bases fort développées affectent par pression réciproque une forme quadratique assez régulière et tout à fait caractéristique.

Oestrus interruptus semble être une espèce assez répandue ; nous l'avons rencontré dans sept lots de larves : les unes provenaient de l'Afrique orientale portugaise, où elles avaient été recueillies par S. A. Neave dans les sinus frontaux d'un *Connochoetes taurinus johnstoni*, Sclater, et de *Sigmoceros lichtensteini*, Peters ; d'autres avaient été récoltées en Uganda par C. C. Gowdey dans les cavités nasales d'un animal dénommé Kongoni (*Bubalis jacksoni*, Thomas) et par Dr. H. Lyndhurst Duke dans les cavités nasales d'un *Damaliscus lunatus*, Burchell ; enfin d'autres encore étaient originaires du Nyasaland, où elles avaient été recueillies par Dr. J. E. S. Old et Dr. J. B. Davey dans les cavités nasales et les sinus frontaux de *Sigmoceros lichtensteini*, Peters.

D'autre part ayant pu examiner les spécimens originaux de Brauer, nous avons reconnu que son *Oestrus* des cavités nasales et frontales de *Bubalis cokei* (Mont Gurui, Afrique orientale), espèce No. 1 de O. Neumann, est en réalité *Oestrus interruptus.* C'est à la même espèce que nous rapportons la larve que King a figurée sous le nom d'*Oestrus variolosus.* Ce sont en effet des examplaires d'*Oestrus interruptus* que ce savant naturaliste a bien voulu nous communiquer pour répondre à notre demande de pouvoir étudier ses larves d'*Oestrus variolosus.* La figure de King reproduit très exactement les champs intermédiaires ventraux que nous avons signalés ci-dessus chez *Oestrus interruptus.* Les examplaires que nous avons recus provenaient du *Damaliscus korrigum,* Ogilby.

4. **Oestrus ovis,** Linné, 1758.

Nous avons trouvé cette espèce dans deux lots : le premier provenait de Zanzibar et avait été recueilli par le Dr. W. M. Aders dans les cavités nasales d'une chèvre ; le second était originaire de Port Herald, Nyasaland, et contenait une larve récoltée par le Dr. J. E. S. Old, dans les cavités nasales d'un mouton.

5. **Oestrus macdonaldi,** Gedoelst, 1912.

Nous rapportons à cette espèce quelques larves, bien que leur spinulation paraisse légèrement moins abondante que celle des exemplaires types. Elles ont été receuillies, associées à des *Oestrus interruptus* dans les sinus frontaux d'un *Sigmoceros lichtensteini,* Peters, les unes par Dr. J. B. Davey dans le Nord Nyasaland à Fort Hill, une autre par S. A. Neave dans l'Afrique orientale portugaise.

Ces larves ont atteint une évolution plus avancée que celles que nous avons étudiées en 1912. Leur examen nous amène à rectifier un détail de notre description primitive : nous avons dit que la face ventrale des segments est dépourvue de tubercules ; or, les exemplaires de la présente collection en montrent d'une manière très évidente. Nous avons examiné à nouveau les types et reconnu la présence de tubercules, qui n'avaient échappé à notre observation qu'à raison de leur faible développement, comme c'est du reste là règle chez les individus jeunes.

6. **Oestrus aureo-argentatus,** Rodhain & Bequaert, 1912.

Syn. : *Oestrus* No. 1, Sjöstedt, 1908.

Nous rapportons à cette espèce quelques larves après les avoir comparées aux types. C'est d'abord une larve recueillie par S. A. Neave dans les sinus frontaux d'un *Sigmoceros lichtensteini* en Afrique orientale portugaise ; ensuite quelques larves récoltées par Dr. H. Lyndhurst Duke en Uganda dans les cavités nasales d'un *Damaliscus lunatus,* Burchell.

Nous avons reconnu d'autre part que les larves décrites par Sjöstedt sous l'indication *Oestrus* No. 1 des cavités nasales et sinus frontaux de *Connochoetes albojubatus,* Thomas, appartiennent à la même espèce.

L'etude que nous avons pu faire de ces différents matériaux nous a amené à reconnaître chez cette espèce la présence sur la face ventrale des segments de tubercules parfois faiblement accusés cependant toujours bien reconnaissables surtout quand on examine la surface ventrale non de champ, mais de côté.

7. **Oestrus disjunctus,** Gedoelst, 1915.

Nous avons trouvé un exemplaire de cette espèce dans un lot de larves récoltées en Uganda par Dr. H. Lyndhurst Duke dans les cavités nasales d'un *Damaliscus lunatus*, Burchell. Il y était associé à des *Oestrus interruptus*, *Oestrus aureo-argentatus* et *Gedoelstia hässleri.*

Rhinoestrus, Brauer, 1886.

8. **Rhinoestrus purpureus,** Brauer, 1858.

Syn. : *Cephalomyia purpurea*, Brauer, 1858 ; *Oestrus purpureus*, Schiner, 1861.

Des exemplaires de cette espèce ont été récoltés par Capt. Bright à Shendi (Soudan anglo-égyptien) dans les sinus ethmoïdaux d'un mulet. Cet oestride a déjà été signalé en Algerie et au Nyasaland ; nous le connaissons aussi du Maroc.

Gedoelstia, Rodhain & Bequaert, 1913.

9. **Gedoelstia cristata,** Rodhain & Bequaert, 1913.

Syn. : *Oestrus*, Brauer, 1896, de *Alcelaphus* (*Bubalis*) *cokei*, sp. no. 2 O. Neumann ; *Oestrus* no. 2 Sjöstedt, 1910, de *Connochoetes albojubatus.*

Cette intéressante espèce a été recueillie par Dr. J. W. Scott Macfie et est indiquée comme provenant d'un *Sigmoceros lichtensteini*, dans la Nigérie du Nord, Province d'Ilorin. La découverte de cet insecte dans cette région étend considérablement son aire de dispersion, qui ne comprenait jusqu'ici que le Katanga et l'Afrique orientale allemande.

10. **Gedoelstia hässleri,** Gedoelst, 1915.

Syn. : *Oestrus* sp., Brauer, 1896, d'une Antilope : Dr. Hässler, Waboni, Afrique orientale.

Nous avons trouvé cette espèce dans trois lots de larves : l'un provenait de l'Afrique orientale portugaise et avait été récolté par S. A. Neave dans les sinus frontaux d'un *Sigmoceros lichtensteini*, Peters ; un second lot comprenait deux exemplaires recueillis dans les sinus frontaux de la même espèce de Bubale par Dr. H. S. Stannus au Nyasaland ; le troisième lot était originaire de l'Uganda et contenait une larve trouvée par Dr. H. Lyndhurst Duke dans les cavités nasales d'un *Damaliscus lunatus*, Burchell.

Kirkia, Gedoelst, 1914.

11. **Kirkia surcoufi,** Gedoelst, 1915.

Cette espèce s'est rencontrée dans trois lots de larves : dans deux elle se trouvait associée à *Gedoelstia hässleri* (lots recueillis par S. A. Neave en Afrique orientale portugaise et par H. S. Stannus au Nyasaland) ; le troisième lot composé exclusivement par cette espèce a été obtenu aussi par S. A. Neave en Afrique orientale portugaise chez un *Sigmoceros lichtensteini*, Peters. Cet oestride étant déjà renseigné dans la région du Chari, le Haut Sénégal Niger et la Côte d'Ivoire, son aire géographique semble s'étendre de l'ouest à l'est à travers tout le continent africain.

Subfam. HYPODERMINAE.

Dermatoestrus, Brauer, 1892.

12. **Dermatoestrus strepsicerontis,** Brauer, 1892.

