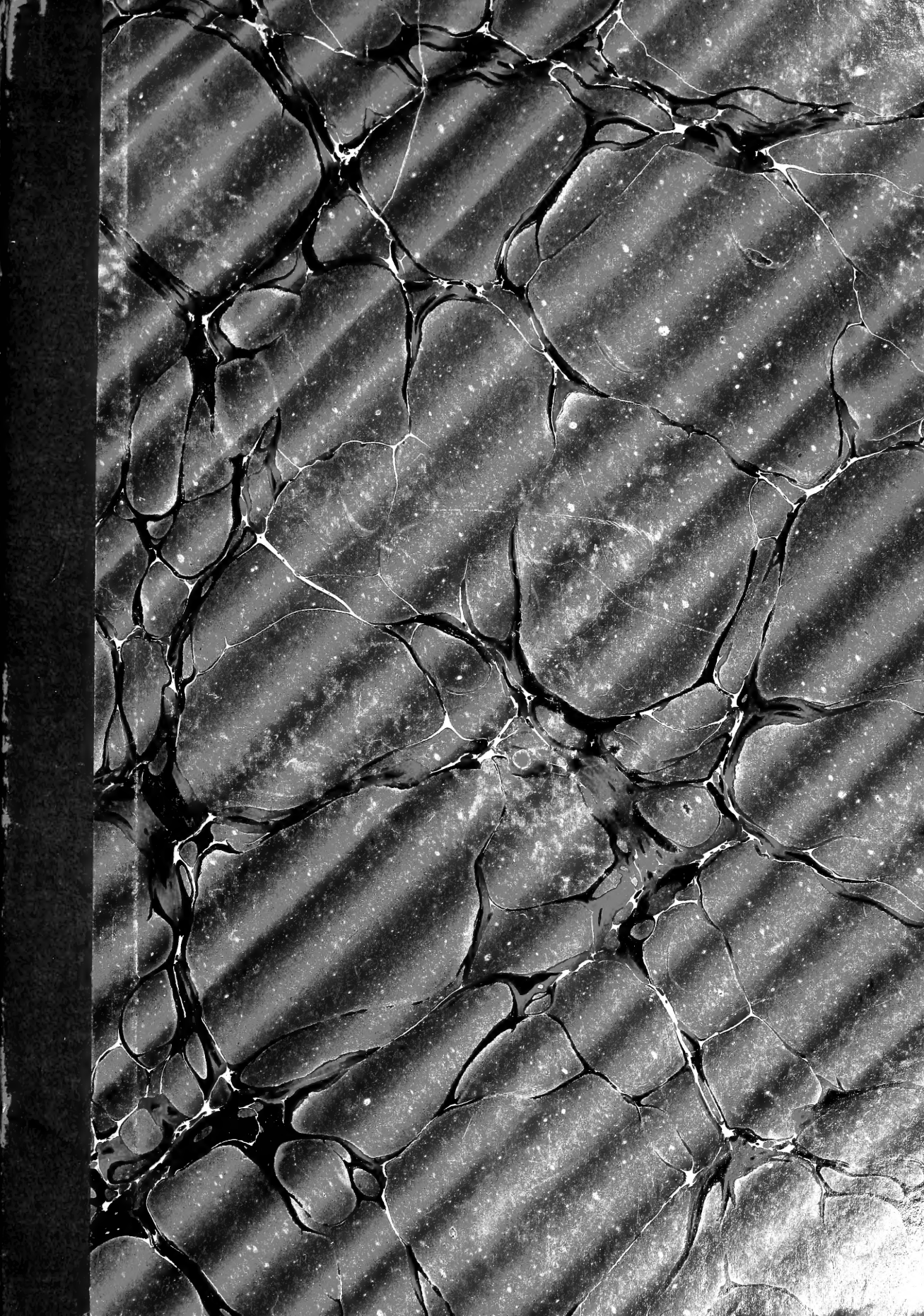

INDIAN MUSEUM NOTES.

ISSUED BY THE TRUSTEES.

VOLUME II.—No. I.

ECONOMIC ENTOMOLOGY.

Published by Authority of the Government of India, Revenue and Agricultural Department.

CALCUTTA:
PRINTED BY THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.
1891.

Price Two Rupees.

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VOLUME II.—NO. 2.

THE WILD SILK INSECTS OF INDIA.

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INDIAN MUSEUM NOTES.

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VOLUME II.—No. 3.

ON

WHITE INSECT WAX IN INDIA.

Published by Authority of the Government of India, Revenue and Agricultural Department.

CALCUTTA.
PRINTED BY THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.
1891.

Price Eight Annas.

EXPLANATION OF PLATE.

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INDIAN MUSEUM NOTES.

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VOLUME II.—NO. 4.

THE LOCUSTS OF BENGAL, MADRAS, ASSAM, AND BOMBAY.

Published by Authority of the Government of India, Revenue and Agricultural Department.

CALCUTTA:
PRINTED BY THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.
1891.

Price One Rupee.

INDIAN MUSEUM NOTES.

ISSUED BY THE TRUSTEES.

VOLUME II.—NO. 5.

Published by Authority of the Government of India, Revenue and Agricultural Department.

CALCUTTA:
PRINTED BY THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.
1891.

Price eight annas.

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INDIAN MUSEUM NOTES.

ISSUED BY THE TRUSTEES.

VOLUME II.—No. 6.

Published by Authority of the Government of India, Revenue and Agricultural Department.

CALCUTTA:
PRINTED BY THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.
1893.

NOTICE.

THE serial *Indian Museum Notes* is issued by the Trustees of the Indian Museum, Calcutta, under the authority of the Government of India, Revenue and Agricultural Department. It is chiefly intended to record information on the subject of the Economic Entomology of India, and thus gradually to furnish materials upon which to base a comprehensive knowledge of this important subject, which has hitherto been but little studied. For the views expressed the authors of the respective notes are alone responsible.

The parts of the serial will be published from time to time as materials accumulate. Communications are invited; they should be written on one side only of the paper and addressed to—

The Editor,
Indian Museum Notes,
Calcutta.

Correspondence connected with Economic Entomology should be accompanied by specimens of the insects to which reference is made. Caterpillars, grubs, and other soft-bodied insects can be sent in alcohol; chrysalids and cocoons, alive, and packed lightly in leaves or grass; other insects, dried and pinned or wrapped in soft paper. Live insects should be sent when there is a reasonable probability of their surviving the journey. Caterpillars, grubs, and other immature insects can often be only approximately determined; they should therefore, where possible, be accompanied by specimens of the mature insects into which they transform; when, however, this is not possible, they should still be sent, as they can always be determined approximately, and uncertainty must necessarily arise in discussing insects when actual reference to the specimens cannot be made.

Insects forwarded for determination should in all cases be accompanied by a detailed report showing precisely in what their Economic importance consists.

THE EDITOR.

INDIAN MUSEUM,
19th March 1891.

Vol. II.] [No. I.

INDIAN MUSEUM NOTES.

No. I.—MISCELLANEOUS NOTES FROM THE ENTOMOLOGICAL SECTION OF THE INDIAN MUSEUM.

By E. C. COTES.

The work of the year 1890-91.

During the year 1890-91 the collection of information on the subject of the Economic Entomology of India went on as usual in the Entomological Section of the Indian Museum. The chief work of the year may be classed under the headings of, (1) Locusts, (2) Silk insects, (3) Reference collections, (4) Lectures, (5) Miscellaneous insects.

In the matter of Locusts, the habits and history of *Acridium peregrinum*, which is the chief locust of North-Western India, were investigated, and a detailed report was issued on the subject.

In the matter of Silk insects, all available information was collected concerning the wild species which produce silk in India, but which have not hitherto been cultivated, and progress was made with a report upon the subject, for publication in these *Notes*. The silk insects which are actually cultivated have been already dealt with in a report which was issued as Volume I, No. 3 of these *Notes*.

In the matter of the Reference collections which are being gradually got together in the Indian Museum, specimens of the insects sent to the Museum for report, were, as far as possible, preserved and identified zoologically for future reference. Help in the identification of the species was received from Entomologists in several quarters of the globe: for in India, where there are, at a moderate computation, some twenty thousand different kinds of insects, many of them unknown to science, the zoological identification of a species is often a matter of very considerable difficulty, while it is necessary that the insects should be identified, as without identification it is impossible to avail ourselves of what has been ascertained in other parts of the world about similar or allied forms. Communication therefore has been established with many of the chief Entomologists in different parts of the world, and several of them have assisted gratuitously by identifying the insects belonging to the particular groups which they have specially studied. In this connection may be mentioned the following Entomologists who kindly gave help during the past year in the identification of species of economic importance :—Dr.

Henri de Saussure of Switzerland; Messieurs Bigot and Desbrochers de Logis of France; Lord Walsingham, Colonel Swinhoe, and Messrs. Buckton and Moore of England; Mons. Kerremans and Dr. Auguste Lameere of Belgium; Mr. Maskell of New Zealand; Mr. Howard of the United States. Progress has necessarily been somewhat slow, but named specimens are accumulating, and it is already becoming the rule, instead of, as heretofore, the exception, when an insect is sent to the Museum as attacking a crop, for it to be practicable to identify it without delay and to refer to what is known about it.

In the matter of Lectures, a course on Forest Entomology was given in the Forest School in Dehra Dun, and it is hoped that the subject will be taken up hereafter by other agricultural bodies.

In the matter of Miscellaneous insects, a large amount of information was collected from the reports and specimens which have been received from Government officers, as well as from private individuals in all parts of India, a large portion of it being furnished through the various directors of Land Records and Agriculture, from whom much assistance has been received. It will be found embodied in the following *Notes*, which are necessarily very incomplete, though it is hoped that they will serve to bring to light points that were previously unrecorded in connection with the insects that attack crops in India. In compiling these *Notes* care has been taken to indicate what is already known about each pest, so as to facilitate the investigations which it is hoped hereafter to institute locally; for the experience gained during the past few years, in the attempt that has been made in Calcutta to investigate the subject of the pests and other insects, which in some cases are not to be found nearer than the other side of India, shows clearly that it is useless to expect to obtain anything like complete information, unless facilities are afforded for visiting the localities where the insects are actually at work.

Maize Stalk Borer.

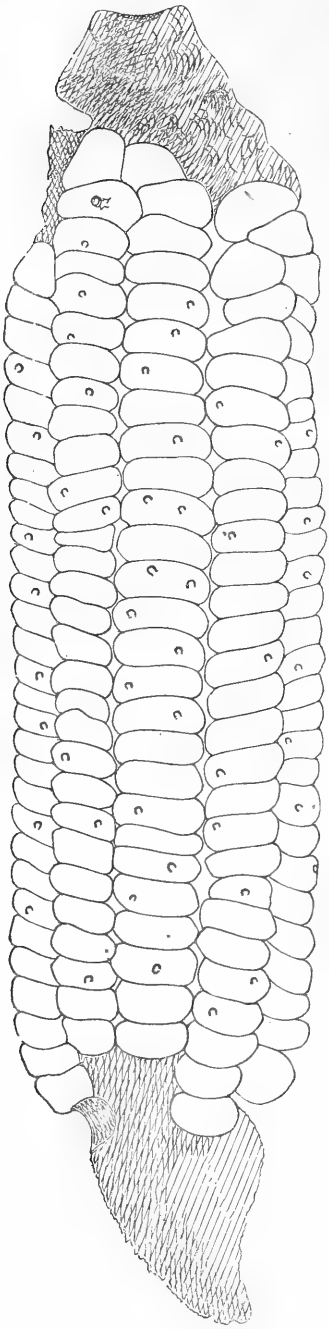
From the Secretary to the Municipal Committee in Amritsar were received in October 1890 caterpillars of a microlepidopterous moth which was said to have proved very destructive to millet and maize around Amritsar, none of the fields being free from it. The damage was variously estimated at from one-sixth to one-tenth of the crop. The caterpillars proved to be either identical with, or very closely allied to, the Sugarcane Borer (*Diatræa saccharalis*), described on pages 22 to 28 of Vol. I, No. 1 of these *Notes*. The maize stalks in which the caterpillars arrived having become somewhat dry, the caterpillars were transferred to pieces of sugarcane, into which they tunnelled eagerly. The sugarcane was periodically changed, but as yet (3rd March 1891) the insects are still

in the larval stage, showing that the insect passes the whole of the cold weather in the caterpillar stage within the stalks.[1] In the case of *Diatræa saccharalis* the eggs are deposited at the base of the leaf sheaths and the larvæ tunnel into the stalks, the chrysalis being formed in the tunnels and several generations being gone through in the year; and this no doubt will also be found to hold good when the insect attacks maize and sorghum. In their work on *Field and Garden Crops* Messrs. Duthie and Fuller notice that in the case of maize this insect is known as *Salai*, while in the case of sugarcane it is known as *Silai*, and in the case of sorghum as *Bhaunri*, the poisonous effect which *Sorghum vulgare* shoots sometimes have on cattle being attributed to it.

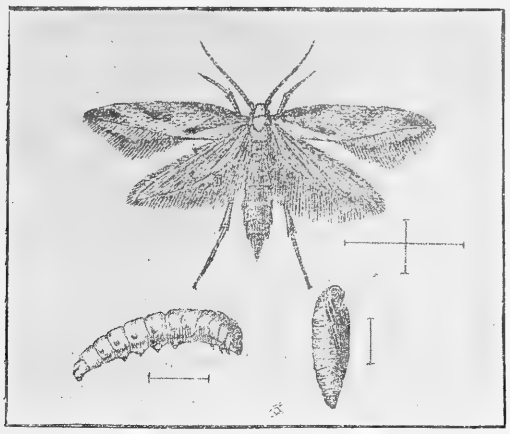
[1] One moth emerged on 31st March, and four more on the 4th and 5th June, soon after heavy rain; these all undoubtedly belong to the species which habitually attacks sugarcane in India. In the North-Western Provinces, according to Duthie and Fuller, maize is sown about May or June, and is reaped about the end of August; so the caterpillar probably lies up in the maize stalks from the time of cutting until the plant springs up again, in the following June. In this case, on Dr. Riley's estimate of thirty days for a generation, about two or three generations would be passed through during the growth of the plant, followed by a nine months' hybernation. The evidence for this, however, is incomplete, and it is by no means impossible that intermediate generations may be passed through in sugarcane, which springs up considerably earlier in the year than maize.

From the Revd. M. M. Carleton have been received American maize cobs grown in Kulu and infested by the larvæ of a small Tineid moth, which is said to swarm in the granaries where the grain is stored. The insect was evidently very closely allied to the Anjoumois Grain Moth (*Gelechia cerealella,* Oliv.) described in the United States Entomological Report, 1884, page 345, but, as this insect had not been previously recorded from India, the specimens were submitted to Mr. L. O. Howard, Acting United States Entomologist, for favour of comparison with the American form. In reply, Mr. Howard writes: "So far as I can see, this moth is indistinguishable from the Anjoumois Grain Moth of this country and Europe, and I have carefully compared it with specimens upon which the illustrations and article in the 1884 Report were based."

The Anjoumois grain moth in Kulu.



The Anjoumois Grain Moth has long been known in the granaries of Southern Europe and of America. It is named after the old Province of Anjou in France, where it proved exceedingly destructive about a century ago. According to the observations which have been made by Entomologists in Europe and of America, the first eggs are generally laid in grain standing in the



fields. The eggs are laid on the ears, and the larvæ tunnel into the grain. The second and subsequent generations are spent in granaries. Each caterpillar tunnels into a single grain, and remains concealed until just before it transforms into a chrysalis. It then cuts a small round valve-like door which is pushed open by the emerging moth. The chrysalis is enveloped in a slight silken cocoon inside the grain. The insect passes the winter in the caterpillar stage inside grain stored in granaries. The normal number of generations in the year is two, the first being spent in grain standing in the fields and the second in grain stored in granaries, but further generations sometimes occur under favourable circumstances. A temperature of 104°F., when sustained for two days, is said to have been found sufficiently high to destroy this insect. The Anjoumois moth therefore is essentially the inhabitant of temperate regions, and is little likely to prove destructive in the plains of India. (The figures show the caterpillar, chrysalis, and imago of the insect, together with a maize cob attacked by it.)

Cut worms.

From the Sub-Divisional Officer of Kurigram, Rungpore, were received in November 1890 Noctues larvæ said to do great damage to paddy by cutting off the unripe ears from the stalks. The insects were reared in the Museum, and in the early part of December produced moths which were found to belong to the species *Leucania extranea*. Caterpillars of the same species were received in the early part of December 1890 from the Collector of Rungpore, who reported that immense mischief had been done by them in many parts of his district. Specimens of a Cut worm probably identical with *Leucania extranea* were also received from the Manager of the Wards' Estate, Rungpore, who reported that the extensive injury caused by these insects, in cutting the paddy, had ruined many of the tenants, who had been impoverished by previous floods and locusts. The crops that were attacked were said to be nearly ready to be harvested, so that nothing could be recommended for use this year. It may be noticed, however, that the United States entomologists have recommended the destruction of Cut worms by strewing leaves poisoned with London purple over the fields, before the crop to be protected appears above the ground; while the

fact that the insect passes most of its time in holes in the ground, makes insecticide dressings, such as gas-lime, wood-ashes, and soot, likely to tend to discourage the increase of the pest. Frequent stirring of the ground also has been recommended as tending to expose the caterpillars to the birds which feed upon them, and in Ceylon tea gardens, according to Mr. E. E. Green, smooth conical holes sunk in the beds, when the earth is moist, have sometimes been found successful as traps. They should be made with a smoothly pointed stake pressed into the earth and rotated until the sides are smooth and firm, so that the caterpillars may be unable to climb out, when they fall into the holes in the course of their nightly wanderings.

Through the Director of Land Records and Agriculture, Bengal, were received in January 1890 specimens of Noctues larvæ, probably belonging to the species *Agrotis suffusa*. These insects had proved destructive to rabi crops both in Murshidabad and in Tipperah. In Murshidabad the Canoongoe of Jungipore reported that altogether he estimated the produce of 2,000 bigahs of land to have been destroyed; the crops chiefly attacked were wheat, barley, gram, oats and peas, oil-seeds and some pulses appearing to be untouched; the insects attacked the very young plants only, the older plants escaping. The only remedy known was irrigation, which caused the caterpillars to come to the surface, where they were exposed to the birds; irrigation, however, was practicable only in some cases. In the Sarail estate, Tipperah, the injury was chiefly confined to young tobacco and potato plants, mustard growing close by being untouched.

From Mr. J. Cockburn were received in March 1890 notes and specimens illustrative of the Cut worms which had recently attacked poppy, gram, pea, linseed and mustard crops in Oudh, many of the cultivators complaining that their individual losses during the season from Cut worms, to crops other than poppy, amounted to from twenty to twenty-five rupees. In the case of poppy fields, both larvæ and pupæ were found in March, the pupæ in the loose damp earth of the ridges between the poppy beds, where they stand erect in the ground from two to four inches below the surface. The larvæ were reared and proved to belong, in some cases, to the species *Agrotis suffusa*, and in others to the species *Ochropleura flammatra*, both belonging to the family Noctuidæ of the group Noctues. Moths of the species *Agrotis suffusa* were rarely seen, but the moths of *Ochropleura flammatra* crowded at night into the house, being apparently attracted by the light, and were largely destroyed by bats. In a subsequent note Mr. Cockburn observes that moths of *Agrotis suffusa* again began to appear in the middle of September 1890.

Noctues larvæ were received in January 1891 from Mr. R. H. Morris, of Mysore, who wrote :—

"Another pest is doing very great damage to my estate. It is a grub or

caterpillar (*Agrotis suffusa*, I think) well known to planters by the popular and significant name 'Ringer.' It eats the bark of the young coffee plants under two years old, in a ring right round the stem, sometimes just above, but generally just below the surface of the ground; the result being that in the dry weather the plant withers and dies, while in the wet weather apparently healthy and vigorous plants suddenly snap and fall over with the first gust of wind. In this latter case occasionally a good sucker is thrown out, which takes the place of the original broken stem. I believe I am well within the mark in saying that I have lost some fifteen thousand fine young plants during the past year, and some idea of their numbers may be gained by my informing you that I have destroyed by hand-picking, during the last two months only, over 1,10,000. These were brought in by the coolies in all stages of growth from little wee threads to big fat caterpillars an inch and a half long and as thick as a lead pencil. I am sending you by post a few specimens which I hope may reach you alive. Hand-picking is not satisfactory, because in the first place, after a field has been searched, plants can be killed by the 'Ringer' before the coolies get round to that field again; secondly, many very young plants are killed, by the searchers having exposed their roots to the sun, as the grubs frequently retreat to a considerable depth in the day-time; and, thirdly, it is an expensive way of getting rid of them, and is out of the question if labour be scarce. I am applying kerosine emulsion to the stem close to, and just below, the ground, with a band of quicklime on the ground right round, but an inch or two away from, the stem. I am afraid, however, that the useful properties of both of the above are too evanescent for the purpose."

The caterpillars were reared in the Indian Museum and in the end of February there emerged moths belonging to two very distinct species of Noctues. One of these is *Agrotis segetum*, and the second, being hitherto unrepresented in the Museum collection, has been sent to Europe for precise identification. The insect *Agrotis segetum* is well known in Europe as a most destructive Cut worm: some doubt, however, has been expressed as to its occurring in India. It may be useful, therefore, to notice that, besides the specimen from Mysore, the Indian Museum contains representatives of this species from Ceylon, and also from such localities along the Himalayas as Sikkim, Kulu, and Solon. In the Catalogue of the Moths of India also, by Cotes and Swinhoe, the insect is recorded from the Nilgiri Hills, Mhow, Poona, Quetta, Dubrai, Hyderabad (Sind), and Thundiani (Punjab). In England, according to Curtis (Farm Insects, 1860) *Agrotis segetum* passes through two or more generations in the year, hybernating in the larval stage and forming its chrysalis in the ground; and very much the same habits, no doubt, obtain in India.

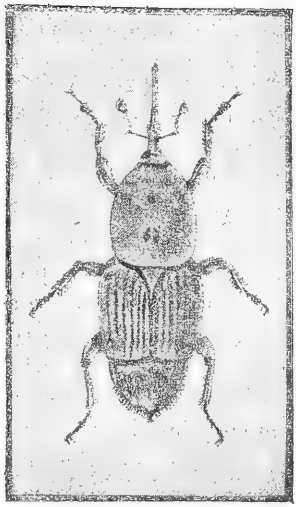
In the end of January 1891 numerous caterpillars of a Noctues moth, belonging either to *Agrotis suffusa* or an allied species of Cut worm, were received through the Bengal Agricultural Department, both from the Jalpiguri district and also from the Santhal Pergunnas. In Jalpiguri the insect is known as *Dora*, and is said to attack the roots of tobacco, potato, and chilli plants, doing considerable injury. In the Santhal Pergunnas the insect is known as *Nagara chandra*, and is said to be found in large numbers in the wheat fields, generally from three to five inches below the surface of the ground. They are found chiefly in fields

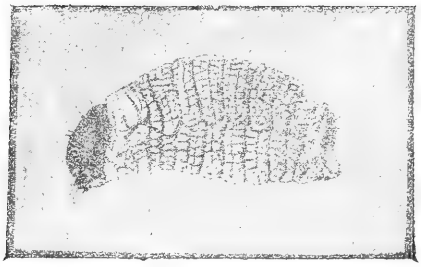
that are comparatively damp, and do considerable damage to young plants, migrating from one plot to another. Rain and irrigation bring them to the surface, when they are greedily eaten by the birds.

In February 1891 some Cut worms were forwarded by the Manager of Baboo A. N. Roy's estate, Berhampore, with the information that they damaged mustard, potato, linseed, and tobacco plants. The insects were thought likely to have belonged to some species of *Leucania* or *Agrotis*; the material, however, was insufficient for precise identification.

Palm Weevil.

From the Superintendent of the Government Horticultural Garden in Lucknow were received in April 1890 specimens, in various stages of development, of the Palm Weevil, described by Ridley in his report on the "Destruction of Cocoanut Palms by Beetles," Government Press Singapore, 1889, under the name of *Rhynchophorus ferrugineus*. In Lucknow, the insect was found to attack the stems of the date palm (*Phœnix dactylifera*). The Superintendent writes :—





"The tree from which these were taken blew down a few days ago. At the base and for half the height of the stem it was quite decayed and full

of the refuse created by the larvæ of the beetle. The upper part was fresh and the leaves green, and until the tree came down it was not noticed to be in bad condition. On examination, a number of other trees were found to be similarly affected, and will no doubt fade before long."

In October the same insect, both in the grub and beetle stage, was found by Mr. Gollan in the stems of date palms in the Saharanpur Botanical Gardens. The trees killed by the weevils had been imported about four years previously from the Persian Gulf, and it was thought possible that the insect came with them, as neither the wild date nor any other species of palm in Saharunpur had been similarly attacked.

According to Mr. Ridley's Report, this insect attacks both healthy and unhealthy trees. It generally lays its eggs at the base of the leaf stalk, though it also takes advantage of any mechanical injury to the stem, or of holes drilled by the *Rhinoceros* beetle (*Oryctes rhinoceros*) for depositing its eggs. The beetles fly chiefly at night and are often found concealed in the holes of the *Rhinoceros* beetle. As with other wood-boring insects, it is probably the case that unhealthy trees are more subject to attack than healthy ones. The only remedies that have been suggested are the obvious ones of destroying the beetles wherever they are found, and of burning trees that are badly infested to check the increase of the pest. Trees however that are not very badly attacked should be spared, as they are said to recover in many cases. (The figures show the beetle, with its grub, pupa, and cocoon, also side views of the head of the male and female to show the difference in the snout of the two sexes.)

Determination of miscellaneous pests.

The minute moth which proved destructive to bales of country blanketing in the Calcutta Army Clothing Department in 1887 has been examined by

Lord Walsingham, who reports that it is a *Setomorpha* (Tineidæ), which he is unable to distinguish from the African species, *Setomorpha rutella* of Zeller.

The common little case-making moth found everywhere on house walls in Calcutta has been identified by Lord Walsingham as *Tinea pellionella*. The moth which has proved destructive to raw wool in the Economic Section of the Indian Museum also appears to belong to this species.

A minute moth referred to in Vol. I, No. 2, of these *Notes* as destructive to the lentil plant (*Ervum lens*) in Patna has been determined by Colonel Swinhoe as *Laphygma exigua*, Guer. (*Family*,—Apamiidæ).

The Microlepidopterous insect whose larvæ were found by Mr. W. J. Simmons boring into the stone of mango fruit in Calcutta, and which forms its pupa case in the ground, has been examined by Colonel Swinhoe, who reports that it is a new species belonging to a new genus allied to *Maruca* (Pyrales, Margaronidæ).

The moth whose larva was found, by Dr. Prain feeding on ornamental oat plants in the Botanical Gardens in Calcutta, in January, has been identified by Colonel Swinhoe as *Leucania extranea* = *separata* (Noctues, Leucaniidæ); *vide* Catalogue of the Moths of India, No. 1674.

An Acridid received on 25th February 1889 from the Collector of Murshidabad as destructive to crops in that district (*vide* page 107 of Vol. I of these *Notes*) has been determined by Dr. Henri de Saussure as a variety of *Acridium succinctum*, St.

Some Acrididæ mentioned in Vol. I, No. 1, of these *Notes*, where they were said to be known as *Bhunga* or *Ankphutta*, and to defoliate sugarcane in Cawnpore, have been determined by Dr. Henri de Saussure as belonging to the species *Oedalus marmoratus* of Linnæus, and *Pœcilocera hieroglyphica* of Klug.

A dipterous insect of the Family Tabanidæ, forwarded by Mr. J. Cleghorn as attacking cattle in Baluchistan, has been determined by Mons. J. M. F. Bigot as belonging to the species *Chrysopis dispar*, Fabr., which is said to be common throughout Southern Asia.

In February 1890 were received from the Deputy Conservator of Forests, Kamrup, Assam, specimens of a boring insect which has proved destructive to young teak trees in the Kulsi plantation. The insects were found to be larvæ of a Cerambycid beetle, probably identical with the species of *Stromatium* previously reported as injurious in this locality.

Kulsi Teak Borer.

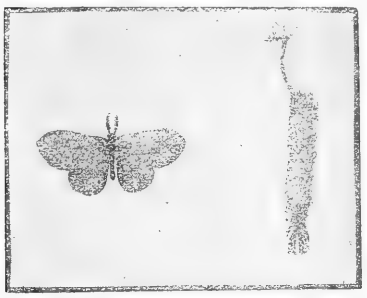
An imago also found in the Museum, marked "Kulsi Teak Borer," and probably the insect described in a note by Mr. A. G. Mein, which appeared in the *Indian Forester* in 1879, has been identified by Dr. Lameere as *Stromatium asperulum*, White. According to the account given by Mr. Mein in 1879, the insect had been noticed since 1873. It chiefly attacks trees that are in their first or second year's growth, though trees five and six years old are also attacked. The presence of the borer is usually marked by a swelling in the stem near the ground, and below this swelling can often be seen a small puncture from which excrement of the grub protrudes. This puncture, no doubt, represents the tunnel formed by the young larva in boring its way into the wood, from the spot where the egg was previously laid by the mother beetle in the bark. After a hot day the affected trees tend to have a faded appearance, but this symptom is not always present, and some trees remain apparently healthy until the larva has tunnelled so far into them that they snap off with the wind. The swelling, which appears where the borer is at work, is thought to be due to the efforts made by the tree to repair the damage, and to strengthen the stem where it is being weakened. These efforts appear in many instances to be successful, for the trees often recover. In 1877 the Forest Officer of Gauhati collected some affected stems and reared the insect. He obtained beetles in the end of June from logs which in March had contained only larvæ. But nothing further is known of the life history of the insect, beyond the fact that the larvæ are to be found in young teak

stems all the year round, so that the insect probably takes at least two years to pass through its various stages. In the Kulsi teak plantation the practice that was adopted in 1879 was to coppice all young trees that were badly attacked, and to encourage the growth of the strongest shoot from the stool to form a new tree by removing all other shoots as fast as they appeared. It was found best to leave older and more vigorous trees alone, provided they showed no signs of fading, as in many cases they recovered.

With the exception of the single specimen from the Kulsi teak plantation, the Indian Museum collection contains specimens of *Stromatium asperulum* from the Malay Peninsula only, *Stromatium barbatum* being the common Indian form. An application, therefore, was made to the Forest Officer of Kulsi for further specimens of the beetle which had been injuring the teak trees. In reply, specimens were forwarded of no less than three very distinct species of Cerambycidæ, *viz. Stromatium barbatum, Neoceramby*x *holosericeus, Ægosoma lacertosum,* the species *Stromatium asperulum* not being represented. Teak logs said to contain the grubs were also furnished, and an attempt is being made to rear the beetle from them in Calcutta, as it will be interesting to learn the part played by the different species, the probabilities being that most of the damage is due to some one kind of insect. (The figures show the beetle *Stromatium asperulum,* with some of the larvæ, furnished by the Deputy Conservator, Kamrup.)

Lagerstræmia Psychid.

The small Psychid, the cone-like cases of whose caterpillars are commonly to be found upon rose bushes, *Lagerstræmia indica* bushes, and other ornamental shrubs in Calcutta gardens, has been determined by Mr. F. Moore, who writes:—"This moth and its case are identical with a species of *Psychidæ* which I have in my collection under the MS. name of *Babula grotei,* the type specimen of which was reared at Alipur by the late Arthor Grote from cases found upon the Babul." The following description of the species has been kindly furnished by Mr. Moore:—



"*Babula grotei,*—upper and under sides uniformly pale cupreous brown, wings sparsely covered with short, very slender, laxly disposed, hair-like scales; ciliæ long, dense; expanse of wings $\frac{11}{12}$th of an inch. *Habitat,*—Calcutta. Type in collection of F. Moore."

The insect does a good deal of damage in Calcutta gardens as a defoliator. The eggs are probably laid by the female inside her case. The young caterpillars at first thatch themselves with little rough bits of leaf, gradually adding to the case thus constructed and making it bigger and neater as they grow older. When full fed, they spin themselves up into their cases, which they suspend from some convenient branch by silken threads. They then turn themselves round inside the case, so that the head rests where the tail has previously been. In this position, inside the case, the caterpillar shuffles off its larval skin and becomes a chrysalis, the male moth finally emerging from what was previously the tail end of the caterpillar's case, and generally leaving part of the chrysalis skin protruding from the case, as shown in the figure. The male is the active little moth depicted in the figure; the female has not yet been observed, but is likely to be a wingless grub-like animal which passes the whole of her life inside the case. London purple wash was tried for destroying this insect upon ornamental shrubs in Calcutta; the results, however, were not satisfactory, though it is only fair to add that the wash was mixed and applied by an unskilled native *mali*, so the fault may have lain with him, and not with the insecticide. The immediate result of applying the wash was to kill the leaves, so that the shrubs consisted for some time of nothing but apparently dry twigs. But, though the leaves were killed, it was found that many of the caterpillars spun themselves up inside their cases on the bare twigs and remained alive during the whole time the shrubs were without leaves, the consequence being that when fresh leaves appeared the caterpillars descended upon them and began eating them up as industriously as before. (The figure shows the male moth, together with the pupa case from which it emerged).

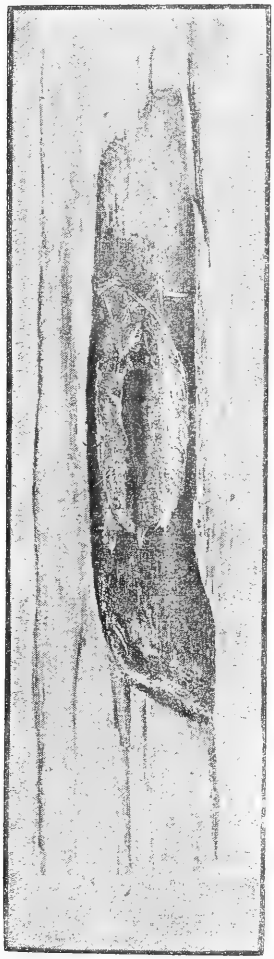
Apple Scale in Bangalore.

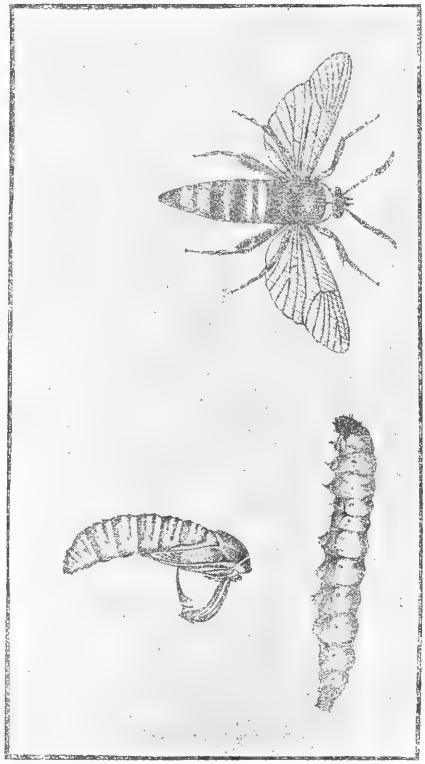
In January 1890 Mr. T. T. Leonard reported injury to apple trees in Bangalore by the aphid *Schizoneura lanigera*. An account of this insect is given on page 51. Kerosene emulsion has proved useful in some cases in keeping this insect in check, but in many cases the destruction of infested trees has appeared to be the only effectual means of dealing with the pest. The life history of the insect has not yet been observed in India, but is no doubt very much the same as what obtains in Europe. In Europe, according to the observations of Lichtenstein, as recorded in the Entomologists' Monthly Magazine, 1878, page 134, a winged sexless female begets the wingless male and female which do not feed but produce the winter egg, which develops in the spring into the wingless female. These wingless females settle down, and, after moulting a number of times, form the gall, and reproduce themselves asexually; their offspring again, which are also wingless, migrate to some fresh spot and then settle themselves

down and moult, as their mother did before them. This asexual reproduction of wingless females goes on through a number of generations until the autumn, when winged asexual females are produced. These winged asexual females produce the wingless sexual form, from which, after copulation, the single winter egg is produced. The root and branch inhabiting forms belong to one and the same species. The galls on both roots and branches are morbid growths of the vegetable tissues, due to the irritation set up by the wingless females in feeding upon the plant. The downy excretion with which these females are covered serves to a great extent to protect them from the weather. Honey tubes are absent, so the insect is not protected by ants.

In Peshin, Baluchistan, according to Mr. J. Cleghorn, the poplar

Baluchistan Poplar Borer.





tree, which constitutes the most generally useful wood of the country, suffers severely from the attack of a boring insect. This insect proves to be the caterpillar of an *Ægeriid* moth, allied to the species which attacks poplar trees in England; it has been kindly examined by Mr. F. Moore, who determines it as a new species of *Sphecia*, which he describes below as *Sphecia ommatiæformis*. The poplar trees are grown from cuttings and when about two years old they are almost invariably attacked by the caterpillar, which bores through the trunk and riddles it in all directions close to the ground, generally killing off the stem before it gets to be five years old, but leaving the roots intact, so that fresh shoots are made from the ground. These shoots, having well established roots to support them, generally manage to survive the attack of the insect and to repair the damage by throwing fresh wood around the injured portion. The loss therefore that is occasioned by the insect, chiefly consists in the throwing back of the growth of the young trees by two or three years. Now, as the tree is a fast-growing one, this loss is very considerable, two-year old trees being often as much as fourteen feet high, with trunks two and a half inches in diameter, when they are killed down by the pest. Out of thirty-five trees, planted out five years previously, Mr. Cleghorn found remaining eight of the original trees which had survived the attack of the insect, fifteen trees, each apparently from three to four years old, and twelve trees each one to two years old, all growing upon the original roots and derived from the shoots sent up after the original stems had been destroyed by the insect. With regard to the life history of the insect, from May to September, only caterpillars could be found in the burrows in the trunks, but in September chrysalids began to be formed in cocoons made of chips and situated near the entrances of the burrows, and moths appeared in October. The eggs therefore are probably laid in the bark in the early part of the cold weather, as the coldness of the Peshin winter makes it unlikely that the moths could hybernate, though the amount of fatty matter found in the body of the moth makes its hybernation in this stage by no means impossible. Whether, however, the moth lays its eggs soon after it emerges in the autumn, or hybernates and lays them in the spring, the cycle of the existence of the insect probably extends through one year.

The moth, which has been reared in the Indian Museum from stumps forwarded by Mr. Cleghorn from Baluchistan, is a small clear winged Ægeriid, and so closely resembles the wasp *Vespa cincta* in appearance as to be easily mistaken for it when looked at superficially; and this likeness, as in the case of other mimicking insects, no doubt affords the moth a considerable degree of immunity from the attack of the birds which would otherwise feed upon it, *Vespa cincta*, with its powerful sting, not being an insect to be molested with impunity. (The figures show the

caterpillar, pupal case and moth of *Sphecia ommatiæformis*, also a section of the tunnel containing the cocoon of chips in which the pupa is formed.)

In addition to the Ægeriid caterpillars a few Buprestid larvæ were forwarded by Mr. Cleghorn as found boring into the poplar trees, one of them being also received from the Deputy Conservator of the Forest Circle, Quetta. Nothing has been ascertained on the subject of the habits of this insect, and specimens of the beetle into which the larvæ transform must be procured before its identification can be determined. It is not expected, however, that it will be found to play more than a subordinate part in injuring the poplar trees.

The description kindly furnished by Mr. F. Moore of the Ægeriid moth is as follows:—

"*Sphecia ommatiæformis*, n. sp., Moore.

Male.—"Head above and thorax chestnut-red; face yellowish, sides whitish; thorax with a prominent gamboge-yellow frontal collar; abdomen chestnut red, each segment with an anterior pale yellow band; second and third joints of palpi gamboge-yellow, the basal joint being bright chestnut-red; legs beneath dark chrome-yellow, legs above chestnut-red and darkest on the tips of the tibiæ. Wings semi-transparent, very pale reddish-ochreous; costal edge, the veins, and ciliæ chestnut-brown; antennæ chestnut-red. Expanse of wings $1\frac{1}{2}$ inch. *Habitat*,—Baluchistan."

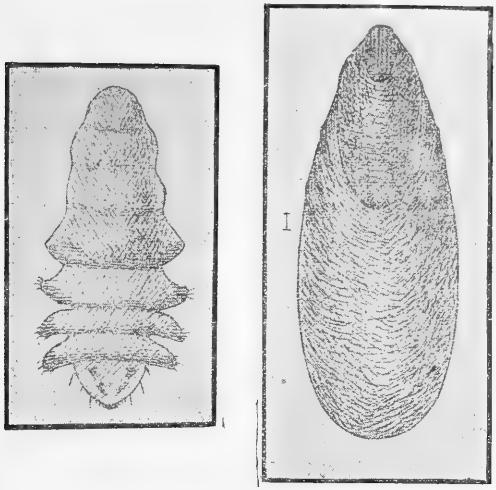
This species is allied to *S. dasypodiformis*, Walker (Catal. Lep. Brit. Mus. VIII, page 12)."

Toon Twig Borer.

The Toon Twig Borer, *Magiria robusta* (Microlepidoptera), which was described on page 35 of Vol. I of these *Notes* as injurious to *toon* trees in Ceylon, has been observed during the past two years as extremely injurious to the *toon* trees which line the roads in Dehra Dun. The caterpillar mines the succulent twigs, constantly destroying the leading shoot, and causing adventitious shoots to be given out on all sides. This goes on year after year, the leading shoot being constantly destroyed, and the trees becoming a mass of stunted branches with no well defined trunk above a few feet from the ground. The insect is chiefly found in young trees, but its work is only too apparent in the majority of the old trees, very few of which have anything approaching a well-grown trunk. Nothing has yet been recorded of the life history of the insect beyond the fact that in Ceylon moths were reared in October from larvæ which became full fed and formed their chrysalids inside the twigs in the latter part of September. The only measure which has been suggested for keeping the insect in check has been the cutting off and burning of the affected shoots; the number of trees, however, which are affected in Dehra Dun, makes any such treatment quite out of the question.

From Mr. Marshall Woodrow, of Poona, were received in October 1890 specimens of a coccid said to attack the *Suparee* nut palm (*Areca catechu*) in the Janjira State, on the coast, about 80 miles south of Bombay, the outturn of dressed beetle nuts having been reduced by the ravages of the pest, from 10 lbs. per tree to 1 lb. per tree. The trees were said to have suffered for the last twenty-five years from this insect, which has become specially troublesome during the past six or seven years. The specimens were submitted to Mr. W. Maskell, who has kindly furnished the following note on the identifications of the species :—

Areca Palm Coccid, in the Konkan.

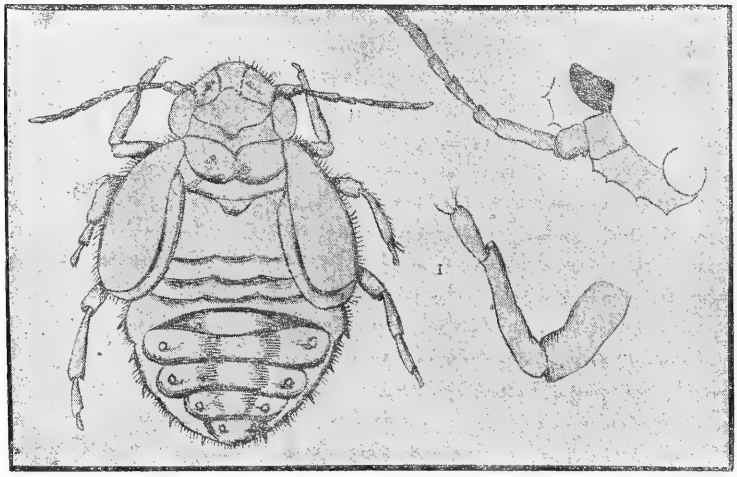


"The insect is, as regards the female, so much like *Chionaspis aspidistræ*, Signoret, that I may consider it identical with that species. The female puparium agrees in its yellow colour and pyriform shape ; the second pellicle is rather large ; and the enclosed insect has the remarkably prominent abdominal segments, as shown in the enclosed rough sketch, characteristic of *C. aspidistræ*. As far as I can make out, *Aspidistra* is a genus of half a dozen species of ornamental plants in China and Japan ; and it seems quite likely that (supposing you to have none of the genus in India) this scale may have other food plants, of which one would be *Areca catechu*. I could not, amongst the numerous specimens you sent me, discover any male puparia. In *C. aspidistræ* these would be small, white, narrow and carinated. In the absence of the perfect certainty which these puparia would give us I think my diagnosis of the female is probably correct."

With regard to remedies, Mr. Woodrow recommended the people to fire the badly-affected trees and to wash those which were but slightly attacked with an emulsion made in the proportion of one gallon of water, one ounce of sulphate of copper, one ounce of kerosine oil, and a handful of cowdung, to be applied three times at intervals of a few days, so as to destroy the young as fast as they emerged. It may also be noticed that, as the experience of entomologists in the United States has shown that kerosine and soap emulsion is the best application for destroying Scale insects of all kinds, recourse might be had to it, if the treatment suggested by Mr. Woodrow should prove insufficient. Full directions for the preparation of kerosine and soap emulsion will be found in earlier numbers of these *Notes*.

Indigo blight.

From the Calcutta Agri-Horticultural Society were received, in the early part of July 1890, blighted indigo shoots, with the information that, according to an estimate made by Messrs. Jardine, Skinner & Co., the indigo crop



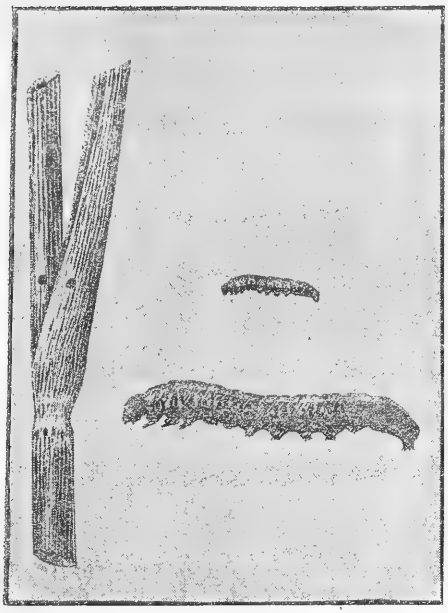
in Bengal has been reduced by about one-third this season, the loss, which amounts to several lakhs of rupees, being ascribed to blight. The indigo shoots were found to be covered with minute black scales, each containing a partially developed homopterous insect, which was at first supposed to be one of the Aphidæ, but which has since been described by Mr. G. B. Buckton as the pupa of a new species of Psyllidæ, which he names *Psylla isitis*. The description kindly furnished by Mr. Buckton is as follows :—

Psylla isitis, nov. sp.

"*Pupa*.—Colour shining yellow with the edges of the abdominal somatic rings rich brown. Vertex bristly, eyes angularly facetted, large and red. Rostrum short and stout, proceeding from between the eyes, and lying between the fore coxæ. Pronotum corrugated and tuberculose. Antenna with eight joints, the two basal joints stout and somewhat globose; the third and eighth joints the longest. Wing-cases double, but not separate. Abdomen globose, the somata edged with rich brown, and marked with stigmata. Tarsus obscurely two-jointed, ending with one claw and two bristles. The larval form is smaller than the pupal, and has less developed antennæ and feet. Size 0·05 × 0·03 of inch."

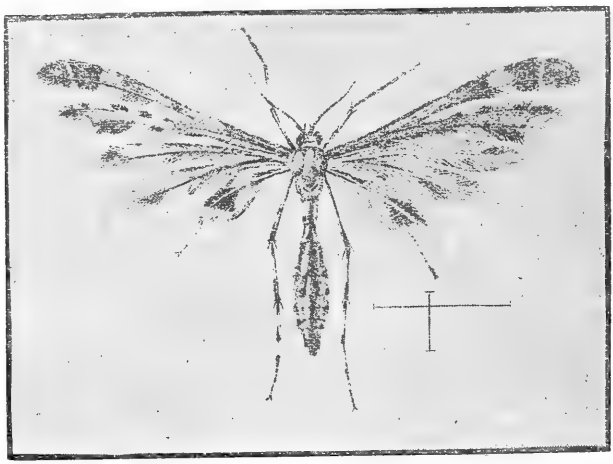
In September 1890 were received through the Agricultural Department of Bombay, carterpillars of a microlepidopterous insect reported by the Collector of Thana to have done a considerable amount of damage to paddy during the past two years in his district. The specimens were insufficient for absolute determination, but were either identical with, or very closely allied to, the Rice Stalk Borer (*Chilo oryzæellus*) of the United States. A very similar insect has been described as destructive to paddy in Perak, though it has not yet been ascertained whether the species found in Perak is identical with that which occurs in the United States. With regard to remedies, the observations of Mr. Howard in the United States, and of Mr. Wray in Perak, have shown that the insect passes the time between the harvest of one year, and the springing up of the crop of the following year, in the self-sown paddy, and perhaps also in the stems of large grasses, which spring up in and around the paddy fields. The careful destruction therefore of these by burning has been thought to be the most promising means of reducing the numbers of the pest. According to Mr. Wray, eggs are laid in batches at the base of the leaves, 600 eggs being sometimes laid by one female. These eggs hatch a few days after they are laid, and the caterpillar at first feeds on the leaves, but after a short time it bores its way into the inside of the stem, where it passes the rest of its caterpillar existence. The chrysalis is formed either in the leaf stalk or inside the stem. A generation takes about two months; so, there are several generations in the course of the year. (The figure shows the caterpillar, natural size and enlarged, together with a piece of rice straw tunnelled by it.)

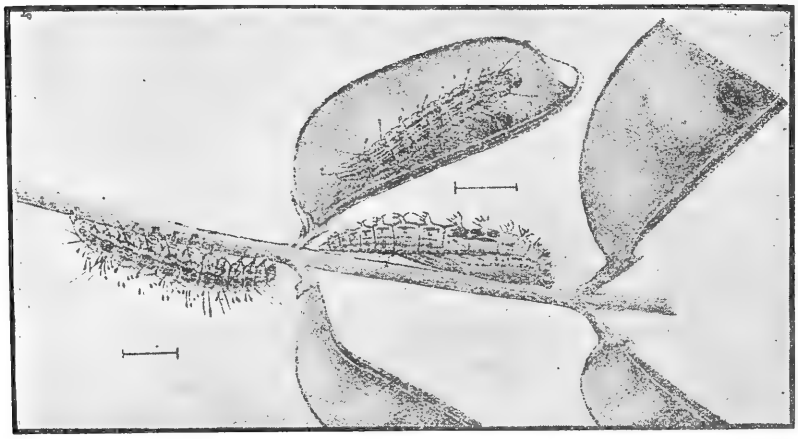
Padi Borer in Thana.



In December 1890 were received, from the Overseer of the Government Farm, Nagpur, amongst other pests, pods of *Dolichos lablab* tunnelled by the larvæ of a minute Plume moth. The caterpillars were reared in the Museum and the moths were forwarded to Lord Walsingham, who identified them as belonging to the species *Sphenarches caffer,* of Zeller [1]. Lord Walsingham gives the synonymy of this species as follows:—

Lablab Plume Moth.





[1] Lord Walsingham notes that a pupa case, sent to him from West Africa, corresponds precisely with the figure made by the Indian Museum artist from a Nagpur specimen, and that the only difference he has observed between the moths from Nagpur and those that have been sent to him from Africa, consists in the Nagpur specimens having the tooth of dark scales, on the hind margin of the third lobe of the hind wings, a very little further removed from the apex, even this slight difference not holding good throughout a series from Burma. Should it turn out, however, that there are two species, then the name *S. caffer*, of Zeller, will belong to the African form.

"SPHENARCHES, Meyr.

"♂ ♀ CAFFER, Z.

Pterophorus caffer, Z.—Hand. Kong. Svensk. Vet-AK., 1852, 118.

Oxyptilus caffer, Z.—Lin. Ent., VI, 348-49 (1852); Wkr. Cat. Lep. Ins. B-M. XXX, 934 (1864); Wlsm., Tr. Ent. Soc., 1881, 279; Meyr., Tr. Ent. Soc., 1887, 268.

"*Sphenarches caffer*, Meyr.—Tr. Ent. Soc., 1887, 268.

"= *Oxyptilus anisodactylus*, Wkr.—Cat. Lep. Ins. B.—M. XXX, 934-353 (1864); Moore, Lep. Ceyl., III, 528 (1887); Meyr., Tr. Ent. Soc., 1887, 268. (Type ♂ ♀ B-M.)

"= *Oxyptilus walkeri*, Wlsm.—Tr. Ent. Soc., 1881, 279; Meyr., Tr. Ent. Soc., 1887, 268. (Type, Cape Town Mus.)

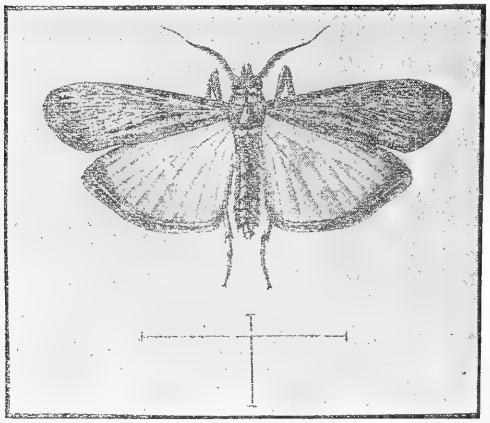
"=*Sphenarches synophrys*, Meyr.—Tr. Ent. Soc., 1886, 17; 1887, 268. (Type, ♂ Mus. Meyr.)

"*Larva*—on "Calabash" (West Africa): in "Lablab" pods (India).

"*Imago*—March (N.-S.-W.)

"*Hab.*—Australia (N.-S.-W.), New Hebrides, Tonga Is.
Africa (Natal, Caffraria, Gambia, East Africa).
Asia (India, Ceylon, Burma, Japan).
(Type, ♂, Stockholm Mus.)"

Perak Pomelo Moth.



From Mr. L. Wray, Jr., Curator of the Perak Museum, were received in October 1890 specimens of the moth which he has found destructive to pomeloes, limes, and lemons in Perak. The specimens were forwarded to Mr. F. Moore, who identified them as belonging to a new species of *Phycitidæ* which he describes as *Nephopteryx sagittiferella*. The following is his description:—

"*Nephopteryx sagittiferella*, nov. sp., Moore.

"Closely allied to *N. physostigmalis*, Walker, described in the Proceedings of the Royal Physical Society of Edinburgh for 1869, the larva of which is stated to feed upon the 'Esere' or 'Ordeal Bean' of Old Calabar.

"Fore wing slightly broader, paler ferruginous, brown, the costal area and between the outer veins silvery-grey; on the discal area is a transverse curved series of elongated very acute sagittate points, which are blackish and with a greyish outer line; at the end of the outer veins is a prominent blackish pointed-dot. Hind wing also broader, pale, pinkish cinereous, silvery-grey along the anterior border (not brown, as in *N. physostigmalis*); veins externally, and the marginal and cilial line, brown.

Body dark cinereous brown; head, thorax, palpi, antennæ, fore and middle legs ferruginous brown; hind legs pale cinereous brown.

"Expanse of wings ♂ 1, ♀ 1⅛ inch. *Habitat.*—Perak."

The following is Mr. Wray's summary of his report upon the subject:—

"At the request of the British Resident of Perak, I made an enquiry into the cause of the destruction of all the pomelo fruit grown in the Residency gardens at Kwala Kangsa, and have ascertained, from actual observations and breeding experiments, that it is primarily to the attacks of the caterpillars of a small moth that the loss is due.

"The life-history of this insect is, as far as I have been able to observe it, as follows:—

"The eggs are laid singly and in small irregular patches on the lower side of the fruit, and when they hatch out, the young caterpillars eat their way into the fruit, making a number of minute holes through the rind, generally over an area of about the size of a shilling. The pith under this patch is riddled with holes, and gum is often subsequently found, both in the cavities of the rind, and also on the outside of the fruit.

"As the caterpillars increase in size, they eat their way through and through the fruit, and make holes through the rind to eject refuse, and also possibly to obtain air. To these holes uneatable portions of the fruit and fæcal pellets are carried by the caterpillars and ejected.

"The caterpillars, which are active, quick-moving insects, jump and twist when touched, and, for caterpillars, can progress with considerable speed. On arriving at maturity they leave the fruit, and, descending to the ground bury themselves in the earth to undergo the change into the pupa state; the caterpillars make in the earth cells of agglutinated earth, lined with white silk; they measure 0·7 inch in length, 0·4 inch in breadth, and 0·3 inch in depth.

"On the twelfth day after quitting the fruit, the transformation is complete, and the moth forces its way through the cell and up out of the earth.

"The perfect insect is about an inch across the wings, and of a warm brown colour, with shadings of silvery grey. In the day-time it is very quiet and sits usually on the earth of the breeding cages, the head and forepart of the body being much raised, and the antennæ laid back on the wings, which are closed and folded closely over the body. When in this position, it is a very inconspicuous object, both as regards colour and form. At night it seems to be lively and is possessed of fairly good powers of flight.

"The first four moths I raised all died in a little over two days, and though they consisted of two of each sex, no eggs were laid. On dissection of the females I found the eggs to be immature and few in number, and deduced from their state that the insect does not deposit its eggs until some days after leaving the chrysalis and that during that time it needs food to enable it to perpetuate its species.

