DEPARTMENTAL NOTES

ON

INSECTS THAT AFFECT FORESTRY,

BY

E. P. STEBBING, F.L.S., F.E.S.,
FOREST ENTOMOLOGIST AND LECTURER ON ZOOLOGY AT THE
IMPERIAL FOREST SCHOOL, DEHRA DUN.

No. I.

CALCUTTA:
OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.
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8, HASTINGS STREET.

PREFACE TO VOLUME I.

THE first number of these notes made its appearance in 1902 and the second in the following year. During the same year a second edition of No. 1 was issued, the first having become exhausted. For this latter edition a revised set of plates, all photogravures, was prepared, the plates issued with the first edition having proved most unsatisfactory. The lengthy period which has elapsed between the appearance of the second and third numbers is due to the work having been interrupted for a period of two years.

Whilst these notes are looked upon merely as a preparatory step towards the publication of a work on the lines of the well-known German *Forst Insekten* their issue is considered necessary for two reasons:— firstly, they greatly facilitate further research work; for as soon as a considerable number of notes have been collected they are put on record, and with this record as a guide further research into uncomplete life-histories is greatly aided; secondly, they enable those interested in the subject to keep *au fait* with the progress made.

The object and chief aim of the Notes is to prove a real help to the non-specialist workers in the subject, those to whom it is of the first importance to possess a reference work to which they can turn in cases of sudden need: and insect devastation in a forest usually makes its appearance in this sudden form. For this reason it becomes necessary to keep the descriptions of the insects as free from technicalities as possible. This was attempted in its strictest sense in the first part; but it soon became apparent that the number of insects of economic importance in the forest and yet hitherto undescribed (especially in such families as the *Scolytidæ*) was so large that it became absolutely necessary, in order to distinguish closely allied species the one from the other, to give to each a sufficiently lucid description so as to render their identification possible. To avoid all technicalities under such circumstances has proved impossible.

The issue of the Notes would not have been practicable but for the kindly assistance which has been forthcoming on a liberal scale from scientific confrères.

To Lieutenant-Colonel Alcock, C.I.E., F.R.S., I.M.S., Superintendent, Indian Museum, whose kindly advice has ever proved of incalculable value to the writer, to Mr. G. Lewis, F.L.S., Sir George Hampson, Messrs. C. O. Waterhouse, Gahan, and others of the British Museum staff, Mr. Distant, the late Mr. Buckton, F.R.S., the Rev., T. R. R. Stebbing, F.R.S., Mr. E. Ernest Green, Ceylon Entomologist and Mons. P. Lesne of the Paris Museum, Dr. L.O. Howard, and the staff of the United States Division of Entomology, to one and all the author owes a deep debt for assistance in identification work and valued criticisms and advice. Lastly, as the volume will itself show, much information of considerable value contained within its pages is the result of the unstinted aid afforded by the officers of the Forest Service themselves, and with them I would make special mention of the name of Mr. B. Ribbentrop, C.I.E., late Inspector General of Forests to the Government of India, to whose recognition of the importance of the study of this branch of Forest lore we owe its present position.

E. P. STEBBING.

Camp Quetta;
October 1905.

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INJURIOUS INSECTS.

Alphabetical List of Trees, with names of Insects by which they are attacked.

Predaceous and Parasitic Insects.

PREFACE.

THE object of issuing the Departmental Notes on Insects that affect forestry in India in their present form is to enable the Officers of the department and others interested in the culture of trees to keep up to date with our knowledge of the subject and to assist the advancement of the work by studying the still unknown portions of the life histories of the various pests detailed and of others still unrecorded. To this end, criticism and discussion are cordially invited.

Several of the insects dealt with are new to science and most of the information on their habits, etc., is new. It has not been considered necessary here, however, to give in full detail the reasons for the statements made with reference to some of the new and more complex of the life histories. The author hopes to publish elsewhere full and detailed technical papers dealing with the matter from the scientific standpoint.

It is proposed to give information in these notes upon :—

i.—Hurtful Insects.

ii.—Useful Insects.

E. P. STEBBING.

DEHRA DUN;
February 1902.

CONTENTS.

Alphabetical List of Trees, with names of Insects by which they are attacked.

Predaceous Insects.

Insecticides.

TRYXALIS NASUTA,

FISCH.

References :—Fisch. Orth. Eur. 299, pl. 15, f. 1,2. Gryllus (Acrida) nasutus, Linn. Mus. Lud. 118-9; Syst. Nat. i. 2, 692. Rors. Ins. ii, pl. 4, fig. 1, 2. Gryllus turritus, De. Vill. Ent. Linn. i, 434, pl. 2, f. 4.

Classification :—Order, **ORTHOPTERA**. Family, **Acridiidæ**.

Description.

This insect varies a great deal in tint and in the distribution of the colouring except that of the antennæ and wings. The body is green or light reddish, glabrous and shining. Head with the upper portion in front of the eyes about an eighth of an inch long, anteriorly obtuse. Wings a little shorter than the tegmina (upper wings), transparent, yellowish, especially at their lower inside portions; the veins of the same colour. Under surface of the abdomen darker than the rest, a dull pink when the insect is alive, becoming brown on drying after death. Tarsi of the same colour as the body; the after tibiæ furnished for the lower two-thirds of their length with a double row of numerous fine spines. ♀. Head and prothorax often have longitudinal rays of green and red sometimes not plainly visible. The elytra, of all the parts of the body, vary most in colour; sometimes bright green all over, at others having a longitudinal dull stripe cut up by white blotches beneath this band there is sometimes a reddish one also present; ♂ with uniform green elytra. Length 2 to 2½ inches. Pl. VI, fig. 1, shows a side view of this insect.

Life History.

Very little is on record as to the life history of this locust as far as it affects our nurseries and forests. It appears to be full grown in July and August, as it is during these months that it has always been reported as doing damage both to crops and to young plants. For the other ten months of the year we have at present no data as to where it is to be found. Observations are needed as to the number of generations it passes through during the year, where the eggs are laid and how long it spends in the young wingless larval stage.

Localities from which reported.

The distribution of the insect in India would appear to be a somewhat wide one. Madras and Bombay have reported the pest as causing considerable injury to crops. In 1897 the Deputy Conservator of Forests sent the locust from the Kangra Division in the Punjab, where it had increased in some numbers. In Madras it formed one of the locusts which gave so much trouble in the invasion of 1878. It, with several other species, probably breeds locally there as also in the other parts of the country it affects.

Mr. Mollison, now Inspector General of Agriculture, sent the insect from the Bombay Presidency, where it had injured crops in the vicinity of Poona in 1893. Next year it did injury in Satara. This insect is also common in the Cape of Good Hope, Senegal, Egypt.

Relations to the Forest.

This *Tryxalis* is said to have done considerable injury during the year 1897 to young plants of *Pinus excelsa* and bamboo (species?). Sowings of these species had apparently been made in various portions of the Kangra Division, and it was found that the locusts were biting off the young seedlings and either wholly or partially consuming them. The insect was accompanied by a companion named *Oxya velox*, these two being responsible for all the damage done.

Protection and Remedies.

It is not possible to prescribe with any certainty of success remedies for insects about whose life history so little is at present known, but where the operation is feasible, I would recommend that the young plants be dusted over a few times in the evenings with a mixture of quicklime and ashes. If the arsenic compound Paris green is available, a good mixture can be made with one ounce of the Paris-green, one ounce of unslaked lime and three pounds of ashes. Powder the substances together very finely, place them in a thin calico bag and dust over the plants.

Points in the life history requiring further observation.

1. When and where the eggs are laid.
2. The length of time the insect spends in the larval, *i.e.*, in the wingless condition. This is important since this and the egg stages are generally the easiest, in the case of locusts, to combat.
3. Length of time spent in the perfect or winged condition.
4. The number of generations passed through during the year.

OXYA VELOX,

BURM.

References :—Burm. Ent. 2. 6. p. 635. Acridium Hyla. Serv. Hist. Orthop. p. 678. Oxya Hyla. And.—Serv. Rev. pag. 96, no. 1. Gryllus velox. Fab. Ent. Syst. Tom. I p. 60.

Classification :—Order, **ORTHOPTERA**. Family, **Acridiidæ**.

Description.

Body shining. Head and prothorax apple green in colour; on the underside of the head behind each eye there is an oblique shining black stripe. Prothorax is pitted; the cross furrows very fine; no dorsal keel is present; on the sides touching the top there is a longitudinal black shining stripe in continuation of that on the head, which runs down on to the sides of the body. The elytra are a little longer than the body, rather narrow, rounded at their ends, transparent, with the inner edges opaque and green in colour; the outer edge is slightly dilated near the base. The under wings are as long as the elytra, transparent and colourless; the cross veins are very fine. Abdomen and tarsus greenish yellow; front legs and tarsus a light azure blue, the spines on the tibiæ being white, tipped with black. Antennæ yellowish, darkening towards the extremities. ♀. Length 1 to 1½ inches.

The male differs in length being ¾ to 1 inch long. Also the outer edges of the elytra have no pronounced dilation.

This species varies a great deal in length. The lateral black stripe is sometimes entirely or partially effaced. Pl. VI, fig. 2, shows this insect.

Life History.

Little has been recorded on the life history of this small locust. It is full grown in July-August, and has been reported as doing damage in many of the warmer parts of India during these months. Immature, *i.e.*, wingless specimens have also been reported from Ganjam, Madras, in November, and it may possibly turn out that these young ones result from the eggs laid by the mature insects found in July-August. No data are available as to what becomes of these young insects during the cold weather months or as to when they mature.

In October 1893 fully mature specimens of this pest were very prevalent in the Peshawar District and neighbouring hills, proving that the life history in the colder parts of India will vary from that of the pest living in the warmer areas. It is probable that the insect will be found to have but one generation in the year in the former case, whereas two, if not more, may be the rule in the latter.

Localities from which reported.

This insect is generally found in company with *Tryxalis nasuta* in India, and is to be found all over the country in the areas given for that insect. In addition, it has been reported from the Khasi and Jaintia Hills, Assam, and the Peshawar District and neighbouring hills

Relations to the Forest.

Oxya velox was reported in company with T. *nasuta* as cutting down and feeding upon young blue pine (*Pinus excelsa*) and bamboo seedlings in sowings made in the Kangra Valley.

Protection and Remedies.

The same as given for *Tryxalis nasuta.*

Points in the life history requiring further observation.

1. When and where the eggs are laid.
2. The length of time spent in the wingless stage.
3. Length of time spent in the perfect or winged condition.
4. The number of generations passed through in the year—
   (*a*) in the warmer parts of the country.
   (*b*) in the colder do. do.
5. Where and how the insect passes through the winter and in which stage.

BRACHYTRUPES ACHŒTINUS.[1]

STOLL.

References :—Stoll. Gryll. pl. 2 c. fig. 8 ♂. fig. ♀.

Classification.—Order, ORTHOPTERA. Family, Gryllidæ.

VERNACULAR NAME.—*Thigi pŏka* (Chittagong Hill Tracts).

Description.

The following is a description of this large thick-set cricket: Body smoky brown, shining above; yellowish beneath. Prothorax longish and only slightly narrower behind, edged all round with a short dorsal furrow, and a faint cross line behind; it has two yellowish patches, longer in the female than in the male. Elytra brown above, the portions bent down on each side yellowish. Abdominal appendages ⅝ths of an inch long and yellowish. Tarsi yellowish; front tibia as long again as the tarsus; tibiæ of the hind legs furnished with two rows of strong spines, four on each side; the hair on the underside of the tarsal joint of front legs, as well as the fringe of its two claws, yellowish. Ovipositor of the female yellow, its valves brown on the outside. Antennæ brownish.

Length 2½ inches. Pl. I, fig. 1, a shows the larva and fig. 1, b the full-grown insect.

Life history.

The insects were first noticed towards the end of April, they being then about a quarter grown, see Pl. I, fig. 1 a. About the end of May to the middle of June they are two-thirds grown, being then 1¾ inches in length. They live in burrows in the ground. These they construct in soft sandy situations, the tunnel starting at an angle to the surface level and running in a

[1] This insect was first reported to me by Ranger Ashutosh Chakravatty, in charge of one of the ranges in the Chittagong Division, Bengal. The notes on the life history are from observations made by the Ranger and myself, whilst the crickets were attacking a young rubber nursery in 1900.

zig-zag manner for some 2 feet and having a diameter of $\frac{1}{2}$ to $\frac{3}{4}$ of an inch. At the end it is enlarged into a small chamber Holes examined were found to contain one, two, or as many as three larvæ. Up to the time the monsoon bursts the insect is a voracious feeder, gnawing off the leaves and top-shoots of young seedlings or cutting off the young plants at the level of the soil and dragging them away to its burrow to eat. It is a most wasteful feeder, as often, after biting through the stem of a young plant, it leaves it and proceeds to the one next to it, which is treated in the same way and then left to die, no part of it having been eaten by the insect. It is a nocturnal feeder and will only be found out of its burrow in the day time in very dull cloudy weather. In the evening it sits at the mouth of its hole and may be recognized by its shrill piping. After the burst of the monsoon the insect apparently disappears for eight to ten weeks, as all injury ceased for this period and the holes were deserted. About September, however, when the rains are slackening, the insects again make their appearance and are then seen to be full grown, being about $2\frac{1}{4}$ to $2\frac{1}{2}$ inches in length and having fully developed wings. They now begin again to feed voraciously, and in October may be found in the holes in pairs, a ♂ and ♀ living together in each burrow. These mature insects disappear at the beginning of November after probably laying their eggs in the ground near young vegetation.

Areas from which reported.

This insect was found attacking a young plantation at Kaptai in the Sitapahar Reserve in the Chittagong Hill Tracts.

The cricket has also been reported as very destructive in tea nurseries in the Jorhat District, Assam, and to jute and rice crops in Comilla, and is likely to have a wide range in the country.

Relations to the Forest.

The ravages of this insect in a nursery, if unchecked, are most serious. In addition to the large numbers of young plants it actually eats, when swarming in numbers, a very considerable quantity are wantonly bitten through by the pest and left lying on the nursery beds or near the mouth of the burrows. It will be found that these latter are made all over the loose sandy soil of the specially prepared beds and will also occupy all sandy patches of soil in the neighbourhood of these beds, even as much as a hundred yards or more away. The presence of the insects can at once be recognized by the round openings of these burrows pitted all over the surface of the beds, and other favourable situations. Green portions of seedlings will often be found protruding from these openings, and the paths to them from the nursery, as well as the beds themselves, will be strewn with half-eaten fragments or whole seedlings dragged up from the soil or cut off at the ground level. This cricket is apparently omnivorous in its feeding but in the attack in the Kaptai nursery India-rubber (*Ficus elastica*) seedlings, with which the nursery was chiefly stocked, were its favourite food, young teak seedlings where found being also consumed.

Protection and Remedies.

In choosing sites for nursery operations, whether temporary or permanent, the area should be carefully inspected to see whether this insect is at work in the neighbourhood, and enquiries should be made as to whether its presence has been noticed.

When the insect has appeared in a nursery in numbers the crickets should be dug out of their holes and killed. Boys can be put on to this work at small expense, and satisfactory results will be obtained. For the ones which visit the nursery from outside, perfectly fresh young seedlings, poisoned by being dipped in a solution of the arsenical powder known as Paris green, should be scattered about the nursery after sunset and also near the holes and runs of the insect outside the nursery. This will get rid of a large number. In October, when the crickets are pairing, every hole should be carefully dug up and the pairs found in them killed.

In the Chittagong Hill Tracts this insect is esteemed a great delicacy by the Mugs, etc., who dig it up eagerly and roast and eat it with great relish.

Points in the life history requiring further observation—

1. Where the eggs are laid by the female and their number.
2. When the young crickets hatch out of the eggs.
3. What becomes of the nearly full grown larvæ between July and September.
4. Is there only one generation in the year.

SERICA ALCOCKI,

BRENSKE.

Reference :—Brenske in litt.

Classification :—Order, **COLEOPTERA.** Family, **Scarabaeidæ.** Sub-Family, **Melolonthini.**

Description.

A smallish thick brown beetle, black to plum-coloured above ; clypes rounded thickly but lightly punctured. Prothorax convex, rounded at sides. Scutellum small but broad. Elytra broadly striated, the striæ being irregularly punctured, the channels lightly punctured. Thighs broad, not spined ; hind tibiæ slightly dilated, front ones with two teeth. Antennæ slender, ten jointed, the club consisting of three small plates. The last joint of the maxillary palpus short, ovate, and pointed. Pl. IV, fig. 1, shows this insect.

Life History.

This beetle is found on the wing in the middle of June, and probably makes its first appearance somewhat earlier. The insect was discovered on the 16th June 1896 by Mr. C. G. Rogers, Deputy Conservator of Forests, feeding on *Mallotus philippinensis.* No further notes on its life history have since appeared, and where the larval and pupal stages are passed has yet to be discovered. As is usual with melolonthids, these will probably be passed in the ground, the larva feeding at night on young seedlings and spending the day in its burrow in the earth. It is thus probable that this pest will be found to do damage in both its larval and imago stages.

Area from which reported.

As far as my available information goes, this insect has only as yet been reported from the Dehra Dun District, North-West Provinces.

Relations to the Forest.

The beetle feeds on the young and tender succulent leaves of *Mallotus philippinensis.* Nearly the whole of the leaf, with the exception of the midrib, is eaten. The pest apparently starts feeding indiscriminately either at the edge or in the middle of a leaf, but was not noticed to eat the old mature harder leaves.

The insect, like several other members of this sub-family, is said to drop to the ground the moment the leaf on which it is feeding is touched, and Mr. Rogers noticed that it was then, owing to its colouring, very difficult to see amongst the dead leaves and decaying vegetation.

Protection and Remedies.

In the nursery the Paris green treatment should prove sufficient to stop this insect's attacks, since it is a foliage-eater in its adult stage. Other treatment will, however, be required for the larva should it make its appearance. The life history requires working out.

Points in the life history requiring further observation.

1. Where the eggs are laid.
2. When and where the larvæ hatch out and feed and the nature of their food.
3. The length of time passed in the pupal stage.
4. The number of generations in the year.

SINOXYLON CRASSUM,

LESNE.

Reference :—Lesne. Ann. Soc. Ent. de Belgique Tom. xli, p. 21 (1897).
S. coptura, Guérin (inédit).

Classification :—Order, **COLEOPTERA**. Family, **Bostrichidæ**.

Description.

Neither the *eggs* nor *larvæ* appear to have been yet described.

The *beetle* is oblong in shape, slightly dilated posteriorly, entirely brown in colour and rather shining. Antennæ and tarsi reddish brown. The elytra are strongly punctate and striated at their lower ends. Length 7—8½ millim. See Plate I, fig. 2, c. *S. crassum* is similar in appearance to *S. anale*, but larger and more robust in build.

Life History.

The beetles appear on the wing in April in the plains of the Punjab: in warmer parts of the country probably in March. They bore into felled timber and also into stag-headed and weakly trees for the purpose of egg-laying, the beetles tunnelling their way into logs either through the bark or through one of the cut ends. The gallery is gnawed straight down to the sap wood and the egg galleries then take off from it at an angle. Little indentations are cut in the sides of these secondary galleries and an egg laid in each. The larvæ on emerging feed on the wood, gnawing out short galleries in which they pupate. The beetles from these larvæ are those of the first generation of the year and come out of the wood towards the end of July. They at once attack fresh wood in which they lay eggs which give rise to the beetles of the second generation which appear in September-October.

Localities from which reported.

Specimens attacking Khair poles (*Acacia Catechu*) from the Raipur forests, obtained by Mr. F. Gleadow in July 1890, were identified as *S. crassum.* The beetles were swarming in the poles. The insect has also been reported from Belgaum (in April) and Canara in the Bombay Presidency and also from Burma.

"Bostrichid beetles" were reported as damaging Sissu billets in the Changa Manga plantation, by Mr. B. O. Coventry in 1899: during April 1901 I found that *S. crassum* was one of the chief beetles engaged in this attack.[1]

Relations to the Forest.

S. crassum does serious damage to the fresh-cut billets and logs of Sissu (*Dalbergia Sissoo*) trees in the Shadhera and Changa Manga plantations in the Lahore Division. It also attacks stag-headed and sickly trees. When in numbers its galleries entirely riddle the sapwood and penetrate into the heartwood (see Pl. I, fig. 2, d). Stacks of wood so treated are covered on the outside with the yellowish wood-powder pushed out of the tunnels by the excavating beetles, and the wood has a dilapidated decaying appearance, its weight being at the same time greatly reduced. The commercial value of the wood is thereby lessened.

When stag-headed and sickly trees are badly infested their vitality is greatly reduced and they eventually succumb.

The beetles only attack felled timber while it is still fresh and sappy, but it appears to be immaterial whether bark is present or not. They also attack Khair (*Acacia Catechu*) wood in a similar manner.

Protection and Remedies.

The beetle's active life lasts from April to October, and during this period it attacks felled and stacked Sissu wood cut in the above mentioned plantations during the previous cold weather, November to March. This wood is stacked in heaps along the compartment lines in the forest and remains there till October, in order that it may dry and so become lighter. Owing to having this constant supply of fresh material always

[1] The beetles were kindly indentified for me by Mr. C. O. Waterhouse of the British Museum.

ready for it, *S. crassum* has increased in enormous numbers in the plantations and has now become a formidable pest.

The following are remedies I would suggest :—

1. Remove from the forest as soon as felled the amount of wood annually cut in the compartments, no fresh-cut wood being allowed to lie in the forest after the end of March.
2. That the fellings be so arranged that wood is not cut in advance of the selling power. The amount on hand at any one time being thus smaller, the number of breeding places for the insects will diminish.
3. The number of breeding places being thus reduced, measures will have to be put into force to deal with the large numbers of beetles which under these circumstances will attack the green standing trees.

(*a*) Careful watch to be kept for attacked standing trees. They will be recognised by small "shot holes" appearing in the bark with probably particles of sawdust at or near their entrances. Such trees, if badly infested, should be cut down at about the end of May (when they will contain larvæ and pupæ) and be chopped up and burnt. To ascertain the time to fell the tree, cut out a strip of bark and see if the bark and sapwood contain small white grubs or pupæ. If so, this is the time to remove the tree. If it is left longer the larvæ and pupæ will change into beetles and these will then bore their way out and leave the tree and attack fresh ones. This careful watch should be kept up between April and October for a year or two after the plan of immediately removing the cut fuel and logs has been adopted.

(*b*) To save green trees from being promiscuously attacked, "trap" trees could be used. Suitable trees are selected in convenient places adjacent to the areas in which fellings have just been made and are ringed or felled about February. The April beetles will lay their eggs in these trees in preference to attacking green ones. The trees should be felled in May, cut up and burnt. In June another set of trees should be similarly prepared to catch the second generation of beetles, this second lot being cut down and burnt about the end of August.

Careful watching will show whether it is necessary to repeat this treatment the next year.

Points in the life history requiring further observation.

1. Where does the insect pass the winter, and in which stage, egg, larva, pupa or imago?
2. The number of generations passed through during the year. It will probably vary in different parts of India.
3. The number of eggs laid by the ♀ and method of laying them.
4. Description of larva and its method of feeding.

The Sissu billets examined were so terribly riddled by the beetles, etc., that my notes on the way in which the eggs are laidand the manner of feeding of the larval require corroboration.

SINOXYLON ANALE,

LESNE.

Reference.—Lesne. Ann. Soc. Ent. Belg. Tom. xli, p. 21 (1897). Stebbing Injur. Ins. Ind. For. p. 42.

Classification.—Order, **COLEOPTERA**, Family, **Bostrichidæ**.

Description.

The *larva* is a little white curved grub with the anterior segments enlarged and a median dark coloured line running down the back; three pairs of legs are present (Pl. I, fig. 2, a). The grub is active in its movements, wriggling about when disturbed. Length when full grown 4½ to 5 millim.

The *pupa* has the ordinary white beetle-like form which gradually assumes the shape of the mature insect (Pl. I, fig. 2,b).

The *beetle* resembles *S. crassum* in appearance but is smaller and of slighter build. It is at first light yellow in colour, becoming darker coloured as its outer parts harden. When mature it is oblong, slightly dilated behind, black, with the elytra anteriorly rufus-chestnut, more or less dusky, with antennæ, palpi and feet testaceous, the thighs being paler in colour and the abdomen reddish at the apex. The head has a toothed forehead. Antennæ end in a strongly fan-shaped club, the second joint of the club being about six times as broad as long. The elytra are strongly punctate posteriorly. Length 4 to 5½ millim. See Pl. I, fig. 2, c.

Life History.

The beetles appear early in April at Changa Manga, apparently at the same time as *S. crassum*. In Chota Nagpur they are to be found in March. They remain active, however, later in the year (as far as present observation goes) than the latter, as I have found them issuing from wood as late as the third week in November. The beetles attack trees and felled timber in a similar manner to *S. crassum*, and often these two pests are to be found at work together. The beetle bores its way into the sap wood and then eats out a largish chamber and from this two or three secondary egg galleries take off. In small billets these may be found at all depths. The eggs are laid at the sides of these galleries, the female blocking up the notches in which they are laid and the gallery itself with sawdust. Larvæ were found in all stages of growth in the third week of April and pupæ between this and the end of the month. In May and June beetles have been reported as active, they being those of the first generation. Fully mature beetles also again appear in September, disappearing according to Mr. B. O. Coventry in October. The writer has found beetles issuing from Changa Manga Sissu billets in November. There would therefore seem to be a probability of there being three generations of this insect in the year. The pest probably hibernates through the winter in the larval stage or as a beetle, coming out and laying its eggs in fresh trees and cut wood in April.

Localities from which reported.

In 1897 I found this insect attacking sâl logs and sickly trees from March well on into June in Chota Nagpur. In October 1899 Bostrichid beetles were reported by Mr. B. O. Coventry from Changa Manga and in April 1901, I ascertained that one of them was *S. anale,* it occurring also plentifully at Shadhera. The following further note on the distribution is given by Mr. P. Lesne:—

Bombay Presidency. Belgaum, taken at light in March, April, and also beneath old bark (Andrews); Canara, found in *Xylia dolabriformis,* Benth. and in Shisham(*Dalbergia latifolia,* Roxb.) (T. R. D. Bell) ; Burma (G. Q. Corbett). Mr. Bell has observed this species boring into the bark of the above mentioned trees and then mining out beneath the bark a longitudinal gallery ; the female chooses dead trees, the wood of which is not quite dry. Mr. Bell has found the male and female in the same gallery in March.

Relations to the Forest.

The action of this pest in the forest is very similar to that of *S. crassum* described above. It is probably the greater pest of the two, since it will attack drier wood than its ally. Owing to this habit it remains burrowing into billets and timber for some time after they have been deserted by *S. crassum* thereby greatly increasing the depreciation in the commercial value of the wood.

As we have seen Sâl, Sissu and Shisham (*D. Sissoō* and *latifolia*) and *Xylia dolabriformis* have up to date been reported as suffering from the attacks of this pest.

As in the case of its companion it appears to bore with equal ease into barked or unbarked timber, and this habit renders it all the more dangerous.

Protection and Remedies.

The remarks made under this head for *S. crassum* apply equally here. In addition dead standing trees should be cleared out since the insect attacks wood in a dry condition.

Further, I would recommend that, if possible, the amount of fuel kept on hand in the fuel depôt at Changa Manga should be reduced to the least possible minimum if it is not possible to do away with the depôt altogether. In April I found *S. anale* riddling the wood in numbers of stacks and others, which had been in the depôt for some time, were very greatly reduced. Plate I, fig. 2, d, shows the results of the beetles' work in this wood.

Points in the life history requiring further observation.

1. The number of generations passed through during the year between March and November.
2. The number of eggs laid by the female and method of laying them.
3. In which stage or stages the insect passes the winter.

[Some natural enemies of *Sinoxylon crassum* and *S. anale.*]

TERETRIOSOMA STEBBINGII,[1]

LEWIS.

Reference:—Lewis, Ann. Mag. N. Hist. Nov. 1901.

Classification:—Order **COLEOPTERA.** Family, Histeridæ.

Description.

Only the male *beetles* have yet been observed. The beetle is a small, compact, cylindrical, somewhat elongate insect, pitchy brown in colour, shining and rather densely punctured above. The head is not hidden by the prothorax; antennæ are short and bent, with a compact club. The elytra are closely applied to the body but leave the last two segments exposed. Five ventral segments of the abdomen are visible. Length 2¾ millim. See Pl. I, fig. 5.

TERETRIOSOMA CRISTATUM,

LEWIS.

Reference:—Lewis, Ann. Mag. N. Hist. Nov. 1901.

Classification:—Order, **COLEOPTERA.** Family, Histeridæ.

Description.

Only the male *beetle* of this insect is known.

This beetle is very similar to the one above described. It is piceous in colour, the thorax being more convex than the dorsal region, and the scape of the antennæ bearing long, palish hairs. The insect greatly resembles the one shown in Pl. I, fig. 5.

[1] This and the following beetles were kindly named for me by Mr. Lewis, F.L.S., to whom my thanks are due. The first two proved new to science.

TERETRIOSOMA INTRUSUM,
MARSEUL.

The characters of this *beetle* are very similar to the above mentioned two species, and for the purpose of these notes the insect will be sufficiently recognised from the above descriptions and figure.

Life history.

The above three species of *Teretriosoma* are predaceous insects and were found together in numbers in the galleries bored by the *Sinoxylon* beetles, and more especially amongst their larvæ on which they feed. It has yet to be observed whether they also attack and devour the *Sinoxylon* beetles in their mature state. These useful insects are at present only known in their imago stage, their larval forms and the manner in which they feed being as yet undiscovered.

Areas from which reported.

All the three species were found by the writer in the galleries made by the *Sinoxylon* beetles in the Shahdera and Changa Manga Plantations of the Lahore division in the Punjab.

Relations to the Forest.

Owing to their predaceous habits these insects are of the greatest importance in the forest, as their operations tend to keep down the numbers of two bad timber-boring beetles.

Protection.

As these beetles are found in the same positions as the *Sinoxylon* beetles, my recommendations for exterminating these latter will result in destroying large numbers of their predaceous enemies. It is evident, however, that at Changa Manga exceptionally favourable conditions have resulted in such an enormous increase of the boring beetles that their *Teretriosoma* enemies are no longer able to cope with the numbers and keep them in check, as, under normal conditions, they would probably be able to do. It has become necessary therefore for the forester to step in and my recommendations for the necessary treatment have already been described.

BOTHRIDES SP.

Reference :—Provisionally named as *Bothrides* sp. by Mr. C. O. Waterhouse of the British Museum, to which collection the insect is new.

Classification :—Order, **COLEOPTERA.** Family, **Colydiidæ.**

The *beetle* is narrow, elongate, parallel, shining, and light brown in colour above and below. The head is largish and protrudes beyond the prothorax ; eyes round and fairly prominent ; antennæ end in a terminal club. Prothorax a little separated from elytra, squarish ; head and prothorax strongly punctate above. Elytra deeply ridged longitudinally and punctate between the striæ. Legs light brown ; tarsi 4-jointed, none of joints being broad ; hind coxæ are separated, fore and middle ones close to one another ; five visible ventral segments. Slender, active insects ; very quick in their movements. (Pl. I, fig. 6).

Life history.

The beetles, which are predaceous, were found in the same places as the *Teretriosomas* above described, and were more especially abundant in the galleries containing numerous *S. anale* larvæ ; it is not improbable that their attacks are confined to these latter, and perhaps to their pupæ.

The notes given under "area from which reported," "relations to forest" and "protection" for the *Teretriosomas* apply equally here.

Points in the life histories requiring further observation :—

1. Female insects of the *Teretriosomas* have yet to be discovered.
2. The larvæ of all these predaceous beetles are yet unknown.
3. We require to know when the eggs are laid and where, and on what the larvæ feed.
4. The pupal stages are still unknown.
5. The number of generations in the year, and whether these correspond in number with those of the insects they live upon.
6. Whether they prey upon the imago stages of the *Sinoxylon* as well as the larval ones.
7. How and where they pass the winter.

MIMASTRA CYANURA.

HOPE.

Classification :—Order, COLEOPTERA. Family, CHRYSOMELIDÆ. Sub-family, Galerucidæ.

Description.

This small beetle is yellow in colour, shining, with filiform antennæ about ¾ the length of the body. The head is small, round and separate from the prothorax. Prothorax quadrangular, slightly longer than broad. Elytra oblong-oval, dilated behind and very obtuse. Legs longish.

Life History.

The beetle appears on the wing about the middle of June or perhaps earlier, it having been found by Mr. C. G. Rogers, Deputy Conservator of Forests, defoliating trees on the 18th of the month. Neither larva nor pupa appear to have been noted, and no further observations on its life history are forthcoming with reference to the dates of appearance of these stages and the number of generations in the year.

Locality from which reported.

This beetle was found in the Dehra Dun District in 1896.

Relations to the Forest.

M. cyanura is a leaf-feeding chrysomelid, and defoliates both young and old trees of the species *Grewia asiatica*. In the attack noticed in 1896 the beetles were said to have appeared in large numbers flying freely and being sufficiently numerous to produce a humming noise as of a swarm of bees passing overhead. The majority of the leaves were badly eaten by the 18th June, in many cases only a short piece of the base of the midrib remaining intact. No birds were present feeding upon these beetles, and it is probable, as noted by Mr. Rogers, that the thick orange liquid which they have the power of emitting from their heads has some distasteful quality in its composition.

Protection and Remedies.

These leaf-feeding beetles are best attacked by one of the arsenical solutions, preferably Paris-green, sprayed on over the plants to be protected, and this spraying should be done either in the very early morning or late in the evening. The beetles feeding upon the leaves take the poison internally, and are thus killed off.

More facts about the life history, such as where the eggs are laid, where the larvæ feed, etc., are required to be known before one can state definitely how such pests can be best attacked.

XYLOTRECHUS VICINUS,

L and G.

References :—L. and G. Mon. p. 38, Decan. Clytus vicinus, Lacord. Ins. IX. 1, 78.

Classification :—Order, COLEOPTERA. Family, CERAMBYCIDÆ.

Description.

Beetle. Head not very large, rounded between the antennæ, convex slightly in front, with short cheeks. Antennæ do not reach to the middle of the elytra, are thin and filiform. Eyes large. Prothorax ovate tapering towards the head. Elytra slightly convex, not meeting at posterior edges, thus leaving a portion of the abdomen exposed. Legs long and not very thick ; the femora slightly thickened and those of the hind legs reaching beyond the elytra. In the females the antennæ are a little shorter and the femora of hind legs only reach to the elytra tips. See Pl. IV, fig. 2.

Life History, etc.

Little is known on the life history of this insect. The larva tunnels into the wood of the Oak (*Quercus dilatata*), and specimens of the mature beetle were discovered in the trees in August last and sent to me by the Ranger in charge of the Kilba Range, in the Bashahr State, Punjab.

The insect is of interest, since it is closely related to the well-known coffee tree borer of South India, *Xylotrechus quadripes*,[1] Chur.

Observations are required as to how long the larva of *X. vicinus* spends feeding in the tree, the length of time passed in the pupal stage, where the eggs are laid, etc.

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1 *Vide* Injur. Ins. Ind. For. p. 80-81.

APRIONA GERMARI,[1]

HOPE.

Classification :—Order, **COLEOPTERA.** Family, **Cerambycidæ.** Sub-Family, **Lamiidæ.**

Description.

The *larva* is a long, white, thick, grub with a well developed head, powerful mandibles, and large thoracic segments. It is legless, and when fully developed is about 3 inches in length and ½ an inch across the thoracic segments.

The mature *beetle* is 1½ inches in length and is covered all over with a golden brown pubescence. Its elytra are rough and scarped at their anterior surfaces, where they are dotted with small black raised points. Colour is more golden on the under surface. Legs same colour as elytra, tarsus slightly darker. Specimens with this colouring were found in 1897. In 1898, one beetle taken resembled in form the above, but differed in colouration. The colour was a dirty yellow, but the elytra had several white blotches on them and there were two bright orange spots on the thorax. It differed also on the underside in having a broad white marginal band round the abdomen extending to the head, thus being unlike the uniform colouring of the other specimens. The first described specimens were identified for me by Mr. C. O. Waterhouse, of the British Museum, as *A. Germari.* I have not seen the 1898 beetle. The difference in markings *may* be due to a difference in sex only. Pl. IV, fig. 3, shows the larva, pupa and imago.

Life History.

The larva of this beetle has been found infesting stems of the mulberry (*Morus indica*). Its presence has been known for

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[1] The notes on this beetle have been drawn up from careful observations made by Mr. B. O. Coventry when in charge of the plantation it infests, from observations made by the writer when visiting the plantation, and from the correspondence on the subject by Messrs. C. G. Rogers and B. O. Coventry, published in the *Indian Forester*, Vol. XXIV, pp. 203, 204 and 341—345; Vol. XXV, pp. 68, 69.

some years (Mr. Rogers mentions finding it in 1892), but neither the pupæ nor beetles were known at the Shahdera Plantation, where it is reported from, till specimens of both were discovered by Mr. B. O. Coventry in 1897.