Un exemplaire de cette intéressante espèce figure dans la collection et a été recueilli sous la peau d'un *Redunca arundinum*, Boddaert, par Capt. Parsons Smith dans la vallée de Zéraf (Soudan anglo-égyptien). Cet oestride a été signalé antérieurement comme parasite de *Strepsiceros strepsiceros*, Pallas, dans la Colonie du Cap.

Hypoderma, Latreille, 1818.

13. **Hypoderma corinnae,** Crivelli, 1862.

Cet hypoderme est connu comme parasite sous la peau de *Gazella dorcas*, L. Les exemplaires qui figurent dans la présente collection ont été récoltés chez cet hôte par H. A. MacMichael, à Gebel Sungur, Kordofan (Soudan anglo-égyptien).

Subfam. COBBOLDIINAE.

Cobboldia, Brauer, 1887.

14. **Cobboldia loxodontis,** Brauer, 1896.

Ce parasite de l'éléphant d'Afrique est représenté dans deux lots de larves : l'un provient de Masindi (Uganda) et a été récolté par C. C. Gowdey, l'autre de la Côte d'or et a été recueilli par Dr. J. J. Simpson.

Malgré la variété des formes qu'elle contient, cette collection est loin de rendre compte de la richesse en oestrides du continent africain. Déjà Brauer (1892) avait reconnu que cette région du globe héberge la plupart des genres et des espèces alors décrits et il en cite une vingtaine d'espèces.

En 1908, Bezzi en énumère non moins de vingt-huit. Actuellement ce nombre s'est considérablement accru comme on peut le voir par le tableau suivant, où nous avons fait figurer à côté du nom de chaque espèce les indications que l'on possède au sujet de leur répartition en Afrique et des hôtes parasités par leurs larves.

	Hôtes parasités par les larves.	Distribution géographique.
GASTEROPHILINAE.		
Gyrostigma rhinocerontis bicornis, Brauer, 1896 ..	*Diceros bicornis*, L., 1766 ; *Diceros simus*, Burchell, 1817	Afrique orientale allemande.
Gyrostigma pavesii, Corti, 1895	.. ..	Afrique orientale allemande.
Gyrostigma meruense, Sjöstedt, 1908	*Diceros bicornis*, L., 1766 ..	Afrique orientale allemande & anglaise, Nyasaland.
Stomachomyia conjungens, Enderlein, 1901	*Diceros bicornis*, L., 1766 ..	Afrique orientale allemande.
Gasterophilus intestinalis, De Geer, 1776.	*Equus caballus*, L., 1766 ..	Egypte, Algérie, Nubie, Soudan, Côte d'Or, Congo Belge, Mozambique, Colonie du Cap.

Gasterophilinae—*cont.*	Hôtes parasités par les larves.	Distribution géographique.
Gasterophilus intestinalis var. *asininus*, Brauer, 1863..	*Equus asinus*, L., 1766; *Equus caballus*, L., 1766	Soudan anglo-égyptien, Soudan français (Haut Sénégal-Niger).
Gasterophilus haemorrhoïdalis, Linné, 1761.. ..	*Equus caballus*, L., 1766; *Equus asinus*, L., 1766 ..	Congo Belge.
Gasterophilus nasalis, Linné, 1761	*Equus caballus*, L., 1766 ..	Haute-Guinée.
Gasterophilus pecorum, Fabricius, 1794	*Equus caballus*, L., 1766 ..	Côte d'Or.
Gasterophilus flavipes, Olivier, 1811	*Equus asinus*, L., 1766 (?) ..	Egypte, Soudan.
Gasterophilus flavipes pallens, Bigot, 1884	.. ..	Soudan anglo-égyptien
Gasterophilus ternicinctus, Gedoelst, 1912	*Equus chapmani crawshayi*, De Winton, 1896	Katanga, Nyasaland.
Gasterophilus sp. no. 1, Brauer, 1896	*Equus chapmani böhmi*, Matschie, 1892..	Afrique orientale allemande
Gasterophilus sp. no. 2, Brauer, 1896	id.	id.
Gasterophilus sp. no. 3, Brauer, 1896	id.	id.
Gasterophilus sp. no. 1, Sjöstedt, 1908	id.	id.
Gasterophilus sp. no. 2, Sjöstedt, 1908	id.	id.
Gasterophilus sp., Karsch, 1887	*Equus chapmani crawshayi*, De Winton, 1896, ou *böhmi*, Matschie, 1892	id.
Oestrinae.		
Oestrus ovis, Linné, 1758 ..	*Ovis aries*, L., 1766; *Capra hircus*, L., 1766	Algérie, Tunisie, Soudan anglo-égyptien, Sahara central, Sénégal, Nyasaland, Afrique orientale allemande, Zanzibar, Colonie du Cap, Afrique Sud-Ouest allemande, Iles Canaries.
Oestrus variolosus, Loew, 1863	*Bubalis major*, Blyth, 1869 ..	Transvaal, Colonie du Cap, Haute-Côte d'Ivoire, Haut-Sénégal-Niger, Soudan anglo-égyptien, Afrique orientale anglaise.
Oestrus macdonaldi, Gedoelst, 1912	*Sigmoceros lichtensteini*, Peters, 1849	Guinée, Katanga, Nyasaland, Afrique orientale portugaise.
Oestrus aureoargentatus, Rodhain & Bequaert, 1912 ..	*Hippotragus equinus*, Is. Geoffroy, 1816: *Sigmoceros lichtensteini*, Peters, 1849; *Connochoetes albojubatus*, Thomas, 1892; *Damaliscus lunatus*, Burchell, 1824 ..	Katanga, Afrique orientale allemande et portuguaise, Uganda.

OESTRINAE—*cont.*	Hôtes parasités par les larves.	Distribution géographique.
Oestrus interruptus, Gedoelst, 1915	*Connochoetes taurinus johnstoni*, Sclater, 1896; *Sigmoceros lichtensteini*, Peters, 1849; *Bubalis cokei*, Günther, 1884; *Damaliscus lunatus*, Burchell, 1824; *Damaliscus korrigum*, Ogilby, 1836	Afrique orientale portugaise et allemande, Nyasaland, Uganda, Soudan anglo-égyptien, Chari.
Oestrus disjunctus, Gedoelst, 1915	*Damaliscus lunatus*, Burchell, 1824; *Hippotragus equinus*, Is. Geoffroy, 1816	Katanga, Uganda, Maroc.
Oestrus compositus, Gedoelst, 1915	*Sigmoceros lichtensteini*, Peters, 1849..	Abyssinie, Soudan, Afrique orientale anglaise, Katanga, Mozambique.
Rhinoestrus purpureus, Brauer, 1863	*Equus caballus*, L., 1766; le Mulet; le zèbre (?) . ..	Algérie, Maroc, Nyasaland, Soudan anglo-égyptien.
Rhinoestrus hippopotami, Grünberg, 1904	*Hippopotamus amphibius*, L., 1758..	Kamerun, Haut Nil Blanc, Congo Belge.
Rhinoestrus nivarleti, Rodhain & Bequaert, 1912..	*Potamochoerus porcus*, L., 1766	Katanga.
Rhinoestrus sp., Blanchard, 1896	*Phacochoerus africanus*, Gmelin, 1788	Congo français.
Gedoelstia cristata, Rodhain & Bequaert, 1913. ..	*Sigmoceros lichtensteini*, Peters, 1849; *Bubalis cokei*, Günther, 1884; *Bubalis major*, Blyth, 1869; *Connochoetes albojubatus*, Thomas, 1892; *Cobus defassa*, Rüppel, 1835 (?)	Katanga, Afrique orientale allemande, Nigérie.
Gedoelstia hässleri, Gedoelst, 1915	*Damaliscus lunatus*, Burchell, 1824; *Sigmoceros lichtensteini*, Peters, 1849 . ..	Afrique orientale portugaise, Nyasaland, Uganda, Abyssinie, Nigérie.
Kirkia surcoufi, Gedoelst, 1915	*Bubalis major*, Blyth, 1869; *Sigmoceros lichtensteini*, Peters, 1849; *Cobus defassa*, Rüppel, 1835 (?)	Afrique orientale portugaise, Nyasaland, Chari, Haut-Sénégal-Niger, Côte d'Ivoire
Kirkia blanchardi, Gedoelst, 1914	*Sigmoceros lichtensteini*, Peters, 1849	Bassin du Zambèze.
Pharyngobolus africanus, Brauer, 1866	*Elephas africanus*, Blumenbach, 1779	?
Cephalopsis maculata, Wiedemann, 1830	*Camelus bactrianus*, L., 1766; *Camelus dromedarius*, L., 1766	Egypte, Tunisie.