"With the next brood of moths I put various fruits, but none of these seemed to their taste, for, though they lived for five or six days, and laid a few eggs, none of these proved fertile. In all I raised over thirty of these insects without getting one egg that would hatch.

"It seems quite possible that, as the fruit on which they feed during the caterpillar stage is seasonal and that there are periods of months at a time during which no food is available that the moths are long-lived, and until their natural food during the imago portion of their lives is discovered, attempts at artificial breeding will be unsuccessful.

"*Egg.*—Oval, dirty white, translucent, with fine raised, irregular network cove ring

surface. Length ·04 inch, and breadth ·025 inch. When laid, they take the form of flattened ovals, with the lower side following the shape of the object on which they are laid, and the upper surface convex.

"*Larva.*—General colour bluish-green, tinted above with pinkish bronze. The four anterior segments being less tinted than the remainder; the young are almost wholly of a rather dull pink. Length of adult ·86 inch, breadth ·15 inch.

"*Pupa.*—General colour warm brown, darkening towards the tail, wing sheaths dull green for the first few days, after which they become dark brown. A dark median line from tail to thorax on the dorsal aspect. Length ·5 inch, breadth ·17 inch.

"The caterpillar of the pomelo moth is able to pierce uninjured the natural defences of the fruit.' Disregarding both the pungent oil of the rind, and the thick layer of pith beneath it, it reaches the cellular portion of the fruit, which it tunnels through and through in all directions, passing through the seeds if they happen to be in its line, but apparently not seeking them out. Fæcal matter is deposited in the burrows, and decomposition as a consequence quickly sets in on its walls. Under the microscope the fluid contents of any cell which has had its containing sac broken by the passage of the caterpillar is seen to be teeming with bacterial life of many kinds. Carefully detaching a sac adjoining one that had been broken by a caterpillar, but which was in itself quite perfect, and microscopically examining its contained fluid, there appeared many bacteria. The most frequent form being masses of cocci, many other forms were present, but in smaller numbers.

"An oval saccharomyces was very plentiful in the injured cells, and is the probable cause of the acid fermentation which takes place in them. It was not present in the adjoining unbroken ones. Presumably the smaller forms only can pass from cell to cell through the connecting vessels.

"It is probably to this secondary attack of micro-organisms that the premature ripening and falling of the fruit may be ascribed, more than to the actual injury done by the caterpillars themselves; other insects taking advantage of the holes made by the caterpillars through the rind can enter the fruit and lay their eggs in the pith and pulp, with the result that large rotten patches spread from the entrance and exit holes. These insects are two or three species of flies, and a small brown beetle, all of which are attracted by any decaying fruit.

"The life-history of the pomelo moth shows that there is only one period of its existence when there is any hope of destroying it in useful numbers, and that is when it is in the caterpillar stage inside the fruit. The eggs are small, and so like the oil cells on which they are laid that without a lens it is difficult to see them; in the pupa state, which is passed beneath the ground, they are well out of reach, and in the perfect stage, being strictly nocturnal and very inconspicuous, there would be little chance of doing any good.

"The only suggestion that I can make is to destroy all fruit that is seen to be inhabited by the caterpillars, or which falls from the trees. The destruction of the fruit which falls is of importance, not only as a means of killing the insects contained in it, but also as preventing its serving for the rearing of another brood.

"As the eggs seem to be laid only on the fruit itself, it would appear that if the young fruit is put into bags, that they would have a chance of arriving at maturity.

"I am inclined to think that the wild species of *Citrus*, known by the native name of *Limau kerbau*, and which is apparently nearly allied to the pomelo, *Citrus decumana*, is the natural food of these caterpillars, as it is a fairly common tree in the jungles of some parts of Perak.

"Since writing the above, bagging the fruit in common thin white cloth has been tried. in the Government gardens, with complete success.

"Quite recently I have found that the common limes, and also European lemons

are attacked, and large numbers of them destroyed by the same insect. The moth bred from them is indistinguishable from those bred from pomeloes.

"Nothing but the destruction of all infected fruit would be of any use in mitigating the ravages of the pest in the case of limes and lemons."

Heliothis armigera.

The cosmopolitan insect *Heliothis armigera*, which has been previously referred to in these *Notes* as attacking opium, cotton, and leguminous plants, has recently been noticed in Ceylon, where, according to Mr. E. E. Green, it feeds upon the fruit of the Cape gooseberry, *Phipalis* (*?*) *peruviana*, often completely destroying the crop. It remains concealed within the persistent calyx that envelops the fruit, and devours the succulent berry. Caterpillars also, which are thought to belong to this species, though the material has been insufficient for precise identification, have been received, in most cases accompanied with a small percentage of larvæ of other moths, from the following:—(1) The Officiating Collector of Backergunge, who reported that in the Patuakhali Sub-division, where the insect is known as *Leda*, the injury done to rice in December 1890 had amounted to an average of about one anna in the rupee. (2) The Collector of Khulna, who reported in February in 1891 that the insect had proved injurious to paddy in his district. (3) The Deputy Commissioner of Sambalpur, Central Provinces, who reported that the insect was known locally as *harnipok*, and attacked rice: it was said to be comparatively scarce just then, though in previous years it had been numerous enough to damage the crop. (4) The Commissioner of Excise in Bengal, who reported in February 1891 that the insect had been damaging the hemp plant (*Cannabis indica*).

According to the observations which have elsewhere been made upon this insect, the larvæ feed in the open upon the leaves and pods of various plants, several generations being passed through in the course of the year. The pupæ seem in most cases to be formed in the ground, the only exception being when they attack poppy capsules, in which case (according to the observations of Mr. Scott) the pupæ are formed within the capsules. In the United States the insect has been found in most cases to hybernate in the pupa stage, though a few of the moths which emerge late in the autumn are also thought to survive the winter.

Baluchistan Melon Fly.

Specimens, in all stages of development, of the fly which attacks melons in Baluchistan, have been received from Mr. J. Cleghorn, who has written an interesting paper upon the subject. The specimens were forwarded to Mons. J. M. F. Bigot, who kindly examined and described the insect as

Carpomyia parctalina, a new species which belongs to the group of Muscidæ distinguished by Rondani as *Tephritoidi*, and is hence allied to *Tephritis onopordinus*, Fabr., which, according to Miss Ormerod, mines the leaves of celery and parsnips in Europe. Mons. Bigot's description of the species will be found on page 50.

According to Mr. Cleghorn's observations, which were made in Peshin (5,000 feet), the Baluchistan Melon Fly hybernates as a pupa from September, and in some cases from July, until April, two or more generations being gone through in the summer months, the later broods being especially numerous and destructive. The insect passes about four days in the egg stage, fourteen days in the grub stage, thirteen days in the pupa stage, and twenty days as an imago: its cycle of existence therefore consists of something over a month. The egg is deposited in the rind, several eggs being often laid in a single hole. The egg-laying is chiefly done in the morning, the fruit selected for oviposition being usually very young, sometimes with flowers still attached. The eggs hatch about four days after they are laid and the grubs work their way towards the seed pulp. The passage grows together behind them as they advance, so that a few days after the egg is laid, the hole in the rind closes up and the tunnel disappears, leaving no sign of attack. The maggot therefore cannot obtain air from the exterior, and it is supposed that it breathes the air contained in the seed cavity. This view appears to receive confirmation from Mr. Cleghorn's observation that in cucumbers and vegetable marrows, in which there is little or no seed cavity, the young grubs remain near to the original hole in the rind, eating out a cavity in the pulp, and only making their way towards the seeds when they have eaten out so large a quantity of the pulp that there is no chance of the passage filling up behind them. When about a fortnight old the maggot becomes full fed; it is then much like a small grain of rice in general appearance, and has its mouth armed with a pair of hooked mandibles and its posterior end provided with the usual paired breathing organs. When full fed, the maggot cuts its way out of the melon and pupates in the ground, where, in the summer time, it remains about a fortnight before emerging as a fly, and where the autumn brood hybernates until the spring. The life of the fly itself is a brief one, about twenty days being the longest that it has been found to live, even when plentifully supplied with melon pulp upon which it feeds. When a melon contains numerous grubs, it becomes stunted and does not develop, but when not more than five or six grubs are present, growth does not seem to be interfered with, unless indeed the grubs cut their way out, in which case the fruit decays. In the case of well-grown fruit, which is full of juice, the grub always cuts its way out of the upper portion,—apparently in order to avoid being choked by the juice,—the practice therefore of constantly turning the fruit in the sun to ripen it

prevents the emergence of the grub and saves the fruit from rotting. The Melon Fly does considerable injury to the melon crop, especially towards the end of the summer, when the later generations of grubs begin to emerge. Mr. Cleghorn recommends enclosing the fruit in muslin bags, which he endeavours to show would repay their cost, many times over, in increased production of melons. He is of opinion that hard winters kill the majority of the hybernating pupæ, so that it is after mild winters that the insect is chiefly abundant.

Kerosine emulsion on Coffee Scale insects.

The following reports have been kindly furnished by Messrs. Green, Crow and Shelley, who have experimented upon their Ceylon coffee estates with a force pump, furnished by Messrs. Woodin & Little of San Francisco for applying kerosine emulsion for the destruction of scale insects: —

"I am now able to report, from personal experience, upon your pump and the kerosine emulsion treatment for 'green-bug.' I find that the cost is not excessive, varying from about ₹20 to ₹30 per acre according to circumstances (nature of land, water-supply, &c.); but I am not satisfied with the results. I find that with the greatest care it is impossible to thoroughly saturate the tree with the mixture, and that a very large percentage of the insects escape. Even some of those that were fully exposed to the spray were afterwards found to have survived the treatment, although the leaves on which they were fixed had been partially scorched by the action of the kerosine. Where the insects were actually killed, the young larvæ were afterwards seen to be crawling in numbers from beneath the dead bodies of their parents. I made the emulsion according to the formula given in Hubbard's *Insects affecting the Orange*, and diluted it before using in the proportion of one part emulsion to nine parts cold water, as recommended in the same work.

Particulars of cost.

To spray 1 acre—

250 gallons diluted mixture = 25 gallons of the emulsion = $16\frac{3}{4}$ gallons kerosine, costing at local rates .	₹16·00
Four pounds, common soap	„ 0·80
Application, 10 men @ ·37 cts.	„ 3·70
Total cost per acre .	„ 20·50

"This experiment was made under the most favourable conditions, the land being comparatively level, and there being an abundant supply of water to hand. This particular form of pump is not the most convenient for the work. The cost of application would be much less if a Vermorel knap-sack pump were used. The principal faults of the present pump are:—(1) The bucket and pump being separate, it requires two men to work and transport the machine. (2) The distributing hose is not long enough, and at its junction with the pump should be guarded with a Bodifield hose-protector to prevent kinking. Of the nozzles, the one with adjustable cap is the most convenient. It gives as good a spray as the cyclone nozzle, and is more readily cleared than the latter. But, unless it can be shown that the treatment is really fatal to the bug (of which I am not assured), it matters little what form of pump is used.

"I have unfortunately been unable to find any one willing to co-operate with me

in testing this treatment. Mr. W. Jackson and others to whom I have applied say that they would have no time to attend to the work, and also that they are not now so much troubled with the pest. Mr. Shelley seems to have confined his experiments to young plants in nurseries."—(*E. E. Green.*)

"At the request of Mr. E. E. Green I am returning you a force pump which you had lent him for the purpose of spraying bug-infested coffee, and which he at my request sent on to me to try some experiments in the same way. I regret to say that the emulsion of kerosine oil was not satisfactory, and the insect seemed to get on the trees almost at once after the application. Pure kerosine seems to have some influence in destroying the bug, but it at the same time rots the skin of the young coffee berries, so that it cannot be used while the crop is on the trees, which in some districts here is practically all the year round. I fear it is useless trying to contend with this pest on a large scale and that we have to look forward to the complete extinction of coffee in this island ere long."—(*J. G. Crow.*)

"It has been an unfavourable season for trying the pump, as we have had hardly any bug to speak of; and what we have had has been on isolated trees here and there; so I am quite unable to say anything as to cost. But I have been much pleased at the result of the emulsion applied with the pump, and all I can say is that under ordinary circumstances, such as not too steep a lay of land, and with water handy, I believe it would be quite easy to keep the bug in check."—(*F. H. Shelley.*)

Stored Sorghum pests.

In May 1890 was received from the Department of Land Records and Agriculture in Madras a packet of weevilled cholum seed (*Sorghum vulgare*), infested by numerous specimens of *Calandra oryzæ* (wheat and rice weevil), also of the common Ptinid (? *Rhizopertha pusilla*, Fabr.), a single specimen of *Silvanus surinamensis* being also found. The injury to the seed appeared to be chiefly due to the *Calandra* and *Ptinid*, which are the two insects that do most of the injury to stored wheat in India, *Silvanus surinamensis* being also a common granary pest which is often found in wheat. As far therefore as can be judged from this sample, it seems that stored sorghum seed and stored wheat in India have common enemies, and that any measures found useful in protecting the one are likely to be efficacious with the other.

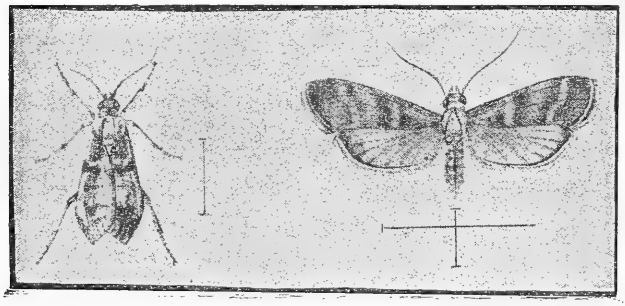
The Madras locust of 1878.

From the Superintendent of the Government Museum, Madras, have been received specimens of six species of Acrididæ said to have been the *locusts* which proved destructive in the Madras Presidency in 1878. The specimens comprised the species *Acridium æruginosum*, Burm., represented by about half a dozen individuals, and *Acridium melanocorne*, Serv. var., *Mecopoda, sp.*, *Tryxalis turrita*, Linn., *Euprepocnemis, sp.*, and *Pachytylus cinerascens* (?), Linn., each represented by one, or at most two individuals, the single specimen of *Pachytylus cinerascens* (?) being in such a poor state of preservation that its specific identification was somewhat doubtful.

So far therefore as these specimens enable us to judge, it appears that neither *Acridium peregrinum*, which is the chief locust of North-Western India, nor *Acridium succinctum*, which was probably the Bombay locust of 1882-83, were concerned in the Madras invasion of 1878. A considerable amount of damage was undoubtedly done by Acrididæ over a wide area in the Madras Presidency in 1878, and the official reports upon the subject seem to show that while Orthoptera of all kinds were particularly abundant in that year, all over the presidency, most of the injury was done by swarms belonging to a single species whose identity therefore has yet to be established.

Baluchistan Pomegranate Moth.

From Mr. J. Cleghorn were received in September 1890 some pomegranates tunneled by the larva of a Microlepidopterous moth. The insect was reared in the Museum and the specimens were forwarded to Mr. F. Moore, who has identified them as belonging to a new species of *Phycitidæ*, which he describes under the name of *Nephopteryx punicœella*. The following is the description kindly furnished by Mr. Moore :—



"*Nephopteryx punicœella.*

"Allied to the European *N. abietella*, but smaller in size, grey ; forewing numerously covered with greyish black scales, but differs from *abietella* in not having the marginal blackish dots ; it has a similar transverse discal or postmedial pale narrow wavy band, and also an antemedial similar band ; the other markings are also similar. Palpi, antennæ, and eyes black ; head, thorax, legs, and abdomen blackish, the latter with greyish segmental bands.

"Expanse of wings $\frac{8}{12}$ inch.

"*Habitat.*—Baluchistan."

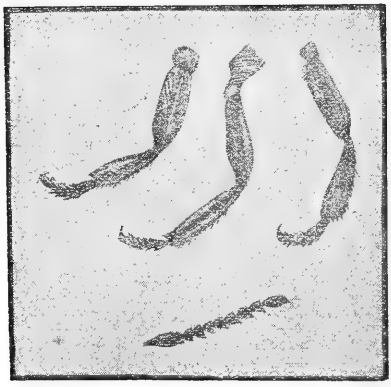
Paddy blight in Bhagalpore.

In August 1890 the Commissioner of Bhagalpore forwarded some paddy plants said to be suffering from the attack of a minute insect known locally as *Mara*, which weakens the plant by sucking up the juice of the leaves. The insects are said to be so small as to be scarcely visible to the naked eye. They occur only in rice fields where there is a scarcity of water, and the damage caused by them has not been very extensive. The leaves of the

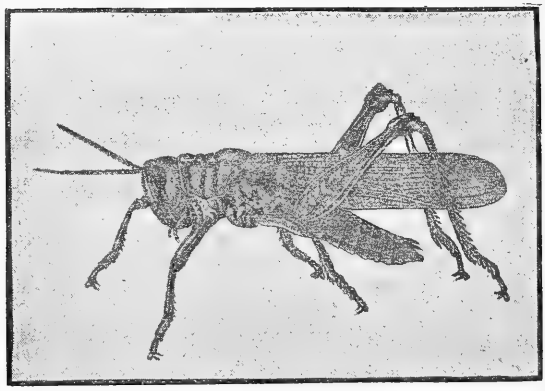
plants that were forwarded to the Indian Museum were covered with what appeared to be a black felted fungoid growth; but the specimens were so old and dry that very little could be made of them. No insects were found, but the fungoid growth may possibly have followed the attack of plant lice on the rice plants.

Lasioderma testaceum.

The beetle, *Lasioderma testaceum*, noticed in Part I of these *Notes* as attacking cheroots, rice, and the leaf coverings of opium balls, has recently been reared in the Indian Museum from pieces of saffron which were found to be tunneled by its larvæ. The larvæ are the little white grubs depicted in the figure; they tunnel into various substances. The external hole, which is usually the first intimation which is noticed of their ravages, is cut by the beetle when it emerges. (The figures show the grub and beetle enlarged, also still further enlarged drawings of the legs and antenna of the beetle).



Hieroglyphus furcifer.



In August and September 1890 a good deal of damage was done in the Rajpipla State, and in the Panch Mahals, Broach, and Thana districts of the Bombay Presidency, also in the district of Sambalpur in the Central Provinces,[1] by grasshoppers belonging to the species *Hieroglyphus furcifer* and its allies. The insect was noticed (*vide* Vol. I of these *Notes*, page 203) as destructive both in the Central Provinces and in Guzerat during the rains of 1889. The specimens that were forwarded to the Museum were found to vary so much in their size and markings that Dr. Henri de Saussure, to whom they were submitted, was of opinion that the more extreme forms should be looked upon as constituting a second species, for which he proposed the name of *Hieroglyphus colesiana*. The specimens, however, which have since been forwarded by the district officers, tend to show that the peculiarities upon which the new species was based are merely due to individual variation. It seems likely therefore that the whole of these insects belong to the one species, *Hieroglyphus furcifer*, which, however, is a somewhat variable one. It is probably non-migratory in its habits, and there is no record of any definite measures adopted against it, though the injury it occasions appears in some cases to be considerable. In Sambalpur, according to the report of the Deputy Commissioner, the insect lays its eggs in cracks in the ground in the early part of the cold weather, the young hatching out with the commencement of the following rains, and often occasioning considerable injury to the young rice plants. In Broach, where, according to the Collector's report, the green standing crops were said to be suffering, the ravages of the insect were effectually put a stop to by a heavy fall of rain, which was supposed to have killed off the pest. In the Panch Mahals, according to the Collector's report, the insect was said to have been injuring maize, rice and *Banti* (?) crops, the loss in some villages being estimated at as much as ten per cent. of the whole. In Thana,[2] according to the Collector's report, the insect was said to

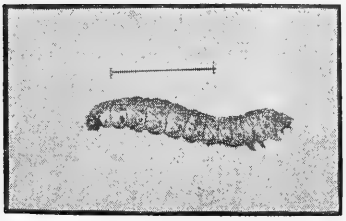
[1] Specimens of the same insect were also received in January 1890 with the information that it had proved destructive to crops in the Kolhapur State (Bombay).

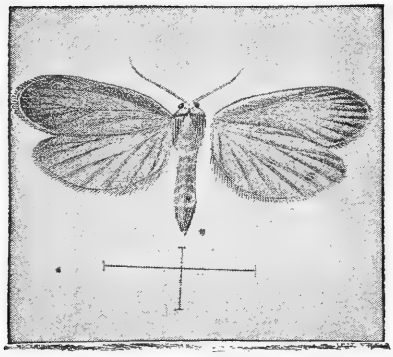
[2] The specimens forwarded from this district as responsible for the injury were accompanied by a few grasshoppers of the genus *Tryxalis*.

have done much mischief to rice that was coming into ear, by destroying the immature grain. In the Rajpipla State the insect was said to have also been noticed in some places in 1889.

The Wax Moth, whose caterpillars attacked the combs of the Ligurian Bee (*Apis mellifica*, var. *ligustica*), which was reared experimentally in the Indian Museum, has been determined by Mr. F. Moore, who writes :— "I have examined this moth and find that it is the species that is so commonly found wherever honey bees are reared, both in England and in other parts of Europe. The moth is *Achræa grisella*, Zeller, and is termed the 'Honey Moth' being a great pest and very destructive in its habits of tunnelling through the combs. It belongs to the family Galleriidæ."

Wax Moth.





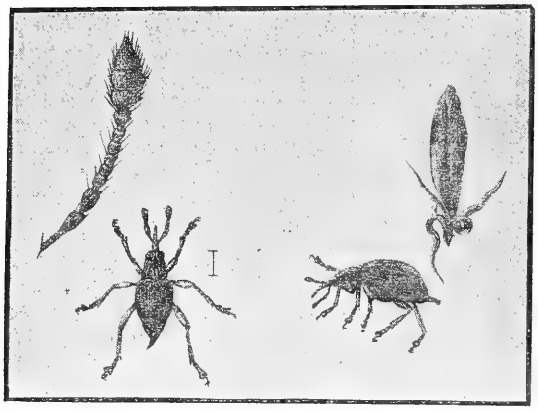
Specimens of the Rice Hispa (*Hispa æneseens*), referred to on page 37 of Vol. I of these *Notes*, have been forwarded during the past year by the district officers of Howrah, Backerganj, and Khoolna, also by Mr. C. H. C. Adamson, of Mandalay. In Howrah the insect is known as *Shanki poka*, in Khoolna as *Sanka poka*, and in Backerganj as *Mazra*. In each case it is reported to have been destructive to the rice crops. The Khoolna report notices that it breeds in low-lying grass which it attacks in the same manner as paddy, the injury occasioned during the past year being less than usual, owing to the heavy rain which is said to check the insect. This insect eats away the parenchymatous tissue of the leaves,

Rice Hispa.

thus weakening the young paddy plants and decreasing the outturn of rice. No practicable remedy is at present known for it.

The Curculionid destructive to the seed of *Strobilanthus pectinatus* (*kibu*) in Sikkim has been determined by Mons. Desbrochers de Loges, as a new species of *Apion*, which he names *Apion strobilanthi*. The *kibu* is a herbaceous weed which grows at an elevation of about 6,000 feet in Sikkim and is used for fodder. In the rains of 1889 the only plant which was observed by Mr. Gilbert Rogers to flower, had the whole of its seeds destroyed by this insect. (The figure shows the insect with its antenna (much enlarged), also a *kibu* pod attacked by it).

Strobilanthus Weevil.



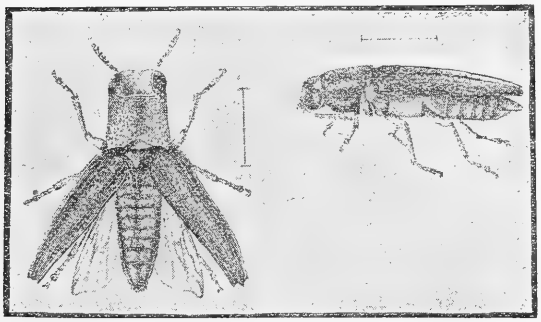
From the Superintendent of the Botanical Gardens, Bangalore, were received in March 1890 specimens of the heteropterous insect *Oxycarenus lugubris*, Mostch., of the family Lygæidæ, said to have proved injurious to cotton in Seringapatam, where, in the early stages of the growth of the plant, fumigating with tobacco had been found efficacious in keeping down the pest. This insect has previously been reported as injurious in Ceylon, where it infests the ripe cotton pods and discolours and cakes the cotton. Nothing further is known of its habits. The cotton was also said to suffer from the

Cotton pests in Seringapatam.

attack of a hemipterous insect probably belonging to the species *Dysdercus cingulatus*. This insect is allied to the "Cotton stainer" (*Dysdercus suturellus*) of the United States, where it is said to puncture the cotton bolls and injure the fibre, also puncturing the rind of oranges and causing the fruit to drop. The remedies recommended for the American species have been, poisoning the insects by traps of sugarcane trash, mixed with Paris green or destroying them when collected upon piles of cotton seed or orange peel, with hot water or kerosine and soap emulsion. It is extremely doubtful, however, to what extent such remedies will be found practicable in India. (The figure is that of *Oxycarenus lugubris*, much enlarged.)

In October 1890, from the Overseer of the Government Farm, Nagpur, were received cotton stalks tunneled by the larvæ of a Buprestid beetle which has been identified by Mons. Kerremans as a new species of *Sphenoptera* which it is proposed to call *Sphenoptera gossypii*. The larvæ were reared in the Museum and produced imagos in November; the insect was said only to attack the country varieties of cotton, the American varieties escaping. With regard to the identification of the species Mons. Kerremans writes :—

Cotton Buprestid in Nagpur.



"Les espèces actuellement décrites de ce genre, et habitant l'Inde proprement dite sont au nombre de onze ; ce sont, *ærosa* Gmel. (= *ænea* F. = *tricuspidata* Ol.), *indica* Cast. et Gory, *orientalis* Cast. et Gory, *perroteti* Cast. et Gory, *pulchella* Cast. et Gory, *angustata* Thoms., *lafertei* Thoms., *nigrescens* Thoms., *pisciformis* Thoms., *cupriventris* Kerr., et *cyaniceps* Kerr. (ces deux dernièrs décrites dans un tout récent mémoire sur les Buprestides du Chota Nagpur). Parmi ces espèces, il n'en manque que trois à ma collection, ce sont *lafertei*, *piceiformis*, et *pulchella* et le spécimen que vous m'avez envoyé ne se rapporte ni à aucune de mes espèces ni aux descriptions des espèces qui me manquent. C'est done une espèce nouvelle....Il se distingue des autres espèces par sa forme parallèle, par sa tête aussi large que le thorax et ses yeux, prominents, par son écusson très grand et cordiforme, et par ses tibias postérieurs incurvés. L'espèce dont il se rapproche le plus est le sp. *angustata*, Thoms., mais celui-ci a le front sillonné, l'épistome tout autrement conformé, et le dessous est d'un cuivreux brillant très prononcé. Sa ponctuation générale est aussi très différente."

Ceylon Tea Aphid.

From Mr. E. Green were received in February 1890 specimens of an Aphid which is said to attack young tea plants in Ceylon, sometimes doing

Ceylonia Thæcola

considerable injury. According to Mr. Green's account, published in the Ceylon *Independent* newspaper, both the winged and wingless forms are found in great numbers on the young succulent shoots in nurseries, and the irritation which they set up causes the edges of the leaves to curl and become distorted. The life history of the insect has not as yet been completely traced, but Mr. Green has observed that both the winged and wingless forms reproduce themselves parthenogenetically, the young settling down beside the mother and becoming full grown in about ten or twelve days after they are born. Honeydew is secreted in the usual way by glands on the dorsal surface of the abdomen, and the insect is consequently attended by ants. It is devoured by the larvæ of Syrphidæ, Hemerobidæ, and Coccinellidæ, besides being parasitized by a minute Ichneumonid, and the combined effect of these insects is so considerable that the Aphid is often completely kept in check by them. Wood ashes, powdered sulphur, and dry carbolic powder, have all been found

useless as applications for destroying the pest, but washes made of dilute kerosine emulsion or of phenyle are found to be efficacious; the proportions recommended are one part of kerosine emulsion to eighty parts of water, or one part of phenyle to two hundred and forty of water. The wash should be applied in the evening or on a cloudy day, as hot sunshine, following its application, is apt to scorch the leaves. In the case of phenyle the application of the wash should be followed the next morning by a copious drenching with ordinary water.

The specimens were submitted to Mr. G. B. Buckton, who kindly examined them and reports that the insect belongs to a new genus and species of Aphidæ which he names *Ceylonia theæcola*.

The following is his note on the subject :—

"The Ceylon Tea Aphis appears to be anomalous and undescribed, and the form has no representative in Europe, as far as I know. In the general appearance of the body, the antennæ, and the cornicles, it follows the genus *Aphis*, but the single furcation of the cubital vein sharply separates it from that genus, and in this particular it more nearly follows *Schizoneura*. I presume, however, that the Tea Aphis neither rolls leaves nor forms galls, neither has it a flocculent covering. The lower wing also shows some modification in the disposition of the oblique veins. I think it will be desirable to place this Aphis under a new genus, and for the present I suggest for its name *Ceylonia theæcola*, which is trivial and not therefore binding to any particular character.

"Genus CEYLONIA.

"Antennæ long and seven-jointed, third and fourth joints nearly equal. Cornicles cylindrical and rather long. Upper wings with the cubitus once forked. Stigma large; oblique veins two. Lower wing with two oblique veins running nearly parallel to each other; tarsus with one joint."

"*Ceylonia theæcola*, nov. sp.

"Colour dark brown or black. Apterous insect, globose, shining, finely punctured. Head square. Antennæ long, seven-jointed, ochrous yellow, with black wings. Abdomen with a row, on each side, of small pores. Whole insect punctured. Legs dirty ochrous, with dark femora. Cauda black and hirsute, cornicles cylindrical. Size of body 0·055 inch. Winged female coloured much like the above. Wing voluminous, with a brownish membrane much punctured. Underside all brown. Rostrum reaching just beyond the third pair of coxæ. Expanse of wings 0·19 inch. Body 0·04 inch. These insects stain weak alcohol a fine port wine red colour."

The Rice Sapper in Chumparan.

Specimens of the rice sapper (*Leptocorisa acuta*, Thumb.) have been received from Mr. J. Cripps, of Chumparan, where the insect is said to have been very destructive to the ears of *Bhuddai* paddy, which is harvested about October. The insects work chiefly on cloudy days and at night, and retire to the foot of the plants in hot sunshine. The cultivators are said to strew the fields with fresh buffalo dung, covered with buffalo buttermilk, in which an insect is said to breed

which attacks and destroys the Rice Sapper. The Rice Sapper occurs all over in India and attacks immature paddy grain in the ear, sometimes destroying a large proportion of the crop, especially when the rains set in early. Little is known of its life history.

A Baluchistan granary pest.

In January 1890 were received from Mr. J. Cleghorn, Harnai, Baluchistan, a number of little cases formed of wheat grains cemented together. It is said that all granaries in Harnai have to be examined and cleaned every month to destroy the insect which constructs the cases, granaries not examined for three months having their whole contents destroyed by it. No specimens were received of the insect, but the cases appear to be the work of one of the *Tineinæ* moths, which are cosmopolitan granary pests. The frequent examination required would seem to point to the insects passing through a number of generations in the year.

Bashahr Grape Fly.

Mons. J. M. F. Bigot, to whom specimens of the Bashahr Grape Fly[1] were submitted for examination, writes from Paris that, though the specimens are insufficient for precise identification, the insect probably belongs to a new species of the genus *Drosophila*, which might be named *Drosophila apicata*.

Further specimens therefore should be procured for examination. In the meantime it may be noticed that the larvæ of other species of *Drosophila* attack both sound and decaying fruit. According to W. C. Fish, as quoted by Packard in his *Guide to the Study of Insects*, one species of *Drosophila*, which is known in the United States as the *Apple Fly*, attacks apples, rendering them unfit for use; in this case the maggot usually enters the apple through some wound caused by other insects, or, if there be no such wound, through the calyx. Many of the maggots arrive at maturity in August, and the fly soon afterwards appears, several generations being gone through before the cold weather, which the insect passes as a pupa in some sheltered spot, the flies emerging in the following spring.

Tea Limacodid.

From Messrs. Williamson and Magor were received in January 1891 caterpillars of a Limacodid moth, said to have proved injurious to tea in the Darrang district, Assam. The caterpillars defoliate the bushes and then descend to the ground, where they roll themselves into the characteristic Limacodid pupal case, resembling a minute potato. Children had been employed to hand-pick the caterpillars, but the numbers of the pest have been too great to be successfully dealt with in this way, and some inconvenience

[1] *Vide* page 202 of Vol. I, No. 4, of this serial.

was also found owing to the stinging properties of the bristles with which the caterpillars were armed. It is not thought likely that these caterpillars will occasion any very serious injury. The moths emerged on 26th January, and were forwarded to Colonel Swinhoe, who has determined them as belonging to a new species of *Miresa*, which he is describing under the name of *Miresa cotesi*.

Horse Œstrid in Baluchistan.

From Handerzai, situated at an elevation of about 4,000 feet in Baluchistan, Mr. Cleghorn sends an Œstrid Fly with the information that he has found it in November laying its eggs at the ends of the hair on horses' legs and other parts of the body that can be reached by the horse's mouth. Whilst laying its eggs the insect does not disturb the horse, but immediately afterwards irritation sets in, possibly from the itching caused by the frequent settling of the fly, and the horse bites the place where the eggs are laid, so that some of the eggs find their way into the animal's mouth, and thence into its stomach where they develop. Careful grooming and the application of a nose-bag to prevent the horse from biting off the eggs have been found to be the most practicable means of protecting the animal from the pest. The specimen was submitted for identification to Mons. J. M. F. Bigot, who reports that it is a variety of the well-known European form (*Gastrophilus equi*), which has been described under the name of *Œstrus bengalensis* (Macq., Dipt. Exot.). The life history of this insect is no doubt the same as that of the true *Gastrophilus equi*, which, according to Williston, lays four or five hundred eggs, generally on the inner side of the horse's knees, the horse showing great annoyance and often becoming unmanageable, though the insect can cause but little irritation in the process of laying its eggs. The eggs hatch a few days after they are laid, and the larvæ get taken in the horse's mouth when it is biting the irritated spots. They are then swallowed with the food, and, upon entering the stomach, attach themselves to the inner membrane by means of the hooklets that encircle the mouth. Here they remain for nine or ten months feeding on the suppurative matter produced by the irritation they set up within the stomach, and when full-fed they loosen their hold and are carried through the intestinal canal and ejected with the excrement. They then burrow into the ground and transform into pupæ, from which the images emerge in thirty or forty days. When only a few grubs are present in a horse's stomach they are said to cause but little injury to the animal, but when they exist in large numbers they may produce sufficient inflammation or loss of blood, in some cases even to cause death.

Coffee Dynastinid.

Through the Calcutta Agri-Horticultural Society was received in November 1890 a specimen of the Dynastinid beetle *Xylotrupes gideon*, var. *mniszechi* (?), said to have caused some damage by eating the pulp of coffee fruit in Cachar.

Mango Liparid.

From Mr. R. Wroughton, of Poona, have been received specimens of the Liparid moth, *Artaxa limbata*, with the information that the caterpillars were injurious to young grafted mango plants. The insect had been reared by Mr. Wroughton, who noted that the caterpillars were found on 23rd September, the cocoons spun on 29th September, and the moths emerged about 12th October.

Acrididæ in Assam.

The Acridid grasshopper *Phymatæus miliaris*, which may perhaps be the *locust* that proved destructive to crops in Nowgong in 1879, is noted by General H. Collett as fairly common in the neighbourhood of Shillong, where it is often to be seen feeding on bushes and grass, though it is thought not to do any appreciable damage to the crops.

Mango maggots.

Through the Calcutta Agri-Horticultural Society were received in June 1890 a series of mangoes from Mozafferpore, where they are known as *Lal kampee* and are said to be attacked, very generally throughout the district, by white maggots. These maggots are about the size of grains of rice, and are found in such numbers in the fruit as to render it unfit for use. The maggots are likely to be the larvæ of some dipterous insect allied to the species (*Rivellia persicæ*) described on page 192 of Vol. I of these *Notes* as destructive to peaches in Chota Nagpore; but for some unexplained reason the mangoes actually received were found to be unaffected by anything of the kind. The only insect discovered in them, after careful search, was the solitary larva of a micro-lepidopterous insect which was about three-sixteenths of an inch long by one thirty-second of an inch thick. It had bored a hole in the side of the mango, but had not penetrated more than about a quarter of an inch into the pulp. It may, possibly, have been the caterpillar of the moth (*Maruca* nov. sp., Swinhoe) which has been found boring into the stones of mangoes in Calcutta. Its position shows that it was in all probability hatched from an egg laid by the parent moth in the skin of the nearly ripe fruit.

Notes from Darjiling forests.

The following information has been furnished by Mr. G. Rogers, of the Forest Department, in Darjiling. In April 1890 a blackish, hair-covered, processional caterpillar, about two inches in length, defo-

liated the *Buk* (*Quercus lamellosa*) trees over an area of about twelve miles long by eight miles broad, near Darjiling, the trees, which were in some cases as much as seventy feet high, being often completely denuded of their leaves. Much injury was not done however, as, at the time that the caterpillar appeared, the trees had only their last year's leaves upon them, while they put forth young leaves again in the following June. The *Sungare katus* (*Quercus pachyphylla*), a valuable forest tree which grows in Sikkim at an elevation of 7,000 to 10,000 feet, suffers from the attack of the larvæ of one of the Curculionidæ beetles, which is estimated to destroy 90 per cent. of the seed. The only specimens that could be obtained were small grubs, about a quarter of an inch in length, and of the characteristic curculionid shape; they are insufficient for precise identification.

A large swift-flying Curculionid beetle, which has been identified as *Cyrtotrachelus dux*, and which, in the male, is characterised by enormously developed front legs, attacks the asparagus-like shoot of the hill bamboo *Dendrocalamus hamiltonii* at elevations of about 3,000 feet above sea-level. In May and June the imago is often found clinging on to the growing shoot, which is perforated by a big hole from which it has emerged. Shoots thus attacked come to nothing.

In June a large green Rutelinid beetle, which has been identified as *Anomala viridis*, strips leaves off the *Al* tree (*Alnus nipalensis*), growing at elevations of from five to six thousand feet above sea-level.

A Stag beetle, which has been identified as *Lucanus mearesi* of Hope, bores into the dead sapwood of the *Kharani* tree (*Symplocos*, sp.) at elevations of between five and six thousand feet above sea-level.

A large wasp, which has been identified as *Vespa magnifica*, builds a nest sometimes two feet in diameter in the trunk of a laurel known locally as *Kawlee*. The nest occupies the whole of the interior of rotten trees, and is to be found in July at elevations of about 6,500 feet. The hill people are in the habit of eating the grubs of this wasp, though the sting of the imago is so severe that an Englishman has been known to have nearly died after being stung by three of them.

The wild bee, *Apis dorsata*, is not often noticed at elevations above two thousand feet, though in one place a large bee which probably belongs to this species builds combs on the face of some rocks at an elevation of four or five thousand feet, and yields, in good years, a revenue of as much as a hundred rupees to the Forest Department.

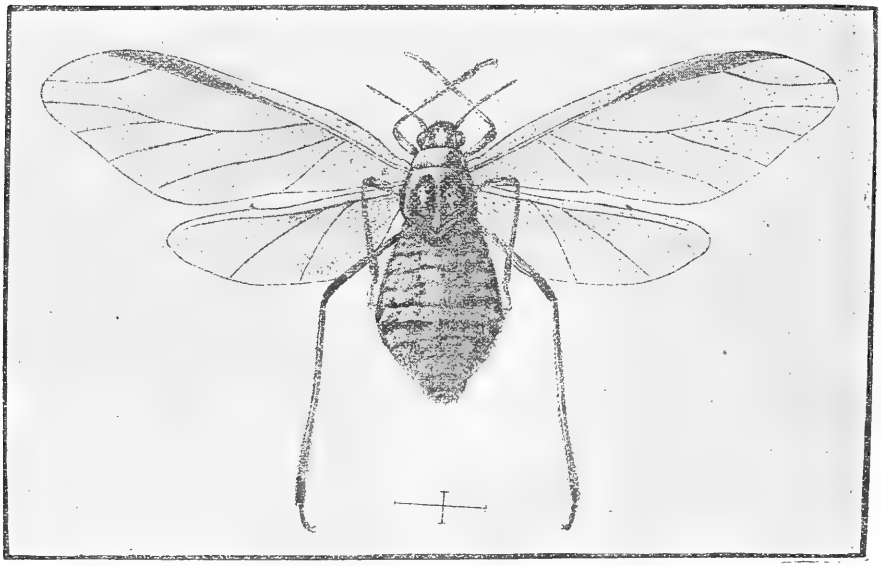
Flata conspersa on tea.

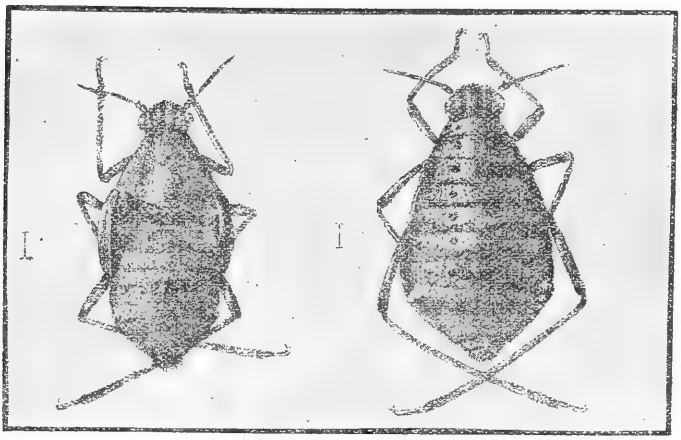
From the Bhergaon garden, Mungledye district, Assam, were received in October 1890, through Messrs. Williamson and Magor, tea shoots attacked by the larvæ of the homopterous insect *Flata conspersa*, which had covered the shoots with its characteristic white secretion and was said to be feeding

on the bushes and retarding the flushes, the whole garden being badly attacked by it. A closely allied insect was once before sent to the Museum as attacking tea, but as nothing further was heard of it the supposition is that it did not occasion any very considerable damage. This is also likely to be the case in the present instance.

Baluchistan Fruit Tree Aphid.

Specimens of one of the Aphidæ have been received from Mr. C. F. Elliot, the Deputy Conservator of Forests, Quetta, Baluchistan, with the information





that they infest apricot, almond, and peach trees, swarming in patches from six inches to a foot in length on the undersides of the branches, especially of the apricot, and causing the trees to bleed profusely.

The wingless forms were noticed from March onwards, and in the early summer they were so numerous that it was found worth while to have them rubbed off daily by hand. Winged-individuals were found for a short time in October, eggs and young appearing on a few trees in the latter part of November, a fortnight's rainy weather in November not appearing to affect them This insect has not been previously recorded as attacking fruit-trees in Baluchistan, though it may not improbably be the same as what has been noticed by Mr. Cleghorn as causing the bleeding of poplar trees in that region. Specimens were sent to Mr. G. B. Buckton, who has determined the insect as a new species of *Lachnus* which he describes as *Lachnus fuliginosus*. The report which he has kindly furnished upon the insect is as follows:—

"The specimens embraced the three different stages of larvæ, pupæ, and a few winged examples of viviparous females. These insects clearly belong to the *Lachninæ*, or Aphides, which show the full number of nervures in their upper and lower wings, possess short six-jointed antennæ and thick mammilliform nectaries or cornicles.

"The Quetta insects do not exactly agree with any described species of *Lachnus* with which I am acquainted.....I may mention that, as a rule, the European *Lachninæ* feed upon conifers, but not exclusively, for an Aphis, very like the one under examination, *viz. Lachnus viminalis*, feeds on the willow bark. Hitherto the plum, the peach, and the apple tree have not been recorded as liable to the attacks of these insects of the genus *Lachnus*. Several important differences, as will appear by the following diagnoses, lead me to suppose this to be a new species, notwithstanding certain resemblances to the willow Lachnus before mentioned. Provisionally I name this Quetta insect *Lachnus fuliginosus*, nov. sp.

"*Larva.*—Variable in shape according to age; either long-oval or globose. Head small, vertical edge round. Eyes, small. Thorax separated from the abdomen by a slight stricture. Antenna rather short, stout, and hirsute, six-jointed, the nail being counted as one. Abdomen rugose, and studded with black shining tubercles. Nectaries stout and mammilliform. Apex of abdomen round, hirsute, and without a visible cauda. Legs long, yellow, with black points to the femora and tibiæ Tarsi black and two-jointed. Rostrum one-third the length of the body. Length 0·16 × 0·09 inch = 4·0 × 2·2 millimetres. Antenna 0·05 inch = 1·27 mil.

"*Pupa.*—More linear in form, but much of the same colour as the larva. On the somite preceding that on which the cornicles are developed, a curious horn-like process rises, out of the dorsum. In *Lachnus viminalis* this horn appears to be restricted to the larval stage. The wing-cases are about equal to one-third the length of the body.

"*Imago.*—Viviparous female. Head small; vertex rounded, and finely pilose. Antennæ black, and fringed with hair; about half the length of the body; with two stout basal joints; the first of which is rather the longest; the third joint the longest of all. The fourth and fifth about equal length; the fourth sometimes shows a constriction or a tendency to subdivide. The nail-like process on the sixth is sometimes so large as to suggest the antennæ to consist of seven joints instead of the normal number of six. Eyes moderately large, and apparently without any supplemental eyelet.

Thorax broad, with two alar muscular bosses. Scutellum small, abdomen pilose, brownish grey, flask-shaped, and much corrugated. Nectaries as in the larval condition. Abdominal apex rounded, fringed with hair, and without a cauda. Legs long, particularly the hinder pair; second tarsal joint the longest, and furnished with two black claws. Wings one-third longer than the body; membrane semi-transparent smoky-brown, densely and finely punctured. Stigma long and straight. Stigmatic vein nearly straight. Cubital vein twice forked; other veins as in Lachnus. Lower wing with two straight cubital veins. Expanse 0·54 inch or 13·7 millimetres. Size 0·17×0·80 inch or 4·24×2·02 millimetres.

"It would be hazardous to describe the colours of the living insects from samples preserved in spirit, but it may be fairly assumed that the colours are of a grey-brown or black, with a few obscure spots on the sides and dorsum. When placed in spirit, they yield to it a deep port wine red tint, and the same stain tinges the insects mounted in Canada balsam."

Paddy caterpillars in Bhamo.

In September 1890 were received, from the Agricultural Department, Rangoon, pupæ of a moth belonging to the family *Limacodidæ*, said to have proved destructive to paddy in part of the Bhamo district. The specimens were insufficient for precise identification.

Rice caterpillars in Ranchi.

From the Sub-Manager of the Encumbered Estates, Ranchi, were received in September 1890 a number of hair-covered caterpillars probably belonging to the heterocerous family *Lasiocampidæ*, but in too poor condition for precise identification. They were said to attack *Dhan* and *Marua* crops in Lohardugga, the damage annually done by the insect in one pergunnah being estimated at from four to six annas of the total crop. The caterpillars appear in the rainy season and defoliate the plants, trenches being dug by the cultivators to prevent their passing from the upland crops to attack the rice which lies at a lower level.

Ants attacking potatoes.

The Executive Commissariat Officer at Thayetmyo reports that the outturn of potatoes grown from English seed in the Commissariat garden in 1889-90 was considerably reduced by the ravages of a small ant which attacked the tubers when quite young. No specimens have been furnished, but, according to Dr. Walsh, the insect may perhaps have been the common red ant *Solenopsis gemminata*. The only remedy suggested is that of following the ants to their nest and destroying them there with boiling water, kerosene oil, or bisulphide of carbon.

Paddy pest in South Arcot.

In October 1890 the Collector of South Arcot reported injury to paddy in his district by caterpillars. Specimens of the caterpillars were forwarded

through the Board of Revenue and the Government Central Museum, Madras, and were found to be the larvæ of a Noctues moth which is probably one of the Leucaniidæ or Heliothidæ. The material, however, was insufficient for precise identification. The injury done by the insect appears to have been slight.

Mosquito blight in Darjiling.

The following is an abstract of a series of Notes on Mosquito blight *(Helopeltis theiovora)* furnished by Mr. C. N. Harcourt, of the Ging factory, Darjiling. For a more detailed account of the insect *vide* page 180 of Vol. I of this serial. *Helopeltis theiovora* injures tea both in spring and also during September; it attacks chiefly the young tea shoots, also fuchsias, and a tree (*Schima wallichii*), known locally as *chilauni*, which is botanically allied to the tea-plant. The blight does not ascend above an elevation of about 4,500 feet, and most of the damage is done in the Terai, tea planted on black sandy soil appearing to be particularly attacked. Gardens are often affected to the extent of closing the crop earlier than usual and considerably lessening the outturn, but precise estimates of the amount of loss occasioned in the Darjiling tea district are not available. The insect punctures the epidermis of the young tea leaf, with its proboscis, and sucks up a little of the sap, leaving a round transparent spot wherever it has been at work, and it seems to have some poisoning effect, as the buds, below an affected leaf, dry and fall off as if burnt. The eggs are laid in the soft stems of the tea shoots, and can only be discovered from the three small hairs which are attached to each egg and which protrude from where it lies. The eggs are about one thirty-second of an inch in length and very slender. When first laid they are hard and white in colour, but they become red before hatching. The larva becomes full grown in about a week after emerging from the egg; it has the characteristic bug-like odour, and the only animal noticed to attack it is a small spider.

Rice pest in Sambalpur.

From the Officiating Commissioner of Settlements and Agriculture, Central Provinces, were received in July 1890, caterpillars of Bombyces moths said to be in the habit of destroying paddy in Sambalpur. The material was insufficient for the precise identification of the insect concerned.

A Darjiling tea pest.

In February 1890 were received from Mr. John Guilt, of Darjiling, caterpillars of the Bombyces moth. *Olene mendosa*, Hübn. They were said to feed on tea bushes.

Kulsi sâl caterpillars.

From the Deputy Conservator of Forests, Kamrup division, Assam, have been received pupæ of a Bombycid moth, probably belonging to the family *Liparidæ*, said to have suddenly appeared in vast swarms and denuded *sal* trees in the Kulsi range of their leaves. This particular caterpillar had not been noticed previously, and the natives attributed the visitation to the successful protection of the forest against fire. Pupæ were found in the end of October 1889. Moths appeared immediately afterwards and laid eggs which produced caterpillars in the beginning of November, after which the pest seems to have disappeared for some time, moths and caterpillars, however, being again noticed in large numbers in the middle of December. Several attempts were made to rear the pupæ in Calcutta to enable the identity of the moth to be ascertained, but the only insects that emerged were Tachinid and Hymenopterous parasites, with which the pupæ seem to have been very much infested.

Boring caterpillars.

The Superintendent of the Government Horticultural gardens in Lucknow, in February 1890, forwarded larvæ of a moth probably belonging to the family *Hepialidæ*, said to be commonly found in the stems of fruit-trees, such as oranges and guavas, which it injures to a serious extent. Mustard oil poured into the hole was found to kill the insect. Specimens either of the moth into which these caterpillars transform, or live pupæ, which no doubt are to be found in the tunnels, are desired to enable the insect to be precisely determined.

Madras cotton pest.

In February 1890 were received, through the Agricultural Department of Madras, specimens of cotton plants said to be attacked by plant lice (*Aphidæ*) which caused the decay of the plants. The specimens were insufficient for any conclusive examination, and the only Arthopoda that were found on them were a number of mites which are not thought to have been connected with the destruction of the plants.

Dysdercus cingulatus.

Injury was reported by Baboo T. N. Mukharji to have been done to musk mallow and cabbages cultivated by the Cossipore Agricultural Society in August 1889, by an insect which proved to be *Dysdercus cingulatus*, Fabr. (Heteroptera, Lygæidæ), noticed on page 127 of Vol. I of this serial. The insects were said to have fed upon the leaves and afterwards to have taken up their abode within the capsules of the musk mallow fruit.

Teak borers.

Through the Madras Museum were received in January 1890 specimens of (1) the Buprestid beetle, *Psiloptera fastuosa*, Fabricius, and (2) heterocerous larvæ, probably belonging to the family *Hepialidæ*, both said to injure the Government teak plantations in Nilambur, Malabar.

Chalcis criculæ.

With regard to the species described on page 80 of Vol. I of these *Notes*, by Professor Kohl, as *Chalcis criculæ*, Mr. W. F. Kirby, of the British Museum, suggests that the species may, perhaps, be identical with the *Chalcis responsata* described by Walker in Tr. E. Soc., Lond. (3) I, page 355 (1862), from North India. He notices that this species has hind tibiæ "white, with the inside of the curve black." An examination of the type specimens of *Chalcis circulæ* in the collection of the Indian Museum shows that the hind tibiæ are yellow, with a very thin black line along the inside of the curve. This seems to point to the probable correctness of Mr. Kirby's supposition, white colour on the tibiæ being very likely to show as yellow in old specimens.

A Casuarina pest.

Some larvæ of a Scarabæid beetle, probably one of the Cetonini, were received in December 1890 from Mr. F. J. V. Minchin, of Ganjam, with the information that they cut the branches, and even the stems of young Casuarina trees across diagonally, as one would cut a stick with a knife. The insect cannot be precisely determined without an examination of the imago; and the observation would seem to require explanation.

Epilachna vigintioctopunctata.

In July 1887 were received specimens in various stages of development of the Coccinellid beetle, *Epilachna vigintioctopunctata*, Fabr. var., from Burdwan, where it was said to feed upon the brinjal plant, whole fields in Burdwan being sometimes destroyed by it. It was thought at the time that some mistake had probably arisen in this observation, the Coccinellidæ generally being carnivorous, but observations since made in Dehra Dun, North-Western Provinces, where the imago was found feeding on a cucurbitaceous plant, point to this species being an exception to the general rule.

Umballa pests.

In January 1890 the Deputy Commissioner of Umballa forwarded, through the Director of Land Records and Agriculture, Punjab, the following insects :—
(1) immature larvæ of a Bombyces moth, said to attack rapeseed;
(2) coleopterous larvæ said to attack sugarcane; the specimens being

in both cases in too poor a state of preservation for precise identification; (3) the common acridid grasshopper (*Chrotogonus*, sp.) said to do considerable injury to wheat, barley, linseed, and rapeseed, appearing in June or July and dying off about December, no means being known of destroying it; (4) caterpillars of the butterfly, *Mancipium nepalensis*, Grey (Rhopalocera, Pierinæ), said to attack gram, *Toria*, linseed, sugarcane and garden vegetables, such as radishes, the only known preventive being ashes, which, in some cases, are thrown over the plants.

Budaon pests.

From the agent of the Lyall Farm, Budaon, have been received;—(1) caterpillars of a Noctues moth said to attack rabi crops, such as mustard, barley, safflower, and wheat; (2) an Acridid grasshopper belonging to the genus, *Chrotogonus*, said to have done such extensive injury to indigo as to have seriously interfered with the cultivation and manufacture of the drug in the district. The grasshopper appears in April and May in large numbers in the indigo fields, and destroys the young plants by biting them off as soon as they appear above the ground; it continues to be found in large numbers up to the end of August, and gradually disappears about November. When the rainfall is deficient in July, it also does much injury to kharif crops, such as Mash (*Phaseolus radiatus*), Bajra (*Penicillaria spicata*), Til (*Sesamum indicum*), and Lobia (*Vigna catiang*).

Orissa pests.

From the Settlement Officer, Koojang estate, Orissa, were received, in February 1890, Noctues caterpillars known locally as *Kala mundi*, and said often to do much injury to rabi crops growing on tracts subject to inundation, sometimes also attacking rice. The insect appears on rabi crops in the early part of the cold weather, and spins a web over the leaves and flowers; it feeds chiefly on the flowers and disappears as soon as these die off. Specimens submitted for examination prove to be the caterpillars of a Noctues moth, which cannot at present be precisely determined without an examination of the moth. Specimens therefore either of the moth itself or of the live chrysalides, which can be reared in the Museum, should be furnished.

The Settlement Officer also reports that in 1887 insects much like locusts, but green in colour, with longitudinal black stripes, appeared just after the flowering season of the paddy, and did great damage to the crop by cutting off the ears, the outturn being said to have been diminished by about half.

Hooghly pests.

The Collector of Hooghly reports (letter dated 12th February 1891) much mischief to the mustard crop by an insect which proves to be one of the *Aphidæ*

(plant lice). The specimens have been forwarded to Europe for identification, as they are unrepresented in the Museum collection. He also notices that wheat is attacked by one of the Lady-bird insects (*Coccinellidæ*).

Nagpur pests.

In December 1890, from the Overseer of the Government Farm, Nagpur, were received—(1) Bombyces caterpillars, probably belonging to the species *Spilosoma suffusa* of Walker; these were said to have attacked the *Til* crop (*Sesamum indicum*), as many as thirty caterpillars being sometimes found upon a single leaf; the same insect was said in the rains to defoliate plantains and *San-hemp* (*Crotalaria juncea*), thence spreading over the neighbouring foliage plants of all kinds. (2) Pods of the *Popat* plant (*Lablab vulgaris* = *Dolichos lablab*) tunneled by the larvæ of a minute Plume moth said to be known locally as *Mekada*; a note on this insect will be found on p. 19. (3) Noctues caterpillars thought to belong to the genus *Leucania*, found boring into the pods of *Tur* (*Cajanus indicus*), the seeds of which they destroy. The injury caused by the three foregoing insects is reported to have occurred owing to the cloudy weather which prevailed for about a week without rain, and was then followed by plentiful rain, which was expected to kill off the insects, and thus prevent further damage.