Larvæ of all sizes can be found in the stems at all times of the year, this clearly denoting that they take a year or more to mature. Both pupæ and beetles were found in the middle of July, but none of the latter are said to be discoverable in the stems in August. It is thus probable that the beetle's flight time is at the commencement of the rainy season. As the perfect insect is not to be found later on in the year, it probably at once pairs and lays eggs on the bark of the stems which, being now full of sap and soft, will be easily bored into by the young still tender mandibles of the small larvæ. The young grubs remain for a time boring in the sapwood and then as they get stronger go into the heartwood and tunnel up and down this. Some tunnels I inspected were 7 to 8 feet and more in length. As soon as the tunnel enters the sapwood, branch tunnels to the outer surface of the bark are gnawed out at intervals for aeration purposes, and the course and direction of the tunnel within the stem can be traced by these holes on the outside, the holes becoming larger and larger since, as the larva grows in size, it necessarily bores a tunnel of larger diameter and the offsets to the outside also increase in circumference. Careful search has failed to show that more than one larva is ever present in any one stem, and therefore it must be considered probable that the beetle lays but one egg on any one tree. The position on the stem where it is laid would appear to vary as Mr. Coventry considers it to be always high up, whereas my own observations on some cut stems showed that in these cases the larva had commenced its tunnel in the sapwood at the foot of the tree. Mr. Coventry wrote :—

> The larvæ, commencing high up, burrow down the entire length of the stem, and often a considerable way down one of the main roots . . . . After reaching its lowest limit the larva appears to hollow out a chamber sufficient to enable it to turn round, and then burrows straight up the stem again, sometimes following the old gallery and sometimes striking a new one.

It is not improbable that the chamber here referred to is made to enable the grub to rest for a period during the coldest part of the winter, but this opinion requires corroboration. By far the longest part of the tunnel, including all the portion with a large diameter, is to be found in the heartwood, the larva seeking this and leaving the sapwood as soon as its mandibles are strong enough to enable it to bore into the former.

Locality from which reported.

Although the larvæ and its work had been known for some years at the Shahdera reserve, a Sailaba plantation on the banks of the Ravi about 5 miles from Lahore, Punjab, it was not until 1897, that beetles were obtained by Mr. B. O. Coventry from which the insect was identified as *Apriona Germari.*

Relations to the Forest.

Mulberry stems are very badly infested by this beetle which confines itself to this tree and does not attack its companion the Sissu. The eggs are most usually laid on the main stems of young living coppice shoots, about three to four years old, and 2½ to 3″ in diameter, and the insect grows in size with the development of the tree. Attacked trees can be recognized owing to a rusty red stain running below each air-hole made by the larva, the stain being caused by the trickling down of sap from these holes; also very often by the presence of saw-dust at the foot and on the bark of the tree. The attacks of the larva do not kill the tree, but the galleries bored up and down the stem ruin the wood for timber purposes, and at Shahdera the mulberry is only sold as firewood. A large proportion of the young trees are infested, and the old ones mostly bear the marks of previous attacks in the unsightly wounds, often of large size, which are to be seen on their stems. These wounds have originated from the air-holes of the larva and the large exit hole made by the beetle. Decay sets in at these points, and is probably accelerated by rain water. These large wounds are not to be found on trees containing living larvæ.

Protection and Remedies.

Mr. Coventry has suggested that the only practical remedy is to cut out all attacked stems and collect and destroy the larvæ. The damage chiefly originates in the young compartments, and the removal of attacked stems would be in the nature of a light thinning which would be beneficial rather than detrimental to the growing stock. This opinion entirely agrees with my own, and, being that of an officer who has held charge of the plantation, is, I conclude, a feasible one. We have already seen that the stems containing larvæ are easily recognised: each stem cut down should be carefully cut up, including the roots if necessary, until the larva is found and destroyed before a fresh one is felled. This work would require the most careful supervision, as upon its being done thoroughly would depend the stamping out of the beetle completely. The larvæ found should be made to tally with the stems cut. If this plan were resorted to and a careful watch kept, I see no reason why the pest should not be exterminated. A strong reason for endeavouring to free Shahdera entirely from this beetle exists in the fact that it has not made its appearance in the Changa Manga Plantation only 40 miles away. Careful search during several years has failed to bring to light a single case of attack on the mulberry at the latter place, and the wood of the tree can thus to a certain extent be sold as timber. The danger of the beetle spreading to Changa Manga is very great, and increases yearly as the pest becomes more numerous at Shahdera. That it has not done so already is probably attributable to one of two causes: either the beetle lays very few eggs or it is heavily parasitised. That it will spread across such a short strip of country if given the time to do so is only too probable.

One further suggestion may be made here. When commencing a search for *A. Germari* at Change Manga I discovered that only one forest guard, out of the whole staff of officers in charge there, had ever seen the work of the longicorn at Shahdera, or knew what its appearance was like or what to look for in the search I was about to institute. I explained with drawings at the time the appearance of larva and beetle and its work in the tree, but if it be feasible I would recommend that the entire staff at Changa Manga should be deputed as occasion offered to visit the Shahdera plantation and there be shown the insect at work. They would thus be in a position to recognise it should it unfortunately get to Changa Manga, and early steps could be taken to stamp it out before it spread.

Points in the life history requiring further observation.

1. The height on the bark of the stems at which the eggs are laid.
2. The number of eggs laid by the beetle.
3. The exact number of years passed in the larval stage.
4. The number of days passed in the pupal stage.
5. Whether the differences in colouration of the beetles found is merely a sexual one, the species being the same.

LIMNOBIIDÆ.

Reference:—The larvæ in question were provisionally identified as Limnobiids by Mr. C. O. Waterhouse of the British Museum.

Classification:—Order, **DIPTERA.** Family, **Limnobiidæ.**

In the tunnels bored by the longicorn larvæ *Apriona Germari*, in the mulberry stems at Shahdera Plantation, I discovered in the oozing sap some thin, semi-transparent, white larvæ, from half an inch to one inch in length. The larvæ were crawling about in the sap in the tunnels and are not improbably sap-feeders and not parasitic on the longicorns.

No further data about the life history of this insect are at present available.

MYLLOCERUS SP.

Classification :—Order, COLEOPTERA. Family, Curculionidæ.

This insect was found in company with *Apoderus sp.* defoliating the leaves of the Sissu trees in the Sutlej valley.

Description.

The beetle is a brightish grey-pink in colour, about half an inch in length. Dorsal surface grey-pink with black hieroglyphic markings on the elytra, which are slightly channelled and pitted. Under surface grey. Antennæ and legs grey. Pl. III, fig. 2, shows a dorsal and side view.

Life History.

This beetle is found on the wing in the middle of June when it defoliates the Sissu, feeding on the leaves of the tree. I was not noticed pairing, and I was not able to form an opinion as to whether it had done so or not. The specimens found seemed to be chiefly intent on feeding.

The writer is not at present able to say whether further observations have been made on the life history of this insect.

Locality from which the insect has been reported.

I discovered this beetle in the Sutlej valley at elevations of between 2,300 and 3,500 feet. It was found on both banks both in the Kulu and Bashahr States.

Relations to the Forest.

This beetle feeds on the leaves of the Sissu tree. It was not very abundant at the time it was observed, but the damage to the leaves was very appreciable. It appears to prefer the older leaves, as it was on them that it was generally to be found, but this may have been attributable to the fact that most of the new ones had already disappeared under the attacks of the *Apoderus* leaf-rolling beetle. The beetles eat into the leaf, gnawing out portions and beginning from the outside edge. The portions eaten out are either circular or irregular in shape, and sometimes the midrib is reached, but this was rarely touched by the insect. The leaf was more often eaten irregularly away on both sides of the midrib, leaving the latter intact.

As this beetle affects the old leaves as well as probably the new, it is capable of doing serious defoliating injury to the trees when swarming in numbers.

Points in the life history requiring further observation.

1. Where the eggs are laid and their number.
2. Where the larva passes its existence, the nature of its food, and time spent in the larval stage.
3. Length of time spent in the pupal stage.
4. Number of generations passed through in the year.

APODERUS SP.

Reference :—Provisionally named as *Apoderous* Sp.

Classification :—Order, **COLEOPTERA**, Family, **Curculionidæ**.

Description.

The eggs are pale yellow in colour with a glistening surface, and about the size of a large pin's head. I have not yet seen the larva. It will probably be a small, whitish, curved, legless grub.

The female beetle is similar in colouring to the male but is larger, being about a quarter of an inch in length, while the male is one-sixth of an inch. The general colour throughout the insect is a bright golden yellow. Head, thorax, and elytra are edged with black except at the outer upper edges of the elytra where they are golden yellow. Snout and eyes are black. Antennæ yellow at the base and furnished with black knobbed ends. Forehead between the eyes black. Elytra channelled and they have three black patches in the form of a triangle on their upper halves, the patch at the apex being at the anterior end: the elytra are edged with black on their inner margins and the anterior outer corner of each bears a light brown spot; they do not completely join at their bases, leaving several body segments exposed. Under surface of the prothorax between the coxæ a darker yellow-brown. Legs bright golden yellow. Pl. III, fig. 1 *a*, shows dorsal and side views of the ♀ beetle, and *b*, dorsal view of the ♂.

Life history.

The beetle appears on the wing in June. From the 18th to 20th of the month I found it in abundance actively engaged in laying its eggs. In a few cases the beetles were seen to be pairing, but this stage was evidently nearly over, as was evidenced by the fact that a large number of eggs had been already laid. My observations showed me that never more than one egg is laid on any one leaf. The mother beetle proceeds about her egg-laying in the following manner. Usually the egg is deposited to the left hand of the midrib near the apex of the leaf. The leaf is then folded along the midrib, the surfaces on either side being turned inwards. The beetle then rolls the leaf tightly up from the apex downwards, tucking in the outer edges, so that the ends on either side are symmetrical and the whole forms a tight little roll. The end of the stalk where it expands into the blade of the leaf is then partially cut through, so that the little rolled-up mass hangs downwards. In other cases the beetle cuts the leaf at a point about one-eighth or at most one-sixth of the length of the leaf above its juncture with the leaf stalk. This is done in two ways: either the leaf is cut through right across by a horizontal incision, only a small portion of the outer edge being left to support the cut portion or the beetle cuts through the leaf horizontally on either side of the midrib, starting on each side from the outer edge of the leaf and cutting inwards to the midrib which is only slightly notched. In each case the egg is laid in the same place and the leaf rolled up as above described. These little bundles containing each an egg hang down (see pl. III, fig. 1, *c*), suspended by the portion of midrib still uncut or by the small portion of the outer edge of the leaf still intact, as the case may be; this small uncut portion soon dries up and the little rolls then fall or get knocked off and drop to the ground. (fig. 1, *d*). I have not yet been able to ascertain how many eggs are laid by each beetle, but it is almost certain that more than one is laid, *i.e.*, that several leaves are so treated by the beetles. From the eggs a small grub will emerge which probably at first feeds upon the store of food thus provided by the mother beetle, subsequently penetrating into the soil and changing into the pupal state. This is what happens in the case of the English leaf-rolling species *Rhynchites betulæ* which rolls up birch leaves into a funnel-shaped structure in which several eggs are laid.

This beetle resembles, in the performance of this marvellous piece of work, a closely related Indian confrère which treats the leaves of the Ban (*Quercus incana*) and Moru (*Quercus dilatata*) oaks in a somewhat similar fashion.

Locality from which the insect has been reported.

The writer obtained this beetle in June 1901 on the banks of the Sutlej river, where it flows between the Kulu and Bashahr States, at elevations of between 2,500 and 3,500 feet.

Relations to the Forest.

Whilst marching up the Sutlej Valley between Nirth and Rampur the writer noticed that the sissu trees on either bank of the river were being heavily defoliated. The trees were growing either in clumps or scattered here and there in the river bed and on the terraces existing on either side of the stream. An examination showed that the defoliation was not due to any ordinary leaf-feeding insect. A certain amount attributable to the latter cause was certainly going on, but the serious part of the work was due to quite a different form of attack. The first thing that attracted notice was the fact that the crowns and ends of all the branches of the trees, consisting of long yellowish green shoots just developed, or in the course of development, were either totally leafless or rapidly becoming so. The effect to the eye was as if one had taken the new leaf-bearing twigs into the hand and pulled them through the closed palm so as to remove the new leaves, leaving behind only the long, bare, whippy, yellow-green new shoots. A closer inspection, however, showed that these shoots were not entirely bare. In many cases small portions of a leaf, looking as if they had been snipped off either just above the juncture of the stalk with the leaf or at the stalk itself, were visible and often hanging down from these a small bundle of rolled-up leaf. These latter enabled me to perceive what was taking place. A leaf-rolling insect was at work and in each of these bundles, as already described, an egg had been placed by the mother beetle, and in so laying their eggs the beetles were stripping the sissu trees of the entire crop of their new leaves. In some cases the little bundles had dropped, in others they had turned black and were ready to do so, whilst others again were still green and fresh, and I was able myself to see others in the course of formation. Every tree on the 16 miles of river I inspected, both on the Bashahr and Kulu sides of the stream, was either entirely defoliated of all its new growth or rapidly becoming so, and there seems no reason for supposing that the attack did not spread some distance further, both up and down stream. The fact that the insect either rolls up the whole of the leaf or cuts it across very close to its base renders the destruction of all leaves attacked complete.

In addition to attacking the whole of the crop of new leaves I noted that the beetle also laid its eggs on and rolled up the older leaves as well though in nothing like the same proportion. It was probably the abundance of the beetles and the shortness of the supply of the new leaves that sent the insects to the old ones, as these must have been infinitely more difficult to bend over and roll up than the soft tender young ones.

Protection and Remedies.

In the present state of our knowledge of economic entomology in this country it is not possible to consider remedies for application over large areas. The beetle probably has both fungus and insect enemies, and the larva likewise, the encouraging or introduction of which would keep it down. In nurseries and small valuable plantations the question is not so difficult. In such places I should advise the sweeping up into heaps of the small fallen leaf rolls, each of which, it must be remembered, contains an egg and therefore a future beetle, and burning them *in situ*. This work will be very simple if carried out when the beetle is just finishing its egg-laying as the ground then will be littered with the small rolls and by jarring the young plants numbers will at once drop. In the case of small areas the ground could be gone over two or three times to make sure of removing and killing off as many eggs as possible. Over larger ones one round would have to be sufficient, and it would be important to choose the right time, so that the maximum number of eggs possible may be destroyed. When the defoliation is about three-fourths complete would be the best time to go round large areas. If the work is delayed longer, the larvæ from the first laid eggs will have left what remains of the small rolls and have gone into the ground, and it will then be too late to take steps against them unless ploughing or hoeing were resorted to, both of which would probably be out of the question as involving too large an outlay.

Points in the life history requiring further observation.

1. The number of eggs laid by the beetle which will show the number of leaves each destroys.
2. Time spent by the larvæ in the rolled-up leaf before leaving it.
3. Ascertain definitely whether the larva enters the ground to pupate.
4. Length of time passed in the pupal stage. It is not improbable that some 10 months or more will be passed in this stage.
5. Whether there is more than one generation during the year.

ALCIDES SP.

Reference:—Provisionally determined by Mr. C. O. Waterhouse, of the British Museum, as a species of Alcides not in the Museum.

Classification:—Order, COLEOPTERA. Family, Curculionidæ.

Description.

The *larva* when full grown is a fat white grub usually more or less curled with twelve segments, the middle ones thicker than those at either end. Head small and bright yellow-brown in colour. Length ¾ inch. See Pl. IV, fig. 6, *a*.

The *pupa* is of the ordinary curculionid shape.

The *beetle* is black in colour with black antennæ and legs the latter clothed with yellowish-brown hairs. The rostrum (beak) is straight, thickish, about half as long as the insect, the grooves (scrobes) in it on either side starting about one-third down from the tip. Antennæ medium sized, fairly thick; the scape is thickened at the joint and the funiculus ends in a thick oval knob. Eyes large and elliptical in shape. Prothorax rather triangular drawn out in front and produced into a small point behind at its junction with the inner angles of the elytra. Elytra meeting well together and rounded at bases. Prothorax and elytra studded with raised points. Body pubescent. Front legs longer than the others. Pl. IV, fig. 6, *b*, shows a dorsal and side view of this beetle.

Life History.

The beetle appears on the wing at about the beginning of August, but at present it is not known when or where it lays its eggs. Larvæ were found full fed in walnuts in the first week in July, and it is therefore probable either (1) that the weevil is to be found on the wing throughout the autumn, hibernating under bark or decaying leaves, stones, etc., on the ground and coming out to lay its egg on or near the young ♀ flowers of the walnut in March or April; or (2) it lays its eggs on the twigs near the young flower buds in the autumn of the year in which it issues as a beetle. No external holes are to be found on the green outer covering of the walnut. I first noticed the attack in the Baghi forest, Bashahr Division, my attention being attracted by the number of fallen walnuts littering the path beneath a large tree. I cut open some of these nuts and found in them the nearly mature fat, curved grubs of this weevil. A large number of nuts were examined, and four to five grubs per nut appeared to be the usual number present, but in many cases 8, 11, and in one or two as many as 13 larvæ were cut out of a single walnut. The attacks of these grubs cause the fruit to wither, and about the first week in July the nuts drop from the tree and the larvæ enter the earth and pupate there about the middle of the month. Fifteen to twenty days suffice for this stage, the first beetle obtained issuing on the 4th August.

Locality from where reported.

This weevil was discovered in the forests between Taklesh, Bahli, Songra, and Baghi, Bashahr State, North-Western Himalayas in 1901.[1]

Relations to the Forest.

Many of the walnut trees examined between the above-mentioned places had their entire crops of seed ruined by the attacks of the larvæ of this curculionid. The effect of these operations within the nut is to reduce the inside to a black rotten mass of tissue and excrement in which the grubs live. The whole of the kernel and inner hard shell (endocarp) is reduced to this state, and only the hard outer green covering (pericarp) with a very thin layer of the inner shell is left intact. No holes of any kind are to be seen on the outside of this green outer covering. By the time the inside of the nut is brought into this condition it falls to the ground into which its weight, which is still considerable, causes it to sink. The period of this dropping of the nuts is also that at which the monsoon usually bursts over the hills and the grubs consequently have no difficulty in entering the softened ground.

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[1] I placed the nuts I collected in a box containing a layer of moist earth. On leaving Simla on July 17th, Mr. J. H. Lace, at the time Assistant Inspector General of Forests, kindly undertook to look after them for me and he obtained these beetles.

Points in the life history requiring further observation.

1. Where and when the eggs are laid—a very important point in connection with attacks of this kind.
2. The length of time spent in the adult stage. Also a very important point.
3. Where, and in which stage, does this insect pass through the winter.

CRYPTORHYNCHUS SP.

Reference:—Provisionally determined as *Cryptorhynchus* sp. by Mr. C. O. Waterhouse, of the British Museum. Mr. Waterhouse wrote that it was at present impossible to name the species, it being new to the Museum.

Classification:—Order, COLEOPTERA. Family, CURCULIONIDÆ.

Description.

The *larva* is a small white, thickish, legless, curved grub of the ordinary weevil type. Length nearly ⅜in. See Pl. IV, fig. 7, *a*.

The *pupa* is naked, dark in colour and tucked round it the developing wings can be distinctly seen. On the underside the legs and the proboscis, both still immature, are to be seen folded on the breast and body.

The *beetle* has the ordinary weevil shape. Head and rostrum black, the latter a little more than a ¼ length of insect, not very thick and tapering slightly to apex ; it is tucked under body at rest: the scrobes (grooves in which the scapes of the antennæ fit) commence a little above the middle of the rostrum and are slightly oblique, directed upwards to the point where the base of the antennæ takes off. Antennæ fairly stout, the scape swollen into a knob at the point of its juncture with the funiculus (upper part of antenna, above elbow) ; funiculus ends in an oblong oval knob. Eyes large, strongly facetted. Prothorax triangular tapering anteriorly, black marked with brownish spots. Elytra reddish-brown meeting well together ; channelled with a small white blotch about their centre and a larger one towards posterior extremity of each. Legs smallish, thighs gradually thicken to a lump where the tibiæ join them, the posterior ones not reaching to the end of the abdomen. Tarsi long and hairy beneath.

Pl. IV, fig. 7, *b*, shows the pupa and, *c*, the mature beetle.

Life History.[1]

The flight time of this weevil is about the beginning of December at which time all the stages of larva, pupa, and adult beetle may be found beneath the bark of the host plant.

The larvæ were found just beneath the bark of young *Pinus Khasya* trees. They apparently feed on the cambium layer and grow to full size here and then gnaw out a cavity in the wood, line it with wood chips, and change into the pupal state within this little cell. These cavities were invariably found to be packed with fresh moist wood chips or 'wood wool' when they contained larvæ, whereas in those containing mature or nearly mature adult beetles the wood wool was found to be dry and yellow. When the weevil is ready to issue, it bores a fresh hole straight through the bark of the sapling and crawls out.

This is all that is at present known about the life history of this pest. Observations on the subject for the other eleven and a half months of the year are required.

Locality from which reported.

This beetle was reported in December 1901 from a plantation in Maymyo, Upper Burma.

Relations to the Forest.

The attacks of this weevil were pointed out to Mr. Long, whilst inspecting an experimental plantation of *Pinus Khasya* by Mr. D. A. Allan, Ranger. Numerous trees, five years old, were seen to be dying. In some cases these trees were suppressed by their neighbours, in others the dominant trees themselves were dying. On felling and examining one of the latter, the various stages of the beetle were found in abundance. Most of the larvæ were already full fed and had left the bark and were ensconced in cavities in the wood of the saplings, these cells having been generally bored within a foot of the ground and never, as far as was observed, more than two feet above the surface of the soil.

[1] The notes here given on the life history of this pest, together with larva, pupa and adult beetle, were forwarded to me in December 1901 by Mr. G. R. Long, Personal Assistant to the Conservator of Forests, Southern Circle, Upper Burma.

The tissue surrounding recent cavities was fresh and sound; that round old ones spongy and rotten. In most cases Mr. Long noted that "the woody tissues, often to the centre of the tree, were stained blue as though by fungoid mycelia, and I incline to think that, although the insects do damage, it is the fungus which they let in that proves fatal."

"The plantation is about 3,200 feet above sea-level, and has a southern aspect. Other *Pinus Khasya* trees, scarcely 200 yards away, having a northern aspect, having so far escaped attack. *Pinus longifolia* also with a northern aspect has not yet been attacked."

This question of the aspect may or may not have any connection with the prevalence of the attack, but these wood-boring pests usually spread slowly: when, however, they appear at a centre in numbers, they spread outwards from this area, and if their attack is unchecked and conditions are favourable, their numbers increase very rapidly, and following this increase the infertation radiates rapidly in all directions from the original source.

Protection and Remedies.

Where feasible, undoubtedly the best remedy in cases of attacks of this nature is to cut out all infected stems and burn them at once. If this operation is carried out carefully, it will effectually stamp out the trouble. This is the remedy I suggested in the case in question, but as many of the weevils would have already issued, a careful search should be made for eggs and a watch kept for the signs of fresh young larvæ appearing in the trees.

With reference to the blue stain in the bark, attributed by Mr. Long to the mycelia of a fungus which he considers may be the final resulting cause of the death of the tree, it must be borne in mind that since it commences at the holes made by the weevils, their attacks would seem to be the primary cause of its presence in the trees. I have not as yet seen any of the attacked stems with this fungus *in situ*, so am unable to express any opinion on the subject.

Points in the life history requiring further observation.

1. Where the eggs are laid. It is not improbable that the weevil makes small incisions in the bark with its proboscis and places its eggs in these.
2. The time spent by the larvæ feeding in the bark of the tree before it gnaws out its pupating chamber in the wood.
3. The life history of the insect from January to November. How many generations in the year does it pass through and the length of time spent by the various stages of egg, larva, pupa and beetle, should there be more than one generation in the year.

WOOD-BORING LEPIDOPTEROUS LARVÆ.

Accompanying the weevil larvæ found in the bark of the *Pinus Khasya* trees as above described, a number of other and larger larvæ were sent to me mixed up with the weevil grubs.

These larger larvæ are pink in colour with three pairs of jointed legs on the first three segments of the body, four pairs of sucker legs, one on each of the sixth, seventh, eighth, and ninth segments and another pair on the anal segment. The presence of these determines the larva to be a lepidopterous one, and it probably belongs to one of the wood-boring families of the *Heterocera* or moths. These larvæ require further careful study as they may prove to do as much, if not more, damage than the weevils. They were only found in the bark and were not full-grown. It will perhaps turn out that as they grow older they will leave the bark and bore into the wood. See. Pl. IV, fig. 8.

I have recommended that some of the stems attacked by these larvæ be kept under supervision with the object of obtaining the pupæ and moths of the pest for identification. All other stems infested with the grubs should be cut out and burnt so as to stamp out the pest before the moths mature and issue from the trees to lay eggs and spread the attack to uninfested ones.

SCOLYTUS SP.[1]

Reference:—Provisionally determined as *Scolytus sp.* near *Scolytus destructor.*

Classification:—Order, **COLEOPTERA.** Family, **Scolytidæ.**

Description.

The *larva* is a small, white, curved, legless grub, about 5·1 millim in length. See Pl. IV, fig. 4, *a*.

The beetle is black and shining, cylindrical, antennæ and legs being fulvous brown with yellowish-brown tarsus. Head projecting with a broad rostrum. Under surface of abdomen is flexed upwards. Thorax longer than broad, sparingly punctured, the punctures being smaller and weaker on upper surface, which is very shining. Elytra uniformly pitted over with punctures, suture of elytra depressed. Length 5·5 to 6 millim. Pl. IV, fig. 4, *b*, shows a dorsal and side view of this insect.

Life History.

This beetle appears about the beginning of May and commences to bore its galleries between the bark and wood of deodar trees, choosing by preference sickly trees, which, if young saplings, it bores into towards the base. In the case of older poles, it is found all over the stem. In the middle of May young larvæ are to be found and the beetles from these would appear to issue about the end of July and in August. They at once pair and re-start the work, and a fresh generation is gone through, larvæ being present through September and beetles issuing about October. It is probable that a portion of the larvæ of this second generation hibernate as such, only a certain number of the earlier developed ones going on to the beetle stage.

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[1] This beetle was first reported as infesting deodar in the Bashahr Division, Punjab, in August 1900, by Mr. Minniken, Deputy Conservator of Forests. Mr. Ribbentrop, then Inspector General of Forests, went up and studied the attack. Further notes on its life history were made by the writer in May-June 1901.

The over-wintering larvæ were discovered by Mr. Ribbentrop curled up in the end of their galleries in the pupa-cradle. In other cases he found a hole at the end of the larval gallery through which the perfect beetle had made its exit from the tree. It will not unlikely be found that the October beetles bore a little way into the bark of fresh trees and hibernate in it through the winter, coming out in May of the following year and boring into fresh trees to lay the eggs of the first generation of the year.

Localities from which reported.

The insect was first discovered by Mr. Minniken in the deodar forests of the Bashahr State in August 1900. The following year the writer found it in deodar trees in the Jaunsar division of the North-West Provinces some 100 miles or so to the south-west of the area in which it was originally discovered.

Relations to the Forest.

The discovery of this *Scolytus* is of some scientific interest, since I am not aware that the genus *Scolytus* has previously been reported as attacking conifers in India. It does not do so in Europe, where it confines its attacks to broad-leaved trees, although it has been reported from America in this connection.

The beetle up to date has only been found attacking pole forest, boring galleries which are partly in the bark and partly in the outermost layers of the wood of the trees.

The mother gallery is from $2\frac{1}{2}$ to $3\frac{1}{4}$ inches in length, ascending and vertical, consisting of a series of short zig-zag curves along both sides of which small notches are gnawed out and an egg deposited in each. The secondary galleries ramify from it in a most graceful manner, the ones taking off from the centre portion of the main gallery being at right angles, whilst those more remote trend away from these at ever-widening angles, the upper ones in an upward direction, the lower ones in a downward one. These galleries are not broader at their ends than the mother gallery; they lie close together and are long, sometimes as much as $3\frac{1}{2}$ to 4 inches though generally about 3 inches in length. See Pl. IV, fig. 4, *c*. Pupal chambers are excavated in the bark or sap wood.

As in the case of most bark beetles, this *Scolytus* probably prefers to attack sickly trees in preference to healthy ones, but in several instances in Jaunsar I cut them out of trees which, as far as external appearances showed, were quite healthy. That the insect is liable to increase in large numbers under favourable conditions and then infest healthy trees would appear to be the case from the 1900 attack in Bashahr. Two areas were very badly attacked, the spots being at some distance from one another and the trees in the neighbourhood of each infested portion being nearly, if not quite, free from the beetle.

I was enabled to inspect some of the poles which had been cut out (and barked) from one of these areas. They were a remarkable sight. Poles 20—25 feet in length of bole (minus top which had been cut off before extraction from forest) and with a girth of 4½ feet at base, were covered their entire length and girth with the scolytid galleries, the mother galleries being at times so close that the larval secondary ones interlaced, all trace of the symmetrical pattern of the scolytid being thereby lost. There could be no doubt of the ultimate cause of death of these trees. The whole of the cambium layer had been riddled by the beetles and their larvæ.

Protection and Remedies.

At this stage of our knowledge of the life history of this pest I can add nothing to the preventive measures instituted in Bashahr under the advice, I believe, of Mr. Ribbentrop.

The origin of the attack was attributed by him to the large number of suppressed and consequently sickly trees in the pole forests.

On both the areas attacked all infested trees were cut out, each one was barked and the bark burnt. In addition to this, each stump was barked and this bark also burnt. Trenches were then dug round the stumps. This latter part of the protective measures was superfluous. Bark beetles only leave the trees by flight. The grubs, as their life history shows, never leave them. Six hundred trees were thus removed from one of the infested areas and fifty from the other, watchers having been posted to give notice of fresh trees attacked. Mr. Minniken reported towards the end of 1900 that no new trees been had infested after the completion of the preventive measures undertaken.

In 1901 the writer made a close inspection of portions of these areas, stag-headed and diseased trees being felled here and there and carefully examined. The watchers of the previous year, who were thoroughly well acquainted with the beetle's method of attack, also aided this search, but no beetles, pupæ, or larvæ were to be found in the trees inspected. This inspection was made at the end of June. It is too early yet, without further study of the habits of the insect, to say definitely that the preventive measures instituted nipped in the bud what might have proved a serious attack of this pest, but I am of opinion that had not the areas been so dealt with, there is every probability that the beetles would have multiplied and spread in all directions from the two infested centres.

Points in the life history requiring further observation.

1. The number of generations in the year. It is probable that this will vary at different elevations. Is there a spring generation at the higher elevations?
2. The length of time spent in the various stages of larva, pupa, and beetle.
3. In which stage is the winter passed?
4. What insects prey upon these beetles and their larvæ in their burrows?

An Insect Enemy of Scolytus sp.

PREDACEOUS CLERID LARVA.

Classification :—Order, COLEOPTERA. Family, Cleridæ.

Accompanying the *Scolytus* beetles found in Bashahr were a number of long fleshy-pink larvæ from a $\frac{1}{2}$ to $\frac{5}{8}$ of an inch long and provided with strong, flat mandibles, twelve distinct rings to the body, the last one ending in two hooks. See Pl. IV, fig. 5.

These larvæ are carnivorous and in all probability prey upon the *Scolytus* grubs. Whether they also attack the beetles or these latter are attacked by the clerid beetles, which is more probable, has yet to be discovered.

These larvæ exercise no doubt a check on the rapid multiplication of this pest, and their protection, whenever possible, is to be desired.

Nothing further on the subject of this insect's life history is at present known, and the beetle has not yet been found. The writer will be glad to receive notes and specimens on the various stages of its life history.

Wood-boring Insects following the Scolytus attacks.

BUPRESTID and LONGICORN BORERS.

(*Buprestidæ* and *Cerambycidæ*.)

In a tree nearly dead but still standing, which had been badly attacked by the *Scolytus* sp. beetle during the 1900 invasion, as evidenced by the numerous galleries on the inside of the bark and in the sap wood, I found a number of two classes of wood-borers tunnelling in the outer layers of the sap wood.

(1) *Buprestid* larvæ.—The most numerous. White larvæ from 1 to 1¼ inches long with a large head and thoracic segments, the segments following being very much smaller in girth. These larvæ were boring shallow galleries in the sap wood in which they were usually to be found with the lower part of the body doubled back on to the anterior segments. These larvæ were in all probability about 8 months old, the egg having been laid during the previous year by the parent beetle. Nothing further is known about the life history of the insect.

(2) *Longicorn* larvæ.—White larvæ, about 1 inch or a little less in length, with large head and prothoracic segments and stout, thick mandibles. The segments of the body are not very much less in diameter than those of the head and thorax. Head black, rest white in colour. No legs present. These were tunneling deeper into the wood, the tunnels being but little wider than the greatest diameter of the grub and in no way resembling those of the *Buprestid* larvæ.

I have no further observations about this insect at present.

The attacks of these buprestid and longicorn grubs follow a general rule that these insects invariably make their appearance in a tree that has been infested by bark-borers. They come at a later stage, when the bark-borers have undermined the strong vitality of the tree, and their grubs remain boring in the wood long after the tree has been deserted by its first invaders. The fresh bark is necessary to many of the young longicorn and buprestid grubs whilst their mandibles are still small and tender. As they become more developed, they are capable of tackling the wood of the tree, and fresh bark is no longer a necessity or even a requirement to them, as is the case throughout the whole of the life history of the bark-borer.

The pupal and imago stages of both these insects have yet to be observed. They will in all probability both take place in the wood.

PSEUDOSPHINX DISCISTRIGA. WLK.

References:—Wlk. Cat. viii, p. 209; Moore, Lep. Ceyl. ii, pl. 73, figs. 1, 1*a*, 1*b* (pupa and larva); C. & S. no. 176. Diludia melanomera, Butl. P. Z. S. 1875, p. 13; C. & S. no. 177. Diludia macromera, Butl. A. M. N. H. (5) x, p. 435. Diludia grandis, Butl. P. Z. S. 1875, p. 260; C. & S. no. 175. Diludia rubescens, Butl. P. Z. S. 1875, pp. 260, 623; C. & S. no. 178. Macrosila obliqua, Wlk. Cat. viii, p. 208; C. & S. no. 174. Anceryx nicreta, Wlk. Cat. xxxi, p. 36; C & S. no. 179. Diludia vates, Butl, P. Z. S. 1875, p. 13; C. & S. no. 180. Anceryx pinastri, Wlk. Cat. viii, p. 223. Hmpsn Faun. Br. Ind. Moths i. p. 105, no. 169.

Classification:—Order, **LEPIDOPTERA.** Sub-Order, HETEROCERA. Family, **Sphingidæ.**

Description.

Larva.—The general colour of the caterpillar is a pale lemon yellow or sap green. The first three segments are studded with whitish specks raised in relief on the surface. The last segment of the body and the horn are also similarly studded with these raised dots of colour; a longish red horn on the last segment but one is also studded with the whitish specks of colour. Head green with a diagonal transverse stripe running from top of head outwards on either side. On the dorsal surface of the body are a series of green lateral lines starting from the centre of the dorsal surface and running forwards and outwards down over the side of the body. On the portions of these lines extending down the flanks of the insect they are bordered for a short distance by short purple-red lines above, and below by a white line along their entire length. From the base of the horn is projected on either side outwards and forwards a whitish line bordered with purple. The prolegs are reddish purple. Clasper legs white. The above description is that of a three parts grown larva. The colours darken slightly as the caterpillar matures, and in the case of one specimen I kept the white, green, and purple diagonal streaks up the two sides of the dorsal surface merged into reddish purple square patches of colour, the white and green being entirely lost. Larva when full grown is a large, thick-built caterpillar of 3 inches in length.

Moth.—A stout large moth of a general greyish appearance, but with considerable variation in colouring and markings. Hampson describes it as follows :—

Head, thorax, abdomen, and forewing grey; dark brown bands along sides of palpi and thorax meeting on metathorax, where there are a few blue and yellow scales; a dark line down vertex of abdomen and paired more diffused subdorsal lines. Forewing with some dark strigae from the costa; two dark streaks in the interspaces below veins 2 and 3; a dark streak from the costa before the apex, curved down to vein 6, then upwards and bent back before reaching the apex; a series of submarginal lunules; cilia chequered brown and white. Hindwing brown, with a pale patch with two dark lines across it near anal angle. Under side paler, with indistinct transverse lines.