	Hôtes parasités par les larves.	Distribution géographique.
HYPODERMINAE.		
Dermatoestrus strepsicerontis, Brauer, 1892	*Strepsiceros strepsiceros,* Pallas, 1766 ; *Redunca arundinum,* Boddaert, 1785 ..	Colonie du Cap, Soudan anglo-égyptien.
Dermatoestrus oreotragi, Scheben, 1910	*Oreotragus oreotragus,* Zimmermann, 1783..	AfriqueSud-Ouest allemande.
Dermatoestrus erikssoni, Poppius, 1907	*Cobus smithemani,* Lydekker, 1899..	Vallée du Luapula.
Strobiloestrus antilopinus, Brauer, 1892	*Oreotragus oreotragus,* Zimmermann, 1783 ; *Pediotragus horstocki,* Jentink, 1900 ..	Transvaal, Colonie du Cap.
Strobiloestrus oreotragi, Scheben, 1910..	*Oreotragus oreotragus,* Zimmermann, 1783 ; *Redunca redunca,* Pallas, 1767 ..	AfriqueSud-Ouest allemande, Sénégal.
Hypoderma bovis, Linné, 1761	*Bos taurus,* L., 1766	
Hypoderma bovis var. *heteropterum,* Macquart, 1843 ..	.. ..	Algérie.
Hypoderma lineata, Villers, 1789	*Bos taurus,* L., 1766	Mozambique.
Hypoderma clarckii, Clarck, 1815	.. ..	Colonie du Cap.
Hypoderma desertorum, Brauer, 1897	.. ..	Egypte.
Hypoderma corinnae, Crivelli, 1862	*Gazella dorcas,* L., 1766 ..	Kordofan.
Hypoderma silenus, Brauer, 1858	.. ..	Egypte.
Hypoderma gazellae, Gedoelst, 1915	*Gazella granti,* Brooke, 1872 .	Afrique orientale allemande.
Hypoderma sp., Brauer, 1892	*Oreodorcas fulvorufula,* Afzelius, 1815 ; *Redunca redunca,* Pallas, 1767	Colonie du Cap, Sénégambie.
COBBOLDIINAE.		
Cobboldia loxodontis, Brauer, 1896	*Elephas africanus,* Blumenbach, 1779	Congo Belge, Côte d'Or, Tchad, Uganda.
Cobboldia parumspinosa, Gedoelst, 1915	*Elephas africanus,* Blumenbach, 1779	Bassin du Zambèze.
Cobboldia roverei, Gedoelst, 1915	*Elephas africanus,* Blumenbach, 1779	Congo Belge.
OESTRIDAE DUBIOSAE.		
Neocuterebra squamosa, Günberg, 1906.	*Elephas africanus,* Blumenbach, 1779	Kamerun.

Bruxelles, Avril 1915.

AN INVASION OF BRITISH GUIANA BY LOCUSTS IN 1917.*

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WITH A COMPLETE ILLUSTRATED ACCOUNT OF THE LIFE-HISTORY OF THE SPECIES.

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British Guiana has not been invaded by migratory locusts since the year 1886, when, as far as it is possible to ascertain from the records of those bygone days, the same species of locust was implicated. Also, on the occasion of this previous attack, it seems very probable that a swarm first infested the North West and Pomeroon areas and, multiplying there, migrated further down the coast to Berbice. In 1917 this further migration did not occur, and it may be fairly stated that this was directly due to the energetic manner in which the destruction of the swarms was prosecuted. This event, as will be described later, admirably illustrates the very real value of legislation—in British Guiana at least—in dealing with outbreaks of insect pests or plant diseases. Such legislation does not affect the honest and hard-working farmer; it helps him by forcing his lazy and indifferent neighbours to carry out remedial measures which, if neglected, would result in the reinfestation of his lands and render his previous work nugatory.

Venezuela appears to be a centre of activity for swarms of migratory locusts, and judging from reliable sources of information, nothing is ever done in that country to destroy them. In consequence, Trinidad is frequently invaded by swarms from the Venezuelan mainland.

In this paper I have given a detailed account of the arrival and distribution of the swarm, which is well illustrated by the accompanying map. A description of the manner in which the campaign was conducted, and of the control methods utilised in the various areas is also set forth. A full account of the life-history has been prepared, with drawings, by Mr. L. D. Cleare, Jnr., of the Biological Division.

I have been unable to secure a generally accepted scientific determination of this species. Some years ago a flight of migratory locusts visited the West Indian Island of Trinidad; specimens were brought thence by the Governor of British Guiana, Sir Walter Egerton, and presented to this Division. On the occurrence of the locusts here in 1917 the adults which originally came from Venezuela were compared with these Trinidad specimens and they appeared similar. The Trinidad specimens were determined as *Schistocerca paranensis*, Burm., by an American authority—I am unable to say exactly by whom. Specimens from British Guiana were then sent to the Imperial Bureau of Entomology, London, and were identified,

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after comparing with specimens in the British Museum, as *Schistocerca vicaria*, Walk. Specimens were also submitted to the United States National Museum and identified as being *Schistocerca americana*, Drury. Further specimens were then submitted to the Imperial Bureau of Entomology and I cannot do better than quote the Director's remarks in a letter dated 14th March 1918. "The remaining locusts appear to me to be all one species and the darker forms agree absolutely with *S. piceifrons*, Walk. . . . It seems to me probable that the type of *S. vicaria*, Walk., is merely a pale form of this species. It is possible that *S. piceifrons* is nothing more than a northern representative of *S. paranensis*, but it presents some constant differences in the markings and puncturation of the thorax."

This unsatisfactory condition of affairs is well summed up by the Director of the Imperial Bureau of Entomology in a later letter to the senior author dated 27th June 1918. He says : "I am afraid the nomenclature of the species of *Schistocerca* is at present in a hopeless state. In the first place, it is extremely difficult to know what really are specific characters in this genus, and in the second place the types of the older species have not been re-examined by recent workers, and, owing to the inadequacy of the descriptions, different species have in many cases been assigned to the older names. Until someone revises the genus properly, I am afraid the confusion will persist."

Previous Locust Infestations.

Official records indicate that *Schistocerca* sp. has visited British Guiana before, and there is an undoubted specimen of this species in the British Guiana Museum which was preserved from this earlier infestation.

In August 1886 a vast swarm visited the County of Berbice and created havoc among the various crops. Large sums of money were expended by the Government in the destruction of the progeny of this swarm.