Patna pests.

From the District Engineer, Patna district, were received, in February 1890, larvæ of the Noctues moth, *Heliothis armigera*, and of a Geometres moth, for the precise identification of which specimens of the imago are required. These insects are reported to attack *Khessari* pods in the months of January and February.

Monghyr pests.

The following is a report by the Officiating Collector of Monghyr on insect pests in his district:—

"In this report are embodied the results of the enquiries made by the Sub-divisional Officer for the sub-divisions and the Sub-Deputy Collector for the sudder subdivision. Several zemindars, &c., in this district were also requested to furnish any information they could regarding the damage insects do to different crops, and to send specimens of such insects, live or dead, but none of them seem to have taken any interest in the matter yet.

"The species of insects which are most injurious are—

"*Gudhiya.*—A small fat grasshopper of about an inch and a quarter long and three-eighths to half an inch broad and quarter inch high, of a dull white colour. The eggs are hatched and the young insects born in May and June. They at once look out for all the young and tender plants just germinating at that time with the early showers prior to the regular rainy season. When this pest attacks a field it eats up either the whole field or a portion of it in patches. It frequently affects a whole village to the extent of about 25 per cent. of its yield.

"The *wheat Keery* (Larka) is a small, soft, round, green caterpillar. An insect of about one and-a-half inch long and one-fifth of an inch in diameter. It is found usually near the roots of the young wheat plants which it eats right through. It makes its appearance in November and disappears when the plants are somewhat developed.

"The *oil seed Keery* (Lahi) are small insects. They devour the oil seed in its early stage. The produce of a village is often affected by them to about 30 per cent. They appear when the rains cease and there is still moisture in the fields.

"*Bhoon* is an insect about two inches long and quarter inch in diameter with a thick covering of mixed white and black hairs about quarter inch long. It appears just after the oil seed Keery (*Lahi*). The damage done by this insect is often 15 per cent. of the wheat crop.

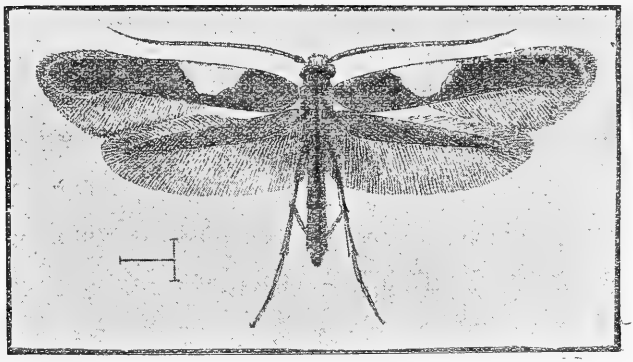
"Besides the above, there is a species of small insect called *Kujra* which cuts off the ears of the paddy crop and eats up the rabi crops also.

"The subject will be given more close attention to during the next autumn, winter, and summer harvest seasons, and more information will be collected and better specimens of insect pests obtained and sent to the Indian Museum."

II.—A NEW SPECIES OF TINEIDÆ.

(*Gracilaria theivora*, Wlsm., sp. nov.)

By LORD WALSINGHAM, F.R.S.



Antennæ, steel-grey, each joint spotted above with purple, basal joint slightly enlarged, purplish.

Labial palpi, ochreous, the apical joint tipped with fuscous beneath.

Maxillary palpi, yellow.

Head, shining grey above, posteriorly iridescent purple: face shining yellow.

Thorax and patagia, iridescent purplish cupreous.

Fore wings, narrow, elongated, pointed, with rounded cilia; brilliant shining purplish cupreous, with a series of slightly darker and ill-defined streaklets along the dorsal margin from the base to the apex: a brilliant shining yellow triangular costal patch commences at one-fourth from the base and reaches to the middle of the wing, its apex is obtusely truncate before reaching the dorsal margin; cilia brownish grey, with a paler line near their base. Under side, greyish-fuscous.

Hind wings, greyish-fuscous; cilia steel-grey, with a slight iridescent lustre. Under side, greyish fuscous.

Abdomen, greyish above, shining yellow beneath.

Legs, anterior,—purplish fuscous, tarsi shining white, spotted above at the joints with fuscous; *posterior*,—greyish fuscous above, tarsi inclining to ochreous, dark spotted above at the joints, spurs ochreous.

Exp. al. 13½ mm.

Larva. Mining leaves of the tea-tree.[1]

Hab. Ceylon (Pandaloya).

Type ♂ ♀ *Mus. Wlsm.*

I have received two specimens of this very beautiful, brilliant and distinct species from Mr. E. C. Cotes; they were bred by Mr. Green from larvæ mining the leaves of the tea-tree (presumably *Camellia theifera*), but it will probably be found to feed on other species of *Camellia*. The nearest allies of this species are the North American *blandella*, Z. and *belfrageella*, Chamb.

[1] According to the account of this insect given by Mr. E. E. Green in the Ceylon *Independent*, the egg is laid on the under side of a young leaf, generally on a young bush. On the hatching of the egg, the young caterpillar mines the leaf, the mine being visible on the under side only, and terminating in a small pocket formed by the folding over of the edge of the leaf. Here the caterpillar sheds its skin, and, this done, it proceeds to roll the leaf together, so as to form a shelter in which it lives for the remainder of its larval life, feeding upon the substance of the leaf. When full fed, it is about three-eighths of an inch in length, and yellowish or greenish in colour, with a few short bristles scattered over its body. The chrysalis is formed in a flat silken cocoon on the leaf, the pupal stage lasting about two weeks. The caterpillar is attacked by minute Ichneumonidæ, besides being often drowned in wet weather by the water that accumulates in the rolled-up leaf.—*E. C. C.*

III.—THE BALUCHISTAN MELON FLY.

(*Carpomyia Pardalina*, ♂ et ♀, nov. sp.).

By J. M. F. BIGOT.

Long. ♂ = 4 mill. et ½; ♀ = 5 mill. et ½ (*cum oviducto*).

♂.—*Oculis æneis; capite fulvido; antennis, palpis, haustello ejusdem coloris; chæto antennale nigro, basi albidâ; macrochætis cunctis nigris; thorace pallide flavido, retrorsum albescente, tergo, ante, angustissime fulvo bilineato, utrinquè nigro nitido trinotato, et retro pariter unimaculato; scutello albescente, nigro nitido quadrinotato; halteribus, abdomine, pedibusque totis, pallide fulvis, femoribus anticis sat incrassatis, interne fuscopilosulis; alis hyalinis, transverse, late, fulvopallido trivittatis, vitta apicale bifida, vittis cunctis cinereo obscuro anguste marginatis.*—♀ *simillima; oviducto abbreviato, fulvido.*

♂.—Les yeux d'un vert bronzé brillant; tête d'un faune pâle, ainsi que les antennes, les palpes et la pipette; tous les macrochètes noirs; chète antennal noir à base blanche; thorax d'un faune pâle; tergum, avec, en avant, deux lignes rougeâtres très étroites, en arrière, largement blanchâtre, ainsi que l'ecusson, de chaque côté, quatre grandes macules arrondies saillantes, d'un noir luisant, les plus grandes situées en arrière; écusson avec trois grandes macules situées sur les côtés, et une petite tache médiane, toutes semblables; les macrochètes noirs; abdomen, pieds, entièrement d'un faune pâle, base des segments legèrement pruineux; les fémurs antérieurs assez notablement renflés, avec quelques poils brunâtres en dessous; ailes hyalines avec trois larges bandes transversales faunes, celle située à l'extrémité, se bifurquant en forme de V, dont la branche extérieure contourne le bout du disque, toutes ces bandes marginées d'une nuance grisâtre, principalement la branche qui borde l'extrémité de l'aile.—♀ Semblable au ♂; l'oviducte court, obtus, rougeâtre.

Plusieurs spécimens ♂ et ♀. Beloutchistan.

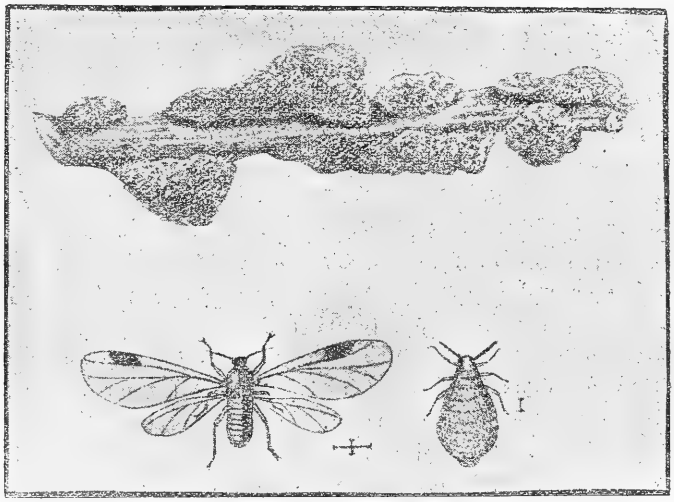
Attaque les *Melons*. Larve, cilyndroide, allongée, légèrement atténué aux extrémités, teinte d'un jaune pâle et luisant, les annéaux fort peu marqués, deux petits crochets noirs à l'une des extrémités; *long.* = *11 millim.*

Cette rémarquable espèce, incontestablement inédite au présent jour, appartient, sans aucun doute, au genre *Carpomyia* (Rondani), inscrit par l'auteur dans son groupe des *Tephritoidi* (*vide Bullet. della Soc. Entomol. Italiano, Vol. III, Fasc 2, 1871, Firenze*).

IV.—AMERICAN BLIGHT[1] (*Schizoneura lanigera*).

By E. T. ATKINSON.

The insect so well known in England as "American Blight," in America as "Woolly Aphis of the apple," in France as "Puceron lanigère," in Germany as "Bluttlaus," has appeared in India and done considerable



damage to orchards in Conoor and Bangalore. It belongs to the order *Rhynchota*, suborder *Homoptera*, family *Aphidæ*, and genus *Schizoneura*, and appears under two conditions, one attacking the branches and trunk, the other the roots. In both cases its presence is readily detected by the abnormal growth of gall-like excrescences or knobs on the parts affected, leading eventually, in many cases, to the death of the tree. During 1888 it was particularly common in England, where much attention has been paid to devising remedies against it.

The aerial form is usually found about the base of twigs or of suckers springing from the trunk, or the base of the trunk itself, and in wounds and crevices of the bark. In autumn they are said to be found abundantly in the axils of the leaf-buds, towards the ends of the twigs, and are easily recognised by the white downy tomentum by which they are covered. Under each patch of down there is usually found a female

[1] The following paper was written shortly before Mr. Atkinson's death. The delay in publishing it has been due to the preparation of the figures by the Museum artist. The winged insect is copied from a figure which has appeared in American and English works on the subject. The larva and the galls are from specimens furnished by Mr. Daly.

with her young. These insects are capable of bearing extreme cold, and it would appear that where they hibernate in the open bark, their downy covering increases much in quantity.

Schizoneura lanigera.

(*Aphis*), Hausmann. Illiger's Mag. Insekt., i, 1802, p. 440; Banks, Hortic. Soc. Trans., ii, p. 162, t 11; Kirby & Spence, Introd. Ent., 5 *ed.*, 1828, i, p. 29, 200; ii, p. 225; iii, p. 182: Hints on Orchards, Salisbury, 1816, p. 39: Andouin, Ann. Soc. Ent. Fr., iv, p. 9. App.: Goureau, Bull. Soc. Ent. Fr. (2 s.) x. 1852, p. lxxix.

(*Schizoneura*) Hartig, Germar's zeitschr. Ent., iii, 1841, p. 367: Kaltenbach, Mon. Pflanzen, i, p. 169: Walker, Cat. Hom., iv, p. 1048: Buckton, Aphides, iii, p. 89, t. 105, 106: Saunders, Insects injurious to Fruits, 1883, p. 13, 27, f. 1, 13, 14.

(*Eriosoma*). Ruricola (Curtis), Gardener's Chronicle, iv, Feb. 1844, p. 116, f. 1—3: Glover, Rep. Dep. Agric., Unit. States, 1877, p. 38, f. 41.

Mali, Coccus, Bingley, Anim. Biogr., iii, 1803, p. 200: (*Eriosoma*), Samouelle, Compend., i, 1819, p. 16: Mosley, Gardener's Chronicle, i, p. 828: (*Myzoxylus*), Blot, Mem. Soc. Linn. Calvados, i, 1824, p. 114; *id.*, Mem. Soc. Agric. Caen, 1830, p. 58: Am. and Serv., Hist. Nat. Ins. Hem., 1844, p. 612: Tougard, Ann. Soc. Hortic. Paris, xiv, p. 341.

Pyri (*Eriosoma*), Fitch, The Senate, 30, 1851, p. 68: (*Schizoneura*); Walker, Cat. Hom., iv, p. 1052; Suppl., p. 302: (*Pemphigus*), Fitch, Fourth Rep. N. Y. State Cab. N. H., 1851, p. 68: Walsh, Proc. Ent. Soc. Philad., i, 1866; *id.*, Practical Entomologist, 1866: Glover, Rep. Dept. Agric. Unit. States 1879, p. 38: Riley, Bull. Unit. States Ent. Com., vi, 1881, p. 59.

Trunk and branch-inhabiting form.—Hausmann describes the form of the first generation as having the body oval and strongly domed: head, eyes, antennæ, rostrum and legs blackish; thorax and abdomen deep honey colour, shining, the latter covered with woolly whitish down. The form of the second generation is winged, somewhat smaller and narrower than that of the first generation, and a second form of the second generation differs in size and its lighter colour. M. Goureau, quoted by Thomas, describes the stages thus:—

"*Apterous individuals*—About one-tenth of an inch long; reddish brown and covered above with a white, cottony secretion; antennæ short and pale yellow; legs yellowish; knees brown; without honey-tubes, but with a circular cicatrix in place of them.

"*Winged individuals.*—Antennæ shorter than the head and thorax, and varying in colour from brown to black; head and thorax black, a brownish ring at

the collar; the abdomen chocolate-brown; legs brownish; wings hyaline, with the veins and stigma deep brown; body enveloped in a white cottony secretion."

Through the labours of Lichtenstein, however, we are able, in some measure, to trace the successive changes through which this insect passes. From the single egg of each female of the last stage comes an apterous so-called female (*Pseudogyne* of Lichtenstein) or 'Queen Aphis' (also called *Stammütter, Altmütter, Fundatrix, Pseudogyne fondatrice*), which becomes the founder of the colony, forms the gall, and after a number of moults fills the gall with its progeny.

Buckton describes this 'Queen Aphis' thus—

"Size of body, ·07 × ·055 inch; 1·77 × 1·39 mill.: length of antennæ, ·015 inch; 0·38 mill.: colour dark shining brown, approaching to black: form oval, flat and ridged: dorsum domed and deeply marked with sutures; eyes very small: antennæ and legs very short, black or reddish: nectaries represented by pale papillæ with a median spot: cauda rudimentary: body sparingly covered with a cottony tomentum, which is most developed at the caudal extremity: rostrum very short, only reaching the second pair of feet. The progeny of the Queen Aphis differs much in size and form from their parent. They are of various shades of red or warm brown, and are less flattened and longer in the body. When just produced, the rostrum is very long, extending far beyond the body, but ceases to grow, whilst the insect itself rapidly increases in size and eventually exudes from its pores long silky threads, which form a covering. After their moults the progeny of the Queen Aphis reaches the second larval state, called the 'Emigrant winged[1] Pseudogynes' by Lichtenstein, when they leave the galls and fly to some other food-plant and deposit small lice, which form the *Gemmantia*, or third larval state, (the whole brood being capable of reproducing their species without any connection with a male by a process of germination or budding forth without being enveloped in a pellicle or pseudovum, as observed by Lichtenstein) This is the curious stage of unlimited apterous reproduction, very much like that observed in the case of the well-known *Phylloxera vastatrix* (vine pest). Out of the numerous colonies formed arises the winged viviparous females (pupiferous of Lichtenstein), forming the fourth larval state, which carry back to the parent tree the pupa from which issue small apterous male and female lice. The latter after copulation lays the single egg from which the Queen Aphis arises and another cycle commences.[2]"

Buckton describes the winged viviparous female thus:—"Expanse of

[1] In Ent. M. M., November 1878, p. 135, Lichtenstein observes that the emigrant, or second larval form of *Schizoneura lanigera*, is wingless.—*E. C. C.*

[2] These stages represent the ascertained facts chiefly in the case of *Aploneura lentisci*, Pass.

wings, 0·2 inch; 5·08 mill.: size of body, ·05 × ·025 inch; 1·27 × ·62 mill.: length of antennæ, ·025 inch; ·62 mill. Uniform colour dusky brown, approaching to black: pronotum rather paler, abdomen carinated and ringed: antennæ short; third joint long and strongly ringed, the three following joints less markedly so: wings ample and rounded at their apices; membrane smoky and slightly punctured: cubitus broad, ending with a large trapezoidal brown stigma: veins black, cubital vein with a single furcation: legs short. The small sexuated lice produced by this female appear to be born within a pseudovum. They have no rostrum, which is represented by aborted buccal processes, its five-jointed antennæ and the tarsi also are not well developed; the eyes are small and the colour of the ♀ is yellow, tinged with red. The length of the ♀ is 0·63 mill., and of the ♂ 0·50 mill. The fact that both male and female in this stage are without the usual sucking organ shows that they exist simply for the propagation of the species, and when that is accomplished, they perish."

Root inhabiting form.—Thomas describes the root-inhabiting form called *Pemphigus pyri* by Fitch thus:—"The young larvæ are scarcely 0·04 inch long, of an oval form, and pale dull yellow colour: legs short, robust and nearly equal in length: the antennæ appear much like a fourth pair of legs and are five-jointed. From the extremity of the abdomen usually appears a white filament of flocculent, cotton-like matter * * *."

Winged individuals.—These are nearly quarter of an inch long to the tips of the closed wings; body, legs and antennæ, coal black; the head and abdomen above covered with cottony down: fore wings transparent and slightly smoky, as though sprinkled with fine dust; veins black; the third vein is rather more slender than the first, nearly straight, not forked, its basal third abortive; stigma dark, smoky brown, oblong; its opposite sides nearly parallel, abruptly conveying to an acute point at each end: hind wings clearer; the two discoidal veins, black. The winged individuals found in Illinois show some slight variation:—"general colour, black; antennæ not quite half as long as the body, third joint half as long as the entire antennæ; abdomen more or less sprinkled with white downy matter: wings transparent, third discoidal vein forked near the middle, its basal portion obsolete; stigma nearly three times as long as it is wide, pointed at each end, and pale brown: length to the tips of the closed wings, about one-seventh of an inch.

Local Reports.—Mr. Daly writes (August 1889) from Conoor:—"It (*S. lanigera*) has destroyed nearly every orchard in Conoor." * * "I have syringed the trees affected, with the kerosine and soap emulsion, afterwards applying lime and ashes with a little salt. I hope I have not killed the trees. I cannot see any blight now, but some of the leaves look as if fire had been placed to them. A friend tells me that they have

got to the roots of his trees and no remedies he can apply eventually destroy them."

Under date November 13th, Mr. Daly writes:—"Out of about 400 apple trees I found about six unmistakably affected. I cut all the branches badly attacked and burned them: then mixed a solution of soap (common country) and kerosine with a little turpentine and boiling water, stirring round until it was of the consistency of butter. After allowing it to cool I mixed one bottle of this with twelve of water and applied with a garden syringe to the branches and roots. I also applied the soapy congealed matter to any of the insects concealed in the crevices of the trees and also to the trunks. I applied in the same manner a mixture of lime and ashes with a little salt mixed. For the last ten days none of these insects are visible and the kerosine and soap emulsion does not appear to harm the trees. In some cases the branches attacked have a knotty appearance like that of the hands of a person suffering from chronic rheumatism. I have heard that planting tomato-plants in the neighbourhood of apple trees alleviates the pest." * * Under date January 1890, Mr. Daly writes:—"My trial of the tomato-plants has led to no further advance of the pests. I have each individual tree examined by a gardener every morning, who is armed with a small pot of the emulsion and a brush, and if he perceives any new comers, they are treated with a dose of the mixture. The trees attacked are now looking quite healthy, and are apparently free from aphides, which, however, may come back."

It is probable that the aerial or trunk-inhabiting form at certain seasons descends to the roots or to herbage in their vicinity, and again with a change in the season ascends, leaving some members of the colonies, however, always above or below. The tomato-plant may therefore only serve as a source of food for the insect when it descends, and serves to propagate it, and in no way protects the trees. In its aerial form at any rate the insect confines itself to the apple in Europe and does not accept any substitute. The brief account given above will, however, indicate the points to be observed locally, for there can be little doubt that some modifications in the habits of this insect must have arisen to suit it to the comparatively strange climate of Conoor and Bangalore.

Natural enemies.—It is probable that insects found to attack the woolly Aphis in other countries will be represented in India. Amongst these are spiders who spin their webs directly over the place where the colony of young lice are found to devour them at their leisure. The next in efficiency are the Chalcid flies (Report, Department Agriculture, United States, 1879, p. 259, t. 6, f. 6: Saunders, Ins. Inj. Fruits, f. 15). The root-inhabiting form is attacked by a Syrphus fly, *Pipiza radicum*, Walsh & Riley (Saunders, Ins. Inj. Fruits, f. 2, 135, 136) in its larval form, when it occurs as a footless maggot of a dirty yellow colour and about quarter of an inch in length. The adult and larval forms of the

Coccinellidæ (Lady-birds) also feed on the plant-lice, and the larvæ of the Lace-winged flies (*Chrysopa*), known by having four delicate lace-like wings (Saunders, *l. c.*, f. 133, 134).

Remedies.—For the trunk and branch-inhabiting form is recommended the use of a stiff brush and the application by it of an alkaline wash. This may be made by mixing five seers of fresh lime with one seer of sulphur and four gallons of water and heating until the sulphur is dissolved. Common country soap, reduced to the consistence of paste by the addition of a strong solution of washing-soda in water, also forms a good wash for application with the brush. This should be rubbed into all hollows in the barks, wounds, and wherever the insects appear. The use of the brush and wash has been found effective in England during 1888, and by Mr. Daly at Conoor in 1889. Another effectual but troublesome plan, described by Harris, is to scrape off the rough bark of the infested trees and make them perfectly clean and smooth early in the spring; then rub the trunk and limbs with a stiff brush, wet with a solution of potash; after which remove the earth about the bottom of the trunks, and with the scraper brush an alkaline liquor over that part so far as the roots can be conveniently uncovered. The earth removed should be carried away to a distance or burned, and be replaced by fresh earth, and all cracks and wounds should be filled with grafting cement or clay mortar. Small infested limbs and branches beyond the reach of the application should be cut down and burned.

As a preventive measure, Blot recommends:—"Avoid giving to the nursery, in which the young trees are, any more shade than is absolutely necessary; avoid placing the trees in too flat or humid ground, give to both nursery and orchard all ventilation possible, so that they may be thoroughly aired, and keep the heads of the trees open so as to favour the circulation of air and the drying of the soil: dig up around the trees frequently, and do not allow rubbish to accumulate at the roots; surround each tree with a mixture of soot or tobacco or sand." The application of a remedy must depend in a great measure on the climate and soil, and from the suggestions made here, the Indian fruit-grower must select that one which experience will show him to be the most suitable.

For the root-inhabiting form Dr. Fitch recommends the clearing away of earth from the roots and the application of soap-suds in sufficient quantities to penetrate the excrescences on the rootlets. Similarly, when transplanting young trees, if the lice appear on the roots, they should be dipped in a solution of soap-suds. Others recommend the application of scalding hot water to the bared roots, but if young trees in a nursery are thus treated, care should be taken not to allow the temperature of the water to exceed 120° to 150° Fahr. Plant-lice appear to flourish in some places best in a dry porous soil; hence some recommend that the earth around the crown of a tree should be kept hollowed

into a sort of basin, in order that water may collect there. Weeding too has the effect of bringing the root-lice nearer to the surface and thus making them more easily reached by the hot water, but lime or ashes should be mixed with the earth. Melted resin, mixed with an equal quantity of fish oil, put on the infested spots, whilst warm, with a brush, also applications of spirits of tar, turpentine, urine, kerosine, soft soaps, and other similar substances, have been recommended, but there is little doubt that the kerosine emulsion fulfils the same purpose quite as effectually.

The following works may be consulted with advantage on the life-history of this insect :—

Buckton, G. B.:—'Monograph of the British Aphides,' iii, 1881, p. 89, t. 105, 106, f. 1 to 6 : Ent. Mon. Mag., xx, p 110.

Comtock, J. H.:—Report, Department Agriculture, United States, 1879, p. 258.

Girard:—Bull. Insect. Agri., ix, 1884, p. 119, f. 11.

Goethe, R.:—Landwirthschaftliche Jahrb., 1883.

Hausmann, F.:—Beiträge zu den materialien für eine künstige bearbeitung der gattung der Blattläuse, in Illiger's Mag. Insekt., i, 1802, p. 426.

Kessler, H. F.:—Deutsche Ent. Zeitschrift, xxvii, 1823, p. 26; Ber. Ver. Cassel, 1883, p. 90; Kosmos, xv, 1844, p. 457; Nova Acta Leop. Carol., xlvii, 1885, p. 107, t. xi; S. B. Verh. Zool.-bot. Ges. Wien, xxxv, 1885, p. xxv; 'Die Entwickelungs—und Lebens-geschicte der Blutlaus, *S. lanigera*, Hausm. Cassel, 1885.

Lichtenstein, J.:—Migrations of plant-lice, Ent. Mon. Mag., xv, 1878, p. 134, 166; *ib.*, xx, 1883, p. 79.

Thomas, C.:—Eighth Report of the State Entomologist on the noxious and beneficial insects of the State of Illinois, p. 126. Springfield Ill., 1879.

Bolt, F.:—Mémoire sur le Pucéron lanigère et sur les moyens de le détruire, Caen, 1831.

Anon.—Programme et résumé des observations et des mémoires présentés à la société d'Agriculture de Caen pour la destruction du pucéron lanigère, Caen, 1830.

Anon.—Moyen de détruire le pucéron lanigère ;—Ann. de l' Agric. Franç., (2 s.) xliv, 1828, p. 380.

V.—DESCRIPTIONS OF NEW COCCIDÆ.

By W. M. MASKELL.

(*With one plate.*)

[Note.—The first insect described below has recently been found attacking tea in Assam and the Kangra valley. The second has been found on the leaves of tea in the Kangra valley. The third has been found destructive to the plant *Cajanus indicus* in Madras.—*E. C. C.*]

Group—*Diaspidinæ.*

Genus—*Aspidiotus*, Bouché.

Female puparia circular; pellicles usually in the centre. Male puparia slightly elongated, not carinated; pellicle at one end.

The absence of carination in the male puparia distinguishes this genus from Diaspis. The pellicles of the female are not always in the centre, and when this is the case an examination of the male puparium is necessary for certitude.

Aspidiotus theæ, Maskell, *sp. nov.*

(*Plate I; fig. 1 a, b, c, d, e.*)

Female puparia clustered thickly on twigs, as nearly circular as their numbers and position will permit: slightly convex: colour light-brown, covered with a very thin coat of white excretion: pellicles yellow, very small, situated near the margin: the fibrous portion of the puparium rather solid. Diameter averaging $\frac{1}{10}$ inch.

Male puparium elongated, not carinated: pellicle at one end: colour similar to that of the female.

Adult female brown peg-top-shaped, the cephalic segment rather large, the pygidium comparatively small. The abdominal segments shrink up more and more as the female approaches gestation. Abdomen ending in two median lobes with a smaller lobe on each side: a few spines and small hairs on the edge. Pygidium on the ventral surface, exhibiting four large "spinneret-groups": the upper pair with from 30 to 40 orifices, the lower pair 15 to 25. On the dorsal surface are a number of tubular spinnerets, and a large patch divided into an irregular lattice-work, the spaces of which are not large, and not constant in shape in different specimens, although the size and position of the whole patch is quite constant.

Larva when just hatched bluish, flat, active, length about $\frac{1}{90}$ inch. The antennæ appear to have six joints, sub-equal, the last widely dilated at the tip and bearing two longish hairs.

Adult male unknown.

Habitat.—On tea-plants in India:—(Assam, Kangra valley, &c.)

The form of the male puparium forbids the introduction of this species into the genus *Diaspis,* but I think none of the described species of *Aspiniotus* has the female pellicles so close to the margin as this one. The "lattice-work" arrangement on the dorsal surface of the pygidium is peculiar and destructive. The only other instance in which this curious feature is reported (as far as I am aware) is in *Ischnaspis filsformis,* Douglas (Entom. Month. Mag, Vol. XXIV, page 27), but in the description of that species it is not stated whether the lattice-work is on the dorsal or the ventral surface.

Chionaspis theæ, Maskell, *sp. nov.*

(*Plate I, fig. 2 a, b, c.*)

Female puparium (figure *a*), light-brown, pyriform, flattish: pellicles brownish-yellow, small length, averaging about $\frac{1}{10}$ inch.

Male puparium (figure *b*) white; deeply and conspicuously carinated; sides more or less parallel: carinations three or four. Pellicle small, yellow. Texture very loose, the puparium having the appearance of three or four short, nearly disconnected, white cottony tubes. Length averaging about $\frac{1}{35}$ inch, breadth about $\frac{1}{70}$ inch.

Adult female brown, elongated, form normal of the genus, with conspicuous posterior segments. Abdomen ending in two median lobes with two others smaller at each side: a deepish median depression: short spines between the lobes, and on the margin three others on each side, the upper pairs of which are rather long and strong. On the last segment above the pygidium two or three longish spines. Five groups of spinnerets: upper group, 8 orifices: upper laterals, 13 and 16: lower laterals, 14: between the groups and the margin a row of single spinnerets. Rudimentary antennæ can be detected on the head. Length of insect about $\frac{1}{30}$ inch.

Adult male unknown.

Habitat.—On tea (Kangra valley, Northern India).

The brown female puparium, the arrangement of the spines on the pygidium and the loose little male puparium, distinguish this from almost all other species of the genus: but it seems, at least in the female, to be very closely allied to *C. brasiliensis,* Signoret. The male puparium, however, in that species is stated to be four times as long as broad, and in texture does not differ from those of other Chionaspides, whereas in *C. theæ* it is half as broad as long, and loose in texture.

Group—*Lecanidinæ.*

Sub-division—*Lecano Coccidæ,* Maskeel.

Genus—*Eriochiton,* Maskeel.

Adult female insects covering themselves with a test of felted matter,

forming more or less complete sacs. Abdominal cleft and lobes present in all stages. Male pupa covered with similar excretion (*Scale Insects of New Zealand, 1887, page 84*).

I have omitted from these generic characters one —"Secretion is conspicuous or absent on adult females," which I included in 1887. Such a character, depending merely upon the *quantity* of the matter covering the insect, is after all more accidental than otherwise, and at best ought only to avail for specific differentiation.

Eriochiton cajani, sp. nov.

(*Plate I, fig. 3 a—n.*)

Test of adult female dirty-grey, moderately thick; so closely felted as to almost resemble wax: elliptical, convex above, usually open beneath, but sometimes closed: covering the insect completely. The tests are congregated in masses on the twigs, mixed with male puparia and with the younger females. There is usually no marginal fringe, but sometimes a fringe of small segments may be detected: the edges are somewhat thicker than the rest. Surface of the test often rugose, as if composed of many small irregular segments. Length about $\frac{1}{12}$ inch.

Test of male pupa elongate-elliptical, convex, whiter and cleaner-looking than that of the female: very thin, transparent and brittle: at the edge there is a small fringe of very minute segments. Length about $\frac{1}{20}$ inch.

Larva elliptical, flattish, active, naked: colour reddish-yellow: length about $\frac{1}{50}$ inch: exhibiting a rather wide abdominal cleft with lobes which do not project beyond the extremity. Antennæ of six joints, of which the third is the longest, the second the shortest, the rest sub-equal: there are a few hairs on each joint, and on the last one, hair very much longer than the rest. Feet rather long, slender: the tibia is longer than the tarsus (a very abnormal character amongst coccids of all groups): a few hairs on each joint: upper digitals rather thick, lower pair only slightly dilated at the ends. Mentum monomerous. Abdominal lobes small, each bearing one very long seta and a short spine. Anal ring with six longish hairs. The spiracular spines are very long: and all round the margin is a row of minute conical spines.

Female of the second stage reddish yellow; elongate-elliptical, flattish, active: length about $\frac{1}{32}$ inch. Antennæ of six sub-equal joints, the last bearing some shortish hairs. Abdominal cleft wide, as in the larva: lobes short, each bearing six shortish setæ, arranged in pairs. Anal ring with numerous hairs. There is a thin, white, mostly fragmentary test, which at the edges forms a fringe of short cylindrical tubes: these tubes spring from the marginal conical spines, which are of two sizes, as in the adult.

Adult female dull brownish-yellow: at first elliptical, tapering somewhat posteriorly, convex, and filling the test: afterwards shrivelling up towards the cephalic end of the test: length from $\frac{1}{20}$ to $\frac{1}{15}$ inch. Epidermis rugose, as in the test. Abdomen ending in a rather wide cleft with short broad lobes, each lobe bearing two short unequal setæ. Anogenital ring with very numerous hairs. Antennæ of seven sub-equal joints, the last bearing a few short hairs. Feet slender, upper digitals long and rather thick, lower pair very widely dilated at the ends: tibia longer, but not much longer, than the tarsus. Edges of the body rather thick, bearing a double row of conical spines, one row larger than the other. Spiracular spines very long. There are a good many tubular spinnerets on the dorsum, mostly near the edges.

Male pupa reddish-brown: length about $\frac{1}{25}$ inch. Four dorsal and two ventral eyes can be made out, and two ocelli.

Adult male unknown.

Habitat.—On *Cajanus indicus* in Madras, [1] India.

This insect is clearly Lecanid, from the abdominal cleft, the very numerous hairs of the anogenital ring, and the seven-jointed antennæ of the adult. It exhibits characters closely allied to those of four described genera. From *Signoretia*, Targioni, it differs in its much more closely felted test and in the antennæ, that European genus having antennæ of eight joints. *Eriopeltis*, Signoret, and *Philippia*, Targioni, have both loose cottony sacs and antennæ of six joints. But the genus *Eriochiton* in New Zealand differs only in the *quantity* of the excreted matter covering the adult female. In the New Zealand forms this is usually fragmentary or inconspicuous, being most easily seen in the second stage: in the Indian insect it is thick and constant on the adult. But such a character may fairly be considered as only trivial. There is indeed one oint in which the new species differs from all the above: and that is the length of the tibia, as compared with the tarsus, in the larva. But this indeed is so abnormal that, if stress were laid on it, not only a new genus, but a new group would have to be established to include the insect: because it is probably an invariable mark of the larval stage in any other coccid that the tarsus is longer than the tibia. Setting, then, this aside, there seems to be no genus to which this insect can be so well ascribed as *Eriochiton*, and it has therefore been here so placed.

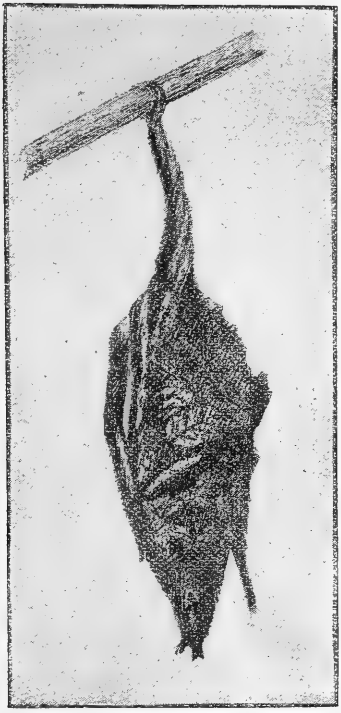
[1] The specimens were furnished, in January 1890, by the Assistant Director of Land Records and Agriculture, Madras, as destructive to the plant *Cajanus indicus*.

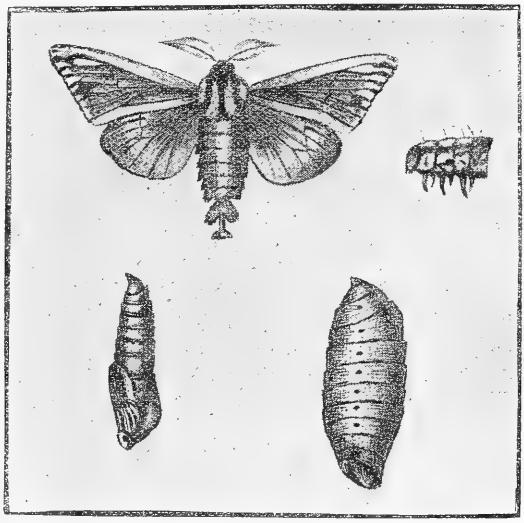
VI.—A DARJILING SAL PEST.

By G. C. DUDGEON.

[Note.—A specimen of this insect, furnished by Mr. Dudgeon, has been examined by Mr. F. Moore, who determines it as a *Psychid* belonging to a new species of *Eumeta*, which he describes on page 66 under the name of *Eumeta sikkima*.—*E.C.C.*]

The larva of this moth is found everywhere in the Darjiling district where sâl trees grow, and would be perhaps the most to be feared as a pest, should it increase greatly, which it has apparently little to prevent it from doing. It appears, however, to be little known, probably on account of its ability of hiding itself within its case, made of moss, bark and dried leaves, at the slightest alarm, and in this manner making itself almost indistinguishable from the bark or twigs near which it may be suspended whilst feeding. Before describing the larva I will proceed to give a short description of the perfect insects, male and female.





The male moth, which, like others of the same family, is alone perfectly developed (the female being a mere bag of eggs without any limbs, wings, eyes, or even antennæ), measures 2·8 inches in expanse.

Wings entire. The scales on both wings are sparsely scattered. The fore wing has the whole space between the costal margin and the subcostal nervure reddish ochre; the discoidal cell distinctly divided into three portions by two interlineal nervules; the whole space between the submedian nervure and the inner margin reddish ochre. All the rest of the fore wing, with the exception of the following markings is semitransparent, and powdered with fuliginous scales; all the nervules are defined distinctly with black; the interspace above the first discoidal nervule is white, basally; there is a marginal triangular white spot in the interspace between the first and second discoidal nervules; the first median nervule is bifurcated from the base, enclosing a large marginal quadrate spot; there is a submarginal black patch connecting the lower branch of the first to the second median nervule; there are also pale spots along the margin between the second and third median nervules, and the third median nervule and submedian nervure. The hind wing is semitransparent fuliginous, with the nervules only slightly darker; the base of the wing is clothed with long dark brown hairs. The antennæ are highly pectinated and are about a third of the length of the fore wing. Eyes smooth. Legs densely covered with hair. Thorax whitish buff with central and subdorsal black longitudinal bands. Abdomen covered with dark brown hair.

The female, which never completely emerges from the pupa shell, unless by accident, until it has laid all its eggs, is simply a skin full of eggs, with a scutellate formation at the head end, and an ordinary ovipositor and sexual organs at the other. My figure gives a correct representation, magnified 2½ diameters, of all that is visible outside the pupa case. There does not seem to be any trace of any limbs or features, which are present in the male. The head end consists of a sharp beak-like protuberance, with an edged under surface, followed by two short pointed processes on a wrinkled hard surface. The backs of the thoracial segments are covered with a hard shell-like formation, of a light brown colour, resembling the pupa shell, but smoother and lighter coloured. The abdomen is of a pale buff colour, with a broad dorsal and narrower lateral yellowish line, extending throughout. There is a ring of tawny velvety scales round the last segment but one, formed of extremely fine scales and the end of the abdominal part of the pupa shell is filled with loose scales of a different shape, which the insect drives out of its pupa shell by means of its maggot-like contortions. I believe that the expulsion of these scales serves to attract the male, and they are probably odoriferous; they are also used to cover the eggs, which are always laid inside the pupa shell. Some collectors have thought that the part of a female Psychid moth which protruded from the cocoon was the sexual organ, but had they seen a male copulating with the female, they would at once have recognised their mistake. Indeed, the head end has at first sight somewhat the appearance of some insects' sexual organs.

The males of this and another species of the same family in my collection, kindly named for me by Mr. Moore as *Gorisana bipars* (?) (Walker), are easily attracted to virgin females. I have taken seven males of the latter species in about two hours, by hanging a virgin female on the branch of a tree, and preventing connection, and when at last connection was formed, I saw one or two males flying round a few yards away, but they did not settle, and only left again in a few minutes. Copulation is formed by the male settling on the head of the female and forcing its abdomen, which it is capable of producing to more than half again its original length, in between the pupa shell and the body of the female, in the meantime the latter performs a series of contortions which facilitate the insertion of the male's abdomen.

The female lays its eggs within the pupa shell among the remaining loose scales, which have not been emitted and which serve as a kind of protection for the eggs. After laying all, or nearly all, its eggs, its abdomen so decreases in size that it drops out of the chrysalis shell and dies. The eggs are yellow, simple, smooth ovals, slightly squared at the ends and unmarked. The outer covering is not hard and shell-like, but is simply a skin, and the least touch will put the egg quite out of shape and useless. The egg stage appears to be the most critical part of the insect's life, as during the larva and pupa stages it is practically safe from the attacks of birds, and from other insects, except ants; but I have often found the empty female's cocoons inhabited by earwigs, and small beetle larvæ, which lead me to think that the eggs have been eaten by these intruders.

The larvæ emerge about the first of April from eggs laid at the beginning of March in the same year. This is the first brood of the year, but the others do not follow in any regularity, and it has been impossible for me to ascertain how many broods there are, as the larvæ and pupæ are found in all stages throughout the rains. Larvæ when first emerged are about one-sixteenth of an inch in length. Colour reddish brown. Heads large, mandibles strong. Body cylindrical, tapering towards the tail end. Pectoral legs large, long, and very powerful; abdominal legs, seen perfectly through magnifying glass, semideveloped, ten in number, including anal legs. Pectoral segments dorsally covered with a light brown shell-like covering. They do not seem to utilise the old cocoon in the construction of their own cases, and walk about for days with the abdominal segments always held perpendicular to the rest of the body. Some form cases about the third or fourth day from bits of moss and bark of sâl trees on the leaves of which they feed, but they constantly desert their cases at first. The larva feeds on the young leaves of the trees at this stage, but afterwards seems almost to prefer the old and tough ones. The larva never leaves its case after it has once begun to enlarge it, which it does by adding small bits of moss, leaves, flowers, stalks, and in one

case the elytra of a beetle was used. The mouth of the case is always made flexible, so that, when alarmed, the insect can draw in its head and the mouth of its case as well. If a full-grown larva be removed from its case (which can only be done by cutting the case open, as it seems to prefer death to being squeezed out) it will be found that it is almost helpless and cannot progress at all on a flat surface, as its anterior legs are too long and its prolegs are too short, and are useless to it without its case. The whole body is a purplish brown, covered with short bristles; the anterior segments have a dorsal shell-like covering of a pale buff colour, variegated with reddish brown. The head is reddish brown, and not very large. The abdomen has a lateral row of small red spots encircling the breathing apertures. Anterior legs strong and rather long. Prolegs very small. When the larva is about to undergo its change, it fastens the upper part of the case firmly round a twig or on to the bark of a tree, and draws out the mouth in the shape of a neck, which it closes. It then covers the inside of the case, now converted into a cocoon, with a very fine, soft loose silk, and then turns round, keeping its head downwards for the change.

The pupa of the male insect is of the usual shape, cylindrical, shiny dark, mahogany coloured. The abdomen is rather long and pointed. Wings and thorax short, antennæ large, broad. Palpi enclosed in a small blunt process at the top of the head. All the abdominal segments are minutely toothed dorsally, and there are a few short bristles on the mesothorax. By this means the pupa can easily draw itself upwards or downwards. The cocoon of the male is smaller than that of the female.

The pupa of the female insect is very much thicker than the male, and is also of a lighter reddish brown colour. Length 1 to 1·17 inches, greatest breadth ·42 to ·5 inches. Shape cylindrical, attenuated at both ends (anal end rather suddenly so), and ending in a sharp curved point; other end truncated and wrinkled, with no trace of the features usually apparent in lepidopterous pupæ. This end is bluntly beaked and keeled on the back of the first three segments. The fourth segment projects slightly over the fifth. There are breathing apertures from the fourth to the tenth segments along the sides. On the under surface of the fifth to eighth segments, there is a sublateral row of dark dots, one on each segment. The whole surface, with the exception of the wrinkled parts on the first three segments, is smooth, and the edges of the segments are slightly defined with dark brown. The edges of the two thickest segments are furnished with a minute row of teeth-like processes, apparently to enable the pupa to work itself upwards or downwards at will. When the pupa changes to the perfect insect, the shell covering the head and thoracial segments alone is cast off, and the

insect cuts its way out of the lower end of its cocoon by means of its sharp edged beak, propelling itself forward by the aid of the two pointed processes and the toothed segments of the abdomen of the pupa shell.

I have occasionally found the caterpillar singly on tea bushes adjoining sâl forest, but, although they eat the leaves, they do not appear to do so by preference, neither do they feed gregariously, as is the case with the larvæ of *Govisana bipars* (?) (Walker), which completely strips the tea bushes it feeds on and often kills them by taking off the bark to make its case.

[NOTE.—Since writing this, I have taken the larvæ commonly on tea bushes at elevations of from two to three thousand feet above sea-level in this district.]

VII.—A NEW PSYCHID INJURIOUS TO SÂL.[1]

BY F. MOORE.

Eumeta sikkima (nov. sp., Moore), nearest allied to the Ceylonese *E. layardi* (Moore, Lep. Ceylon, II, 102, pl. 118, fig. 2, ♂). Darker coloured generally. Fore wing with the costal border, the area longitudinally below the cell, and the posterior border darker brown; the veins also blacker. On the hind wing the general colour is also darker throughout. Body much darker coloured, and the black tufts of hairs on thorax and abdomen more prominent. Expanse of wings $1\frac{3}{4}$ inch.

Habitat.—Sikkim.

The larva feeds on the sâl (*Shorea robusta*), and forms a large fusiform case longitudinally covered with leaves of the tree, and before pupating suspends the case to an adjacent twig.

[NOTE.—*E. sikkima* is quite distinct from the Ceylonese *E. crameri* and its ally the Bombay *E. leithii*, both of which latter species are much smaller in size, and each have the antennal combs on both sides of the shaft about half the length of those in *E. layardi* and *E. sikkima*, the breadth of the antennæ in both the latter species being conspicuously broad. All the species of the genus *Eumeta* are much alike, superficially. *E. crameri*, *E. leithii*, and *E. layardi* are stated to form twig-covered cases, whereas the Sikkim species covers its case with leaves.]

[1] The life-history of this species is described above by Mr. G. C. Dudgeon.

Government of India Central Printing Office.—No. 237 R. & A.—21-11-91.—975.—F. J. B.

Vol. II.] [No. 2.

INDIAN MUSEUM NOTES.

THE WILD SILK INSECTS OF INDIA.

By E. C. COTES.

The following account of the wild silk-producing insects of India is intended to be a supplement to the paper on the cultivated forms, published as Vol. I, No. 3, of these *Notes*. It includes a summary of what has been ascertained about the various forms of Saturniidæ and Bombycidæ which occur in India—the mulberry-feeding silk worms, and the *Eri*, the *Muga*, and the *Tusser* alone being omitted, as they have already been dealt with in the paper on the cultivated forms.

It is a well known fact that the caterpillars of most moths spin a small amount of silk. The only groups, however, which contain species whose silk is at all suited for utilization are the Saturniidæ and Bombycidæ, and the whole of the Indian species belonging to these groups, therefore, have been included in the present report, though many of them do not produce sufficient silk to be of any use. So much, however, has of late years been said about the wild silk insects of India, and such exaggerated opinions have been expressed as to their value, that it has been thought best to deal exhaustively with the matter, so as to clear the ground and show precisely how the question really stands.

All that is known about the possible commercial utility of the cocoons of the various species has been noticed in dealing with each insect. The conclusion arrived at has been, that while many of the wild species produce silk which would be of considerable value if it were forthcoming in sufficient quantities, there is nothing to show that any of it is superior to the silk produced by the species which are already under cultivation; and although the cocoons of numerous wild species are collected, when they happen to be found, and are sold to be spun up with other materials, this source of supply is too precarious to have any commercial importance; so that upon the whole it may be concluded that an increased demand for Indian silk is far more likely to stimulate the production of the species which are already under cultivation than to bring any of the wild forms into general use.

The only cocoons, other than those of the cultivated forms, which are to be found in any appreciable quantity in the Calcutta market, belong

to the species *Attacus cynthia*, and even these do not appear in sufficient numbers to be of any importance. Of the remaining wild species, the most promising seem to be; (1) *Cricula trifenestrata*, whose golden colored cocoons are often to be found in large masses upon mango and other trees in many parts of India, and have been favorably reported upon by some experts, though the silk is said to irritate the skin of the wearer, owing to urticating properties of the caterpillars' hairs which are liable to get spun up with it; (2) *Antheræa roylei*, which lives upon hill oaks in the Himalayas and is closely allied to the oak feeding species *Antheræa pernyi* and *Antheræa yamamai* which produce most of what is known as the *Tussore* silks of China and Japan; (3) *Theophila huttoni*, whose cocoons are sometimes to be found in considerable number upon wild mulberry trees in the North-West Himalayas, and might occasionally be worth collecting, though, according to Captain Hutton, the crop is too precarious to have much value.

In drawing up this account constant reference has been made to the collections of the Indian Museum, which now contain representatives of all the commoner forms of Indian Saturniidæ and Bombycidæ. The literature of the subject has also been carefully consulted and an attempt has been made to introduce some order into it, by indicating the affinities of a number of so-called species, which have in many cases been founded solely upon trifling peculiarities detected in dried specimens, though these peculiarities are often so slight that the insects are practically indistinguishable. Where, therefore, there is no known difference in structure or life history to justify the separation of what are evidently very closely allied forms, it has been thought best to deal with them under the headings of the ones earliest described, the existence, however, of the allied forms being in each case indicated, so as to prevent the possibility of confusion arising, in the event of fundamental differences being in any cases hereafter brought to light. Figures of all the well marked forms have been appended, where possible, with illustrations of the caterpillars and cocoons; and in all cases where there is any possibility of doubt about the identity of a species which has been figured, the authority adopted for its identification has been quoted. The most reliable specimens in the Museum collection of Saturniidæ and Bombycidæ are probably those collected by the late Mr. Otto Möller in Sikkim and determined by Mr. H. J. Elwes, but the Museum also possesses several of the late Captain Hutton's types, as well as numerous insects determined by Mr. F. Moore, and the whole of these specimens have in each case been carefully examined, reference being also made to a considerable collection of Indian moths belonging to Colonel A. M. Lang and determined by Mr. F. Moore.

With regard to the plates with which this report is illustrated, the figures of the larvæ of *Theophila affinis*, *Th. huttoni*, and *Th. bengalensis*,

are from colored drawings made some years ago by the Museum artist, Behari Lal Dos, under the direction of the Superintendent of the Indian Museum. The figure of the cocoon of *Theophila affinis* is a photograph kindly taken by Mr. Wood-Mason. The figures of *Antheræa yamamai* and *A. pernyi* are after figures published in the Rev. et Mag. de Zool. and the Tijd. Voor. Ent. in illustration of papers by Guérin Méneville and Westmaas. The figure of the larva of *Ocinara lactea* is after one published in the Trans. Ent. Soc., Lond., in illustration of a paper by Captain Hutton. The remaining figures have been made from the specimens by the Museum artist, Grish Chunder Chuckerbutty, under the direction of the writer.

ATTACUS ATLAS, Linn. *Plate 2, fig. 1.*

This moth is well known on account of its great size, some of the specimens in the Indian Museum being more than ten inches across from tip to tip of wings. It is common on the slopes of hill ranges all over India and Burma; and, according to Gosse, ranges in South-Eastern Asia over 35° of latitude and 55° of longitude, being abundant in China and scattered over the whole of the Malay Archipelago.

The life history of the insect has been fully described by Gosse (Entomologist XII, p. 25), Manuel (Journ. Agri. Hort. Soc. Ind. n. s. Vol. VII, p. 291), and by Brownlow (Journ. Agri. Hort. Soc. Ind. n. s. Vol. V, p. 183). According to Manuel the insect spins once a year in its natural state, though in domestication in Burma it will spin twice or even three times,—once at the commencement of the rains, once during the rains, and again at the close of the rains, the best cocoons being those formed towards the beginning of the cold weather. The female moth is very sluggish, and seldom flies; the male, which has a powerful flight, usually seeking her out and fertilizing her as she clings to the cocoon from which she has emerged; for this purpose the male is furnished with some sense, probably of smell, which enables him to find the female unerringly, however thick the foliage in which she is concealed. After fertilization the female lays about 300 eggs in masses which are firmly gummed on to the under surface of the leaves upon which the caterpillars afterwards feed. The food plants are very numerous; in Almorah the caterpillar has been found upon a bush belonging to the genus *Berberis;* in the hills about Mussoorie upon *Falconeria insignis* (Hutton); in Assam on *Vangueria spinosa* (Stack); in Sikkim upon *Teucrium macrostachyum,* a species which grows abundantly from an elevation of 6,000 feet upwards (Otto Möller); in Bangalore upon a species of *Ocimum* (Cameron); in Burma upon *Ardisia sp., Clerodendron infortunatum, Dillenia pentagynia, Lagerstræmia indica, Nauclea rotundifolia, Phyllanthus emblica,* and *Schleichera trijuga* (Manuel); while Gosse succeeded in rearing it upon apple, and in Ceylon the form

described by Moore as *Attacus taprobanis*, which is said to be very common about Colombo, feeds upon cinnamon (Thwaites).

The eggs are oval in shape, about 0·08 of an inch in diameter, in color greenish white, with brownish purple clouding, which readily washes off. They hatch about a week after being laid, and the caterpillars which emerge are generally sluggish and solitary in their habits, seldom wandering to any distance from their birthplace unless driven by scarcity of food. When first hatched they are little dark colored creatures, about a third of an inch in length, and covered with hairy tubercles; they grow rapidly, however, and after the first molt become lighter in color and are soon covered with a dense white flour-like secretion which accumulates upon them after each molt. After passing some twenty days as caterpillars, and molting about five times, they are full grown and ready to spin themselves up into their cocoons; a very large proportion of them, however, fall victims, before they reach this stage, to the ants, wasps, and other foes which are always on the look-out for them. When the caterpillars leave off feeding, preparatory to spinning, they are sometimes as much as five inches in length by an inch in diameter, but they contract considerably before actually commencing their cocoons. The cocoon is spun in the usual manner and is so closely enveloped in the leaves of the food plant that, when it is torn away, permanent impressions, showing the shape and neuration of the leaves, are left upon the silk. The cocoon is generally drab colored, and from two to three inches long, by an inch in diameter; it is irregular in shape, with thin firm walls, which are scarcely at all silky in appearance, except at the upper extremity where there is a natural orifice for the exit of the moth. This orifice is formed, as in the cocoons of other Saturniidæ, by the convergence of a great number of silken fibres, which are left ungummed and are therefore soft and flossy, opposing an almost impenetrable hedge to any animal which tries to force its way into the cocoon, but opening readily when pushed aside by the moth which emerges from within. The moth thus effects its escape with hardly any perceptible disarrangement of the fibres, which close together again behind it. The stiff gummed parchment-like wall of the cocoon passes upon one side of the orifice, so as to form a cord, which is firmly wrapped around the twig from which the cocoon hangs, thus securing it from mishap in case the leaves, in which it is wrapped, become detached. The cocoon contains a large amount of thick strong silk which cannot indeed be reeled easily enough to make it worth doing, but which would have a considerable market value for carding and spinning purposes, if large quantities could be obtained; it is said that some of these cocoons have been collected in Burma and exported to England for this purpose, while attempts have also been made to domesticate the insect in China; but upon the whole experts seem to be agreed

that there is no chance of the *Atlas* silk competing successfully with that of such species as the *tusser*, which can be obtained so much more easily. Connected with *Attacus atlas*, besides *Attacus edwardsii*, which is probably a distinct though closely allied species, we may notice *Attacus silhetica* of Helfer (Journ. A. S. B. VI, p. 41, 1837) and *Attacus taprobanis* of Moore, Lep. Ceyl. II, p. 124, 1882), both of which forms, so far as the descriptions and figures of them go, seem indistinguishable from *Attacus atlas*.

ATTACUS EDWARDSII, White. *Plate 2, fig. 2.*

A large species, somewhat darker in color and with somewhat larger and differently arranged white markings, but very similar, both in general appearance and in size to *Attacus atlas*, of which it is little more than a constant variety. It is found in the hills in many parts of India (Sikkim, Shillong, Khasi Hills, Mussoorie, Western Ghats, and Mysore), but is usually scarce. In Sikkim, according to the late Mr. Otto Möller, it is found at an altitude of from 6,000 to 7,000 feet and goes through but one generation in the year, hibernating as a pupa inside the cocoon, from which it emerges as a moth during the rains (July to September). The cocoon is much like that of *Attacus atlas*, but is somewhat denser in structure and sufficiently different in shape to be distinguishable. The caterpillar is very like that of *Attacus atlas*, but differs from it markedly in possessing a number of black speckles on the two anterior pairs of fleshy protuberances. The specimen from which the drawing of the larva has been made was obtained by Mr. A. V. Knyvett at Kurseong. Mr. Knyvet describes the caterpillar as follows :—" General color, green-powdered above, especially on the tentacles, with a white powder which comes off in flakes, tentacles about half an inch in length, occurring in pairs on the third, fourth, fifth, sixth, seventh, eighth, ninth, tenth, and eleventh segments, the twelfth segment being furnished with a singlemedium tentacle : the tentacles on the third and fourth segment are bluish, dotted with black, those on the other segments are green at the base, bluish at the apex, and covered with flakes of white powder; stigmata, light greenish blue in color; anal claspers with a large vermilion spot."