There are four well-marked varieties which are not locally constant :—

(1) *rubescens*, a dark red-brown form with a prominent oblique black streak from costa of forewing to lower end of cell; hind wing very dark;

(2) *discistriga* = *melanomera* = *macromera* = *grandis*, a grey form, much powdered and suffused with dark brown;

(3) *obliqua*, a whitish-grey form with a prominent black streak on fore wing as in *rubescens*, but continued to the outer margin; hind wing very dark; the patch at anal angle remaining pale;

(4) *increta* = *vates*, a pale form, but slightly powdered with brown.

Expanse of wings 90—140 millim. See Pl. II, fig. 1.

Life History.

The larvæ of this moth are to be found feeding on teak leaves towards the end of July, at which period they have been found of all sizes up to nearly, if not quite, full grown. It is probable that the young make their first appearance when the teak is putting on its new foliage somewhere about the beginning of the month. Sphingid larvæ are, as a general rule, by no means either very common or gregarious in their habits. This rule does not apply to *P. discistriga* which was exceedingly plentiful on teak in Berar in July 1901, swarming over the trees and feeding voraciously and wastefully. It apparently rarely entirely finishes a leaf, eating from ⅓ to ⅔ only and then seeking a fresh one. When feeding, it eats straight on through all the ribs and minor veins of the leaf and thus its attack can be easily distinguished from those of its offtime companions *Hyblæa puera* and *Pyrausta achœralis*. It is to be found at all elevations between 1,800 feet, and 2,900 feet, and at the latter elevation appeared to almost entirely take the place of *H. puera* and *P. achæralis*. The caterpillar when alarmed takes up a characteristic attitude, raising the first few segments of the body and curling them over downwards so as to roll up and protect both head and prolegs. As its growing period is during the rainy season, it is perhaps natural that it should be unaffected by rain. I have watched it feeding unconcernedly in the heaviest of tropical showers, and I noticed them to be numerous on the trees on the morning after a 6 inch fall of rain during the night.

One moth, just issued from the chrysalis and with wings still unexpanded, was found on August 3rd.

I think it is improbable that this insect has more than one generation in the year, but further observation is required on this point.

Localities from which reported.

Larvæ of this insect were exceedingly plentiful in the Melghat teak forests, Berar, in July 1901. A few specimens and one moth were also found in the Central Nursery, Poona, at the beginning of August during a visit made there with Mr. Wroughton, Conservator of Forests

Mr. Williamson, Deputy Conservator of Forests, informed me that the insect is to be found generally throughout the Melghat teak areas. Hampson gives the habitat of this moth as Chinat, throughout India and Ceylon.

Relations to the Forest.

P. discistriga is to be found defoliating the teak in company with the two well known defoliators *Hyblæa puera* and *Pyrausta achœralis*. Its own attacks can be easily recognised by the large irregular shaped holes eaten out of the leaves, all veins being indiscriminately consumed. The attack thus differs very considerably from that of its companions, the former of which leaves untouched the chief and side veins, eating everything else, whilst the latter feeds only on the parenchyma, leaving all veins untouched. Mr. Williamson, who has eight years experience of the Melghat forests, informed me that he has noticed them as constantly present on the teak at the beginning of the rains, and he is of opinion that this caterpillar does more general defoliating damage at that time in those forests than either of its companions. In 1897, he noted that 90 per cent. of his teak areas were entirely defoliated in August and September, but he is not able to say which of these three species was most responsible. They appeared to feed equally upon both young and old trees and eat old and new leaves indiscriminately. I occasionally found it on other trees, but teak is its chief host.

Protection and Remedies.

This pest requires further study. I noted that the larvæ appeared to be heavily parasiticised, but I am not at present able to say whether the parasites were Hymenopterous or Dipterous flies.

In the Poona nursery the young insects were said not to be numerous : should they become so, I recommend the spraying of the young plants with the arsenical powder Paris green.

Points in the life history requiring further observation.

1. Where the eggs are laid. Is it on the twigs of the teak ?
2. Length of time spent in the larval stage.
3. Length of time spent in the pupal stage and where the larva pupates.
4. Length of time spent in the imago stage.
5. How the insect passes the cold weath er months. Is it in the egg stage ?

CLANIA CRAMERI.[1]

WESTWOOD.

References:—Westw. P. Z. S. 1854, p. 236; Moore, Lep. Ceyl. ii, pl. 118. figs. 1, 1a (larva-case); C. & S. no. 490. Hampsn. Faun. Br. Ind., Moths, I, p. 291. no. 617.

Classification:—Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family, Psychidæ.

Description.

The *larva* lives within a small case of longitudinally arranged twigs which it carries about with it like a snail carrying its shell. The larva adds to this case as it grows, but never leaves it. See Pl. II, fig. 2 a.

The *pupa* is formed within the case of twigs, in which it remains if the insect is a female, this sex being practically wingless.

Moth. ♂.—Head, thorax and abdomen clothed with light and dark brown hair. Antennæ bipectinated to tips. Fore tarsus with the terminal joint long; tibia with a long spine. Fore wing red-brown, the veins streaked with black; the interspaces with pale streaks; more or less fuscous suffusion on outer area. Hind wing smoky brown. Wings rather short and broad.

Expanse of wing 30 millim. See Plate II, fig. 2, *b*, *c*.

Life History.

The larvæ hatch out in July and at once commence to feed on the needles of the *Pinus longifolia,* which tree this insect defoliates. The caterpillars are voracious eaters and continue feeding upon the needles until November. Trees of all ages are attacked.

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[1] This insect was found in 1898, in the Jaunsar Division, North-Western Himalayas, by Mr. B. B. Osmaston, F.C.H. The observations on the life history were made by him. Some old larval cases were sent to the Indian Museum in June 1897, by Babu Sadanand Gairola, from the Jaunsar Division.

The winter is passed probably in the larval or semi-pupal state. Perfect pupæ are to be found within the twig cases in April of the year succeeding that in which the defoliation takes place.

The moth appears in June. It is probable that only the male moth is to be found on the wing in the forest, the ♀'s of this family being wingless insects never quitting the twig case in which, after being fertilised by the male, they lay their eggs.

Plate II, fig. 2, *b*, shows the case made by the larva with the pupal case of the male protruding from it, the insect having escaped ; fig. 2, *c*, the ♂ moth.

Area from which reported.

This insect was reported from the Jaunsar forests in the North-Western Provinces in 1898.

Hampson in the Fauna of British India gives Ceylon as the habitat.

Relations to the Forest.

This insect occasionally does a large amount of damage to *Pinus longifolia* by stripping the trees of their needles.

It is apparently to be found to a greater or less extent every year in forests consisting of this tree, but in 1898 it was particularly numerous, doing a vast amount of damage to trees of all ages.

Points in the life history requiring further observation.

1. Where the eggs are laid. It will probably be found that they are laid by the wingless female moth within her pupal case inside the twig case made by the larva.
2. Where the larva hangs up or fixes its twig case before changing to the pupal state. This is important since on it depends to a great extent the fact as to whether any remedies are possible in nurseries and plantations in which this pest might appear plentifully.
3. The exact stage within the twig case in which the insect passes through the winter. Is it the larval, semipupal or pupal stage ?

SUANA CONCOLOR,

WLK.

References :—Wlk Cat. vi, p. 1463; C. & S. no. 1508; Lebeda bimaculata, Wlk. Cat. vi, p. 1463; C. & S. no. 1506; Moore Lep. Ceyl. ii, pl. 140, figs. 1, *1a, b* (larva); Suana ampla. Wlk. Cat. vi, p. 1502; C. & S. no. 1505; Suana cervina, Moore, P. Z. S. 1879, p. 410; C & S. no. 1507. Hmpsn. Faun. Br. Ind. Moths, I, 406. no. 903.

Classification :— Order, **LEPIDOPTERA.** Sub-Order, HETEROCERA. Family, Lasiocampidæ.

Description.

The larva is a pale greyish-brown in colour covered with numerous black striæ; the second and third segments with raised dorsal humps covered with close black or dark brown hair; immature specimens have small white-haired dorsal papillæ on the fourth to the tenth segments, each with a pair of red brown papillæ in front and a pair of crimson papillæ on each side; the eleventh segment has a black dorsal tuft; there are lateral brownish tufts on each segment; the head is longitudinally banded with black. (This description, which differs slightly from Hampson's, is that of living specimens.) Pl. V, fig. 1, *a* shows the larva of this insect.

The larva when pupating spins a long semi-elliptical cocoon grey to grey-brown in colour consisting of coarse silk and hairs from its own body and some 3½ to 4 inches in length. (Fig. 1, *b.*)

The *pupa* is black, shining, slightly concave dorsally and 1 to 1·25 inches long. The pectinate antennæ of the future moth can be seen outlined on the pupal skin.

Moth. ♂. Head, thorax, and abdomen dark red-brown. Fore wing dark red-brown, the costa greyish; a more or less distinct yellowish subbasal spot; a silvery-white spot at end of cell; two antemedial, a medial, and two postmedial dark waved lines; a submarginal lunulate line, with yellow marks more or less prominent in the undulations. Hind wing dark red-brown.

Some specimens lose the white spot and others are very dark. Expanse of wings, 52—64 millim.

♀. Much paler; the markings similar; fore wing with a small grey patch at the base.

The form *ampla-concolor* has lost the white spot at end of cell of fore wing which is present in *bimaculata*; all the intergrades are to be found. Expanse of wings 106—146 millim. Pl. V, fig. 1, *c*, shows the pupa, *d*, the moth of this pest.

Life History.[1]

The moth appears on the wing at the end of March and beginning of April in Northern India. It is not known as yet where it lays its eggs, but it will be probably found to be somewhere on or near its food-plant which is the sâl tree (*Shorea robusta*, Gaertn.). When the young larvæ come out of the egg is not known, but towards the end of October they are nearly full grown and pupate about the middle of November. They spin a tough, stout cocoon of coarse silk mixed up with much of their own hair which they fix either in crevices of the rough bark of the stems of large trees or to branches, twigs, or beneath the bark of the trees. The winter is passed through in this stage, the moth appearing, as already stated, at the beginning of April.

Localities from which reported.

The insect is common in the sâl forests of the Eastern Dun in the North-West Provinces. Hampson gives throughout India and Ceylon, Philippines and Java as the habitat of this moth.

Relations to the Forest.

The caterpillar defoliates the sâl and at times this defoliation would appear to be somewhat heavy. Further observations are however, required on this point since this tree has apparently many defoliating pests, and it is necessary to determine which are those to be the most feared.

Observation has, however, led me to the conclusion that it will not unlikely be found that the sâl defoliators of Assam

[1] These observations were made by Mr. F. Gleadow, Deputy Conservator of Forests, Student Subramarian, and the writer.

and Eastern Bengal differ from those attacking the same tree in Madras and the Central Provinces, and that both these would seem to differ from those to be found in the Siwalik sâl forests of the North-West Provinces.

Protection and Remedies.

The pupæ in their long semi-elliptical shaped cocoons are so easily seen that in nurseries and plantations, when this insect is giving trouble, their collection should be enforced, all cocoon cases with their contents being burnt or destroyed in some suitable manner. Until the life history of the larva is, however, known, it is not possible to state how it might be best attacked.

Points in the life history requiring further observation.

1. Where the eggs are laid?
2. When the young caterpillars hatch out? Length of time spent in the larval stage?
3. Is there more than one generation in the year—
   (i) In the Siwalik sâl forests?
   (ii) In other warmer parts of India?

TRABALA VISHNU.[1]

LEF.

References:—Lef. Zool. Journ, iii, p. 207; C. & S. no. 1456; Moore, Lep. E. I. Co. pl. xxii, figs. 3, 3b (larva) Gastropacha sulphurea, Koll. Hügel's Kaschmir, iv, p. 471; C. & S. no. 1449; Trabala mahananda, Moore, P. Z. S. 1865, p. 821; C. & S. no. 1454; Amydona basalis, Wlk. Cat. vi, p. 1415; Amydona prasina, Wlk. Cat. vi, p. 1417. Amydona pallida, Wlk Cat vi, p. 1417; Hmpsn. Faun. Br. Ind. Moths. I. 421; no. 936.

Classification:—Order, **LEPIDOPTERA**. Sub-Order, HETEROCERA. Family, Lasiocampidæ.

Description.

Larva. Head yellow, spotted with red; the body colour brownish grey, with long lateral tufts on each segment; that on the first black and grey, the others grey; paired dorsal and lateral black spots on each segment, from which spring long black hairs, the spots on the thoracic segments coalescing.

Another form of the larva is blackish with a broad white dorsal stripe, the anterior tufts red-brown.

A third form is reddish with the lateral spots blue.

Cocoon is ochreous in colour, with short black hairs projecting from it, which are intensely irritating.

Moth. ♂. Pale apple-green; antennæ ochreous brown, the disk of fore wing and inner margin of hind wing whitish; fore wing with a faint pale antemedial line curved below the costa; a dark speck at end of cell; a pale straight oblique postmedial line, which becomes medial on the hind wing; both wings with a series of small submarginal dark spots. Pl. V, fig. 2, shows the male moth.

♀. Yellowish green, which fades to ochreous; the lines and spots of both wings enlarged and blackish; the spot at end of cell of fore wing large, conspicuous, and irrorated with black scales, and sometimes centred with grey; a red-brown patch

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[1] This insect was reported to be defoliating sâl forest near Dubri, Assam, in company with *Lymantria grandis* and *Dasychira* sp., by Mr. J. Campbell, Deputy Conservator of Forests.

thickly irrorated with black occupying the whole medial inner area from the median nervure to inner margin ; cilia of both wings blackish.

Expanse of wings ♂ 50—60 ; ♀ 80—90 millim.

Hampson gives the habitat as China, throughout India, Ceylon, Burma, and Java.

Life History, etc.

In Assam the larva of this moth is to be found in the sâl forests during April-May, and apparently does a certain amount of defoliation. The moth appears on the wing in June and was sent to the Indian Museum in 1898 from the sâl areas near Dubri where it was defoliating the trees in company with *Lymantria grandis*. No further accounts of this insect's life in the forest are at present available. It is probable that there will be at least one other generation of the insect during the year about August September.

This adds one more to the lengthening list of sâl defoliating *Heterocera*, and observations are required as to which of the species are reponsible for most of the damage done.

Points in the life history requiring further observation.

1. Where the eggs are laid. Are they laid on the sâl twigs?
2. The time spent in the larval stage.
3. The time spent in the pupal stage.
4. The number of generations in the year. If more than one, the times spent in the various stages of each generation.
5. Where the insect spends the winter, and in which stage of its metamorphosis.

DASYCHIRA SP.

References :—Ind. Mus. Notes, V. 1, 33.

Classification :—Order, LEPIDOPTERA. Sub-Order, HETEROCERA, Family, Lymantriidæ.

Description.

No description of this pest appears to have been published.

The caterpillars of the genus are, however, hairy and the pupa is formed in a silken cocoon.

The moths are medium sized, the male smaller and more brightly coloured than the female.

The palpi of these insects are porrect, the second joint heavily fringed with hair, antennæ with the branches long in male, short in ♀ ; legs hairy. Fore wing with the outer margin oblique.

Life History.[1]

The larvæ of this moth made their appearance in a portion of the Assam sâl forests in August 1897, and, despite the very heavy rainfall which followed the great earthquake which had taken place the preceding June, did a certain amount of defoliation.

This generation did not spread much but in the following November a second generation of the larvæ appeared, and in company with other species of caterpillars spread greatly. A third generation of larvæ appeared about the end of January, the number of caterpillars being reported as enormous. Towards the end of March yet a fourth generation of the *Dasychira* appeared, and the pests did not finally disappear until May. Caterpillars of this fourth generation collected on the 23rd March, changed into the pupal stage on the 30th and 31st March, and an imago emerged on the 20th April 1898.

It would appear that the two first of these generations took some 8 weeks to pass through the various stages of their

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[1] *Vide* Ind. Forester Vol. XXIV, 9 (1898).

metamorphoses, whilst in the case of the last two, six weeks sufficed from egg to mature moth.

The life history from May to August has still to be studied.

Locality from where reported.

The insects were sent from the Goalpara district in Assam.

Relations to the Forest.

The sal was completely defoliated throughout this district in 1893-94. This was repeated in 1897-98, the *Dasychira sp.* appearing towards the close of August in the Hil and Charaidaka blocks. In November the area affected extended over the greater portion of the Ripu Reserve and on into Chirang. The third generation in January was the most mischievous, invading almost every sâl tree throughout the Goalpara division. Early in March the sal forest presented the appearance of a mere mass of upright bare poles, without a vestige of foliage on them except in the case of a few young trees near the Bhutan border on the west of the district which escaped attack. When the leaves of the trees should have fallen, none were left to fall, all having been devoured. The inflorescence which usually appears about the close of January or early in February failed to develop at all. With reference to this, it is stated that the Guma Reserve, about 26 square miles in extent, where the insects were few in number, was a mass of foliage and inflorescence in March, prognosticating an excellent seed season, when this pest appeared in thousands and cleared off both leaves and flowers. New shoots and leaves started sprouting in March and were left untouched till the end of the month when the fourth generation cleaned them off the trees. Other trees suffered as well as sâl but to an insignificant extent, except the few *Terminalia tomentosa* in the west of the district which were stripped in a similar manner to the sâl.

The damage done to the trees is serious. Growth is arrested, numerous young shoots and twigs die, and it is stated that the number of unsightly knots on branches have their origin in this manner. Poor soils and shallow exposed situations and ill-grown trees are first attacked, but depredations are not limited to these, and the defoliation is said to become so complete that not a vestige of a leaf is left. The numbers can only be imagined from the area worked over, which in the Reserved Forests alone exceeded 500 square miles.

Dasychira was accompanied by *Leucoma diaphana*, Moore, during the August attack; by *Trabala vishnu*, Lep., during the last or May generation; and by *Lymantria grandis*, Wlk. throughout all its generations, the latter being as numerous and active as the *Dasychira*.

The first mention of these great defoliating attacks was made by Mr. W. R. Fisher in 1878, the next reference being 14 years later in 1892.

Protection and Remedies.

As would be expected, these hordes of caterpillars are infested by numerous parasites, although little is at present known about them. Great difficulty was, however, experienced at the time in breeding out moths from the larvæ owing to the parasitical attacks to which they were subject. It is stated that in spite of the vigour and numbers of the larvæ, one should rather say by reason of it, these parasitic attacks increased, and whilst the larvæ were swarming in thousands, large numbers were seen to be in a sickly condition. Red ants are said to have been attracted and to have helped to kill off the larvæ.

Enquiries made seem to point to the fact that these attacks have become more serious since wholesale fire protection was introduced by the Department. This latter is said to have become only really effective over the sál areas in this part of Assam in 1891, and it is since then that the insects have returned annually in larger or smaller hosts. It is impossible without further careful recorded observations to say what truth there may be in this theory. It is, however, certain that serious attacks by insect pests did occur in the old days before fire protection and equally so that very little attention was at that time paid to defoliating or other insect attacks.

Points in the life history requiring further observation.

1. Where the eggs of each generation are laid.
2. The exact length of time spent in the egg, larva, pupa, and moth stage of each generation.

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3. What becomes of the insect between May and August? Is it in the egg stage during this period, and if so, where are these eggs laid?
4. The identification of all the caterpillars which accompany the *Dasychira* in its various generations is required.[1]

[1] *Note.*—I shall be much obliged if specimens of all stages of all these defoliating pests could be sent to me to Dehra Dun, with a full note as to locality obtained from, with elevation, nature of forest (*i.e.*, pure or mixed, good or poor), the amount of damage done, and dates of appearance, etc.

LYMANTRIA AMPLA,

WLK.

References :—Wlk. Cat. iv, p. 883; Moore, Lep. E. I. Co, pl. 9 a, fig. 4, and pl. 15, figs. 7, 7a, 8, 8a (larva); C. & S. no. 1028, Hmpsn. Faun. Br. Ind. Moths, I, 460, no. 1028.

Classification :—Order, LEPIDOPTERA. Sub-Order, HETEROCERA, Family, Lymantriidæ.

Description.

The *larva* is brown in colour and clothed with tufts of short hair and long hair from the anterior and posterior segments; male with a pale subdorsal line and dorsal and lateral white spots; female with black dorsal spots and a white spot on the ninth segment. Head and legs ochreous.

Moth, ♂. Palpi hairy. Head, thorax, and abdomen yellow brown, legs spotted with black. Fore-wing greyish-brown; a black sub-basal line with some spots beyond it; an antemedial waved line; a spot at middle of cell and lunule at end of it; a diffused postmedial band and double waved postmedial line. Hind wing brown, with an indistinct waved postmedial line; an elongate black mark near anal angle; cilia of both wings spotted with black.

♀. Antennæ serrate. Head, thorax, and aborted wings white, spotted with black; abdomen blackish.

Expanse of wings 40 millim.

Life History, etc.

This insect is a very close ally of the well known destructive European pest *Lymantria* (*Liparis*) *monacha*, Linn., and it is therefore recorded in these notes. At present little is known of its life history in India, although it exists throughout the entire continent as also in Burma and Ceylon. It has proved a destructive defoliator to the Peepul tree (*Ficus religiosa*) in Calcutta.

LYMANTRIA OBSOLETA,

WLK.

References:—Wlk. Cat. iv, p. 880; C. & S. no. 1014. Lymantria bhascara, Moore, Lep. E. I. Co., p. 345. Lymantria vinacea, Moore, P. Z. S. 1879, p. 402. Lymantria albolunulata, Moore, P. Z. S. 1879, p. 403; C. & S. no. 999. Lymantria sobrina, Moore, P. Z. S. 1879, p. 402, pl. 33, fig. 5. Hmpsn. Faun. Br. Ind. Moths, Vol. I, p. 461. no. 1031.

Classification:—Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family, Lymantriidæ.

Description.

General colour of the moth is brown with black markings. The head and thorax black. Hampson describes it as follows:—

♂. Head and thorax brown; abdomen slightly tinged with crimson. Fore wings irrorated with dark scales; indistinct, double lunulate antemedial, medial, and postmedial lines; a black lunule at end of cell, but no spot in the cell. Hind wing pale brownish fuscous.

♀. Abdomen crimson, with a dark line on vertex and series of black spots, the extremity brown; hind wing with the inner area suffused with crimson.

The form *albolunulata* from the North-West Himalayas has the fore wing more irrorated with black; the postmedial lines with whitish lunules between them. A form from the Khasís has the ground-colour of fore wing paler; the hind wing nearly pure white, with a fuscous lunule at end of cell and irregular sub-marginal band; the cilia of both wings chequered black and pinkish.

In the form *sobrina* the lines of the fore wings are better defined; the hind wing with the inner margin tinged with pink; female with the abdomen yellowish.

Expanse of wings: ♂ 42, ♀ 72 millim.

Areas from which reported.

This moth was plentiful in 1899 in the sál forests of the Jalpaiguri Duars situated at the foot of the North-East Himalayas in Bengal. (Sir H. A. Farrington, *Bart.*)

It has a wide range as Hampson gives its habitat as China, Formosa, and throughout India and Ceylon.

LYMANTRIA TODARA

MOORE.

References :—Moore, P. Z. S. 1879, p. 402, pl. 33, fig. 6; Hmpsn. Ill. Het viii, pl. 141, fig. 15 (♀); C. & S. no. 1020. Hmpsn. Faun. Br. Ind. Moths, Vol. I, p. 463. no. 1035.

Classification :—Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family, Lymantriidæ.

Description.

A largish moth with white wings with blackish markings white head and thorax, black antennæ. Hampson thus describes it :—

♂. Head and thorax white; antennæ black; a yellow line behind the head; two black spots on collar; and four on vertex of thorax; abdomen yellow. Fore wing with the postmedial waved lines single towards inner margin. Hind wing pale yellow, with a fuscous marginal band.

♀. Abdomen yellow and black. Fore wing with the waved lines absolescent; the black patches on costa and inner margin large and well defined, the first three on costa crossing the cell; a patch on centre of outer margin; the one on inner margin Y-shaped. Hind wing fuscous white, slightly tinged with yellow; the sub-marginal band almost obsolete.

Expanse of wings: ♂ 54, ♀ 88 millim.

Areas from which reported.

This moth was found in company with *L. obsoleta* in 1899 in the sál forests of the Jalpaiguri Duars at the foot of the North-East Himalayas in Bengal. (Farrington). Hampson states that it has also been reported from the Nilgiris and Ceylon.

LYMANTRIA MATHURA,

MOORE.

References:—Moore, P. Z. S. 1865, p. 805; C. & S. no. 1026. Lymantria aurora, Butl. A. M. N. H. (4) xx, p. 403. Hmpsn. Faun. Br. Ind. Moths, I, pp., 464—465. no. 1038.

Classification :—Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family, Lymantriidæ.

Description.

♂. Head and thorax pale fuscous, marked and spotted with black; the line behind the head yellow; third joint of palpus orange; two orange spots on mesothorax; abdomen orange with black spots on its vertex; anal tuft black. Fore wing very pale fuscous; an orange speck and thin black spots at base; a broad subbasal black band; an antemedial line; a spot near end of cell and lunule on discocellulars; a median band; two postmedial and one submarginal lunulate line; a marginal series of spots. Hind wing orange with a black spot at end of cell and conjoined series of submarginal spots forming a curved band; some spots on centre of outer margin.

♀. Head and thorax white; frons fuscous; two black spots each on collar, meso, and metathorax; palpi, antennal tuft, and two spots on mesothorax crimson; abdomen crimson, with small black spots on vertex, the terminal segments whitish; legs, black and crimson. Fore wing white; some crimson and black basal spots; a subbasal line; an antemedial waved line joining at inner margin two postmedial lunulate lines, the space between which is often completely filled in with fuscous; a fuscous spot towards end of cell; some lunulate submarginal marks forming a more or less complete band; a marginal series of spots; costa and cilia crimson. Hind wing crimson, with a fuscous spot at end of cell; a sub-marginal maculate band and some spots on centre of margin. Expanse of wings: ♂ 40—54, ♀ 96—112 millim.

Areas from which reported.

This pest was found in company with *Lymantria obsoleta* and *L. todara* in the sál forests of the Jalpaiguri Duars in Bengal. (Farrington.)

Hampson also gives Japan, North-West Himalayas and Sikkim as its habitat.

LYMANTRIA BIVITTATA,

MOORE.

References :—Moore, Lep. Atk., p. 57; C. & S. no. 1022. Hmpsn. Faun. Br. India, Moths, I, p. 466. no. 1043.

Classification :—Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family, Lymantriidæ.

Description.

♀. Head and thorax white; palpi and antennæ black; frons tinged with crimson; basal joints of antennæ and line behind the head crimson; abdomen crimson, the basal and terminal segments white. Fore wing silvery white; two black basal marks; an outwardly oblique antemedial line with waved edges, joined at inner margin by an inwardly oblique antemedial line with waved edges joined at inner margin by an inwardly oblique postmedial line; a series of marginal spots. Hind wing white. Expanse of wings 100 millim.

Areas from which reported.

This moth was found in company with *Lymantria obsoleta*, *L. todara*, *and L. mathura* in the sál forests of the Jalpaiguri Duars at the foot of the North-East Himalayas. (Farrington.)

Hampson also gives Sikkim and Sylhet as its habitat.

Description of eggs and larva.[1]

The *eggs* are apparently laid in masses on the bark, the individual eggs being stuck together by an excretion of the female. Dried specimens are small, round, silvery little globes, about as large as an ordinary sized pin's head which they greatly resemble. No description of the *larvæ* of the above four Lymantriid moths was made at the time of the reported attack. It may, however, be noted that the caterpillars of the family

[1] It is at present doubtful as to which of the many different kinds of larvæ sent in connection with these attacks produce the various species of Lymantria moths above described. They have therefore been dealt with collectively.

Lymantriidæ are hairy, being generally clothed with very thick hair or with thick tufts of hair.

The *pupæ* are described as being formed within cocoons, the latter consisting of the caterpillar's hairs fastened with a very small quantity of silk.

I have taken these four moths together since no data are at present available as to which larva is the most abundant and their descriptions are still required.

Life History.[1]

The caterpillars probably make their appearance some time during the latter part of August, since the defoliation of the Mairaghat Forest was observed to be complete about the middle of September.

Some larvæ were collected on 22nd September and placed in a box under observation. On the 4th October pupation commenced, both amongst the caterpillars in the box and generally amongst those in the forest, the caterpillars being full-fed about the end of September.

Caterpillars were, however, to be found in small numbers in the forest after October 4th.

The insect remained in the pupal stage for about nine days, the first *moths* emerging on the 13th October. From the above descriptions of the latter it will be noticed that the females are generally larger than the males.

Eggs were laid by the females in about two days after fertilisation which took place almost as soon as they had left the cocoon and become fully developed. After egg laying the female moths died.

This is at present all we know about these life histories. I am of opinion that it will probably be found that this Septem-

[1] The specimens of these insects were sent to me in December 1899 be Sir H. A. Farrington, Bart., from the Jalpaiguri forests, Bengal, of which he was in charge. The notes on the life history which he sent me were, he says, drawn up by his Range Officer Babu L. R. Sen. No observations were made before the middle of September as the Ranger was away on leave till then, and Sir Henry did not visit that portion of his division till October. On the Ranger's return he found the sál trees in his range leafless, the defoliation being due to caterpillars of the above described moths.

ber generation of the pest was not the first one of the year, and investigation will not improbably show that there is at least one, if not more, earlier generation. The forests should be carefully watched at the time the spring crop of leaves is appearing on the sál and other trees attacked.

Relations to the Forest.

Whilst the insects are to be found on other species of trees common to sál areas, the heavy defoliation accomplished by them appears to be chiefly confined to sál trees. Both sál standards and sál coppice were completely defoliated in the attack of 1899, whereas coppice of other species escaped to a great extent. The damage is of the most serious nature, since as soon as the trees lose their crop of leaves and become leafless, all growth is stopped and the annual increment put on by the tree greatly lessened. The defoliated sál trees commenced putting on new leaves about 1½ months after they were completely stripped.

Sir Henry states that the caterpillars did no damage in evergreen forest and little in mixed forest.

The following trees, amongst others, were also attacked:—

Lagerströmia parviflora, *Terminalia tomentosa*, *T. bellerica*, *T. Chebula*, *Careya arborea* (slightly), and *Macaranga denticulata* (slightly). Neither Dillenia nor Chilauni were apparently attacked.

Protection and Remedies.

It is stated that evergreen forest was not attacked, and mixed forest only slightly, coppice of species other than sál also only slightly. On areas therefore where this insect is found to make its appearance annually once or twice in the year, I recommend that where possible mixed forest should replace pure sál. In the case of coppice, where complete defoliation is most serious since it greatly retards the growth of the young trees, which will not have reached the size expected or required of them at the end of the rotation if subject to annual or triennial attacks of these pests, a mixture with other suitable trees is also to be strongly recommended.

Points in the life histories requiring further observation :—

1. The number of generations in the year. This is most important. Is there a spring generation?
2. When the eggs are laid?
3. Descriptions of the various larvæ engaged in the attack. Which is the most numerous?
4. The life history of the insect from the time in October when the females lay eggs and die until some time during August when the autumn larvæ are defoliating the forest.
5. Careful watch should be made for larvæ when the young new leaves are appearing on the trees in the hot weather, and when new flushes of leaves appear after a heavy defoliating attack.

LYMANTRIA GRANDIS,[1]

WLK.

References :—Wlk. Cat. iv, p. 874; C. & S. no. 1008. Lymantria maculosa, Wlk. Cat. iv, p. 881. Lymantria metarhoda, Wlk. Trans Ent. Soc. (3) 1, 1862, p. 7. Hmpsn. Faun. Br. Ind., Moths, I, p. 465. no 1040. Ind. Mus Notes, v. 1, p. 33.

Classification :—Order, LEPIDOPTRA. Sub-Order, HETEROCERA Family, Lymantriidæ.

Description.

The *larva* is very hairy, of an ashy-brown colour overlying a darker hue, with two conspicuous tufts on the first segment of the body. It is about 2 inches long.

Moth. ♂. Differs from *L. mathura* (already described) in having the orange markings replaced by crimson, except that the abdomen is somewhat orange towards the extremity. The shaft of the antennæ and ground colour of thorax and fore wing are pure white.

♀. Differs from *L. mathura* in the frons being black, the second joint of palpus with a black spot.

Expanse of wings :— ♂ 58, ♀ 110 millim.

Life History.

In the 1897-98 defoliating attack upon the sâl trees in Goalpara, Assam, this insect was reported as working almost contemporaneously with the *Dasychira sp.* larvæ; in other words, four generations of the larvæ appeared between the end of August 1897 and the end of April 1898 the caterpillars being present in August-September (1st generation), November (2nd generation), end of January-February (3rd generation), and March (4th generation). Notes were made in the case of

1 Specimens of this insect were sent to the Indian Museum in June 1898 by Mr. J. Campbell, Deputy Conservator of Forests, Golaghat Division, Assam. As the moths were much rubbed and damaged, the identifications were said to be to a certain extent doubtful.

this last generation as to the dates of appearance of the other stages of the metamorphosis, larvæ collected on 23rd March changing into the pupal stage on the 30th and 31st (as did the *Dasychira sp.*) and imagos issuing on the 10th, 11th, and 12th April.

In September of the following year specimens of the larva pupa, and moth were sent from Jalpaiguri and identified as *L. grandis.*

The specimens of the other species of Lymantria (above described) sent to me during the same year from Jalpaiguri pupated in October, the first moths appearing only on the 13th of the month, this corresponding with the 1st generation in Assam. It would therefore seem certain that either *L. grandis* appears earlier at work in the forests than its four companions, or that its larval life is shorter. Its life history between June and August requires study, as also the length of time spent in the various stages of its metamorphosis in the different generations. The larvæ are said to be possessed of great vitality and are not so parasitised as the *Dasychira sp.*

Localities from which reported.

Both the Golaghat Division in Assam and the Jalpaiguri Division in Bengal report this insect from their sál forests.

Hampson gives the known habitat of the pest as Ceylon.

Relations to the Forest.

L. grandis commits the same havoc in the sál forests as its confrères above described. This defoliation on a large scale of the Duars and Assam sál forests has been known for some years and numerous insects in various stages of decay have been sent for identification as causing the damage. Correspondence on the subject has in consequence become much confused and the identifications, in many cases often only partially attempted, very unreliable. It would be of the greatest service if, when the next attacks appear in Bengal and Assam on a large scale, the various stages of the insect are carefully watched and copious notes made whilst they are in progress in the forest. The different kinds of larvæ appearing to be concerned in the defoliation should be kept in *separate* boxes and the moths bred out of them, species of each larva being kept separate (in spirits) with its pupa and moth (latter in small triangular paper slips). Notes should be made as to which larva appears to be most plentiful in the forest, the dates on which it appears, and the length of time it spends feeding.

If notes on the above lines are made and specimens kept, it will be possible to settle which of the many reported species are doing the greatest damage in the sál forests.

PORTHESIA XANTHORRHŒA,

KOLL.

References:—Koll. Hügel's Kaschmir, iv, p. 470; C. & S. no. 958. Euproctis subdita, Moore, P. Z. S. 1879, p. 400; id. Lep. Ceyl. ii, pl. 112, figs. 5, 5a; C. & S. no. 930. Euproctis virguncula, Wlk. Cat. iv, p. 836; Moore, Lep. E. I. Co. pl. 16, figs. 3, 3a (larva); C. & S. no. 932. Euproctis marginalis, Wlk. Cat. vii, p. 1731; Butl. Ill. Het. V, pl. 89, fig. 12; C. & S. no. 929. Euproctis subnigra, Moore, Lep. Atk., p. 48; C. & S. no. 931. Euproctis flavonigra, Moore, P. Z. S. 1879, p. 400, pl. 32, fig. 11; C. & S. no. 939. Hmpsn. Faun. Br. Ind. Moths, I, 485, no. 1106.

Classification:—Order, **LEPIDOPTERA**. Sub-order, HETEROCERA. Family, Lymantriidæ.

Description.

The *larva* is black, with head striped with white; the first segment with a crimson band; a dorsal series of yellow spots with a crimson line through them on the second, third, and sixth to tenth segments; first segment with long forwardly-projecting tufts of black hair; the other segments with shorter tufts.

Moth. ♂. White with a very slight fuscous tinge. Palpi long, slender, and obliquely pointed: the branches of antennæ long and brownish, and tuft orange; the whole apical and outer areas of hind wing on upperside, and the underside of both wings, except the outer margin, suffused with black. See Pl. V, fig. 3, *a, b*.

In the form *virguncula* (which is the form as identified by Sir G. Hampson, Bart., to which the present note on the life history applies) the only trace of black suffusion on either wing is on the underside of costa of fore wing; in *flavonigra* the fore wing is bright ochreous, the hind wing black with the base white, the cilia ochreous; all the intermediate stages occurring. Expanse of wings 28 millim. ♀ without any black suffusion. Expanse of wings 37 millim.