From evidence that I gathered from some of the oldest inhabitants in the North West District—Indians and others—it became clear that a big swarm of locusts descended on that locality about the year 1886 and defoliated large areas. In those days there was very little agriculture in the North West, but the Indian cassava fields were destroyed. The locusts also appeared in the Pomeroon. These old inhabitants were unanimous in the opinion that the species of locust of 1886 was the same as in 1917.

Whether the swarm that invaded the North West in 1886 was responsible for the swarm in Berbice, or whether the Berbice locusts were a separate swarm which came from Venezuela at the same time, it is impossible to tell. It seems likely, however, that as no destruction of the locusts in the North West was undertaken they bred without hindrance and produced a further swarm which flew to Berbice.

The following extract from a report by Mr. A. L. Layton, District Commissary in Berbice, dated New Amsterdam, September 1886, is of extreme interest, as the description which he gives of the immature stages of that species of locust strongly coincides with similar stages of the 1917 locusts.

"I crossed over to De Resolutie and walked about and found a great deal of corn and cassava destroyed. These two vegetables they seem to prefer to anything else. They have attacked the young plantains in some places and killed them, but no other ground provisions do they eat, yams, tannias, sweet potatoes, etc., getting off free. If the cassava is near its maturity it is not injured by the leaves being eaten, but the corn, of course, is killed at any stage of its growth.

"The kind of locust visiting the parts is the Gryllus migratorius, the most destructive of locusts; they cannot fly against the wind. I saw them blown back, but when they wish to seek for fresh pastures they wait for a favourable breeze and travel with it, rising some hundreds of feet before starting.

"They are a yellow and black and a dark colour. The eggs are laid where they feed by the female thrusting her posterior into the ground and depositing three separate blocks of eggs, each block containing on the average 30 eggs. The egg is about three-eighths of an inch long and a tenth of an inch in diameter, and is of a light brown colour. It is hatched in the ground in three weeks, and brings forth a small bright green locust. The colour is soon changed to a dark colour and these young ones are doing all the damage; the old ones are dying and flying away, as comparatively speaking there are few full-grown ones to be seen.

"The blacks are collecting these young dark ones by pouring boiling water over them to kill them and carry them to Highbury and Friends for payment. A dollar per diem is easily earned, many making two. They are measured in paraffin oil tins, which contain four to eight shillings worth.

"At Highbury they are burying the dead and at Friends burning them, and the stench at both these places is something fearful, resembling the smell of a decomposing human body, but worse.

"Mr. Hunter, of Friends, informed me that a few settled on seven and a half acres of canes, and he killed forty-seven millions in two weeks and got rid of them.

"In my opinion the locusts are not so numerous and are not doing as much damage as perhaps may be supposed, and the inhabitants seem to expect that they will all disappear with the northerly wind generally prevailing about this time of the year.

"This report is necessarily rather hurried, but I shall be only too glad to provide any further information that may be required."

In Berbice the people were paid by the Government to collect the locusts in kerosene tins and roughly \$26,000 (£5,416 13*s.* 4*d.*) was thus spent. The recent locust infestation cost the Government nothing like so much as this, and the situation was controlled by the Plant Diseases and Pests (Prevention) Ordinance. No money was paid out for the collection of locusts in any stage.

Arrival and Distribution of the 1917 Swarm.

The arrival of the immense swarm of locusts which invaded British Guiana from Venezuela by way of the boundary station of Yarakita in the North West District was witnessed by only a few people. The exact date of the invasion is uncertain, as there are a number of conflicting statements. It is safe to say that it took place somewhere late in the month of June 1917. The passing of the swarm is supposed to have lasted from 7 a.m. till 3 p.m. on the same day.

Fig. 1. Sketch-map of British Guiana showing the area on the North West Coast infested by locusts in 1917 (indicated by dotting).

As the swarm reached British Guiana each piece of cleared and cultivated land received a detachment of winged locusts, more especially those areas situated on the higher lands. This distribution was most uniform; only very few grants escaped. Roughly, the course taken by the swarm was over Yarakita (see map) and the neighbourhood (where a large detachment stayed behind) and from thence practically all agricultural areas on the Aruau, Aruka, Barima and Waini Rivers were thoroughly infested. They penetrated even to Arakaka. Their course from the North West District to the Pomeroon District (see map) is uncertain. Rumours were prevalent of a large swarm being seen moving over the sea, at some distance from the land though in a parallel direction. It appears more probable, however, that they flew from point to point overland. Thus cultivations in the neighbourhood of Santa Rosa (see map), Acquero and Waramuri on the Moruca River were infested by the locusts.

The Pomeroon River appears to have been a particular objective, as almost every grant—and there are many—for some twenty-five miles up the river soon swarmed with winged locusts. On the Essequibo Coast, from Hampton Court to Good Hope on the Supenaam Creek, a large number of scattered areas swarmed with winged locusts, and they penetrated inland some seven or eight miles. Thus the cassava cultivations of the Arawak Indians living on the large fresh-water lakes in this vicinity were attacked. They made their appearance at several places on the right bank of the Essequibo River as far up as the Penal Settlement, and also appeared on the left bank at the Hills Estate and at Agatash. These points appear to have been the limits of their flight.

It is fairly certain that this large swarm originated on some of the islands in the mouth of the Orinoco River. If this was the case, the insects that reached the Penal Settlement in British Guiana must have covered roughly about 200 miles in their flight and that against the direction of the prevailing wind. No locusts penetrated into the County of Demerara or reached Berbice, as they appear to have done on a previous occasion.

The Campaign Against the Locusts.

Official information concerning the swarm of locusts which had invaded the North West area of the Colony was received at headquarters on 23rd July 1917, together with specimens of the insect. On 26th July we left for the invaded area and proceeded to investigate the situation.

The gravity of the position at once became apparent. In this part of the Colony there are numerous small farms, ranging in size from 20 to about 100 acres. The majority of them have only come into existence during recent years, and many of them still show signs of having been lately cleared of forest. These cultivations produce large quantities of vegetables, such as tannias, eddoes, yams and cassava; a great quantity of maize or Indian corn is also grown. Permanent crops consist of Liberian coffee and rubber (*Hevea brasiliensis*). The North West District supplies a large part of the vegetables consumed in Georgetown, and since the war, and consequent food shortage, such a supply has naturally become important. The threatened destruction of such crops by a swarm of locusts was therefore a matter of no small consequence.

The original swarm in passing over the area had apparently left detachments of varying size in each grant. These had already commenced to feed voraciously on the growing corn and cassava and in many cases had entirely stripped the foliage. Although other cultivated crops were attacked by the adult insects, corn and cassava were specially singled out and destroyed.

At this stage it can be safely said that with very few exceptions every piece of cultivated land throughout this area contained large numbers of adult locusts. Even the cassava fields of the Aboriginal Indians, which are invariably hidden away in the middle of the forest, did not escape. As cassava is the principal food of such people, the elimination of their crop created a likelihood of starvation in the near future.

The attitude of the farmers towards the locusts was in the majority of cases one of indifference. Some took up a position of helpless despair, while others assumed that the insects would go as they had come. A few evinced an inclination to destroy them, but soon lost heart as the difficulty of the task became evident. No farmer that I encountered supposed for one moment that the locusts would lay eggs and increase a thousand-fold. They were soon disillusioned, however. I describe the mental aspect of these people as it has considerable bearing on the methods employed by the Government to suppress the locusts as completely as possible.

After a stay of about 15 days in the North West another tour was made of the Essequibo Coast, Pomeroon River, and some districts on the Moruca River. Scattered infestations, some exceedingly severe, were found in Essequibo, the plants attacked being much the same as in the North West. Some of the large areas under sugar-cane were infested by the locusts. A large number of the farms belonging to the coastland villages were attacked, as well as the cassava grounds of the Aboriginal Indians living on some large fresh-water lakes about four miles inland.