ATTACUS CYNTHIA, Drury. *Plate 3.*

This species is very closely allied to the *eri* silk moth (*Attacus ricini*) and is probably the original wild form from which the *eri* has been derived by domestication. It can, however, be easily distinguished from the *eri*, by its larger size and brighter and more golden coloration, and as the two forms appear to have somewhat different habits, it seems best to look upon them as belonging to distinct species.

Attacus cynthia is said to range over India, China, and some of the Malay Islands; in the Indian Museum are specimens from Mussoorie,

Sikkim, Shillong, Buxa, and Sibsagar, besides a single specimen from the Andaman Islands of what seems to be a local variety.

It is said to be common up to 5,000 feet in Sikkim, where, it is thought to be trivoltine, feeding upon *Zanthoxylum acanthopodium*, or *Z. alatum* (Möller). Its larval stages do not appear to have been observed in India. The cocoons, though much smaller in size, are very similar in structure, coloration, and general appearance to the cocoons of *Attacus atlas;* they are smaller and more compact than cocoons of *A. ricini*, but appear nevertheless to contain a considerable amount of silk, which would no doubt be valuable for carding purposes if it could be obtained in any considerable quantities. Of late they have appeared in the Calcutta market, where they are known as *Junglies*. Mr. G. C. Hodson writes that they are brought to market by Mahomedans, while the *eri* and *muga* trade is entirely in the hands of Marwarries. According to Captain Hutton the insect is also identical with a semi-domesticated species which is reared on a small scale in some parts of China, upon *Ailanthus glandulosa*, for the production of silk, and which has also been raised experimentally upon the same plant in Europe.

The forms *Attacus guerini* (Moore), *Attacus obscurus* (Butler), *Attacus canningii* (Hutton), and *Saturnia iole* (Westwood), have at different times been described as distinct species. From the descriptions and figures that have been given of them, however, they appear to be so nearly related to *A. cynthia* and *A. ricini* that until cause is shown for their separation it seems best to look upon them as synonyms of one or other of these two species. Of the species *Attacus vesta* (Walker) no description has been found, and it may, therefore, be neglected.

The moths, figured on plate 3, were determined by Mr. H. J. Elwes; the cocoon was one furnished by Mr. Otto Möller.

ACTIAS SELENE, Hübner. *Plate 4.*

This species is common in collections from all parts of India, and is said to occur in Ceylon and China. In the Indian Museum are specimens from Simla, Shillong, Khasi Hills, Sylhet, Sibsagar, Manbhum, Gobindpur, Lakhimpur, and from the neighborhood of Calcutta. In Sikkim, according to Möller, it is fairly common at an elevation of from 3,000 to 5,000 feet. It passes the winter as a pupa inside the cocoon, and goes through two generations in the summer, the first set of moths appearing in early spring and the second in July and August. The food plant of the caterpillar is *Zanthoxylum acanthopodium* or *Z. alatum*. In the hills around Mussoorie it was found by Hutton to feed on the wild cherry, wild pear, walnut, *Cedrela paniculata*, *Coriaria nepalensis* (Munsoory) and several other forest trees. The cocoon is coarse in texture, yields but little silk, and, as it is not forthcoming in any considerable quantities, it has no commercial value.

The following account of the rearing of the caterpillar in Mussoorie is taken from Captain Hutton's writings as given in Moore's Catalogue of Lepidoptera in the East India Museum :—

"Moths, found in *coitu* in the middle of April, each laid, in the course of a few days, about 300 eggs which are about the size of mustard seed. After depositing their eggs the moths rapidly died off and the eggs began to hatch about the end of the month. The larvæ when first hatched are about a quarter of an inch in length, hairy, and of a pale rufous red with a single black band across the middle of the body, and a small black transverse mark on the anterior segment; along the back are two rows of small tubercles and another along each side, from each of which spring a few short hairs, the base of which forms a small black dot. There is also an anal tubercle, larger than the others, and placed between the two last tubercles of the dorsal rows; the head is black. . . . The first molt commenced when six days old, and this occupied three days, so that at the end of nine days the larva appeared in its second stage. The black transverse band upon the body had disappeared, but the head still remained of that color, and the rest of the body was hairy and rufous, the tubercles being black on the summit and more prominent; pro-legs brown. The period between each change was about ten days in some specimens, but varied in others between that and shorter periods, . . In the third stage the caterpillar appeared of a bright rufous color, the black dots, or tubercles, being larger and more prominent, but there were no black bands. In the fourth stage the change was still more remarkable, for the caterpillar now appeared of a beautiful apple green, each tubercle headed with bright orange, except the four which spring from the second and third segments, which are ringed with black and crowned with pale yellow; and the anal and two posterior tubercles, which are green throughout. From each tubercle springs a small tuft of hair, the centre one of each being longer than the others; the head and pro-legs brown. Along each side is a line, which is red above and yellow below, and the spiracles are red; there is a line of very small yellow dots along each side between the rows of tubercles. In the fifth stage the colors are the same as they are in the fourth, also in the sixth and seventh stages; but the caterpillar increases rapidly in size, and is most beautiful and delicate in appearance, with a semi-transparency of hue which makes it look something like waxwork. One of these commenced spinning its cocoon on the 17th of July, being then about forty-six or forty-seven days old, and the remainder after the interval of a day or two; that is, on the 19th, 20th, and 25th July. The cocoon is formed of coarse brown silken threads, closely interwoven and of an ovate form. It is inclosed among the leaves of the tree, which are, in fact, glued closely round it. It is hard and not furnished interiorly with a soft silken bed, the chrysalis lying within a hard and hollow chamber. The chrysalis remained thus until the 14th August, when the one which had turned on the 17th July produced a perfect female after a period of twenty-nine days. Another, which had turned on the 19th July, came forth a male on the 16th August, showing the time to be pretty uniform. A large caterpillar, however, found in the forest on the 16th July, turned to a chrysalis on the 24th of that month; but, instead of coming forth in the autumn, it remained in the chrysalis state throughout the winter, as did some others, coming out in the following summer, namely on the 11th, 14th, and 18th of June."

Hutton also describes the manner in which the moth works its way out of the cocoon by the aid of its wing spurs, which seem to have a cutting edge and to be used to sever the silk strands of the cocoon.

The moths from which the figures were made were determined by Mr. H. J. Elwes; the cocoon was furnished by the late Mr. Otto Möller.

ACTIAS LETO, Doubleday. *Plate 5.*

This is a large insect allied to *Actias selene;* it is found at low elevations in the Himalayas and in Assam. According to Möller it is bivoltine, hibernating as a pupa inside its cocoon, the moths appearing in spring and autumn, its food plant in Sikkim being *Turpina pomifera.* In the Indian Museum, besides specimens of the moth from Sikkim, Buxa, and Sibsagar, there is a cocoon received from Sikkim as belonging to this species. It is much like cocoons of *A. selene* in structure and appearance, but is remarkable for a number of neat round holes, each about the sixteenth of an inch in diameter which penetrate the cocoon on all sides; these, however, may possibly have been caused by hymenopterous parasites.[1] Little seems to be known about the species, which is far too rare to have any value as a silk producer. It is chiefly remarkable for the great difference in the shape and coloration of the two sexes, which are so dissimilar in appearance that they were for many years thought to be distinct species, and in most works on Entomology are described—the male as *A. leto*, the female as *A. mænas.* Connected with *Actias leto* is a form which is found in the Andaman Islands and which has been described by Moore under the name of *Actias ignescens* (P Z. S. 1877, p. 602). There are no representatives of it in the Indian Museum, but from the description it appears to be little more than a local variety of *A. leto.*

The moths from which the figures were made were determined by Mr. H. J. Elwes; the cocoon was furnished by the late Mr. Otto Möller.

ANTHERÆA FRITHII, Moore. *Plate 6.*

In the Indian Museum are specimens of this species from Sikkim, Sibsagar, and Buxa. According to Möller it is a bivoltine species, common at low elevations in Sikkim, where it feeds upon sâl (*Shorea robusta*), hibernating as a pupa, and the moths appearing in March and August, respectively. Rondot (*L'Art de la Soie* II, p. 117, 1887) writes that according to Fallon, who reared it in France, the larva is of an ochre yellow, ringed with black. The cocoons are yellowish white in color and very similar to those of *A. roylei*, but less silky on the exterior. According to Rondot they contain a considerable amount of silk. The above seems to be all that is known of *Antheræa frithii*, which is too scarce to be likely to be of any use as a silk producer.

The specimens from which the figures were made were reared in the Indian Museum from cocoons furnished by the late Mr. Otto Möller.

[1] Since the above was written information has been received from Mr. A. V. Knyvett, who has observed this species in Sikkim, and has found the holes invariably present in the cocoons.

ANTHERÆA HELFERI, Moore. *Plate 7, fig. 1.*

In the Indian Museum are several moths of both sexes of this species from Sikkim, but there are no authentic cocoons, and little seems to be known about it beyond the bare fact of its occurrence in Sikkim, and Hutton's observation (Journ. Agri. Hort. Soc. Ind. III., p. 125, 1871) that the cocoon resembles that of the Tusser (*Antheræa mylitta*). The insect is far too scarce to have any commercial value whatever. The moth from which the figure of the male was made was determined by Mr. H. J. Elwes. The figure of the female is taken from a specimen in Colonel A. M. Lang's collection determined by Mr. F. Moore.

ANTHERÆA ROYLEI, Moore. *Plate 9.*

In the Indian Museum are specimens of this species from Simla, Mussoorie, Sikkim, and the Khasi Hills, also a cocoon from Sikkim. It is said to be very closely allied to *Antheræa pernyi*, a semi-domesticated species largely reared upon oaks in China for the production of silk. Rondot, indeed, in his *L'Art de la Soie*, Vol. II, notices that a hybrid race has been obtained by crossing *A. pernyi* males with *A. roylei* females. If, therefore, Hutton is right in saying that *A. roylei* can be easily reared upon the common hill oak (*Quercus dilatata?*), it is not by any means impossible but that it may become of value for the production of silk in the Himalayas, the cocoons being of a kind which would certainly be valuable for carding, if not for reeling purposes. Little has hitherto been recorded about this insect, though it has been bred by several people both in India and in Europe (see Entomologist, XIV, p. 246, and Bull. Soc. Ent. France (5), IV, p. 154). Hutton writes in the Journ. Agri. Hort. Soc. Ind. III, p. 125, 1871: "*Antheræa roylei* is common at Simla, Mussoorie, Almora, and I think Darjiling. It feeds upon the common hill oak, spinning a large but thin cocoon between three or four leaves . . . . The outer coating is very strong, and I do not think it could be reeled, but within this case is the true cocoon, of an oval form and yielding good silk. The worms are easily reared and sometimes give two or three crops, but this is when treated in the house." Major Harford also, writing recently from the North-West Himalayas, notices the peculiar double-walled cocoons which he has found upon *ilex* (hill oak?) and the khakee colored males and pinkish females he has bred from them. Some observations also on the habits of *A. roylei*, by the late Mr. Otto Möller, appeared on page 201 of Vol. I of these *Notes*; it is thought, however, that these observations referred to some other species, as the cocoon forwarded with them was single-walled and pedunculate, instead of having the double-walled structure characteristic of typical *A. roylei* cocoons. A double-walled cocoon found by Mr. A. V. Knyvett on a chestnut tree in Sikkim was sent to

the Indian Museum in May 1890, and produced, in the early part of the rains, a female moth of the typical pinkish color, and Mr. Knyvett also writes that he has found *A. roylei* cocoons on *Mohwa* trees, oak, and birch in Sikkim. The above is all that we at present know about *A. roylei* proper. The figures of the caterpillar and cocoon are taken from specimens obtained by Mr. A. V. Knyvett in Sikkim; those of the moths from Hutton's type specimens which are in the Indian Museum collection. Closely connected with *A. roylei* proper is an insect with a firm single-walled pedunculate cocoon which has been found by Mr. A. V. Knyvett upon wild cherry trees in Sikkim. The cocoons of this form, which have been sent to the Indian Museum, are much like the cocoons of *Antheræa frithii*, but moths reared from them by Mr. Knyvett are almost indistinguishable from moths reared from the typical double-walled cocoons of *A. roylei*, the chief distinction consisting in the greater pinkness of those reared from the pedunculate cocoons. As, however, the females reared from double-walled cocoons show every variety of color from pink to greenish brown, and are in some cases altogether indistinguishable from females reared from pedunculate cocoons, it would seem most probable that the difference in the structure of the cocoon is to be attributed more to the difference in the food plant than to any specific distinctness in the insects. The differences observed by Mr. Knyvett between the caterpillars of the two forms, though very remarkable, not being of a sufficiently radical nature to warrant their separation under distinct specific names.

Oak Silk Worms of China and Japan. *Plate 7, fig. 2, and plate 8.*

An account of *Antheræa roylei*, which is the oak-feeding silk worm of the Himalayas, would be incomplete without a notice of the very closely allied oak-feeding silk worms of China and Japan. These are *Antheræa pernyi* (Guérin Méneville, Rev. et Mag. de Zool. 1855, p. 297, pl. 6, fig. 1), which is reared in a semi-domesticated state over large areas in Northern China, for the production of silk, and *Antheræa yamamai*, which is the corresponding form in Japan. About twenty-five years ago, when mulberry silk raising in Europe was threatened with extinction, these species attracted a good deal of attention, and were introduced[1] and partially acclimatized in France by experimentors, who hoped to furnish a substitute for the mulberry-feeding species. The revival of the mulberry silk industry, however, with the adoption of Pasteur's treatment for the silk worm disease, has thrown the oak-feeding species again into the

[1] As told by Van Westmaas (Tijd Voor. Ent. VII, 1864), the story of the obtaining of the eggs of *A. yamamai*, through a young Japanese, who in 1862 risked his life to get them for M. Pompe van Meerdervoort in Japan, recalls the difficulties encountered in the middle ages by the monks who first introduced the eggs of the mulberry-feeding species into Europe from China.

shade, so that the experiments, which at one time seemed distinctly promising, have not led to any practical results. That *A. pernyi* and *A. yamamai* are at least very closely allied to *A. roylei* is shown not only by the great superficial resemblance of the three forms (*vide* plates 7 and 8), but also from the fact that hybrids have been raised in Europe both between *A. pernyi* and *A. yamamai* (Berce and Goossens: Bull. Soc. Ent. France (5), IV, p. 154), and also between *A. roylei* and *A. pernyi* (Wailly: Ent. XIV, p. 246). An excellent account of *A. pernyi* in China is given by Rondot (*L'Art de la Soie*, II, 1887, p. 127). The following is an abstract:—

Antheræa pernyi is a bivoltine species found both wild and also in a semi-domesticated state upon oak trees in many parts of China, where it is reared extensively for the production of silk. The amount of fresh cocoons annually reared has been estimated at twenty-two millions of kilogrammes, of which a considerable amount is imported into Europe. Two yields of silk are obtained in the year, one in the spring and another in the autumn; the spring rearing occupying about sixty days and the autumn rearing about a hundred. The insect is generally reared indoors, but to a certain extent also upon trees or bushes in the open air. The worm is also common in a wild state in the forests and copses of oak trees on the mountain sides. In Koüeitcheou (according to Father Perny) there is an annual variety of the worm which is less esteemed than the bivoltine one, a fact which is noticeable in connection with the tendency to become annual, which has been observed in the species when reared in France. The cocoon is enveloped in two or three oak leaves drawn together by a network of silken strands, and is further attached at one end to some small branch or leafstalk by a flat silken cord. The cocoon of the spring rearing contains only about half as much silk as that of the autumn rearing, but the silk itself is far more brilliant, that of the autumn rearing being somewhat dull and lustreless. The cocoons are either reeled or spun. The reeling is done in two ways—either wet or dry. In the dry process the cocoons, after having been dipped in a mordant made from oakwood ashes, are washed in clean water and are then reeled dry, the basket containing them, however, being sometimes steamed over a vessel of boiling water. In the wet process, the cocoons are simply reeled as they lie in the iron boiler, which contains either a solution of raw soda or strong mordant made out of oak ashes, the liquid being but just sufficient to cover the cocoons; the wet process therefore differs materially from that of mulberry silk filatures, where deep basins of water are used for holding the cocoons while they are in process of reeling. Of the wet and dry processes, the dry one is preferred and gives the most satisfactory results. A large portion of the autumn crop and all the pierced cocoons are spun, the spinning being done either by hand or with a jenny worked by the foot.

The figures of *A. roylei* are from specimens in the Indian Museum; those of *A. yamamai* after Snellen's figures (Tijd Voor. Ent. VII, 1864); those of *A. pernyi* after Guérin Méneville's figures (Rev. et Mag. de Zool., 1855).

Other Indian Species of Antheræa.

Besides the cultivated species—*Antheræa mylitta* (Tusser), *A. assama* (Muga)—described in Vol. 1, No. 3 of these *Notes*, and the wild species—*Antheræa roylei*, *A. helferi*, and *A. frithii*, which have been noticed above, five other Indian species of the genus *Antheræa* have been described by entomologists. There are no specimens of them, how-

ever, in the Indian Museum collection, and it seems very doubtful to what extent they are entitled to be looked upon as distinct. They are as follows:—(1) *Antheræa cingalesa* of Moore from Ceylon: Moore's figure of the moth, in his Lepidoptera of Ceylon, Vol. II, is very like some forms of *A. mylitta*, but his figure of the larva presents certain peculiarities; (2) *Antheræa andamana* of Moore, from the Andaman Islands: no figure seems to have been published of this insect, and as no comparison is drawn, in the description, between it and other *Antheræas*, it is impossible to judge to what extent it is distinct; (3) *Antheræa perrottetii* of Guérin Méneville from Pondicherry. This insect, according to Walker (B. M. Cat. Lep. VI, p. 1379), is very nearly allied to *A. assama*, and Guérin Méneville's description of the cocoon (Mag. de Zool. VI, pl. 123, 1844) also answers to that of *A. assama*, so it is not improbable that it may be a variety of that species, though Guérin Méneville's figure of the moth presents some peculiarities. According to Rondot (*L'Art de la Soie*, II, p. 117) it feeds upon *Eugenia jambolana*, *Zizyphus sp.* and other trees; (4) *Antheræa simplicia* of Massen and Weymer, from the "East Indies." The writer has not had an opportunity of comparing the description of this species, so its precise habitat and identity remain to be ascertained; (5) *Antheræa fraterna* of Moore (P. Z. S. 1888, p. 402) from Kussowlee and Kangra: this species also is unknown to the writer.

Cricula trifenestrata, Herr Schäff. *Plate 10, fig. 1.*

This variable species is said to be common in all parts of tropical India, and especially in Burma, Assam, and Chota Nagpore. The Indian Museum possesses specimens from Sikkim, Sibsagar, Cachar, Dacca, the Andaman Islands, and Java. The larvæ are usually found upon mango trees, but also feed upon a number of other trees; they are gregarious in their habits and spin large agglutinated masses of gorgeous reticulated cocoons, which are of the color and brilliancy of molten gold when fresh. They are thought by some silk experts to be likely to prove valuable for carding purposes, though Stack in his account of Silk in Assam (1884) reports that the silk is almost worthless. He writes: "The cocoons are of a thin and open texture, yielding very little silk, which cannot be reeled. The worm is covered with hairs, which produce irritation of the skin, and for this reason it is regarded as unclean by the Hindus, but Kacharis, Rabhas, and Meches occasionally mix the silk with *eri*, where it reveals its presence by the itching it causes. This irritating property of the worm is said to protect it against crows and bats."[1]

[1] Mr. G. C. Hodgson writes:—"The *Cricula trifenestrata* found in Ranchi would be a valuable silk for carding purposes, but so far we have never been able to get it in a form fit for export. The chrysalids are usually alive when brought to Calcutta, whilst for commercial purposes they must be thoroughly dessiccated before being screwed into bales."

The insect is said to go through a series of generations in the year, each generation taking about two months to complete, and the rains broods being the strongest and producing most silk.

The moths from which the figures were made were determined by Mr. H. J. Elwes.

CRICULA DREPANOIDES, Moore. *Plate 10, fig. 2.*

This insect differs very markedly from *C. trifenestrata* in general coloration; it is recorded as occurring in Sikkim, from which locality also the Indian Museum possesses specimens. Nothing seems to be known on the subject of its habits. It is presumably very rare.

The moth from which the figure was taken was determined by Mr. H. J. Elwes.

RHODIA NEWARA, Moore. *Plate 11.*

This fine species is common in Sikkim, where it spins a brilliant green cocoon, with slit-like opening at the upper extremity, through which the moth makes its escape, and drain-like passage at the bottom, which is supposed to serve for the escape of any water which may happen to enter the cocoon during the rainy season owing to the imperfect closing of the upper slit. According to Möller the insect is found at an elevation of from 4,000 to 7,000 feet in Sikkim, and goes through but one generation in the year; it hibernates in the egg; the larvæ emerge early in the spring, and finish spinning their cocoons by the end of May; the moth appears during the first half of November at 5,000 feet, and somewhat earlier at higher elevations; the larvæ feed upon the weeping willow and wild walnut.

The specimen from which the figure of the moth was taken has been determined by Mr. H. J. Elwes; the cocoon was furnished by the late Mr. Otto Möller.

SATURNIA STOLICZKANA Felder. *Plate 13, fig. 4.*

This species was figured by Felder (Reise Novara, Lep., pl. 87, fig. 3, 1864—75) from Ladak. Nothing seems to have been recorded about it, but in the Indian Museum are some broken wings from an elevation of 10,500 feet in Lahoul, and also a specimen from Kulu, which answer to the figure.

SATURNIA CIDOSA Moore.

S. cidosa (Moore, Trans. Ent. Soc. Lond.(3), ii, p. 423, pl. 22, fig. 2, 1864—66) is represented in the Museum collections by a single moth from Sikkim. According to Hutton (Journ. Agri. Hort. Soc. Ind., iii, 1871, p. 125) it is closely allied to *S. pyretorum*.

Saturnia pyretorum, Westwood.

This species was originally described by Westwood (Cab. Or. Ent., p. 49, pl. 24, fig. 2, 1848) from China, and was noticed by Hutton (Journ. Agri. Hort. Soc. India, III, p. 125, 1871) as occurring in Sikkim and Cachar; there seems, however, to be some doubt as to whether it extends into India. In China, according to the *resumé* given by Rondot (*L'Art de la Soie*, II, 1887, p. 205), the caterpillar is of medium size, longitudinally streaked with bright turquoise blue, alternating with canary yellow, and covered with bristling yellow hairs; it feeds chiefly upon the *Liquidambar formosana* and *camphor* trees. The cocoon is ovoid, much produced in length, pointed, open at one end, and surrounded with floss, which is deep brown in color. The silk is silver grey or brownish grey in color, coarse and very tough; it is said to be used on a considerable scale commercially, the silk glands of the worm being also used for the preparation of gut for fishing lines.

Other Saturnias.

Saturnia grotei (Plate 13, fig. 2), *Saturnia lindia*, *Saturnia anna*, and *Saturnia hockingii* are so closely allied to each other that it seems most convenient to consider them together, as very little is known about any of them. *Saturnia grotei* (Moore P. Z. S. 1859, p. 265, pl. 65, fig. 2, and Butler, Ill, Typ. Lep. Het. B. M. V, p. 61, pl. 94, figs. 3 and 4) is represented in the Museum collections by specimens from Kulu and Sikkim; *Saturnia lindia* (Moore, Tr. E. Soc. (3), ii, p. 424, pl. 22, fig. 3, 1864—66) by specimens from the N.-W. Himalayas; *Saturnia anna* (Moore, P. Z. S. 1865, p. 818) by specimens from Sikkim; while *Saturnia hockingii* (Moore, P. Z. S. 1865, p. 818 and Butler, Ill, Typ. Lep. Het. B. M. VII, p. 39, pl. 124, figs. 2 and 3), described from Kulu, is not represented in the Museum Collection. It should be noticed for the fact that Moore records that the cocoon, which is formed "under stones," is "pyriform, dark brown, hard, pointed, and lax at the upper end." The specimen from which the figure of *S. grotei* was taken has been identified by Mr. H. J. Elwes.

Loepa katinka, Westw.

Four species of the genus *Loepa* have been described from India, *viz. Loepa katinka* (Westw., Cab. Or. Ent., p. 25, pl. 12, fig. 2, 1848), found in Sikkim, at an elevation of from 5,000 to 7,000 feet, and also in Assam; *L. miranda* (Moore, Trans. Ent. Soc., Lond. (3), ii, p. 424, 1864—66) from Sikkim; *L. sikkima* (Moore, P. Z. S., 1865, p. 818) from the hot valleys in Sikkim; *L. sivalica* (Hutton, Journ. A. H. Soc. Ind., III, 1871, p. 125, and Moore, Wardle's Wild Silk, 1881, p. 7) from Mussoorie. In the Indian Museum are specimens, determined by Mr.

Moore as belonging to the three forms—*katinka*, *miranda*, and *sikkima*, together with intermediate varieties; so, taking into consideration the fact that the three forms are found within a few miles of each other in Sikkim, it seems very doubtful whether they are really distinct. With regard to the fourth form,—*L. sivalica*,—found by Hutton in Mussoorie at an elevation of 5,500 feet, Hutton notes that it is closely allied to *L. katinka*, while Moore writes that it spins a long cocoon, pointed at each end, and of a dark greenish grey color. The above, with Atkinson's note (P. Z. S. 1865, p. 818) to the effect that moths of the *L. sikkima* form appear in the beginning of August, while *L. katinka* appears later, concludes what has been recorded on the subject of this genus in India.[1]

The specimen of *L. miranda* from which the figure has been taken is in Colonel A. M. Lang's collection; it was identified by Mr. F. Moore.

NEORIS HUTTONI, Moore. *Plate 13, fig. 3.*

In the Indian Museum are a male and female of this species from Mussoorie. Hutton notices that he found the larvæ at 6,500 feet elevation in Mussoorie in April feeding on the wild pear tree, the cocoon being an open network worthless for silk production (Journ. Agri. Hort. Soc. Ind. III, 1871, p. 125). A second species of this genus has been described by Moore (P. Z. S., 1872, p. 577) under the name of *Neoris shadulla*, from the neighbourhood of Yarkand; there are no specimens of it in the Indian Museum.

The figures of *N. huttoni* are from Captain Hutton's specimens.

SALASSA LOLA, Westw. *Plate 12, fig. 1.*

This fine species was described by Westwood (Cab. Or. Ent., p. 25, pl. 12, fig. 3, 1848) from Sylhet, and the Indian Museum possesses specimens of it from Sikkim. With regard to its habits, Mr. A. V. Knyvett has observed in Sikkim that the caterpillar, previous to transforming into a chrysalis, spins a few leaves and chips together into a sort of rough covering in the ground exactly as is done by the species *Salassa* (*Saturnia*) *royi*.

The specimen from which the figures of the moths were taken was determined by Mr. H. J. Elwes; the caterpillar was drawn from a specimen furnished by Mr. A. V. Knyvett.

SALASSA ROYI, Elwes. *Plate 12, fig. 2.*

This species was described by Elwes (P. Z. S., 1887, p. 447, and Trans. Ent. Soc., Lond., 1888, pl. 8, fig. 2) from a male taken at an

[1] Since the above was written the following note has been received from Mr. A. V. Knyvett, who has observed this genus in Sikkim: "The high elevation form *L. katinka* is quite distinct from the hot valley form, which may be either *L. miranda* or *L. sikkima*."

elevation of 10,000 feet in Sikkim. It was originally referred to the genus *Saturnia*, but the observations of Mr. A. V. Knyvett indicate pretty clearly that it should rather be included in the genus *Salassa*. According to Mr. Knyvett, the caterpillars are very like those of *Salassa lola*, only bigger; the chrysalis also is formed in the ground in a little, loose silk, much as is the case with *Salassa lola*.

The male was figured from specimens determined by Mr. H. J. Elwes, the female from a specimen deposited for a short time in the Indian Museum by the late Mr. Otto Möller.

CALIGULA SIMLA, Westw. *Plate 14, fig. 1.*

In the Indian Museum are specimens of this species from Simla, Mussoorie, Sikkim, and Khasi Hills, besides cocoons which are supposed to belong to it and which were obtained in Dehra Dun, probably from the Mussoorie Hills. Hutton writes (Journ. Agri. Hort. Soc. Ind., iii, 1871, p. 125) that the larva feeds on walnut, *Salyx babylonica*, and wild pear, the cocoon being a coarse open network, through which the pupa is visible, and yielding no silk.

CALIGULA THIBETA, Westw. *Plate 14, fig. 2.*

In the Indian Museum is a male of this species obtained from Sikkim. According to Hutton (Journ. Agri. Hort. Soc., Ind., III, 1871, p. 125) the original specimen from which the species was described came from Kumaon, and he also found it in Mussoorie on *Pieris ovalifolia*. It seems to be a well marked species, quite distinct from *C. simla*. A third species of the genus *Caligula*, viz. *C. cachara*, was described by Moore (P. Z. S. 1872, p. 578) from Cachar; there are no specimens of it in the Indian Museum. Butler (Ill. Typ. Lep. Het. B. M. V, p. 61, pl. 94, fig. 2, 1881) describes a species from Sikkim, under the name of *Rinaca extensa*. From the figure this insect would seem to be indistinguishable from *C. thibeta*.

The figure of *C. thibeta* is from a specimen determined by Mr. H. J. Elwes.

RINACA ZULEIKA, Hope. *Plate 14, fig. 3* (Trans. Linn. Soc., Lond., XIX, p. 132, pl. 11, fig. 5, 1845).

This species has been recorded from Sylhet, Sikkim, and Simla; the Indian Museum possesses moths from Sikkim, also a single chrysalis case, but no cocoon. Rondot (*L'Art de la Soie*, II, 1887, p. 205) writes that the cocoon is reticulated and without economic value. According to Möller, the caterpillars feed in Sikkim upon the plants *Actinodaphne sikkimensis* and *Acer caudatum vel campbellii*. According to Mr. A. V. Knyvett, the caterpillar is to be found at an elevation of about 7,000

feet in Sikkim through October and November. It spins a rough open cocoon on the ground at the foot of the food plant, the moth emerging in the following August.

The figure is from a specimen determined by Mr. H. J. Elwes.

BRAHMÆA CERTHIA, Fabr. *Plate 15, fig. 1* (Ent. Syst. iii, I, p. 412, 1793).

This species is represented in the Museum Collection by specimens from Sikkim and Shillong. Nothing seems to have been recorded of its habits or development. Three closely allied forms—*B. whitei* Butler, from North-West India, *B. conchifera*, Butler, from Sylhet and Darjiling, *B. wallichii*, Gray, from Assam and Nepal—have been figured by Butler (Ill. Typ. Lep. Het. B. M. V, pl. 95, figs. 1, 2, 3, 4, 5, and 6). They appear to be so closely related to *B. certhia* as to be scarcely distinguishable from it. A fourth form—*B. rufescens*—Butler, from North-East Bengal, has been described (Ann. Mag. N. H. 5, VI, p. 62, 1880) as related to, and in some respects intermediate between, the others. It seems most convenient to await further observation on the habits and life histories of these insects before endeavouring to separate them into distinct species.

The figure of *B. certhia* is from a specimen determined by Mr. H. J. Elwes.

THEOPHILA HUTTONI, Westw. *Plate 15, fig. 3.*

This is a bivoltine species, which is common upon wild mulberry trees on the lower slopes of the North-West Himalayas. The caterpillars of the first generation, according to Hutton (Trans. Ent. Soc., Lond. , 3, ii, 1864—66 ; and Journ. Agri. Hort. Soc., Ind., III, 1871), appear about April, and the cocoons are formed in May and September respectively. The insect hibernates in the form of eggs glued on to the bark of its food plant. The cocoon is whitish in color and of soft loose consistence, not unlike the cocoons of some Bengal *Bombyx* silk worms, but much less compact ; it is formed between the leaves of the food plant. The silk is of excellent quality, and, according to Cope (Rondot, *L'Art de la Soie*, II p. 6), can be reeled ; so, if it could be obtained in any considerable quantities, there is little doubt but that it would be of value. Hutton's attempt, however, to cultivate it for commercial purposes proved unsuccessful, as the worms were too restless to submit to domestication in the house, and when left at liberty upon the trees were so much attacked by birds and predaceous insects as to render the yield of silk unprofitable. It is possible that the restlessness exhibited by the worms, when under cover, may have been due to want of the moisture to which they are ordinarily exposed on the hill slopes ; this having proved to be the case with tusser

(*Antheræa mylitta*) whose larvæ can only be raised in captivity when they are frequently watered (see footnote to page 160 of the first volume of these *Notes*). Even if this should turn out to be the case, however, with *T. huttoni*, it would seem of doubtful utility to employ mulberry leaves for rearing it, when they might with no greater expenditure of labor be utilized for rearing one of the *Bombyx* varieties which are already domesticated and which produce a silk whose commercial value is undoubted.

The figure of the larva is copied from a colored drawing prepared by the Museum artist under the direction of Mr. Wood-Mason.

Connected with *Theophila huttoni* are several forms which are so closely allied to it as to make it very doubtful to what extent they can reasonably be looked upon as distinct. They are the following :—

(1) *Theophila religiosa* (=*Bombyx religiosa*, Helfer, Journ. As. Soc. Beng., Vol. VI, p. 41, 1837).—This insect feeds upon the Pipal tree (*Ficus religiosa*) in Assam. Helfer originally described it, without seeing the insect, from a figure which was sent to him, and Moore (Cat. Lep. Mus. E. I. C., p. 381, 1858) writes : "After examination of typical specimens of *B. huttoni*, and comparing them with the descriptions of Dr. Helfer's *B. religiosa*, I am inclined to believe that they are one and the same species." This form therefore may be neglected.

(2) *Theophila bengalensis* (Hutton, Trans. Ent. Soc. Lond., (3), ii, p. 322, pl. 19, fig. 5, 1864—66; and Journ. Agri. Hort. Soc. Ind. iii, 1871, p. 125).—This form feeds upon the *Artocarpus lacoocha* tree, in Lower Bengal, and has been also found at an elevation of 2,000 feet in Sikkim upon *Artocarpus chaplasha* (see page 200 of Vol. I of these *Notes*). The moth and cocoon closely resemble the typical *T. huttoni* from the North-West Himalayas, but the larvæ, as figured by Hutton, differ from *T. huttoni* larvæ both in being greyish white, instead of yellow mottled with brown, and in having somewhat smaller spines. If this difference should prove constant, *T. bengalensis*, feeding as it does upon a different plant and living in a different locality, might be considered to constitute a distinct species. For the present, however, it seems most convenient to look upon it as a variety only; and this view is supported by the fact that the form which has been described as *T. affinis* is to a certain extent intermediate between *T. huttoni* and *T. bengalensis*.

The figure of the larva (Plate 15, fig. 4) is copied from a colored drawing prepared by the Museum artist under the direction of Mr. Wood-Mason.

(3) *Theophila affinis*, plate 15, fig. 2 (Hutton, Journ. Agri. Hort. Soc. Ind. III, p. 125, 1871).—This form was described by Hutton as resembling *T. huttoni* in shape, coloration and marking, and differing from it only in its smaller size and in being polyvoltine. In Chota Nagpur the caterpillar feeds, like *T. bengalensis*, upon the *Artocarpus*

lacoocha tree, but Hutton succeeded in rearing it upon mulberry. In the Indian Museum are moths and cocoons of this form from Gobindpur; also a moth which is thought to be Hutton's type from Chota Nagpur; they are indistinguishable from moths of *T. bengalensis* from the neighbourhood of Calcutta. There is also a carefully colored drawing made by a Native artist in the Museum, of a full grown larva from Gobindpur, showing the yellow and brown markings and the prominent spines which are supposed to be characteristic of *T. huttoni*. *T. affinis*, therefore, may be looked upon as intermediate between *T. bengalensis* and *T. huttoni*, and is consequently a variety of the latter.

The figures of the moth and of the cocoon are from specimens in the Museum Collection; that of the larva is copied from a colored drawing made by the Museum artist under the direction of Mr. Wood-Mason; the cocoon is from a photograph taken by Mr. Wood-Mason.

(4) *Theophila sherwilli* (=*Bombyx sherwilli*, Moore, Trans. Ent. Soc. Lond. 3, II, p. 423, pl. XXII, fig. 1, 1864—66; also Hutton *loc. cit.*, p. 324).—This form was described from a moth said to have been obtained in the Eastern Himalayas; nothing, however, has been recorded of its habits or transformations. The original figure and description of the moth would answer completely to a large specimen of the variety *T. bengalensis*, with the exception of the black tip to the abdomen which *T. sherwilli* is represented as possessing. In the absence, therefore, of further information, this form may be looked upon as a somewhat exceptionally marked specimen of *T. huttoni*, var. *bengalensis*.

Trilocha varians, Walker. *Plate 15, fig. 5.*

This small species is common all over India and Ceylon; it spins a minute but compact cocoon of yellowish silk between the leaves of the trees upon which it feeds. It is fairly common, but the cocoons are not found in any large quantities together, and are far too small to make it worth while to collect them individually. In Calcutta the moths are often attracted by lamps into houses in the cold weather and the larvæ have been reared in the Indian Museum upon the leaves of Bukool tree (*Mimusops elengi*). According to Hutton (Tr. E. S. III, 2, p. 331, 1864–6), Grote found it in February and March in Calcutta feeding on *Trophis aspera*, *Ficus indica*, and *Ficus religiosa*, while in Madras Elliot found it upon *Ficus religiosa*; and according to Moore (Lep. Ceyl. II, p. 136) Thwaites found it in Ceylon upon *Artocarpus integrifolia*. Nothing further seems to have been recorded of its life history, but from the fact of the moths and larvæ being found in the middle of the cold weather it would seem likely to be a polyvoltine.

The figures are from specimens reared in the Indian Museum.

TRILOCHA ALBICOLLIS, Walker.

Larvæ of this species were found by Forsayeth in August, feeding upon Pipul (*Ficus religiosa*) in Mhow, the moths emerging the same month (Trans. Ent. Soc. Lond. p. 408, 1884). Forsayeth's description and figures of the various stages of the insect agree very closely with the *T. varians* of Calcutta, and it would seem by no means improbable that the two forms are little more than varieties of each other. A third species—*Trilocha cervina*, was described by Walker (Brit. Mus. Cat. Lep. Het. xxxii, p. 489, 1865) from India; but no particulars are given beyond a bare description of the moth. The precise locality is unknown, and there are no specimens in the Indian Museum; so, the form must either be extremely rare or identical with one of the better known species.

OCINARA LIDA, Moore.

This species was originally described (Cat. Lep. Mus. E. I. C., p. 381, 1858) from Java, and an account of its habits was subsequently given (Trans. Ent. Soc. Lond. 3, II, p. 326, 1864—66) by Hutton, who named it in the first instance *O. moorei*, but afterwards recognized its identity with *O. lida* of Moore (Journ. Agri. Hort. Soc. Ind. III, p. 125, 1871). Hutton found it between 5,000 and 6,000 feet elevation in Mussoorie in the North-West Himalayas, where it feeds upon the leaves of *Ficus venosa*, and spins a small white oval cocoon. The cocoon is generally enveloped in a leaf, and covered with loose silk; it is to be found both in May and August, and Hutton supposed that at least two, and perhaps three or four, generations are gone through in the year. He considers the cocoon too small to be of any use. The larva is rough and resembles the bark so closely as to be very difficult to be distinguished from the latter upon the twigs to which it clings.

OCINARA LACTEA. *Plate 10, fig. 3* (Hutton, Trans. Ent. Soc. Lond. 3, II, p. 382, 1864–66).

This species was found by Hutton feeding with *O. lida* upon *Ficus venosa* in Mussoorie. The two forms are evidently closely allied and have very similar habits, but Hutton was of opinion that they are distinct, and as there are no satisfactory specimens of *O. lida* in the Indian Museum, it has not been possible to compare them. *O. lactea* is represented in the Museum collection by specimens from Sikkim and Kulu, as well as from Mussoorie; so, it is probable that the species extends throughout the Himalayas, though it is too rare and the cocoons are too small for it to have any value as a silk producer. The figure of the moth is from Captain Hutton's specimen in the Indian Museum; that of the larva is after Captain Hutton's figure in the Trans. Ent. Soc. Lond.

Ocinara comma (Hutton, Trans. Ent. Soc. Lond. 3, II, p. 330, 1864—66).

In the Indian Museum are moths which are thought to be Hutton's type specimens of this species from Dehra Dun (2,300 feet elevation in the North-West Himalayas), where, according to Hutton, they are found upon mango trees. They are very similar in appearance, and seem to be closely allied to *O. lactea*.

Ocinara diaphana, Moore.

This species was described by Moore (Descr. Ind. Lep. Atk. I, p. 83, 1879) from the Khasia hills in Assam. Nothing seems to be known about it beyond Moore's note that the male moth differs from *O. lactea* of Hutton "in the absence of the black markings on the forewing and on the abdominal margin." These appear to be characters of very secondary importance, so it may reasonably be inferred that, like *O. comma* and *O. lida*, it is very closely related to *O. lactea*.

Other Indian Bombycidæ.

Aristhala sikkima (Moore, P. Z. S. 1879, p. 406, pl. 33. fig. 3) from Sikkim, *Aristhala thwaitesii* (Moore, Lep. Ceyl. II, p. 136, pl. 33, fig. 2, 1882 from Ceylon, and *Primosticta fenestrata*, Butler (Ill., Typ. Lep. Het. B. M. VI, p. 20, pl. 106, fig. 5, 1886) are usually included in the family of *Bombycidæ*; so, they are noticed here, though nothing is known of them beyond the bare descriptions and figures which have been published of the moths. There are no specimens of them in the Indian Museum, and it is even doubtful whether they spin cocoons; so, they may be neglected in considering the silk-producing species which are to be found in India.[1]

[1] The species—*Hanisa subnotata* (Walker, Journ. Linn. Soc. Lond. III, p. 188, 1859; and Moore, P. Z. S., 1879, p. 406)—given erroneously in the Catalogue of the Moths of India as occurring both in Singapore and India, has only as yet been recorded from Singapore; so, it does not enter into the geographical area under consideration in this paper.

Govt. of India Central Printing Office.—No. 222 R. & A.—21-9-91.—1,000.—F. J. B.

Vol. II.] [No. 3.

INDIAN MUSEUM NOTES.

WHITE INSECT WAX IN INDIA.

[*With one Plate.*]

Preliminary.

In the early part of 1891 the Trustees of the Indian Museum undertook, at the suggestion of the Government of India in the Revenue and Agricultural Department, to furnish a report upon the subject of white insect wax in India. Attention had previously been drawn to the subject by the authorities of the Royal Botanical Gardens at Kew, as there is said to be a considerable demand for the wax owing to its property of "breaking the grain" of otherwise crystalline substances and thus rendering them suitable for candle-making. The following report therefore has been drawn up in the Entomological Section of the Indian Museum, and is founded, partly upon the specimens and replies furnished by the Forest Officers of the Central Provinces and Bengal, in answer to a circular letter addressed to them by the Inspector General of Forests, and partly upon information gathered from specimens, already preserved in the Museum collection, and from the papers previously published upon the subject. Help in the chemical and botanical examination of the specimens has been kindly afforded by Mr. T. H. Holland of the Geological Survey and Dr. D. Prain of the Botanical Gardens.

The occurrence of the insect in India.

The white wax of commerce is produced by one of the Coccidæ insects, known to entomologists as *Eriocerus pela*. This insect has long been cultivated in China, where it yields a large amount of wax, which is used chiefly in candle-making, though the extent of the industry is said to have fallen off considerably of late years, owing to the introduction into China of kerosine oil, which has largely taken the place of the candles previously in use.[1] So far as our present information goes, the insect which produces white wax in China does not occur in India, but it has long been known that an insect, closely related to it, is occasionally to be met with, especially in the jungles of Southern and Central India. This insect is the one referred to by Dr. Watt in his paper[2] on candles. It was originally described in the year 1790, under the name of *Coccus ceriferus*,[3] and is known to modern entomologists as *Ceroplastes ceriferus*.[4] It produces a

[1] Hosie: *Three Years in Western China*, London, 1890.

[2] *Vide* Dr. Watt's Dictionary of the Economic Products of India.

[3] J. Anderson: *Monographia Cocci ceriferi*, Madras, 1790.

[4] Signoret: Ann. Soc. Ent. France (5), vol. ii, p. 40 (1872).

certain amount of wax, but is very rare and has never been utilised commercially. It was shown too, by Dr. Pearson,[1] as long ago as the year 1794, that its wax is not altogether suitable for candle-making, as both the wax itself, and also mixtures of the wax with olive oil, when made into candles, burn with a dim smoky light, and give off a resinous odour.

A good deal of confusion in our knowledge of the matter has arisen from the fact that a totally distinct insect, which is known to entomologists as *Phromnia marginella*, produces considerable quantities of a white sugary secretion, which has no connection with wax, but on the contrary, is totally useless for candle-making, though it has sufficient superficial resemblance to white wax to have often been mistaken for it. This fact not only accounts for many of what would otherwise appear to be hopeless contradictions in the reports of different observers on the subject, but has also led to the supposition that white wax is to be procured in India in very much larger quantities than is really the case. The mistake seems to have originated in the figures and description given of the White Wax Insect of China, in the year 1797, by Sir George Staunton,[2] this being the origin of the more elaborate figures and description published in Westwood's edition of Donovan's Insects of China[3]; in each case an insect closely allied to *Phromnia marginella* being erroneously described as the White Wax Insect of China. The error was very clearly pointed out in the year 1843 by Captain Hutton,[4] but the mistake, once made, seems to have cropped up again and again, the belief in it being further extended by some observations made, about the year 1850, by Dr. Charles Murchison.[5] Dr. Murchison examined the flocculent appendages attached to the bodies of the larvæ of an insect, which, from his description, seems to have belonged either to the species *Phromnia marginella* or to something very much like it, and he found that these appendages consisted of what he believed to be wax. An examination, recently made by Mr. Holland of the flocculent appendages of larvæ of *Phromnia marginella* preserved in the collections of the Indian Museum, has not confirmed Dr. Murchison's observations.[6]

[1] "Observations and experiments on a Wax-like Substance resembling the *Pela* of the Chinese, collected at Madras by Dr. Anderson, and called by him, 'White lac'" : Philos. Trans., Royal Soc. Lond., vol. 84, p. 383 (1794).

[2] Embassy to China, London, 1797, vol. i, p. 353.

[3] London, 1842, pl. 17.

[4] Journ. As. Soc. Bengal, vol. xii, p. 898 (1843).

[5] Proc. Linn. Soc. Lond., vol. ii, p. 379 (1848—55).

[6] The flocculent matter attached to the specimens preserved in the Indian Museum collection consists of fibrous matter which not only refuses to melt, but, on the contrary, decomposes when heated, does not dissolve in naphtha, and under the microscope appears to consist of minute curved filamentous particles. That observed by Dr. Murchison, on the other hand, melted on heating into transparent colourless wax, which was readily soluble in naphtha and which crystallised on cooling, into acicular crystals, arranged in stellate masses, this form of crystalisation being one readily observable in the wax secreted by *Ceroplastes ceriferus*.

But even in the event of the flocculent appendages being found in some cases to contain wax, the quantity in which they occur is so small that they can be of no practical value; and the only reason for calling attention to them in this notice is owing to the fact that the sugary secretion, which is produced in considerable quantities by the insect, is liable to be confounded with the flocculent matter with which the larvæ are clothed. The scarcity of the White Wax Insect in India is remarkably illustrated by the material which has recently been collected by the officers of the Forest Department. This material, which has been forwarded to the Indian Museum, consists of four specimens, three of them connected with *Phromnia marginella*, while the fourth specimen is the only one which represents the White Wax Insect, and even it comprises only about a score of individuals, which would altogether yield but a minute quantity of the wax.

Phromnia marginella is so entirely different, both in its habits and appearance, from the White Wax Insect, *Ceroplastes ceriferus* that it is easy in most cases to make out which of the two species is referred to in the papers which have been published on the subject. In order, therefore, to prevent further confusion between the two insects, they are both included in the following *résumé*, which is accordingly arranged under the headings of *Ceroplastes ceriferus* and *Phromnia marginella*.

CEROPLASTES CERIFERUS.

The specimens of *Ceroplastes ceriferus* that have been forwarded to the Museum in connection with this investigation consist of about a score[1] of scales found by Mr. W. P. Thomas, Deputy Conservator of Forests, Hoshangabad, Central Provinces. Mr. Thomas found them in February 1889 on one of the hill spurs of the Panchmari range near Mogra, on saplings of *Terminalia chebula*, *Buchanania latifolia*, and *Terminalia tomentosa*,[2] and he reports that the insect was very scarce and only found after long search, while the natives knew nothing at all about it. The wax has been kindly examined by Mr. T. H. Holland, who reports on it as follows:—

"The wax occurs on the twigs in small mounds of dull, buff colour and puckered surface, apparently from drying. Under the thin crust the material is light pink in colour and presents a waxy lustre, with, also, a pleasant smell.

"The wax melted at 140° F. (60° C.) to a clear liquid, and, on cooling, produced microscopic, spherulitic growths of radially arranged, polarising crystals.

"About 20 per cent. of the material dissolved in cold absolute alcohol; but it was almost completely soluble in boiling alcohol, from which it is again precipitated as a

[1] Of these three have been preserved in the collections of the Indian Museum for reference.

[2] The leaves sent with the specimens have been kindly examined by Dr. D. Prain, wh identifies them as belonging to the species *Buchanania latifolia*, Roxb., and *Terminalia chebula*, Roxb.

white opalescent cloud on addition of cold water, and is not again cleared by boiling. The wax is soluble in benzol.

"The specific gravity at 84°F. was 1·04 (determined by suspension in a solution of salt).

"As an average of two determinations, the amount of moisture was found to be 10·4 per cent., but the discrepancy between the two results (9·8 and 11·0) was no greater than one would anticipate from the appearance of the specimens.

"By the action of strong nitric acid the wax was decomposed to a yellow solution, with a faint aromatic smell; but the quantity at my disposal was too small to determine the products of oxidation, which might be of interest to compare with the results obtained by a similar treatment of *Pela*, the Chinese wax investigated by Buckton. The few determinations made do not closely agree with the properties of cerotate of ceryl $(C_{59}H_{108}O)_2$ the principal constituent of Chinese wax."

Ceroplastes ceriferus was originally described in the year 1790 by Dr. Anderson,[1] who found it in Madras. It was afterwards figured and described by Westwood,[2] whose description, however, as quoted by Signoret,[3] is confined to the mass of white wax, which is irregularly hemispherical in shape, of the size of a large split pea, encloses the shell of the female insect, and was originally found in Madras on the twigs of a species of *Celastrus*, which is referred to as *Celastrus ceriferus*. Dr. Anderson's original paper has not been found, but Dr. Pearson[4] gives a detailed account of Dr. Anderson's white wax, which was submitted to him for examination. According to Dr. Pearson, Dr. Anderson procured some pounds' weight of the wax and sent it in the year 1792 to the Royal Society, at the same time complaining that the children, whom he employed to gather it, were tempted by its sweetness to eat so much of what they collected as materially to diminish the produce of his trees; the wax was also believed to possess medicinal qualities. Pearson found that the raw wax in its dry state has a saltish and bitterish taste, and in the mouth is soft and tough, having thus lost the sweetness which characterises it in its fresh state. It contains a large proportion of a watery liquid, which has a slightly saltish taste. In its raw state the wax is as light, or lighter than as, bees' wax, but, after being melted and purified by straining, it sinks in water, and is therefore specifically heavier than most bees' wax. Two thousand grains of the raw article, when melted and purified by straining through fine cloth, produced 1,220 grains of wax. This purified wax was yellow in colour, hard and brittle, with scarcely any taste, melted at a temperature of between 145° and 146° Fahrenheit, was soluble in volatile oil of turpentine, and partially soluble in alcohol. Candles, with cotton wicks, were made of the purified wax; they burnt more rapidly, but were thought to give less light than wax candles of the same size; they also smoked and produced a resinous smell. Saturated

[1] *Monographia cocci ceriferi*, Madras, 1790.

[2] Gardener's Chronicle, 1853, page 484.

[3] Ann. Soc. Ent. France, ser. 5, vol. ii, page 40.

[4] Philos. Trans. Royal Soc. London, vol. 84, page 383 (1794).

solution of the wax in alcohol, when spread upon surfaces of paper, cloth, and wood, left, on drying, a thin coat of resinous matter, which, however, was not bright or smooth, so this solution does not afford a good varnish. The wax, when united with olive oil, became whiter in colour, and as soft as bees' wax, but it burnt, as before, with an unsteady light, smoking and producing a resinous smell. Dr. Pearson concludes that bees' wax and white wax are homogeneous substances, formed of very much the same constituent parts, the proportion of these parts however being very different in the two substances.

According to an account published in the Journal of the Agri.-Horticultural Society of India, Volume V, page 76 (1873—78), the species was again brought to notice in the year 1875, when Mr. Peppe forwarded specimens which he had found upon *pepul* twigs in Chota Nagpur, and noticed that he had also found it upon mango and *arjoon* trees. The specimens were identified by Mr. F. Moore, who also had the wax analysed, the following being an abstract of the analysis furnished by him :—

" Wax, of a dull opaque pale brown colour. The outer shell, darker and somewhat translucent. Moderately hard and brittle, of somewhat pleasant smell. On crushing in a mortar minute drops of water made their appearance. On heating it spluttered much, owing to the disengagement of steam. At 55°C. it melted to a clear liquid with a slightly flaky deposit. 0·5868 grm., burnt, left an unweighable trace of ash. Absolute alcohol dissolved 34 per cent. Boiling absolute alcohol dissolved 98·08 per cent. In benzine the wax was very easily soluble, with the exception of a little brownish matter. In ether it dissolved freely, but not entirely. In essence of turpentine, and also in carbonic sulphide, it was very sparingly soluble. The percentage of water varied from 11·02 to 13·16 in the specimens examined. Organic analysis gave, in 100 parts of the wax, carbon from 78·57 to 78·79, hydrogen 13·46 to 13·08, oxygen 7·97 to 8·13, and the wax therefore was supposed to consist of a compound of 13 atoms of carbon, 26 atoms of hydrogen, and 1 atom of oxygen."

The insect does not seem to have been again noticed until 1889, when a few specimens were sent to the Indian Museum from the Kangra Valley, where they were found in small numbers upon tea bushes. In this case the specimens were identified by Mr. W. M. Maskell, but nothing was ascertained regarding the habits or transformations of the insect.

PHROMNIA MARGINELLA.

There is some confusion in the synonymy of the insect which produces the white sugary secretion in India, but it is undoubtedly the *Cigale phalenoide-verte*, described and figured in the year 1788 by Stoll. (*Cigal*, p. 50, pl. 11, fig. 54), and quoted in 1791 by Olivier (*Encyclop. Meth. Ins.* vi, p. 575, No. 43), under the name of *Fulgora marginella*, also in 1862 by Stål (Öfvers. K. Sv. Akad. Stockholm, xix, p. 490), under the name of

Phromnia marginella.[1] In the Asiatic Researches, (Volume 14, p. 182, published in Calcutta in the year 1822, Major-General T. Hardwick describes and figures an insect under the name of *Chermis mannifer*,[2] which is probably identical with *Phromnia marginella*, Oliv. But by far the best account of the insect is given by Captain T. Hutton in the Journal of the Asiatic Society of Bengal, vol. xii, p. 898, Calcutta, 1843, where the name attributed to the species is *Flata limbata*.

The insect was found by Captain Hutton on the lower slopes of the Mussoorie Hills in the North-West Provinces, the sugary secretion being only obtainable throughout the dry weather from January to June, as it gets washed away by the first heavy rain that falls upon it. According to Captain Hutton the eggs hatch in December, and the larvæ cluster like sheep upon the food plant. They feed by sucking up the juices of the leaves, and moult several times, gradually increasing in size until the setting in of the rainy season in June, when winged imagos begin to emerge. In the imago the front wings are grass green, with anterior margins red, the posterior wings are milk white, the body is greenish, and the abdomen is generally covered up with white flocculent matter similar to what is found upon the larvæ. The eggs are laid in considerable numbers in the bark of the twigs, a slight swelling of the wood often taking place where the eggs have been laid. The imagos

[1] In his *Entomologia systematica* published in the year 1794, Fabricius notices that his *Cicada limbata* from South Africa is identical with Stoll's species from Ceylon. There would seem, however, to be some doubt upon this point owing to the geographical position of the two localities. The references to *Cicada limbata* are as follows:—

Cicada limbata, Fabr., Sp. Ins. ii, p. 322, No. 3 (1781).
„ „ „ Ent. Syst. iv, p. 27, No. 3 (1794).
Flata limbata, Fabr. Syst. Rhyn., p. 46, No. 6 (1803).