Life History,[1] etc.

The larvæ of this moth were noticed to have completely defoliated *Parottia Jacquemontiana* bushes in the Chatri forest of the Chamba State, North-West Himalayas, in April-May 1896. Mr. J. H. Lace, noting this defoliation, secured some of the larvæ and bred out some moths. This pest must have several other food plants since Hampson gives its reported habitat as throughout India, Ceylon, and Burma; also Java.

Further observations are required on the following points:—

1. The length of time spent in the larval state by the April-May caterpillars.
2. Where the moth lays its eggs.
3. The number of generations passed through during the year.
4. The different food plants of the insect in different parts of the country.

[1] These notes on the life history were made by Mr. J. H. Lace, Conservator of Forests, at the time in charge of the Chamba Forest Division.

LEUCOMA DIAPHANA,

MOORE.

References :—Moore, Lep. Atk. p. 46; C. & S. no. 1051; Hmpsn. Faun. Br. Ind. i. 488, no. 1114.

Classification :—Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family, Lymantriidæ.

Description.

Moth. Palpi slightly fuscous; frons orange, as is also the costa of the fore wing. Antennæ branched, the branches tinged with orange; the legs tinged with orange, wings diaphanous with a few hair-like scales.

In the Burmese specimen patches of scales remain at the upper and lower angles of cell of both wings. Expanse of wings 44 milim.

Hampson gives the habitat as Sikhim; Bernardmyo, Burma. To this must be now added Golaghat, Assam.

Life History, etc.

The larvæ of this insect were found accompanying the defoliators *Dasychira* sp. and *Lymantria grandis* in their great attack on the sál trees in the Goalpara district which commenced towards the end of August 1897. The *L. diaphana* larvæ were reported as very conspicuous during the first appearance of the other two, *i.e.*, during the August-September generation, but after that to have been scarce. They were again noted in the January-February attack which was that of the third generation of the above two pests. What generation of the *L. diaphana* larvæ these February ones represented does not appear to have been noted.

We thus see that larvæ of this insect are found in August-September and again in February. The dates of the pupal and moth stages still require to be observed Also (2) what becomes of the insects between February and the end of August, (3) the number of generations it has in the year, and (4) where the eggs of the various generations are laid.

AGROTIS YPSILON,
ROTT.

References :—Rott, Naturf. xi, p. 141. Noctua suffusa, Fabr. Mant. Ins. ii, p. 157; Moore Lep. Ceyl. iii, pl. 147, fig. 6; C. & S. no. 2001. Phalena idonea, Cram. Pap. Exot. iii, pl. 275 H. Bombyx spinula, Esp. Schmett, iii, pl. 63, figs. 6, 7. Hmpsn. Faun. Br. Ind. Moths, ii, p. 182, no. 1623. Stebbing, Injur. In. of Ind. For., p. 113, pl. vii. 2. a, b, c.[1]

Classification :—Order, **LEPIDOPTERA.** Sub-Order, HETEROCERA. Family, **Noctuidæ.**

Description.

The *larva* of this moth is the so-called cut worm which for years has done an immense amount of damage to crops and plants in India, and is one of the worst pests at present known in the country.

The *eggs* are pale fulvous yellow in colour, nearly spherical in shape, the base being somewhat flattened.

The *larva* is a stout, naked, earth-coloured worm, varying from half an inch to two inches in length when full fed. In its early stages it is a semi-looper.

The *cocoon* is formed of fine particles of soil, firmly cemented together. On opening this the small *pupa* will be found inside. It is about half an inch in length and of a yellowish-red colour, the eyes and antennæ of the moth being distinctly prominent through the pupal case.

The moth is medium sized, the males having bipectinate antennæ, the branches being of moderate length. The insects are whitish brown, pale brown, or fuscous; palpi darker at sides; collar with dark line; abdomen whitish. The forewing suffused with brown, with double waved sub-basal ante and postmedial lines; the submarginal line dentate, with two black streaks on it below the apex and a marginal series of specks; the orbicular and reniform with dark centres and edges and

[1] See also Indian Forester, Vol. XXVII, pp. 62, 63, 243, 244 (1901).

with a black streak beyond the reniform ; the claviform small and black ; all these markings are much obscured in the darker specimens. Hind wing more or less suffused with fuscous brown with a dark marginal line. Expanse of wings 42—56 millim.

For diagrams of the larva and moth, see *Injurious Insects*, Pl. VIII, fig. 2, *a*, *b*, *c*.

Life History.

The eggs of this pest are laid in small batches and often in two or three layers covered sparsely with long scales from the abdomen of the female moth. These eggs are laid near the ground on twigs and branches of trees *away* from the food plant of the young larvæ which have therefore to seek their food plant when they hatch out. The eggs are also probably laid at times on the bare ground. The larva can be recognised by its colour and by the fact that it rolls itself up into a ball when disturbed. They are enormous feeders and devour and destroy young plants on a large scale. When full fed the caterpillar buries itself from 2 to 8 inches deep in the soil and there constructs a firm, irregular, oblong cell of earth, in which it pupates. The period spent in this state will probably vary in different parts of the country. The moths fly only in the dusk or at night, and except that they lay the eggs which give rise to the cut worms, do not themselves injure plants.

It is probable that this pest passes through at least two, if not more, generations in the year in the warmer parts of the country. In the North-West Provinces and Bengal the winter one has long been known. Young larvæ appear early in November and continue feeding until February when they pupate, this stage lasting rather less than a month. The moths appear on the wing in February and are to be found often in enormous numbers up to the middle of March.

A larva sent from Kurseong, Eastern Himalayas, in May changed into a pupa on the 17th, and a moth on the 28th of that month in the Indian Museum, Calcutta ; whilst another from the Jessore district, Bengal, changed into a moth in September. It is these September moths which give rise to the November larvæ. It would thus appear that there may be three generations in part of Bengal. This very important point requires further observation. From the above it will become evident that the different generations have generally, if not always, different host plants. In its cold weather generation in the plains the cut worm is known to feed on opium plants. Later on in the rainy season legumes and pulses replace the opium in the fields and the later generation adapts itself to the changed food plant and feeds upon these. In the case of the colder climate of the North-West Himalayas the number of generations will be reduced. The insects here pass the winter months probably as half-grown larvæ, hibernating under stems or logs or buried beneath the surface of the soil. In May they re-commence feeding, and they have been found at work in young deodar nurseries from the third week in May onwards through June into July, and probably pupate somewhere about the time the monsoon bursts over the hills. Mr. B. O. Coventry obtained pupæ at Gora Gali (Rawalpindi division) about the middle of July from which a moth emerged in the middle of October. These October moths, I think, will be found to lay eggs at once which hatch into the young larvæ, and these latter hibernate through the winter. If this proves to be correct, it will be found that in the colder climate of the hills, as in the colder portions of other parts of the world, *A. ypsilon* passes through but one generation in the year.

Localities from which reported.

Hampson gives this insect's habitat as "universally distributed all over the world with the exception of South America." It has been reported for many years as destructive to crops in various parts of India. In 1900 Mr. B. O. Coventry reported it as damaging young deodar seedlings in the Gora Gali nursery in the Rawalpindi division, Punjab, and I found larvæ feeding in the same way in 1901 (May to July) in nurseries of deodar in the Simla and Bashahr divisions of the same province.

Relations to the Forest.

Cut worms are serious pests to young vegetation of all kinds, being more especially destructive in dry seasons when they often increase in immense numbers and do extensive damage.[1] The injury is committed by the larvæ gnawing off the plants close to the ground and feeding upon them. They are exceedingly wasteful in their methods since they will often gnaw off one or more you ng plants and then drag them a portion of the way to their burrows and, dropping them, attack fresh ones. The caterpillar's presence can often be detected by the presence on the surface of the soil of these cut-through and withering young seedlings, whilst others, or portions of their leaves and stems, are visible, protruding from the openings of the insect's burrows. The larvæ are nocturnal feeders and rest during the day in their burrows in the ground. In dull weather they may be found on the surface feeding by day as well as night.

Mr. B. O. Coventry thus describes the attack at Gora Gali :—

"During the summer months of 1900, it was noticed that a considerable number of deodar seedlings from seed shown in December 1899, had withered in the nurseries at Gora Gali in the Rawalpindi Division. It was found that the withered seedlings had been cut through close to the ground and the upper portion dragged down in to the soil."

At a nursery in the Kalela forest, Simla division, I found young deodar seedlings being attacked in a similar manner at the end of May, and the pest was also destroying seedlings in the forest. Later on, when with Mr. E. M Coventry, we ound the caterpillars in a nursery in the Nagkela reserve (Kotgarh, Simla division), and also eating seedlings put out or sown in patches in the forest. There can be no doubt that *Agrotis ypsilon* commits very considerable damage yearly amongst deodar seedlings, checking very appreciably the young growth in those areas in which it has obtained the upperhand.

Protection and Remedies.

There are several remedies which will be found effectual in getting rid of this pest from nurseries, etc :—

1. Before the young seedlings have come up place bundles of any succulent crop plant which may be growing in the neighbourhood (in America cabbage,

[1] Opium and other crops have been reported as suffering very heavily from the pest, occasionally scores of acres being as effectively swept clean as if a swarm of locusts had been over the area.

turnips and clover have been found most effective) at intervals on the seed beds, first sprinkling the bundles with Paris-green water. The young larvæ will feed on these and be killed off before the seedlings come up.

2. Crows, mynas, starlings, the cattle egret, and many other nesting birds all eat the grubs whenever they can find them, and they are particularly active in this respect in damp weather and after irrigation. Thus, whenever possible, the beds attacked by the pest should be flooded with water in the daetime. The water will fill the burrows and force out the insects, which, if birds are plentiful, will be picked up and eaten by them. If birds are not numerous hand-picking must be resorted to.
3. Another good method of checking the pest is to dust the plants over a few times in the evenings with a mixture of quicklime and ashes, or better still, add the arsenic compound Paris green to the two in the following proportion :—One ounce of Paris green with 1 ounce of unslaked lime and 3 lbs. of ashes. Powder the substances together very finely, put them into a calico bag and dust over the plants, loosening the soil around them first.
4. In nursery beds already attacked the surface of the soil should be carefully inspected, and all holes containing portions of leaves, stalks, etc., should be dug up and the larvæ at the bottom killed. This was the method resorted to at Gora Gali and gave good results.

It should be borne in mind, however, that our efforts should be in the direction of preventing the attack commencing or at any rate from becoming serious. With this object numbers 1 and 3 of the above remedies are recommended. The former would be well understood since the practice of poisoning jackals and porcupines is a very common one amongst the natives of India.

Points in the life history requiring further observation :—

I. In the warmer parts of India—

1. The number of generations passed through during the year and the length of time spent in the various stages of these generations.
2. The different food plants fed upon by the insects of these different generations.

II. In the colder climate of the North-West Himalayas and other cold areas in the country—

1. What becomes of the October moth ? Does it lay eggs at once and die, and do these eggs hatch out the same year ?
2. Does the insect hibernate through the winter in the soil as a half-grown larva?
3. Are the larvæ found feeding in May-July the offspring of the October moth ?

[Other Noxious Grubs having the same habits.]

MELOLONTHA OR LACHNOSTERNA SP. ("WHITE GRUBS".)

Reference :—Stebbing, Inj. Ins. Ind. For., p. 35.

Classification:—Order, **COLEOPTERA**. Family, Scarabæidæ. Sub-Family, Melolonthini.

Description of Larva.

The *larva* is a large, heavy, yellowish-white, curved grub, the posterior segments of which are swollen up in a bag-shaped manner, being black in colour. The head is light brown, bearing two antennæ and a pair of long curved exceedingly powerful mandibles. Length 1½ to 2 inches. See Pl. VI, fig. 3.

Only the larva has at present been found.

Information at present known concerning the insect.

These grubs were discovered by the writer killing off deodar seedlings in July 1901 in the Taranda forest, Bashahr division, Punjab. This forest had been cut over in 1898 and sowings were made in patches in February 1901, those made the previous year having failed. On inspecting the patches of young seedlings numbers were found lying dying or dead on the surface, cut through at their bases, whilst portions of others were found protruding from largish holes visible on the surface of the turned over soil. The following is a description of one patch which may be taken as typical of what was occurring in many of them, the state of affairs accounting probably for the failure of the young plants in previous years :—There were probably 25 seedlings originally in the patch. At the time of inspection five green uncut ones were all that remained standing in the soil. Most had been cut off either at the apex of the stalk just below the crown of needles or some way down the stalk but above the ground. These cut seedlings had been in some cases partially eaten or a few needles only had been consumed and then the seedling left to wither, whilst fresh ones were attacked. Others had been dragged to the holes of the larvæ and entirely or partially dragged down the burrows. On digging down into the soil two of the above described large larvæ were discovered, they being responsible for the damage done. Had this patch been inspected two days later there would probably not have been a single seedling left in it. Several patches in the neighbourhood were in this latter condition.

I have not as yet been able to obtain the imago of this grub. The latter probably spends more than one year in this stage of its existence.

Further observations required.

Beyond the above notes apparently nothing further has been recorded on the subject of the life history of this pest. It and its method of attack were quite unknown to the forest guard whose beat I was in at the time and who accompanied me on my inspection. The length of time spent in the larval and pupal stages has still to be observed and specimens are required of the perfect beetle.

The remedies proposed under *Agrotis ypsilon* are applicable to this pest also. When hoeing up the soil before sowing the seed all such larvæ should be carefully killed and poisoned baits should be made use of when the young seedlings are beginning to appear above the soil.

In *Injurious Insects* under *L. impressa*, page 36, I mentioned the fact that although "white grubs" had not been up to then recorded as injuring seedlings in forest nurseries, etc., it was probable that they did so.

ELATERIDÆ (CLICK BEETLES).

Reference:—Stebbing. Inj. Ins. Ind. For., p. 40.

Classification:—Order, COLEOPTERA. Family, Elateridæ..

Description of Larvæ.

1. Larva light reddish-brown in colour with a horny, shiny, chitinous external covering, flat in section, with 3 pairs of prolegs on the first three segments of the body. Length $1\frac{1}{4}$ inches. This larva is shown in Pl. VI, fig. 4.

2. Larva brown in colour, hard, shining, with three pairs of prolegs on first three segments of body. Length $\frac{1}{2}$ an inch.

Only the larvæ of the above two insects have yet been obtained.

Information at present known concerning these insects.

1. One specimen of this "wire-worm," as the grubs of elater beetles are called, was discovered feeding at the roots of an English chestnut plant (*Castanea vesca*) in a small plantation near Kathian in the Jaunsar division, North-West Himalayas. It was noticed that several of the young plants, which had been raised from seed sent out from home, were dying or dead, and the cause was attributed to bad planting in several cases. One young plant I dug up had its roots rather badly gnawed, patches of bark having been peeled off. This wire-worm, a large specimen, was found at the roots and was responsible for the bad condition of the young plant. See Pl. VI, fig. 4.

2. The small wire-worms above described were found in the patches of deodar seedlings in the Taranda forest already alluded to as being destroyed by the large Melolonthid larvæ. The elaters were not very abundant and their attack was distinguishable from that of the cockchafer grubs, since they only cut the roots beneath the surface of the soil. The young plant was seen to be dead or dying without any apparent cause

until it was pulled up when it came away in the hand, its roots having been clean cut off. In this way these grubs move down lines of young plants in European nurseries, cutting through and feeding on the roots. They do not appear or feed upon the green portions of the plant above ground.

Further observations required.

No observations of the action or numbers of these insects in nurseries and young plantations, etc., have been recorded up to date. It will doubtless prove, however, that their probable presence should be taken into consideration on areas on which young plants are to be reared.

We have yet to discover how long these grubs spend in this condition, when they appear as the perfect beetle and what this insect is like.

Flooding the nursery beds and hand-picking are remedies to be recommended when these pests make their appearance.

ACRONYCTA ANÆDINA,[1]

BUTL.

References :—Butl. Trans. Ent. Soc. 1881, p. 19. Triæna maxima, Moore, P. Z. S. 1881, p. 333; C. & S. no. 1771. Hmpsn. Faun. Br. Ind. Moths, II, p. 240. no. 1813.

Classification :—Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family, Noctuidæ.

Description.

The *larva* is a hairy caterpillar, blue-black in colour, with short tufts of blue-black hair on each segment of the body. In between these short tufts arise long pencil tufts of bright canary yellow hairs which stick out all round the insect, giving it a very woolly appearance.[2] See Pl. II, fig. 4, *a*.

The *pupa* is stout, dark chestnut coloured, and about 1⅛ inch in length.

The *moth* has a general greyish appearance and is thus described:—

♂. Whitish grey; palpi black at sides; thorax clothed with hair and scales; abdomen fuscous. Fore wing with some fuscous blotches on costa; a waved black fascia in interspace from base to below the orbicular; the antemedial double lines very faint; the orbicular and reniform black-edged, with a black streak between them, which is sometimes obsolete; the inner border of reniform double; the postmedial curved double lunulate line prominent, filled in with white and with a black streak, and sometimes a second one, crossing it; a marginal series of black spots. Hind wing fuscous white, with a postmedial line, the cilia whitish. Underside of both wings with a cell-spot and curved postmedial line.

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[1] The notes on the life history of this insect are from observations made by Mr. B. B. Osmaston, F.C.H., who discovered it doing damage in the Jaunsar forests in 1899, and from others recorded by myself from specimens sent me by Mr. Osmaston and kept under observation.

[2] This description is made from a coloured drawing by Mr. Osmaston.

♀. Darker grey; fore wing with the streak between the stigmata and also the upper postmedial streak always present; hind wing darker fuscous; underside with the cell-spot to hind wing large. Expanse of wings:—♂ 54-60; ♀ 70 millim.

Pl. II, fig. 4, *b*, shows the pupa and, *c*, the moth of this insect.

Life History.

The eggs are laid some time during July, but it has not yet been reported where they are deposited.

The caterpillars are to be found on the trees they attack all through August, feeding upon the leaves of the food-plant. Towards the end of the month they spin a rough hairy cocoon and change into the pupal state inside it. They remain in this stage until the following July, the moths hatching out at the beginning of the month. Some pupæ collected in October and made over to me in December hatched out at Dehra Dun,[1] towards the latter part of May .This proves that in Jaunsar the insect has but one generation in the year, the earlier date at which my pupæ issued being accounted for by the fact that they were kept in a warmer place throughout the winter.

Localities from which reported.

The insect has been reported as doing considerable defoliating damage in the Jaunsar forests of the North-West Himalayas. Hampson gives the habitat of this moth as Japan, North-West Himalayas, Punjab, and Rangoon, so it has a wide distribution and has other food-plants besides the ones mentioned below.

Relations to the Forest.

A. anædina has proved itself a serious pest to the horse chestnut (*Æsculus indica*, Colebr.). It swarms all over the trees, entirely defoliating them in bad seasons. In 1889 by the end of August the trees were all leafless and the insect appeared to be equally abundant the following year. The hill tun tree

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[1] Elevation 2,000 feet. They were kept through the winter in a room. They were brought down and made over to me at Chittagong in Eastern Bengal, and the weeks spent in this much warmer climate doubtless led to their issuing earlier.

(*Cedrela serrata*, Royle) is also attacked and to a less extent the walnut (*Juglans regia*, Linn.).

Protection and Remedies.

It has not been stated where the larvæ spin their rough cocoons, but it is probable that it is in exposed places, such as the bark of the main stem, branches, or on adjacent stems, etc. I would suggest, therefore, if the insect makes its appearance in nurseries of young walnut, that these hairy cocoons should be carefully searched for, collected, and destroyed. Since the insect spends some ten months of its life cycle in the Western Himalayas in this stage, this collection should not present any great difficulties.

The pest is doubtlessly kept in check to some extent by the parasitic flies with which numbers of the cocoons were infected. A determination of the species of these flies has not yet been effected.

Points in the life history requiring further observation:—

1. Where the rough hairy cocoons are spun by the larva before it changes into the pupal state.
2. The life history of the insect in Lower Burma. It will doubtless prove to have at least two generations in the year in the damp hot climate of that locality.
3. The food-plants of the insect in Burma.

PLECOPTERA REFLEXA,

GUEN.

References :—Guen. Noct. ii, p. 430; C. & S. no. 2312. Trigonodes gammoides, Wlk. Cat. xv, p. 1833. Poaphila simplex, Wlk. Cat. xv. p. 1840. Poaphila hamifera, Wlk. Cat. xxxiii, p. 992. Poaphila uniformis, Moore, Lep. Atk., p. 172, pl. 5, fig. 10; C. & S. no. 2313. Hamp. Faun. Brit. Ind. Moths, Vol. II, p. 519. no. 2549.

Classification :—Order, **LEPIDOPTERA**. Sub-Order, HETEROCERA. Family, **Noctuidæ**.

Description.

The *larva* is of the looper type, about an inch in length when full grown. It is green in colour with five white longitudinal lines running down its back. The head is paler green, or almost white. It is an active caterpillar, wriggling violently when touched.

The *pupa* is red and about ¾ inch in length. No cocoon is formed.

The *moth* is small and brownish and is thus described by Hampson :—

Palpi slight and reaching vertex of the head, the third joint minute; antennæ of male with long cilia and bristles; thorax and abdomen smoothly scaled; tibiæ slightly hairy and without spines. Fore wing with the apex nearly rectangular. Grey-brown in colour; the head and collar bright fulvous. Fore wing with obliquely waved antemedial line; a large reniform spot, often with black centre and with a rufous spot on the costa above it; an inwardly oblique waved postmedial line and sinuous submarginal line; a marginal series of minute dark specks. Hind wing fuscous brown; the outer area slightly darker. Underside greyish white; the outer area fuscous; male with the costal area of hind wing also fuscous. Wing expanse of 30 millim.

Pl. III, fig. 3, a, shows the larva, b, the ♂ and ♀ moths of this insect.

Life History.

The larva hatches out about the middle of April and spends some weeks feeding upon young sissu plants. It descends to the ground and changes into a pupa beneath the surface of the soil towards the end of June. A week is spent in this stage, the moths appearing at the end of June and on into July. These moths lay eggs, probably on the young shoots of the sissu plants, a second generation of larvæ appearing at the beginning of August. This is as far as observations of the life history have at present been carried and from them we see that there are at least two generations of the pest during the year.

The notes on the life history from 26th June onwards were made by Mr. B. O. Coventry in 1899. The writer found the young larvæ in the plantation in April 1901.

Localities from which reported.

This insect has been reported from Northern India, Poona and the Andamans. Mr. B. O. Coventry reported it from the Changa Manga Plantation near Lahore in 1899.

Relations to the Forest.

As far as is at present known, the larvæ confine themselves to defoliating young sissu growth. They do not apparently affect the older trees. With reference to the damage done Mr. B. O. Coventry wrote:—

> "The larvæ do very considerable damage, as this year at least 100 acres stocked densely with one year old sissu coppice were denuded of every leaf . . . . This is the first year this plague has been noticed by me, although in the Changa Manga working-plan mention is made of larvæ having appeared in sissu coppice . . . ."

Protection and Remedies.

Until the full life history of the pest is known it is not possible to prescribe remedies. In this connection it is especially important to discover the stage in the life history in which the winter is passed through.

Points in life history requiring further observation:—

1. How and where the eggs of the first generation are deposited.

2. Time spent in the larval state by the caterpillars of the second generation.

3. Time spent in the pupal stage of the second generation.

4. Date of issuing of moths of the second generation.

5. Whether there are more than two generations of the insect during the year.

6. When and in which stage the insect passes through the winter. Is it as eggs in the axils or on the sides of the branches, or is it as larvæ or pupæ in the ground?

DIRADES THECLATA,

GUEN.

References :—Guen. Phal. ii, p. 36. Dirades adjutaria, Wlk. Cat. xxiii, p.849 ; C. &. S. no. 3049. Dirades binotata, Wlk. Cat. xxxxv, p. 1650 ; Moore, Lep. Ceyl. iii, p. 399, pl. 186, fig. 7 ; C. & S. no. 3051. Erosia vertecaria, Feld. Reis. Nov. pl. 128, fig. 7' Hmpsn. Faun. Br. Ind. Moths III, 132, no. 3065.

Classification :—Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family, Epiplemidæ.

Description.

The *larva* is a small, smoke-coloured grub, provided with 5 pairs of prolegs. Head yellow. It has a warty appearance, and is sparsely clothed with hair. Length when full grown half an inch.

Pupa yellow to yellow-brown, showing three clear marked abdominal rings on lower portion ; $\frac{1}{4}$ inch in length.

A small *moth* ; ground colour grey with yellowish markings.

♂. Antennæ and vertex of head whitish ; head and thorax violaceous grey ; abdomen ochreous, except at base. Fore wing violaceous grey ; a large triangular patch outlined with double brown lines on the costa beyond the middle ; a similar oval spot with darker centre on inner margin ; a series of marginal fuscous lunules. Hind wing with the basal half violaceous grey, darkest at inner margin ; the outer half pale ochreous brown, the two areas defined by a rufous and pale line ; a series of marginal fuscous lunules.

♀. Abdomen and hind wing of the same violaceous grey as the ground colour.

Expanse of wings 22 millim.

Pl. V, fig. 4 *a*, *b*, *c*, shows the larva, pupa, and moth of this defoliator.

The notes on the life history of this pest were made by Mr. Gisborne-Smith in the teak forests of Damoh in the Central Provinces. He found the insect defoliating teak and *Adina cordifolia*, Hook.

Life History.

When first observed in the middle of August, these larvæ were about half grown. On the 28th or about the end of the month they become full fed and change into the pupal state. Only a week is spent in this stage, moths having been obtained on the 3rd and 4th September from larvæ which pupated on the 28th August. If a month is allowed for the larvæ to grow to their full size, we thus see that five weeks suffices for this summer generation. It is very probable that it will be found that there are several others in the year.

Localities from which reported.

The insect has a wide distribution. Hampson gives its habitat as W. Africa, throughout India, Ceylon, and Burma. These notes on its life history were made in the Central Provinces.

Relations to the Forest.

The larvæ defoliate the teak (*Tectona grandis*) tree in the Central Provinces. They were found feeding on the leaves in the Damoh District forests in company with the well-known teak defoliators *Hyblæa puera* and *Pyrausta machœralis*. The extent of the injury actually done by *D. theclata* requires further careful observation, but as a result of its attacks and those of the *Pyrausta* Mr. Gisborne-Smith stated that in certain areas at the end of August the teak trees were quite brown, the whole of the foliage having been skeletonised and killed by these two caterpillars. *D. theclata* was also found feeding upon *Adina cordifolia* and "paraspipal" trees.

Protection and Remedies.

The prescription of remedies for these defoliating larvæ is difficult and impossible until their full life histories are known. Mixed forest is, however, generally found to escape these heavy defoliating attacks better than a forest consisting entirely of the one species of tree attacked, and it is advisable to bear this point in mind when laying out plantations and coppice areas.

Points in the life history requiring further observations:—

1. Where the eggs are laid.
2. Time spent in the larval stage by the August caterpillar.
3. What becomes of the September moths.
4. The number of generations in the year.
5. Where the insect passes the cold weather and in which stage of its metamorphosis.

BOARMIA SELENARIA,

HÜBN.

References :—Hübn. Samml. Eur. Schmett., Geom. fig 163. Boarmia dianaria, Hübn. Samml. Eur. Schmett. Geom. fig. 483. Boarmia reciprocaria, Wlk. Cat. xxi, p. 336. Boarmia imparata. Wlk. Cat. xxi, p. 372; C. & S. no. 3344. Boarmia promptaria, Wlk. Cat. xxi, p. 379; C. & S. no. 3333. Opthalmodes cretacea, Butl. A. M. N. H. (5) iv, p. 373. Hmpsn. Faun. Br. Ind. Moths, III, p. 264. no. 3403.

Classification :—Order, **LEPIDOPTERA.** Sub-Order, HETEROCERA. Family, **Geometridæ.**

Description.

Larva.—When young the larva is pale sap-green in colour with a yellow head and a yellow stripe running down each side of the body. There are two dark-coloured spots on the last but one abdominal segment, and another pair on the sixth segment. The caterpillar is of the "looper" type, having three pairs of jointed legs on the first three segments, one pair of anal claspers and only one other pair of clasper legs placed on the ninth segment; the larva moves forward by looping up its b dy in the manner peculiar to the caterpillars of this family. As the insect grows older a dark purple line becomes visible down the dorsal surface, the spots on the last segment but one and on the sixth segment being still present. The sides, the last abdominal segment, and the ventral surface are still greenish-yellow, but in addition the sides have a row of purple spots, becoming almost a continuous line, running down them. The head is reddish yellow, squarish in outline when seen from the front. The last pair of claspers are very large. When full grown the caterpillar may have the above colouring or the insect may be coloured an exact imitation of a sál twig, the ground colour being a reddish-brown with patches of purple-black and a purple-black line down its dorsal surface; a series of purple spots down the sides, slightly dorsally, and a whitish-yellow line down the ventral surface. Head reddish and square in outline. Length $2\frac{1}{2}$ to $2\frac{3}{4}$ inches. Mature caterpillars with this colouring were more common than the green variety.

The *pupa* is stout, reddish-brown in colour, shining and hairless. Length $\frac{7}{8}$ths inch. The pupal stage is passed in the earth, the larva descending the tree and burying itself amongst the leaves and soil at the foot. No cocoon is formed.

The *moth* is greyish in general colouring with brown markings more or less speckled over the wings. Lower edges of wings slightly scalloped. Hampson describes it as follows :—

"Antennæ of male minutely serrate and fasciculate; hind tibiæ slightly dilated. Ground-colour whitish, grey or pale fuscous, irrorated with dark brown; abdomen with paired dark dorsal specks. Fore wing with indistinct curved and slightly waved median line, becoming straight and antemedial on hind wing; both wings with grey centred lunule at end of cell; a prominent crenulate postmedial line; traces of a sinuous submarginal pale line; a marginal series of dark specks. Underside pale, with large black cell spots; fore wing with a diffused sub-apical black patch. Expanse of wings: ♂ 45—50, ♀ 45—56 millim."

Life History.

The eggs are probably laid by the moths on the twigs of the trees. Towards the end of April, when first found in the Dun forests by Mr. Milward and the writer, the larvæ were of all sizes, from a few days old to nearly or quite mature. From the defoliated state of the trees the caterpillars had evidently been at work for some time. They probably first appear some time during March just as the sál trees, upon which they chiefly feed, are bursting into new leaves. The larvæ feed voraciously, devouring both new and old leaves, flowers, and green leaf stalks, the older ones even gnawing down the new green shoots of the year. Thus when a band of these caterpillars have swarmed over a tree, they do not leave it until practically all green growth has been stripped from it. The colouring of the dark variety of larva is an exact imitation of a sál twig, but they do not appear to make any use of the protection thus afforded them. The sap-green variety is also almost invisible at a short distance amongst the leaves and flowers. Both, however, are to be found indiscriminately all over the tree. When they have stripped a tree, they drop on to the nearest unattacked one or on to the ground, letting themselves down by means of silken threads, and march off to fresh trees. The caterpillars become full-fed at the end of April, and they then drop down to the ground by means of their silken threads and pupate in the earth at the foot of the tree, no cocoon being constructed.

A number of larvæ were taken by the writer into Dehra Dun, and the first seventeen of these transformed into the pupal state on May 5th, and remained in this stage until the 16th of the month.[1]

The first twelve imagos appeared on the 16th May followed by eleven more on the 17th, and others within the next few days: the moths emerging in approximately the same order in which the larvæ transformed into pupæ. An attempt made to obtain eggs was not successful, the moths kept for this purpose being attacked by ants and killed. This is as far as the life history has been taken at present. It is probable, however, since the insect makes its first appearance in the spring and attacks the spring growth, that *B. selenaria* is at least double brooded, a second generation of larvæ appearing when the summer flush of leaves comes on to the sál trees in August. Larvæ were reported to have appeared in various parts of the forest in this latter month, but no specimens were kept or definite results observed. The question as to the number of generations is however important.

Localities from which reported.

Hampson gives the following distribution of this pest:—

Europe, Amur, Japan, China, North-West Himalayas, Nepal, Khasis, Congo, South Africa.

The insect has therefore a very wide distribution and is consequently the more to be feared since its powers of adaptability to varied environments must be considerable, as also its powers of rapid multiplication when conditions are favourable.

[1] Owing to my absence from head-quarters on tour the moths were kindly bred out for me by Forest Ranger Birbal, Curator, Imperial Forest School. The dates in question are those noted by him.

In the Dehra Dun forests the present reported range is from the Saharanpur-Chakrata Road on the west to the eastward boundary of the forest on the Ganges River, only the northern slopes of the Siwaliks being noted as affected. Within this area the intensity of the attack in 1901 varied, being much more severe in some parts than in others.

No reports from the officers in charge of adjacent sál areas have been received with reference to this pest.

Relations to the Forest.

When the caterpillars appear in large numbers in the forest the damage they are capable of doing is very considerable. When full grown the larva is of considerable size and during its whole life it is apparently a voracious feeder, attacking and entirely stripping the trees of all green growth, as also of the flowers. In the middle of April numerous large sál trees were to be seen entirely defoliated having the appearance of deciduous trees in winter, whilst others were rapidly becoming leafless under the attacks of the swarming larvæ. The annual increment put on by these trees is much less in years of serious defoliation, since growth ceases until the summer flush of leaves makes its appearance in August. If, however, the damage done to the mature trees is great, that suffered by the young growth is much greater. Young saplings, entirely stripped of all green growth in the spring, were found in September standing black and gaunt in the forest, still alive, but having been quite unable to recover sufficiently from the spring attack to be able to put out any summer crop of leaves. Thus heavy defoliation by this pest in the spring causes a cessation of all growth in young saplings during the year. If the pest appeared in similar numbers in successive years, it is evident that the young growth in the forest would rapidly deteriorate and much of it would succumb.

What rendered the attack even more serious in the Dun forests in 1901 was the fact that *B. selenaria* appeared in several of the areas already attacked by the scale insect, *Monophlebus Stebbingii*, and both insects were often to be seen in large numbers on the same trees, both young and old, the looper stripping the leaves and green parts off the tree, the scale tapping the branches and taking a heavy toll of sap.

Protection and Remedies.

Until the life history of this pest has been worked out, it is not possible to say what remedies may be practicable over large extents of forest. We have yet to ascertain what insect and fungoid parasites attack the pest. Mr. Milward noticed that the caterpillars were practically absent from an area which had been burnt over in the preceding hot weather. The old trees had suffered to a certain extent from the fire and most of the young growth had been killed. It may have been that the foliage of the trees proved acrid and distasteful to the larvæ, or the insect may have been in its pupal stage in the soil and leaves on the ground and thus got roasted and killed off.

If there is a second generation, it may perhaps not appear in areas that were devastated by the first one. The moths on coming out about the middle of May will not lay their eggs in areas where the food-supply, owing to the heavy attack made by the April larvæ is likely to be deficient for their offspring. In searching for these latter therefore, it will be necessary to inspect adjacent areas of sál untouched in the spring in addition to those which suffered from the April larvæ.

Points in the life history requiring further observation :—

1. Where the eggs are laid—
   (1) by the moth of the April generation,
   (2) by the moth of the subsequent generation, if there is one.

   An examination of the branches when the moths are on the wing should show this.
2. Whether there is a second generation, and, if so, the dates of appearance of the various stages of egg, larva, pupa, and imago.
3. In which stage the insect passes the winter, and where.
4. What insect or fungus parasites attack it, and their methods of procedure.

TRACHYLEPIDEA FRUCTICASIELLA,

RAG.

Reference :—Rag. Ann. Soc. Ent. Fr. 1887, p. 260.

Classification :—Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family, Pyralidæ.

Description.

The *larva* is a smoky grey above, pale yellowish white beneath, the segments of the body being covered with scattered bristly hairs. Length 1 to 1¼ inches. See Pl. V, fig. 5*a*.

The *moth* is small, grey brown in colour, the antennæ in the male being simple, with a tuft on the basal joint. Fore wing with the median area darker and clothed with rough erect scales, especially towards the costa; indistinct ante- and post-medial lines of raised dark scales, the former oblique and obsolete towards costa, the latter oblique and angled inwards on vein 5; a very indistinct discocellular spot; a marginal series of specks. Hind wing dull brownish yellow. Expanse of wings ♂ 20—27; ♀ 29—34 millim. Pl. V, fig. 5 *b*, shows the moth of this pest.

Life History.

The writer found the caterpillar of this moth tunnelling in *Cassia Fistula*, Linn., pods at the beginning of February. The grub was at the time nearly full-grown. It changes into the pupal state towards the end of the month by which time the pods are ripe. The moth appears at the beginning of May,[1] *C. Fistula* flowers in April, and it is probable that the moths lay their eggs near or on the young forming fruit, and the larvæ on hatching out tunnel into the pod and increase in size with the growth of the bean. More than one egg is laid in this position by the moth since several larvæ have been found in

[1] The pod taken by myself on the 1st February and brought into Dehra was made over to Babu Birbal, Curator of the Imperial Forest School, in April, and he bred out moths from it on the 3rd May.

each pod. Thus it would appear that some nine to ten months of the life of the insect are spent in the larval stage.