Many of the agricultural grants in the Pomeroon were found to contain innumerable locusts. These areas have been cultivated for a much longer period than those in the North West, consequently many of them contain fully established permanent crops, such as coffee and coconuts. A few instances occurred where coconut palms were defoliated, but the coffee was untouched. Large areas of corn were damaged, also cassava. A somewhat more intelligent class of farmer exists in this district, and the situation was therefore better understood. On the Moruca River, at the various Indian settlements and Missions, the locusts were greatly in evidence and had played havoc with the cassava crop.

Shortly after my return from this visit the expected report came in from the North West that the locusts had commenced to deposit their eggs. A further visit was paid and the report confirmed. Similar reports followed from the other districts.

The appearance of the hoppers in vast swarms soon followed. Early in the campaign a notice was prepared dealing with the nature and dangerous possibilities of the locust invasion. Remedial measures were also suggested in accordance with practices which had proved successful in other countries. This was printed in the Official Gazette and reprints were widely and copiously distributed within the invaded districts.

Reports from the Resident Agricultural Instructors in the various areas, and my own deductions, soon made it perfectly clear that unless stringent measures were promptly adopted by the Government the control of the locusts would soon get out of hand all together.

In all the districts a certain small percentage of better class and more intelligent farmers were destroying the hoppers to the best of their abilities, only to have their efforts nullified by fresh swarms from the lands of their neighbours who were doing nothing. In 1914 an Ordinance entitled the Insect Pests and Plants Diseases (Prevention) Ordinance was passed. It provided that any person who failed to carry out instructions issued bythe Board of Agriculture for the destruction of any insect pest became liable to imprisonment or a very heavy fine. Accordingly an order of the Board of Agriculture was drawn up embodying instructions for destroying the locusts, which consisted of a number of methods suitable for all classes of farmers. These were widely disseminated in the form of posters. At the same time a warning was issued clearly setting forth the action which the Government would take if the instructions were not complied with and the hoppers destroyed.

It now became necessary, so as to enforce the execution of these instructions, to appoint in each district individuals who had the right to summons, if necessary, the recalcitrants. This was done and a number of the Agricultural Instructors were detailed for this work. They were constantly employed travelling about from farm to farm advising as to the best methods to be adopted and watching the progress of such work.

As soon as it became perfectly clear that the Government intended to take immediate action, the destruction of the hoppers was energetically carried out in all the districts. In some cases, however, summonses were necessary, which served as an example and stimulant to the others. The work went on apace, and by the end of November the greater number of the swarms had been destroyed. Only one instance of locusts that had been bred in the colony migrating has been recorded, thus disproving the theory ventilated by certain individuals, entirely without a satisfactory basis, that this species of locust only migrates at one particular period of the year. It is an interesting point that this was the first time that legal proceedings were instituted under the Insect Pests and Plant Diseases (Prevention) Ordinance.

At a meeting of the Board of Agriculture, specially convened to discuss the locust situation, considerable doubts were expressed by some members as to the advisability of instituting legal proceedings. It was held that better results would be obtained by paying farmers and others to destroy the locusts—a scheme which was instituted in 1886 during a previous locust invasion and which cost the Government many thousands of dollars.

The success of legal proceedings was amply demonstrated by the results obtained, and from my own observations in the various districts I can still further testify to this success.

Below are the names of those officers of the Department who bore the brunt of the locust control work both in the field and laboratory from July to December, 1917.

North West District. Mr. Abraham, Resident Agricultural Instructor, assisted for some months by Mr. E. M. Morgan.

Pomeroon District. Mr. W. H. Mathews, Resident Agricultural Instructor, assisted at various times both by Mr. C. C. Dowding and Mr. Indrobeharry.

Essequebo Coast. Mr. C. C. Dowding, Agricultural Assistant, assisted occasionally by Mr. P. M. de Weever and Mr. Indrobeharry.

The working out of the life-history of the locust was performed by Mr. L. D. Cleare, Jnr.

Mr. C. K. Bancroft, Assistant Director, temporarily directed operations in the North West and Essequibo districts. The plan of the whole campaign was arranged by the Director of Science and Agriculture in collaboration with myself. I had charge of the actual execution of the work.

Life-History of the Locust.

Oviposition.

This operation, under field conditions, appears to take place during the cooler hours of the afternoon. In a suitable spot large numbers of females congregate for this purpose and at times almost cover the surface of the ground, the most favoured localities being on soil of medium texture, though in some cases holes are drilled in the stiff clay. In all cultivated areas where pegass soils exist the decayed root system of palms, which are familiar objects on such recently cleared

Fig. 2. *Scelio venezuelensis,* Marsh.; parasitic on the eggs of *Schistocerca.*

grants, are specially selected as an egg-laying site. Several hundred egg-masses were frequently removed from these places. The egg-masses are often placed in the soil along the edges of drainage trenches and on the sides of raised earthen dams. From frequent observations it appears that the most suitable spot is one where the soil is of medium texture and neither too dry nor too wet. With a little practice it becomes a fairly simple matter to indicate in locust-infested areas where the eggs are to be found.

The manner of oviposition closely coincides with the published descriptions of the process in other species in other parts of the world. The female, by means of the four hardened processes with which the anal extremity is furnished, proceeds to bore a hole in the ground by successively opening and shutting these appendages accompanied by a downward boring movement. In favourable circumstances the boring is complete within 15 minutes and the deposition of the ova commences. If obstacles or interferences are experienced, or if the nature of the soil, weather conditions, or other similar causes are unsuitable, the female either ceases her movements for a period or moves off and elsewhere begins the performance afresh. When the hole is complete the bottom is prepared for the reception of the eggs by a quantity of white frothy substance which is voided by the female. This substance when dry becomes spongy and slightly crisp. Eggs to the number of about 50 or 60 are then laid, accompanied by a further supply of froth, which serves to bind the mass together and, to some extent, forms a protective covering. Finally a large quantity of froth is exuded which serves to isolate the mass from external interferences. When the female withdraws her tail very few traces of her operations are left.

During the oviposition period the male is invariably in attendance, perched on the back of the female, and vigorously withstands attempts at removal. His presence at that particular time is inexplicable and apparently unnecessary.

The depth of the boring varies, the average being about $2\frac{1}{2}$ inches, and it is directed slightly backwards. There is little doubt that the boring follows the line of least resistance.

The mass soon dries and solidifies to such an extent that it is possible with the exercise of a little care to remove the whole intact from the boring. This bundle of eggs appears as a roughly formed cylinder conforming to the shape of the hole in which it was deposited. Within the bundle the eggs point upwards at right angles to the surface of the ground. After some days, when the eggs commence to grow inside, they break away from the mass and remain as a loose heap within the hole.

Description of Ova.—On deposition the egg is 1·9 mm. in breadth and 9 mm. in length. The colour is a deep yellow, which becomes dull as the eggs increase in age; they finally turn a dull green colour and the eyes of the developing embryo become conspicuous. The eggs gradually increase in size and at the time of hatching both the length and breadth have increased by 2 mm. In shape they are not unlike a cigar, but bluntly pointed at both ends and slightly curved. They are popularly described locally as resembling a grain of rice. The surface of the egg on magnification is seen to be very slightly roughened.

Development of Ova.—The duration of the incubation period is about two or three weeks, varying according to conditions of temperature and moisture. The young locust ruptures the shell longitudinally. All the eggs in a mass hatch at about the same time and the nymphs proceed to make their way slowly upward to the surface of the soil, which procedure occupies some little time and is accomplished by continuous wriggling movements made in unison. The spot where a number of young locusts have thus penetrated to the surface is indicated by the presence of a small heap of whitish, almost transparent exuviae. On emergence a rest is taken to allow the chitin to harden. Under natural conditions the eggs appear to hatch during the earliest morning hours.