In the British Museum Catalogue of Homoptera, published in 1851, further confusion has arisen between *Phromnia marginella* and *Flata nigricornis*. The latter is a species which differs very markedly from *Phromnia marginella* in having the forewing brown with black dots along the posterior margin, instead of its being bright green with anterior margin red, as in *P. marginella*. As far as has been made out, the references to *Flata nigricornis* are as follows, though the diversity in the localities from which it is recorded, are so remarkable as to seem to point to some confusion in identification:—

Flata nigricornis, Fabr., Syst. Rhyng., p. 45, No. 1, 1803, America.
„ „ Donov. Ins. China, p. 40, pl. 17, 1842, China.
Cigale portelaine, Stoll., Cigales, p. 101, pl. 26, fig. 145, 1788, Africa.
Fulgora pallida, Oliv., Encyclop. Meth. Ins. vi, p. 575, No. 42, 1791, Africa.

[2] This insect was found upon a species of *Celastrus* in the neighbourhood of Pachmari and is referred to by Blanchard (Bull. Soc. Zool. de France, 1883, p. 277) as synonymous with the Scale insect *Coccus manniparus* described by Ehrenberg (Hemprich and Ehrenberg's *Symbolæ physicæ*, vol. iii, pl. x, 1829) as responsible for the sugary secretion which is collected at the present day by the Arabs from the *Tamarix gallica* plant in Sinai, and which is supposed to be identical with the *manna* eaten by the children of Israel in the wilderness. A comparison however of the figures given by Ehrenberg and Hardwick shows clearly that the insects they respectively describe are totally distinct from each other.

move but little from the food plant and often live on until after their eggs have hatched in the cold weather. The larvæ, and to a less extent the imagos, are covered with masses of white flocculent matter, which is thought to be secreted by small glands distributed over the abdomen, and opening by minute pores in the integument. The sugary matter is said to be excreted in a liquid state by the larvæ, and drops on to the leaves, where it hardens. Little is known of the method of its origin, but it is likely to be secreted by the large gland-like organs which are situated on either side at the extremity of the abdomen in the larvæ (Fig. 2 *d*).

The specimens, furnished by the Forest Department, consist of larvæ and pieces of sugary secretion found by Mr. W. P. Thomas, in February 1889 in the Narsingpur district of the Central Provinces. The insects were found on the green succulent coppice shoots of *Elæodendron roxburghii*, growing on elevated ground, and the sugary secretion was found coating the leaves below where the larvæ were feeding. Mr. Thomas ascertained that the *Koorkoos* and other tribes know the insect, but make no use of the sugary secretion, which they say has a narcotic effect when eaten. To this Mr. R. H. E. Thompson adds that he has found the insect both in several of the warmer valleys of the North-Western Himalayas, and also at elevations, ranging from a thousand to fifteen hundred feet above sea-level, in the forest-clad country of the Central Provinces to the south of the river Ganges. He notices that in Garhwal the natives eat the sugary secretion and call the insects *Dhaberi, i e.* "sheep," on account of their habit of clustering together and jumping away when disturbed.

In the collections of the Indian Museum are representatives of the species from Dehra Dun, Sikkim, Naga Hills, Cachar, Margherita (Assam), Tavoy, and Siam.

CALCUTTA :
6th May 1891.

E. C. COTES,
Indian Museum.

Government of India Central Printing Office.—No. 248 R. & A.—5-10-91.—1,000.—F. T. B.

Vol. II.] [No. 4.

INDIAN MUSEUM NOTES.

THE LOCUSTS OF BENGAL, MADRAS, ASSAM, AND BOMBAY.

[*With one plate.*]

A report has recently been issued on the subject of *Acridium peregrinum*, which is *par excellence* the locust of North-Western India. In gathering together the materials upon which this report was based, information was obtained concerning other locusts which have from time to time proved destructive in Bengal, Madras, Assam, and Bombay. The present report, therefore, is intended to record what has been ascertained about these other locusts. To complete the subject, a short *résumé* has been added of what is known of the chief locusts that are found in other parts of the world.

The principal sources of information have been the reports and specimens furnished by the Revenue and Agricultural Department of the Government of India and by the Agricultural Sections of the various Local Governments in India, but reference has also been made to the more important papers published in the United States, Algeria, and Europe, on the subject of locusts.

A short preliminary sketch of a portion of this paper was submitted in November 1889, since which date a good deal of fresh information has accumulated.

The writer takes this opportunity to acknowledge the help which has been most kindly afforded by Dr. Henri de Saussure in identifying species.

Locusts in Bengal.

In Bengal, it is chiefly in the comparatively dry country to the west that locusts appear, though occasionally flights traverse the whole of Bengal and even penetrate into Assam. These flights are composed of insects belonging to very different species, and there are at least three distinct sources from which they come. In the first place, flights of *Acridium peregrinum* occasionally penetrate from the North-West frontier into Bengal. This was the case both in 1863 and 1890. An account of what is known of these flights is given in the report on *Acridium peregrinum*. Secondly, flights occasionally penetrate into Bengal from

the highlands of Southern India, and in these cases they probably belong to some of the various species which occasionally prove destructive to crops in the Madras and Bombay Presidencies and in the Central Provinces[1]. This was probably the case with the flights of 1877 and 1878, notices of which are given below. Thirdly, flights are believed occasionally to arise locally[2]. This is probably what happened in 1881, when a flight invaded the Manbhoom district from hills in Hazaribagh. No information has yet been obtained on the subject of the identity of these local species; they may, perhaps, in some cases have belonged to the species *Acridium succinctum*.

Whatever the origin of the flights, the injury done by them in Bengal has never been very extensive, and no special measures have been adopted against them. According to a report, dated 14th July 1883, by Mr. W. H. Grimley, low-class Mahomedans and Hindoos are said to store the locust, both for food and also in order to extract an oil believed to be useful in the treatment of gout and rheumatism, but upon the whole the pest is of no very great importance.

The following is an abstract of the records of the invasions of locusts other than *Acridium peregrinum* in Bengal :—

In 1862 locusts visited Monghyr and did considerable damage to the crops (Report, dated 26th June 1890, by the Commissioner of Bhagulpore and the Santhal Parganas). We have no clue to the identity of this locust, except that in this, as in the following instances, the year was not one in which *Acridium peregrinum* was prevalent in its regular breeding grounds in North-Western India; so, it is pretty certain that the species was not *Acridium peregrinum*. In 1865 locusts passed over Manbhoom, without, however, doing serious damage to the harvest (Hunter's Gazetteer); they also appeared in this year in Durbhunga (Mr. W. H. Grimley's Report, dated 14th July 1883).

In 1873 they are said to have passed over part of the Burdwan district (Commissioner of Burdwan's Report, dated 28th April 1890). In 1877 they visited Monghyr and did considerable damage to the crops (Commissioner of Bhagulpore and the Santhal Parganas' Report, dated 26th June 1890); a flight was also observed in this year in the neighbourhood of Patna (Mr. Scott's Note), and a specimen obtained from it on 1st July

[1] The chief of these species are said to be *Acridium succinctum*, *Pachytylus cinerascens*, *Acridium aeruginosum*, *Acridium melanocorne*, *Tryxalis turrita*, *Hieroglyphus furcifer*, *Caloptenus erubescens*, *Caloptenus eruginosus*, *Cyrtacanthacris ranacea*, *Oxya furcifera*, *Euprepocnemis bramina*, *Oxya velox*, and *Chrotogonus* sp.

[2] With regard to the origin of locusts in the Durbhunga district, the Commissioner of Patna reported (16th July 1890) that the swarms were said to come from the Darjeeling Hills, though some authorities were of opinion that they breed in the large tract of grass jungles that fringe the river Ganges. The supposed inability of these local species to cross any large body of water is noticed in this report.

1877 by Mr. Scott has recently been identified by Dr. Henri de Saussure as closely allied to the species *Acridium succinctum*. In 1878 locusts which had probably strayed from the flights then prevalent in the Madras Presidency, appeared in the Patkour subdivision of the Santhal Parganas from the south, but did not alight (Commissioner of Bhagulpore and the Santhal Parganas' Report, dated 26th June 1890). They also appeared in small numbers in Orissa, but did no appreciable damage (Babu C. N. Ghose's Report, dated 20th February 1890), and passed over Chumparan (Mr. W. H. Grimley's Report, dated 14th July 1883). In 1881 a flight of local origin appeared in Manbhoom and did some slight injury. The following is an extract from a report, dated 14th July 1883, by Mr. W. H. Grimley on the subject :—

"The subdivisional officer of Gobindpore, in the district of Manbhoom, reports that in June 1881 a swarm of locusts visited the subdivision, extending over an area about ten by five miles, and about a quarter of a mile high. They are said to have emerged partly from the Lagoo Pahar, and partly from the Paresnath hill, in the Hazaribagh district. Considerable numbers alighted on the young *dhan* seedlings, Indian-corn and *gondlee*, which had just sprouted, and destroyed them. Much damage is said to have been caused by the insects, but they did not stay for more than four or five hours." . . . . The insects were "about four inches long with heads and wings of a red colour. A large number were destroyed by the people, and some were eaten up by the kites and crows, also by low-caste aborigines. They are said to possess the flavour of shrimps or lobsters."

Locusts in Madras.

Both in 1889 and 1890 flights of *Acridium peregrinum* from North-Western India penetrated into the Madras Presidency, and did slight damage over considerable areas; generally speaking, however, the locusts, which occasionally prove destructive to crops in Madras, are of more local origin. There does not appear to be any one species which is invariably complained of, but in years of drought numerous species, which are ordinarily present in small numbers, multiply so as to injure the crops, some of them, however, being much more destructive than others. An account of what has been ascertained about the flights of *Acridium peregrinum*, which penetrated into the Madras Presidency in 1889 and 1890, has been given in the report on that species. The following is a summary of what is known of the other species of locusts that have proved injurious in the Madras Presidency :—

In 1866, a year of scarcity, locusts appeared in one of the villages of the Chingleput district, in the Madras Presidency, and did some damage (Mr. W. R. Robertson's Report, dated 23rd April 1883). No information has been obtained as to the identity of this insect.

In 1878, the last year of the great South Indian famine, locusts invaded the whole of the Madras Presidency, not generally doing a great amount of injury, though in some cases the injury was sufficient seriously

to increase the distress caused by the famine. The young locusts began to appear in January, and were found in great numbers in different districts from that date on till September and October, the earlier swarms being found in the west and south of the Presidency, and the later ones in the north and east. The winged locusts were first observed in the end of March and beginning of April in the south-west (Wynaad and Nilgiris), and they afterwards spread over the Presidency to the east and north, not finally disappearing in the north-east until about November and December. They were supposed, at the time, to have originated locally in hills and waste lands in different parts of the Presidency. The evidence, however, seems rather to point to the locusts having started, in the early part of the year, from the Wynaad and Nilgiri Hills, in the south-west, and thence to have worked their way, with the prevailing wind, over the Presidency to the north and east, occasionally stopping to feed or to deposit their eggs in the ground; for it is otherwise difficult to account for the fact of their appearing so much earlier in the south-west than in the north-east. Little is known of the life-history of the insects, but it may be noticed that locusts were observed pairing in the Salem district in the latter part of June, and also that the young locusts, which were found in the early part of May in the Udamalpet taluq were supposed to be the offspring of the large flights of winged locusts which had appeared in the preceding February in the same taluq. The connection between the autumn broods of young locusts and those which appeared in the early part of the year has not been made out satisfactorily.

Of the measures adopted against these locusts, the most successful seem to have been;—the destruction of the swarms of young wingless locusts by driving them into lines of burning straw; the preventing the flights of winged locusts from settling in the fields by lighting fires, beating drums, and waving branches and cloths in the air, as soon as a flight appeared; and the driving of the winged locusts out of the fields, when they had already alighted, by beating through the crops. It is said that in cases where winged flights were driven persistently through a number of villages, without being allowed to settle, the locusts perished without doing injury. The above account of the Madras locust invasion of 1878 is chiefly taken from the official reports preserved in the Proceedings of the Revenue and Agricultural Department of the Government of India. With regard to the identity of the insects concerned in the Madras locust invasion of 1878, nothing seems to have been ascertained at the time of the invasion, though the insects were spoken of in one of the reports as belonging to the species *Locusta migratoria*. This, however may possibly have been due to the fact that the locust of Central Europe is often referred to in old entomology books under this antiquated name; much importance, therefore, cannot be attached to the identification, and

the only clue which we possess lies in the specimens preserved in the collections of the Central Museum, Madras. From this museum a set of specimens, which are supposed torepresent the Madras locust of 1878, have been kindly furnished by Mr. Edgar Thurston. They have been identified by Dr. Henri de Saussure and prove to comprise no less than six very distinct species, which are as follows: (1) *Acridium æruginosum*, Burm., represented by five or six specimens, which vary a good deal in the arrangement of the wing markings, (2) *Acridium melanocorne*, Serv., var., (3) *Tryxalis turrita*, Linn., (4) *Mecopoda* sp., (5) *Eupropocnemis* sp., represented in each case by one or at most two specimens, (6) a specimen, in a very poor state of preservation, which belongs either to the species *Pachytylus migratorius* or to *Pachytylus cinerascens*.

In July 1890 locusts were noticed in the Ganjam collectorate, the following being the Collector's report to the Revenue Board, Madras, on the subject :—

"I have the honour to inform you that on the 24th instant I visited Purushottapur in order to see whether anything could be done to destroy the locusts reported to be doing so much mischief there.

"I had two large 'bag nets' made of bamboo matting, 15 feet long; and hoped that I might have been able to do something with them; but am sorry to say that all attempts ended in failure. I also attempted to drive the insects into trenches, but without success. The reason for the failure is, that the insects, which are of four or five different kinds, succeed in evading the net or the drive, the large ones by flying away when approached, the smaller ones by dropping to the ground and clinging there, so that nothing would remove them which would not at the same time root out altogether the crop. The number of large brown insects which seem to be really locusts is comparatively small, the great bulk are small brown and green grass-hoppers, which are in myriads. A great deal of damage has undoubtedly been done. The pest extends over about 10 square miles, chiefly in the Pubbakhandam mutah of the Berhampore taluk. Of one hundred and four villages (including Agraharams and Mokhasas) in the mutah, fifty-five are more or less affected and ten have suffered seriously.

"All the villages most affected are near the Dalibhillo Tampara, the embankment of which breached in the floods of last year and has not yet been repaired, in consequence of which a large expanse of ground, usually under water, has been lying dry. The ryots report that the insects first made their appearance in the vicinity of the Tampara, and I think it probable that they were brought out in unusual quantities owing to the unusual extent of dry ground there. Steps are being taken now to repair the embankment, and I trust that next year the Tampara will not afford so convenient a breeding ground, and that the insects will either not re-appear or do so in diminished numbers."

Specimens were forwarded to the Indian Museum and were found to consist of (1) ten adults and eight larvæ of *Pachytylus cinerascens* [1], (2)

[1] These specimens were identified by Dr. Henri de Saussure; the species is so closely allied to *Pachytylus migratorius*, which is the common migratory locust of Central Europe, that it is very doubtful as to whether the two forms are separable. Koppen indeed (*vide* Zool. Record, 1872, page 398) considers that *P. cinerascens* is only a variety of

four specimens of *Tryxalis turrita*, Linn., (3) one specimen of *Oxya velox* Burm., (4) one specimen of a species which is probably *Epacromia dorsalis* Thumb., (5) one larva of a grass-hopper probably belonging to the genus *Œdalus*. Of these the immature specimens are probably the "small brown and green grass-hoppers," alluded to by the Collector as present in myriads, while the full-grown specimens of *Pachytylus cinerascens* are likely to have been the "locusts" mentioned as present in comparatively small numbers. Now, *Pachytylus cinerascens* is one of the chief migratory locusts of Europe, where it sometimes does a great deal of damage. The insect is essentially an inhabitant of the temperate zone, and this would make it appear probable that its permanent breeding-ground lies somewhere in the Nilgiri or other hills, whence it might easily be carried upon the south-west monsoon across the presidency. The presence of nearly full-grown larvæ shows that the original flight must have remained in the district sufficiently long to have laid their eggs, and for the eggs to have hatched, and for the larvæ to have passed through most of the early stages, a process which probably occupied some months. In the Palæarctic zone *P. cinerascens* is said to lay its eggs in the autumn, the young hatching out in the following summer, but we are as yet entirely in the dark as to the habits which the insect acquires when it passes out of a temperate climate into a tropical one.

Locusts in Assam.

Assam is not generally troubled by locusts, though in the cold weather of 1890-91 a stray flight of *Acridium peregrinum* from North-Western India penetrated into it. In 1879 also both the autumn and winter crops in Nowgong were reported by the Director of Agriculture to have been largely destroyed by locusts, which were said to have come from the tall grass jungle at the base of the Khasi and Mikir Hills, where they breed permanently. Nothing is known of the identity of this

P. migratorius, and the specimens of the two forms in the Indian Museum (as determined by Dr. Henri de Saussure) seem to point to this being the case. According to the synopsis given on page 119 of Dr. Saussure's *Prodromus Œdipodiorum*, in *P. cinerascens* the male is smaller than the female, the punctation on the pronotum is somewhat coarse, the notch in the carina is well marked, and the teeth on the posterior femora are large; while in *P. migratorius* the male is much the same size as the female, and the punctation on the pronotum, the notch on the carina, and the teeth on the posterior femora are less marked. To these characteristics Mons. Frey Gessner adds that the carina on the thorax of *P. cinerascens* is elevated into a well-marked ridge, while that of *P. migratorius* is much less distinct. These characteristics however seem, in the absence of any well-marked geographical boundary between the areas in which the two forms occur, to be of scarcely sufficient importance to justify their separation into two species, this being especially the case, as Dr. de Saussure writes that the females of the two forms are often almost indistinguishable.

locust, though it may possibly have been the insect *Phymateus miliaris*, which was sent to the Indian Museum in September 1890 by General Collett with the information that it was common in the neighbourhood of Shillong. The following is taken from a report, dated 15th February 1883, by the Director of Agriculture in Assam :—

"I spent three weeks marching in the Nowgong district, and visited most of he district, except the hill tracts. The *Kakotiphoring*, or Paper grass-hopper, as the locust is called, is very well known. It is said to attain a length of six to seven inches. It breeds in the tall reed and grass jungle, especially in the jungle at the foot of the hills along the south of the district (the Khasia and Mikir Hills). The time of the appearance of the insect is in the early spring, and it continues to feed till July.

"Local visitations of locusts are common enough. I found it generally stated that they took place every two or three years. But one general invasion was well remembered everywhere; the date was 1879: it began early and ended late, so as to include both mustard and rice in the area of devastation. The mustard ripens in January.

"The direction in which the locust swarms moved was somewhat different in different places. Near the Khasia and Mikir Hills they seemed to come from the south, *i.e.* from the submontane jungle. In the Chapari Mahals, between the Kalang and Brahmaputra, the direction of their course was eastwards. They seem to have moved with great regularity from west to east along this tract, a distance of some 50 miles. The ryots, moved perhaps by rumours of the Afghan war, which had penetrated thus far, told one another that they came from Cabul. Their numbers were such that the reeds and grass of the jungle were bowed down by their weight when they alighted, and they made a clean sweep of all the fields in their way. The Mikirs and Lalungs eat locusts after parching them in the fire. Locusts can commonly be had in the month of Bohag (April-May). The only remedy adopted against locusts is one which the people appear to have invented for themselves. They sprinkle the threatened crops with water in which salt has been dissolved, and in which onions have been steeped. This remedy is said to have been effectual in 1879, after some time; probably the locusts would have moved on in any case."

Locusts in the Bombay Presidency, excluding Sind.

General.

In the autumn of 1890 flights of *Acridium peregrinum* from North-Western India penetrated into the Bombay Deccan and Konkan, and did slight damage over considerable areas. An account of these flights has been given in the report on *Acridium peregrinum*, and we are now chiefly concerned with the locusts which invaded the Presidency in 1882-83, though it should also be noticed that, according to Hunter's Gazetteer, locusts appeared in 1878 in Kolaba and damaged the cold weather crops of 1878-79, nothing further, however, being recorded about them.

In 1882-83 locusts proved destructive throughout the whole of the Bombay Deccan and Konkan, and though the identity of the insects concerned was not altogether definitely ascertained, the history of the invasion was very completely recorded in numerous official reports. The

sections, therefore, on the history of the invasion and on the remedies adopted have been taken, much of them, *verbatim* from the reports of the Bombay Government by Mr. J. Nugent, as recorded in the Records of the Revenue and Agricultural Department of the Government of India. The section on the life-history of the insect is from a report by Mr. Hatch, as reprinted in the *Indian Forester*, Volume X.

The history of the invasion.

In May and June 1882 locusts were noticed in the south-west of the Presidency (Dharwar and Kanara Collectorates), but they attracted little attention, as such swarms are annual visitors of the Kanarese forests, and neither in Kanara nor in Dharwar did they cause any material injury. With the setting in of the south-west monsoon however, they spread in flights over the Presidency, to the north and north-east (Satara, Poona, Nasik, Ahmednagar, and Khandesh), and early in the rains proceeded to lay their eggs and die. These eggs hatched in the end of July, or beginning of August, and the young locusts did a large amount of damage, over a wide area, through the months of August and September. In the early part of October, with the setting in of the north-east monsoon, the young locusts, which had by this time acquired wings, took flight and travelled with the prevailing wind in a south-westerly direction, doing some injury in the Poona collectorate as they passed. They then struck the Western Ghâts, and spread slowly over the Konkan in November, and thence travelled into the Native State of Sawantwari, and the Kanara district. During the remainder of the cold season and the hot weather (December 1882 to the end of May 1883) the flights clung to the line of Ghâts, occasionally venturing inland into Belgaum, Dharwar, the Kolhapur state, and Satara, and devouring the spring crops in the coast districts, but ordinarily returning to the vicinity of the hill ranges. With the commencement of the south-west monsoon however, in the latter part of May 1883, the flights began to move in a north-easterly direction, as they had done the preceding year, but in larger numbers.

At the commencement of the rains they began to alight in vast numbers over an immense tract of country comprising the six Deccan collectorates of Sholapur, Poona, Khandesh, Ahmednagar, Satara, and Nasik, and also in the three coast collectorates of Ratnagiri, Kolaba, and Thana. They deposited their eggs, and died, and early in August the young locusts hatched out in countless numbers, but were apparently more backward and possessed of less strength and stamina than were those of the preceding year. The unusually heavy rainfall killed vast numbers of these in different parts of the country, and elsewhere the insects seemed stunted and feeble, and grew but slowly. They were destroyed in vast numbers by the vigorous measures initiated by the officials, and were also said to be diseased and attacked by mites and *nematode* para-

sites. As late as November the mass of the young locusts appeared unable to fly and made no general movement to the south-west, as they had done the year before. The invasion was, in fact, at an end, and though (according to Hunter's Gazetteer) swarms appeared in Sawantwari in 1883-84, no further injury of a serious nature seems to have occurred.

The injury occasioned to the rain crops by the locusts was very considerable, over a great portion of the Deccan and Konkan both in 1882 and 1883. But though some relief works were started, especially in the coast districts, it was found, at the end of the invasion, that the abundance of the cold weather crops had compensated to so great an extent for the injury occasioned to the rain crop, that no widespread injury had been occasioned.

The life-history of the locust.

Mr. Hatch describes the life-history of the locust, as observed in the Konkan, as follows [1]:—

"In the Konkan locusts coupled in great numbers between the 15th May and the 15th June 1883, and died off naturally immediately after the eggs had been deposited. The eggs are deposited mostly in flat and gently sloping land of soft friable soil, rocky and sandy soil being avoided, and land which has been ploughed up, and the lee side of banks, where the soil has accumulated, are mostly selected. The eggs are piled in a small cylindrical hole, parallel to its sides, and are attached to one another by some cohesive siccable substance. Filling the mouth of the hole is a plug, consisting of a soft fibrous substance, and below it the eggs, arranged as described, averaging 70 in each hole. The holes are from 1·5 to 2 inches in depth, and in a good locality four might be found in a span. They are not easily visible, but when one is found, others are generally near it. Brushing off the loose dust and digging here and there facilitates search.

"The eggs themselves are of a dirty ochre colour, in length ·2 to ·3, and in diameter ·05 to ·08 of an inch, rounded in section, with a slight curve, and tapering very slightly towards the rounded ends. . . When fresh, the contents of the eggs are of a dirty orange colour, liquid but slightly viscous, with a somewhat acrid taste. The envelope apparently consists of two layers, the outer one coloured and tough, and the inner one white and fragile. When broken, the eggs give off an odour like a broken root. As the eggs approach maturity, they assume a distinctly greenish hue, and the young locust bursts the shell down the middle on issuing into life. I experimented on some eggs by placing them in damp and very damp soil, but the water did not affect the hatching.

"The young locusts appeared in myriads in my district (Chiplum taluka) between 1st and 20th August, so that the period the eggs required to hatch was a little more than two months, say seventy days.

"The young locusts vary somewhat in colour, most being a dullish light green, some light green, but hardly verdant, and a few almost white and only tinged with green. A few minutes after hatching they are strong enough to jump . . . . The antennæ are darksome and short, whilst on the thigh cases small black spots, and on the upper side of the abdomen a faint black line, are just visible. . . . .

"The young locusts generally cast their slough for the first time about 15 days after birth, and in their new skin the black line and spots become darker and the green colour of a deeper hue. They now leave the grass land and seek the shelter of the crops, and are in length ·8 of an inch.

[1] From his report, as reprinted in the *Indian Forester*, vol. X, p. 425.

"After another interval of 15 days they again cast their slough and enter on the third state. In this the black line becomes very intense, as also do the spots, which lengthen and form the so-called 'Koranic verses'—they do show a certain similitude to some letters of the Arabic alphabet vernacular. They are now 1·2 of an inch in length.

"They enter the 4th stage by casting their slough after another 15 days, and assume, including the antennæ, a yellow colour, which, towards the end of the stage, becomes pinkish grey. The black line and the 'Koranic verses' are now very intense in colour, and the insect attains the length of 1·6 of an inch.

"A great transformation is witnessed on entry into the 5th stage after 15 more days. The female is now 2 inches long, whilst the male is somewhat less. The colour of the head, prothorax, and abdomen is a grey or drab, speckled on the prothorax, and darker along the upper side of the abdomen. The ringed antennæ are a deep yellow, the eyes chestnut and striated, whilst for the first time appears an oblong mark under each eye, indigo green in colour, and bordered on each side by yellow. The Arabic letters have now disappeared, whilst the spots on the thigh cases are obsolescent. The young wings, too, now first appear. At first very small, they grow during the period of this stage—20 days. The contents of the wing-sprouts are at first liquid, and the young wings may be seen forming within the semi-transparency. When they are fully formed, the insect is of a dark brownish grey colour, whilst on the prothorax and elsewhere may be distinguished the colouring of the next stage.

"In its 6th and perfect stage the insect presents a brilliant appearance. The female is now 3 inches, and the male 2½ inches, in whole length, from head to tips of wings which overlap the abdomen by ·5 of an inch, and are rounded. On casting the slough, the wings dry and unfold, and the body of the insect, at first soft and moist, gradually hardens in the sun. The antennæ are ·8 inch in length, and of a bright yellow colour; the head is a brownish yellow, and the eyes, finely striated, are of a deep chestnut. The prothorax is alternately banded with a bright yellow and a rich brown, parallelwise to the body, and the legs are of an ochreish hue. Along the upper rim of the femur runs a deep brown stripe, and the knee-caps are of the same colour. The tibia, tarsus, and foot are a bright ochre, and the first is armed with 8 black-tipped spurs on the outside and 11 on the inside, while there are a pair of spurs on each side of the ankle-joint and on each side of the foot. The outer wings, or wing cases, have the colours on the prothorax extended to them, and on the back they form a flat surface, tapering to the extremity. They are strongly veined and finely reticulated, and towards the extremities are irregularly brown marked. The inner wings, which are expansive, are hardly coloured. The abdomen is a light brown, darker along the ridge, and in the female there are four spiky processes at its extremity, the upper pair curling up and the lower pair downwards. In the male the lower pair is replaced by one spiky process, larger and stronger.

"The locust now packs with its kindred, and they form the swarms which ravage the country. After a month or so they assume a red tinge, which gradually deepens and continues until their death, which takes place after the sexual function has been performed in May or June. The proportion of males to females appeared to me about 1 in 6.

"The whole life of the insect, including the egg-period, is exactly one year."

Remedies.

Various methods were employed in the Bombay Presidency in 1882-83 to destroy the locusts, which were to a large extent kept under by the energetic measures taken against them. The Cyprus screen system,[1] was found utterly inapplicable and

[1] The Cyprus screen system consists in erecting a long line of screens, each two to

had to be abandoned. The search for eggs also was not found successful as a means of destroying the pest. A plan was tried of marching lines of beaters, armed with bundles of twigs through the fields beating the ground so as to crush the young locusts. This was to some extent successful in short grass, but could not be made use of with growing crops. The plan of dragging country blankets rapidly over a field where locusts were to be found, and squeezing up the cloth every few yards to kill the insects which had been caught, was found useful in bushy tracts, but required, for its successful working, a good deal of activity and intelligence. The most successful method consisted in dragging over the fields a capacious bag, five or six feet deep by eight or ten feet long and much like a huge bolster case, but open at the side, instead of at the end. This was held by two men, one at each end, and was run along over the grass or young crops, to catch the locusts, which tumbled in, and, being unable to escape, could, from time to time, be killed by twisting up the bag. This was found to be a simple and easy means of destroying the locusts, and the people took to it readily all over the locust-affected area. Little or no injury was done to the crops by the men working it, and millions of insects were killed.

With regard to the numbers destroyed during the locust invasion, the Collector of Nasik reported the destruction in his collectorate alone of some forty-five tons of locusts, which he estimated must have represented about a thousand millions of individual locusts. Similarly in the Satara collectorate one hundred and eighty tons were reported to have been destroyed by the local officials. The numbers destroyed in these two collectorates were no doubt greater than in most of the collectorates which suffered from the locusts, but the figures give some idea of the extent of the invasion.

The identity of the locust.

With regard to the identity of the locust of 1882-83 Dr. Macdonald in his report, reprinted in the *Indian Forester*, Vol. X, advanced the supposition that the insect was *Acridium peregrinum*, and this name was adopted in most of the official reports which subsequently appeared. There seems, however, to be conclusive proof that the insect belonged to some other species. In the reports, both of Lieutenant Colonel Swinhoe and

three feet high, in front of an advancing swarm of young wingless locusts, pits being dug at intervals, close to the screens and at right angles to them, on the side towards the advancing swarm, the object being that the young locusts, on arriving at the screens, may turn to the right and left, and thus pour into the pits, where they can be destroyed. The chief advantage of the screen system is, that it enables a series of pits, dug at intervals, to take the place of the continuous trench that would otherwise be necessary to catch the whole of a swarm. The material hitherto chiefly used for the screens has been cloth, bound along the top with a strip of slippery oilcloth about four inches wide to prevent the locusts climbing over, but smooth mat screens are likely to be cheaper for use in many parts of India. The pits are usually furnished with overhanging zinc edges to prevent the locusts escaping.

of Lieutenant Colonel Bradford, the locust of Rajputana, which is undoubtedly *Acridium peregrinum*, is spoken of as distinct from the Bombay locust of 1882-83. *Acridium peregrinum* has been shown to be essentially the inhabitant of sandy deserts, while the Bombay locust of 1882-83 originated in the tropical forests of the Western Ghâts. The habits also of the Bombay locust of 1882-83 differed materially from those of *Acridium peregrinum*, in that the young wingless larvæ of *Acridium peregrinum* can be readily driven into traps, while those of the Bombay species entirely declined to be destroyed in this manner. Again, specimens said to be "locusts" were sent from the Bombay Presidency in 1883 to the well known entomologist Mr. F. Moore, who identified them as belonging to no less than five species, namely:—*Acridium succinctum*, *Caloptenus erubescens*, *Caloptenus caliginosus*, *Cyrtacanthacres ranacea*, and *Oxya furcifera*; *Acridium peregrinum* being unrepresented, a circumstance which is not likely to have occurred if this had been the species which was at that time swarming over the Presidency. Again, at a meeting of the Entomological Society of London, held on the 4th of April 1883, Mr. W. F. Kirby, of the British Museum, exhibited specimens of a locust which he identified as *Acridium succinctum* and which he had received from Mr. T. Davidson, who stated that it was the species which had lately been destructive in the Deccan and other parts of India. In the absence, therefore, of actual specimens, which do not seem to have been preserved, it may be concluded as most probable that while numerous species of Acrididæ may have been present in great numbers in the Bombay Presidency in 1882-83, the insect chiefly responsible for the injury to the crops was *Acridium succinctum*, which, therefore, would be the one spoken of by most of the observers, who, from their reports, seem to have noticed but one kind of insect.

Locusts in other parts of the world.

General.

Many species of Orthoptera occasionally increase vastly in numbers, so as to cause serious injury to agricultural crops; and there are, in different parts of the world, certain species, which are known distinctively as *Locusts*, and which possess this habit to a remarkable degree, often migrating in swarms which devour the crops over wide areas of country. Migratory locusts usually breed permanently in tracts where the vegetation is sparse. In years when they increase excessively, they descend in flights from their permanent breeding-grounds, upon cultivated districts, where they destroy the crops, lay their eggs, and maintain themselves for a limited period, but are unable to establish themselves permanently, usually disappearing in the year following the invasion, to be succeeded, after an interval of years, by fresh swarms from the permanent breeding-ground.

Generally speaking, the life circle of a locust extends through one year, in which period it passes through its various stages of egg, young wingless larva, active pupa, and winged adult which lays the eggs that are to produce the next generation, the only recorded exception being *Acridium peregrinum*, which is believed to pass through two generations in the year in India.

The eggs are laid in little agglutinated masses in holes which the female bores with her ovipositor in the ground. In temperate climates the eggs are usually laid by the end of summer, and the parent locust dies before the winter commences, the eggs remaining in the ground during the winter months, and hatching out in the following spring. In sub-tropical countries, where there is but little winter, the winged locusts live on through the cold season and do not die off until the following spring, when they deposit their eggs. In this case the eggs hatch after lying in the ground for about a month. In both temperate and sub-tropical regions alike, the young wingless locusts, on emerging from the eggs in the spring or early summer, feed voraciously and grow rapidly for one or two months, during which period they molt at intervals, finally developing wings and becoming adult. The adult locusts fly about in swarms, which settle from time to time and devour the crops. The damage done by locusts is thus occasioned, first, by the young wingless insects, and afterwards by the winged adults into which the young transform after a couple of months of steady feeding.

The following are the chief species of locusts found in different parts of the world other than India :—

Pachytylus migratorius, the chief migratory locust of Europe, occurs especially in Eastern Europe and Southern Russia, also in Central Asia, Siberia, North China, Japan, Fiji Islands, New Zealand, North Australia, Mauritius, Madeira, and possibly in South Africa, very little, however, being known about its distribution in the Southern Hemisphere (Mc Lachlan: article *Locust*, Encyclopædia Britannica). It may be looked upon as the chief locust of the temperate zone, excluding America. An elaborate account of this species in South Russia is given by Köppen (Horæ, Soc. Ent. Ross. iii, pp. 89—246; reviewed in Zool. Record, 1867, p. 457). From eggs laid in the autumn the larvæ hatch in the spring (April and May), and molt four times before they become adult. The larvæ band themselves together and move in search of nutriment, feeding chiefly on graminæ, and doing a vast amount of damage. The imagos emerge about July, copulate soon afterwards, and oviposition extends from August to October. Each female copulates and oviposits about three times, at intervals of about a month; each time laying from 50 to 90 eggs, in a hole bored by her horny ovipositor in the soil. This hole is about 1½ inches deep and is lined with frothy matter, which hard-

ens into a case for the eggs. The eggs have been found to withstand as low a temperature as 26° F. below zero. The dry steppes constitute the chief haunts of the locusts, which avoid damp places. The females generally oviposit in solid virgin soil, and seldom visit ploughed land for this purpose. Köppen is of opinion that the countries in which the swarms are seen are also, generally speaking, the countries of their origin.

Pachytylus cinerascens, Fabr., and *Œdipoda tatarica,* Motsch., which have been described by different authors as distinct from *P. migratorius*, are considered by Köppen to be but varieties of one and the same species (Horæ, Soc. Ent. Ross. iii, 1867). *P. cinerascens* is the form which has usually appeared in England and Belgium, in the latter of which countries Köppen notices that it probably breeds (Zool. Record, 1872, p. 398). It also occurs in India (*vide* pp. 101 to 104 on Locusts in Madras).

Pachytylus pardalinus has been described as destructive in South Africa (Trans. Soc. Afr. Phil. Soc. i, p. 193, 1880).

Pachytylus stridulus, Œdipoda vastator, Stauronotus vastator, and *Pezotettix alpina* have been noticed amongst other locusts as occasionally destructive in Southern Russia, especially when associated with the common migratory species *Pachytylus migratorius* and *Caloptinus italicus* of that region (Köppen, Horæ, Soc. Ent. Ross. iii, 1867).

Caloptenus spretus, the Rocky Mountain locust (see Reports of United States Entomologists—Riley, Pachard and Thomas,—Washington, 1877-79), caused injury, between the years 1874 and 1877, estimated at 200 million dollars. It breeds permanently only in a broad and comparatively barren region in the north-west of America, whence the invading winged swarms swoop down upon the fertile plains of the south and south-east, not appearing in the Mississipi valley until the latter part of July or the beginning of August, when wheat, barley and oats have generally reached perfection and been harvested. This, it is reported, renders it possible to prevent serious injury by relying chiefly on these crops when there is reason to fear incursions. On arrival the locusts devour everything green to be found, until they deposit their eggs and die in the autumn. From these eggs are produced in the spring vast hordes of young which devour everything green they can find, travelling along the ground (not having yet acquired wings) from the fields they have exhausted to fresh ground. They may be destroyed in vast numbers by systematic rolling, collecting by hand, by drawing bags over the field, &c., and their advance may be prevented by digging ditches in front of them with a streak of tar at the bottom, and also by driving them into heaps of straw to be then burnt, the trees being protected by bands formed of poisonous or impenetrable substances. When the larvæ are full-fed and acquire wings they rise up, by this time followed by hosts

of insect parasites (Tachinæ, Ichneumonidæ, &c.), and weakened by disease, and make their way more or less directly towards their permanent breeding-grounds; they perish by millions on the road, so that but few ever reach their home, in the high and barren north-west, where alone they are able to propagate permanently. They leave (it is reported) a great part of the country sufficiently early to allow of corn of rapid growth being produced after their departure, and succeeding swarms avoid the parasite-stricken districts which their immediate predecessors have deserted. Hogs, poultry, and all kinds of birds, besides various insects, destroy vast numbers of the locusts; and as they can only exist permanently in the comparatively barren north-west, it is supposed that when this breeding-ground is irrigated and settled, the locusts will gradually be exterminated.

Caloptenus italicus occurs on the European side of the Mediterranean (Italy, Austria, &c.); it is also found in North Africa and South Russia (Verz. Zool. Bot. Ges. Wien. xviii, p. 930; Bull. Ent. Ital. xiii, p. 210). It has been reported as destructive.

Stauronotus cruciatus has proved injurious in Italy and Sicily (Bull. Ent. Ital. xiii, p. 210). It also periodically invades Cyprus and the Troad (Proc. Ent. Soc. Lond. 1881, pp. xiv & xxxviii; also, Brown:—Report on the Locust Campaign of 1885-86 in Cyprus).

In Cyprus the locust is indigenous to the island. The young hatch out about the middle of March, and take about six weeks to become adult, when they acquire wings, take flight, and soon afterwards copulate and oviposit. The eggs are laid in uncultivated rocky ground, ploughed land and light soil being avoided. Each egg-pod contains about 33 eggs. Some damage is done by the winged swarms, which, however, generally disappear by about the middle of June, the eggs remaining in the ground until about the following March, when they hatch.

Serious loss is often occasioned by the locusts, and of late years a regular warfare has been waged against them by the Government of the island. The following was found to be the most satisfactory method of destroying them: Cloth-screens, about three feet high and bound at the top with a strip of oilcloth to prevent the locusts from climbing over, were erected in front of the advance of the young locusts, pits being dug at intervals close to the screens and at right angles to them on the side towards the locust swarm, the edges of the pits being protected by frames made of cloth and wood, with zinc edge arranged to prevent the young locusts from escaping from the pits. A swarm, on arriving at the screen, was found invariably to turn right and left along it, apparently endeavouring to go round it, the young locusts thus poured in vast numbers into the pits dug to receive them, and being unable to escape, were destroyed wholesale. In the case of the locust in-

vasion of 1886 Brown reports (*vide* official report presented to both Houses of Parliament by Her Majesty, February 1887) :—

"There were very few places where the locusts were sufficiently dense to justify the use of screens and traps, and they were in most cases destroyed by covering the ground they occupied by a thin layer of dry brushwood or rubbish and setting fire to it. By this means large areas were burned. Where the locusts were so sparsely scattered, or the scarcity of brushwood rendered this method inapplicable, they were destroyed by beating (an improved beater or locust flap of leather, weighted with lead, having been introduced by me this season). The weak point of these methods, as compared with the screen and trap system, is that, although the locusts may be greatly reduced, it is practically impossible absolutely to exterminate them, whereas our experience of 1883 and 1884 abundantly proved that when carefully worked it is possible, by the continuous screen system then first introduced, to completely clear large tracts of land where the locust swarms were most dense."

Stauronotus maroccanus.—This insect, which is found in most of the countries bordering on the Mediterranean, and which has also been reported from Badghis in Afghanistan, has of late (1887—89) proved very destructive to grain crops in Eastern Algeria, where its increase has been favoured by drought. Unlike *Acridium peregrinum*, which periodically invades Algeria from the south, it breeds permanently on the sparsely-vegetated hill ranges in Algeria itself (Batna, M'lila, M'sila, Bordj, Rendir, &c.), and thence descends in countless numbers into the cultivated plains towards the shores of the Mediterranean. The invading flights appear in the summer, and the females proceed, on arrival, to deposit their eggs in holes about an inch deep, which they bore with their ovipositors in the ground. About thirty or forty eggs are deposited in a mass of mucilage in each hole. These eggs remain in the ground throughout the autumn and winter, and hatch in the following spring (eggs laid in the end of June and beginning of July 1888 hatched in April 1889). After hatching out, the young locusts band themselves together and march through the country devouring the crops. The loss occasioned in 1888 was estimated in the Consular report at about a million sterling. In 1888 measures were taken upon a large scale by the French Government for the destruction of the eggs, about 600,000 francs being said to have been expended in buying eggs, at the rate of 1 fr. 50 c. for two decalitres, from the Arabs. These measures, however, proved insufficient, and were considered unsatisfactory, M. Künckel d'Herculais indeed showing that whereas a man can rarely collect as much as 2·60 litres of egg cases, containing some 72,000 eggs, in a day, he can destroy about a million young locusts by collecting them after they have emerged from the eggs. In 1889, therefore, the Government introduced the Cyprus screen system upon a considerable scale for the destruction of the young locusts. About 300 kilometres of screen were procured and 100,000 people were employed in destroying the young

locusts. These measures seem to have been attended with considerable success, though definite information has not been received as to what extent the country was cleared of the pest[1].

Acridium peregrinum.—This is the chief locust of Northern Africa, Arabia, Persia, Baluchistan, and North-Western India. It has been fully dealt with in the report already issued.

Acridium paranense has been described as the migratory locust of the Argentine republic, though some writers are of opinion that it may perhaps be the same as *Acridium peregrinum* (*vide* McLachlan: Encyclop. Brit., article *Locust*).

E. C. COTES,

13th May 1891. *Indian Museum.*

[1] The above account is chiefly drawn from (1) Reports I and II by Mons. J. Künckel d'Herculais, dated May and August 1888; (2) Diplomatic and Consular Report on Agriculture in Algeria, No. 469; (3) Papers which have appeared in the *Illustrated London News*, *Le Mobacher* published in Algiers, and *Insect Life* published in Washington.

Government of India Central Printing Office.—No. 267 R. & A.—17-9-91.—1,000.—F. J. E.

MAY 22 1897

Vol. II.] [No. 5.

THE ECONOMIC IMPORTANCE OF BIRDS IN INDIA.

By W. L. SCLATER, M.A.

Birds may be economically considered in two very different ways: first, from the direct point of view of the economic products of the birds themselves; secondly, from the indirect point of view of the benefit derived from the destruction of noxious insects by birds, which, no doubt, is of very great importance to agriculture.

It has been argued by certain people interested in agriculture that insectivorous birds, which are so directly important as insect pest destroyers, should be protected by law, but the question arises as to whether insectivorous birds are destroyed for their direct products in any quantities which would make it worth while to introduce special legislation for their protection. In considering this question, the first thing to do is to find out what birds are destroyed in any large quantities in India.

There are only two purposes for which this is done—

(1) For the sake of their skins or feathers, which are exported in considerable quantities.
(2) For eating purposes.

The following are the principal birds killed for their skins or feathers: *Herodias alba, Herodias intermedia,* and *Herodias garzetta* (Egrets), all of which have in the breeding season a dorsal or pectoral train of what are known as decomposed feathers; that is, feathers whose barbs are not connected with one another. These feathers are sold and exported in very large quantities and fetch very high prices.

Other birds of the *Heron* family, such as *Buphus coromandus* (the Cattle Egret), *Ardeola leucoptera* (the Pond Heron), *Ardea cinerea* (the Blue Heron), all produce feathers which are also sold in large quantities, but not at such high prices as the Egrets proper.

Another bird whose feathers have a certain market value is the Indian Snake Bird *Plotus melanogaster*. The lengthened scapular feathers, which are the only ones sold for export, are also, according to Jerdon, "looked on as a badge of royalty by the Khasias, and were once the badge of one of the Bengal regiments of Irregular Cavalry."

Many of the pheasants are exported in large quantities, more especially the Monaul *Lophophorus impeyanus*. The bulk of the specimens of the

pheasants brought down to Calcutta are shot, I believe, in Bhutan and Nepal, and I have been offered as many as a thousand skins at once; the other pheasants occurring in any quantity likely to be exported are the two species of *Ceriornis* (*C. satyra* and *C. melanocephala*) known as the Sikkim and Simla Argus Pheasants respectively, though, of course, they are neither of them the true *Argus*, which is a bird found in the Malay Peninsula only.

The only other birds which to my knowledge are exported in any quantity are the common species of the genus *Palaeornis* to which all the Indian Parrots belong, the Blue Jay or Roller (*Coracias*), the Kingfishers (*Ceryle* and *Halcyon*), and the jungle fowls (*Gallus*). The heckles of the Southern Jungle Fowl (*G. sonneratii*) are used for making fishing-flies among other things.

For the following list of the birds commonly eaten in India, I am greatly indebted to Mr. Hume's Gleanings from the Calcutta Market (*Stray Feathers*, Vol. VII, p. 479), which not only gives the birds brought to the market in Lower Bengal, but which is also more or less applicable to the whole of India :—

Charadrius fulvus = Golden Plover.
Gallinago stenura = The Pin-tailed Snipe.
Gallinago gallinaria = The Common Snipe.
Totanus glareola = The Spotted Sandpiper or Snippet.
Totanus calidris = The Red Shanks or Snippet.
Hydrophasianus chirurgus = The Pheasant-Tailed Jacana.
Nettapus coromandelianus = The Cotton Teal.
Chaulelasmus streperus = The Gadwall.
Dafila acuta = The Pintail.
Fuligula rufina = The Redcrested Pochard.
Fuligula nyroca = The White Eye.
Querquedula circia = The Blue-Winged or Garganey Teal.

The following are birds commonly eaten when shot by European sportsmen throughout India, but are not found anyhow commonly in the Calcutta bazaar :—

Crocopus phœnicopterus = *Hurrial* or Green Pigeon.
Columba intermedia = *Kabutar* or Blue Rock Pigeon.
Eupodotis edwardsii = *Tokdar Sohan* or Bustard.
Sypheotides bengalensis = *Charras* or Florikin.
Grus antigone = *Sarus* or Sarus Crane.
Ciconia leucocephala = *Manikjor* or Beefsteak Bird.
Calandrella brachydactyla = *Baghaira* or Ortolan.
Pterocles exustus = *Kuhar* or Sandgrouse.
Pavo cristatus, = *Mor* or Peacock.
Gallus ferrugineus = *Jungli Murgi* or Jungle-fowl.
Gallus sonnerati = Gray-fowl.

Galloperdix spadiceus = Red Spur-fowl.
Francolinus vulgaris = *Kalatitur* or Black Partridge.
Francolinus pictus = Painted Partridge.
Ortygornis gularis = *Bontitar* or The Kyah Partridge.
Coturnix communis = *Batter* or Gray Quail.

But in a country such as India, where an enormous percentage of the inhabitants are purely vegetable feeders, the number of birds killed for the table (except, perhaps, in the neighbourhood of great towns, such as Calcutta) is insignificant. Of all the birds mentioned in the above list, killed both for their plumage and their flesh, hardly one can be called an insectivorous bird.

The food of the Herons and Egrets consists entirely of fish and frogs; the Cattle Egret perhaps devours a few grasshoppers, but the bulk of its food consists of fish and tadpoles; the Snake Bird is entirely piscivorous.

Pheasants only occur at considerable elevations in the Himalayas; they are chiefly vegetable feeders, though now and then they maydevour a few insects.

Parrots are all fruit-eaters and do considerable damage in this way. Neither Snipe nor Duck are insectivorous in a true sense of the word.

The following is a list of the purely insectivorous birds :—

Paradoxornithinæ = Crowtits.
Crateropodinæ = Babbling Thrushes.
Timeliinæ = Solitary Babblers.
Brachypteryginæ = Ground Babblers.
Liotrichinæ = Ioras and Green Bulbuls.
Dicruridæ = Drongos or King Crows.
Certhiidæ = Creepers.
Sylviidæ = Warblers.
Laniidæ = Shrikes and Minivets.
Muscicapidæ = Fly-catchers.
Saxicolinæ = Chats.
Ruticillinæ = Red Starts and Robins.
Accentorinæ = Hedge Sparrows.
Hirundinidæ = Swallows.
Motacillidæ = Wagtails and Pipits.
Pittidæ = Ground Thrushes.
Cypselidæ = Swifts.
Caprimulgidæ = Goatsuckers.
Picidæ = Woodpeckers.
Upupidæ = Hoopoes.
Meropidæ = Bee-eaters.
Coraciidæ = Rollers.
Trogonidæ = Trogons.
Cuculidæ = Cookoos.

The following are the birds of mixed diet, partly insectivorous and partly fruit and grain-eaters, in varying proportions :—

Parinæ = Tits.
Sibiinæ = Sibias, White Eyes, &c.
Brachypodinæ = Bulbuls.
Sittidæ = Nuthatches.
Oriolidæ = Orioles.
Sturnidæ = Starlings and Mynas.
Turdidæ = Thrushes.
Fringillidæ = Finches.
Alaudidæ = Larks.
Nectarinidæ = Sun Birds.
Dicæidæ = Flowerpickers.
Phasianidæ = Pheasants.
Tetraonidæ = Partridges.
Turnicidæ = Button Quails.
Rallidæ = Rails.
Gruidæ = Cranes.
Otididæ = Bustards.
Limicolæ = Waders of all sorts.

The following are those birds which live either in or about water and wet places; their food consists of fish, frogs and tadpoles, aquatic larvæ of insects, and such small animals as fresh water crustaceans :—

Cinclinæ = Ouzels.
Halcyonidæ = King-fishers.
Phalacrocoracidæ = Cormorants.
Pelecanidæ = Pelicans.
Ardeidæ = Herons and Egrets.
Tantalidæ = Ibis.
Anseres = Ducks, etc.
Laridæ = Gulls and Terns.

To complete the list of birds I have divided the rest of them into the following three groups :—

Carnivorous.

Striges = Owls.
Accipitres = Vultures and Hawks.

Omnivorous.

Corvinæ = Crows.
Ciconiidæ = Storks.

Frugivorous.

Eulabetidæ = Hill Mynahs.
Ploceidæ = Weaver Birds.
Bucerotidæ = Hornbills.
Capitonidæ = Barbets.
Psittacidæ = Parrots.
Columbæ = Pigeons.
Pteroclidæ = Sandgrouse.

Of the above lists it will be seen that very few, if any, of those in the list of purely insectivorous birds are to be found among the birds mentioned in the first part of the paper, *i.e.*, those destroyed for plumage or food. With regard to those of mixed diet given in the other lists, it would certainly be unadvisable to protect them, since they may do much greater harm in devouring fruit and grain than they do good in destroying insects, such is specially the case with crows and starlings.

With regard to the time of breeding, most small birds in Upper India at any rate, breed between April and July. Of course there are many exceptions; but the four months—April, May, June and July—would practically cover the breeding time of nearly all the birds which require protection.

In Southern India many birds breed in December and January, and in the hills the breeding season, as for instance in the case of the Monaul, is in July and August. In the case however of Lower Bengal, the best months are undoubtedly April, May and June.

THE METHODS ADOPTED IN TUNIS FOR DESTROYING LOCUSTS.

(Reprinted from No. 209 of the Miscellaneous Series, 1891, of Her Majesty's Foreign Office in London.)

[*N.B.*—The following correspondence on the methods adopted in Tunis for the Destruction of the locust *Acridium peregrinum* is of particular interest in India, as *Acridium peregrinum* is the species which has been so destructive during the past few years in Sind, Rajputana and the Punjab.—ED.]

Consul-General R. Drummond-Hay to the Marquis of Salisbury.

My Lord,

With reference to Your Lordship's Despatch of 2nd June, I have the honour to enclose a Report on the Methods adopted in Tunis for Destroying Locusts during the Campaign of this year.

I have, &c.

(Sd.) R. DRUMMOND-HAY.

Tunis, July 27th, 1891.

Report by Mr. Drummond-Hay on the Methods adopted in Tunis for Destroying Locusts during the Compaign of 1891.

First appearance of flying locusts.

The locusts made their first appearance in the regency early in February of this year, flying from the south in a northerly direction.

The oasis of Tozeur, renowned for its groves of date palms, was the first spot to be invaded, and, by the end of March, the swarms had penetrated far into the interior, attacking the provinces of Gabes, Gafsa, and Sfax. In the month of April they reached the agricultural districts in the vicinity of Susa. Here they settled in enormous quantities and deposited their eggs, about April 13th, amongst the olive plantations where the ground was particularly favourable for the purpose.

They flitted again on April 18th, and wended their way across the large cultivated plains of the Enfida to Kairwan and thence on to the wooded and rocky hills of Zaghouan, where the largest egg deposits took place.

During the month of May the rich plains north of Zaghouan and the environs of Tunis and Bizerta were invaded in their turns by large flights, which have left their marks throughout those districts by considerable deposits of eggs.

Crops and vines.

During this invasion of flying locusts, most of the crops were saved from destruction by their advanced stages of maturity, and next to no damage was done to the vines in consequence of instructions issued by the general commanding the brigade of occupation to the officers under his command to afford every possible assistance to the "Contrôleurs Civils"[1] in the protection of their districts against the invasion of locusts.

Measures adopted by the military authorities.

Scaring of flying locusts.

When the approach of a swarm was signalled to the military authorities, troops were immediately despatched to the spot and divided into bodies of fifty men, who were told off to the different vineyards of the estate, each man being provided with an empty tin petroleum can and a small stick.

When the flights appeared, the men were placed in line and ordered to strke the cans as they advanced in open marching order through the vineyards.

These measures were never known to fail, and are generally acknowledged to be far more effective than the employment of smoke for scaring away the locusts, especially where a large tract of country has to be covered.

Grants of the Tunisian Government.

The Tunisian Government has granted sums amounting to 4,166*l.* to meet the expenditure in connection with the locust invasion and a Decree has been issued by the Bey, dated May 7th, 1891, declaring the measures adopted by the Government as obligatory on all proprietors, farmers and tenants of land, and empowering the local authorities, and all agents employed in the locust campaign to impress the number of inhabitants required for the work of destruction, even outside their own properties.

Beylical decree.

Instructions to Kaids and Sheikhs.

On the appearance of locusts in a kaidat,[2] instructions were issued by the "Contrôleur Civil" to the kaids and sheikhs of his district to mark the spots where locusts had alighted and coupled, and if possible, to plough up the ground on their departure.

Destruction of eggs by ploughing.

These precautionary measures are believed to have caused the destruction of a large percentage of eggs on cultivated land where the plough could be employed. The natives were also enjoined to collect eggs, and in some of the

[1] District Commissioners. [2] The district of a Kaid.

kaidats they received orders to weigh them daily in the presence of their sheikhs.

It was thus that between April 24th and May 12th over 60,000 kilos were collected in the kaidats of Susa, Djemel, and Mehedia. On the same principles it is reported that 76,000 decalitres of eggs were collected at Medenine in the extreme south of the Regency, 6,800 decalitres around Gabes, and 2,700 around Gafsa.

Coupling grounds.

With regard to the laying of eggs, Mr Henry, Contrôleur Civil of Tozeur, in an interesting report on the subject, recommends that when a flight of locusts alights for coupling purposes, the ground should be noted and carefully examined, as subsequent flights will usually select the same spot with a similar object.

Egg deposits.

These observations facilitate the discovery on the surface of the earth of numbers of holes, such as are caused by heavy raindrops, and which are formed by the locusts with their sterns for the deposits of eggs in clusters containing each from 98 to 102 eggs.