Localities from where reported.

The insect was found attacking the pods of a tree at Beribara in the Saharanpur Division, North-West Provinces.

Hampson gives Beyrout, Egypt, and the Punjab as the recorded distribution of the insect.

Relations to the Forest.

The larvæ bore up and down the long pendulous sausage-like pods which are from 1-1½ ft. long when fully grown. Only one hole is apparently made through each partition separating the seeds from one another. The seeds are tunnelled through and the pod turns black and rots. As these latter have a medicinal value, the attacks of this pest are of some importance. This insect should be distinguished from a smaller moth, *Cryptophlebia carpophaga*, Wlsm., a Tineid whose larva also attacks these pods.

Points in the life history requiring further observation:—

1. The chief point is to ascertain definitely where the eggs are laid. This will give the clue as to whether it is possible to prescribe any satisfactory method of checking the attacks of this insect in cases when it would pay to institute them.
2. When and where the larvæ first make their appearance.
3. What becomes of the May moth.
4. Occasionally the *C. Fistula* flowers a second time in the autumn. Where this occurs, is this larva found attacking the resulting pods?

EUZOPHERA CEDRELLA,[1]

HMPSN.

Reference:—Hampson in litt.

Classification:—Order, **LEPIDOPTERA**. Sub-Order, HETEROCERA. Family, **Pyralidæ**.

Description.

A small *moth* with palpi up-turned and reaching vertex of head. Head, thorax, and body greyish. Fore wing long, narrow, with apex somewhat rounded; dark grey to blackish in colour; a series of black spots near outer margin and an erect, jagged, white antemedial band. Under wings smoky-grey with a dark line and fringe on lower margin. Expanse of wings about 15 millim. See Pl. II, fig. 6*a*.

Localities from which reported.

As far as at present discovered this insect's habitat is the coniferous forests of the Jaunsar, Teri-Garhwal and Simla Hills in which area its larva attacks the cones of the deodar and spruce trees.

[1] The identifications of this and various other moths mentioned in these notes have been very kindly determined or checked for me by Sir George Hampson, *Bart.*, to whom my very best thanks are due. *E. cedrella* is a recently discovered species.

PHYCITA ABIETELLA,

SCHIFF.

References:—Schiff. Wien. Verz. p. 138. Tinea decuriella, Hübn. Samml. eur Schmett, fig. 74. Tinea sylvestrella, Ratz. Fortz. 1, p. 244, pl. 15, fig. 1. Pinipestis abietivorella, Grote, Bull. U. S. Geol. Suvr. iv, p. 701. Hamps. Faun. of Brit. Ind. Moths, iv, p. 91, no. 4387.

Classification:—Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family, Pyralidæ.

Description.

This is a small *moth ;* the upper wings greyish in colour with blackish-brown markings ; lower wing a uniform dark grey. It is thus described in the Fauna of British India:—

"Head, thorax, and abdomen grey and fuscous. Fore wings grey, thickly irrorated and suffused with fuscous ; a dark brown patch on base of inner area ; a dark antemedial line with a grey band on its inner edge, angled outwards below costa and inwards on median nervure and vein 1 ; a larger brown patch inside the grey band, less prominent towards costa ; a prominent quadrate discocellular grey spot with a brown patch below it ; a grey-edged dark postmedial line angled inwards at vein 6, then bent outwards and minutely dentate, some brown suffusion beyond the line ; a prominent marginal series of dark specks. Hind wings semi-hyaline with a brown tinge ; the cilia white, with a brown line at base.

"The prominence of the grey and fuscous markings of fore wings varies considerably. Expanse of wings 22—34 millim." (See Pl. II, fig. 7*a*.)

Localities from which reported.

The insect's range as at present discovered is the forests situated on the Jaunsar-Barwar and Teri-Garhwal hills to as far west as Simla. The writer has bred out specimens from cones obtained from various parts of this area.

It has a widespread distribution since the species has also been reported from the United States, Europe, and Japan.

Description of larvæ.

The two moths above described have both been bred out of deodar and spruce cones. *P. abietella* has in addition been reared from infested silver fir and blue pine cones. It follows that there are at least two, if not more, different species of larvæ attacking these cones, and I have found this to be the case with all the cones although the *E. cedrella* moth has only been obtained from the deodar and spruce. I have not as yet been able to settle which *larva* produces the individual moths in question, and the larvæ are therefore described here together.

Some immature larvæ about a fourth grown were about ¼ inch long, dirty yellow smoke-coloured with a black head. (Taken from deodar cones on 22nd May.)

Mature or nearly mature larvæ :—

1. A dirty yellow grey in colour with a tinge of green, smooth, and shining ; head black. Length 1¼ inches. Some similar forms had scattered bristles over their bodies. (From blue pine, spruce, deodar, and silver fir in July.) See Pl. II, fig. 7*c*.
2. Light reddish earth-coloured, light green on ventral surface ; first abdominal segment yellow. Head blackish yellow. Length 1 inch. (From spruce in July.)
3. Similar to No. 2 but more pink in colour, with black head and a black band or collar on upper surface of first abdominal segment. (From spruce in July.)
4. Purplish on dorsal surface becoming a pale greenish yellow on ventral surface. Head black. Length 1½ inches. (In deodar cones from Jaunsar in September.)

Pl. II, fig. 6 *b*, *d*, show a larva and pupa taken from a deodar cone and thought to be the larva and pupa of *E. cedrella*. I consider this, however, doubtful since at the time it was not known that there was more than one species of larva attacking the cones.

Life History.

As far as is at present known the life history of both these insects is approximately the same. The *eggs* have not yet been discovered. It is possible that both the insects deposit them either on the twigs near the young female flowers or, in the case of the deodar, in the young flowers themselves as they are open in October. The eggs should be looked for between September and November.

The larvæ make their appearance in the spring, but the first part of their life history is unknown. The attack is first noticeable owing to the small holes surrounded by resin which make their appearance on the lower half of the cones—see Pl. II, fig. 6*e*. I have seen these as early as May in the case of the deodar cones; in June in spruce, blue pine, and silver fir cones. On cutting up such diseased cones the larvæ will be found tunnelling up or down them (depending upon the point of entrance), the seeds being often pierced through and eaten; the grubs will be found wallowing in the large amount of turpentine exuded by the cone through the wounds thus made. The long cylindrical spruce and blue pine cones become contorted into fantastic shapes under this attack.

Towards the end of July and first part of August most of the larvæ appear to be full fed (though some are to be found on into September) and change into the pupal state. By this time the cone will have become so diseased that it will have fallen to the ground and some of the larvæ (if not all the species) leave it and enter the ground and pupate there.

I think it probable that at least one of these larvæ migrates from cone to cone. I have usually found more than one grub in a cone though there may not be more than one of any individual species present, the moths having only laid one egg near or on each flower. The mature insects appear on the wing between September and October. Specimens I bred out at Dehra Dun[1] issued as follows: on 12th September two moths from silver fir; 19th September moths from blue pine and on

[1] The warmer climate of Dehra, of course, affected the period of issuing of the moths.

28th from spruce; on 4th October from deodar. All these were *P. abietella*. *E. cedrella* was obtained from spruce and deodar in October.

Relations to the Forest.

Our knowledge is at present insufficient to enable us to say which of these two pests is the most aggressive, or whether there may not be others at work with them. The effect of their attacks is, however, most injurious since in bad years the majority of the seed crops are entirely lost. This was the case with the deodar crop in 1898, nearly the whole of which, according to Mr. Ribbentrop,[1] was lost from the trees round Simla, whilst Mr. Osmaston reported the destruction of cones the same year in the Jaunsar forests. The attack does not seem to have been noticed (or at any rate reported) on the spruce, silver fir, and blue pine during the year. The insects have been more or less plentiful in deodar cones during the succeeding years, and last year (1901) they were found not only abundant in deodar but also in spruce, silver fir, and blue pine. It is probable that they caused the loss of the majority of the seed of these four trees during 1901 in the portions of the Simla and Bashahr divisions visited by the writer.

Protection and Remedies.

Until the full life history of these insects is known it is too soon to even attempt to suggest here what remedies, if any are possible, can be recommended for trial in the case of such pests.

Points in the life history requiring further observation:—

1. Where the eggs are laid. The discovery of this point is most important.
2. When the larvæ first hatch out, and where they spend the first stages of their life histories.
3. The number of different species of larvæ attacking the cones, and which species of cone they are most common in.
4. The length of the various pupal stages.

[1] *Vide* "Notes on the Deodar," *Indian Forester*, Vol. XXV, Appendix.

5. The length of time during which the moths are to be seen on the wing in the forest.

6. The stage in which the insects pass through the winter. Is it the egg stage?

7. The description of the larva of *E. cedrella* and that of *P. abietella*.

NOTE.—The above observations are required for each tree. With reference to No. 3, I recommend that cones be cut up monthly from Apri onwards, and that the larvæ taken from each be carefully examined, described and then put into formalin, which will prevent their colours going, and sent to me to Dehra Dun.

To ascertain No. 7 I recommend the following: Species of each of the different kinds of larvæ should be put on to uninfected cones on convenient trees where they can be constantly watched—one on each cone, a description of the larva in each case being first made. Each cone should be then tied up in a muslin bag until about the end of July. It should then be cut off and placed in a small wooden box with a layer of moist earth at the bottom of it and the moth bred out. In this way it should be possible to definitely ascertain not only which are the larvæ belonging respectively to *E. cedrella* and *P. abietella*, and whether they have any other companions, but also which is the greater pest of the two.

MACALLA MONCUSALIS,[1]

WLK.

References :—Wlk. Cat. xvi, p. 252; C. & S. no. 2942. Allata penicillata, Wlk. Cat. xxvii, p. 111; C. & S. no. 4640. Orthaga obscura, Moore, Lep. Atk., p. 201; C. & S. no. 4490. Pseudolacastra inimica, Snell, Trans. Ent. Soc. 1890, p. 566 (nec. Butl.) Hmpsn. Faun. Br. Ind. Moths, IV, 113, no. 4440.

Classification :—Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family, Pyralidæ.

Description.

The *larva* is said to be small, of a dull cream colour and more or less transparent, much resembling that of *Tetridia caletoralis*, but smaller. A cocoon of loose white silk is spun by the larva before it changes to the pupal state.

The *moth* is small dark fuscous in colour and with up-turned palpi. Fore wing with apex rectangular and with traces of dentate antemedial line angled in the cell; the fan of scales in end of cell grey; a black discocellular speck; an obscure dentate postmedial line highly angled at vein 4 and with diffused grey on its outer edge. Underside of hind wing with traces of discocellular lunule and minutely dentate postmedial line excurved from vein 6 to 2, ♀ paler and more olive-green. Expanse of wings ♂ 26, ♀ 26-32 millim.

Localities from which reported.

Hampson gives the reported range of this insect as Sikkim, Bhutan, Nagas, and Manipur. The sál forests in the Ganjam District, Madras, are now added to the above.

Life History.

The larvæ are full fed in the latter part of June. In the case of specimens kept in a box, the larvæ spun a cocoon of

[1] This insect and the Pyralid moth *Tetridia caletoralis*, Wlk., were sent to me from the Ganjam District, Madras, by Mr. C. E. C. Fischer, Deputy Conservator of Forests. The notes on the life history, etc., of the species are from his pen. The identifications were kindly made by Sir George Hampson, *Bart.*

silk to the sides of the box and pupated in this. It is probable that this cocoon is spun on the leaves or twigs of the food plant in the forest. The insect spent 15 days in the pupal condition, a larva which changed into this state on 24th June issuing as a moth on July 8th.

The time spent in the larval stage and the number of generations of the moth in the year have yet to be ascertained.

Relations to the Forest.

These larvæ were found in company with those of the Pyralid moth *Tetridia caletoralis* defoliating young sál saplings from 3 to 5 feet high in the Kriamba Reserve of the Ganjam District in Madras. The damage done, as far as it has at present been observed, has not been heavy.

Protection and Remedies.

In nurseries and plantations larvæ of this description when they become numerous, and therefore dangerous, are best treated by spraying the young plants with the arsenical compound Paris green. The method of doing this has been described elsewhere. Dusting the plants over with a mixture of Paris green, unslaked lime, and ashes, as described for the locust *Tryxalis nasuta*, might be tried as an alternative method.

Points in the Life History requiring further observation—

1. Where the eggs are laid.
2. Length of time passed in the larval stage by the June caterpillars.
3. What becomes of the July moths ?
4. The number of generations in the year.
5. What becomes of the insect in the winter ?
6. Does it feed on old as well as young trees ?

TETRIDIA CALETORALIS,

WLK.

References :—Wlk. Cat. xviii, p. 651; C. & S. no. 4233. Botys vinacealis, Moore, P. Z. S. 1877, p. 619; C. & S. no. 4236. Polythlipta albieandalis, Snell. Tijd. v. Ent. xxiii, p. 221, nnd xxvi, pl. 8, figs. 7, 7a, b, c. Hmpsn. Faun. Br. Ind. Moths IV, 395, no. 5138.

Classification :—Order, **LEPIDOPTERA.** Sub-Order, HEEROCERA Family, Pyralidæ.

Description.

The *larvæ* are described as being of a dirty dull cream colour more or less transparent. Length 1 to $1\frac{1}{8}$ inches. It has been noticed that before changing into the pupal stage they become light claret coloured. The caterpillar spins together a portion of a leaf with silk, forming a rough cocoon before changing into the pupal state.

The *pupa* is ochreous brown, shining, and just under $\frac{3}{4}$ inch in length.

A small *moth* red-brown in colour with a vinous tinge; antennæ of male minutely ciliated and considerably longer than fore wing, those of female about same length as fore wing; palpi porrect triangularly scaled and white below; fore tibiæ and tarsi marked with white; mid tibiæ and tarsi white; the tibial fringe of hair fulvous; abdomen with a white streak on anal tuft. Fore wing with waved antemedial black line; a waved discocellular line; both wings with a minutely crenulated postmedial line, nearly straight from costa to vein 3, then retracted to below end of cell, and on hind wing terminating at anal angle; a marginal series of black specks. ♀ pale ochreous, rufous. Fore wing with the costa tinged with fuscous; the margin and cilia of both wings fuscous; the legs not marked with white. Expanse of wings 34 millim. See Pl. v, fig. 6 *a, b*.

Localities from which reported.

Hampson gives the range as Sikkim, Khasis, Sibsagar, Ceylon, Burma, Andamans, Borneo, Celebes. Ganjam District, Madras, is now here added.

Life History.[1]

The larvæ are full fed at the end of the third week in June and pupate by spinning themselves up in a portion of a leaf of the food plant by means of a white silk. Within the covering they turn into pupæ. About 15 days is spent in this stage, larvæ which pupated on 23rd June issuing as moths on the 7th July. This is at present all that has been reported on the life history. We still require to know the length of time the June larvæ spend feeding and the number of generations of the insect there are in the year.

Relations to the Forest.

The larvæ of this insect defoliate the sál (*Shorea robusta*) in Madras. They were found feeding on sál seedlings from 3 to 5 feet high in the Kriamba Reserve of the Ganjam District. The damage done, as at present observed, has not been very heavy. It is found feeding in company with *Macalla moncusalis*, Wlk.

Points in the life history requiring further observations :—

1. Where are the eggs laid? Is it on the branches of the sál trees?
2. Length of time passed in the larval stage by the June caterpillars.
3. What becomes of the July moths?
4. The number of generations in the year.
5. What becomes of the insect in the winter?
6. Does it feed on old as well as young trees?

[1] The notes on the life history of this insect, together with specimens, were sent to me by Mr. C. Fischer, Deputy Conservator of Forests, Ganjam District, Madras.

CRYPTOPHLEBIA CARPOPHAGA,

WLSM.

Reference :—Wlsm. Indian Mus. Not. iv. 3, 106.
Classification :—Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family, Tortricidæ. Sub-Family, Olethrentinæ.

Description.

The *larva* is about five-eighths of an inch in length, but though it has been figured, no description of it as yet appears to have been made.[1] See Pl. V, fig. 7, *a.*

Moth.—Antennæ pale tawny. Palpi tawny, paler on their inner sides, shaded with fuscous externally. Head tawny, shaded with reddish fuscous above. Thorax blackish. Fore wings tawny with a blackish patch towards the centre of their lower surfaces and a small crescent-shaped mark on the outside of these. Outer edges also blackish. Hind wings brownish fuscous. Abdomen greyish with a slight ochreous tinge, a black tuft above the anal segments. Hind legs bone-grey with the tufts on the tibiæ strongly irridescent dark purplish on the upper sides.

In the ♀ the tufts of hair present, in the ♂ are absent. In the hind wings little sign of the pouch-like fold in the neighbourhood of the abdominal margin can be seen. The fore wings are reddish-tawny. It will probably be found that there is some variation in the ground colour of these moths. Expanse of wings ♂ 18 millim, ♀ 17 millim. Pl. V, fig. 7, shows, *b,* the pupal case protruding from the bean and *c, d,* the ♂ and ♀ moths.

Life History.

Little is known about this insect. The larvæ were found in the cold weather feeding in pods of *Cassia Fistula, L.* and *C. occidentalis, L.* They changed into the pupal state inside the pods.

[1] This moth was bred from *C.* Fistula pods in the Museum in Calcutta in 1894, and from *C. occidentalis* pods also from Calcutta in 1895. The insect was named by Lord Walsingham, both genus and species proving new to science.

These pupæ appear to cut their way through the skin of the dry and ripe pod and protrude half their length or more from the pod before the moth bursts the skin and escapes. Moths issued at the beginning of January, and it is probable that the dates on which they issue in different parts of the country depend to a certain extent on the time of flowering and fruiting of the trees it attacks. Its life history is likely to be somewhat similar to that of *Trachylepidea fructicasiella*, which also attacks the pods of *C. Fistula*.

Points in the life history requiring further observation:—

1. When the eggs are laid.
2. How long the larva spends tunnelling in the pods?
3. What becomes of the January moths?
4. The number of generations in the year.

YPSOLOPHUS SP.

Reference:—Provisionally determined as such by Mr. M. Durrant.

Classification:—Order, LEPIDOPTERA. Sub-Order, HETEROCERA, Family, Plutellidæ. Sub-family, Gelechinæ.

Description.

Larva.—When full grown the larvæ are about half an inch in length, pale lemon yellow in colour and translucent. Head light brown. Body tapers towards posterior segments, the last two of latter having a dark coloured spot on their dorsal surface. A dorsal median brown line runs down the 8 anterior segments of the body. The colouring is the same in the young larvæ, but the head is black and well developed, standing out on either side of the body, which is not the case in the full grown one where it is of the same width as the body.

Pupa.—Anterior end black, abdominal segments yellowish-brown. Length slightly under half an inch. The pupa is contained within a loose net-work of fine silk which the larva spins across the inside of a leaf before changing to the pupal state.

Moth.—Small, with narrow wings. Fore wings a pale yellowish-brown, fringed on their outer extremities. Under wings grey, their lower edges heavily fringed, a buff-coloured line running between the outer edge of wing and the fringe. Antennæ filiform.

Plate III, fig. 4, shows the larva, pupa (which is attached to the centre of a Sissu leaf), and moth of this small pest.

Life History.

The larvæ were found defoliating Sissu leaves on the 18th April and were then of all sizes, some being about full grown. My attention was drawn to the attack by the fact that the lower branches of the large Sissu trees were festooned with long thin strands of silky web which had caught and enclosed masses of the dead flowers of the tree. The ends of the whippy branches were often entirely enclosed by this silk, and the leaves were then either partially or entirely defoliated. An examination of some of these branches showed numbers of small larvæ feeding upon the leaves. In some cases, the larvæ were full fed and were then to be found in twos and threes, either between two leaves bound together by silk threads or amongst the dead and shrivelled up calyces of the inflorescences which were interwoven into the silken meshes. The larvæ are partially gregarious since they bind up two or three leaves together, fastening them so as to form a small tent, the upper surfaces of the leaves being outermost. Within this small shelter several larvæ may be found living and feeding together. They usually eat the underside of the leaf leaving the upper epidermis intact; this shrivels up into a brown, wrinkled, papery substance which remains bound up in the webs. When the larvæ have finished the leaf tissue within their small tent, they vacate it and proceed to fresh leaves. In the course of these wanderings enormous quantities of silk are spun by the grubs, festooning the trees more especially in the lower halves of their crowns, though at times the silk could be seen covering the summits of the trees as well. The Bari Doab Canal, which runs through the Changa Manga plantation, presented a remarkable sight. Great silken streamers, 20 to 30 feet in length, hung across the canal from the branches of the trees on either side. The ends of the branches themselves were woven up in a (in many cases) complete net of silken strands which entirely enveloped all the branchlets and leaves. Garlands went from branch to branch, and tree was festooned to tree along the banks in a remarkable manner. The almost horizontal rays of a setting sun gave the scene a most bizarre effect and showed, as no other play of light could have done, the seriousness of the attack. When the smallness of the caterpillar is taken into consideration it becomes evident that millions and millions must have been present to have produced this enormous amount of silk.

The larvæ change into the pupal state about the end of April, spinning a flimsy silken net-work across the inside of a leaf or two thereby drawing the edges together. Within this they change into the pupa. The pupal stage lasts about ten days, moths of larvæ taken to Dehra Dun issuing about the 13th May.

This much of the life history has been studied up to the present. It is almost certain that there will be at least one more generation, if not several, of the insect during the remainder of the year since the first generation is completed by the middle of May, and this point requires further careful observation.

Locality from which the insect has been reported.

This insect was found by the writer seriously defoliating the Sissu (*Dalbergia Sissoo*) in the Changa Manga plantation near Lahore in April 1901.

Relations to the Forest.

The damage is done by the caterpillars who completely or partially defoliate the Sissu trees. They appear to prefer the older, or it would be more correct to say, the taller trees, and were by no means numerous in small coppice. They eat the whole of the leaf, or the greater portion of it, leaving generally intact the upper epidermis. The Sissu was the chief tree attacked, though here and there I saw the webs and found the larvæ on the mulberry and the *Acacia modesta*. The attack had by no means ended when I left the plantation, but even then I estimated that 50 per cent., and probably more, of the trees were suffering from the caterpillar. Compartments here and there had, however, entirely escaped up to the date of my departure. I first noticed and examined it in compartments 72 and 73. Amongst other it was also more or less severe in compartments 1 and 8 in Block I, 9, 51, 52, 54, 86, 87, 89, and 90.

Protection and Remedies.

Until more has been ascertained about its life history it cannot be said with any certainty that a feasible remedy is possible. It should, however, be remembered that such attacks always take place on a larger scale in pure forest than in a mixed one, as the caterpillars have no difficulty in the former of obtaining as much food as they require, and a judicious mixture of the Sissu and mulberry would no doubt have the effect of checking this pest. I have said above that here and there the webs were to be seen on mulberry trees interspersed amongst the Sissu, but in no case did my observations show me that the mulberry leaves were being eaten. It is not improbable that the mulberry was merely used as a stepping-stone from one Sissu to the next.

Points in the life history requiring further observation :—

1. In what stage, egg, larva, pupa, or moth does the insect pass through the winter?
2. The duration of the first generation of the larva. The time when they first appear on the leaves should be ascertained.
3. What happens to the moths which appear early in May? Where and when do they lay eggs, and when do the eggs hatch out? If in May or commencement of June, the length of time passed in the different stages of the subsequent generations requires watching.
4. Number of generations passed through in the year.

OCHROPHARA MONTANA,[1]

DISTANT.

Reference :—Trans. Ent. Soc. Lond., pt. I, pp. 165, 166 (1900).

Classification :—Order, **HEMIPTERA**. Family, Pentatomidæ.

Description.

Adult insect. Ochraceous, somewhat thickly and darkly punctate ; lateral margins of the corium, apex of the scutellum and a faint central fascia to same, body beneath, legs, rostrum, and antennæ pale ochraceous; fourth and fifth joints of antennæ reddish-ochraceous.

Body elongate: second joint of antennæ shorter than the third, third and fifth subequal in length, fourth a little longest. Lateral lobes of the head coarsely punctate, central lobe more sparingly punctate, a space before the eyes and at base, smooth. Pronotum coarsely but sparingly punctate, with a narrow central polished impression, posterior angles obtusely sub-prominent. Scutellum with a small slightly raised smooth callosity near each basal angle; basal area somewhat transversely wrinkled. Membrane pale greyish. Length. 12-13 millim.

The species is of the most extraordinary variability, not only as regards markings, which are not abnormal, but exhibiting a plastic mobility in structure which is very unusual.

Pl. I, fig. 6, shows, *a*, young wingless larva ; *b*, winged adult of this insect.

Life History.

This insect does damage in both the larval and imago stages of its life. The present information on its life history is, however, very meagre. It is reported to have appeared in enormous numbers over a portion of the Central Provinces at the

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[1] Specimens of this insect with all that is at present known of its life history were sent me by Mr. A. E. Lowrie, Deputy Conservator of Forests, in charge of the Chanda Division of the Central Provinces. At the time the insects were swarming in enormous numbers and destroying the crop of seed of the bamboo, *Dendrocalamus strictus*.

beginning of January 1900, and fed voraciously from the middle of the month right on through February into March. Specimens I received, taken about the second week in March, consisted of both larvæ and imagos of the pest, but I am unable to state whether both stages were present in January and February. Heavy rain during the latter part of February was said to have killed off the greater number of the insects, but a few were still to be found in the third week in March.

This appears to be all that is at present known of the life history of this pest, which was described for the first time in 1900.

Areas from which reported.

Distant in his description of the insect in the Transactions of the Entomological Society of London gives its habitat as the Naga Hills, Tavoy, and Karen Hills. To these must be now added the Central Provinces.

Relations to the Forest.

This insect proved itself to be a most serious pest during the cold weather of 1901. There was a very general flowering of the bamboo, *Dendrocalamus strictus*, during this period throughout the Chanda district (it is said owing to the drought experienced during the year), over an area of some 1,200 square miles. Just before the seed began to ripen this bug appeared on the bamboos, swarming over every clump, and commenced sucking up the sap of the young newly forming seeds. Four to six weeks were occupied in this way, with the result that the entire crop of seed was ruined over this area. Having finished off the bamboo seed, the insects were said to have descended on to the *Jawari* crop then ripening in the fields and to have done damage to that.

Protection and Remedies.

It is not possible to prescribe remedies for this pest until we know something more about its life history.

Points in the life history requiring further observation:—

1. Where and when the eggs are laid and length of time spent in this stage?

2. Date on which the young larvæ first make their appearance and the plants they feed upon.
3. Length of time spent in the larval stage.
4. Dates of appearance of imagos and length of time spent in this stage.
5. The number of generations in the year. If more than one, the length of time spent in each.

CERATOPACHYS VARIABILIS,[1]

DALLAS.

Reference :—Dallas, Cat. Hemip. Ins. Brit. Mus., Pts. I & II, p. 502.

Classification :—Order, **HEMIPTERA.** Family, **Coreidæ.**

Description.

The eggs of this insect when first laid are of a brilliant green colour which later on turns to reddish green. The imago varies in colouring. The following three varieties are described :—

Var. α, ♂. Head, thorax, and body beneath pale green. Eyes and ocelli red. Thorax thickly and finely punctured with the posterior margin reddish. Coriaceous portion of the elytra thickly punctured, red, with the outer margin green, a narrow fulvous line on the apical margin, and a small yellow spot in the inner apical angle; membrane blackish brown. Margins of the abdomen pale green, with indistinct blackish bands at the posterior margins of some of the segments. Thighs greenish, with the apex brown; tibiæ and tarsi brown. Rostrum greenish, with the tip black. Antennæ black, with the second and third joints pale green at the base; third joint much dilated at the apex.

Var. β, ♀. Head, thorax, and body beneath orange. Head reddish in front. Thorax with the lateral margins and a broad band across the posterior margin red. Scutellum yellow, tinged with green. Coriaceous portion of the elytra thickly and finely punctured, greenish testaceous, with the basal portion of the outer margin yellow, and a broad red band running along the whole inner and apical margin; inner apical angle with a yellow spot. Margins of the abdomen very indistinctly marked with red at the posterior margins of some of the seg-

[1] The notes on the life history of this insect are from observations made by Munshi Fazl Din, Khan Bahadur, Extra-Assistant Conservator of Forests, in charge of the Montgomery Division, forwarded to me by Mr. C. F. Elliott, late Conservator of Forests, Punjab.

ments. Breast greenish. Basal portion of the thighs fulvous. Base of the second and third joints of the antennæ pale yellow. In other respects like var. α.

Var. γ. Head red. Thorax and under-side of the body as in the preceding. Scutellum deep orange. Coriaceous portion of the elytra pale olive, thickly and finely punctured with black with the nervures blackish; the basal portion of the outer margin and a spot in the inner apical angle yellow. Margins of the abdomen reddish, with a black band at the posterior margin of each segment. Thighs orange, with the apex pitchy; tibiæ and tarsi pitchy black. Rostrum orange, with the apical joint brown. Antennæ as in var. β.

Pl. I, fig. 5 shows a dorsal and side view of this insect.

Life History.

Early in February the young larvæ of this pest make their appearance and commence to feed by sucking the juices of the host plant. By the middle of March they are full grown and coupling takes place. It has not yet been recorded when the eggs from these females are laid, nor how many generations of the insect there are between these March imagos and those which are to be found in November. It is stated, however, that both larvæ and imagos are to be found attacking coppice shoots throughout the year with the exception of a couple of months in the cold weather. There is likely to be therefore more than one generation of the pest between the March and November fully-developed bugs. On the 6th November insects were found coupling, and on the 13th of the month eggs were laid; each ♀ laid from 6 to 10, and these hatched out on the 25th. Unfortunatly they all died on the 7th December, the parents having died off soon after the young had hatched out. The eggs are laid deep down in the hollows of the coppice stumps, in crevices of bark, etc., the dead bodies of the ♀ insects being found in these positions after egg-laying is over. Observation has shown that the young ones hatched out in November spend the two winter months hidden away in hollows in the coppice stools of the host plant or attach themselves to the roots or hide under bark, pieces of waste wood, etc, lying about on the ground. They are also to be found hibernating in the thicker coppice bushes. They commence feeding again in February and become fully developed in March.

The length of time spent in the larval stages, after hatching out from the egg, to the time when the insect becomes fully developed is said to be as follows :—

Time spent as a wingless larva	two weeks.
Do. do, with rudiments of wings . .	,, ,,
Wings developing from rudiments to fully developed	three ,,

The insect now flies well and coupling takes place. When in this condition the tips of the abdomen are joined together and the insects only crawl about and do not fly even if frightened. The coupling season is said to last six weeks. Thus seven weeks are spent as a larva and about three in the imago stage, that is, if the summer generations of the imagos die off within a fortnight of laying their eggs as is the case with the November one. This would give 10 weeks for one generation with the exception of the November one, which takes about 14 weeks since the insects hibernate for a portion of the winter.

The pest is said to become scarce during the rainy season if heavy rain occurs.

Areas from which reported.

The insect has been reported from the Montgomery division in the Punjab as damaging coppice shoots.

Specimens in the British Museum (Capt. Boy's collection) are labelled as collected in North-West India.

Relations to the Forest.

This insect has appeared in large numbers on Jhand (*Prosopis spicigera*) coppice in the Montgomery division. It attacks the shoots in all its stages, sucking up the juices of the plants and only ceases its depredations for about a couple of months—December and January—in the cold weather. The insects prefer the tips of the young new shoots and commence work in February on the young shoots arising from stools felled over in the previous December. The insect sucks the sap and the leaves become colourless and dry and fall, and the ends of the shoots turn mud-coloured and die back. The coppice growth is thus retarded a year. The damage done in two-year old coppice is said to be inconsiderable.

Protection and Remedies.

According to present observations the insect apparently passes the winter in the larval stage hidden away in the stumps or roots of the stools. An experiment might be made of washing some of them over with a kerosene emulsion solution two or three times during December and January, taking care that the solution reaches the insects. This, if done carefully, should be sufficient to kill off the larvæ. The solution is made as follows :—

Violently churn together two parts of kerosene oil, the purer the better, with one part of milk, or better, soap solution. The soap solution is made by boiling about a pound of common yellow soap with a gallon of water and then mixing with the kerosene until a thick cream is produced. Add about 12 parts of water and spray on to the stools. An ordinary watering can might be used in the trial attempts. The stools should not be soaked : only the amount of the solution necessary to reach the insects should be sprayed on.

Points in the life history requiring further observation :—

1. Number of generations passed through during the year and length of time spent in passing through each generation.
2. The insects are said to hibernate at the roots in the winter. Are they to be found on the roots at any other period of the year?
3. Do the insects confine themselves to the one year old coppice throughout the year?
4. What other trees, shoots, etc., are attacked by the pest?

PSYLLA OBSOLETA,
BUCKTON.

Reference :—Ind Mus. Notes V. 2. 35, 36.

Classification :—Order, HEMIPTERA. Family, Psyllidæ.

Description.

Antennæ filiform obscurely ten-jointed, basal joint large. Apex with two minute bristles. Thorax robust with two small spines underneath. Ferruginous in colour above, shining black below. Abdomen similarly coloured and having rings with pale edges. Forewings veined, transparent, and placed in a roof-shaped manner over the body when at rest; they are much longer than body. Hind wings obsolete or represented by mere membranous flaps. Pl. VI, fig. 5, shows, a, the winged insect, and b, gall formed by larva on leaf.

Life History.[1]

This insect forms small galls on the leaves of a forest tree. These galls are yellowish-red, rough, and have the appearance of the galls known as oak spangles which are to be found on oak leaves in England. The galls are apparently ripe, *i.e.*, the insects in them are mature and quit their abode in January and February. Although the insects were abroad under the trees at the time the samples of galls were taken and sent to Mr. Buckton for identification, none of them were perforated and the method by which the insect leaves the gall has still to be observed. When first emerging from the pupæ the insects are uniformly pale coloured. The colours darken afterwards.

Relations to the Forest.

So far as at present observed, the damage done appears to be entirely to the younger plants of *Diospyros melanoxylon.*

[1] This insect was discovered on the leaves of the *Diospyros melanoxylon* tree in the Shahapur taluka of the South Thana Forest Division by Mr. G. M. Ryan, Deputy Conservator of Forests, and sent to Mr. Buckton, F.R.S., for identification.

The leaves of young plants of some 6-7 years old and 3-4 feet high are attacked, the young larvæ sucking the tissues and by the irritation thus produced a gall growth arises on the leaf. After the insects have deserted the galls, the latter disappear, leaving holes all over the leaf. Mr. Ryan states that he has seen the leaves of larger trees, 8 to 10 feet high, attacked in this manner, but the damage done, so far as at present observed, would appear to be slight.

This is all that is at present known of this Psyllid. Its life history during the rest of the year has yet to be studied. The eggs are presumably laid on the young leaves or in the angle of a bud, and the time when the young larvæ first appear on the leaves and the length of time they spend sucking their juices requires to be noted upon.

ALEURODES EUGENIÆ,

MASKELL.

Reference :—Ind. Mus. Notes IV, 2, 52.

Classification :—Order, HEMIPTERA. Family, Aleurodidæ.

Description.

The *larva* is elliptical, very slightly convex dorsally, flat beneath: colour dull white ; length about 1 millim. $=\frac{1}{25}$ inch.

A faint indication of the enclosed insect may be made out beneath the wax with which it is surrounded, but in this stage it is not conspicuous.

Pupa elliptical, slightly convex dorsally, flat beneath : colour of waxy covering very pale, dull yellow ; the enclosed insect is dark brown, and its outline may be made out beneath the wax ; length of test about $\frac{1}{20}$ inch. Dorsally, the test is very finely striated, the striations being most distinct near the margin. There is no marginal fringe. On turning over the test, the rudimentary feet may be clearly seen, folded inwards, and the antennæ much more faintly : the abdomen tapers posteriorly to the usual vase-shaped orifice which is common to the genus. Pl. VI, fig. 6, shows a ventral view of the pupa of this insect.

The adult form is as yet unknown. It is likely to be a small white fly, the wings of which will be more or less floury and possibly slightly spotted.

Life History, etc.

Little appears to be known concerning the life history of this small insect which, until discovered by Mr. Marshall Woodrow in Poona, was unknown to science.

The insect infests *Eugenia jambolana* trees in Poona and is said to very considerably injure them. Both larvæ and pupæ are to be found in February on the trees.

The adult insect and the subsequent life history of this small pest during the rest of the year require further careful observation.

FIORINIA THEÆ,

GREEN.

Reference:—Ind. Mus. Notes V. 1, 3-4. Pl. I, 4-8.