Development of Hoppers.

The complete life-history has been worked out in the insectary of the Biological Division. On their emergence a number of the young hoppers were isolated in suitable glass receptacles and regularly supplied with fresh leaves of cassava (*Manihot utilissima*). Others were also allowed to develop in a spacious cage constructed of glass and wire, which allowed the insects freedom of movement and a maximum quantity of light and air.

Careful records were kept of each stage. The life-history thus worked out proved to be slightly shorter than under field conditions. Feeding took place mostly during the night.

First Nymphal Stage.—In two or three weeks the eggs hatch and the nymphs emerge by a longitudinal rupture. The nymphs are a light pea-green in colour, with dull black markings and spots, and are covered with fine light-coloured hairs.

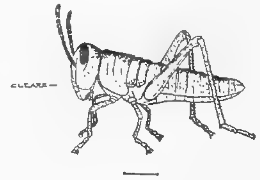

Fig. 3. First stage nymph.

The antennae are black, the base of each segment being yellow. There is a black meso-dorsal line and the hind femora show three broad bands of black.

Length	9·0 mm.
Length of hind femora	5·0 mm.
No. of segments of antennae	14

About four days after emergence the nymphs become much darker and assume a blackish tinge. This change in colour is so noticeable that it can almost be taken for another nymphal stage, but in reality, it is only the colouration from below and precedes the 2nd nymphal stage by some four days. When the change to the second nymphal stage does take place it can be easily recognised and shows that the darkening in the 1st stage was really due to the colouration below.

Second Nymphal Stage.—In this stage the insects can almost be considered black with light markings. The dorsal line has broadened considerably and extends the entire length of the insect. Two broad lateral lines of black have now appeared, which almost cover the whole of the lateral areas and are only separated from the dorsal one by narrow stripes of a pinkish yellow colour, the insect thus appearing black with lighter markings. The head, too, is mostly black, the vertex, the clypeus and the mouth-parts being of this colour, while the genae bear a stripe of the same colour; the antennae are black. The legs are also largely black;

the 1st and 2nd pairs are heavily spotted with this colour, and the femora of the 3rd pair show the black very distinctly, the tibiae and tarsi being almost wholly

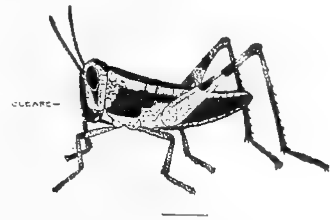

Fig. 4. Second stage nymph

black. The ventral surface is yellow-brown with many black spots, and there is a distinct white ventral margin to the abdominal areas.

Length	11·5 mm.
Length of hind femora	8·0 mm.
No. of segments of antennae	17

Third Nymphal Stage.—The general appearance of this stage is like the preceding one. The front of the head is not so black, in fact it is a brownish colour, while the abdomen shows considerably more white. The pronotum too has become lighter on the lateral areas. The antennae are still black. The distal portion of the hind tibiae and the first two joints of the hind tarsi have also become lighter, being now

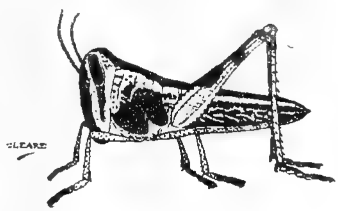

Fig. 5. Third stage nymph.

only marked with black. The ventral surface is spotted with black and now shows a median white stripe. On the whole the insect is noticeably lighter in colour than the previous stage. The wing-pads appear in this stage for the first time.

Length	14·7 mm.
Length of hind femora	10·0 mm.
No. of segments of antennae	20

Casting of the third Nymphal Exuviae.—Ecdysis was only observed in one instance, and in this case the nymph failed to free itself of the exuviae. The process, however, will be described.

When first observed (3.15 p.m.) the operation was already in progress and the body was almost half withdrawn. The exuviae were ruptured mid-dorsally, and the head and thorax appeared to have been first withdrawn. The thorax was very much arched, as if great pressure was being exerted, and the body was expanded and contracted in much the same manner as in a human being when breathing. The abdomen was then gradually withdrawn by arching the thorax and first few segments of the abdomen. At this stage the legs were still encased in the exuviae and apparently took no part in the operation. In fifteen minutes the abdomen was entirely withdrawn and stood out at right angles to the old skin. An effort was then made to free the legs. Resting on its head it exerted great pressure and at the same time raised its abdomen as if to lever the legs out. The insect, however, failed to free itself entirely and consequently was given help.

Fourth Nymphal Stage.—In appearance this stage closely resembles the third nymphal stage. The wing-pads are somewhat bigger and quite noticeable, and the auditory organs are conspicuous on the first abdominal segment. The antennae are somewhat longer than in the preceding stage.

Length	20·0 mm.
Length of hind femora	12·0 mm.
No. of segments of antennae	22

Fifth Nymphal Stage.—This stage is easily recognised and differs from the preceding ones in that the wing-pads are now very noticeable. The markings to a large extent are the same as in the third and fourth stages, but the white stripes on the thorax are somewhat broader and broaden as they extend backwards,

Fig. 6. Fifth stage nymph.

in this way forming a somewhat triangular area, almost a right-angled triangle, with the hypotenuse dorsal. The abdomen is as in the previous stage, but the wing-pads (black in colour) now break the formerly continuous white stripes from thorax to abdomen. Head, antennae, legs and ventral surface as in previous stage.

Length	27·0 mm.
Length of hind femora	16·0 mm.
No. of segments of antennae	24

Sixth Nymphal Stage.—This stage is dark also, the markings being practically the same as in the preceeding stage. There is, however, much more black and this has caused the lighter areas, which have now become a pinkish brown, to be reduced somewhat. This is particularly noticeable in the lateral markings of the

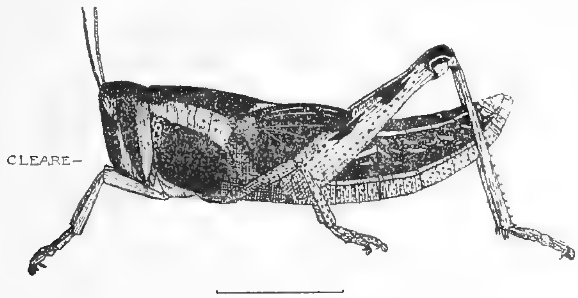

Fig. 7. Sixth stage nymph.

thorax and abdomen. The hind femora now show a lunule of a lighter colour on the genicular lobes which is only to be found in this stage.

Length	3·2–3·3 c.m.
Length of hind femora	2·0 c.m.
No. of segments to antennae..	26

The Adult.

In general appearance this insect resembles the sugar-cane locust, *Schistocerca pallens*, Thunb., but differs from that insect in a few well-defined ways which, once known, are easily recognised. Perhaps the most noticeable and distinct

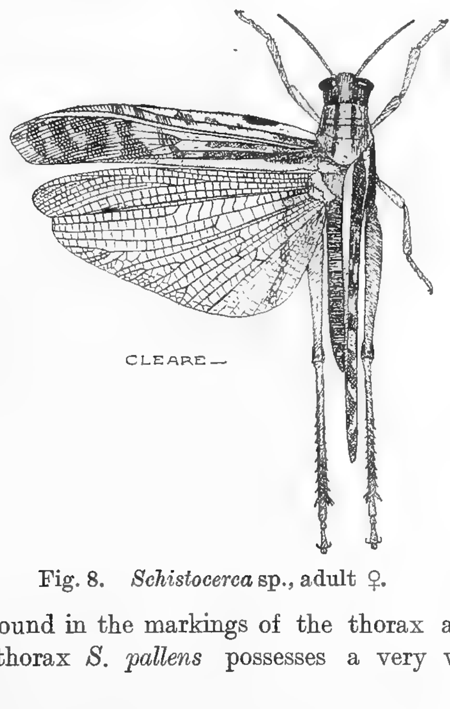

Fig. 8. *Schistocerca* sp., adult ♀.

differences are to be found in the markings of the thorax and tegmina. On the lateral areas of the thorax *S. pallens* possesses a very well defined diagonal creamy-coloured area, which is characteristic of the species. *Schistocerca* sp. possesses a somewhat similar area but it is not so large, so well marked or so white. The tegmina too show distinct differences; in *S. pallens* the costal area bears a few dark markings, and the other maculations on the tegmina are more numerous and darker in *Schistocerca* sp. than in *S. pallens*.