It then suffices to scrape the earth to a depth of about 2 inches to lay bare the eggs which should be carefully crushed or burnt in a trench, and subsequently buried.

Species of locusts.

The locust which has invaded the Regency this year belongs to the species *Acridium peregrinum*.

Period of incubation.

The period of incubation varies from twenty-five to forty days according to the season of the year, and temperature of the country where the eggs are deposited.

Hatching.

The hatching of a swarm continues for five or six days.

When the young locusts appear, they are of a greyish hue, which turns to black in twenty-four hours.

Importance of the first five days.

These first five days are the most favourable for their destruction before they gain strength and form themselves into large marching columns.

They can be crushed and burnt in large quantities from about an hour before sunset to the same time after sunrise, when they are clustered in masses on bushes and plants.

Migration.

On the sixth or seventh day after they are hatched, when the young locusts have assumed a greenish hue, they commence grouping for a migratory march, and it has been observed that their speed can then be calculated at about

60 yards an hour during the first three or four days, but, as they increase in size, their movements become more rapid.

The crawling stage of the locust lasts from forty-five to fifty days. During the last five days its movements are sluggish. On the eve of transformation, it assumes a reddish hue, and attaches itself to a leaf or twig where the process takes place by shedding a scale which envelopes the whole of its body to such an extent that when the winged insect drops to the ground, the shell that is left behind has all the appearance of a live locust. It will then reclimb a bush, and remain suspended in the sun for several hours before commencing its new career as a winged locust.

Algerian system of destruction.

The destruction of young locusts in the "contrôles" of the interior of the Regency, such as Tozeur, Gafsa, and Kairwan, was effected on the methods adopted in Algeria before the introduction of Cyprian screens, consisting in the employment of large numbers of men during the first days for the purpose of crushing and burning the locusts when they are stationary as already described. When in movement, the swarms are gradually encircled and driven into a heap or into trenches and destroyed by fire.

These methods appear to have been successful in the oasis of Tozeur, where the young locusts were destroyed in the space of twenty-one days without recourse being had to screens, which, it is now generally admitted by experienced persons, are indispensable only when the young locusts have succeeded in forming themselves into large columns.

Rules to be observed on appearance of flying locusts.

The first rules to be observed on the appearance of flying locusts are—

1. To carefully observe the flights, and mark the ground selected for hatching purposes.
2. To employ watchmen to give notice when the hatching days commence.
3. To organise in the meantime gangs of labourers.
4. To destroy the eggs either by gathering them or by ploughing up the hatching grounds.
5. To collect the necessary fuel around the contaminated spots.
6. *After hatching.*—To take advantage of the first five days to destroy the young locusts before they form into columns.

Operations facilitated in cultivated districts.

The work of destruction was most successful in the cultivated and populous districts, where the operations of beating the locusts and destroying their eggs and young were facilitated by reason of the open country and numerous hands; but in the mountainous and rocky or woody districts which are, as a rule, thinly populated, the difficulties to be en-

countered are seriously augmented. The locusts deposit their eggs in ravines or in the midst of thickets where human vigilance is rendered impossible. The young insects are consequently hatched unmolested, and cannot be dealt with until their line of migration leads them out of the forests into open country.

Under these circumstances the operations were effected with more thoroughness in the plains and open districts of South Tunis than in the wooded and mountainous regions of the northern division.

Plan of campaign against young locusts.

The plan of campaign adopted by the Tunisian Government against the young locusts is as follows.

Sections.

The infested part of the country is divided into sections. A military officer, or a civilian, is placed at the head of each section, with a certain number of soldiers under his command, and the power to impress native labour.

Mounted patrols.

The chief of each section is also provided with two mounted natives, whose duty it is to patrol incessantly the country comprised in the section in order to ascertain and report on the positions of the young locusts.

These reconnaissances are of the utmost importance, and wherever they have been properly attended to, the surprises have been few, and time has been afforded for methodical operations.

Division of sections.

Experience has shown that the division of the infected districts into large sections, under the command of a captain in the army, has had better results than the experiments first made in the north of Tunis of smaller divisions, commanded by lieutenants and sub-lieutenants.

The Zaghouan and Fahs districts were, for instance, divided into five sections, commanded by a captain with five lieutenants, in charge of each section, composed as follows:

Section.	Officers.	Soldiers.	Natives.
1	1	30 Zouaves	...
2	2	60 Tirailleurs	...
...	...	60 Beylical troops	160
3	1	30 Tirailleurs	100
4	1	30 „	120
5	1	30 „	100
Total .	6	240	480

In addition to the above, there were two companies of Zouaves, numbering 220 men, for special service, under the direct orders of the captain.

The gardens and vineyards in the immediate vicinity of Zaghouan were guarded by 305 Arabs, under the supervision of a captain of the Tirailleurs, assisted by 60 of his men.

Concentration of forces.

The five above-mentioned sections had at one time to be concentrated by the captain for the destruction of large columns advancing into the plain from the wooded slopes of the Zaghouan hills, on the eastern side of the district, and the vacated sections were then re-inforced by two companies of Tirailleurs, or 300 men under five officers, in consequence of the approach of fresh columns on to the Fahs district.

Extra pay to officers and men.

The officers and men employed on the locust campaign receive extra pay, the former at the rate of 3 frs. and the latter at 15 cents. a day.

Rations to natives.

When natives are employed on farms situated in their own districts and close to their homes, they are supplied by the Kaid with rations of bread and oil; but when summoned to a long distance, the proprietors of lands threatened by the locusts have to provide rations of coffee, mutton, and 35 cents. each a day.

Compulsory service of natives.

Each tribe has to furnish one-third of its number that pays the "medjba," or poll tax.

The Zaghouan sections.

With a view of explaining the methods hitherto adopted in Tunisia for the destruction of young migratory locusts, I have selected as an example the districts of Zaghouan and Fahs, where the struggle was greatest, owing to the unfavourable nature of the country, and the intensity of the invasion.

The line of defence extended over 35 miles along the cultivated plains, bordered in the south-east by the Zaghouan range of hills.

The division of the district into five sections, under the command of a captain of Zouaves, and the number of soldiers and natives under that officer, have been already described.

Length of lines of screens.

In the early part of July, when the migration to the plains was at the highest point, 25 miles of screens were in position, and the sections were supplied with 500 yards of zinc for the traps, and 40 barrels of asphyxiating liquids.

Ten miles' length of the screens were used for the protection of farms and vineyards, and 15 miles' length for field operations.

The most infected spot was the plain of Zaghouan, where, for some days, as already stated, the combined forces of all the sections had to be collected for the protection of gardens and vineyards situated in the long valley, flanked on the northern and southern sides by brushwood swarming with young locusts.

Description of screens used in Tunis.

The screens furnished by the authorities are mostly manufactured in Tunis, purporting to be facsimiles of the article used in Cyprus. It is possible that they are made on the same model, but, judging from a personal inspection, the material must be very inferior. They are composed of strips of cotton texture, 50 inches long, by 70 centims. broad, which stand no wear and tear, and the strip of oilcloth bordering the upper edge is very apt to crack, and thus cease to act as a barrier against the locusts, who take advantage of the rent in the surface to crawl over the screen.

Traps.

During the campaign of the year many experiments have been made, with a view to ascertain the most serviceable and destructive form of trap.

Fire traps.

In the early days the screens were placed in position to receive the advancing column, with openings measuring about 5 yards wide, and a semi-circular trench dug across. The trench was filled with brushwood, which was burnt down to glowing embers. This mode of destruction answered fairly well where firewood was plentiful and easily procured, but, as the trenches required re-filling from time to time with fuel, the men at work, and the clouds of smoke, were apt to scare the locusts and turn the columns.

Traps lined with zinc.

Destruction by fire has, therefore been abandoned in favour of traps lined with zinc, which have worked with considerable success, the preference having been given to the latter invention.

Trap A.

Trap A is from 2 metres to 2 metres and 25 centims. long, by 1 metre wide and 60 centims. deep. It has the sides lined with zinc, fixed into frames of wood of the same dimensions.

The latter are laid on to the edges of the trap, and covered with earth or stones to keep them in position.

Trap B, which is identical in size, is simpler and equally effective.

Trap B.

It consists merely of two laths of wood for the sides and two others for the ends. These laths are about 15 centims. wide and entirely lined with zinc on one side, but only partially on the other.

When the trap is prepared, the frames are placed along the edges with the tin lining undermost and protruding about one-third over the brink. The four corners where the frames join should be carefully closed, and all apertures filled in with earth.

The locusts entering these traps are able to crawl up the earthen sides, but on reaching the protruding rim of zinc, they lose their grasp and fall back into the pit.

A great advantage in this invention is the portability of the laths and the simplicity of their adjustment to the trenches.

Advantages of Trap B.

The traps can also be easily enlarged either in length or breadth by adding the necessary laths. In fact, during the latter part of the campaign it has been found that large traps, measuring 12 metres to 16 metres in length, by a metre in width and depth, are preferable to the smaller ones, when the locusts are numerous and their movements rapid.

I am indebted to Major R. Catroux, Contrôleur Civil of the Tunis district, for the following rules to be observed in the employment of the newly invented traps.

During the first fifteen days traps of two metres long by one metre wide are placed at distances of about 50 metres apart along the line of screens.

Rules for employment of traps.

From the fifteenth day to the thirtieth day the length of the traps are increased in proportion to the importance of the columns. They should measure from six metres to eight metres in length by one metre in width and 60 centims. in depth, and be placed about 50 metres apart.

After the thirtieth day the locusts become exceedingly shy and have been known to halt at a distance of about 400 yards from the screens and to alter their course with such accelerated speed that they have succeeded in outflanking the screens.

In such eventualities their movements can be successfully intercepted by placing a line or lines of screens projecting at right angles.

The dimensions of the traps may vary from 10 metres to 20 metres in length, by 1 metre or 2 metres in width, and 60 centims. in depth, situated at distances of 100 metres to 150 metres apart.

The following instructions were issued on June 17th last, by Mr. Paul Bourde, the Director of Agriculture in Tunis, for guidance in the use of screens :—

Instructions of the Director of Agriculture.

"Care should be taken to place the pickets at distances of three yards apart. If the cloth is well stretched the screen serves its purpose, but if badly stretched, it is useless.

"Many persons are under the impression that a screen should be fixed with pickets 1½ metres apart. This is an error. There is no necessity for doubling the pickets when the screen is provided with a cord, which keeps it more taut than additional pickets.

"The trenches should be dug at reasonable distances and when they are bordered with plates of zinc, the young locusts that enter the traps are unable to escape.

"The lower edges of the screen should be covered with earth so as to avoid any crevices between the cloth and the ground. But the earth should be placed on the front part of the screen. When placed behind the cloth, it is apt to draw on the picket tapes and give way. It is very important for the preservation of the screens to follow these rules.

"The dust which inevitably collects on the screens is an assistance to the locusts in scaling the oil-cloth. It is, therefore, necessary to damp the oil-cloth on the screens, at least twice a day, with a rag soaked in oil. The chiefs of sections will observe carefully these precautions and see that every gang is provided with a bottle of oil.

"All the efficacy of the screen lies in the band of oil-cloth, which should always be stretched vertically and kept smooth and slippery.

"The chiefs of sections will organise their squads with the greatest care and assign to each person a definite duty.

"A few men thoroughly acquainted with their duties will perform more useful work than large disorganised bands.

"Four men are sufficient for fixing the screen—six at the most. A larger number of hands is unnecessary and only impedes the work.

"After unfolding the screen, two men measure the distances and fix the pickets; a third attaches the cord to the heads of the pickets; a fourth ties the tapes to the pickets and cords; a fifth collects the earth; and a sixth applies it to the screens.

"The same man should, if possible, always be employed for the same work. Great attention should be paid to the screens.

"The young locusts arriving in swarms are so numerous that the slightest flaw in the cloth, a picket wrongly pitched at the juncture of the screens, a tape hanging over the oil-cloth, a crease in the material of the screen, forms a passage for the locusts.

"The chief of the section will always inspect personally the line of screens to assure himself that all is in proper order.

"The natives that are impressed must be divided into gangs of ten or twelve. They render good service if employed on simple labour, and treated with patience and forbearance.

"The chiefs of sections will remind landowners, and especially proprietors of vineyards and gardens where the cultivation is most precious, that they are particularly requested to guard their own boundaries. No vigilance can equal that of persons individually interested. With proper reconnaissances time is afforded to organise the defence. These reconnaissances are indispensable in bushy districts.

"To attack a column of locusts in the rear is a bad tactic. When a column has been reconnoitred, the screen should be pitched several hundred yards in advance of the head of the column. The screens are placed in an angle, of which the sides are extended according to the supposed breadth of the column. At the head of the angle a large trench is dug, and bordered with zinc. As soon as the screens are fixed into position, the workmen should not show themselves either in front or behind the line. The locusts are easily scared in their march, and a whole column may thus change its direction.

"All the workmen should be employed on the flank of a column to drive the locusts gently towards the screens. This operation, well conducted, leads to the complete annihilation of a column.

"When a landowner believes that his property is in danger, he will address himself to the chief of the section in his district. When the chief of a section requires hands or material, he will address himself to the Contrôleur Civil or to the person delegated by that officer."

Screens furnished by Government.

In the beginning of the campaign against the young locusts, the authorities furnished the southern districts with about 1,460 screens, and 1,100 were reserved for the districts of North Tunis, which have been since considerably increased for the protection of the sections included in the districts of Zaghouan, Kef, Beja, Bizerta, Ain Draham, &c.

"*Huile lourde*" (creosote oil).

The experiments made with "*huile lourde*," a liquid for asphyxiating the locusts, have been found most successful.

Twenty-thousand kilos. were first ordered from Oran, where the invention originated, for employment in places where fuel was scarce, but the destructive effects of the liquid, combined with its antiseptic properties when sprinkled over myriads of locusts at this hot season of the year, when putrefaction sets in so rapidly, caused it to be universally and infinitely preferred to the former system of burning or crushing the locusts.

"*Huile lourde*" is "creosote oil," a product obtained by distilling coal tar, and is sometimes called "Soft oil."

Cost of the oil and modes of use.

The liquid costs from 11 to 13 frs. per 100 kilos. It is mixed with 60 parts water to 40 parts "*huile lourde*," and is useful—

1. For the destruction of young locusts collected in small patches which do not call for the employment of screens. It then suffices to sprinkle the locusts with the liquid in the morning or evening, when they are clustered together.
2. For the destruction of young locusts collected in the traps by pouring the liquid through the rose of a watering-pot.

The process of asphyxiation is very rapid, and the over-powering stench which usually arises from the masses of dead locusts is considerably lessened.

Another liquid called "*acide phénique,*" or carbolic acid, has also been employed for the same purpose in quantities of 20 per cent. of the acid to 80 of water.

Carbolic acid.

Although the destructive qualities of the "*acide phénique*" are not inferior to those of the "*huile lourde,*" the latter has been preferred for economical reasons, being a much cheaper article.

The campaign at Zaghouan and the Fahs has now terminated, and, although some of the gardens and vineyards have suffered owing to their close proximity to the surrounding bushy country, the operations have been conducted with success.

Successful termination of the Zaghouan campaign.

It has been calculated that about 600 cubic metres of locusts have been destroyed by traps in those sections.

The destruction by ploughing up of lands, collection of eggs, and burning of young locusts was also actively carried on at the proper time, and it is believed that a large percentage of locusts were exterminated by these precautionary measures.

A careful observer of the habits of the locust during this campaign informed me that he had always noticed a certain number of full-grown locusts on the hatching grounds after the departure of the large flights, and that when the migration of the young locusts commenced, the columns were usually under the leadership of the old insects. The fact of the young being guarded by full-grown and experienced locusts would account for their nearly always choosing the proper course leading towards cultivated or fertile lands.

Columns led by adult locusts.

Several personal inspections of various sections in the north of Tunis enables me to testify to the energetic and methodical measures adopted by the Administration, and to the services rendered by the troops throughout the Regency, to whose activity the work of destruction is mainly, if not entirely, due.

Energy and activity of administration and troops.

By entrusting the command of sections to European officers, aided by a few of their own troops, order and discipline are ensured. The tactics are carried out with greater precision, and the natives required for the work of each section are careful to obey orders when summoned to assist in the operations.

Discipline insured by military command.

GAS TREATMENT FOR SCALE INSECTS.

(An extract from the Report of Mr. D. W. Coquillet, published in the U. S. Department of Agriculture Division Entomology, Bulletin No. 23.)

[The following report on gas treatment for the scale insect *Aspidiotus aurantii*, Maskell, is of interest as both coffee and tea in India suffer largely from scale insects, which could no doubt be destroyed by any treatment that is found to answer with the orange scale. The chief difficulty in applying the gas treatment to orange scale seems to be owing to the size of the orange trees, as this necessitates the employment of tents of considerable dimensions. Tea and coffee shrubs, therefore, being very much smaller than orange trees, would seem to be more favourably constituted for the treatment. According to Mr. A. E. Shipley (Kew Bulletin No. 57, 1891) the gas treatment has been used on a very extensive scale in California, some 20,000 trees in orange country alone being treated by it in 1890, and Mr. Coquillett states that he has not heard of any accident resulting from the gas, though great care is necessary in using it owing to the fact that it is poisonous to man and other animals.—Ed.]

"Briefly speaking, this process consists in covering the infested tree with an air-tight tent, and afterward charging the tent with hydrocyanic gas. The material commonly used in the construction of the tent is what is known as blue or brown drilling. A few persons have used ducking instead of the drilling, but this is much inferior to the latter; in the ducking the threads of which it is composed extend only lengthwise and crosswise, whereas in the drilling they also extend diagonally—this belonging to the class of goods to which our merchants apply the term "twilled"—and for this reason the drilling is both stronger and closer in texture than the ducking.

"After the tent is sewed up it is given a coat of black paint, as it has been ascertained that tents treated in this manner last longer than those which have been simply oiled with linseed oil. Some persons mix a small quantity of soap suds with the paint in order to render the latter more pliable when dry, and therefore less liable to crack. Instead of thus painting the tent some persons simply give it a coating made of an inferior glue called "size," first dissolving this in water and then covering the tent with it, using a whitewash brush for this purpose. Sometimes a small quantity of whiting or chalk (carbonate of lime, Ca Co_3), is added to this sizing with or without the addition of lamp-black. A few make use of the mucilaginous juice of the common Cactus (*Opuntia engelmanni*, Salm.) for this purpose; to obtain this the Cactus leaves or stems are cut or broken up into pieces, thrown into a barrel and covered with water, after which they are allowed to soak for three or four days; the liquid portion is then drawn off, and is ready for use without further preparation. Tents which I saw that had been prepared with this substance were to all appearances as air-tight and pliable as when prepared in any other manner.

"A tent 26 feet tall by 60 feet in circumference—a size large enough to cover the largest orange tree now growing in this State—if made out of drilling, and either

painted or sized, as described above, will cost completed about 60 dollars. Where the trees to be treated are not more than 12 feet tall the tent can be placed over them by means of poles in the hands of three persons; to accomplish this, three iron rings are sewed to the tent at equal distances around, and 6 or 7 feet from the bottom of the tent; immediately under each of these rings an iron hook is attached to the lower edge of the tent. When the latter is to be placed over a tree each of the hooks is fastened into the corresponding ring above it; one end of a pole is then inserted into each of these rings, and the tent is raised and placed on the tree. The hooks are then released from the rings and the lower edge of the tent allowed to drop upon the ground.

"Instead of allowing the tent to rest directly on the tree some growers use an umbrella-like arrangement, the handle of which is in two pieces, which are fastened together with clamps provided with pins; this allows the handle to be lengthened or shortened according to the height of the tree. This apparatus is put up over the tree, and the tent allowed to rest upon it. By the use of this simple device the danger of breaking off the small twigs on the upper part of the tree by the weight of the tent is avoided. Mr. Leslie, of Orange, used four tents and tent rests of this kind, and he informs me that with the aid of two men he fumigated 120 trees in one night. To remove the tent from one tree, place it over another, and charge the generator required only one minute and a half. In the place of poles some persons attach a circle of gas pipe to the lower edge of the tent; then two men, each taking hold of opposite sides of this circle, threw the tent over the tree. Dr. J. H. Dunn, of Pomona, informs me that four men, using six tents like the above, fumigated 240 orange trees in one night and that the average for each night was over 200 trees, the latter being 8 feet or less in height. After the tent is placed over the tree the next step is to charge it with the gas. The materials used for the production of the gas consist of commercial sulphuric acid ($K_2 SO_4$), fused potassium cyanide (KCN), and water, the proportions being one fluid ounce of the acid, one ounce by weight of the dry cyanide, and two fluid ounces of water. The generator is placed under the tent at the base of the tree; it consists of a common open earthenware vessel. The water is first placed in the generator, then the acid, and last the cyanide, after which the operator withdraws to the outside of the tent and the bottom of the latter is fastened down by having a few shovelfuls of earth thrown upon it. The tent is allowed to remain over the tree for a period of from fifteen to thirty minutes, according to the size of the tree.

"It was found by experimenting that the trees were less liable to be injured by the gas when treated at night than they were when operated upon in day time, and at the same time the gas is just as fatal to the scale insects when applied at night as it would be if applied in the day time; and, indeed, it appears to be even more fatal when applied at night. This is accounted for by reason of the fact that in the day time the light and heat decompose the gas into other gases which, while being more hurtful to the trees, are not so fatal to insects. At night the trees are also more or less in a state of rest, and, therefore, are not so liable to be injured by the gas as they would be in the day time, when they are actively engaged in absorbing nourishment and replacing wasted tissue with new materials.

"Of the different materials used in generating the gas, the most important is the potassium cyanide; of this there are three grades; the mining cyanide, commercial cyanide and the C.P. (chemically pure). Of these three brands, the mining cyanide is wholly unsuitable for the production of the gas, and the C.P. is too expensive; the commercial brand (fused) is the only one that is used for producing the gas, but even this varies greatly in strength, containing all the way from 33 to 58 per cent. of pure potassium cyanide. It is, therefore, of the utmost importance that the

operator should know the exact percentage of pure potassium cyanide that his cyanide contains, and when large quantities of it are purchased at one time it would be advisable to obtain one or more analyses of it by a reliable analytical chemist; or if it is not possible to submit the cyanide to such person, an analysis of it could be made by almost any person accustomed to the use of chemicals or drugs.

"The only substance required for this purpose is the crystals of nitrate of silver ($AgNO_3$), which may be obtained at almost any well-stocked drug-store. Dissolve the nitrate in cold water contained in a glass or earthen vessel, using one-fourth of an ounce (Troy) of the crystals to one pint of water; this dissolves in a few minutes, forming a whitish, semi-transparent solution. The cyanide, when dissolved in water, forms a transparent, nearly colourless solution; when a small quantity of the nitrate of silver solution is added to this it at first spreads out in a white cloud, like milk, but it soon breaks up into small, white, floccy pieces which gradually disappear upon being agitated, leaving the solution nearly as transparent as at first; when more of the nitrate of silver solution is added from time to time the above process is repeated except toward the last, when the cyanide solution becomes somewhat milky, but it still remains semi-transparent, permitting the operator to see quite clearly the bottom of the vessel containing the solution. As soon as a sufficient quantity of the nitrate of silver solution has been added to the cyanide solution the latter immediately becomes white and opaque, like milk, completely concealing from view the bottom of the vessel containing it. This completes the operation, and the quantity of nitrate of silver solution used will indicate the strength of the cyanide tested. When absolutely pure, $5\frac{3}{4}$ grains of the potassium cyanide dissolved in water will require one fluid ounce of the above nitrate of silver solution before the turbidity occurs, indicating that the cyanide is 100 per cent. strong; if only one-half of a fluid ounce of the nitrate of silver solution produces this turbidity, this indicates that the cyanide is only half strength, or 50 per cent. strong; if only one-fourth of a fluid ounce is required then the cyanide is 25 per cent. strong; and so forth. The nitrate of silver solution should be added to the cyanide solution very slowly, the latter being agitated by gently shaking it each time that any of the nitrate solution is added. Wherever any of the nitrate of silver solution comes into contact with the skin or nails of the hand it produces a reddish or black stain, which can easily be removed by washing the stained part in a solution of cyanide and water; this will quickly remove the stain without causing any injury to the parts affected, except, of course, when the stains occur upon a sore or cut in the hand, in which case it would be dangerous to apply the cyanide to these places.

"It sometimes happens that the percentage of cyanogen (CN or Cy) is given instead of the percentage of potassium cyanide (KCN or KCy); but in cases of this kind the percentage of cyanide can be readily ascertained by always bearing in mind that two-fifths of a given quantity of potassium cyanide is cyanogen. Thus, if a certain brand of cyanide contains 24 per cent. of cyanogen, this is equivalent to 60 per cent. of pure potassium cyanide. Potassium cyanide when absolutely pure (equal to 100 per cent.) contains 40 per cent. of cyanagen; and, therefore, no grade of cyanide could contain a larger percentage of cyanogen than this.

"The potassium cyanide used for producing the hydrocyanic acid gas is principally manufactured by two firms: Power and Weightman, of Philadelphia, Pa., and the Mallinkrodt Chemical Works, of St. Louis, Mo. That made by the first-named firm is the most largely used; when purchased by the ton the price is 36 cents per pound for the grade containing about 57 per cent. of pure potassium cyanide, packages and carriage extra. It is put up in tin cans holding 10 pounds each, and also in barrels

holding about 400 pounds each. That in the cans is much to be preferred, since the quantity in each is so small that it will soon be used up after the can is opened; whereas the barrel containing so large a quantity, the cyanide used towards the last will have lost much of its strength by contact with the air. It is customary to weigh out the cyanide in small paper parcels and mark each parcel with the number of ounces of cyanide that it contains: then when the tree is to fumigated it is an easy matter for the operator to select one of the parcels containing a sufficient quantity of the cyanide for the tree, thus saving the trouble of weighing out the cyanide as it is to be used for each tree. As the fumigating is done only at night the weighing of the cyanide is frequently done by the ladies of the house upon the day preceding its use.

"The quantity of cyanide to be used on each tree will, of course, depend not only on the size of the tree but also on the strength of the cyanide used. The following table will aid in determining the proper quantity of each ingredient to be used on different sized citrus trees, the cyanide being about 58 per cent. pure:—

Height of Tree.	Diameter of Tree-top.	Water.	Sulphuric Acid.	Potsasium Cyanide.
Feet.	Feet.	Fluid ozs.	Fluid ozs.	Ounces.
6	4	$\frac{2}{3}$	$\frac{1}{3}$	$\frac{1}{3}$
8	6	2	1	1
10	8	$4\frac{1}{2}$	$2\frac{1}{4}$	$2\frac{1}{4}$
12	10	8	4	4
12	14	16	8	8
14	10	10	5	5
14	14	19	$9\frac{1}{3}$	$9\frac{1}{2}$
16	12	16	8	8
16	16	29	$14\frac{1}{2}$	$14\frac{1}{2}$
18	14	26	13	13
20	16	36	18	18
22	18	52	26	26
24	20	66	33	33"

PARIS-GREEN AS AN INSECTICIDE FOR DESTROYING CATERPILLARS.

(*Reprinted from a leaflet issued by Miss Eleanor Ormerod, Feby. 1891.*)

[Paris-green is an arsenical compound, very much like London purple, both in composition and also in the effect which it has upon insects. It is applicable to caterpillars and other mandibular insects, many of which are very destructive to crops in India. The methods recommended for use in England will no doubt be found to be equally applicable in India, while the recommendations of so well known and cautious an observer as Miss Ormerod will do much to remove the prejudice which is naturally felt against the treatment, on account of its poisonous nature—Ed.]

"The object in view in bringing forward the use of spraying with Paris-green is the pressing need which has long been felt of having some kind of application at hand which is cheap and sure in its action, and which can be brought to bear at once when required on any, or all sorts of, moth caterpillars together (whatever their various natures or previous histories may have been), and will kill the whole collection of ravaging hordes at once, without damaging the leafage.

"For some years back trials have been made, in many isolated cases, of various kinds of treatment which it was hoped *might* be of use in lessening this yearly amount of loss; but, as these experiments were seldom carefully recorded as to details or results, they have been of little public benefit.

"Therefore, about the end of February in last year, 1890, at a conference of fruit-growers held at Evesham, a Committee of Experiment was formed, of gentlemen personally interested in the subject (and also qualified practically, as well as scientifically, to superintend experiments in orchard treatment, and report results), in order to try the effect of any kind of sprays, washes, or other applications which they might judge likely to be effective in destroying the caterpillars on orchard trees without injuring the leafage; and to meet at various different centres from time to time, so that the whole Committee could judge of results of various treatments, and consultation and detailed reports of the method of treatment respectively take place, or be given by the members.

Paris-green was one of the applications especially selected for experiment, as having been known for many years to act trustworthily as an insecticide in the United States and Canada, and also because, from the Government reports of both countries, we were able to learn all requisite details as to precise methods of application; and further, we were most kindly aided in our experiments by advice from Mr. J. Fletcher, the Dominion Entomologist of Canada.

"At the meetings of the Committee the several experiences of the members were given, showing clearly that even under careful experiment just the same uncertainty occurred with regard to reliable effects of *almost* all the applications, as has appeared to be the case for years back. Alum, hellebore, ammoniacal liquor, and many other applications were tried, and sometimes found useful; sometimes as, in the case of alum, found occasionally useful, but also, and on very careful trial elsewhere, of not the slightest service; and later on, when the caterpillar was more advanced, the alum was found to be of no service at all.

"Paris-green used as a liquid application—that is, mixed in an excessively small quantity with very much water, and sprayed as a mist on the trees—answered for the most part well; and I give the following directions for use, and also cautions required (the chemical being of a poisonous nature), from the Government publications of Canada and of the United States, together with our own experiences of last year.

"*For liquid application.*—The amount recommended in Canada for spraying for Codlin Moth or young 'looper' caterpillar is 'not more than from 2 to 4 ozs. in 40 (forty) gallons of water, or $\frac{1}{8}$ to $\frac{1}{4}$ oz. in a pail of water (4 gallons, E. A. O.), to be applied as a fine spray by means of a force-pump. The foliage must not be drenched, but the spray should only be allowed to fall upon the trees until it begins to drop from the leaves.

"*For general use on mature foliage.*—Half a pound of Paris-green, 50 gallons of water. First mix the Paris-green separately with a small quantity of water, then add to it the whole supply. All washes containing Paris-green must be constantly stirred to keep it in suspension, or it will sink to the bottom.'

"The amount found serviceable by the Evesham Fruit Committee coincided almost exactly with the weaker mixture mentioned above. The Committee decided that they could recommend 'Paris-green paste in the proportion of 1 oz. to 8 or 10 gallons of water for Plums; and 1 oz. to 20 gallons of water for Apples.' Apple leafage was found to be more tender than that of Plums. Pear leafage should be treated like that of Apple.

"For Currants the strength found safe was the same as for Plums—1 oz. of 'green' to 10 gallons of water; but as the foliage grew stronger, 1 oz. to 8 gallons of water was found not too strong. Neither of these strengths of mixture damaged the leafeage, but they killed the caterpillar.

"*These proportions should not be exceeded.*—In some instances greater strength has been used without bad effects on the leafage; but this was certainly attributable in one case to heavy rain following the over-application, and probably, if details were procurable, non-injury from over-strength could be traced to casual coincidence in other cases also.

"Captain Corbett, the Superintendent of the Toddington Fruit Grounds, writing to me on the 3rd of July, and mentioning his satisfaction with the results of spraying, also noted, 'Proportions I fixed upon after the first trials, *viz.*, 1 oz. to 10 gallons of water for Plums, and 1 oz. to 20 gallons of water for Apples, must not be exceeded.'

"*Paris-green is an aceto-arsenite of copper and of a poisonous nature,* and therefore should be used with care in mixing, and should never be applied *to fruit or to vegetables that are used for food.* But, as is shown above, the quantity to which, in order to be beneficial, it is *requisite to limit application* in spraying is excessively small, and our English experiences of the past season, as well as those on the Continent of America where Paris-green has been used regularly in farm and orchard prevention for many years, show that with proper care it may be used with perfect safety.

"*The cautions to be observed in the use of Paris-green are:* The bags should be labelled POISON and kept locked up, and especially kept safely out of the way of children, who might be attracted by the beautiful green colour of the powder.

"Workers with the powder should not allow it to settle in any sore or crack in the skin of the hands, nor stir it about unnecessarily with the hands; and they should be *very careful not to breathe in the powder* through mouth or nose whilst measuring or mixing it.

"For this reason it is most desirable that purchasers of Paris-green should have it sent, *not* in bulk, to be divided for use on receipt, but wrapped in single pound (or

small) packages by the senders, or, what is better still, have it in form mentioned opposite as "Paris-green paste," that is, the powder just damped so that it cannot fly about. If swallowed in any quantity by being drawn in with the breath it would certainly be harmful. An instance is on record in which a man employed to weigh out and wrap 5 cwt. in 1-lb. papers lost his life therefrom. But, with the most ordinary care, the application may be mixed and used, as well as hellebore and other poisons often applied in orchard and other farming work, with perfect safety.

"*In mixing and in the use of Paris-green as a fluid dressing or spray,* one of the first points to be borne in mind is that this chemical does *not* dissolve in water. It is simply held in suspension; the following is a good recipe for mixing, so as to ensure the powder and water being thoroughly mixed to start with: 'Two bucketsful of water are first poured into the can, then three tablespoonsful of good green, well mixed with another halfbucketful of water and strained through a funnel-shaped strainer . . . . the use of which prevents the larger particles of the green from getting into the can and clogging up the sprinkler.'

"The exact method of mixing, however, is quite immaterial—only remembering that the powder should be thoroughly diffused through the water, not allowed to be in lumps; and also the methods are best which allow of the operator mixing without handling or inhaling the powder.

"For the above reasons, and also for convenience in mixing, the 'paste' form before-mentioned is preferable to the powder.

"*Mixture of flour with Paris-green.*—The addition of flour to the mixture of Paris-green has been found to answer here, and has been strongly advised in the United States, because of the greater adhesiveness thus given, and also because the difference of colour helps to show the amount that has been distributed on the leaves. 'Two or three pounds of flour' is an amount named as useful to add to a mixture of Paris-green in 40 gallons of water, but the precise quantity does not appear to be very important.

"Where the plan is adopted of mixing flour with the Paris-green, the following method has been advised:—To take a large galvanised iron funnel of capacity suited to the work; for filling a 40-gallon barrel a funnel of 13 quart capacity is noted. This funnel has inside it a kind of strainer (described as a 'cross-septum') formed of fine wire gauze, such as is used for sieves, and this also has vertical sides and a rim to keep it from rocking on the barrel. The quantity wished of cheap flour is placed in the funnel, and washed through the sieve-like wire gauze by water poured in; thus, the flour is finely divided and diffused in the water and the Paris-green subsequently added and washed down in the same way by addition of the rest of the water until the barrel is full.

"*In application of Paris-green sprayings, it must always be borne in mind that, whatever kind of engine or spraying machine is used, the mixture must be kept an even strength throughout, and no sediment allowed to form at the bottom or damage to leafage is sure to happen.*

"On these points Mr. Fletcher, the Dominion Entomologist of Canada, wrote to me as follows, and also enforcing care as to over-application:—

"'*Paris-green.*—You are quite safe in recommending this; but insist upon these two things, *viz.*, *first,* to keep the mixture (which is a mixture, not a solution) well stirred all the time, and have the barrel well washed out after it has been filled ten or twelve times. The Paris-green is very heavy, and will keep sinking to the bottom unless constantly agitated; and as the barrel is frequently re-filled the residue will keep accumulating, until it will be too strong as the mixture reaches the bottom.

"'*2ndly.* The other point is to insist upon the mixture not being made too strong; 1 lb. to 200 gallons I find very useful and I never use stronger than 1 lb. to 120 gallons.—(*J. F.*')

"*With regard to method of application of the spray.*—This should be thrown so finely as to reach all parts of the tree and both sides of the leaves, and coat the leaves as with a fine dew, but it should *not* be allowed to run down and drip. As soon as dripping begins spraying should cease.

"*It should on no account whatever be thrown* so as to 'swill' or 'souse' the trees, and run off the leaves in drops or streams; this is bad practice in every way. It uses a great deal more of the chemical than is needed; the leaves get little but pure water at their highest part, and much too strong application where the fluid has settled at the tips; and also a drip is caused on to the ground beneath, which may render the grass temporarily poisonous.

"*Also, spraying should not be done whilst the trees are in blossom,* and warning is also given in the American works that sprayings should not be given in rapid succession. Several days, it is advised, should elapse between, unless, of course, as may easily happen in difficulties of first experiments, the spray was manifestly so weak that the previous application counted for nothing. The effect of the Paris-green on the caterpillars does not always show directly, and it is undesirable to waste labour and material where the work is already done, and only requires a day or two to show it.

"*Non-feeding of animals under sprayed trees.*—As it is totally impossible to guard against what may be done by careless workers, or those who will not take the trouble to understand what they are about, in all *we* (that is to say, the Experimental Committee as a body and myself personally) are desired to advise on, we most scrupulously direct that *cattle and stock and other animals should never be allowed to pasture or feed under trees that are being, or have recently been, sprayed,* for fear of injury from feeding on Grass on which there may have been drip. We give no opening for possibility of mischief occurring from this cause where our advice is followed; but (having noted this duly) there is no harm in mentioning here that where the fine spraying is properly carried on, it is at least open to doubt whether any risk in the above way is incurred.

"In the course of reporting it appeared that one observer fed his mares and foals beneath the Paris-greened trees with no ill-effects. Mr. Lee Campbell, of Glewstone Court, Ross, also alluding to this point, wrote me: 'You will recollect that I sprayed the trees this year ten times with Paris-green, partly 2 oz. to the gallons and later with only one, and during the caterpillar season (in fact, all the year until the fruit was becoming ripe) fowls have had a free run all over the field.'

"With regard to Bees, as the trees should *not be sprayed when they are in blossom,* this gets over any fear of Bees being poisoned by sucking the honey.

"*Spraying machines.*—One great point, in selection of spraying machines, is that either by mechanical contrivances (when on a large scale), or in the portable forms, by arrangements which will make the movement of the bearer serve the same purpose, the mixture should be so kept in movement that the powder should not settle down. It is necessary to keep the mixture in agitation during application, and also it is necessary to have the barrel 'well washed out after it has been filled ten or twelve times.' If this is not done the mixture will very soon be too weak at the top and too strong at the bottom, and the gradually increasing settlement will presently (in all probability) cause a seriously too strong overdose. The mixture should be kept at an even strength throughout during the whole time of distribution, and also, as before mentioned, it should be so distributed that it will be thrown as a fine spray or mist, and will *rest and remain* on the sprayed leafage as a fine film or dew.

"*Various forms of apparatus would answer this purpose;* but to give mention of a few different kinds of spraying machines which have been found to answer here, there is, for use in fruit grounds where the trees are too closely packed with undergrowth for anything but a portable form to be admissible, the kind known as the knapsack sprayer. The knapsack pump, l'Eclair, No 1, is a can or reservoir which may be carried on a man's shoulders, and by means of a hose and nozzle throws a fine spray to the height of fourteen or fifteen feet. This spraying machine answers well so far as the spray reaches. It is procurable from the English Agents of M. Vermorel, Messrs, Charles Clerk & Co., Windsor Chambers, Gt. Helen's, London, E. C. Price 35s., packed and delivered in London, at any railway station.

"Another form of spraying machine is in a barrel holding about 36 gallons of water, fitted with powerful pump and two jets and sprayers, and also automatic dashers for keeping the fluid properly mixed. The pumps will draw to a height of thirty to forty feet.

"'The barrel is of course mounted on wheels, and has a pump fixed to the rear with two delivery pipes, to which are attached whatever length of tubing (India-rubber) may be necessary. Three men go with the apparatus, two men to spray and one to pump.' Under ordinary circumstances of wind this machine will spray three thousand trees in a day. The manufacturers are Messrs. Boulton and Paul, Rose Lane Works, Norwich. The price £8 15*s.*

"The Strawsonzier is another form of sprayer that, where fitted for vertical delivery, may be expected to be exceedingly useful. Information as to different forms of this "air drill," for throwing fluid or dust dressings, would be procurable from the manufacturers, Messrs. R. Hornsby & Sons, Spittlegate Iron Works, Grantham.

"In mentioning the above forms of sprayers, I in no way wish to infer that any kind is better than another, so long as it meets the essential requirements; but I am aware of the two first-named being successfully used. An ordinary garden engine *can be made* to serve the purpose, but this method involves great loss of material from quite unnecessary quantity of fluid spread abroad, and also great risk of over application to the leafage.[1]

Paris-green, or Emerald-green, as it is frequently called, is procurable at small cost. Probably retail traders would not furnish the pure article under 1*s.* 6*d.* to 1*s.* 3*d.* per pound according to quantity; but Messrs. Blundell, Spence & Co. (Limited) of Hull, and 9, Upper Thames Street, London, Colour Manufacturers and Exporters, with whom I have had much correspondence on the subject, inform me that they would deliver quantities of 14lb. and upwards, carriage paid, at 1*s.* per pound packed in 1lb. paper parcels, or in the paste state in large glass jars of 4 and 7lb. at the same price, jars free.

"The Paris-green is also procurable from Messrs. Hemingway & Co., of 60, Mark Lane, London, E.C., and doubtless from many other good and reliable firms.

"I understand that, in order to lessen difficulties arising from the 'green' powder settling down in the water, it is the intention of Messrs. Blundell, Spence & Co. in the coming season to grind the pulp or paste (that is the Paris-green powder damped with water) to a much finer condition, so that the particles of powder being in this finer state will be much less liable to sink to the bottom of the fluid. This will be a great improvement, and the issue of this paste in glass jars will prevent difficulties regarding corrosion of metal caused by chemical action of the Paris-green.

[1] Wherever any variation is made in form in which the Paris-green is procured, experiment as to strength of application safe to leafage should always be made before use on a large scale.
Observations now going on show that an ordinary Garden engine (small barrel with two wheels) fitted with a Scott's nozzle answers excellently—*E. A. O.—April 7.*

This is a point that should be borne in mind in the use of iron or galvanised iron pumps or apparatus. These should be carefully washed out before being put away, or the bottoms may be corroded away by chemical action.

The above observations refer solely to the use of Paris or Emerald-green as an application—*simply mixed with water for destruction of moth caterpillars* in the way in which we have found by many years' experience in America, and now by our own here, that with proper regard to directions and cautions, the work may be carried on with safety and great benefit."

In a note, dated 21st April 1891, Miss Ormerod adds :—

"At present the number of kinds of 'sprayers,' or the improvement in details goes on so fast that in my reports I can hardly keep up with the advance. We now find that Mr. Scott's nozzle answers most excellently, and with this and an ordinary garden engine (small barrel with two wheels) we can send a most beautiful spray to the top of any plum-tree. . . . . .

Messrs. Blundell, Spence & Co., of Hull, are issuing Paris-green *damped* in bottles. This is an immense improvement, for it cannot fly, be the mixers as unhandy as they please. Also, the powder being ground, extra fine does not settle as much as under ordinary circumstances."

INSECTICIDE WASHES AGAINST DATE PALM SCALE.[1]

(*Reprint of a report published in "Insect Life," Vol. III, p. 441, by the United States Entomological Department.*]

About July 8th, 1890, the Department of Agriculture received from Algiers, Africa, nine date-palm trees, two to four feet high after having been cut off at the top, and probably from seven to ten years old from suckers.

About the 1st of August, fifty-four small trees of date palm were received from Cairo, Egypt, one to two feet high and about three years old from suckers. These trees were all badly infested with a species of *Parlatoria* which proved, on comparison, to be identical with *P. zizyphi*, Lucas. As it was the intention of the department to establish these trees in California, and it was highly undesirable to introduce the scale with them, the entomologist was instructed to take steps to destroy the insects and free the plants. The efforts to do so are of interest in view of the great difficulty experienced in effecting the *complete* extermination of the scales by the use of the insecticide washes which our experience has shown to be so successful against the various introduced and native scale-insects of our orchards.

The difficulty was in part due to some peculiarity of the scales themselves, and also to the fact that they were so thickly massed that the underlying insects were at first not reached by the insecticides. It emphasizes the necessity of abundant caution in all similar cases and the need of the most thorough and intelligent supervision.

The first lot of trees were sprayed about the middle of July and the second lot about the 1st of August with kerosene and soap emulsion diluted fifteen times. August 16th the plants were still, in many places, covered with live Scales and were all again sprayed with the kerosene emulsion diluted *ten* times. August 18th and 19th examination showed a considerable percentage of seemingly healthy scales. The trees were uninjured. Two test sprayings were then made as follows: Two of the younger lot of trees were sprayed with the resin wash made after Coquillett's formula (see Bulletin No. 22), and two were sprayed with the kerosene emulsion diluted only five times. These trees were examined August 22nd and September 2nd, and the effect of these applications noted

[1] Scale insects attack palms of various kinds in India, and the following report, therefore, is interesting as showing the difficulty of eradicating the pest.—ED.

as follows :—The resin treatment was practically without value and had no injurious effect on the plants ; the trees treated with the kerosene were, August 22nd, somewhat yellowed and injured and the scales were all apparently dead. Later, September 2nd, the plants had partly regained their normal colour and no living scales were found.

On September 5th all the trees were carefully examined, and about 5 per cent. of living scales were found, showing that many of the scales, at first apparently unaffected by the earlier washings, had eventually succumbed.

It was hoped that the remaining living scales had been affected and would die, but examination, September 18th, showed about the same percentage of healthy scales and also a few young. The trees were then thoroughly washed with a stiff brush to remove the loosely adhering dead scales and were again sprayed, October 4th, with a newly made and excellent kerosene and soap emulsion, diluted eight times. Continuous rains fell on the 6th and 7th, and on October 8th very few living and apparently healthy scales were found. October 9th the application of the emulsion in the same proportion was repeated, the rain having vitiated the preceding application. This spraying, we believe, affected the final and complete extermination of the scales, but, as the trees stood these applications without injury, to put the matter of extermination beyond doubt, and as a final precaution, they were again all sprayed, and were shipped October 10th.

It will be noted that the earlier sprayings were practically successful, 90 to 95 per cent. of the scales eventually dying; but in this instance it was essential that not a single scale should escape or the work would have been valueless, and hence the necessity of the additional treatments. A further outcome of these experiments is the very evident fact that the date palm is not apt to be injured even by the application of very strong kerosene washes, repeated at comparatively short intervals.

Government of India Central Printing Office.—No. 736 R. & A. D.(77)—27-1-92.—1,000.

Vol. II.] [No. 6.

A CONSPECTUS OF THE INSECTS WHICH AFFECT CROPS IN INDIA(1).

[*N.B.*—In the following conspectus the words *large*, *small*, *minute*, etc., as applied to insects, are merely intended to indicate their relative size as compared with other species in the same order.]

Contents.

THE following conspectus, which has been drawn up by the direction of the Trustees of the Indian Museum on the suggestion of the Government of India, comprises the insects and mites which have, up to the present, been noted as attacking crops in India. To complete the subject the parasitic species have been included, as some of them are of great importance to Indian agriculture, on account of the wonderful effect which they have in keeping down injurious insects. The list is as complete as it has been possible to make it in the present state of information on the subject, but much of it will no doubt require modification, and a large number of additions will have to be made when further investigation comes to be instituted in the field. The species have been arranged in the first instance in zoological order, so that the ones which are related to each other in structure and habits may be placed side by side. In accordance with a suggestion made by the Government of India, tables have been added in which the primary arrangement is accorded to the plants and other products attacked by the insects. These tables are divided under the headings of—I, Agricultural plants and produce; II, Forest and fruit-trees and their produce; III, Miscellaneous. They are likely to prove useful for purposes of reference, but it should be noticed that they are necessarily very incomplete; for what is at present known on the subject of insect pests in India is chiefly derived from the reports and specimens that have been sent to the Indian Museum by people who, with few exceptions, have no special knowledge of entomology. The chief object of the senders, in the great majority of cases, has been merely to learn the name of the insect and to secure any information that might be forthcoming in the Museum on the subject of the best practical methods of dealing with it. Except, therefore, in cases where subsequent attacks of other crops, by similar insects, have happened to offer special features of fresh interest, the information received has generally related to the attack of the crop on which the insect was first noticed. The result is that, while the conspectus will probably be found to contain references to the majority of the insects which have lately proved destructive to

(1) Help with the botanical names of the plants referred to in this paper has been most kindly afforded by Mr. J. F. Duthie, Director of the Botanical Department, Northern India.

any very large extent in India, it is certain to be very deficient in the list of crops and other products which these pests attack. This defect is being gradually remedied as information accumulates, but progress is necessarily slow.

Extent to which the habits of the insects are known.

The habits of many of the insects that are recorded in this conspectus have been more or less completely traced in India, and the number of such species is constantly increasing. With regard to the remainder, although little has been done in observing them in India, yet, in the great majority of cases, a good deal is known as to the main features of their habits; for almost all of them are allied to, and some of them are actually identical with, species which have been kept under observation in other parts of the world. It is true that in some instances closely allied species are found to have very different habits, but the cases where this is likely to happen are fairly well known, so that upon the whole it does not seriously interfere with the reliability of the deductions that can be drawn from the work that has been done elsewhere.

Their relative importance.

With regard to the relative importance of the insects that have been included, some of them (*e.g.*, the *mosquito blight* of tea, the *coffee borer* and *green bug* of coffee, the *cut worms*, *sapper*, and *hispa* of rice, the *borer* of sugarcane, and the *weevil* of wheat) are known to do great damage in India; these are printed in capital letters to distinguish them from the majority of the species which, though they attack crops and are always liable to increase so as to do serious damage, are not actually known to have done so as yet. As information accumulates, many of the insects at present only recorded as occurring on crops will no doubt have to be transferred to the ranks of those which are known to do serious damage, while it will be possible to weed out others to form a third division of such insects as attack crops but are of no economic importance. In the present stage of the investigation the division of the insects, which are known to attack crops in India, into two groups, is all that can profitably be attempted.

The difficulty in identifying species.

The difficulty in identifying insects is very great, for there are at least twenty thousand different kinds of insects in India already described, besides a vast number of minute species which have hitherto been very much neglected by entomologists, though many of them are of great importance economically. Each of these insects passes through several stages of growth, which generally have no more resemblance to each other than the silk worm has to the moth into which it changes. Again, in the great majority of cases, the injury to the crops is done by immature insects. Now, the immature forms of different insects are

often so much like each other that entomologists are sometimes unable to determine precisely what an insect is, unless they are able to examine mature specimens. Mature specimens, however, are often difficult to get, for some insects take years in developing, while others are not easily reared under artificial conditions. Even when the mature form is forthcoming, the determination of the species does not by any means follow as a matter of course, for many insects, when full grown, still have much superficial resemblance to other insects, though in reality they may differ from them in important points. Again, the confusion which has been widely introduced into entomological writings, owing to the indiscriminate manner in which new species have again and again been described on evidence obtained solely by examining limited collections of dried specimens, has added what is at present perhaps the greatest stumbling-block in the way of arriving at the correct identification of Indian insects. It is generally impossible therefore to identify a species with certainty from a description, unless the description is a very minute one, and even then mistakes are always liable to occur, unless comparison can be made with authentically identified specimens. A treatise, therefore, of some length would be required to give sufficient descriptions to make it possible even to attempt the identification of all the insects that are noticed in this paper; and as the principal object in the present instance is to give a list of the species which affect crops, it has been thought best merely to notice roughly what a few of the more important of them look like superficially, disregarding the fact that the same remarks would very often apply equally to other insects with different habits.

The extent to which the Native names are reliable.

Much reliance cannot be placed in the accuracy of the Native names that are quoted; for, although some names appear to be used with great constancy for denoting particular insects (as, for example, *gandhi* for the rice sapper—*Leptocorisa acuta* of Bengal), in many instances they seem to be used loosely and to have little more significance than such popular English terms as *caterpillar, weevil, grub,* and *locust,* all of which cover a multitude of distinct species—many of them with very different habits. Besides the inaccuracy due to the indefinite significance of many of the names themselves, great carelessness has also been noticed in the naming of some of the specimens that have been sent to the Museum, as, for instance, where some butterfly caterpillars and red Hemiptera were sent in one bottle under a single Native name, though it is scarcely credible that any one could have supposed that such different creatures were forms of one and the same animal. Again, what is apparently one name often appears under several forms (*e.g.*, *pamari, paruli,* and *pavali,* all

for the rice *Hispa*). The disentanglement of this subject requires more local knowledge than is possessed by the writer, and in the following paper therefore he has contented himself with quoting the native names that have been furnished to him, merely omitting the ones that are obviouly misleading.

COLEOPTERA = BEETLES.

Cicindelidæ = Tiger beetles.

1. *Cicindela sexpunctata* Fabr.—An active beetle, which devours other insects. Reported from Chumparun as very effectual in destroying the *Rice sapper* (*Leptocorisa acuta*).

Carabidæ = Ground beetles.

2. *Calosoma orientale* Hope.—An active black beetle, about the size of a small cockroach: it feeds on other insects, and has been reported as very useful in the Punjab in destroying young locusts of the species *Acridium peregrinum*.

Trogositidæ.

3. *Trogosita mauritanica* Linn.—A small brown beetle, which in its grub stage does some injury to stored wheat (*Triticum sativum*) in Bengal, but which in its beetle stage is said to feed upon the Tineid moths, which are also destructive in granaries.

Cucujidæ.

4. *Silvanus surinamensis* Linn.—A tiny little brown beetle, with white active grubs, which is a common warehouse pest in India. It has been reported as destructive to ships' biscuit in Calcutta and to cholum (*Sorghum vulgare*) seed in Madras. It has also been found in date (*Phœnix dactylifera*) fruit in the Calcutta bazar.

Dermestidæ.

5. *Dermestes vulpinus* Fabr.—A little dark coloured beetle, with white hairy grubs, which is a common warehouse pest. It has been reported as destructive to stored silk cocoons in Rajshahye, also as destructive to badly preserved skins.

6. *Æthriostoma undulata* Motsch.—(*Trogoderma sp.*, of the British Museum)—A little brown beetle, with white hairy grubs, known as *Kapra* in the Delhi bazaar, where it is said sometimes to destroy as much as six or seven per cent. of wheat (*Triticum sativum*) stored in godowns.

Lucanidæ = Stag beetles.

7. *Lucanus lunifer* Hope.—A big dark-green coloured beetle, the male with enormously developed jaws. It is thought to be the species reported as very destructive in Naini Tal to oak trees (*? Quercus sp.*) into the wood of which the grubs tunnel (*Thompson*).

Melolonthini = Cockchafers or White grubs.

8. LACHNOSTERNA IMPRESSA Burm.—A thick-set brown beetle, with curved white fleshy grubs, which were reported as very destructive in gardens in Darjeeling in the year 1883. The insect did a great deal of damage to young tea (*Camellia theifera*) plants in the same district in October 1891.

9. *Lachnosterna pinguis* Walker.—Said to be one of the insects known as *white grub*, which have proved very destructive to coffee (*Coffea arabica*) bushes in Ceylon. The insect is chiefly known by the curved white fleshy grubs which are found in the ground about the roots of the coffee bushes on which they feed.

10. *Ancyclonycha sp.*—Another of the insects known as *white grub* in Ceylon coffee (*Coffea arabica*) estates (Nietner).

11. *Undetermined cockchafer larvæ* were reported as very destructive to paddy (*Oryza sativa*) and maize (*Zea Mays*) in Chittagong in 1881.

Dynastini = Goliath beetles.

12. ORYCTES RHINOCEROS Linn.—A large black or brown beetle, with a protuberance like the miniature horn of a rhinoceros on the upper part of its head. It has been reported as very injurious to palm trees, especially cocoanut (*Cocos nucifera*) palms in Madras and Singapore; it has also been noticed in Calcutta. The Cinghalese name for it is said to be *Gascooroominga*. It damages palm trees by cutting large holes through the young leaf shoots.

Buprestidæ.

13. *Chrysobothris sex-notata* Gory.—Thought to be the insect reported by Mr. Thompson as boring into sâl (*Shorea robusta*) wood after it is felled, sometimes rendering the timber unfit for use.

14. *Psiloptera fastuosa* Fabr.—Said to attack teak (*Tectona grandis*) trees in Malabar.

15. *Belionota scutellaris* Fabr.—Thought to be the insect reported by Mr. Thompson as boring into the wood of the *khair* tree (*Acacia Catechu*).

16. *Sphenoptera gossypii* Kerremans.—A small species, which has been reported to injure cotton (*Gossypium herbaceum*) plants in Nagpur, the larvæ tunneling into the stems.

17. *Undetermined Buprestidæ.*—A large species, said to tunnel into mango (*Mangifera indica*) trees (Thompson); also a small species said to attack *chir* (*Pinus longifolia*), sometimes rendering the wood unfit for beams (Thompson); and a species which has been sent to the Museum as boring into poplar (*? Populus euphratica*) trees in Baluchistan. (*N.B.*—In the case of the Buprestidæ the injury is done by the immature insect which tunnels into timber. The larvæ are flattened legless grubs, with the front portion of the body expanded laterally).

Ptinidæ.

18. *Gibbium scotias* Fabr.—A tiny brown beetle, reported from Behar as injuring the outer portion of opium (*Papaver somniferum*) cakes by tunneling into them.