Classification:—Order, **HEMIPTERA**. Family, Coccidæ.

Description.

The pale yellow eggs are deposited in two rows within the hinder part of the female scale, the ♀ insect shrinking up after oviposition and occupying the anterior extremity only.

♀. The adult ♀ is pale yellow and is blunt elliptical in shape.

The antennæ are close together, on the anterior margin; each antennæ consists of an irregular tubercle with a single curved bristle on one side. From between the antennæ springs a proboscis-like projection which is not chitinous but of the same consistency as the surrounding parts of the body. The margin of the thorax and abdomen has a series of minute spinneret ducts opening on to small conical tubercles. The scale of the female completely encloses the adult insect and is without any secretionary margin. It is elongate and narrow in shape with a moderately distinct median ridge. Colour bright castaneous to dark ferruginous brown, the median longitudinal area darkest: opaque; not revealing the form of the insect beneath. Length 1·25 to 1·50 millim. Breadth 0·50 millim. The insects found by the writer when alive were covered with white filamentous hairy matter, the stems and leaves of the host plant appearing to be covered with a white fluffy wool. Neither the male scale nor the adult male have yet been discovered.

Pl. VI, fig. 7, shows a, portion of a leaf with insects *in situ* b, scale of adult ♀ and c, ventral surface of adult ♀.

Life History.

The writer found this scale insect on the Olive (*Olea glandulifera*) at the end of June in the Bashahr State close to Kilba in the Sutlej Valley. The ♀ insects were thickly clustered on both the under and upper sides of the leaves being more numerous on the former. They were also gathered thickly on the stems, especially at the juncture of the leaves with the stem. The coccids had their probosces firmly fixed in the tissue of the leaves and stems and were engaged in sucking up the sap.

As a result of the attack, the leaves and stems of the Olive trees turned yellow, the former dropping off.

This insect was first discovered [1] in 1899 by Dr. George Watt on tea bushes in the Kangra Valley and Assam. It will be most interesting to find out what trees it attacks in the latter Province in addition to the tea plant and also its complete life history throughout the year.

[1] The insect was determined as a species new to Science by Mr. E. E. Green, Government Entomologist, Ceylon. Mr. Green very kindly identified my species for me as identical with Dr. Watt's.

MONOPHLEBUS STEBBINGII,[1]

GREEN.

Reference :—Green in litt.

Classification :—Order, HEMIPTERA. Family, Coccidæ, Sub-Family, Monophlebinæ

Description.

When this insect first appears on the leaves of the host plant, probably soon after leaving the egg, it is a minute little coccid covered with white woolly hair. Soon afterwards as it increases a little in size, the larva loses this hair and is yellow in colour, changing to a yellow-brown. At this stage it is sti l less than one-sixteenth of an inch in size. A fortnight later the brown colouring becomes more pronounced, the scale being then about $\frac{1}{12}$th of an inch long, elliptical in shape, convex on dorsal surface, and flat beneath, with three pairs of black legs, black antennæ, and a longish black proboscis. After a further period of fifteen days has elapsed the larvæ are about $\frac{1}{8}$th inch in length, dark brown on the dorsal surface, changing to orange yellow or pale canary yellow in the older specimens ; ventral surface canary yellow ; legs, antennæ, and proboscis black. This colouring remains much the same till the insect reaches maturity, but the whole of the upper surface becomes, when the scale is about a third of its full size, covered with a white powdery mealy scurf. This larva is the female one only. Both sexes are full grown and mature in April.

Wingless ♀. In general appearance the full grown ♀ is a thick, fleshy, white insect with three pairs of black legs, a pair of

[1] The observations and notes given here are mostly my own, but in many cases they are corroborated by those of Messrs. Oliver and Milward, who have watched this insect for the last two and three years, respectively, and by planters in the district who have known the insect locally for some years.

I am indebted to Mr. Oliver for drawing my attention to the insect in the first instance on my arrival in the Dun early in 1901.

black antennæ, inserted ventrally and not dorsally, and a black proboscis tucked away on the under surface of the body. Elliptical in shape, being convex on the dorsal surface, and consisting of twelve segments in all. When rubbed, so as to remove some of the powdery material which gives the scale its white appearance, the body is seen to be dark yellow to light reddish-brown in colour. As seen on a dorsal view a white filamentous edging runs round the contour of the insect when alive and unrubbed. Size when fully grown is ⅝ inch long and ½ inch or a little less in greatest breadth. The ♀ is apparently sexually perfect before it attains its full size, a few amongst those noticed pairing being only about ½ inch in length and dark brown to brownish-red in colour with no white powdery mantle over them. Pl. I, fig. 7, shows the wingless female insect.

Winged ♂. A small insect with one pair of black wings. Antennæ long, consisting of from 19—20 joints, black with the joints swollen in the middle and a single circular row of longish, stiff, bristly hairs arising from the thickest portion of the joint. The antennæ, as ordinarily seen on the insect in life, appear to be white and feathered; this is simply due to the fact that the hairs become covered with the white powdery substance with which the dorsal surface of the wingless ♀ is covered. The body is red and flattened and terminates in three abdominal appendages on either side of the posterior end. The male has no mouth parts. It is very active and flies about freely. Length ⅛th inch. Wing expanse ½ inch. Pl. I, fig. 8, shows the male insect of *Monophlebus dalbergiæ* to which that of *M. Stebbingii* is very similar.

Life History.

The young ♀ larvæ are to be found early in January on the leaves of the sál and in dry years, such as the present (1902), they doubtless first appear in November or December. They are usually clustered on the midrib both on the upper and underside of the leaves, but more usually the latter, their probosces being buried in the tissue of the rib. Soon after losing the white hair, with which they apparently start life, the little scales undergo their first moult and the little whitish papery cast skins can be found stuck to the leaves by the copious sugary secretion excreted by these insects. The female larva appears to spend from six to eight weeks feeding in this position and then descends to the young twigs. Soon after this change in position is made a further cast of skin takes place. When moulting, or shedding its skin, the latter is ruptured at the anterior end of the insect at a horizontal line of cleavage just above the insertion of the antennæ extending to the first segment of the thorax on either side. At the same time the skin ruptures from a central point in this horizontal line of cleavage down to the end of the thoracic segments on the dorsal surface and to the coxæ of the first pair of legs on the ventral surface. The insect then slowly crawls out of the old skin. Consequently on the underside of the discarded skin the black empty leg and antennal cases are to be found.

On the twigs the insects, when numerous, collect in clusters and thickly cover the young thin-barked portions ; they also descend lower down and gather in knots at wounds or cracks in the thicker bark below. The insects are about ⅛th of an inch in size when they first descend to the twigs. From now onwards their growth becomes more rapid, at least one more casting of the skin taking place, until they mature towards the end of March or middle of April. When mature, twigs and branches may be seen with 6—9 inches of their length covered with white clusters of these insects, looking as if encrusted with snow, the scales lying one on top of another, often tipped up at an angle and resting on a companion below : each has its proboscis firmly fixed in the bark and is occupied in sucking up the juices. During their whole life they are very active and march about a great deal over the tree, and they excrete during the whole of this period copious amounts of a sugary secretion. This covers the leaves and twigs, clogs up the stomata, and runs down the branches, dripping down on to the ground below in enormous quantities when the insects are plentiful. The male larva has not yet been discovered, but the ♂ imago appears on the wing in April, perhaps earlier in dry years. It is not so plentiful as the female and fertilizes more than one of these latter. It is an active little insect, flying about over the serried masses of females or walking over the backs of the thick clusters. Pairing continues for about three weeks. The method of operation is as follows. The insect flies up to a female and alights on her back and then forces itself under her between her ventral surface and the twig on which she is sitting, turning on its back in doing so. It then pushes its anal appendages into the anal ventral opening in the female. When attached to her its head is usually facing in the opposite direction to which she is sitting.

After fertilization the ♀ scales apparently cease feeding and march down the tree to search for convenient places to deposit their eggs. Towards the end of April, in badly infested areas, large numbers of the insects may be seen marching about in this way. The eggs have not yet been found, but I am of opinion that they are laid in the crowns of the trees and the perambulations of the fertilized females are probably undertaken with the object of finding unattacked trees or branches on which to lay them. Where they are very numerous the crowns of the trees are so thickly covered with the sugary secretion that it is unlikely they would choose such positions for egg-laying.[1]

The insects disappear about the end of May, in dry years at the beginning of this month.[2] A few are still to be found in June, and even in August and September a very few full-sized ♀ scales have been found, but these are in all probability unfertilized females which had managed to linger on.

Areas from which reported.

The at present known habitat of this insect is the drier portions of the sál forests on the Siwalik Range of Hills running from the Ganges on the east to the Kalesar forest, situated on

[1] I have recently (May 1902) obtained eggs from fertilized females kept under observation. They are apparently very often laid under the rough bark of the sál trees.

[2] The dates of first appearance of the young larvæ, and consequently of the culminating point of the attack when the insects are mature, depend on the climatic conditions to which the insects are exposed. The winter of 1901-1902 has been exceptionally mild, and the scales are at least a month more forward in their development than they were at the corresponding period of 1900-1901.

the western bank of the Jumna river, on the west. No reports[1] of its presence have yet been made from the Ganges Division to the east of the Ganges River.

Mr. Milward gives the following distribution for the forests of the Dehra Dun Division situated on the northern slopes of the Siwaliks :—

"The areas in the Dun Government forests which are subject to the severest attacks are those in the dry Western Dun. In each of the three years 1899—1901 in which it has been noticed it has been particularly active on the Siwalik's side in compartments 9 and 10 of the Jumna Range, but it has also been found in large numbers also between the Saharanpur-Chakrata road and Malhan village. It was in enormous numbers in Dholkot forest in 1900 and in the same forest chiefly at the Selakni end of it in 1901. It was also in large numbers in parts of Chandpur and Ambari forests in the latter year. In the damper Eastern Dun forests it has not been seen as a pest in the last three years, but in small numbers in the Ganges Range in 1899 and 1901. It has never been seen in the Tirsal Range."

The young scales were found in enormous numbers in January of the present year (1902) in the Lakarkot forest on the southern slope of the Siwaliks, the undergrowth being thickly coated with their sugary excretion.

Relations to the Forest.

The published knowledge of the life histories and methods of attack of monophlebids[2] in Indian forests is very meagre and the present one is therefore of some interest and importance. As far as observations have yet been carried, the insect's attacks would appear to be most prejudicial to the growth of the trees, both young and old. The female scale is the chief aggressor, the mature male not feeding at all. The damage

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[1] Whilst this note was in the press, the presence of this insect was reported in forests east of the Ganges by Mr. Dickinson, Conservator of the Circle.

[2] Mr. E. E. Green, Government Entomologist, Ceylon, an authority on Coccidæ, very kindly named this insect for me. Up to the date of my sending him specimens of the ♀ and ♂ insects there were but five species of the genus Monophlebus recorded from the Indian region, and of these four were described from the male insects only, the females being still unknown. To this number the writer has been able to add three new species during the past year.

arising is due to the heavy loss of sap experienced by the tree when the insects are in very large numbers. This damage arises in two ways, firstly, by the clogging up of the stomata and pores of the tree with the sugary excretion which envelops leaves, twigs, etc., with a film making them look as if they had been varnished. This is more serious in dry years when no rain falls to wash it off. Secondly, the twigs and branches dry up from the effect of the constant tapping. The crowns of large trees thus become thin and straggling under repeated attacks, whilst young saplings have a crooked method of growth, the younger ones not improbably dying down under constant repetition of the treatment. As the attack culminates in the spring when the trees are putting forth new leaves and flowers, serious injury is done to these. The development of the former is stopped and they shrivel up and wither on the smaller twigs. Information with regard to the flowers is not yet available; experiments are being carried out with seed in order to ascertain whether its vitality is impaired.

The insect prefers the crowns of the trees of the high forest, where it occasionally multiplies and congregates in enormous numbers; it is, however, to be found on small trees and saplings as well, collecting on the smaller branches and twigs or clustered for some inches up the leading shoots.

Mr. E. M. Coventry in reporting insects, which I identified as *M. Stebbingii*, from Kalesar forest at the end of April 1901, confirmed these observations relative to young growth. He wrote:—

"They are seen crawling up the trunks of large trees, but generally they are found crowded together all round the stems, sometimes for a length of six inches. The damage they do is that they sit and suck the juices of the young shoots so that the parts above dry up and drop off. The leading shoots are generally attacked in this way, so that very often the trees become crooked. I have been trying to find some coppice shoots or young saplings that have escaped injury, but every one I have seen shows signs of having been attacked in this way. When the leading shoot is killed, next year several new shoots are put out a little lower down. One of these probably takes the lead and is killed in its turn, and so on. The result is a more or less crooked habit of growth."

In parts of the Dun forests the scale insect was accompanied in April 1901 by a looper caterpillar, the larva of the moth *Boarmia selenaria,* which entirely stripped the sál trees of leaves, flowers and green shoots.

Protection and Remedies.

No natural enemies of this scale have been as yet observed attacking the insect in the forest.[1]

Following the famous precedent of the introduction of a ladybird beetle into Florida to exterminate the fluted scale which was rapidly ruining the orange and citron industry by killing off the trees, I am endeavouring to obtain colonies of likely beetles of this family to introduce into the sál forests. Both *Vedalia cardinalis* and *Vedalia fumida* var. *roseipennis* will be experimented with with this object.

Points in the life history requiring further observation :—

1. When the eggs are laid, their number, and the time spent in this stage (see above).
2. When the ♀ larva makes its first appearance.
3. When the ♂ larva first appears, where it lives, what it feeds upon, and when and where it undergoes its transformations into the imago state.
4. The number of generations in the year.
5. In many of the forests where this scale appears, if not in all, the branches of the trees have curious knotty swellings on them. Are these swellings the result of the coccid's attack, and, if so, how do they originate?

Is there any connection between these swellings and the method and position of egg laying by the females?

Is the second stage of the life history of this insect passed within the tissues of the bark, and are these swellings connected with this second stage?

[1] Since this note was written I have spent some time further studying this scale which has been very abundant again this year (1902). Many new facts regarding its life history have been observed, not the least important of which being the discovery that the pest is most heavily preyed upon by a occinellid beetle and its larva.

MONOPHLEBUS DALBERGIÆ,

GREEN.

References:—Green in litt.

Classification:—Order, HEMIPTERA. Family, Coccidæ. Sub-Family, Monophlebinæ.

Description.

The following are rough descriptions made when the insects were taken, and whilst they were still alive. The writer was fortunate enough to secure both the male and female coccids.

♀ Light orange-yellow in colour but covered with a white mealy substance. Legs black, antennæ and eyes black. Greatly resembles the ♀ of *M. Stebbingii* already described in these notes (see Pl. I, fig. 7.)

♂ Winged form. Wings black, rounded at angles and with a spread of a little over ¾ inch. Antennæ nearly ½ inch in length, black, much flattened and with bristly hairs running up them. Head, thorax, and body light red in colour. Legs black. Appendages to end of body 8 in number, 3 large ones on either side, and 2 shorter ones. Pl. I, fig. 8, shows the ♂ of this insect.

Life History.

Very little is at present known on the subject of the life history of this insect. Mature winged males and apterous females were found on Sissu trees growing in the Sutlej valley. This was on the 19th June 1901. Next day further specimens were taken in the same locality higher up the river. As the writer then left the valley, he was unable to make further observations on the subject. From the portions known of the life histories of other species of *Monophlebinæ* in India it is probable that the young larvæ appear towards the end of April on the old Sissu leaves, and that as they increase in size they move down to the twigs, feeding the whole time by suction, imbibing the sap of leaves and twigs through their beaks. As the rains come on they probably descend the tree, the females laying their eggs in crevices of the bark or on the twigs and branches.

Locality from which the insect has been reported.

The species is new to science and was discovered in June 1901 in the Sutlej valley, at elevations of between 2,300 and 3,500 feet, feeding upon the Sissu.

Relations to the Forest.

The apterous ♀ insects do damage to the tree by sucking the sap from the leaves, and more particularly the branches, thus impairing their vitality. As they increase in size, they attach themselves to the previous year's shoots, the young cortex of which they are easily able to pierce. The present species was found more especially in the two latter places, but some of the insects were still on the older leaves. When the insects are numerous the effect of the tapping reduces the vitality of the shoots which subsequently die off. In the case of large trees, the effect is bad, as their growth is considerably interfered with, but more serious damage is occasioned to young saplings, as the insects, when very numerous, cluster round the leading and side shoots and suck them dry. The tree in this case, if not killed (and the latter probably only takes place if the attack is renewed year after year) is stunted and badly shaped.

Protection and Remedies.

At present the best method known for dealing with such pests is to ascertain if it is possible to procure and introduce a natural enemy, such, for instance, as a Lady Bird beetle. This has been successfully done in the case, *e.g.*, of the scale insects on the orange trees in Florida and elsewhere, and I have hopes of being able, as our knowledge of the subject becomes greater, to work out some such remedy for our more dangerous forms of Monophlebus, one of which has already proved itself a serious pest in the sál forests of Dehra Dun and adjacent divisions.

Points in the life history requiring further observation :—

1. The month in which the young scale first makes its appearance on the old leaves of the tree. It will then be probably a minute yellow insect.

2. The month in which the insect disappears from the trees.
3. The place where the eggs are laid.
4. The abundance or otherwise of the insect. My visit was all too short to enable me to definitely ascertain this.
5. The range and elevation of the insect on the Sissu in the Sutlej valley.
6. Where the second stage of the life history is passed. Is this stage pupa-like, and is it passed in the tissues of the bark?

MONOPHLEBUS TECTONÆ ?

GREEN.

Reference:—Provisionally named by Mr. E. E. Green. The specimens of this insect obtained to date have proved insufficient to fully determine and describe it.

Classification:—Order, **HEMIPTERA.** Family, **Coccidæ.** Sub-Family, **Monophlebinæ.**

Description.

♀. Larva. Only from a quarter to one-third grown larvæ of this insect have yet been discovered. They much resemble externally those of *M. Stebbingii*, Green, the maturer forms being covered with the white powdery substance. A few in a more advanced condition were obtained.

♂. The male insect is not yet known in any of its stages.

Life History.

Only the younger stages of the female have yet been discovered. They were found sucking the juices from the leaves of the teak tree (*Tectona grandis*) during the latter part of July in Berar. Later on in August I found them in a more advanced stage feeding upon the twigs of the trees in the Central Provinces. I pointed the insect out to the Range Officer in the Singrampur forest of the Damoh division and he informed me that it was sometimes to be found in large numbers crowded on the twigs and branches in November. If this proves to be the case the fact is most interesting and is well worthy of the closest attention, since these insects when in large numbers are capable of greatly retarding the growth of the trees they attack, whilst at the same time often probably rendering their shape crooked and distorted.

Areas from which reported.

This insect was discovered in the Melghat forest, Berar, in July, and the next month in the Damoh division of the Central Provinces, in each case on the teak tree.

Beyond the above notes nothing is known about the life history of this *Monophlebus* which has still to be worked out. Both the ♂ and ♀ mature insects are likely to resemble externally those shown in Pl. I, figs. 7 and 8.

A Note on the Application of Paris Green as an Insecticide for destroying Caterpillars.[1]

Nature of the poison.

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 more satisfactory than the latter compound as it is less liable to injure the foliage, and its use has proved safe at the rate of one pound of the Paris green to 150 (one hundred and fifty) gallons of water.

Method of preparing the mixture.

Before mixing the Paris green with water it is advisable to add an equal weight of freshly slaked lime (flour has been used instead of lime, but the latter is the better of the two, if procurable), mixing thoroughly. The lime takes up any free arsenic and prevents possible injury to the foliage.

Application of the poison.

The poison can be best applied by means of an ordinary spray pump and nozzle, and during the process of application the solution should be kept constantly stirred to prevent the poison from settling to the bottom. This is most important.

Time of application.

The worms are most readily poisoned when newly hatched, and it is therefore very important to spray as soon as the young worms first appear. This also, of course, prevents the damage which they would commit as a result of delaying. The above is a general summary of the nature and method of application of Paris green. I will now consider the question more in detail.

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[1] This note was written at the instance of Mr. R. Wroughton, Conservator of Forests, Bombay, with the object of endeavouring to exterminate the larvæ of *Hyblæa puera* and *Pyrausta machœralis* which defoliate the young teak plants reared in the Central nursery near Poona.

Since this note went to press, I have received information that the appication of this poison as here recommended was attended with success.

Strength of the mixture.

Paris green does not dissolve in water: it is simply held in suspension. The strength of the mixture depends on the quality of the foliage to be sprayed. The teak has a thick, tough leaf even when young, and the mixture of 1 lb. of Paris green to 150 gallons of water should be tried first. If it does not appear to kill off the larvæ, it might be made stronger up to 1 lb. of Paris green to 130 gallons of water. The lime or flour used has of course no effect: it is simply to enable the Paris green to mix better whilst at the same time the lime would take up any free arsenic.

Method of mixing.

The exact method of mixing is quite immaterial, only remember that the powder should be thoroughly diffused through the water, not allowed to be in lumps. The mixture must be kept an even strength throughout. The Paris green and lime should be first mixed up with a small quantity of water, and then the rest added till the full amount has been made up. The operator should not handle or inhale the powder.

Applying the mixture.

It should be applied as a fine spray by means of a force-pump. It 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. 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. All washes containing Paris green must be kept constantly stirred to keep it in suspension, or it will sink to the bottom. This is important. The following points should be insisted on:—

(*a*) As above mentioned, keep the mixture well stirred all the time.

(*b*) Have the barrel or vessel used for the mixture well washed out after it has been filled ten or twelve times. The Paris green is very heavy and keeps sinking to the bottom. As the barrel is frequently refilled, the residue will keep accumulating until it will be too strong as the mixture reaches the bottom.

The mixture 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 a bad practice in every way. It uses a great deal more of the chemical than is needed; the leaves getlittle but pure water at their highest part and much too strong an application where the fluid has settled at their tips.

Several days should elapse between the sprayings, 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 immediately, and it is undesirable to waste labour and material where the work is already done and requires only a day or two to show it.

Effect of the spraying.

The effect is to poison the leaves and the caterpillars feeding on them take arsenic interiorly and are thus killed. The sprayings should be discontinued as soon as it is seen that all the caterpillars are killed.

Cautions as to use of the Paris green insecticide.

Paris green is an aceto-arsenite of copper and of a poisonous nature, and therefore should be used with care in mixing. The bags of the mixture should be labelled "Poison" and kept locked up, and especially kept out of the way of children who would 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 careful not to breathe the powder through the mouth or nose, whilst measuring or mixing it.

For this reason it is 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 better still have it in the form known as "Paris green paste", that is, the powder just damped so that it cannot fly about.

How to procure the powder.

Large firms in Bombay or Calcutta, etc., will supply the arsenic. It is procurable at small cost (about Re. 1-4 per pound), and is known to the trade as "Paris-green" or "Emerald-green". I believe Messrs. Blundell, Spence & Co. (Limited) of Hull and 9, Upper Thames Street, London, England, Colour Manufacturers and Exporters, would deliver quantities of 14 lbs. and upwards at 1*s*. per pound packed in one pound paper parcels or in paste state in large glass jars of 4 to 7 lbs. at the same price. Messrs. Hemmingway & Co., of 60, Mark Lane, London, E.C., also, I believe, supply the powder.

Spraying machines.

Various spraying machines have been invented. At first it will be sufficient to use an ordinary sprayer, but the nozzle must be a very fine one, so that the application may be made as a fine spray and not as a stream. This is essential.

Should the apparatus be successful, it would be practicable to get one of the machines specially made for the purpose. Many firms make them and their catalogues could be obtained. A good one is an ordinary barrel mounted on wheels to hold, say, 36 gallons. In the rear a pump is fixed with two delivery pipes to which are attached whatever length of tubing may be required. Three men go with the apparatus, two men to spray and one to pump.

The manufacturers are Messrs. Boulton and Paul, Rose Lane Works, Norwich.

A knapsack form of sprayer known as the Chiswick Co.'s Sprayer can, I believe, be procured from the Planters' Stores and Agency Co., Ld., 3, Mission Row, Calcutta.

Spraying should not be done in a high wind.

PLATE I.

Fig. 1. Brachytrupes achœtinus, Stoll. *a.* Young wingless larva ; *b.* Winged adult.

„ 2. Sinoxylon anale, Lesne. *a.* Larva ; *b.* pupa ; *c.* dorsal and side view of mature beetle ; *d.* Piece of sissu wood showing borings of *Sinoxylon crassum* and *S. anale* (½ nat. size).

„ 3. Teretriosoma Stebbingii, Lewis. Dorsal and side view.

„ 4. Bothrides sp. Dorsal and side view.

„ 5. Ceratopachys variabilis, Dallas. Dorsal and side view.

„ 6. Ochrophara montana, Distant. *a.* Young wingless larva ; *b.* Winged adult.

„ 7. Monophlebus Stebbingii, Green. Dorsal and side view of mature ♀.

„ 8. Monophlebus dalbergiæ, Green. ♂, enlarged three times. E. E. Green, del.

Note.—When not otherwise stated, the drawings are by Artist S. B. Mondul. Hair lines represent the actual size of the insects.

S. B. Mondul, del.

1. BRACHYTRUPES ACHŒTINUS, STOLL
2. SINOXYLON ANALE, LESNE
3. TERETRIOSOMA STEBBINGII, LEWIS.
4. BOTHRIDES SP
5. CERATOPACHYS VARIABILIS, DALLAS.
6. OCHROPHARA MONTANA, DISTANT.
7. MONOPHLEBUS STEBBINGII, GREEN.
8. MONOPHLEBUS DALBERGIAE. GREEN.

Regr. No. D. 16. I. F. O. - Feby. 1902 - 500

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, March 1902

PLATE II.

Fig. 1. Pseudosphinx discistriga, Wlk. ♂. (After Hampson).

„ 2. Clania crameri, Westw: *a.* Larva in twig case (after Hampson); *b.* pupa of ♂ moth protruding from case; *c.* ♂ moth.

„ 3. Lymantria Mathura, Moore. *a.* ♂ moth (after Hampson); *b.* ♀ moth.

„ 4. Acronycta anædina, Butl. *a.* Larva; *b.* pupa; *c.* moth.

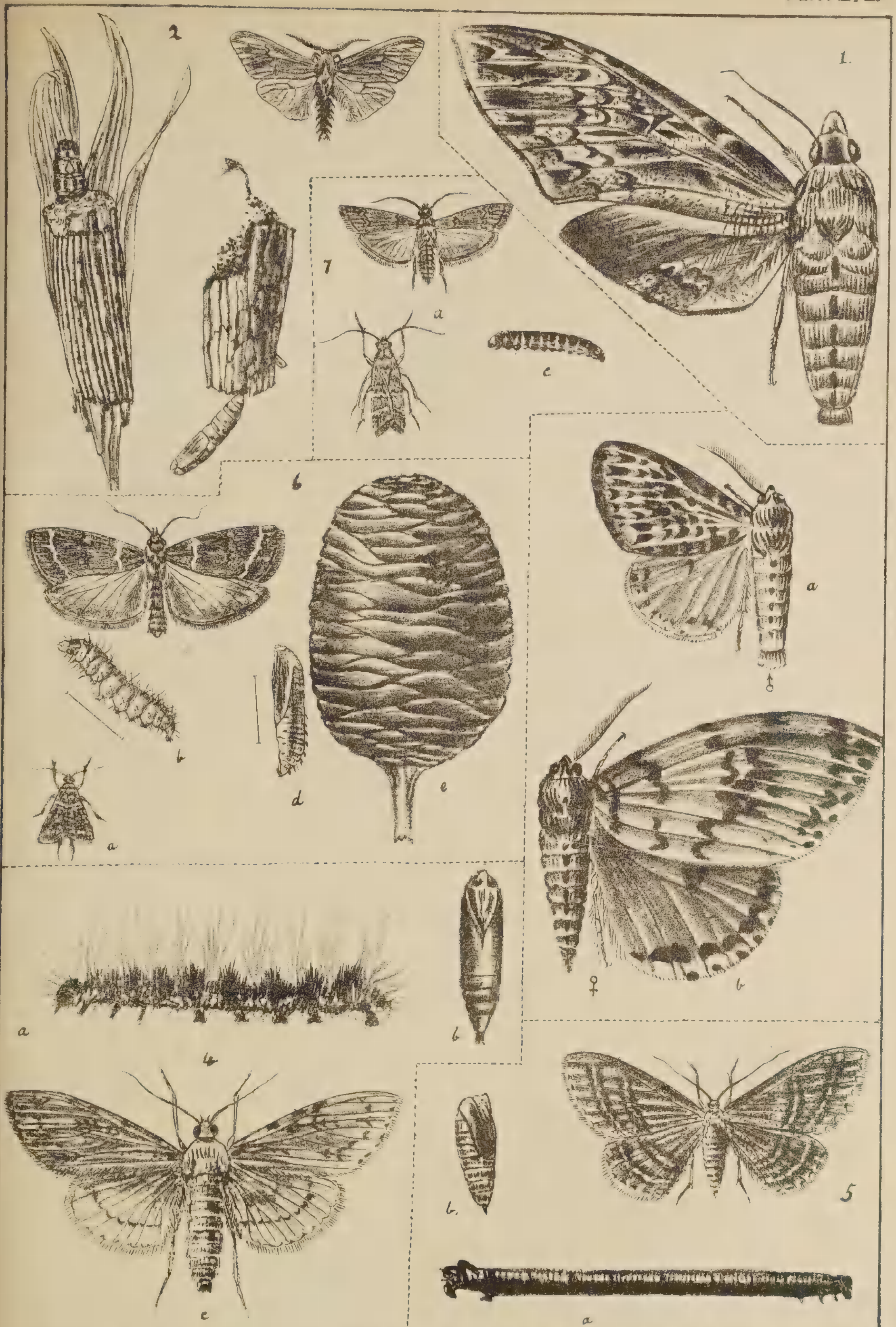
„ 5. Boarmia selenaria, Hübn.; *a.* Larva; *b.* pupa; *c.* moth.

„ 6. Euzophera cedrella, Hmpsn. *a.* moth, nat. size and enlarged.

„ 7. Phycita abietella, Schiff. *a.* moth, at rest and with wings spread.

(Figs. 6 and 7:) *b, c,* larvæ from the cone. It is at present uncertain as to which larva belongs to which moth; *d.* pupa, perhaps of *E. cedrella*; *e.* Deodar cone showing borings of larvæ.

Note.—Hair lines represent natural size of the insects.



S.B Mondul. del.

1. PSEUDOSPHINX DISCISTRIGA, WLK
2. CLANIA CRAMERI. WESTW.
3. LYMANTRIA MATHURA, MOORE.
4. ACRONYCTA ANAEDINA, BULT.
5. BOARMIA SELENARIA, HÜBN.
6. EUZOPHERA CEDRELLA, HMPSN.
7. PHYCITA ABIETELLA, SCHIFF.

Regr. No. 11 16, I. F. O. - Feby. 1902-500

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dun, March 1902

PLATE III.

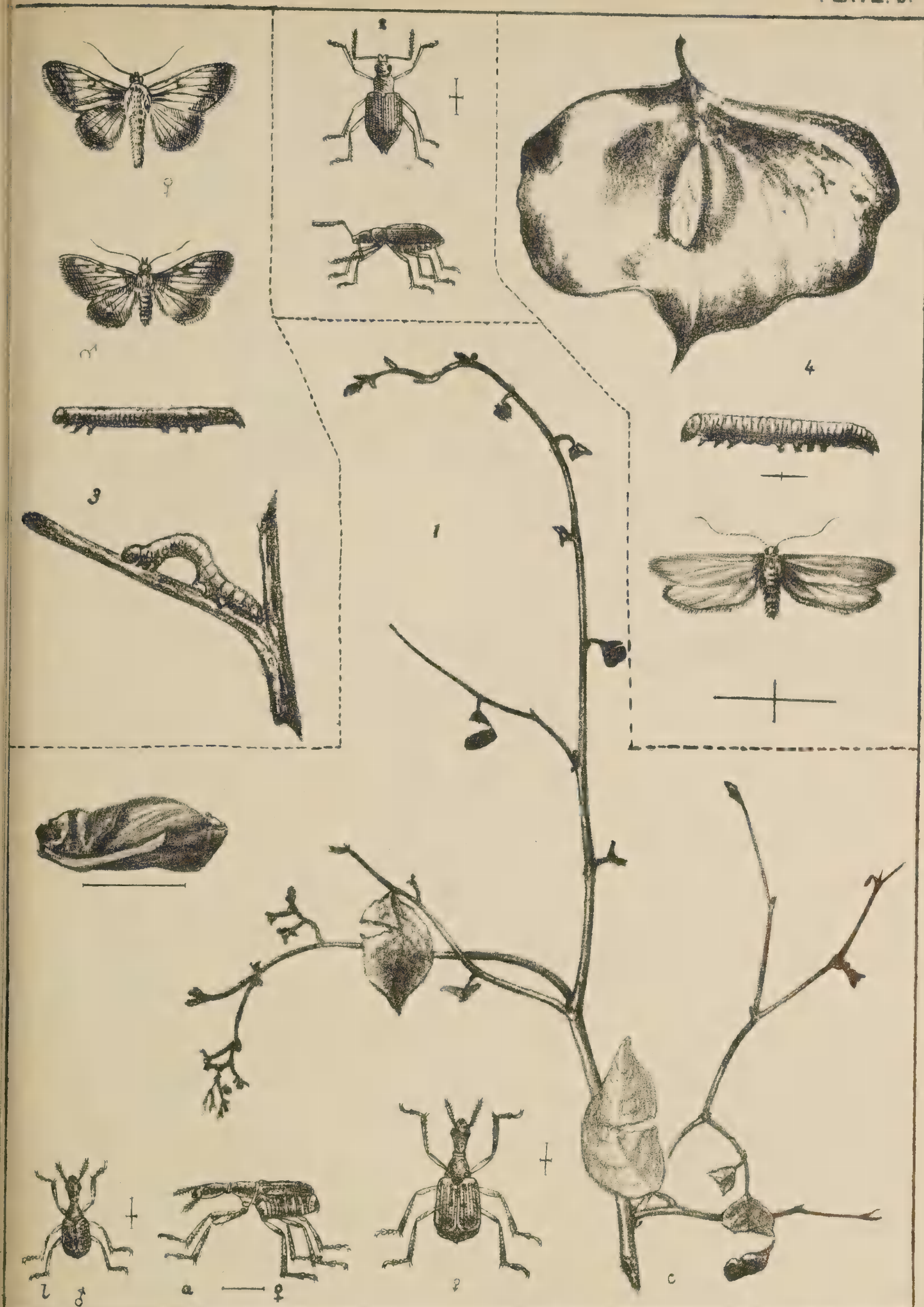
FIG. 1. APODERUS SP. *a*. Dorsal and side view of ♀; *b*. dorsal view of ♂; *c*. a new Sissu shoot showing method of defoliation by beetle for the purpose of egg laying (from a drawing by the author); *d*. Rolled up leaf containing an egg showing method of rolling adopted by insect.

" 2. MYLLOCERUS SP. Dorsal and side view.

" 3. PLECOPTERA REFLEXA, Guen. *a*. Larva; *b*. ♂ and ♀ moths.

" 4. YPSOLOPHUS SP. *a*. Larva; *b*. pupa, attached by fine silk hairs to the centre of a Sissu leaf; *c*. moth.

NOTE.—Hair lines represent natural size of the insects.



S. B. MONDUL, del.

1. APODERUS SP.
2. MYLLOCERUS SP.
3. PLECOPTERA REFLEXA, GUEN.
4. YPSOLOPHUS SP.

Regr. No. D. 16, I. F 0 - Feby. 1903 - 500

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dun, March 1932.

PLATE IV.

FIG. 1. SERICA ALCOCKI, Brenske. Imago.

" 2. XYLOTRECHUS VICINUS, L. and G. Imago.

" 3. APRIONA GERMARI, Hope. *a.* Larva; *b.* pupa (ventral view); *c.* imago (dorsal view).

" 4. SCOLYTUS SP. *a.* Larva; *b.* dorsal and side view of the beetle; *c.* galleries made by beetle in deodar sap wood. The horizontal gallery is the egg gallery; the vertical galleries are the larval galleries.