The duration of the various stages is as follows:—

Egg to 1st nymph	2– 3 weeks.
1st to 2nd nymph	8 days.
2nd to 3rd nymph	7– 8 days.
3rd to 4th nymph	10–13 days.
4th to 5th nymph	10–13 days.
5th to 6th nymph	9–11 days.
6th to adult	14–16 days.

Control Methods.

As previously mentioned the destruction of the adult insects by any mechanical means, or by hand, is an exceedingly difficult matter and also expensive.

In a few instances, in some districts, attempts were made to kill the adults, but these were soon given up. The original swarm from Venezuela caused considerable damage to certain crops, especially Indian corn and cassava. In accordance with their habits, as soon as they alighted, they started feeding and continued to do so for some weeks, till oviposition was accomplished and the next generation safely established. Death then ensued naturally, owing to general weakness and the frayed condition of their wings which prohibited flight.

The immense swarm of hoppers which eventually made their appearance in the majority of instances got but little opportunity of doing material damage to the crops, owing to the previously described prompt action by the Government. In a few localities, where they were more or less neglected, large areas were completely defoliated.

A variety of control methods were recommended by this Division, all of which proved efficacious in dealing with the hoppers. Some of these suggestions were based on methods which had proved successful in other countries and others were evolved locally. Thus the molasses sheet method was so successfully practised by Mr. E. S. Nicholson of Anna Regina, Essequebo, that it came to be widely used in other areas. The tar method, though by no means novel in principle, was modified to suit local conditions by the senior author and Mr. A. A. Abraham, then Agricultural Instructor in the North West District. The trench method, in conjunction with a surface film of kerosene oil, was suggested naturally by the presence of innumerable drainage systems rendered necessary by the flatness of the country in the maritime lands of British Guiana.

Destruction of Eggs.

This is a most effective method and, when practised on a large scale, gave excellent results. It was not widely utilized, as at this stage but few of the farmers had begun to realize—or were indifferent to—the gravity of the situation. With a little practice the discovery of spots where eggs had been deposited became an easy matter, and it was only necessary to fork up the soil to the depth of a few inches so as to secure the masses.

Burning.

This proved a particularly successful procedure on the coastland areas, where the atmospherical conditions are drier than those within the forest area. Thus on the Essequebo Coast at Onderneeming, and other centres, the greater number of the young hoppers were destroyed within a week of their appearance by this means. The usual method on locating a swarm in low bush was to collect a large quantity of dry bush, roughly surround the insects, and put fire all round simultaneously.

A modification of this method, when the hoppers were found in cultivations, was to drive the swarm slowly towards a pile of dry bush roughly arranged in the form of a semicircle ; as soon as the young hoppers arrived within this area the bush was promptly lighted all round and, fresh bush being placed behind the swarm, they were thus totally surrounded and destroyed. A swarm in high bush were killed by chopping away the surrounding growth thus isolating the infested area. Dry bush was then piled around and set on fire.

Early in the morning and also towards eventide the hoppers clustered together in dense masses. This habit gave the burning method full scope.

This manner of elimination proved efficacious till the hoppers were half-grown, after that their improved powers of locomotion made it possible for them to leap through the flames and escape. Also at this period of growth and later the insects became more restless in their movements and the slightest disturbance or the appearance of human beings caused the whole swarm to scatter in a general "*sauve qui peut.*" They also became wary and the faintest suspicion of smoke from burning vegetation caused them to make off. These acquired characteristics eventually rendered attempts to destroy them by burning a profitless method.

In the forest areas, such as the North West District and some parts of the Pomeroon and Moruca Rivers, dampness caused by heavy rainfalls and dew rendered the burning method less easy than elsewhere, but in these areas the presence of numerous small drainage trenches created an excellent alternative.

Driving into Trenches.

This proved an easy and efficacious method. When a swarm had been located, it was slowly driven by a number of people towards a drainage trench, and as soon as it reached the water kerosene oil was poured in, which instantly formed a film on the surface. This film of oil rapidly killed the hoppers as soon as they came in contact with it. Here again, when the hoppers became about three-parts grown their increased strength often enabled them to make their way across the trench and escape. A futher objection to this method was that driving could only be effectively performed when the vegetation was scant. Thick grass or bush allowed the hoppers to secrete themselves among the roots, and it was observed that they soon became highly skilful at effacing themselves in this manner.

The Use of Tar and Molasses.

The most viscous quality of American tar was utilized in this method. For hoppers up to about two weeks old it proved most useful and was largely used in the North West District. At this stage of growth the " clustering " habit was more marked than at a later period.

The tar was copiously smeared on any rigid surface, such as small sheets of metal from kerosene oil tins, the young stiff fan-shaped leaves of the Troolie palm (*Manacaria saccifera*), banana leaves, etc. A dense cluster of young hoppers having been located on some foliage it was at once surrounded by such tarred surfaces laid on the ground, the tarred surface being uppermost. This had to be done carefully so as not to disturb the swarm. The hoppers were then brushed off and, falling on to the tar, at once adhered firmly thereto and quickly died. In some instances the hoppers were driven on to large sheets smeared with tar.

Under certain conditions tarpaulins, about 8 feet square, smeared with molasses were utilized to trap the hoppers, especially those almost fully grown. For this operation a good thick quality of molasses is very necessary. The method gives best results on ground which is not encumbered with growth, being specially suitable for cultivated land where the soil is kept free from weeds. Some of the most successful drives that I personally organised were carried out on a number of cultivated patches containing well grown cassava. Thus a tarpaulin about 8 feet square was covered with a layer of hoppers about 3 deep, and similar results were obtained for two weeks ; this was in a heavily infested area. There is little doubt that, given the favourable conditions, this method yields superior results to any other. It was originated by Mr. E. S. Nicholson of Plantation Anna Regina.

The Use of Poisons.

Shortly after the arrival of the invading swarm large supplies of arsenical poisons were secured by the Government from the neighbouring West Indian Islands. These consisted solely of Paris green and arsenate of lead. None of the other arsenicals were obtainable. These insecticides were offered to the public at half their cost price, and careful instructions were given as to their use, but very few people availed themselves of the offer. From the experience that I gained during the whole campaign I have arrived at the conclusion that, in British Guiana at least, a plague of locusts is best dealt with by mechanical means of destruction. There are various reasons for this which I may briefly enumerate here.

The small farmer in British Guiana cannot afford to buy large stocks of insecticides, and the purchase of spraying machinery is likewise out of his reach. He prefers the cheaper and more evident means of destruction provided by the previously described mechanical methods. For instance, it would afford him infinitely greater satisfaction to destroy a swarm by fire—where he sees them actually perish—than to spray a quantity of foliage with an insecticide which will (from his point of view) problematically destroy the hoppers at a later date. A number of farmers have explained this to me on various occasions. They vaguely mistrust the action of the poison, but there was no doubt about seeing the insects burning. This idea was substantiated by the action of the lead arsenate, which in comparatively weak solutions is slow in its action.