19. Lasioderma testaceum Duft. (the Cheroot weevil).—A little brown beetle with white grubs. It is said to seriously interfere with the trade in Indian tobacco (*Nicotiana Tabacum*). It has also been noticed as attacking stored rice (*Oryza sativa*), saffron (*Crocus sativus*), and the leaf coverings of opium (*Papaver somniferum*) cakes. The larvæ tunnel through and through the substances they attack, making holes the biggest of which are about a sixteenth of an inch in diameter.

20. *Rhizopertha pusilla* Fabr.—A little brown beetle, which is a common warehouse pest. It has been reported in India as attacking stored wheat (*Triticum sativum*), cholum (*Sorghum vulgare*) seed, and ships' biscuits.

21. Dinoderus sp. (the Bamboo insect).—A small brown beetle with white grubs. It is very destructive to bamboos (*Bambusa sp.*) in all parts of India. It is said to be known in the North-Western Provinces as *ghoon* and in Mysore as *cootee*. The minute holes with which bamboos are so often studded are the work of this insect.

22. *Cœnophrada anobioides* Waterh. *Bostrychus sp.* and *Sinoxylon sp.* Small black beetles, all of which have been reported as tunneling into guava (*Psidium Guava*) trees in Hazaribagh.

Tenebrionidæ.

23. *Opatrum depressum* Fabr.—A little flat beetle, which has been reported as attacking linseed (*Linum usitatissimum*) and wheat (*Triticum sativum*) plants.

24. *Tribolium ferrugineum* Fabr.—A tiny little, brown beetle, which is a common warehouse pest in India. It has been reported as damaging ships' biscuit in Calcutta.

25. *Obscure Tenebrionid larvæ* have been reported fom Mysore as damaging sandalwood (*Santalum album*) trees by boring into the stems.

Cantharidæ = Blister beetles.

26. *Epicauta rouxi* Cast, also *E. tenuicollis* Pall. Said to attack cholum (*Sorghum vulgare*) plants in Madras.

Curculionidæ = Weevils.

27. Calandra oryzæ Linn. (the Wheat and Rice Weevil of India).—Very destructive to stored wheat (*Triticum sativun*), rice (*Oryza sativa*), and cholum (*Sorghum vulgare*) seed. Known in the Delhi bazar as *sulsi*.

The loss occasioned by this insect to wheat exported from India has been estimated at as much as 2½ per cent. The insect itself is a tiny brown beetle, with long snout and elbowed antennæ. Its young are little white legless grubs, which inhabit the grains.

28. Rhynchophorus ferrugineus Oliv.—The larvæ of this large weevil are white fleshy legless grubs; they tunnel into the trunks of date (*Phœnix dactylifera*), cocoanut (*Cocus nucifera*) and other palms in India, and kill a large number of trees.

29. *Cyrtotrachelus dux* Bohem.—A large brown weevil, the male with enormously developed fore legs, has been reported as destroying the young succulent asparagus-like shoot of the hill bamboo (*Dendrocalamus Hamiltonii* in Sikkim.

30. *Calandra sp.*—Said to damage stored opium (*Papaver somniferum*) seed (Scott).

31. *Cryptorhynchus mangiferæ* Fabr.—A small earth-coloured weevil, with white legless grubs. It is said to be very destructive to mango (*Mangifera indica*) fruit in Bengal and Sylhet.

32. *Astycus lateralis* Fabr.—A small greenish weevil, reported in the beetle stage as defoliating mulberry (*Morus*) bushes in Rangoon. Also thought to be the species which has been reported by Mr. Thompson as tunneling into the timber of *chir* (*Pinus longifolia*) in the North-Western Provinces; in this case the injury is no doubt done by the larvæ.

33. *Sipalus granulatus* Fabr.—Thought to be the species which has been reported by Mr. Thompson as tunneling into Dhak (*Butea frondosa*) in the North-West Provinces.

34. *Desmidophorus hebes* Fabr.—Reported as attacking Hibiscus plants in Durbhanga.

35. *Sitones sp.*—A small weevil, thought to belong to this genus, has been reported as destructive to opium (*Papaver somniferum*) seedlings in Ghazipur.

36. *Arhines destructor* Neitner.—Said to attack the leaves of coffee (*Coffea arabica*) bushes in Ceylon, occasionally doing considerable injury (Nietner).

37. *Cylas turcipennis* Nietner.—Said to be destructive to sweet potatoes (*Ipomœa Batatas*) in Ceylon (Nietner).

38. *Sphœnophorus planipennis* Nietner.—Said to injure cocoanut (*Cocosnucifera*) trees in Ceylon (Nietner).

39. *Apion strobilanthi* Desbroch.—Reported as destructive to the seed of the herbaceous weed (*Strobilanthes pectinatus*) in Sikkim.

40. *Undetermined Curculionidæ larvæ* have been reported as very destructive to young mahogany (*Swietenia Mahagoni*) trees in the Western Dooars. They were found tunneling beneath the bark.

41. *A minute undetermined weevil,* said to have been excessively destructive to the seed of sâl (*Shorea robusta*) trees in the North-Western Provinces in the year 1863 (Thompson).

42. *A small undetermined weevil,* reported as destroying 90 per cent. of the seed of the forest tree (*Quercus pachyphylla*) in Darjeeling.

Scolytidæ.

43. *Trypodendron domesticum* Linn., also *T. signatum* Fabr.—Minute brown beetles, which are said to attack the casks in which beer is shipped to India.

44. Xyleborus perforans Wollast. (=*X. saxeseni* Dist.).—A little brown beetle, considerably bigger than the preceding. It is thought to be the species which so often drills small holes into the staves of casks in which beer is shipped to India. It is also said to have proved very destructive to sugarcane (*Saccharum officinarum*) in the West Indies, and is likely to prove troublesome in a similar manner in India.

45. *Diapus impressus* Janson.—A minute brown beetle, reported as tunneling into oak stumps (*Quercus sp.*) in the North-West Himalayas.

46. *Polygraphus sp.* (allied to *P. pubescens* of Europe).—A minute brown beetle, reported as tunneling into the bark of *Pinus excelsa* trees. It is not thought to do any very serious injury.

47. *Pityogenes scitus* Bland.—A minute brown beetle, which tunnels into the shoots of conifers. Little is known about it.

48. *Platydactylus sexspinosus* Motsch.—A small brown beetle, reported as destructive to paddy (*Oryza sativa*) in Burma. The injury is due to its tunneling into the stalks.

49. *Undetermined species of Scolytidæ,* perhaps identical with some of the above, have been noticed as very destructive in India to the oak (*Quercus incana*) ; also to immature sâl (*Shorea robusta*) and *chir* (*Pinus longifolia*) timber. Like the bamboo borer (which, however, belongs to a different group of beetles), these insects are known in the North-West Provinces as *ghoon* (Thompson).

Bruchidæ.

50. Bruchus chinensis Linn.—The small brown gram weevil of Calcutta. It is very destructive to stored pulses (*Cajanus indicus,* etc.). It is said to be known in Nuddea as *Ghora poka,* and in Ganjam as *Pesala puruga.* The larvæ are little white grubs which inhabit the pulse seeds.

51. *Bruchus emarginatus* Allard. *var.*—The large grey pea weevil of the Calcutta bazar. It attacks stored peas (*Pisum sativum,* etc) exactly as the gram weevil attacks pulses.

52. *Caryoborus gonagra* Fabr.—A small brown beetle about the size of a pea. Its larvæ, which are little white legless grubs, do some damage to the tamarind (*Tamarindus indica*) in Calcutta, by tunneling into the seed.

53. *Bruchus sp.*—Said to damage stored poppy (*Papaver somniferum*) seed (Scott).

Cerambycidæ = Longicornes.

54. Xylotrechus quadrupes Chevr.—*The coffee—borer* of Southern India and the *white* or *Indian borer* of Ceylon coffee planters. This is a slender beetle about three quarters of an inch in length; it proved exceedingly destructive to coffee (*Coffea arabica*) in Southern India about the year 1867. As in the case of other Cerambycidæ the larva is a white fleshy legless grub, with powerful jaws and hardened cuticle suitable for its life in the wood of the coffee stem. The damage is due to the holes which the grubs bore into the stems of the coffee bushes.

55. *Cœlosterna scabrata* Fabr.—The *sâl girder*. Reported as damaging sâl (*Shorea robusta*) trees in Oudh. A large thick-set beetle with long antennæ. It damages the tree by ringing the shoots in order to render them suitable for the reception of its eggs.

56. *Plocederus obesus* Gahan. (= *P. pedestris* Cotes). Reported as tunneling into sâl (*Shorea robusta*), jingham (*Odina Wodier*), and into dhak (*Butea frondosa*). It is a brown beetle, about an inch and a half in length, with long antennæ. When full grown, its larva shelters itself in a curious egg-like case which is to be found in the burrow in the timber.

57. *Neocerambyx holosericeus* Fabr. (= *Cerambyx vatica* Thompson). —Reported as attacking sâl (*Shorea robusta*) and sâj (*Terminalia tomentosa*) in the North-West Provinces, also teak (*Tectona grandis*) in Kulsi, Assam. It is a large beetle, covered with golden pubescence.

58. *Stromatium barbatum* Fabr.—Noticed as attacking the sapwood of dry khair (*Acacia Catechu*) wood in the Dehra Forest School Museum, also packing-cases made of dealwood (*Pinus sp.*) in Calcutta, and growing teak trees (*Tectona grandis*) in the Kulsi plantation.

59. *Batocera rubus* Short. = *Curuminga* of the Cinghalese.—A large beetle said to tunnel into cocoanut (*Cocos nucifera*) trees (Short).

60. *Batocera sp.* Said to bore into the wood of the wild willow tree (*Salix tetrasperma*) (Thompson).

61. *Monohamus soongna* Thompson (= *Batocera sp.*).—Said to attack a number of trees, including the *seemul* (*Bombax malabaricum*), the soangna (*Moringa pterygosperma*), and the roongra (*Erythrina suberosa*), much injury being often done by it (Thompson).

62. *Stromatium asperulum* White, and *Ægosoma lacertosum* Pascoe. —Both reported as tunneling into teak (*Tectona grandis*) in the Kulsi plantation.

Chrysomelidæ.

63. Hispa ænescens Baly (the rice Hispa of Bengal).—Very destructive to young paddy (*Oryza sativa*) plants. A small beetle, dark green in colour, covered with minute prickles. Like other Chrysomelidæ, it injures the plant by feeding on the leaves. The Native names of the insect, as reported from Lower Bengal, are *paruli, pavali poka, pamari, sanki, shankipoka,* and *sankapoka*; while in Chittagong it is said to be known as *Burma chandali,* and in Durbhunga as *kal* or *mudhwa.*

64. *Diapromorpha melanopus* Lacord. (known as the *Orange beetle*). —A small yellow beetle, reported as attacking tea (*Camellia theifera*) shoots in Sibsagar, Assam.

65. *Aulacophora abdominalis* Fabr. A small yellow beetle, reported from Saharanpore as attacking *Cucurbitaceæ* of all kinds; from elsewhere in the North-West Provinces it has been reported as attacking water caltrop (*Trapa bispinosa*); from Ganjam it has been reported as attacking cotton (*Gossypium herbaceum*), gram (*Cicer arietinum*), and cucumber (*Cucumis sativus*); from Nuddea it has been reported as "injurious to plants and vegetables;" while from Hooghly it has been reported as attacking paddy (*Oryza sativa*).

66. *Aspidomorpha militaris* Fabr.—A little golden-coloured shield-shaped beetle, with black markings. Reported as defoliating Convolvulaceæ.

67. *Haltica nigro-fusca* Pearson.—Said to attack the leaves of garden vegetables in the Himalayas, also indigo (*Indigofera tinctoria*) in Rungpore (Pearson).

68. *Chætocnemis basalis* Baly.—Said to attack paddy (*Oryza sativa*) seedlings in Burma (Shipley).

Coccinellidæ = Lady-bird beetles.

69. *Chilocorus circumdatus* Schonh.—A little beetle, said to prey upon the *brown bug* (*Lecanium coffeæ*) of coffee (*Coffea arabica*) bushes in Ceylon (Nietner).

70. *Scymnus rotundatus* Motsch.—Said to prey on the *white bug* (*Pseudococcus adonidum*) of coffee (*Coffea arabica*) bushes in Ceylon (Nietner).

71. *Epilachna viginti-octo-punctata* Fabr.—This insect (contrary to the usual habits of the members of the family) has been found defoliating pumpkin (*Cucurbitaceæ*) in Dehra. It is also reported as destroying whole fields of brinjal (*Solanum Melongena*) plants in Burdwan, and as attacking this plant in Balasore.

HYMENOPTERA.

Formicidæ.

72. *Solenopsis gemminata* Fabr.—An ant, thought to belong to this species, reported as injuring potato (*Solanum tuberosum*) tubers in Thayetmyo, Burma.

Ichneumomidæ.

73. *Pimpla punctator* Linn.—A yellow and black wasp-like insect with long body. It is parasitic upon the caterpillars of a number of wild silk moths.

74. *Pteromalus oryzæ* Cameron.—A minute coppery-green coloured insect, believed to be parasitic upon the wheat and rice weevil (*Calandra oryzæ*).

Chalcididæ.

75. *Chalcis* (*Brachymeria*) *euplœa* Westw.—Parasitic on the Dooars tea and sâl caterpillar (*Dasychira thwaitesii*). It is a little four-winged insect, about the size of a house fly.

76. *Chalcis criculæ* Kohl.—Said to be parasitic on wild Cricula silkworms in Ranchi.

77. COTESIA FLAVIPES Cameron.—A minute fly-like insect, which is parasitic upon the sorghum-borer (? *Diatræa saccharalis*). It has been noticed as very effectual in keeping this destructive borer in check.

78. *Aphelinus theæ* Cameron.—A minute fly-like insect, said to attack the tea scale bug (*Chionaspis theæ* Maskell).

79. *Cirrhospilus coccivorus* Motsch. MS.—Said to be parasitic on the brown bug (*Lecanium coffeæ*) which attacks coffee (*Coffea arabica*) in Ceylon Nietner).

80. *Encyrtus nietneri* Motsch.—A minute yellowish fly-like insect, said to be parasitic both on the brown bug (*Lecanium coffeæ*) and also on the white bug (*Pseudococcus adonidum*) which attack coffee (*Coffea arabica*) in Ceylon (Nietner).

81. *Encyrtus paradisicus* Motsch. MS.—Said to be parasitic on the brown bug (*Lacanium coffeæ*) of Ceylon (Nietner).

82. *Scutellista cyanea* Motsch.—Said to be parasitic on the brown bug (*Lecanium coffeæ*) of coffee (*Coffea arabica*) in Ceylon (Nietner).

83. *Marietta leopardina* Nietner.—Said to be parasitic on the brown bug (*Lecanium coffeæ*) in Ceylon. (Nietner).

84. *Chartocerus musciformis* Motsch.—Said to attack the white bug (*Pseudococcus adonidum*) of coffee (*Coffea arabica*) in Ceylon (Nietner).

85. *Cephaleta purpureiventris*, Motsch., *C. brunneiventris* Motsch., also *C. fusciventris* Motsch. MS.—Said to be parasitic on the brown bug (*Lecanium coffeæ*) of coffee (*Coffea arabica*) in Ceylon (Nietner).

Proctotrupidæ.

86. *Platygaster oryzæ* Cameron.—A minute fly-like four-winged insect which attacks the rice fly (*Cecidomyia oryzæ* W. Mason).

RHOPALOCERA = BUTTERFLIES.

Lycænidæ = Blues and coppers.

87. *Virachola isocrates* Fabr.—The caterpillar of this graceful purplish butterfly bores into loquat (*Eryobotrya japonica*), guava (*Psidium Guava*), and pomegranate (*Punica Granatum*) fruit, but does not often occasion any very extensive injury (De Niceville).

88. *Lampides elpis* Godart.—The caterpillar of this butterfly has been reported to tunnel into cardamom (*Elettaria Cardamomum*) seeds in Ceylon, where it is said to do a considerable amount of injury.

Pierinæ = White butterflies.

89. *Mancipium nepalensis* Grey.—The caterpillar of this butterfly has been reported as attacking gram (*Cicer arietinum*), linseed (*Linum usitatissimum*), sugarcane (*Saccharum officinarum*), and other plants in Umballa.

Papilionidæ = Swallow-tailed butterflies.

90. *Papilio erithonius* Cramer (also allied species).—The caterpillars of these large butterflies have been reported as doing a considerable amount of damage by defoliating young oranges (*Citrus Aurantium*) and lemon (*Citrus medica*) trees in different parts of India.

Hesperidæ = Skippers.

91. *Gangara thyrsis* Fabr.—The caterpillar of this butterfly has been reported as destructive to the leaves of cocoanut palms (*Cocos nucifera*) in Malabar.

92. *Suastus gremius* Fabr.—The caterpillar of this butterfly has been reported as attacking paddy (*Oryza sativa*) in Bangalore, where it is said to be known locally as *Pattanai*. (Information somewhat doubtful.)

HETEROCERA = MOTHS.

Ægeriidæ, Cossidæ, Hepialidæ and Allies.

(Caterpillars all wood-borers.)

93. SPHECIA OMMATIÆ-FORMIS Moore (Ægeriidæ).—The caterpillar of this moth is said to do considerable damage to poplar (? *Populus euphratica*) trees in Baluchistan by tunneling into the stem close to the ground. The moth is a brightly coloured insect, which looks superficially almost exactly like a big yellow and brown wasp.

94. ZEUZERA COFFEÆ Nietner (Cossidæ).—Known as the *red borer* of coffee (*Coffea arabica*) bushes in Southern India. The caterpillar tunnels into coffee stems and has been reported to do considerable damage on coffee estates. It has also been reported as tunneling into the stems of tea (*Camellia theifera*) bushes in Ceylon and Cachar, and into the stems of young sandalwood (*Santalum album*) trees in Mysore. The moth is a fluffy white insect, speckled with dark greenish spots. The caterpillars are reddish grubs.

95. *Phassus purpurescens* Moore (Hepialidæ). The caterpillar of this moth is said to tunnel into the wood of cinchona (*Cinchona sp.*) in Ceylon (Moore).

96. Undetermined caterpillars belonging to this group of wood-borers have been reported as follows:—(1) a large red caterpillar, probably belonging to the genus Zeuzera, reported as very destructive to teak (*Tectona grandis*) trees in Travancore; (2) caterpillars said to attack teak in Nilambur, Malabar; (3) caterpillars said to be very destructive to the charcoal tree (*Sponia orientalis*) in South India (Bidie); (4) caterpillars reported as doing serious damage to orange (*Citrus Aurantium*) and guava (*Psidium Guava*) trees in Lucknow.

Psychidæ = Bag worms.
(*Caterpillars inhabit cases.*)

97. *Babula grotei* Moore.—The caterpillar of this little moth shelters itself in a cone-shaped case which it carries about upon its back. It defoliates ornamental bushes, such as *Lagerstræmia* and roses (*Rosa sp.*), in Calcutta. It is also thought to be the species which has been reported as attacking the gallnut tree (? *Terminalia Chebula*) in the Madras presidency.

98. *Eumeta crameri* Westw.—The caterpillar of this moth builds a case almost exactly like a miniature faggot of sticks, in the middle of which it lives. It has been reported as defoliating tea (*Camellia theifera*) bushes in Assam, Sikkim, and Ceylon, but does not appear to occasion any very serious injury. It is sometimes known as the *Faggot worm.*

99. *Eumeta sikkima* Moore.—The caterpillar of this moth builds a large rough case out of bits of leaves and stick. It is said to defoliate sâl (*Shorea robusta*) trees in Sikkim, occasionally also attacking tea (*Camellia theifera*) bushes. It does not seem to do much damage.

100. *Govisana bipars?* Walker.—The caterpillar of this moth has been reported as defoliating tea (*Camellia theifera*) bushes in Sikkim; it is said sometimes to kill the bushes by stripping off the bark to form its case.

101. An undetermined *Psychid* has been reported as defoliating tea (*Camellia theifera*) plants in Ranchi.

Limacodidæ.

102. *Parasa lepida* Cramer (= *Limacodes graciosa* Nietner).—Known as the "Blue-striped nettle grub" by Ceylon planters; has been reported as defoliating tea (*Camellia theifera*) and coffee (*Coffea arabica*) bushes in Ceylon (Nietner and Green).

103. *Narosa conspersa* Walker.—Said to attack the leaves of coffee (*Coffea arabica*) bushes in Ceylon (Nietner).

104. *Natada velutina* Kollar, or an allied species, reported as defoliating young mango (*Mangifera indica*) trees in Poona.

105. *Parasa sp.*—A slug-like caterpillar, thought to belong to this genus, has been reported as attacking young gram (*Cicer arietinum*) plants in Ganjam. The local name given for the insect was *Aku-telu*.

106. *Undetermined Limacodidæ* have been reported as follows:—(1) caterpillars destructive to paddy (*Oryza sativa*) in the Bhamo district, Burma: (2) caterpillars which defoliated tea (*Camellia theifera*) bushes in the Darrang district, Assam: (3) caterpillars which defoliated young mahogany (*Swietenia Mahagoni*) trees in Bangalore.

Notodontidæ.

107. *Stauropus alternus* Walker, or the "Lobster caterpillar," said to attack the foliage of tea (*Camellia theifera*) and cocoa (*Theobroma Cacao*) plants in Ceylon (Green).

Arctiidæ, Liparidæ, and Lasiocampidæ.

[These are fluffy moths with hair-covered defoliating caterpillars.]

108. *Aloa lactinea* Cramer (*Arctiidæ*).—Reported as a very injurious defoliator in the Sambalpur district, Central Provinces, where it is known as *Palu-pok*. It is also noticed by Mr. Nietner as occasionally attacking the leaves of coffee (*Coffea arabica*) bushes in Ceylon.

109. *Spilosoma suffusa* Walker (*Arctiidæ*).—Caterpillars thought to belong to this species have been reported as attacking til (*Sesamum indicum*) and other crops in Nagpur.

110. Spilosoma sp. (*Arctiidæ*).—Caterpillars closely allied to the preceding have been received from Maldah, where they are said to be very destructive to jute (*Corchorus sp.*); also from Ganjam, where they are reported as attacking gingelly (*Sesamum indicum*), castor-oil (*Ricinus communis*), and other plants. In Ganjam the local name for the insect is said to be *Gongali purugu*.

111. Dasychira thwaitesii Moore (Liparidæ).—Reported as doing much damage by defoliating tea (*Camellia theifera*) and sâl (*Shorea robusta*). The sâl trees throughout two hundred square miles of forest in Assam are said to have been defoliated by it in 1878.

112. *Artaxa limbata* Butler (Liparidæ). Reported as defoliating young mango (*Mangifera indica*) plants in Poona.

113. *Olene mendosa* Hübn. (Liparidæ).—Reported as attacking the leaves of tea (*Camellia theifera*) bushes in Darjeeling.

114. *Orgyia ceylanica* Nietner (Liparidæ).—Said to attack tea (*Camellia theifera*) bushes in Ceylon (Nietner).

115. *Euproctis virguncula* Walker (Liparidæ).—Said to attack coffee (*Coffea arabica*) bushes in Ceylon—(Nietner).

116. *Trichia exigua* Feld. MS. (Liparidæ).—Said to attack coffee (*Coffea arabica*) bushes in Ceylon—(Nietner).

117. *Spalyria minor* Moore (Lasiocampidæ).—A hairy caterpillar, reported as attacking numerous plants in Shwebo, Burma, where it is said to be known locally as *Pagaungde* or *Rugaungde*.

118. Undetermined hair-covered caterpillars, allied to the preceding, have been reported as follows:—

(1) a species which is thought to be Liparid, said to have defoliated sâl (*Shorea robusta*) in Kulsi, Assam;

(2) caterpillars said to have been very destructive to paddy (*Oryza sativa*) in Ranchi;

(3) caterpillars said to attack *raōi* crops in Monghyr, where they are known as *Bhua*;

(4) caterpillars said to do much damage to paddy in Burma in the rainy season;

(5) caterpillars which are thought to be Arctiidæ, said to have attacked tea (*Camellia theifera*) in Jorhat, Assam;

(6) caterpillars said to attack rape-seed (*Brassica glauca*) in the Umballa district;

(7) processional caterpillars said to have defoliated oak (*Quercus lamellosa*) trees in Sikkim.

Noctues.

[These are generally thick-bodied moths with thread-like antennæ. Their larvæ are smooth caterpillars, usually with four pairs of prolegs and one pair of anal claspers.]

119. Achæa melicerte Drury (Ophiusidæ).—A greyish moth, the hind wings dark brown, marked with greyish white. The caterpillars are said to be known as *Janga purugu* in Madras, and as *Nooludaram purugu* in Ganjam. They have been reported as defoliating castor-oil (*Ricinus communis*) plants in Madras, Ceylon, Calcutta, Assam, and Bellary; also as attacking dhal (*Cajanus indicus*) plants in Dehra Dun, and sugarcane (*Saccharum officinarum*), paddy (*Oryza sativa*), and brinjal (*Solanum Melongena*) plants in Ganjam.

120. Heliothis armigera Hübn. (Heliothidæ).—This is a small greyish moth, with dusky brown hind wings. The caterpillar attacks crops in all parts of the world and is most destructive. In India it has been reported as follows:—attacking paddy (*Oryza sativa*) in Backergunj, where it is said to be known as *leda*; attacking paddy in Sambalpur, Central Provinces, where it is said to be known as *harnipok*; attacking paddy in Khulna; attacking the hemp (*Cannabis sativa*) plant in Bengal; attacking khesari (*Lathyrus sativus*) in Patna, where, like other Noctues caterpillars, it is said to be known as *lurka*; attacking pulse (especially *Dolichos Lablab*) in Bangalore; attacking poppy (*Papaver somniferum*) capsules in Behar, where it has been described under the name of *Mamestra papaverorum* Scott. It is thought to be the species which is said to be known as *kajra* in Monghyr, where it is reported to do great damage by devouring both paddy and rabi crops. It is likely to be the species referred to by Duthie and Fuller as *bahadura*, an insect which they notice as very destructive to gram and pea crops (*Leguminosæ*) in the North-West Provinces. It is also likely to damage the immature bolls of the cotton plant (*Gossypium herbaceum*) in India, for in the United States, where it is known as the boll worm, it does a vast amount of damage in this way to the cotton crop.

121. *Mudaria cornifrons* Moore (Hadenidæ).—The caterpillar of this moth injures the pods of the silk cotton tree (? *Bombax malabaricum*) in Calcutta by tunneling into them.

122. *Polytela gloriosa* Fabr. (Glottulidæ).—A brightly coloured yellow and black caterpillar, which does some damage in gardens, both in Calcutta and in Dehra, by defoliating ornamental plants.

123. *Leucania extrania* Guen. (Leucaniidæ).—Reported as doing much damage in Bengal by biting off young paddy (*Oryza sativa*) plants. It has also been found feeding upon ornamental oat (*Avena sativa*) plants in Calcutta, and is said to attack the pea (*Pisum sativum*) in Patna.

124. *Leucania loreyi* Dup. (Leucaniidæ).—One of the insects known in Sambalpur, Central Provinces, as *harnipok*. It is reported to have destroyed an eighth of the paddy (*Oryza sativa*) crops in some parts of Sambalpur in September 1888

125. *Laphygma exigua* Hübn. (Apamiidæ).—The caterpillar of this moth has been reported as attacking the lentil plant (*Ervum Lens*).

126. *Prodenia littoralis* Boisd. (Apamiidæ).—The caterpillar of this moth has been reported as attacking mulberry (*Morus*) bushes.

127. *Galleriomorpha lichenoides* Felder MS. (Hypogrammidæ).—Said occasionally to attack coffee (*Coffea arabica*) bushes in Ceylon (Nietner).

128. Agrotis segetum Schiff. (Noctuidæ).—A smooth earth-coloured caterpillar, which does a good deal of damage in coffee estates in Southern India and Ceylon by biting off the young coffee (*Coffea arabica*) plants close to the ground. It is known by coffee-planters as the *ringer*. In India it is believed to be confined to comparatively high elevations, such as the Himalayas and the Nilgiris. It is well known in Europe as a destructive Cut worm to many crops.

129. Agrotis suffusa Fabr. (Noctuidæ).—The caterpillar of this cosmopolitan moth does a great deal of damage in India by biting off young plants of all kinds close to the ground. It has been reported as follows:—(1) attacking young opium (*Papaver somniferum*) plants: in this connection it is said to be known in Ghazipur as *kerouna*, in Fatehgarh as *suree*, and in Behar as *kumwah*; (2) attacking young tea (*Camellia theifera*) plants in Ceylon; (3) attacking potato (*Solanum tuberosum*) plants in Kurseong; (4) attacking such rabi crops as mustard (*Brassica*) and linseed (*Linum usitatissimum*) in Jessore; (5) attacking young plants of wheat (*Triticum sativum*), barley (*Hordeum vulgare*), gram (*cicer arietinum*), oats (*Avena sativa*), and peas (*Pisum sativum*), in Murshidabad and Tipperah; (6) attacking the leguminous plant *Lathyrus sativus* in Patna. When full grown, the caterpillars are smooth earth-coloured grubs, about a couple of inches in length and as thick as lead pencils; they are to be found in holes in the fields they frequent.

130. *Ochropleura flammatra* Linn. (Noctuidæ).—The caterpillars of this moth are much like those of *Agrotis suffusa*; they have been reported as attacking opium (*Papaver somniferum*) plants in the same manner.

131. *Plusia nigrisigna*? Walker (Plusiidæ).—Said to attack the gram plant (*Cicer arietinum*) in Patna.

132. *Undetermined Noctues scaterpillars* have been reported as follows:—(1) boring into the seeds of the Tur plant (*Cajanus indicus*) in Nagpur; (2) doing much damage to rabi crops in Orissa, where they are known as *kala mundi*; injurious to crops in Tipperah (Bengal), where they are known as *leda poka*; (4) attacking red gram and country beans (Leguminosæ) in Ganjam, where they are known as *kandula purugu* or *penki purugu*: (5) attacking paddy (*Oryza sativa*) in South Arcot; (6) attacking such rabi crops as mustard (*Brassica*), barley (*Hordeum vulgare*), safflower (*Carthamus tinctorius*), and wheat (*Triticum sativum*) in Budaon; (7) cutting off potato plants in Rajshahye; (8) defoliating teak (*Tectona grandis*) trees in Midnapore; (9) injuring jute (*Corchorus*) plants in Maldah.

Geometres.

[The moths are usually slender-built creatures, with large wings and comb-like antennæ. The caterpillars are long, slender, smooth creatures, which have but few prolegs, and these set very far back; they hump up the middle of the body into a loop in progressing, and are hence called *loopers*.

133. *Epithecia coffearia* Felder MS. (Larentidæ).—Said to attack coffee (*Coffea arabica*) bushes in Ceylon (Nietner).

134. *Boarmia leucostigmaria* Felder MS.; also *Boarmia zeylanicaria* Felder MS. (Boarmidæ).—Both said to attack coffee (*Coffea arabica*) bushes in Ceylon.

135. *Obscure Looper caterpillars*, reported as defoliating tea (*Camellia theifera*) bushes in Nowgong, Assam.

Deltoides.

136. *Dragana pansalis* Walker (Herminiidæ).—A small moth, said to be injurious to sugarcane (*Saccharum officinarum*); nothing further is known about it.

Microlepidoptera.

[Minute moths, with very various habits.]

137. Diatraca saccharalis Cotes (Crambidæ).—The caterpillars of this moth are little white grubs, about an inch in length. They tunnel into sugarcane (*Saccharum officinarum*) and maize stalks (*Zea Mays*), and do a great amount of damage in India. Closely allied or identical insects tunnel into sorghum stalks (*Sorghum vulgare*), not, only destroying much of the crop, but also rendering the plant unwholesome to cattle. The insect is said by Duthie and Fuller to be known by the natives of the North-West Provinces, in the case of sugarcane as *silai*, and in the case of sorghum as *bhaunri*. The sugarcane borer has been reported from Baroda, where it was said to be known as *narkote;* from the Rungpore, Hooghly, and Burdwan districts, where it was said to be known as *dhosah*; from Mymensingh, where it was said to be known as *mandaruah*; from Ganjam, where it was said to be known as *monjikila purugu*; from Sibpore, where it was said to be known as *majera;* and from Cawnpore, where it was said to be known as *reotha*. An allied caterpillar tunnels into the stems of brinjal (*Solanum Melongena*) plants: this insect has been reported from Ganjam, where it is said to be known as *vanga purugu;* also from Berhampore and Ranchi.

138. *Eudioptes indica* Saunders (Margaronidæ).—Described a attacking the leaves of cotton (*Gossypium herbaceum*) plants in Java. I is likely also to occur in India.

139. *Maruca sp.* (Margaronidæ).—The caterpillar of an undescribed species of moth, reported by Colonel Swinhoe to be allied to this genus, tunnels into the mango (*Mangifera indica*) fruit in Calcutta.

140. *Paraponyx oryzalis* Wood-Mason (Hydrocampidæ).—The caterpillar of this species is aquatic in its habits. It has been reported as attacking paddy (*Oryza sativa*) in Burma, where it is known as *Palanbyoo* or *Teindoung-bo* (Wood-Mason).

141. Magiria robusta Moore (Phycitidæ).—The caterpillar of this moth tunnels into the young shoots of toon (*Cedrela Toona*) trees. It has been reported as very injurious to toon trees in Dehra and Ceylon, and is also said to tunnel into young branches of mahogany (*Swietenia Mahagoni*) trees, and into the green seed pods of toon. The caterpillars are little white grubs, which are to be found in the young terminal shoots.

142. *Nephopteryx punicæella* Moore (Phycitidæ).—The caterpillar of this moth tunnels into the pomegranate (*Punica Granatum*) fruit in Baluchistan.

143. *Nephopteryx sagittiferella* Moore (Phycitidæ).—The caterpillar tunnels into pummalo (*Citrus decumana*) and lime (*Citrus medica*) fruit in Perak, where it is reported as doing a good deal of damage.

144. Chilo oryzæellus? Riley (Crambidæ).—The caterpillar of a moth, which is closely related to this destructive American species, has been reported as tunneling into paddy (*Oryza sativa*) stalks in the Thana district, Bombay; also as tunneling into paddy in Backerganj, where it is known locally as *magra*. A very similar caterpillar has been reported as attacking wheat (*Triticum sativum*) in a similar manner in Nagpur and Poona.

145. *Sphenarches caffer* Zeller (Pterophoridæ).—The caterpillar of this minute plume moth tunnels into the pods of the *popat* plant (*Dolichos Lablab*) in Nagpur. It is said to be known as *mekada*.

146. *Pandemis menciana* Walker (= *Capua menciana* Durrant = *Cacœcia sp.* Green). A Tortricid said to damage the leaves of tea (*Camellia theifera*) plants in Ceylon (Green).

147. *Tortrix coffearia* Felder MS. (Tortricidæ).—Said to attack coffee (*Coffea arabica*) bushes in Ceylon (Nietner).

148. *Depressaria gossypiella* Saunders (Plutellidæ).—The caterpillar of this moth is said to tunnel into cotton bolls; it has been reported as having been very destructive in Broach (Saunders). It is perhaps the same as the insect referred to by Duthie and Fuller ("Field and Garden Crops") under the native name of *sundi*.

149. *Gracilaria coffeifoliella* Motsch (Plutellidae). Said to attack coffee (*Coffea arabica*) bushes in Ceylon, but to do little or no damage to

them. It thus differs from an allied species, *Elachista coffeella* G. M., which is said to be very injurious to coffee (*Coffea arabica*) in the West Indies (Nietner).

150. *Gracilaria theivora* Walsingham (Plutellidæ).—Reported as attacking the tea plant (*Camellia theifera*) in Ceylon (Green).

151. *Gelechia cerealella* Oliv. (Plutellidæ).—The caterpillar of this moth has been reported as destructive to stored maize (*Zea Mays*) in the Himalayas. It is a well known pest in the United States, where it does a good deal of damage by tunneling into stored maize seed.

152. *Setomorpha rutella* Zeller (Tineidæ).—The caterpillar of this moth has proved destructive to bales of country blanketing in Calcutta.

153. *Tinea pellionella* Linn. (Tineidæ).—The caterpillar of this moth is a minute creature that protects itself in a case much like the case made by *Psychidae* caterpillars. It has been noticed as very destructive to woollen material in Calcutta. It is a well-known pest in Europe and America.

154. Undetermined Microlepidopterous caterpillars have been reported as follows:—(1) a minute Tineid caterpillar, which attacks stored *dhan* or unhusked rice (*Oryza sativa*) in Calcutta, spinning the grains together into a web: (2) the caterpillars of a small undetermined moth, which has been supposed to be one of the Pyrales, reported as very injurious to the leaves and flowers of the mustard crop (*Brassica*) in Assam, where the insect is known as *bhur*: (3) a minute caterpillar, said to attack the lentil plant (*Ervum Lens*): (4) a species of Tineina, said to tunnel into the fruit of *Ficus Roxburghii* in Calcutta (Cunningham).

Diptera.

155. *Cecidomyia oryzæ* Wood-Mason (Cecidomyidæ).—A minute two-winged fly, reported as attacking paddy (*Oryza sativa*) in Monghyr.

156. *Syrphus nietneri* Schiner MS.; also *Syrphus splendens* Dolesch (Syrphidæ).—The larvæ of these flies are said to prey on the coffee louse (*Aphis coffeæ*) in Ceylon (Nietner).

157. Trycolyga bombycis Becher (Muscidæ-Tachinæ).—Parasitic on the mulberry and eri silk-worms of Bengal and Assam. It is much like a big house fly, and is most destructive in silk-rearing establishments, where it often destroys a large proportion of the silk-worms. Closely allied forms have been reared from many species of caterpillars in India, and they are believed to be about the most effectual check which exists for preventing the undue multiplication of defoliating caterpillars of all kinds. A very similar insect is parasitic on the locust of North-Western India (*Acridium peregrinum*).

158. *Masicera grandis* Bigot (Tachinæ).—A large fly, which is

parasitic on the caterpillars of the tusser silk-worm (*Antheræa mylitta*).

159. *Phora cleghorni* Bigot (Muscidæ).—A minute fly, said to destroy the larvæ of the silk-worm Tachinid (*Trycolyga bombycis*), which it attacks much in the way that the Tachinid attacks the silk caterpillar.

160. Anthomyia peshawarensis Bigot (Muscidiæ). Parasitic upon the eggs of the locust *Acridium peregrinum*. It is believed to have a considerable effect in keeping down the numbers of this locust in India. In appearance it is not unlike a very small house fly.

161. *Oscinis theæ* Bigot (Muscidæ). The grubs of this minute fly are said to tunnel into the leaves of tea (*Camellia theifera*) bushes in Ceylon. They are not thought to do any appreciable damage.

162. *Drosophila apicata* Bigot (Muscidæ).—The grubs of this minute fly are said to attack the fruit of the grape vine (*Vitis vinifera*) in Bashahr.

163. *Anthomyza coffeæ* Nietner (= *A. coffeifolia* Motsch).—The grubs of this fly are said to mine the leaves of coffee (*Coffea arabica*) bushes in Ceylon, where however they are not very common (Nietner). The insect is one of the Muscidæ.

164. *Dacus ferrugineus* Fabr. (Muscidæ.)—The grubs of this fly have been reported as doing considerable damage to mangoes (*Mangifera indica*) in Mozufferpore. When full grown, they are about the size of grains of boiled rice, and are to be found in the pulp of the fruit attacked by them.

165. *Rivellia persicae* Bigot (Muscidæ).—The grubs of this fly have been reported as seriously interfering with the growth of peach (*Prunus persica*) fruit in Chota Nagpur.

166. *Carpomyia paretalina* Bigot (Muscidæ).—This fly has been reported as most injurious to melon (*Cucurbitaceæ*) cultivation in Baluchistan. Larvæ also, which may perhaps belong to the same species, have been reported as destructive to gourds (Cucurbitaceæ) in Berhampore. The grubs bore into the fruit and cause it to rot.

Rhynchota.

167. *Canthecona furcellata* Wolff. (Pentatomidæ).—A small active yellowish insect, reported to destroy tusser silk-worms (*Antheræa mylitta*), and likely also to help in keeping down the numbers of defoliating caterpillars. It is armed with a proboscis with which it transfixes its victims and sucks up their blood.

168. *Apinis concinna* Dallas (Pentatomidæ).—Reported as attacking rabi crops in the North-West Provinces.

169. *Stachia geometrica* Motsch. MS.—Said to attack young coffee (*Coffea arabica*) berries in Ceylon (Nietner).

170. Leptocorisa acuta Thunb. (Coreidæ).—The rice sapper :—A yellowish insect, about the size of a small wasp. It is most destructive to paddy (*Oryza sativa*). It sucks out the juices of the unripe grain and seriously interferes with the yield of the crop. As much as three quarters of the yield have been reported as sometimes destroyed by it. In parts of Bengal, the North-West Provinces, and Assam, it is said to be known as *gandhi*; in Tinnevelly it has been reported as *munju-vandu*; in Bankura as *bhoma*; in Sylhet as *mohua*; while in Ceylon the Cinghalese name is said to be *goyanmessa*, and the Tamil name *vandu*.

171. Dysdercus cingulatus Fabr. (Lygæidæ).—A conspicuous red-coloured insect, about the size of a wasp. It is said to be known as *jhanga* in Cawnpore. It has been reported as attacking cotton (*Gossypium herbaceum*) in Seringapatam, bottle gourds (*Lagenaria vulgaris*) in Cawnpore, and musk mallow (*Hibiscus Abel moschus*) and cabbages (*Brassica oleracea*) in Cossipore. It is closely allied to the species *Dysdercus suturellus*, which is well known as a cotton pest in the United States.

172. *Oxycarenus lugubris* Motsch. (Lygæidæ).—This small black fly-like insect has been reported as attacking cotton (*Gossypium herbaceum*) plants in Seringapatam and Ceylon. It is not unlike the destructive Clinch bug (*Blissus leucopterus*) of America.

173. *Lohita grandis* Grey (Lygæidæ).—Reported to attack cotton (*Gossypium herbaceum*) plants. It is said to be known as *kapasi-poka* in Chuadanga, Nuddea (Atkinson).

174. *Physopelta schlaubuschii* Fabr. (Lygæidæ).—Said to be known as *kuti poka* in Kushtea (Nuddea). Reported as attacking rice (*Oryza sativa*) plants (Atkinson).

175. Helopeltis theiovora Moore (Capsidæ).—Superficially very much like a mosquito, and hence generally known as the *mosquito blight*. It does a great deal of damage to tea (*Camellia theifera*) bushes in India. It chiefly attacks the tender shoots, which are the ones used in making tea; and as it affects wide areas, it is a very formidable enemy of the tea trade. In Ceylon the *mosquito blight*, which attacks tea, has been referred to as *Helopeltis antonii* Signoret, a species which has also been recorded as a formidable enemy to cacao (*Theobroma Cacao*) in that island; while in Sikkim a closely allied or indentical species, which attacks cinchona, has been recorded under the name of *Helopeltis febriculosa* Bergroth. The three forms will probably prove to be identical.

176. *Disphinctus humeralis* Walker (Capsidæ). A small insect, said to attack cinchona in Sikkim. It is not thought to be of any importance.

177. *Flata conspersa*, Walker (Fulgoridæ).—A small insect, reported as attacking tea (*Camellia theifera*) in the Mungledye district, Assam. It is not thought likely to be of any importance.

178. CHLORITA FLAVESCENS Fabr. (Jassidæ).—A small green insect, about the size of a house fly, which is known in Assam as the *blister blight* and in Sikkim as the *green fly blight*. It attacks tea (*Camellia theifera*) bushes and damages the vitality of the leaves by sucking up their juices. It is said in some cases to do considerable damage.

179. *Idiocerus niveosparsus* Lethierry (Jassidæ).—A small green insect, much like the *green fly blight* of tea. It attacks the flowers of mango (*Mangifera indica*) trees, and is said to damage them to a serious extent. The closely allied species *I. clypealis* Leth. and *I. atkinsonii* Leth. have also been reported in the same connection.

180. SCHIZONEURA LANIGERA Hausmann (Aphidæ).—A minute insect, known as *American blight*, which has been reported as exceedingly destructive to apple (*Pyrus Malus*) trees in the Nilgiris and North-West Himalayas. The pest is a cosmopolitan one. It may be easily recognised by the peculiar knotty tumours which it raises on the branches and roots of the trees attacked by it.

181. *Lachnus fuliginosus* Buckton (Aphidæ).—A minute insect, which has been reported as doing considerable damage to apricot (*Prunus armeniaca*), almond (*Prunus communis*), and peach (*Prunus persica*) trees in Baluchistan. It is found on the branches, which it is said to wound to such an extent as to cause them to bleed profusely.

182. *Aphis coffeæ* Nietner (Aphidæ).—A minute insect, known as the *Coffee louse*, which is said to attack coffee (*Coffea arabica*) bushes in Ceylon (Nietner).

183. *Ceylonia theæcola* Buckton (Aphidæ).—A minute insect, known as the *Tea aphis*, which is reported as attacking young tea (*Camellia theifera*) plants in Ceylon (Green).

184. *Pemphigus cinchonæ* Buckton (Aphidæ).—A minute insect, found feeding on cinchona (*Cinchona sp.*) in Sikkim, but not noticed to do much damage.

185. *Cerataphis sp.* (Aphidæ).—A minute insect, said to attack cinchona (*cinchona sp.*), in Sikkim, not hitherto noticed as doing any particular damage.

186. *Aphis brassicae* Linn. or an allied species (Aphidæ).—Is a minute insect, which has been reported as doing much mischief to the mustard (*Brassica*) crops in Hooghly. It is likely to be the same as the Aphid which has been reported as attacking the mustard crop in Assam, where it is known by the Assamese as *mowa* or *mewa*.

187. *Psylla isitis* Buckton (Psyllidæ).—A minute insect, which forms galls on indigo (*Indigofera tinctoria*) plants. It was reported in 1890 as excessively destructive to indigo in Bengal.

188. *Psylla cistellata* Buckton (Psyllidæ).—A small black fly-like insect, reported as attacking the young shoots of mango (*Mangifera*

indica) trees in Dehra. It causes the abortion of the young shoots.

189. *Lecanium acuminatum* Sign. (Coccidæ).—A minute scale-like insect, which has been reported as attacking mango (*Mangifera indica*) trees in Ceylon.

190. *Lecanium coffeæ* Nietner (Coccidæ).—A minute scale-like insect known as the *scaly bug* and said to attack coffee (*Coffea arabica*) and tea (*Camellia theifera*) in Ceylon.

191. *Lecanium nigrum* Nietner (Coccidæ).—Known as the *black bug*, and reported as occasionally found upon coffee (*Coffea arabica*) in Ceylon. Also as attacking the croton oil plant (*Croton Tiglium*) and ceara rubber (*Manihot Glaziovii*).

192. LECANIUM VIRIDE Green (Coccidæ).—A minutes cale-like insect, known as the *Green scale bug*. It is reported to have proved very destructive to coffee (*Coffea arabica*) bushes in South India and Ceylon. It is also said to be found upon cinchona (*Cinchona sp.*), lime (*Citrus medica*), orange (*Citrus Aurantium*), and guava (*Psidium Guava*) plants, and occasionally on tea (*Camellia theifera*).

193. *Pseudococcus adonidum* Linn. (Coccidæ).—Known as the *white or mealy bug*, said to attack coffee (*Coffea arabica*) bushes in Ceylon (Nietner).

194. *Aspidiotus flavescens* Green (Coccidæ).—Known as the *yellow bark louse*, reported as attacking young tea (*Camellia theifera*) plants in Ceylon (Green).

195. *Eriochiton cajani* Maskell (Coccidæ).—A scale insect, which has been reported as attacking the *Cajanus indicus* plant in Madras.

196. *Chionaspis theæ* Maskell (Coccidæ).—A minute white scale insect, which has been reported as attacking tea (*Camellia theifera*) plants both in the Kangra valley and in Ceylon (=*Aspidiotus theæ* Green).

197. *Chionaspis aspidistræ* Signoret (Coccidæ).—Reported as doing considerable injury to *suparee* palms (*Areca Catechu*) in the Konkan.

198. ASPIDIOTUS DESTRUCTOR Signoret (Coccidæ).—A minute insect, which to the naked eye looks like a mealy scurf on the leaves. It has been reported as extremely destructive to cocoanut (*Cocos nucifera*) palms, both in the Laccadive islands and in the Isle de la Réunion. It sucks up the juice of the leaves to such an extent as to sap the vitality of the trees and to destroy great numbers of them.

199. *Aspidiotus theæ* Maskell (Coccidæ).—Reported as attacking tea (*Camellia theifera*) plants both in the Kangra valley and in Ceylon.

200. *Aspidiotus transparens* Green. (Coccidæ).—Said occasionally to attack tea (*Camellia theifera*) plants in Ceylon, where it has been designated the *transparent scaled bark louse* (Green).

201. *Dactylopius adonidum* Linn. (Coccidæ).—Said to attack coffee (*Coffea arabica*), also a species of *Cedrela*, several species of *Ficus*, and other trees in Mysore.

202. *Dactylopius cocotis* Maskell (Coccidæ).—A minute insect, with white cottony secretion. It attacks the leaves of cocoanut (*Cocos nucifera*) trees in the Laccadive islands, but is not thought to do much damage.

203. *Pseudo-pulvinaria sikkimensis* Atkinson.—Said to attack cinchona (*Chinchona sp.*) in Sikkim, but not thought to do any serious damage.

Orthoptera.

Acrididæ.

204. Acridium peregrinum Oliv. (the locust of North-West India).—Periodically invades the fertile plains of India from its home in the sandy plains of Rajputana, Sind, and the Punjab. It is also prevalent throughout the whole of South-Eastern Asia and Northern Africa. The full-grown insect is a big thick-set grasshopper, with short antennæ. When it first acquires its wings it is salmon pink in colour, but as it gets older it becomes at first yellowish and afterwards dull purple in tint. It forms vast flights, which are sometimes thick enough to hide the sun from sight as they pass in the air. The young are little black and yellow wingless grasshoppers which emerge from the eggs that are laid in the ground. The insect feeds voraciously throughout the whole of its existence, and both in its wingless and winged stages does much damage to green standing crops of all kinds over wide areas in India. It also attacks the foliage of trees, and in fact almost every kind of green plant.

205. Acridium succinctum Linn.—There is evidence to show that this is the insect which did most of the damage to standing crops in the Deccan and Konkan in the Bombay locust invasion of 1882-83. It is the locust which was reported in the Patna district in 1877, and which has since been reported as destructive to crops in Murshidabad. It is superficially much like *Acridium peregrinum*, but belongs to the damper and more fertile regions of India.

206. *Acridium melanocorne* Serv.—One of the Acrididæ reported in connection with the Madras locust invasion of 1878.

207. *Acridium æruginosum* Burm.—One of the Acrididæ reported in connection with the Madras locust invasion of 1878. It has recently been reported to have appeared in the Vizagapatam and Cuddapah districts.

208. *Caloptenus erubescens* Walker, and *C. caliginosus* Moore.—Two of the Acrididæ reported in connection with the Bombay locust invasion

of 1882-83. A species of *Caloptenus* also has been reported amongst other Acrididæ as nipping off young chir (*Pinus longifolia*) plants in the North-West Provinces.

209. *Cyrtacanthacris ranacea* Stoll.—One of the Acrididæ reported in connection with the Bombay locust invasion of 1882-83.

210. *Oxya furcifera* Serv.—One of the Acrididæ reported in connection with the Bombay locust invasion of 1882-83.

211. *Oxya velox* Burm.—One of the Acrididæ reported in connection with the damage done by so-called locusts in Ganjam in 1891. It was also similarly reported in the same district in 1890.

212. *Pachytylus cinerascens* Fabr.—This well-known migratory locust of the Palæarctic zone was reported amongst other Acrididæ, both in connection with the Madras locust invasion of 1878, and also in connection with the damage said to have been done by locusts in Ganjam in 1890.

213. Crotogonus sp.—A small thick-set, brown grasshopper, which seems to be very destructive to young crops of all kinds. It bites off the young plants as soon as they appear above the ground. Specimens of it have been sent to the Museum from numerous places, and it has been reported as follows:—

(1) as doing extensive injury in Budaon to young indigo (*Indigofera tinctoria*) plants; also attacking such crops as mash (*Phaseolus radiatus*), bájra (*Pennisetum typhoideum*), til (*Sesamum indicum*), and lobia (*Vigna Catiang*):

(2) as destructive in Monghyr to opium (*Papaver somniferum*), indigo (*Indigofera tinctoria*), and rabi crops generally; in this district it was said to be known as *fatinga* or *gaduhya*:

(3) as doing considerable damage in Umballa to wheat (*Triticum sativum*), barley (*Hordeum vulgare*), linseed (*Linum usitatissimum*), and rape-seed (*Brassica glauca*):

(4) as associated with other Acrididæ in doing considerable damage to indigo (*Indigofera tinctoria*) in the North-West Provinces, where the insect was said to be known locally as *gadhao:*

(5) as associated with other Acrididæ in nipping off young *chir* (*Pinus longifolia*) plants in the North-West Provinces.

214. *Catantops axillaris* Sauss.—Reported as attacking young paddy (*Oryza sativa*) plants in Howrah, where, with other Acrididæ, it is said to be known as *katforing*. An allied species, identified by Dr. de Saussure as *Catantops indicus*, has been reported as one of the Acrididæ which nip off young chir (*Pinus longifolia*) plants in the North-West Provinces.

215. *Œdalus marmoratus* Linn.—Reported, with other Acrididæ, as defoliating sugarcane (*Saccharum officinarum*) plants in Cawnpore. Species of *Œdalus* also have been reported both amongst the Acrididæ

which nip off young chir (*Pinus longifolia*) plants in the North-West Provinces, and also amongst the so-called locusts which did some damage in Ganjam in 1890.

216. *Epacromia dorsalis* Thunb.—Reported as attacking young kharif crops in the Upper Sind Frontier district; also reported as injurious in Ganjam.

217. *Pœcilocera picta* Fabr.—Reported as injuring young crops in Jhalawad Prant, Kathiawar, where it was said to be known as *khapedi*.

218. *Pœcilocera hieroglyphica* Klug.—Reported as attacking sugar-cane (*Saccharum officinarum*) in Cawnpore, where, like other Acrididæ, it was known as *bhunga* or *aukphutta*.

219. *Phymatæus punctatus* Fabr.—Said to attack crops of all kinds in Ceylon, occasionally doing some damage to coffee (*Coffea arabica*) bushes (Nietner).

220. *Heteropternis sp.*—Reported as destructive to young kharif crops in the Upper Sind Frontier district, where it was known a *khapedi*.

221. Hieroglyphus furcifer Sauss.—Reported as destructive to crops in the Rajpipla state, and in the Panch Mahals, Broach, and Thana districts in the Bombay presidency; also in the Sambalpur district in the Central Provinces, and in the Kolhapur state, Bombay. Young paddy (*Oryza sativa*) and maize (*Zea Mays*) were specially noticed amongst the crops attacked. It was also one of the so-called locusts which were reported in Ganjam in 1890.

222. *Tryxalis turrita* Linn.—Reported amongst other Acrididæ in connection with the Madras locust invasion of 1878, also with the injury done by so-called *locusts* in Ganjam both in 1890 and 1891.

223. *Atractomorpha crenulata* Fabr.—Reported amongst other Acrididæ in connection with the damage done by so-called locusts in Ganjam in 1891.

224. *Mecopoda sp.*—Reported amongst other Acrididæ in connection with the Madras locust invasion of 1878.

225. *Euprepocnemis bramina* Sauss.—Reported as destructive to young paddy (*Oryza sativa*)and small millet (*Panicum miliare*) in the Central Provinces; also reported as one of the Acrididæ which proved injurious in Ganjam in 1891. A species of *Euprepocnemis* also has been forwarded with other Acrididæ as attacking paddy (*Oryza sativa*) in Howrah; while an allied insect was reported as concerned in the Madras locust invasion of 1878.

226. Undetermined *Acrididæ* have been reported as follows:—

(1) a locust known as the *kakotiphoring*, or paper grasshopper, reported to have done a good deal of damage to crops in the Nowgong district, Assam, in 1879; it has been suggested

that the insect may have been the species *Phymateus miliaris* Linn., which is said to be common in the Khasia hills ; this however requires confirmation :

(2) insects described as " much like locusts, but green in colour with longitudinal black stripes ", which are reported to have done much damage to green paddy (*Oryza sativa*) in Orissa in 1887 :

(3) an insect, described by Mr. Bidie under the name of *Locusta coffeæ*, but from the figure obviously an Acridid, said occasionally to defoliate coffee (*Coffea arabica*) bushes in South India.

Gryllidæ.

227. *Schizodactylus monstruosus* Drury.—An enormous mole cricket, reported as injuring young tobacco (*Nicotiana Tabacum*), and other crops growing on high ground in Durbhunga, by cutting their roots. The local name given for the insect was *bherwa*.

228. *Gryllotalpa sp.*—Said to injure opium (*Papaver somniferum*) plants by cutting them off when they are considerably advanced in growth (Scott).

229. *Acheta sp.*—Said to injure young opium (*Papaver somniferum*) plants (Scott).

PSEUDONEUROPTERA.

Termitidæ.

230. TERMES TAPROBANES Walker.—The common white ant of Lower Bengal. Very destructive to inferior timber and other dried vegetable matter, also attacking young and unhealthy plants. It is likely to be the species which has been reported as injuring sugarcane (*Saccharum officinarum*) in Cawnpore, and the tea (*Camellia theifera*) plants in Lohardug gah.