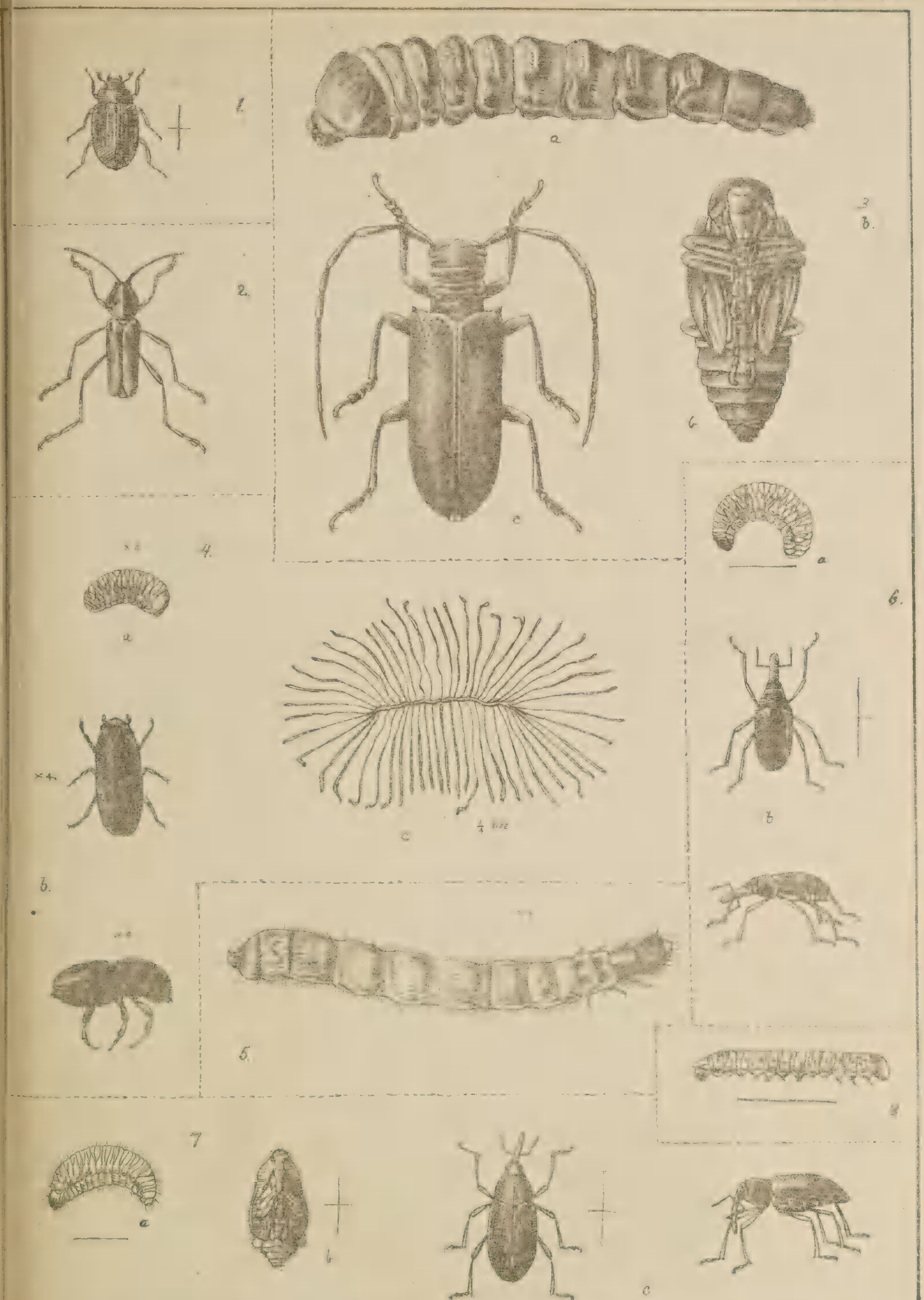
" 5. CLERID larva.

" 6. ALCIDES SP. *a.* Larva; *b.* dorsal and side view of beetle.

" 7. CRYPTORHYNCHUS SP. *a.* Larva; *b.* pupa; *c.* dorsal and side view of beetle.

" 8. LEPIDOPTEROUS wood-boring larva.

PLATE IV.



.B. Mondul del.

1. SERICA ALCOCKI, BRENSKE
2. XYLOTRECHUS VICINUS, L. AND G.
3. APRIONA GERMARI, HOPE
4. SCOLYTUS SP
5. A CLERID LARVA
6. ALCIDES SP
7. CRYPTORHYNCHUS, SP
8. A LEPIDOPTEROUS WOOD-BORING LARVA

Regr. No. D. 31, I. F. O. - April 1902 - 500

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, June 1902.

PLATE V.

FIG. 1. SUANA CONCOLOR, Wlk. *a.* Larva; *b.* pupal case attached to a sál twig; *c.* pupa, taken out of case; *d.* moth (moth after Hampson).

„ 2. TRABALA VISHNU, Lef. Imago. (After Hampson).

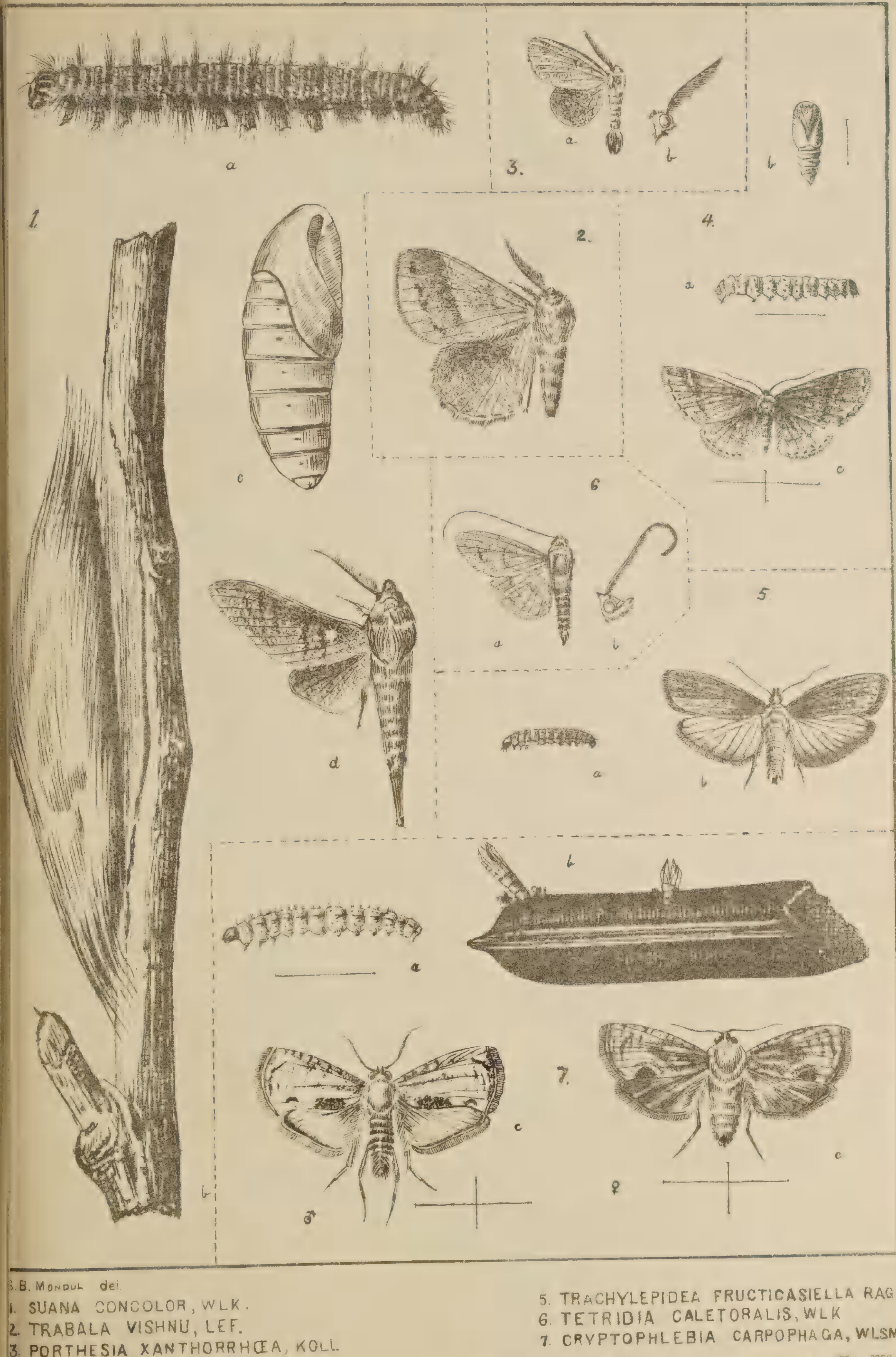
„ 3. PORTHESIA XANTHORRHŒA, KOLL. *a.* Imago; *b.* side view of head (after Hampson).

„ 4. DIRADES THECLATA, Guen. *a.* larva; *b.* pupa; *c.* moth.

„ 5. TRACHYLEPIDEA FRUCTICASIELLA, Rag. *a.* Larva; *b.* moth.

„ 6. TETRIDIA CALETORALIS, Wlk. *a.* Imago; *b.* side view of head (after Hampson).

„ 7. CRYPTOPHLEBIA CARPOPHAGA, Wlsm. *a.* larva; *b.* pupal case protruding from the bean; *c.* ♂ moth; *d.* ♀ moth.



S. B. Mondul del.

1. SUANA CONCOLOR, WLK.
2. TRABALA VISHNU, LEF.
3. PORTHESIA XANTHORRHŒA, KOLL.
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6. TETRIDIA CALETORALIS, WLK
7. CRYPTOPHLEBIA CARPOPHAGA, WLSM

Photozincographed at the Office of the Trigonometrical Branch, Survey of India. Dehra Dún, May 1902.

Regr. No. D. 31, I. F. O. - Mar. 1902 - 500

PLATE VI.

FIG. 1. TRYXALIS NASUTA, Fisch. Imago (side view).

" 2. OXYA VELOX, Burm. Imago (side view).

" 3. A MELOLONTHID larva. Side view.

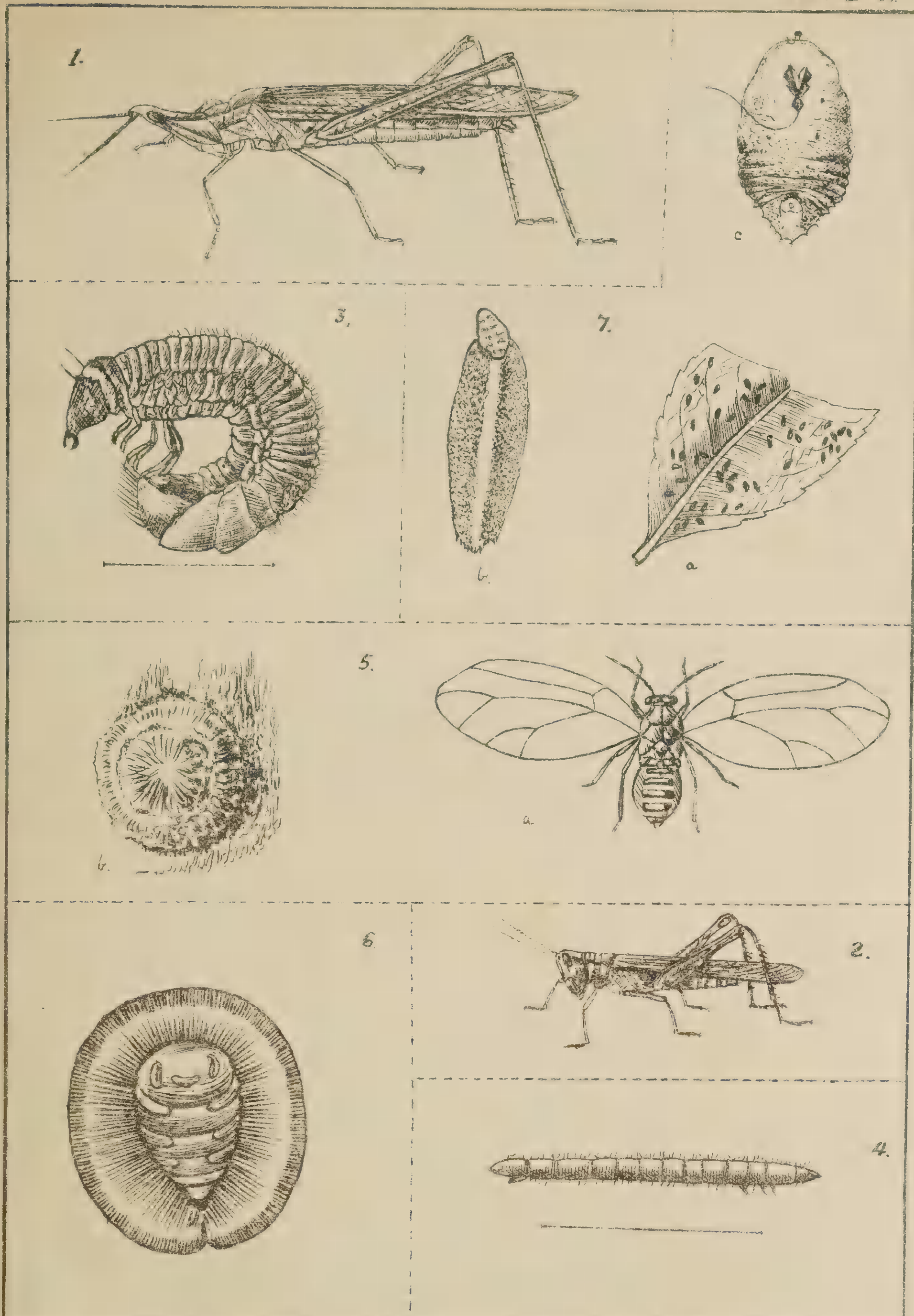
" 4. An ELATERID larva.

" 5. PSYLLA OBSOLETA, Buckton. *a.* Winged insect ; *b.* gall formed by larva on leaf. (After Ind. Mus. Notes.)

" 6. ALEURODES EUGENIÆ, Maskell. Pupa, ventral view. (After Ind. Mus. Notes.)

" 7. FIORINIA THEÆ, Green. *a.* Leaf with insects *in situ* (nat. size) ; *b.* scale of adult ♀ ; adult ♀, removed from scale, ventral view. (After Green.) *b.* and *c.* enlarged.

G. I. C. P. O.—No. 1169 R. & A.—18-7-1902.—500.—J. W. DeB.



S.B. MONDUL del.

1. TRYXALIS NASUTA, FISCH.
2. OXYA VELOX, BURM.
3. A MELOLONTHID LARVA.
4. AN ELATERID LARVA.
5. PSYLLA OBSOLETA, BUCKTON.
6. ALEURODES EUGENIÆ, MASKELL.
7. FIORINIA THEÆ. GREEN.

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dun, April 1902.

Regr. No. D 31; L F O - April 1902 500

DEPARTMENTAL NOTES

ON

INSECTS THAT AFFECT FORESTRY,

BY

E. P. STEBBING, F.L.S., F.E.S.,

FOREST ENTOMOLOGIST UNDER THE GOVERNMENT OF INDIA.

No. 2.

CALCUTTA:

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GOVERNMENT OF INDIA CENTRAL PRINTING OFFICE

8, HASTINGS STREET.

Correction Slip to No. .

Page ii, line 34. *For* ' Monophlebus Stebbingii ' *read* ' Monophlebus Stebbingi.'

" 103, lines 36 and 37 *For* " " " " "

Pages 135 to 142, wherever mentioned. *For* ' Monophlebus Stebbingii ' *read* 'Monophlebus Stebbingi.'

Page 145, line 11. *For* ' Monophlebus Stebbingii ' *read* ' Monophlebus Stebbingi.

Plate I, fig. i. " " " " " "

Page 19, line 14.	" 'Pl. I, fig. 5'	"	'Pl. I, fig. 3.'
" " " 24.	" " "	"	" "
" 52, " 32.	" 'pro-legs'	"	'thoracic legs.'
" " " 33.	" 'clasper legs'	"	'pro-legs.'

Omit paging of Descriptions of Plates.

PREFACE.

THE object of issuing the Departmental Notes on Insects that affect forestry in India in their present form is to enable the Officers of the Department and others interested in the culture of trees to keep up to date with our knowledge of the subject and to assist the advancement of the work by studying the still unknown portions of the life histories of the various pests detailed and of others still unrecorded. To this end, criticism and discussion are cordially invited.

Several of the insects dealt with are new to science, and most of the information on their habits, etc., is new. It has not been considered necessary here, however, to give in full detail the reasons for the statements made with reference to some of the new and more complex of the life histories. The author hopes to publish elsewhere full and detailed technical papers dealing with the matter from the scientific standpoint.

It is proposed to give information in these notes upon—

i.—Hurtful Insects.

ii.—Useful Insects.

Owing to queries having been received on the subject it should perhaps be pointed out that the descriptions of the insects do not aim at being scientific ones, they having been drawn up merely as simple aids to identifying the insects by fellow-workers in the field. It is hoped that the new species will be described with the help of scientific confrères. The writer hopes in time to deal himself with the *Scolytidæ* and *Platypodæ* of which already considerable collections of unknown species have been made.

E. P. STEBBING.

DEHRA DUN;
The 25th October 1902.

No. 2.

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INJURIOUS INSECTS.

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Predaceous and Parasitic Insects.

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Plates.

SIREX SP.

Plate VII, fig. 1, a–f.

Reference :—Provisionally determined as *Sirex* sp.

Classification :—Order, HYMENOPTERA. Family Siricidæ or Uroceridæ.

Tree attacked :—*Picea Morinda* (Spruce).

Description.

Larva.—A stout canary-yellow thick grub, about 1¼ inches in length and just under ⅓rd inch breadth. Head small and yellow with brownish black mandibles, toothed on their upper edges giving them the appearance of molar teeth. The thoracic segments are enlarged, the anterior one almost forming a hood over the small head. These segments each bear on their under surfaces a pair of small projections representing the thoracic legs. There are no other legs behind these, but some slight protuberances take their place. Following these three segments are nine others, the terminal one of which is enlarged and ends in a brownish black spike bearing a few short spines upon it. On either side of each segment there is an elliptical brownish spiracle placed anteriorly. (See Pl. VII, fig. 1, a.)

Pupa. ♀.—A pale yellow in colour, unenclosed in any covering and lies quite free at the end of the larval boring. All the parts of the future insect are developed but, with the exception of the eyes, which are brown and elliptical, they are all of a uniform pallid colour in the initial stages. In the pupa being described the palpi, antennæ, legs and wings (about one-third their future length) were all quite free and pressed close to the ventral side of the insect. The three parts of the ovipositor were present and separated, as also the augur terminating the last segment. Length to end of augur 1½ inches. Ovipositor ⅝ths of an inch. The pupa described is a female. The male has of course no ovipositor. (See Pl. VII, fig. 1, b.)

Imago. ♂.—A large handsome insect. General colouring a metallic blue-green and rich chestnut. Head and thorax very dark metallic green-black and clothed with hair, which is dense on the dorsal surface of the thorax; antennæ bristle-like, 22-jointed, a little over ⅓rd length of insect, the first five joints being chestnut brown, the other 17 joints black; the first joint is thickened and longer than the others. Legs long, chestnut brown in colour except the posterior tibiæ and 1st tarsal joint, which are black and very much flattened out. Anterior tibia is armed at its base with a spur. These tibiæ and tarsal joints are doubtless used to push out wood-dust from the galleries as the insect moves forward in its boring operations. The tarsi terminate in a pair of curved sharp claws, which are spined at their junction. Wings membranous with a rich coppery sheen; they reach to the end of the insect, leaving only the portion of the body bearing the short augur uncovered. In the upper wing there are two marginal cells, the lower one of which does not reach the end of the wing, and three submarginal cells. The middle portion of the wing is occupied by six cells, none of which reach the outer edge, the two centre ones of which are the smallest. There are three veins on the lower marginal edge, the one nearest the outer edge being the smallest. Under surface of thorax black-green. Body is flattened, shining and smooth; first three segments of abdomen metallic green, shading off laterally on the third into red, the following four dark metallic red with a dash of yellow in it, the lower edge of the fourth being ultramarine blue, the seventh a pale ultramarine brown and the last ultramarine. These last two segments glow brilliantly when they catch the light. Each of the red segments has on the posterior edge of its dorsal surface a spot of ultramarine. Under surface of abdomen same as upper, except that both the last segments are a brilliant metallic ultramarine.

Length just under 1⅜th inches. (Described from a living specimen. See Pl. VII, fig. 1, c.)

♀. Head and thorax a deep metallic green above, beneath clothed with hair as in ♂. Legs chestnut brown, except coxæ and trochanters which are dark metallic blue, and last tarsal joint and claws, which are black; posterior tibia and 1st tarsal joint not thickened. Wings with a rich old gold metallic lustre with thick well-marked black veins. The wings leave the last segment of the body and the augur exposed. The abdomen is smooth and is a brilliant metallic blue verging to black on the under surface. Ovipositor consisting of three portions and black in colour, $\frac{11}{16}$th inch in length. Length $1\frac{7}{16}$th inch to end of ovipositor, and $1\frac{1}{4}$th inch to end of augur. (See Pl VII, fig. 1, d.)

Life History.

This insect appears on the wing about the middle of June, perhaps earlier. It attacks spruce trees, and the writer has found it at the end of the month both in the wood and flying about in the forest. The insect is to be found in all its stages of larva, pupa, and imago at this period.

The eggs are laid by the female in the wood of dead spruce trees (I think it possible that blue pine and perhaps other trees are also attacked by it or an allied species) some time during July. The larvæ on hatching out are small yellowish grubs and bore straight into the wood, in which they remain feeding and tunnelling for over a year. The latter is, I think, probable, since I have found small larvæ and large full-grown ones together in the same tree. The length of time spent in the pupal stage is not at present known. Pupæ have been found in the tunnels in the middle of June and on into July, and it is probable that the adults issue at intervals for several weeks until the burst of the monsoon. On becoming mature the *Sirex* bores its way out of the wood to the outside, the tunnel being either horizontal or at an angle, depending apparently on the position of the larva when it ceased feeding. When this latter occurs the head of the larva is generally, if not always, pointing in the direction of the outside of the tree, and not facing inwards, but as often as not this tunnel is at an upward angle. The imago will then bore in a line straight for the outside, but the tunnel may be curved upwards. I have never found imago-tunnels pointing downwards. The larval gallery is always tightly packed with dry wood chips, so that during its feeding operations it is always moving forward, and when full fed the only free part of its gallery is the space it is lying in. The depth within the tree at which it changes into the pupal condition appears to vary.

It may be only an inch inside the sapwood or several inches. The imago cuts its way out by means of its powerful mandibles, making a circular hole through the wood and bark of a ¼ inch in diameter.[1]

Locality from where reported.

This insect was discovered by the writer in dead spruce trees in Tehri Garhwal, North-West Himalayas (Jaunsar Division), at an elevation of about 7,000 feet.

Relations to the Forest.

The injury done by this insect is entirely to the commercial value of the wood, the timber, when the larvæ are numerous, being riddled by their borings. (See Plate VII, fig. 1, e.) I have not ascertained how deep the borings go in large trees, but in a spruce of 3 feet diameter I found tunnels as deep as 1 foot in from the outer edge of the sapwood, excluding the bark. The young larva soon after getting into the wood turns at an angle and bores up and down in the longitudinal axis of the tree, and a section of the wood of a badly attacked tree will show numerous galleries packed tightly with the wood chips. (See figure 1, e.) The tunnel is small in diameter at first but increases until, when the occupant is full grown, it is ¾ inch in circumference. It is invariably very tortuous.

Whilst the damage done to the timber by the larvæ is of itself very considerable, it is increased by the exit holes bored by the adults, and these let in moisture and fungi which soon ruin the rest of the sound timber. In Pl. VII, fig. 1, f, the larger holes and galleries in the bark are those of this insect.

Protection and Remedies.

We require to know exactly what species of trees are attacked by this insect before we can decide as to the damage

[1] Since this note went to press I have bred out adults of this species at Dehra Dun from wood brought down from Jaunsar in July and kept under supervision. A male issued on the 22nd September and a female on the 1st October. The male specimen is smaller than those obtained in the Himalayas in June and July. The female is the first specimen of that sex obtained. I am of opinion that the lower elevation of Dehra (2,000 ft. only), and the consequently hotter climate, is the cause of these insects appearing at this time of the year. It is improbable, I think, that the mature insects ordinarily appear more than once in the year, *i.e.*, in June and July.

to be expected from it. As long as timber is cut up and sold green it would appear that the pest is not to be feared, since it probably does not commence its attacks until the tree is either dead or felled. Ringing trees is to be avoided where such insects exist in a forest, as it provides them with exactly the food they require. Dead trees should, whenever possible, be cut out and removed.

Points in the life history requiring further observation.

1. How the eggs are laid. Does the ♀ cut through the bark into the wood with her ovipositor and a ugur and lay them in the wood? Is the bark necessary to the ♀ or will she lay her eggs in unbarked trees and timber?
2. Length of time spent by larva boring in the wood.
3. Length of time spent in the pupal state.
4. Length of life of imago.
5. Is there more than one generation in the year? If not, do the adults only issue during June and July, or do they issue irregularly between June and October?

THALESSA,
OR
RHYSSA SP.

Plate VII, fig. 2.

Reference :—Provisionally determined as above.

Classification :—Order, HYMENOPTERA. Family, Ichneumonidæ. Parasitic upon SIREX sp. and perhaps upon XYPHIDRIIDES.

Description.

♀. A fair-sized insect. Head black. Eyes black with a longitudinal oval orange mark on either side almost surrounding them. Antennæ long, filiform. Thorax black with yellow spots, wings membranous, yellowish, with black veins. Legs long, black, except coxa which is yellow, and trochanta which is yellow above and black beneath. Body black, shining, with a pink cerise spot on either side of each segment at the posterior edge. In dead dry specimens these spots are either a dirty yellow or pale greenish blue. The coxæ and trochantas are also blackish.

Length 1 inch. Length of ovipositor 1¼ to 1½ inches. (See Pl. VII, fig. 2.)

Life History.

This insect appears on the wing in June towards the beginning of the month, the time of emergence depending upon the elevation. I have only as yet found the perfect insect but under conditions such that I have no doubt that it is parasitic upon the *Sirex* sp. I have found them together plentifully in spruce trees, the smaller exit holes of the ichneumon being mixed up with the larger ones of the sirex. (See Pl. VII, fig. 1, f. The smaller holes and upper section of a gallery are those of the *Thalessa*.) Numerous dead ichneumons were also found both in the wood and bark, but under different conditions. Many of those in the wood were in borings which did not reach to the outside and were facing outwards, seeming to show that they had not been able to bore their way out, the larvæ which their grubs had infested and finally killed having gone too deep into the wood. When this latter happens the ichneumon fly is said to bore in the direction of the outside of the tree for a certain period and if it does not reach it within this time it gives up and dies, probably from exhaustion. The other adults found had apparently drilled a hole through the bark and in some cases a little way into the wood, by means of their saw-like ovipositors, until they reached a larval gallery in which they probably laid their eggs. The larvæ developing from these eggs probably feed upon the *Sirex* larvæ as external parasites. Dead insects were numerous in the tree, their ovipositors and portions of their bodies being often found in holes in the bark, the former being fixed in the wood whilst the upper portion of the body protruded from the bark. From examinations I was able to make of numbers of these, I am of opinion that it may be possible that the ichneumons die *in situ* after laying their last eggs either near or amongst the *Sirex* eggs or in the larval tunnels. It would also appear probable that instinct leads the Thalessa to lay its egg in the right place by enabling it to unerringly know where the larval tunnels and larvæ in the wood are. Without such knowledge it would seem impossible for the parasite, whose ovipositor is only 1½ inches in length, whilst the spruce bark is often over an inch in thickness, to reach the larval tunnels. I think this latter is very probably the case since the number of insects found in this position was considerable.

Locality from where reported.

This insect was found in the same locality as already given for *Sirex* sp.

Relations to the Forest.

This ichneumon is evidently of some utility since it helps to keep down the numbers of so serious a timber-boring pest as the *Sirex*. It does not prevent the damage being done to the actual tree in which it is found since it is probable that the larvæ reach a considerable size, or, in other words, do a very considerable amount of damage, before they succumb to the attacks of the ichneumon grubs. At the same time it does a small amount of damage to the wood itself since it has to bore its way out from the larval gallery where it has matured.

Points in the life history requiring further observation.

1. The number of eggs laid in each larval gallery and the age of the *Sirex* larva in whose gallery they (if more than one) are laid. Are the eggs only laid in very young larval galleries, or are older larvæ attacked?
2. The length of time spent in the larval state.
3. The length of time spent in the pupal stage.
4. Does more than one ichneumon grub attack any one *Sirex* larva?

CALLIRHYTIS SEMICARPIFOLIÆ,
CAMERON.

Plate VII, fig. 3, a, b, c.

Reference:—Cameron in litt.

Classification:—Order, HYMENOPTERA.

Tree attacked:—*Quercus semicarpifolia* (the Kharshu Oak).

Description.

The *larva* is a minute white grub. (See Pl. VII, fig. 3, a.)

The *pupa* is white and the parts of the perfect insect are seen nearly free, each covered in a very delicate skin. It is found simply lying in its cell and is unenclosed in any kind of silky cocoon. As the insect matures the head becomes black, as also the upper surface of the thorax and abdomen, the latter becoming pale yellow on the under surface.

Imago.—Head and antennæ black; upper parts of thorax and abdomen black, sides and ventral surface dark amber-yellow; legs amber-yellow and moderately long; body is ovate-elliptical and blunt at posterior end. Wings four in number 1½ times length of body. Expanse of wings $\frac{5}{16}$th inch. Pl. VII, fig. 3, b, shows the pupa and fig. 3, c, the imago of this insect.

Life History.

This insect was discovered by the writer in acorns on July 5th. It proves to be new to science. All stages of the insect from full-grown larvæ to fully mature imagos, and also pupæ, were present in the seeds. It may thus be taken that the fly reaches its full development during the first fortnight in July or just before the burst of the monsoon.

The pupal stage is evidently a very short one.

As far as present observation goes the species would appear to require a cold climate, since the elevation at which this oak grows is from 8,500 to 10,000 feet.

The tree flowers in July-August, and it would appear probable that the flies lay their eggs either in the female flowers or on the twigs adjacent to them, as the insect's life from the young larva to the fully developed fly is spent within the acorn. On maturing the imago bores its way out, a small hole on the outer surface of the seed showing the place of exit. This is all that is at present known of the life history of this pest.

Locality from which reported.

This insect was discovered in an oak forest near Baghi in the Bashahr State, Punjab, at an elevation of between 8,500 and 9,000 feet.

Relations to the Forest.

The acorns in a piece of pure Kharshu Oak (*Quercus semicarpifolia*, Smith) forest were badly attacked by this insect in 1901. Under the attack the acorns turned quite black and later dropped to the ground. Many were still on the trees on July 5th but came off quite easily in the hand. In most instances, beyond the colour and a certain shrivelled appearance, there was no external evidence of the attack upon the acorn, this proving that the insect was only just reaching maturity. In a few instances only a hole at the base of the seed, piercing through the calyx, showed where the perfect insect had escaped. Inside the acorn was found to consist of a mass of hymenopterous cells containing larvæ, pupæ or nearly mature and mature insects. In several instances on exposing these later to the air they at once flew off.

The attack of this insect and some lepidopterous allies (to be considered later) was most serious, as I estimated that fully 80 per cent. of the seed over the area inspected was infested, and it is not improbable that the percentage was higher.

Protection and Remedies.

Wholesale attacks of this nature to the seed of forest trees require the most careful study, since they are most intimately connected with regeneration of the areas. In the present instance further close observation is necessary to discover whether the pest is itself infested with insect or fungoid parasites.

I would suggest that over small areas, where feasible, when such a large proportion of the acorns are infested by pests of this nature, it would be a good plan to sweep up into heaps and burn all the fallen seeds. If this is done thoroughly it is true that the small proportion of good seed will be destroyed but along with it enormous numbers of larvæ, pupæ, etc., will be killed off: as a result, the eggs laid being so much fewer in number, in the following year there will be every chance of obtaining a large crop of good seed. This remedy, when it is applicable, could be usefully tried in the case of cones and other fruits the seed of which suffers under similar attacks. (See No. 1, p. 110 of these notes.)

Points in the life history requiring further observation.

1. When are the eggs laid by the fly and where? Is it in the flowers or on the twigs adjacent to them?
2. When the young larvæ hatch out of the eggs.
3. Length of time spent in the larval stage.
4. Length of time spent in the pupal stage.
5. Does the ♀, on leaving the acorn, at once pair and lay her eggs?
6. What parasites, insect and fungoid, attack this pest?

HETEROCEROUS ALLY OF C. SEMICARPIFOLIÆ, CAMERON.

Inside the black-coloured acorns attacked by the above described hymenopterous fly were also some small (probably micro-lepidopterous) caterpillars. These were of all sizes up to about ⅓rd inch in length and two different species were present—

(1) In colour whitish-translucent, with blackish-green head, and a small partial collar of the same colour on the top of the dorsal surface of the first segment.

(2) Small brownish hairy larvæ, about ¼th inch in length, with numerous short tufts of hair with long hairs interspersed amongst them. (See Pl. VII, fig. 4.)

These larvæ appeared to be burrowing within the acorn amongst the hymenopterous cells. Both hymenopterous and lepidopterous larvæ were cut out of the nut practically alongside one another.

Owing to constant shifting of camp I failed to breed out any of the moths from these caterpillars. It is not improbable that the larvæ pupate in the soil after the acorn has dropped to the ground.

We have still to observe, with reference to these insects, where the eggs are laid, how long the larvæ spend in the larval stage, where they pupate, and when the moths appear. Until the latter are found the insects cannot of course be named.

OTHER HETEROCEROUS LARVÆ ATTACKING THE ACORNS OF QUERCUS SEMICARPIFOLIÆ.

Description of larvæ.

Three different kinds of caterpillars appeared to be present, all differing in appearance, two markedly so, from those already described as accompanying *Callirhytis semicarpifoliæ*:

No. 1. Whitish-translucent with markings similar to the one already described ((1) above) but the grub was much larger, being ½ inch in length. This *may* prove to be the same as one of the two found with *C. semicarpifoliæ*.

No. 2. This differed totally in appearance. Yellowish-red in colour, with a black head and a row of blackish tubercles down each side situated above the median plane. Length ½ inch.

No. 3. A larger caterpillar, ¾ inch in length, differed in appearance from the above both in size and colouration, etc., though I considered it might be only in a more developed stage. It was dark brown and hairy on its dorsal surface, yellow on its ventral one, with a yellow head and thoracic segments. Dorsally it was covered with numerous tubercles bearing tufts of brown hair; running down each side, were a row of orange-coloured tubercles bearing shortish tufts of hairs of the same colour together with pencils of long, fine, yellow hair.

Life History, etc.

The above-described larvæ were cut out of acorns which were not infested by the hymenopterous fly.

Nos. 1 and 2.—The acorns from which these were taken were reaching normal size, being roundish in contour and green, touched with red on one cheek. They had holes on their outer surfaces and within I found as many as three larvæ feeding on their contents. Never more than three were found and sometimes only two.

No. 3.—This was cut out of an acorn which had turned dark brown in colour. It was feeding in the interior.

This is as far as observations on these caterpillars have been carried at present. Unfortunately, though an attempt was made, no moths were successfully reared from the larvæ.

From the holes visible on the outer surfaces of the green acorns, it is probable that at least one of the larvæ wanders about during this stage of its existence and enters the acorns from the outside. In no instance was any trace of the hymenopterous fly found in acorns attacked by these three larvæ. If No. 1 is the same as the caterpillar (1) accompanying Callirhytis, its development would appear to be quicker when infesting acorns free from the fly. Further observation is required on this point.

Points in the life history requiring further observation.

1. Where are the eggs laid and when?
2. Length of time spent in the larval stage by the various caterpillars.
3. Where they pupate (is it in the ground after the acorn has fallen from the tree?), and length of time passed in the pupal stage.
4. When the various moths issue and period spent in this stage.[1]

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[1] I should be much obliged if specimens of these moths, when procured, were sent to me to Dehra Dun.

A further note on the life history of SINOXYLON CRASSUM, LESNE.

(*See pp. 12-15 in No. 1 of these Notes.*)

Trees attacked :—*Shorea robusta* (Sâl); *Terminalia tomentosa*, Roxb.

Description.

The beetle varies greatly in size. Specimens taken in the Dehra Dun sâl forests are as much as $\frac{5}{16}$th of an inch (7·8 millim.) in length.

Life History.

This insect has been found boring into sâl shoots and seedlings by students Littlewood and B. C. Gupta.[1] The insect was found in the beetle stage in the third week in February, and examination showed me that it was egg-laying. It bores a large circular entrance hole into the wood and then mines up the shoot. The shoots infested were dead ones at the end of the branches of sâl poles, and the beetles were plentiful. Student Littlewood made the following note: "The beetles were found in little bores in the dead upper part of young sâl shoots ; almost every shoot was bored into, the entrance hole being usually above a node and the gallery proceeding downwards. Beetles found in the Phandowalla sâl areas."