Recently described methods for locust destruction by the use of arsenical compounds, such as those employed in the Malay States, appear to be highly successful, but they are carried out under Government control by trained European officers who are employed solely on this work. It is now a definitely established fact that only the most poisonous arsenic compounds are of any use in strong solutions which scorch and destroy all vegetation with which they come in contact. Such a procedure is unnecessary in this Colony. The previously described mechanical methods in conjunction with a judiciously administered Plant Diseases and Pests (Prevention) Ordinance have proved adequate.

Note.—The cost of this campaign, has recently been calculated ; it was \$2,038.60 (£424 14*s.* 2*d.*). The area affected and dealt with was 250 square miles. See Journal of the Board of Agriculture, British Guiana, xi, no. 2, p. 68.

COLLECTIONS RECEIVED.

The under-mentioned collections were received by the Imperial Bureau of Entomology between 1st July and 31st December, 1918, and the thanks of the Managing Committee are tendered to the contributors for their kind assistance:—

Dr. W. M. Aders, Government Economic Biologist:—10 Culicidae, 3 other Diptera, 4 Coleoptera, and 1 sp. of Coccidae; from Zanzibar.

Dr. W. Allan, W.A.M.S.:—334 Culicidae; from Sierra Leone.

Lieut. P. J. Barraud, R.A.M.C.:—1 Tabanid, 2 Asilidae, 3 Hymenoptera, and 9 Odonata; from Macedonia.

Mr. G. E. Bodkin, Government Economic Biologist:—2 Diptera, 17 Hymenoptera, 21 Coleoptera, 1 Caddis-fly, 2 Mallophaga, 7 packets of Coccidae, 12 other Rhynchota, 3 termites, 11 Orthoptera, 3 Odonata, 1 Tick, 1 Spider, 6 Scorpions, and 5 Centipedes; from British Guiana.

Mr. J. R. Bovell, Superintendent of Agriculture:—1 *Tabanus*, 4 other Diptera, 10 Hymenoptera, 7 Coleoptera, 6 Coccidae, 2 other Rhynchota, and 1 tube of Worms; from Barbados.

Mr. J. H. Burkill, Director of the Botanic Gardens:—10 Elaterid beetles; from Singapore.

Capt. P. A. Buxton, R.A.M.C.:—37 Culicidae, 26 Tabanidae, 2 Hippoboscidae, 37 other Diptera; 25 Proctotrupidae, 25 Coleoptera, 6 Lepidoptera, about 350 Aphididae, 10 lots of Coccidae, 121 other Rhynchota, 10 Orthoptera, and about 300 Mites; from Mesopotamia.

Capt. A. G. Carment, R.A.M.C.:—159 Culicidae, 8 Simuliidae, 22 Tabanidae, 41 other Diptera, 4 Hymenoptera, 10 Lepidoptera, 2 Trichoptera, 5 Coleoptera, 1 *Panorpa*, 1 Bed-bug, 1 other Bug, 2 Orthoptera, 2 Odonata, and 1 Spider; from North Russia.

Capt. G. D. H. Carpenter:—7 Tabanidae, 4 Hymenoptera, 2 Coleoptera, and 2 Orthoptera; from Victoria Falls and Portuguese East Africa.

Dr. K. W. Dammerman, Government Entomologist:—28 Coleoptera, 11 Lepidoptera, and 20 Rhynchota; from Java.

Mr. P. R. Dupont, Curator of the Botanic Station:—9 Coleoptera, 2 Lepidoptera, and 5 spp. of Coccidae; from Seychelles.

The Division of Entomology, Pretoria:—6 Coleoptera, and 2 Orthoptera; from South Africa.

Mr. R. J. Elders:—4 Orthoptera; from Macedonia.

Capt. E. W. Ferguson:—18 Culicidae, 20 Tabanidae, and 63 other Diptera; from Abbéville, France.

Mr. T. Bainbrigge Fletcher, Imperial Entomologist:—32 Coleoptera; from Assam.

Dr. L. H. Gough, Government Entomologist:—10 Pyralid moths, and 1 larva; from Egypt.

The Government Entomologist, Madras:—73 Coleoptera; from South India.

Mr. C. C. Gowdey, Government Entomologist :—22 Tabanidae, 1 Hippoboscid, 111 other Diptera, 182 Chalcids, 236 other Hymenoptera, 242 Coleoptera, 5 Lepidoptera, 2 Isoptera, 1 Chrysopid, 302 Thysanoptera, about 250 Aphidae, 5 spp. of Coccidae, 125 other Rhynchota, 8 Anoplura, 4 Odonata, 52 Orthoptera, and 30 Ticks; from Uganda.

Mr. E. Hargreaves :—397 Calicidae, about 500 Culicid eggs, about 50 Chironomid larvae, 9 *Phlebotomus*, 14 Tabanidae, 67 other Diptera, 49 Hymenoptera, 67 Coleoptera, 2 Trichoptera, 5 Planipennia, 25 Rhynchota, 13 Orthoptera, and 1 *Lepisma*; from Italy.

Mr. F. K. Hull :—6 Culicidae, 13 Culicid larvae, about 25 Hymenoptera, 23 Thysanoptera, and 27 Rhynchota; from Brazil.

The Imperial Institute: 10 Orthoptera; from Cyprus.

Dr. A. Ingram, W.A.M.S. :—53 Culicidae, about 600 Anoplura, 10 Mallophaga, 34 Cimicidae, 2 Orthophera, about 250 *Hemimerus*, 4 Ticks, and large numbers of *Phlebotomus*, and other Ceratopogoninae, *Cordylobia* larvae, Siphonaptera, and Gamasid mites; from the Gold Coast.

Mr. H. H. King, Government Entomologist :—5 pinned specimens and 4 preparations of *Glossina*; from Khartoum.

Messrs. Lever Brothers, Ltd. :—8 mycetophagous Beetles; from the Belgian Congo.

Monsieur R. Mayné, Government Entomologist :—4 Diptera, 22 Hymenoptera, and 31 Lepidoptera; from the Belgian Congo.

Dr. W. Roepke, Government Entomologist :—3 Hymenoptera, 77 Coleoptera, 8 Lepidoptera, and 5 Rhynchota; from Java.

Major H. S. Stannus, Senior Medical Officer :—21 Diptera, 3 Hymenoptera, 25 Coleoptera, 11 Lepidoptera, 1 Caddis-fly, and 2 Rhynchota; from "German" East Africa.

Dr. van Hall, Director, Instituut voor Plantenziekten en Cultures :—50 Coleoptera, and 15 Rhynchota; from Java.

Mr. R. Veitch, Entomologist, Colonial Sugar Refining Company :—29 Diptera, 75 Hymenoptera, 93 Coleoptera, 22 Lepidoptera, 1 Trichopteron, 92 Rhynchota, 12 Orthoptera, and 7 Spiders; from Fiji and North Queensland.

Capt. J. Waterston, R.A.M.C. :—about 75 Culicidae, 25 *Phlebotomus*, 34 *Chrysops*, a number of eggs of blood-sucking flies, 213 other Diptera, a number of Chalcids, 86 other Hymenoptera, 105 Coleoptera, 7 Lepidoptera, 8 Planipennia, 3 species of Coccidae, 64 other Rhynchota, and 65 Odonata, 9 Orthoptera, and 1 Centipede; from Macedonia.

Mr. C. B. Williams :—23 Coleoptera, 648 specimens of the Froghopper *Tomaspis saccharina*, and 1 Spider; from Trinidad.

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