231. *Termes fatalis* König.—Said occasionally to attack coffee (*Coffea arabica*) bushes in Ceylon, but to do little damage to them (Nietner).

232. *Termes sp.*—Said occasionally to damage tea (*Camellia Thea*) plants in Ceylon (Green).

Thripsidæ.

233. *Thrips sp.*—Minute black winged insects, reported as severely injuring the turmeric (*Curcuma longa*) plant in Madras, where the local name is said to be *sutta thegulu*. An undetermined species of *Thrips* has also been said to attack the opium poppy (*Paparer somniferum*) in Behar, where it was known locally as *lhi* or *lehi* (Scott). Another species has been found to damage the leaves of the tea (*Camellia theifera*) plant in Ceylon—(Green).

NEUROPTERA.

Myrmeleontidæ.

234. ***Micromus australis*** Hagen.—An ant lion said to attack the coffee louse (*Aphis coffeæ*) in Ceylon (Nietner).

ACARINA = MITES.

235. TETRANYCHUS BIOCULATUS Wood-Mason.—The *red spider* of tea planters, a red mite not unlike a small spider in appearance, which attacks the leaves of tea (*Camellia theifera*) bushes both in India and Ceylon, often seriously interfering with the yield of tea.

236. *Tetranychus sp.*—Said to do much damage to stored poppy (*Papaver somniferum*) seed in Behar (Scott).

237. *Typhlodromus carinatus* Green, or the *five-ribbed tea mite.*—Said to attack the leaves of tea (*Camellia theifera*) bushes in Ceylon (Green).

238. *Acarus coffeæ* Nietner.—Said to attack the leaves of coffee (*Coffea arabica*) bushes in Ceylon (Nietner).

239. *Acarus sp.*—Said to injure the leaves of the opium poppy (*Papaver somniferum*) in Behar (Scott).

240. *Acarus translucens* (Nietner), or the *Yellow tea mite.*—By Green said to attack young tea (*Camellia theifera*) shoots in Ceylon; by Nietner thought to prey on some of the Scale insects which attack coffee (*Coffea arabica*) in Ceylon.

I.—Table to show the Agricultural Plants and Produce reported as attacked by insects in India.

[The name of the plant is followed by the serial numbers of the insects which attack it.]

Avena sativa (Oat) 123, 129.
Bájra, see *Pennisetum typhoideum.*
Barley, see *Hordeum vulgare.*
Bottle Gourd, see *Lagenaria vulgaris.*
Brassica glauca (Rape Seed) 118, 213.
Brassica oleracea (Cabbage) 171.
Brassica sp. (Mustard) 129, 132, 154, 186.
Brinjal, see *Solanum Melongena.*
Cabbage, see *Brassica oleracea.*
Cacao, see *Theobroma Cacao.*
Cajanus indicus (Tur) 50, 119, 132, 195.
Camellia theifera (Tea) 8, 64, 94, 98, 99, 100, 101, 102, 106, 107, 111, 113, 114, 118, 129, 135, 146, 150, 161, 175, 177, 178, 183, 190, 192, 194, 196, 199, 200, 201, 230, 231, 232, 233, 235, 237, 240.
Cannabis sativa (Hemp) 120.
Cardamom, see *Elettaria Cardamomum.*
Carthamus tinctorius (Safflower) 132.
Castor-oil, see *Ricinus communis.*
Cholum, see *Sorghum vulgare.*
Cicer arietinum (Gram) 65, 89, 105, 129, 131.
Chinchona sp. 95, 175, 176, 184, 185, 192, 203.
Coffea arabica (Coffee) 9, 10, 36, 54, 69, 70, 94, 102, 103, 108, 115, 116, 127, 128, 133, 134, 147, 149, 163, 169, 182, 190, 191, 192, 193, 219, 226, 238, 240.
Corchorus sp. (Jute) 110, 132.
Cotton, see *Gossypium herbaceum.*
Cucumber, see *Cucumis sativus.*
Cucumis sativus (Cucumber) 65.
Cucurbitaceæ 65, 71, 166.
Curcuma longa (Turmeric) 233.
Dolichos Lablab (Sembi) 120, 145.
Elettaria Cardamomum (Cardamom) 88.
Ervum Lens (Lentil) 125, 154.
Gingelly, see *Sesamum indicum.*
Gossypium herbaceum (Cotton) 16, 65, 120, 138, 148, 171, 172, 173.
Gram, see *Cicer arietinum.*
Hemp, see *Cannabis sativa.*
Hordeum vulgare (Barley) 129, 132, 213.
Indigofera tinctoria (Indigo) 67, 187, 213.
Ipomœa Batatas (Sweet Potato) 37.
Jowar, see *Sorghum vulgare.*
Jute, see *Corchorus sp.*
Kharif crops generally 216, 220.
Khesari, see *Lathyrus sativus.*
Lagenaria vulgaris (Bottle gourd) 171.
Lathyrus sativus (Khesari) 120, 129.
Leguminosæ generally 120, 132.
Lentil, see *Ervum Lens.*
Linseed, see *Linum usitatissimum.*
Linum usitatissimum (Linseed) 23, 89, 129, 213.
Lobia, see *Vigna Catiang.*
Maize, see *Zea Mays.*
Mash, see *Phaseolus radiatus.*
Mustard (*Brassica sp.*) 129, 132, 154, 186.
Nicotiana Tabacum (Tobacco) 19, 227.
Oat, see *Avena sativa.*
Oryza sativa (Rice) 11, 19, 27, 48, 63, 65, 68, 92, 106, 118, 119, 120, 123, 124, 132, 140, 144, 154, 155, 170, 174, 214, 221, 225, 226.
Panicum miliare (Small Millet) 225.
Papaver somniferum (Poppy) 18, 19, 30 35, 53, 120, 129, 130, 213, 228, 229, 233, 236, 239.
Pea, see *Pisum sativum.*
Pennisetum typhoideum (Bájra) 213.
Phaseolus radiatus (Mash) 213.
Pisum sativum (Pea) 51, 123, 129.
Poppy, see *Papaver somniferum.*
Potato, see *Solanum tuberosum.*
Rabi crops generally 118, 120, 168.
Rape seed, see *Brassica glauca.*
Rice, see *Oryza sativa.*
Ricinus communis (Castor-oil) 110, 119.
Saccharum officinarum (sugarcane) 44, 89, 119, 136, 137, 215, 218, 230.
Safflower, see *Carthamus tinctorius.*
Sembi, see *Dolichos Lablab.*
Sesamum indicum (Gingelly) 109, 213.
Small Millet, see *Panicum miliare.*
Solanum Melongena (Brinjal) 71, 119, 137.
Solanum tuberosum (Potato) 72, 129, 132.
Sorghum vulgare (jowar or cholum) 4, 20, 26.
Standing crops generally 108, 110, 117, 120, 128, 129, 132, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 216, 217, 221, 222, 223, 224, 225, 226.
Sugarcane, see *Saccharum officinarum.*
Sweet potato, see *Ipomœa Batatas.*

Tea, see *Camellia theifera.*
Theobroma Cacao (Cocoa) 107, 175.
Tobacco, see *Nicotiana Tabacum.*
Trapa bispinosa (Water Caltrop) 65.
Triticum sativum (Wheat) 3, 6, 20, 23, 27, 129, 132, 144, 213.
Turmeric, see *Curcuma longa.*
Tur, see *Cajanus indicus.*
Vigna Catiang (Lobia), 213.
Vine, see *Vitis vinifera.*
Vitis vinifera (Vine) 162.
Water Caltrop, see *Trapa bispinosa.*
Wheat, see *Triticum sativum.*
Zea Mays (Maize) 137, 151, 221.

II.—Table to show the Forest and Fruit Trees and their Produce reported as attacked by Insects in India.

[The name of the tree is followed by the serial numbers of the insects which attack it.]

Acacia Catechu (Khair) 15, 58.
Almond, see *Prunus communis.*
Apple, see *Pyrus Malus.*
Apricot, see *Prunus armeniaca.*
Areca Catechu (Suparee Palm) 197.
Bambusa sp. (Bamboo) 21.
Bombax malabaricum (Cotton tree) 61, 121.
Buk, see *Quercus lamellosa.*
Butea frondosa (Dhak) 33, 56.
Ceara Rubber, see *Manihot Glaziovii.*
Cedrela Toona (Toon) 141.
Charcoal tree, see *Sponia orientalis.*
Citrus Aurantium, (Orange) 90, 96, 192.
Citrus decumana (Pummalo). 143.
Citrus medica (Lemon) 90, 143, 192.
Cocoanut, see *Cocos nucifera.*
Cocos nucifera (Cocoanut) 12, 28, 38, 59, 91, 198, 202.
Cotton tree, see *Bombax malabaricum.*
Date, see *Phœnix dactylifera.*
Dead wood generally, 230.
Deal, see *Pinus.*
Dendrocalamus Hamiltonii (Hill Bamboo) 29.
Dhak, see *Butea frondosa.*
Eryobotrya japonica (Loquat) 87.
Erythrina suberosa (Roongra) 61.
Ficus Roxburghii (Fig.) 154.
Gall-nut tree, see *Terminalia Chebula ?*
Guava, see *Psidium Guava.*
Hill Bamboo, see *Dendrocalamus Hamiltonii.*
Hill Oak, see *Quercus.*
Jingham, see *Odina Wodier.*
Khair, see *Acacia catechu.*
Lemon, see *Citrus medica.*
Loquat, see *Eryobotrya japonica.*
Mahogany, see *Swietenia Mahagoni.*
Mangifera indica (Mango) 17, 31, 104, 112, 139, 164, 179, 188, 189.
Manihot Glaziovii (Ceara Rubber) 191.
Moringa pterygosperma (Soaugna) 61.
Morus (Mulberry) 32, 126.
Mulberry, see *Morus.*
Odina Wodier (Jingham) 56.
Orange, see *Citrus Aurantium.*
Peach, see *Prunus persica.*
Phœnix dactylifera (Date) 428.
Pinus excelsa 46.
Pinus longifolia (Chir) 17, 32, 49, 208, 213, 214.
Pinus sp. (Deal) 58.
Pomegranate, see *Punica Granatum.*
Poplar, see *Populus euphratica.*
Populus euphratica (Poplar) 17, 93.
Prunus armeniaca (Apricot) 181.
Prunus communis (Almond) 181.
Prunus persica (Peach) 165, 181.
Pyrus Malus (Apple) 180.
Psidium Guava (Guava) 22, 87, 96, 192.
Pummalo, see *Citrus decumana.*
Punica Granatum (Pomegranate) 87, 142.
Quercus incana 49.
Quercus lamellosa (Buk) 118.
Quercus pachyphylla 42.
Quercus sp. (Hill Oak) 7, 45.
Roongra, see *Erythrina suberosa.*
Sáj, see *Terminalia tomentosa.*
Sâl, see *Shorea robusta.*
Salix tetrasperma (Wild Willow) 60.
Sandalwood, see *Santalum album.*
Santalum album (Sandalwood) 25, 94.
Shorea robusta (Sâl) 13, 41, 49, 55, 56, 57, 99, 111, 118.
Sponia orientalis (Charcoal tree) 96.
Soaugna, *Moringa pterygosperma.*
Supari Palm, see *Areca Catechu.*
Swietenia Mahagoni (Mahogany) 40, 106.
Tamarindus indica (Tamarind) 52.
Teak, see *Tectona grandis.*
Tectona grandis (Teak) 14, 57, 58, 62, 96, 132.
Terminalia Chebula ? (Gall-nut tree) 97.
Terminalia tomentosa (Sáj) 57.
Toon, see *Cedrela Toona.*
Wild Willow, see *Salix tetrasperma.*

III.—Table to show the miscellaneous products reported as attacked by insects in India.

[The name of each product is followed by the serial numbers of the insects reported to attack it.]

Beer Casks 43, 44.
Convolvulaceæ 66.
Croton Tiglium (Croton-oil plant) 191.
Crocus sativus (Saffron) 19.
Garden plants 123.
Hibiscus Abelmoschus (Musk Mallow) 171.
Hibiscus, sp. 34.
Kibu, see *Strobilanthes pectinatus.*
Lagerstræmia indica 97.
Leather 5.
Musk Mallow, see *Hibiscus Abelmoschus.*
Rosa sp. (Rose bushes) 97.
Saffron, see *Crocus sativus.*
Ships' Biscuit 4, 20, 24.
Silk Cocoons 5.
Silk-worms 76, 157, 158, 167.
Strobilanthes pectinatus (Kibu) 39.
Warehouse goods 3, 4, 5, 6, 18 19, 20, 24 27, 30, 50, 51, 52, 151, 152, 153, 154, 230, 236.
Woollen material 152, 153.

E. C. COTES,
Officiating Deputy Superintendent Indian Museum.

CALCUTTA,
17th May 1892.

Govt. of India Central Printing Office.—No. 103 R. & A.—8-2-93.—1,5050.—P.

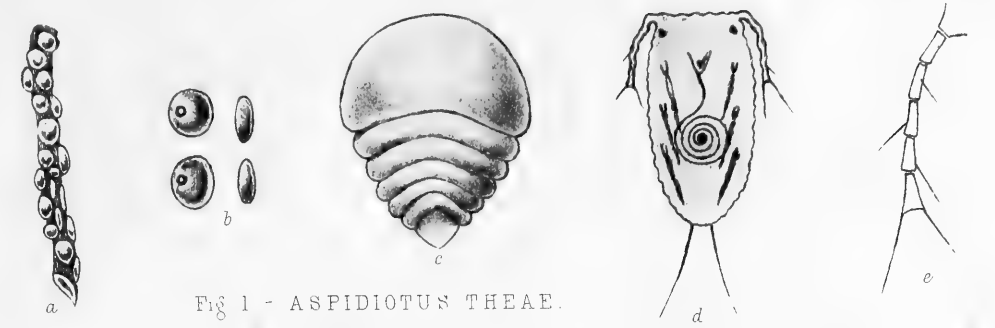


Fig 1 - ASPIDIOTUS THEAE.

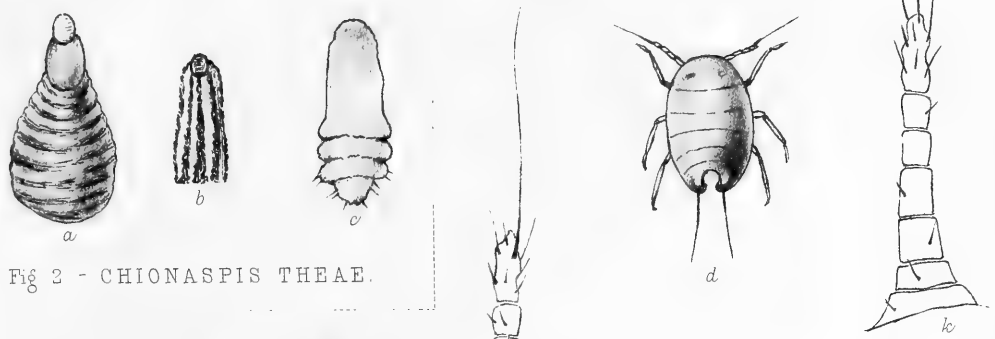


Fig 2 - CHIONASPIS THEAE.

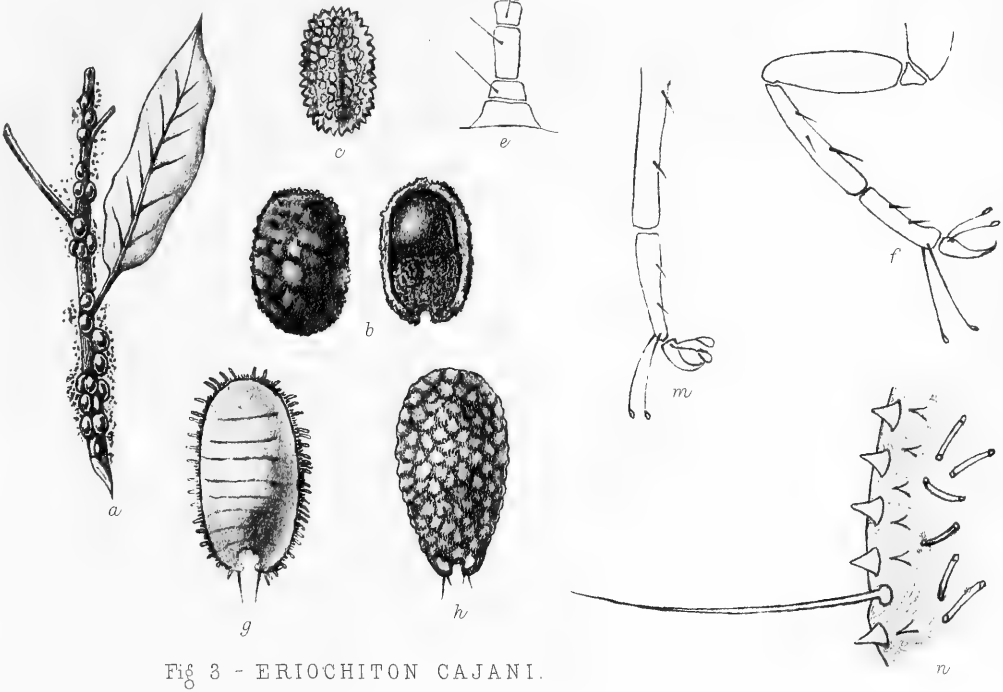


Fig 3 - ERIOCHITON CAJANI.

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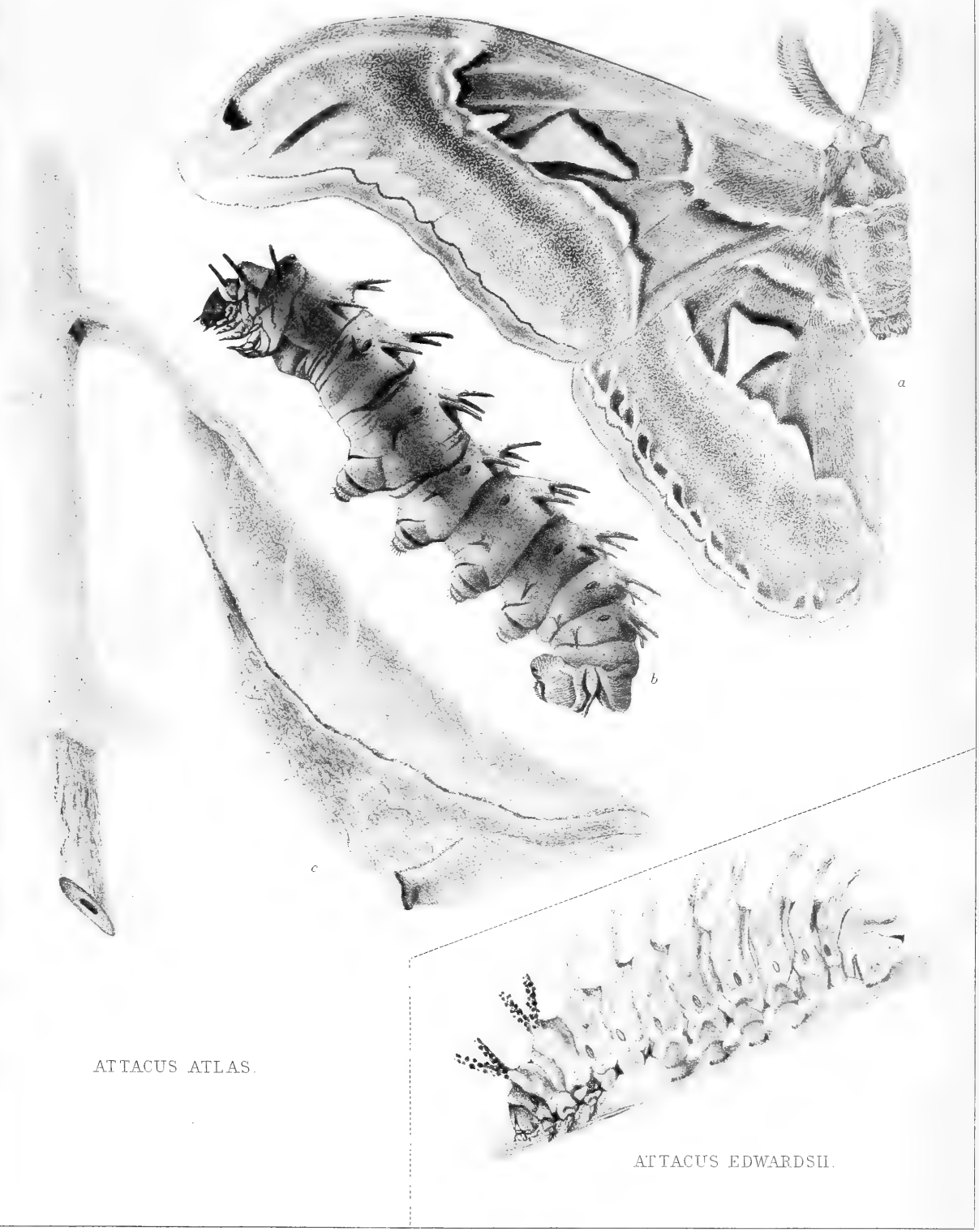
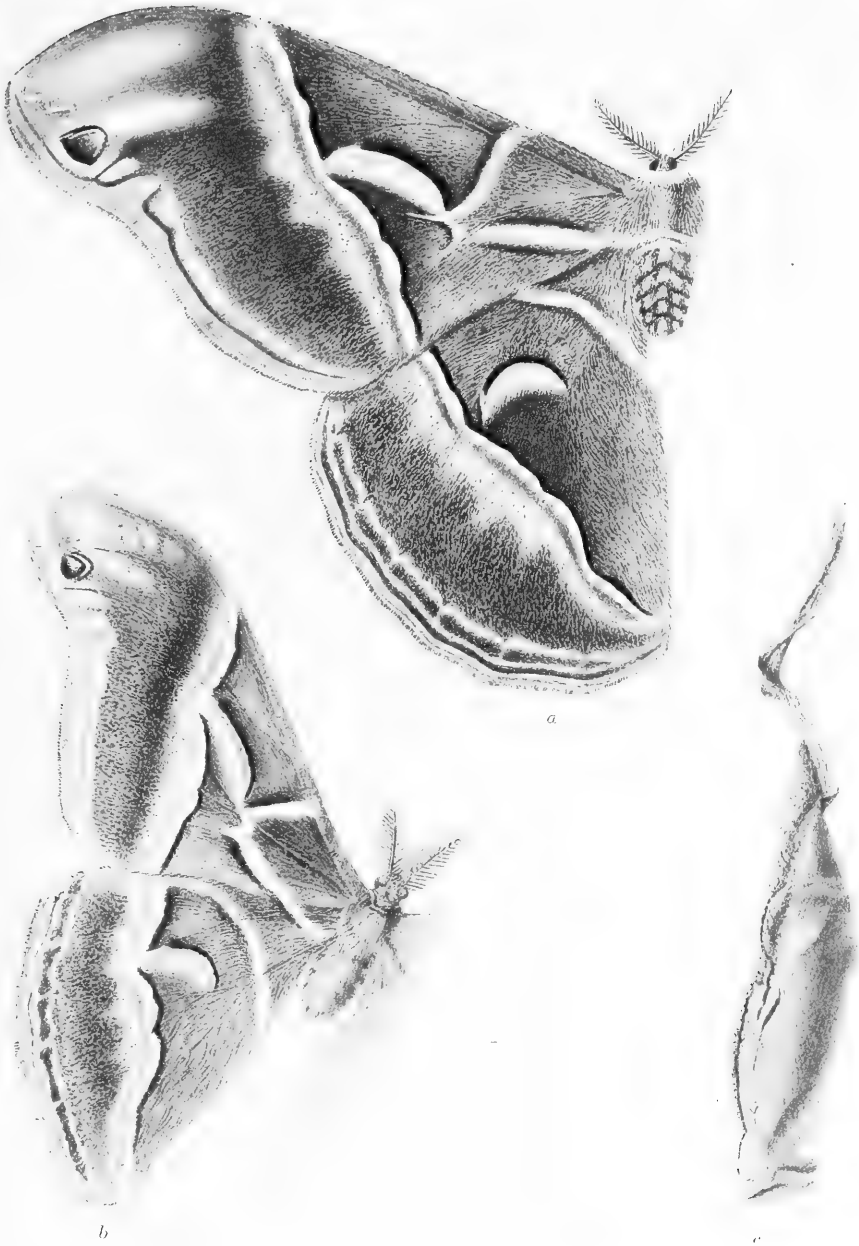


ATTACUS ATLAS.

ATTACUS EDWARDSII.

Photo-etching from the original drawings, Survey of India Offices, Calcutta, June, 1891.



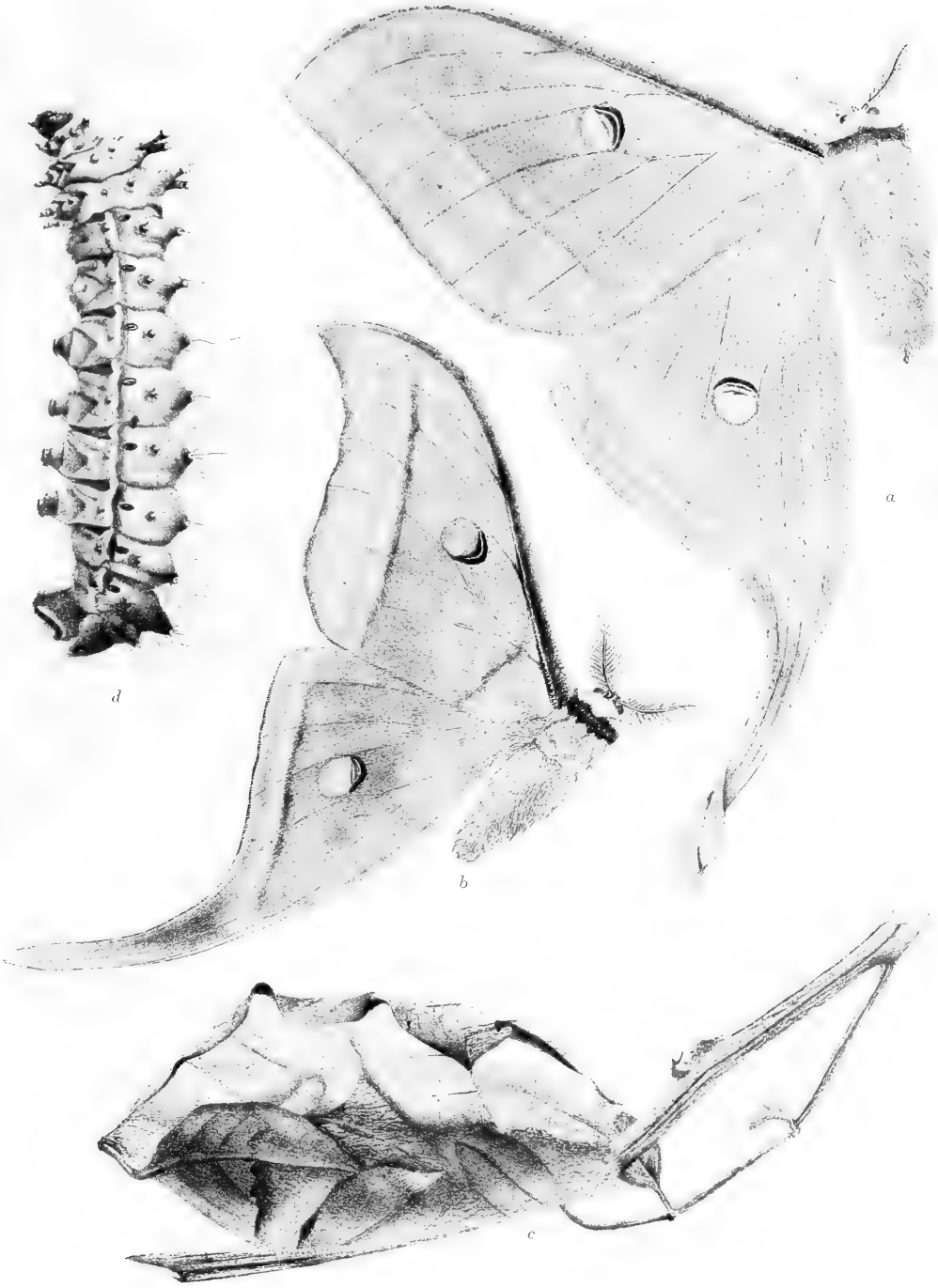
a

b

c

ATTACUS CYNTHIA.

Photo-etching from the original drawings, Survey of India Offices, Calcutta, June, 1891.

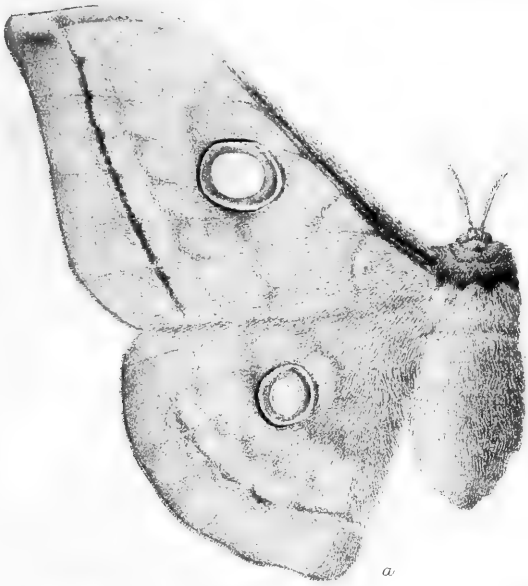


ACTIAS SELENE.

Photo-etching from the original drawings, Survey of India Offices, Calcutta., June, 1891.

ACTIAS LETO.

Photo-etching from the original drawings, Survey of India Offices, Calcutta, June, 1891.



a

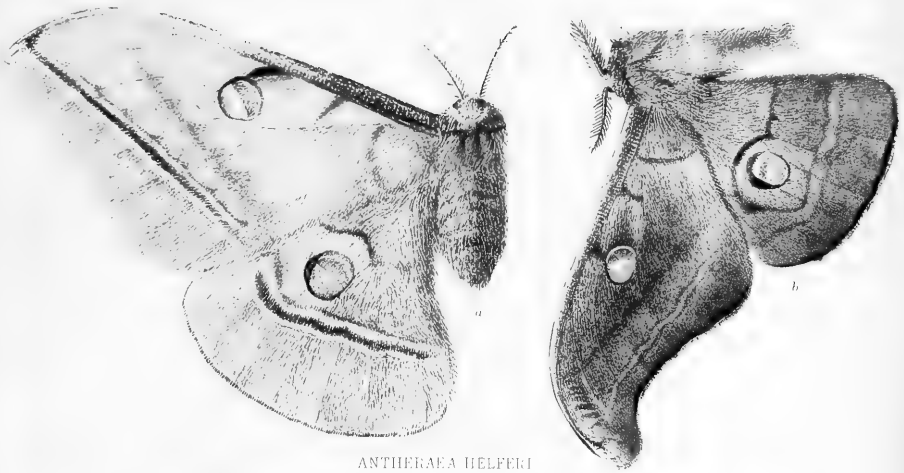
c

b

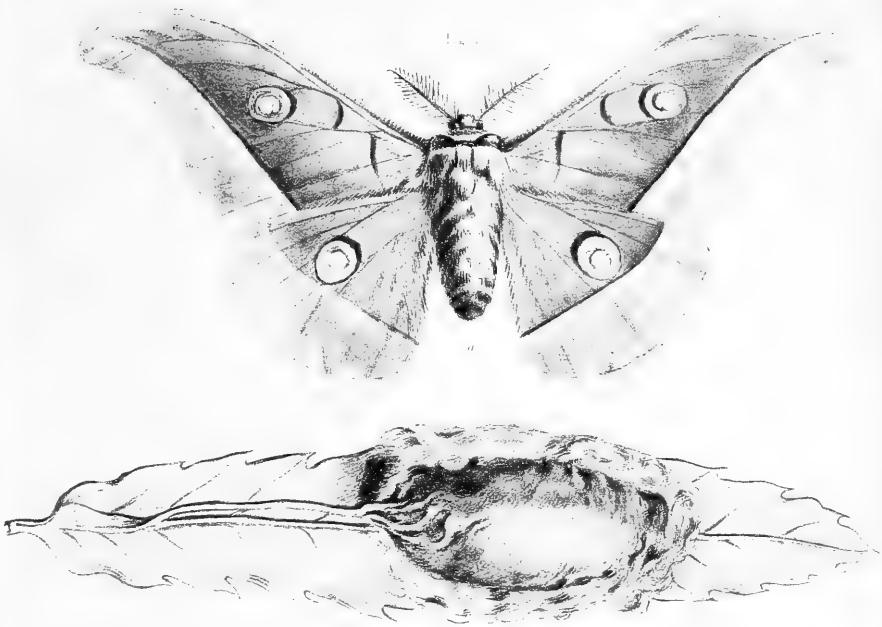
d

ANTHERAEA FRITHII.

Photo-etching from the original drawings, Survey of India Offices, Calcutta., June, 1891.



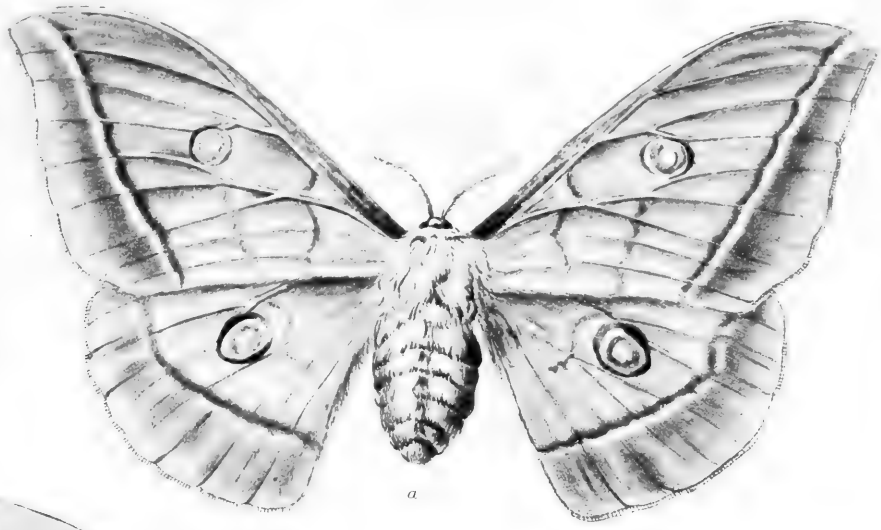
ANTHERAEA HELFERI



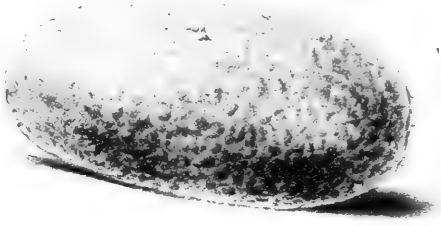
ANTHERAEA PERNYI.

AFTER GUERIN-MÉNEVILLE

Photo-etching from the original drawings, Survey of India Offices, Calcutta, June, 1891.



a

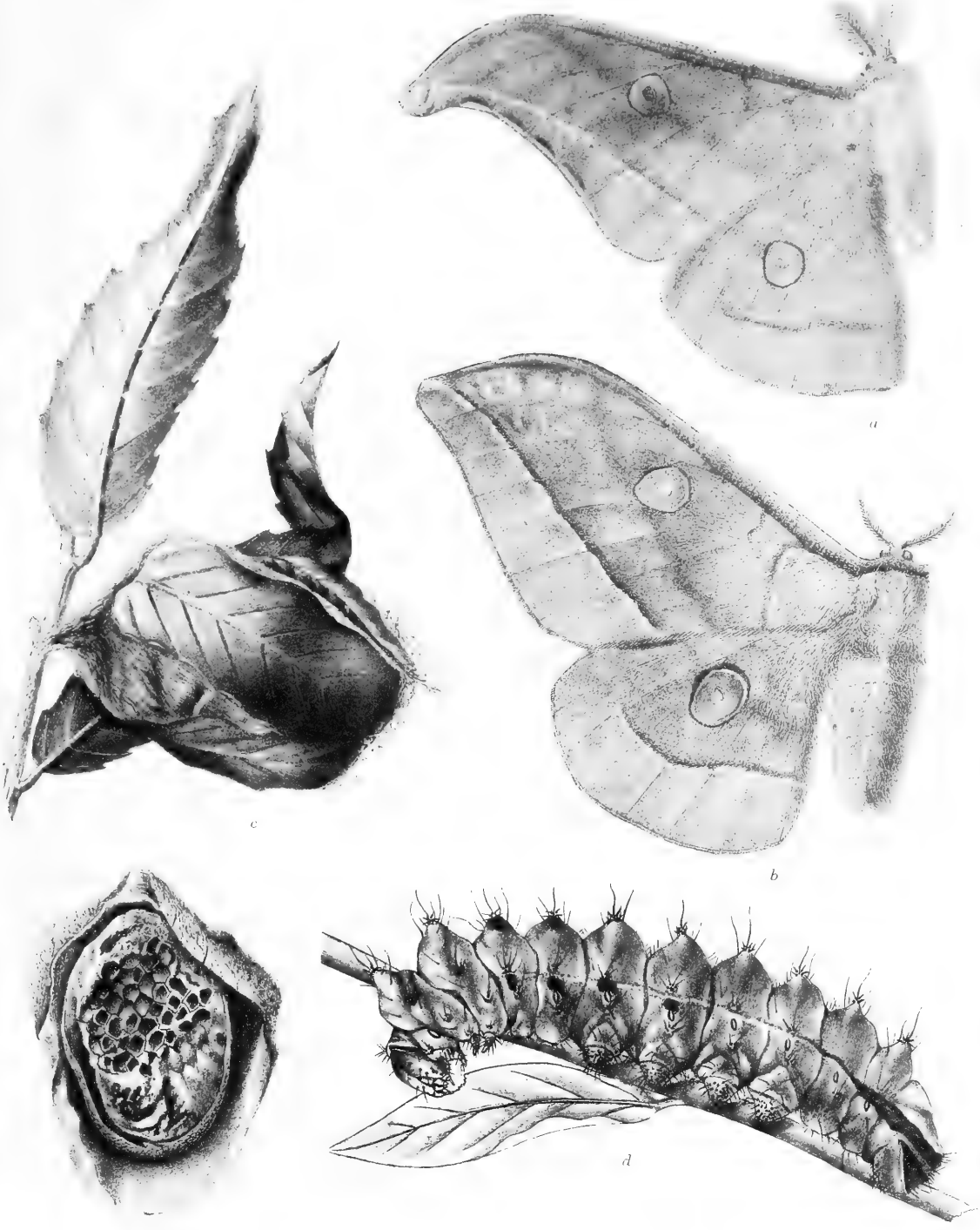


c

b

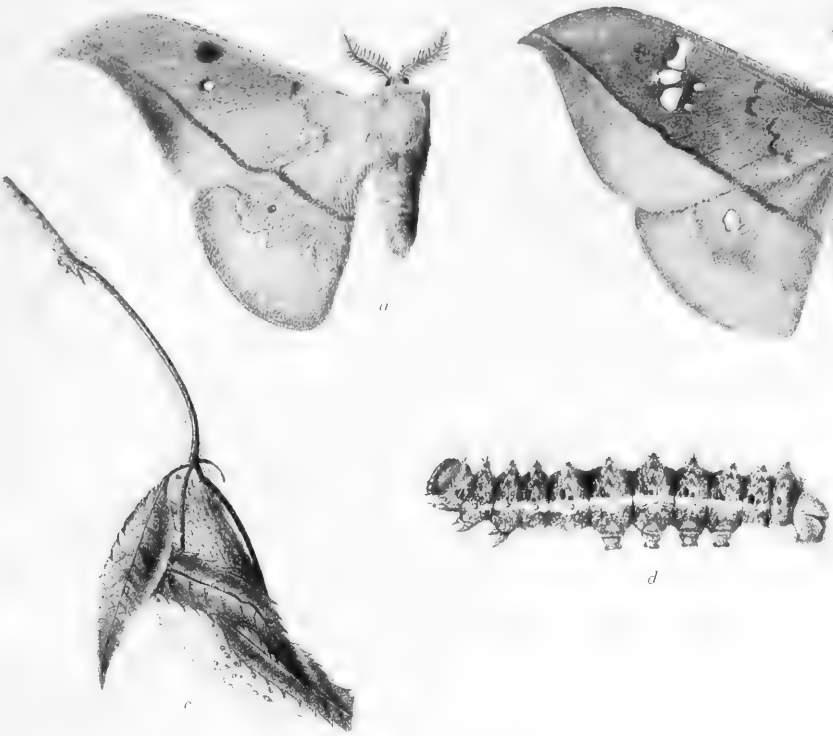
ANTHERAEA YAMAMAI.
AFTER WESTMAAS.

Photo-etching from the original drawings, Survey of India Offices, Calcutta, June 1891.



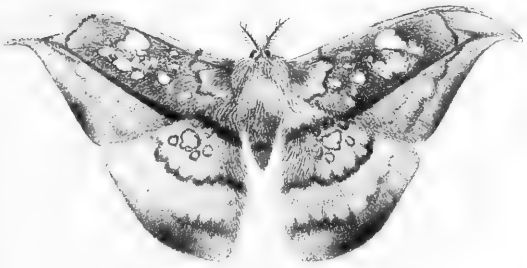
ANTHERAEA ROYLEI.

Photo-etching from the original drawings, Survey of India Offices, Calcutta, June 1903.



CRICULA TRIFENESTRATA.

Fig. 2.



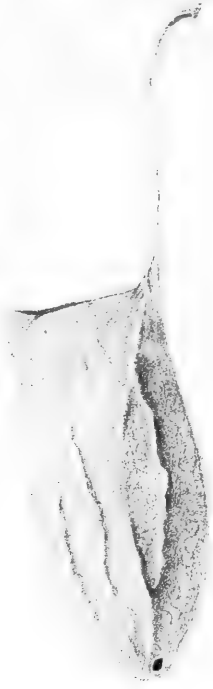
CRICULA DREPANOIDES.

Fig. 3.

OCINARA LACTEA.

Photo-etching from the original drawings. Survey of India Offices, Calcutta, June, 1891

a



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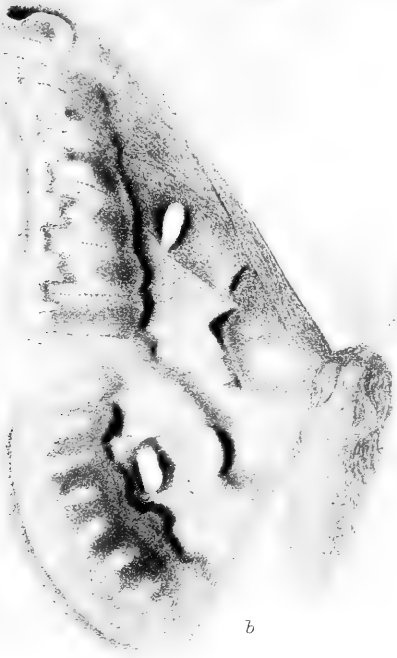
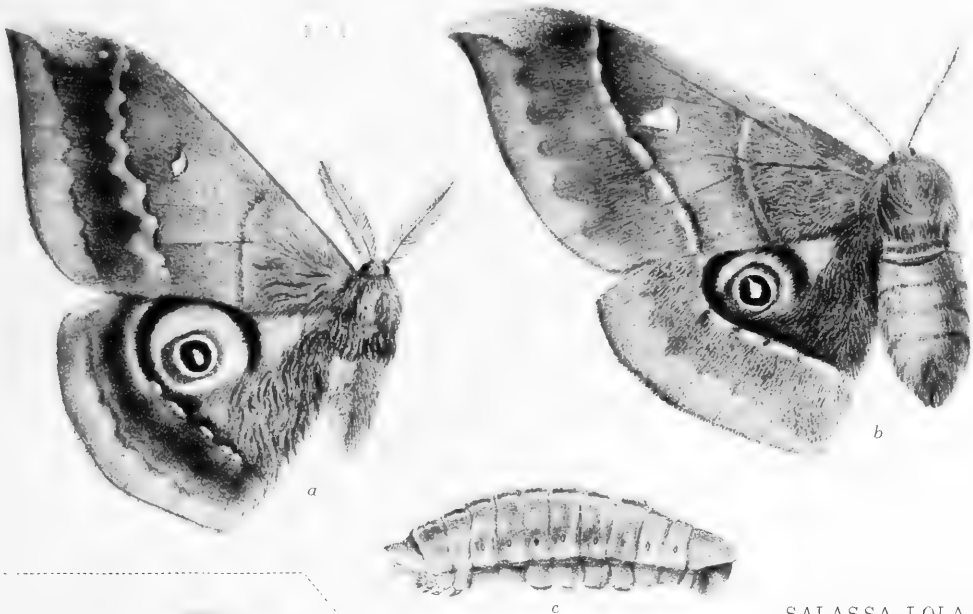


b

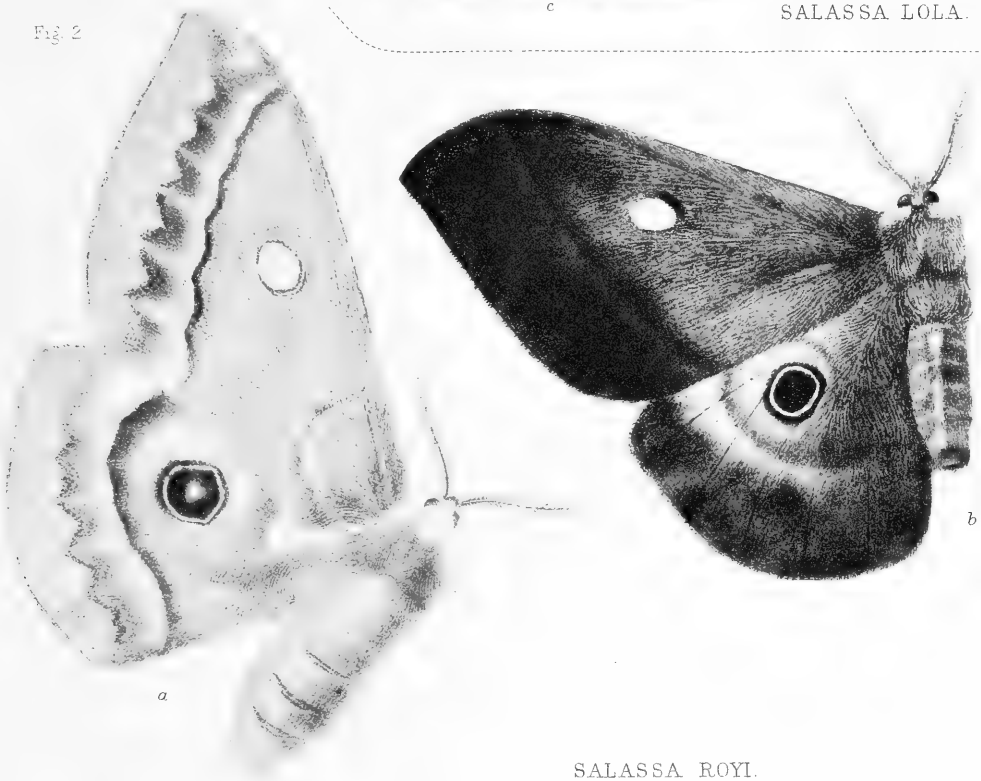
RHODIA NEWARA.

Photo-etching from the original drawings, Survey of India Offices, Calcutta, June, 1891.



SALASSA LOLA.

Fig. 2



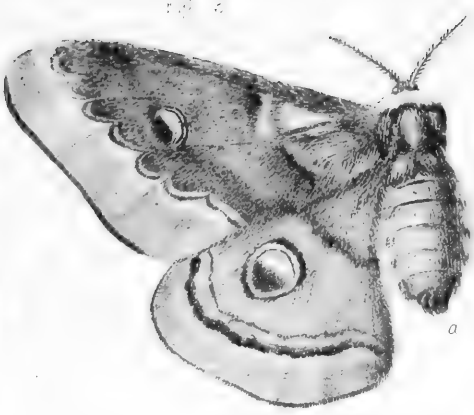
SALASSA ROYI.

Photo-etching from the original drawings. Survey of India Offices. Calcutta. June. 1891.

Fig 1

LOEPA MIRANDA.

Fig 2



NEORIS HUTTONI.

SATURNIA GROTEI.

Fig 4

SATURNIA STOLICZKANA.

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Fig 1.

Fig 2.

CALIGULA THIBETA

a

Fig 3.

b

CALIGULA SIMLA

RINACA ZULEIKA.

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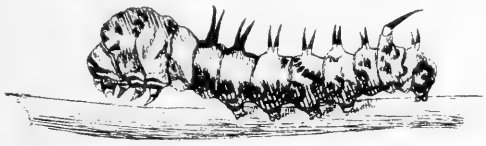
Fig. 1.

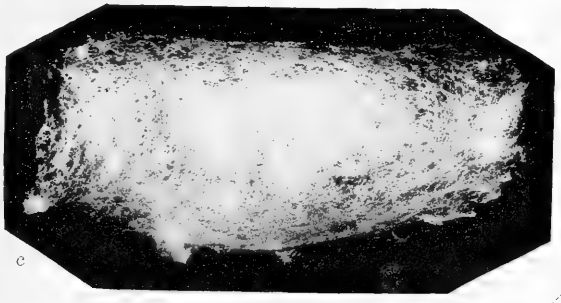
BRAHMAEA CERTHIA.

Fig. 2.

a



b



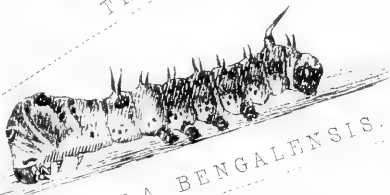
c

THEOPHILA AFFINIS.

Fig. 3.

THEOPHILA HUTTONI.

Fig. 4.



THEOPHILA BENGALENSIS.

Fig. 5.

b

a

c

TRILOCHA VARIANS.

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Fig 1. CEROPLASTES CERIFERUS.

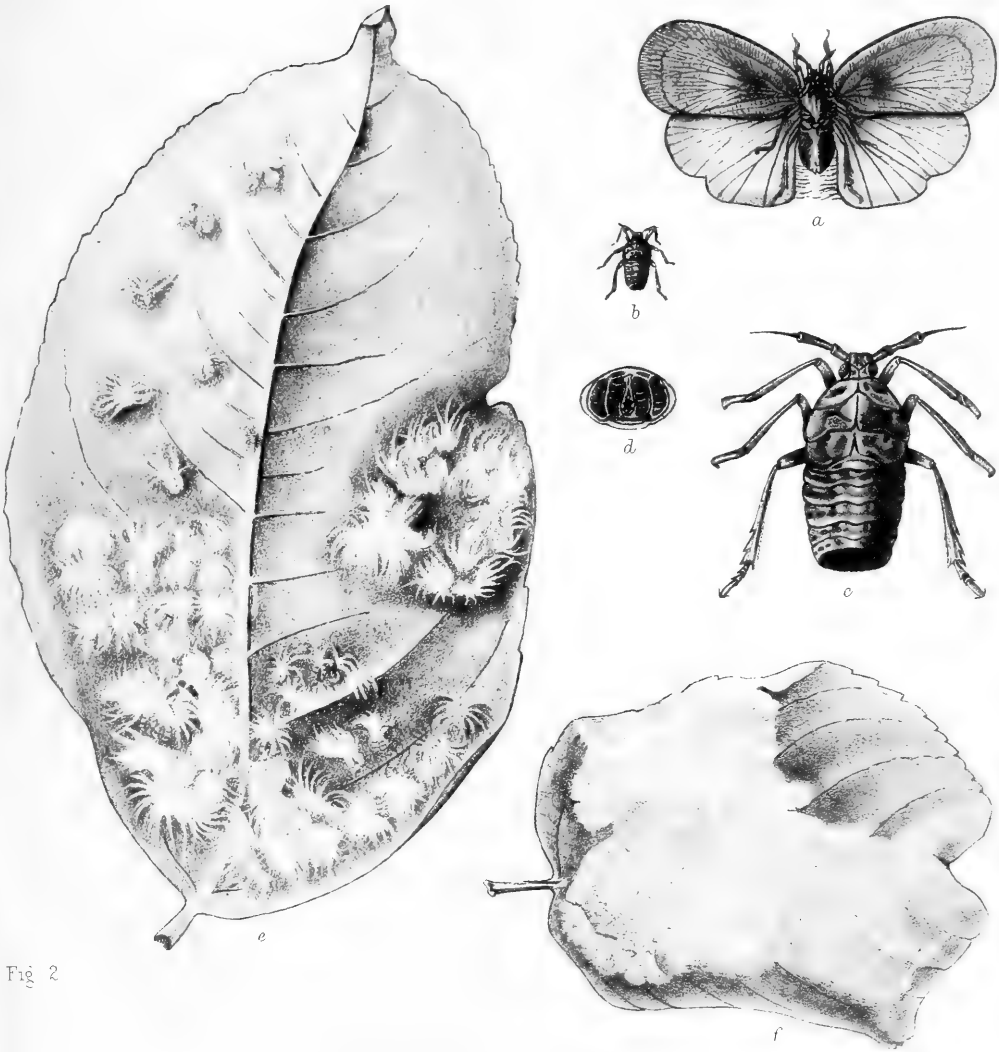

Fig 2. PHROMNIA MARGINELLA.

G.C.Chukrabotty, del.

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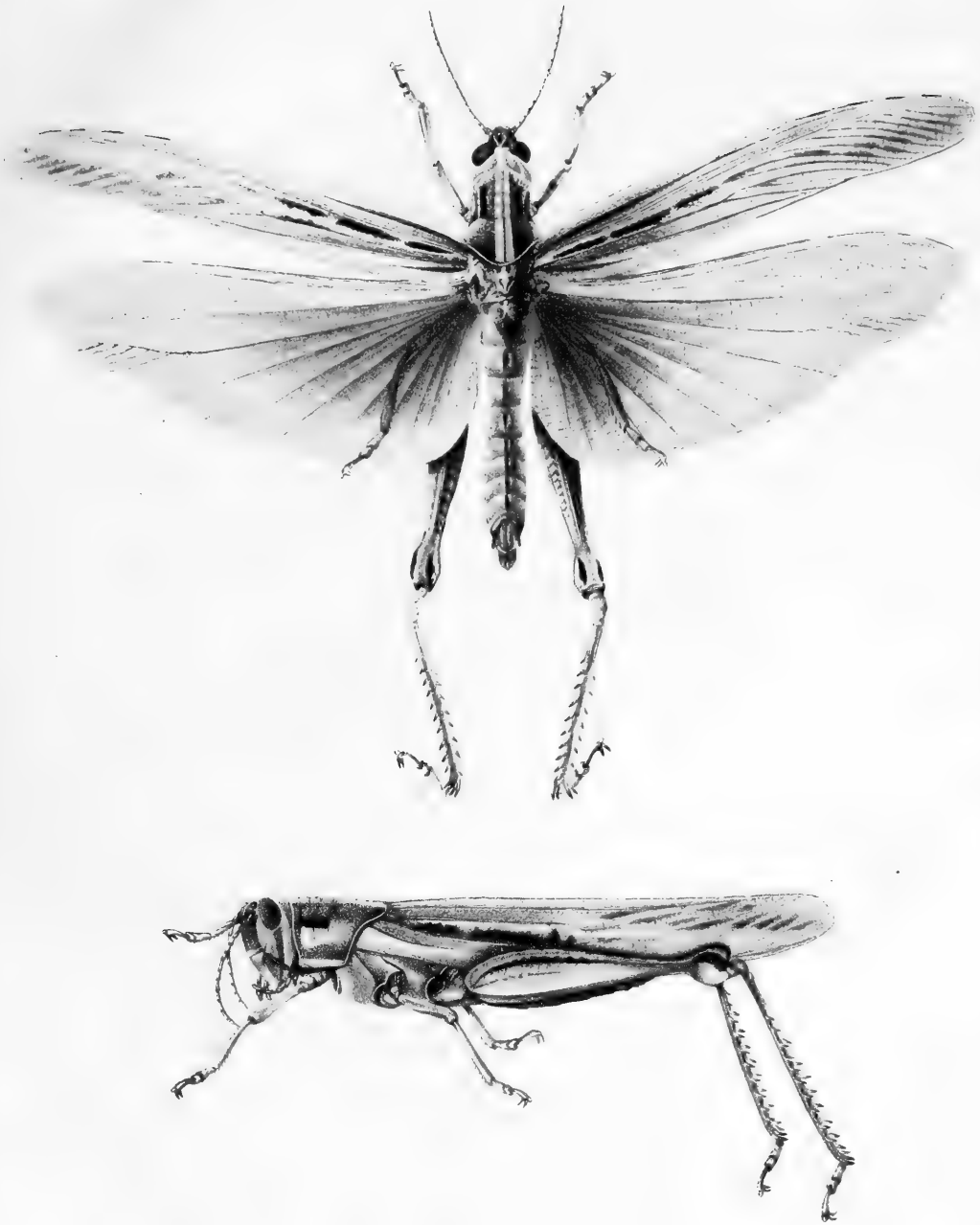

ACRIDIUM SUCCINCTUM LINN.

G.C.Chukrabotty, del.

Photo-etching from the original Drawings - Survey of India Offices, Calcutta, August 1891.