The beetle has not previously been reported as commencing the first egg-laying of the year before April. The fact that it begins work so much earlier in the year in the Dun forests and that it is of so much larger size would appear to be of some importance, and its life history in these forests requires working out.

Owing to its large size, I was doubtful of its identity with *S. crassum*. Mr. Lesne, who settled this point for me, tells me that he has already had it reported as infesting the sâl, but does not mention from where the insect was sent.

S. crassum was also found infesting the *Terminalia tomentosa* last year in the Central Provinces.

[1] Of the Imperial Forest School, Dehra Dun.

Terminalia tomentosa is a tree of some value in parts of India. In the Central Provinces it is in demand for rafters etc., used in the construction of bungalows. Whilst in Seoni, in August last year, my attention was drawn to the state of the roofs in some newly-built bungalows put up by the Bengal-Nagpur Railway. They had the ordinary thatched roof so common in the country, the rafters, carrying the superstructure of bamboos and thatching grass, consisting of roughly-barked *Terminalia tomentosa* posts. These latter were being badly riddled by the Sinoxylon beetle which was egg-laying, the floor and furniture beneath being covered with little yellow spots of saw-dust dropping from the beetle borings. Mr. C. O. Hanson, the Deputy Conservator in charge of the Seoni Division, who was my companion at the time, informed me that most, if not all, of the roofs of the new bungalows were in a similar state, some being very bad indeed. One of these latter I was subsequently shown, and the number of beetles at work in the roof was very large. Through the courtesy of the railway officials, Mr. Hanson was able to send me up one of the attacked posts taken from this roof the following month (September). The post was sent up in lengths, together with some insects cut from a portion of it. Amongst these were some *S. crassum* beetles. The insect was egg-laying in September, both beetles and half-grown larvæ being found in tunnels in the wood. Under favourable circumstances, some of these larvæ develop into beetles, which issue about the beginning of November and hibernate as such through the cold-weather, or a portion of the cold-weather, months.

Protection and Remedies.

Bostrichids of this kind do not infest green living trees, nor will they attack fresh-cut posts immediately after felling. As soon, however, as the sap has begun to dry off a little from the post, the bostrichids make their appearance and commence boring into the wood for egg-laying purposes. It is immaterial, in the case of these beetles, whether the pole is barked or not, as it is the wood, and not the bast layer, which they require. It is during the drying stage, therefore, whilst chemical changes are taking place in the wood, that posts require protection, and although the matter is at present, I believe, little understood, it has been discovered that if the posts are kept in water after being cut whilst these changes in their interiors are taking place, their liability to attack by bostrichid beetles is apparently enormously decreased. My studies in this matter, as far as they have at present been carried, lead me to believe that this is not infrequently an undoubted fact, both in the case of wood and bamboos.

I therefore recommend that, whenever possible, poles (and bamboos), when cut, should be—

(1) Felled (preferably) when the sap is down.

(2) As soon as cut, placed in water, and kept there for some time.

(3) If the latter is not possible, smoked as soon after felling as possible.

Locality from where reported.

The insect was found at Phandowalla in the eastern Dun forests of the United Provinces; elevation about 2,000 feet. It was also obtained at Seoni in the Central Provinces.

A further note on the life history of SINOXYLON ANALE, LESNE.

(*See pp. 16-18 and Pl. I, fig. 2, of No. 1 of these Notes.*)

Plant attacked—Bamboo.

Dehra Dun, United Provinces, must now be added to the area of distribution over which this beetle ranges. It was discovered in October 1901 in tunnels in bamboo tent poles in the store-room at the Imperial Forest School, Dehra Dun.

I am not aware that the beetle has been previously reported as infesting bamboos.

Protection.—I would recommend that, when tents are put away after the camping season is over, a plentiful supply of naphthaline (in lumps, not powder) be packed in amongst the folds, and that pieces be placed in the heaps of stacked tent poles. This will have the effect of keeping away other pests affecting the canvas in addition to keeping the poles free of borers.

DINODERUS PILIFRONS,
LESNE.
THE BAMBOO BORER.

Plate VIII, fig. 1, a, b.

References:—Lesne, Ann. Soc. Ent. Fr. (1895). Stebbing, Injur. Ins. Ind. For., 42—45. Fig. 26.[1]

Classification:—Order, COLEOPTERA. Family, Bostrichidæ. Sub-family, Dinoderinæ.

Plants attacked:—*Dendrocalamus strictus* and probably other bamboos.

Description.

I add the following to the short description of this beetle given on page 43 of *Injurious Insects* :

Beetle.—Long oblong, parallel, reddish brown with the appendages and lateral edges of the abdomen lighter in colour. Long reddish hairs near the eyes and on the clypeus (lower portion of front part of head). The upper part of the antennæ has the same hairs. The teeth on the anterior surface of the prothorax are more or less pointed and projecting. Punctation on the elytra fine anteriorly, becoming much stronger at the posterior declivity.

Length $3\frac{1}{3}$ to $3\frac{3}{4}$ millim. (See Pl. VIII, fig. 1, a.)

Life History.

This insect is one of the several small bamboo-borers of India. It infests the bamboo (*Dendrocalamus strictus*) in the Siwalik forests. This bamboo grows in clumps and is often seen to have towards its base the contorted shape shown in Pl. VIII, fig. 1, b. This may be due to congestion in the clumps, but the matter has not been satisfactorily explained as yet. Some pieces of bamboo contorted in this manner were cut green at the beginning of February and placed in a breeding box towards the end of the next month. By July the box was an inch deep in bamboo saw-dust amongst which were enormous numbers of the *Dinoderus pilifrons* beetles, which had bored their way out of the bamboos. On examination larvæ were

[1] Given as Dinoderus sp. Since named by Mons. Lesne as *Dinoderus pilifrons*.

found in the bamboos, which were very much riddled. (See fig. 1, b.) Many of the insects were left in the box with the bamboos and continued breeding and egg-laying until November, in which month there were many mature beetles still alive in the bamboos and at the bottom of the box.

From the above it becomes evident that this insect has several generations during the year, and my present observations lead me to the conclusion that these generations probably overlap, and that consequently beetles are to be found, with the exception of the colder months, December to March, throughout the year.

That the beetle lays an enormous number of eggs and has the power of very rapid multiplication is evidenced by the very large number of insects bred out from the few small pieces of bamboos placed in the breeding cage.

Localities from where reported.

Mysore and Dehra Dun (N.-W. India) and the adjacent forests are the localities from which the insect has been especially reported as doing damage. M. Lesne gives the distribution of the insect as India, China and the Philippines, Bangkok (Dr. Hammond), Belgaon (H. E. Andrewes).

Relations to the Forest.

This beetle and a closely allied species, *D. minutus*, are serious pests of bamboos in India. As long as the bamboo is green and healthy it is apparently unattacked, but if through any cause it becomes sickly whilst still standing in the clump or as soon as it is cut, the beetles attack and lay their eggs in it. There is no doubt that the duration of the life of the cut bamboo for building and other purposes is greatly shortened all over the country by the operations of this pest.

The natives have many superstitions with reference to these insects, the one most generally believed in being that bamboos should not be cut at full moon and when they are full of sap.

The Madras Board of Revenue instituted enquiries on these heads in 1898, and a series of interesting experiments were made by the Department in that Presidency. The evidence on some points is conflicting and this was to be expected since the conditions under which the bamboos were experimented with were not the same in all cases. The concensus of opinion of the majority would seem, however, to favour cutting bamboos in the winter months, *i.e.*, November to March when the sap is low. Bamboos cut in the spring or summer suffer very seriously from the borers, as also do newly-cut ones kept in the shade. This statement is considered to apply to newly-cut poles also. Whilst there can be no doubt that there is a good deal to be said for these theories, the point should not be lost sight of that at present we know very little about the life histories of these borers. It is known that there is more than one species (and more than one genus) of beetle which attacks the bamboos. One or more of these may hibernate in the wood through the winter months either as a larva or beetle, commencing the first attacks of the year on neighbouring bamboos towards the end of March. This being the case it may follow that bamboos cut between December and the middle of March, containing as they do little sap, may rapidly dry and thus, besides becoming distasteful to some of the borers, at the same time by contraction kill off the hibernating insects within them. I would suggest that it is not so much the phases of the moon, etc., which require to be studied but rather the life histories of the beetles.

My experiments with the Dun bamboos would seem to show that the beetles, having once got into the stems, continue boring and breeding in them throughout the spring and summer months or at any rate that this is the procedure of *Dinoderus pilifrons*. Other species may perhaps leave the bamboo when quite dry.

Protection.

1. Whenever possible bamboos as soon as cut should be immersed for a few weeks in water. It is an undoubted fact that they then become less liable to attack from wood-borers. The reasons are threefold :—

(1) Whilst submerged the beetles cannot get at the bamboos to attack and lay eggs in them.

(2) Any beetles and larvæ that may be at work in them will be drowned.

(3) It is considered that the water dissolves out much of the nutritive matter in the wood cells, upon which the borers and their larvæ feed.

2. In thinning bamboo clumps in the systematic manner now carried out in parts of India, the contractor should be made to remove, as far as possible, the larger refuse from the cut-over clumps. It is usual to remove only the straight pieces of any one bamboo cut out, these alone having a marketable value. The rest is left lying *in situ*. The thin branchwood stuff would probably be too expensive to either remove or burn, but the thicker rejected tops and ends should be cleared out of the forest. If they are thrown into the nearest stream it will suffice. It is more than probable that the systematic working of the bamboo clumps, whereby the formerly large amount of dead and dying bamboos in the forest, which always provided a sufficiency of food for the beetle, is disappearing, will bring the pest into prominence, by localising it in centres and thus rendering it dangerous, if the larger refuse is left round the thinned clumps in the coupes.

3. Cut bamboos in the cold weather months, preferably between December and the end of February, since there is the greater probability of the borers being in the hibernating stage of their life history during these months.

Points in the life history requiring further observation.

1. The number of generations of the insect in the year.
2. Length of time spent in the larval and pupal stages of the insect in the various generations.
3. What other trees are attacked by this *Dinoderus* ?

DINODERUS MINUTUS,

FABR.

References :—Fabricius, 1775, Syst. Ent., p. 54—Olivier, 1790, Enc. méth., Ins., V, p. 111.—Id., 1795, Ent., IV. No. 77, p. 15, pl. II, f. 12. *substriatus* Stephens, 1830, Ill. Brit. Ent. III, p. 352. *siculus* Baudi, 1873, Berl. Ent. Zeit., XVII, p. 356.—Id. 1873, Ann. Mus. Gen., 1873, p. 265 ; *bifoveolatus* Zoufal (*non* Wollaston), 1894, Wien. Ent. Zeit., XIII, p. 42. Lesne, Ann. Soc. Ent. Fr. LXVI, pp. 329—334 (1897).

Classification :—Order, **COLEOPTERA**. Family, Bostrichidæ. Sub-Family, Dinoderinæ.

Plant attacked :—Bamboos (sp.?).

Description.

Beetle.—Slightly elongated, brown, with the lower dorsal portions of the elytra lighter coloured, occasionally almost reddish. The stiff hairs on the front portion of the clypeus always few in number and very short. 10-jointed antennæ, the upper portions not fringed with hair ; the second joint of the club less than one and a half times as large as long. Front edge of the prothorax armed with more or less pointed teeth, not set very close together, the middle ones being more gaping than the outer. Posterior portion of the pronotum strongly and thickly punctate (pitted), but the pits do not join. Elytra covered with short bristly hairs becoming denser on their posterior declivity. Elytra are thickly and densely pitted, more deeply so on their anterior portions. This beetle is very like the one shown in Pl. VIII, fig. 1, a, but is smaller.

Life History.

This insect has been so often contused with its close ally *Dinoderus pilifrons* that it is impossible to say with any certainty what its life history really is. It undoubtedly infests bamboos in great numbers and not improbably often works in company with its companion. This has, however, to be yet observed. It was not present amongst the *D. pilifrons* bred out of the bamboos obtained in the Siwalik forests. It is apparently very common in the Bombay Presidency where it is said to be plentiful in houses from December to February flying slowly about (H. E. Andrewes). There should therefore be no great difficulty in working out its life history in that Presidency. This is of some importance since it may turn out that bamboos are subject to the attacks of the borers throughout the year on the Bombay side if *Dinoderus pilifrons and D. minutus* are equally plentiful. It has been found boring into bamboo in Guadaloupe, in the dry roots of *Smilax borbonica* in the Island of Réunion and in lianas from Brazil in which cotton had been packed.

Localities from where reported.

Lesne states that this beetle is cosmopolitan in tropical regions. It is the commonest species of the genus and is at times found in ports and large towns in temperate climates.

As I have said, Andrewes reported it as very common in the Bombay Presidency.

Relations to the Forest, etc.

The same remarks apply as given for *D. pilifrons.*

The remarks with reference to the best time for cutting may require modification in Bombay for this beetle. It is not possible to make any definite statement, however, until its life history has been worked out.

Points in the life history requiring further observation.

1. The number of generations in the year. Since the beetle is found on the wing from December to February, during the colder months, and since it has such a wide spread, it is not improbable that the number of life cycles passed through in a year are very large.
2. Length of time spent in the various stages of egg, larva, pupa and beetle in the different life cycles.
3. The different food-plants of the insect.
4. Does the beetle attack sickly still-green trees, etc., or does it only infest dry dead plants?

BOSTRICHUS PARALLELUS,
LESNE.

Plate VIII, fig. 2.

Reference:—Lesne, Ann. Soc. Ent. de France, LXIII, 170 (1894).

Classification:—Order, **COLEOPTERA**. Family, **Bostrichidæ.**

Plant attacked:—*Dendrocalamus strictus* (Bamboo).

Description.

Beetle.—Black, shining, somewhat narrow, elongated, with parallel sides. The joints of the antennæ from 3—7 taken together are longer than the first and second united. The dorsal surface of the elytra is strongly punctated, the punctations being disposed in a regular series of striæ. The sides of the prothorax and elytra covered with a stiff pubescence, which is not thick. Ventral surface of the body densely pubescent. In the ♂ the posterior declivity of the elytra is fairly highly punctured. In the ♀ the forehead is not convex; the declivity of the elytra has not projecting edges.

Length 9·13 millim. (See Pl. VIII, fig. 2.)

Life History.

This beetle was found in the middle of June boring into dead stacked bamboos. It was in the imago stage, and was probably egg-laying. It was cut from the wood tissue.

Locality from where reported.

The beetle was sent from Raipur, Central Provinces, by the late Mr. A. M. Long, then in charge of the forests at that place. The insect has a very wide distribution, as M. Lesne gives the following as its geographical distribution: Indo-China, Hindustan, Formosa, Sumatra, Philippines.

Relations to the Forests, etc.

These are much the same as already given for the two species of *Dinoderus* beetles already described. With reference to this beetle, it is necessary to discover whether it infests bamboos as soon as cut or whether it only attacks already dead ones.

Points in the life history requiring further observation.

1. Method of egg-laying and number of eggs laid.
2. Length of time spent in the larval and pupal stages.
3. The length of time spent as a beetle.
4. The number of generations in the year. In all probability, this will be more than one, perhaps several.
5. The condition of the bamboos when attacked by the beetle, whether green or absolutely dry.
6. The other food-plants of the beetle.

PLATEROS DISPALLENS,

WLK.

Classification:—Order, COLEOPTERA. Family, Malacodermidæ. Sub-Family, Lycides.

Tree attacked:—*Tectona grandis*, L. (Teak).

Description.

Egg.—Dirty pale yellow in colour and elliptical in shape. Very small.

Beetle.—Head and prothorax shining black. Prothorax entirely covers the head, wider than long, with a deep sinus running round its edge. Antennæ longish, serrate, and shining black, as also are legs; elytra soft, leathery, not meeting rigidly at the suture; rounded at ends. Anterior half of elytra orange yellow, posterior portion black. Under-surface of insect shining black. ♂ resembles ♀ in colouration, but latter is slightly larger Length ½ inch when fresh. Pl. VIII, fig. 3, shows the ♂ and ♀ of *Plateros* sp., to which this one is very similar in appearance.

Life History.

The insect is to be found on the wing in the middle of August, about which time it pairs. The eggs appear to be laid very soon after pairing, as beetles kept under observation laid within 24 hours of coupling. The eggs are laid in batches of irregular shape, from 30 to 35 being deposited close together in a batch. The eggs were not laid upon the teak leaves placed in the tube with them, but on the sides of the tube. It is not improbable that they may be laid upon the teak twigs in the forest or round and on the buds. This point requires further observation. *Plateros dispallens* frequents teak forests at this time of the year and does a certain amount of surface defoliation to the leaves. So far my observations have shown me that it eats patches out of the parenchyma of the upper surface of the teak leaves; as a consequence, the lower untouched portion of the leaf dies and turns brown.

Locality from where reported.

This insect is at times common in parts of the Damoh forests in the Central Provinces.

Relations to the Forest.

From our present slight knowledge of the habits of this Plateros it is impossible to say whether the damage it is capable of doing in the forest is considerable or otherwise. A certain amount of leaf tissue is lost under its attacks as already stated, but present observations have not shown that this loss is sufficiently heavy to materially affect the health of the tree.

Points in the life history requiring further observation.

1. Where the eggs are laid. Is it on the teak leaves or twigs?
2. When and where does the larva hatch out and on what does it feed?
3. Length of time spent in the larval stage.
4. Length of time spent in the pupal stage.
5. Number of generations in the year.

PLATEROS SP.

Plate VIII, fig. 3.

Reference:—Provisionally determined as *Plateros* sp. new to the British Museum Collection.

Classification:—Order, **COLEOPTERA.** Family, **Malacodermidæ.** Sub-Family, Lycides.

Tree attacked :—*Tectona grandis*, L. (Teak.)

Description.

This beetle differs from *P. dispallens* in both size and colouration.

Egg.—Pure white in colour and egg-shaped resembling a minature hen's egg. Slightly larger than that of *P. dispallens*.

Beetle.—General colour is a reddish-orange beneath and a russet brown on head and thorax dorsally. Anterior two-thirds (basal portion) of the elytra, which resemble in consistency and formation those of its smaller companion, russet-brown in colour, the posterior third being black at tips shading off anteriorly into the russet-brown colour. Legs black, tinged with russet-brown. Antennæ longish, serrate, black. Two segments of the body project beyond the elytra. ♂ smaller than ♀.

Length of ♂ $\frac{1}{3}$ inch; of ♀ $\frac{1}{2}$ inch (measurements of fresh specimens). Pl. VIII, fig. 3 shows a dorsal and side view of the ♂ and ♀ of this insect.

Life History, etc.

The notes on the life history, locality where found, etc., already given for *Plateros dispallens*, apply equally to this beetle. The insects were found on the teak leaves in company and both the species were coupling. The eggs are laid shortly after coupling in a similar manner to those of its companion, the numbers laid being from 35—40 deposited in irregular patches. The insects readily take to flight on being disturbed.

The further observations on the life history required for the one are the same for the other.

HALTICIDES.

Plate VIII, fig. 4.

Reference:—Provisionally determined as belonging to the *Halticides*. not in the British Museum Collection.

Classification:—Order, **COLEOPTERA**. Family, **Chrysomelidæ.**

Tree attacked :—*Boswellia serrata.*

Description.

Beetle.—A medium-sized thick set insect with small yellow head and two prominent black eyes. Thorax yellow, slightly broader than long, small. Elytra broader than thorax, yellow to brownish in colour, the yellow being generally in irregularly-shaped faint blotches. At times a few faintly marked black spots are present. In the ♀ the elytra are sometimes all yellow with scattered brownish markings and small spots. The elytra are broadly striated with rows of punctures between the striæ and are deflexed posteriorly leaving one segment of the body exposed. The body is thick and pointed posteriorly, yellow to yellow brown beneath and shining. Antennæ and legs canary yellow, the former being slender and short. Posterior pair of legs are long and have their femora (thighs) remarkably thickened and developed, thus enabling the insect to leap the great distances it is capable of doing. These femora are at times dark yellow to brown in colour. The posterior tibiæ are spined at their bases. The third tarsal joint is deeply bilobed.

Length ♂ $\frac{5}{16}$ths inch; ♀ $\frac{3}{8}$ths inch. Pl. VIII, fig 4, shows a dorsal and side view of this Chrysomelid.

Life History.

This beetle appears on the wing at the beginning of August and possibly during the latter part of July.

It feeds upon the leaves of *Boswellia serrata.* These leaves are compound ones, and it apparently attacks the upper leaflets, first feeding downwards until about two-thirds of the compound leaf (from top downwards) has been more or less eaten away.

At other times all the leaflets disappear entirely. The beetle begins by eating the leaflet irregularly round the edge, patches being gnawed out, or it commences on the inner part and eats out holes in the leaf tissue. The effect of this defoliation is to cause the leaflets to shrivel up, turn brown and fall off.

At the beginning of August, when these beetles were observed at work, the insects were pairing ; the male, the smaller insect of the two, being carried about on the back of the female. This Chrysomelid is a powerful jumper, and even when coupled the ♀ will often take a long leap. Like many *Chrysomelidæ* they are extremely wary and take to flight at the slightest motion which alarms them. If too late to fly, they drop off the food-plant like a stone and sham death on the ground, where, owing to a similitude in colouring, they are extremely difficult to see. When coupled, they appear to lose some of their extreme wariness.

At present I have no further observations on the life history of this pest.

Locality from where reported.

This insect was found in the Bhamburda Reserve near Poona in the Bombay Presidency.

Relations to the Forest.

I have described above the manner of feeding of this Chrysomelid. There can be no doubt that when in any numbers it is capable of doing a large amount of defoliating damage. We do not yet know where its larval stage is passed or upon what the grub feeds.

Protection and Remedies.

When feasible in nurseries and young plantations, this beetle can be attacked in its adult stage by means of the Paris green arsenic treatment described on pages 146—149 of these notes (No. 1). The beetle, being a leaf-feeder, will take the poison internally and be killed off. We require to know more about its life history, however, as it may prove easier to attack it in its grub stage.

Points in the life history requiring further observation.

1. When the eggs are laid.
2. When and where the grubs hatch out and on what they feed. Length of time spent in this stage.
3. Length of time spent in the pupal stage and where this stage is passed.
4. Number of generations in the year.
5. What other, if any, trees and plants this beetle feeds upon. This is important since the beetle is a fair-sized one and active, and consequently if it made its appearance in the large central nursery recently formed near Poona, it would not unlikely commit considerable havoc amongst the young plants.

STROMATIUM BARBATUM,

FABR.

THE KULSI TEAK BORER.

References :—Fabr. Syst. Ent. p. 189. Stebbing, Inj. Ins. Ind. For. 73-76, figs. 48 (larva), 49 (imago).

Classification :—Order, **COLEOPTERA.** Family, **Cerambycidæ.** Sub-Family, **Cerambycides.**

Tree attacked :—*Dendrocalamus strictus* (Bamboo).

In *Injurious Insects* this insect has already been reported as attacking teak and khair.

Description.

Larva—Is a whitish thick grub with a pale brown prothorax larger in breadth than the rest of the segments. The mouth parts are black.

Beetle—Has a general brown to brownish colour and is covered with a moderately dense orange yellow pubescence. Eyes kidney-shaped, the antennæ being inserted forwardly on the head in the angle in the eye. Antennæ long slender, basal joint being thickened and black; other joints brown and set with a longitudinal row of stiff hairs on the under-surface of the joints. Prothorax is broader than the head, wider than long, with irregular-shaped swellings and knobs on its dorsal surface. Laterally on either side there is an ear-shaped depression filled w th densely set hairs which are a bright orange yellow in male, a dull purple in ♀. Legs longish and slender, the tarsi being clothed with yellow hairs. Elytra long, of the same width as the thorax from which they are separated by a small neck; rounded at their ends and broadly striated and pitted in longitudinal rows on their dorsal surfaces.

♂. Antennæ stout, longer than body. Length 1 inch.

♀. Antennæ not as long as body, more slender than in ♂. Portion of the last abdominal segment projects beyond the tips of elytra. Length a little over 1 inch.

Life History.

I have already described what is known of the life history of this insect in *Injurious Insects*. It is known as the Kulsi Teak borer, and has proved destructive to young teak saplings at the Kulsi Teak Plantation, Assam. It was also reported as attacking dry khair (*Acacia catechu*) wood in the Forest School Museum, Dehra Dun. In this latter case the eggs were probably laid in the bark of green wood, and the young larvæ then bored into the tree and remained boring in the wood after it had been sent to the Museum, as it is known that they spend more than one year in this stage of their life history.

The beetle is now reported as having issued from dry bamboos in the Raipur Division, Central Provinces. In this case also it is probable that the eggs were laid in the green bamboos soon after they were cut.

Relations to the Forest.

This pest is known as a dangerous one in Teak plantations in parts of India. The fact that it also attacks bamboos would tend to show that it has several food plants, and it becomes important to fully work out its life history.

Points in the life history requiring further observation.

1. Length of time spent by the larva in this stage. As larvæ of various sizes (and ages) are to be found at all times of the year in infested stems, it is certain that the grub lives for more than one year in this stage.
2. The different kinds of trees infested by the insect and the age at which the tree is attacked.

MYLLOCERUS ACACIÆ, MS.

Plate VIII, fig. 5.

Reference :—Provisionally named as **Myllocerus acaciæ**, MS. new to the British Museum collection.

Classification :—Order, **COLEOPTERA**. Family, **Curculionidæ**.

Tree attacked :—*Acacia Catechu.*

Description.

Beetle.—A greyish oblong weevil clothed above and below with short fine golden yellow hairs. Proboscis or rostrum not quite as long as broad, thick and slightly enlarged at its tip. Scrobes (the groover on the proboscis) deep and easily seen from above and in front. Antennæ placed anteriorly on proboscis near its tip, long, and clothed with short yellow hairs. Scape of antenna (basal portion of antenna below elbow) thickens anteriorly; funiculus (upper portion above elbow) with first two joints long and equal, third to seventh joint short; club oval-oblong and jointed. Eyes large. Prothorax broader behind than in front; scutellum small. Elytra almost flat in front, convex behind, deflexed to a point at their tips; are set with parallel longitudinal rows of fine punctures running down them. Femora thickened; third joint of tarsus bilobed and all joints set with a fine pubescence. Second abdominal ventral segment wider than the succeeding ones and separated from the first by a suture which is arched in the middle. Length $\frac{1}{4}$ inch. Insect winged and flies well. (See Pl. VIII, fig 5.)

Life History.

This weevil was noticed feeding upon, and defoliating to a certain extent, the leaves of *Acacia Catechu.* The insect apparently only feeds upon the young green leaflets. The compound new leaves of this tree were at the time, the beginning of August, half unfolded, and it was then that the weevil was engaged in its defoliating operations.

The insect did not appear to be pairing, and consequently the attack had possibly only just commenced. At the time of my inspection the damage done was but small.

I know nothing more about the life history of this beetle, which is quite different from the species described on p. 31 (No. 1) of these notes as defoliating the Sissu.

Locality from where reported.

The insect was found in the Bharuburda Reserve near Poona in the Bombay Presidency.

Relations to the Forest.

As I have described, this *Myllocerus* in its adult stage does a certain amount of defoliation. Further than this, nothing appears to be known about the weevil. When and where it lays its eggs, where the larva lives and on what it feeds and the time spent in this stage have yet to be observed. Also the number of generations in the year and how the cold weather is passed.

Note.—A second minute bright metallic-green *Myllocerus*, the species being as yet undetermined, was also found in company with the *M. acaciæ* MS. above described feeding upon the leaves of the *Acacia Catechu*. The insect was somewhat plentiful, but owing to its small size, about $\frac{1}{8}$th inch in length, the damage done by it was inappreciable. This weevil was pairing at the time of capture.

CYPHICERUS SP.

Plate VIII, fig. 6.

Reference :—Provisionally named Cyphicerus sp. not in the British Museum Collection.

Classification :—Order, COLEOPTERA. Family, Curculionidæ.

Tree attacked :—*Tectona grandis*, Lin. (Teak).

Description.

Beetle.—♀. General colour brown with blackish head and thorax. Insect covered more or less with short stiff hairs. Rostrum not longer than head. Antennæ inserted near top; scrobes short and deep. The antennæ are not inserted right at top of rostrum in ♀ (they are so in ♂) but a little way down it; are set with hair: scape thick, thickening anteriorly, slightly arched; funiculus with first joint short, second nearly twice as long, third to seventh short and the club oval-oblong and pointed at its extremity and jointed. Eyes large, only slightly convex, oval-oblong, oblique. Prothorax rather narrow, straight in front and behind. Elytra oblong-oval, wider than prothorax, widening posteriorly and deflexed at their apices which meet in a point; brown in colour with a dull white transverse band in their posterior third; longitudinal parallel series of striæ and punctures run down the elytra. Legs moderately long, thighs thickened and ending in a little spine beneath; tarsus very hairy beneath, third joint much broader than first and second. Body oblong, ♂ more yellow in colour without the white transverse patch on elytra and with the golden short stiff hairs much thicker on elytra. Antennæ inserted at top of rostrum. Length ♂ $\frac{3}{16}$th inch; ♀ $\frac{1}{4}$th inch.

Pl. VIII, fig. 6, shows a dorsal and side view of this insect.

Life History.

This insect appears on the wing in Berar in July, probably generally about the time the monsoon bursts. It feeds upon the leaves of the teak tree. Either the life of the beetle is a somewhat lengthy one or the eggs develop at irregular periods since a month later the weevils were found common in the Damoh forests in the Central Provinces.

In Berar the beetles were noticed pairing on July 26th, the insects being very numerous on the teak trees, both young and old being infested.

In the middle of August the weevils were found in a similar condition in the Damoh forests. On the 20th of the month I noted the beetle as equally numerous in the Jubbulpore Division between Jubbulpore and Luckneedown. Here, as in the portions of Damoh visited, the beetle was far more plentiful during this month than either of the teak leaf defoliators, *Hyblæa puera* or *Pyrausta machæralis*, which were present with it on the trees.

In Berar (in the Melghat forest) the weevil had an additional companion in the larva of the hawk moth *Pseudosphinx discistriga* and was in parts very much more abundant than the latter, although it was not noted as ascending quite so high into the hills as the sphinx. In these forests both the latter and the weevil were much more abundant than the *Hyblæa* and *Pyrausta*. Its method of defoliation is as equally distinct from that of the hawk moth (described in No. 1, p. 52 of these notes) as from that of the *Hyblæa* and *Pyrausta* (described later on in this number). The weevil attacks the leaf in two ways: either by eating out patches from somewhere within the leaf, avoiding the edges, so that the leaf becomes full of irregular-shaped holes, the larger veins being always left untouched, or it eats out irregular portions from the edges, the latter having thus a ragged and frayed appearance. In both cases the edge left by this beetle always has this frayed and ragged appearance owing presumably to the very small portions of leaf tissue it is able to take out at a time in the case of so thick a leaf as the teak leaf. The patches eaten out by this weevil can thus be easily distinguished from those of a caterpillar attack since the latter's bite when it goes through the leaf is always a clean cut: a frayed edge is never left. So marked is this jagged appearance of the leaves that it caught the eye and told me of the presence of the beetle as I was riding along a road in Damoh bordered with teak trees before I had been into a forest in that district.

Neither the eggs nor larvæ of this pest have yet been found.

Locality from where reported.

The writer found this weevil common at the lower elevations in the Melghat teak forests lying between Ellichpur and Chikalda; in the Damoh Division between Damoh and Singrampur; between the latter place and Jubbulpore; and between Jubbulpore and Luckneedown on the Jubbulpore-Nagpur road.

Relations to the Forest.

While this weevil undoubtedly does a certain amount of defoliation on the teak in years when it is plentiful, attacking the leaves of both young and old trees, present observation does not show it to be anything like as bad a pest as its three lepidopterous companions, and it appears doubtful as to whether it would ever be capable of entirely denuding a teak forest of its leaves. It must, however, certainly be considered an enemy of the tree, and it is important that the rest of its life history should be worked out, especially the point as to where its larva lives and on what it feeds.

Protection and Remedies.

In nurseries spraying young plants attacked with the Paris green arsenical solution would have the effect of killing off the beetle. This should be done as soon as the pest makes its appearance, and repeated at intervals through July and August. The earlier the beetles are attacked, the less chance is there of their reaching the pairing stage and laying eggs.

Points in the life history requiring further observation.

1. Where the eggs are laid.
2. Where the larva lives and upon what it feeds.
3. Length of time spent in the larval stage.
4. Where does the larva pupate?
5. The number of generations in the year. Are there one or more spring (hot weather) generations and a late autumn one as in the case of its companions *Hyblæa* and *Pyrausta?*
6. Where and in which stage of its metamorphosis does it pass through the cold weather?

APODERUS INCANA, MS.

Plate VIII, fig. 7, *a—c*.

Reference :—Provisionally named Apoderus incana, MS. new to the British Museum collection.

Classification :—Order, COLEOPTERA. Family, Curculionidæ.

Trees attacked :—*Quercus incana* and *Q. dilatata.*

Description.

The *egg* is yellow, shining, elliptical in shape and about $\frac{1}{16}$th inch in length.

♀ The *beetle* is small, shining, dark yellow brown with black markings on the elytra. Rostrum brown, short, broad, and armed at end with a pair of large mandibles. Antennæ inserted near base, the scape short and inverted cone-shaped; funiculus fairly long, first joint small, second and third longer and of equal length and with the following ones increasing in breadth upwards to the elongated cone-shaped club which is dark brown, the rest of antenna being yellow. Head short, semi-elliptical in shape narrowing to a point posteriorly, dark yellow-brown in colour. Prothorax joined to head by a short neck widening posteriorly and having a raised collar where it joins the elytra. Scutellum small, black. Elytra much broader than thorax, a little longer than broad, widening slightly to their ends and deflexed here, only lightly covering the body and leaving portions of two segments of the abdomen exposed; yellow in colour, channelled at their bases with two elongated black spots in their basal half; the external edge is raised and thickened slightly all round and is crimson to dark red in colour, being especially bright at the suture. Abdomen thick, lighter yellow ventrally. Legs bright yellow, long, with their femora thickened; 2 claws to end of tarsus. Length $\frac{9}{32}$nd inch. Pl. VIII, fig. 7, shows a dorsal and side view of this beetle.

Life History. [1]

These beetles appear on the wing about the close of the first week in May. At present only the perfect beetle is

[1] The curious method of egg-laying of this insect was studied by Mr. F. Gleadow, Ranger Subramarian, and by the writer in May 1901.

known. The insect when found was egg-laying and for this purpose it attacks the leaves of both the oaks, *Quercus incana* and *Q. dilatata.*

The ♀ beetle lays its egg in the left-hand corner of the apex of the leaf. The latter is then, in the case of the *Quercus incana,* either cut across two-thirds of the way down the leaf, the cut being made on both sides from the exterior edge horizontally inwards till it meets the midrib, or the leaf is cut right across from one side to very near the edge of the other, a small piece of the leaf tissue only being left. In either case the portion above the cut is folded inwards down the midrib and then rolled up from the apex downwards, the outer edges being tucked in so as to form a neat little cylinder which remains suspended to the lower part of the leaf by the uncut portion. (See fig. 7, b, c.) This latter is however, whether midrib or leaf tissue, nicked across so as to ensure the little roll of leaf tissue dropping to the ground when it has become dry. In the case of the *Quercus dilatata* the procedure is much the same except that the leaf appears to be almost invariably cut lower down (fig. 7, c.).

The little leaf rolls soon turn black as the tissue decays and are then very conspicuous upon the trees. It is probable that a small white or yellow curved grub hatches out of the egg and feeds upon the decaying leaf tissue of the roll, and subsequently when this latter has fallen to the ground, burrows into the earth to pupate. This part of the life history has, however, yet to be studied.[1]

The insects may be observed egg-laying for about three weeks during May, but the number of eggs laid by each female has yet to be ascertained.

Locality from where reported.

Throughout-Jaunsar Bawar and the adjacent Native States of Tehri-Garhwal, Jubal and Balsan this insect was very plentiful in 1901.

Relations to the Forest.

The peculiar method of laying its eggs adopted by this insect results in the trees attacked being very heavily defo-

[1] Compare the life history of the species of *Apoderus* attacking the Sissu (*Dalbergia Sissoo*) tree described in No. 1, pp. 33, 34 of these notes.

liated when the weevil is numerous. Trees of all ages are infested, and it is the new just unfolded leaves which are primarily treated in this manner, the older ones being only resorted to after the newer ones have been all occupied. Pl. VIII, fig. 7, *b*, shows a portion of a branch with the upper leaves defoliated by this insect.

In 1901 the insect was very plentiful and large numbers of the leaves of the two oaks were treated in this way. The insect was less plentiful during the present year. In 1896 Mr. Gamble, at the time Director of the Imperial Forest School at Dehra Dun, sent some of the attacked leaves with the little rolls attached to the Indian Museum, Calcutta, with a request to be informed, if possible, as to what insect acted in this manner. This letter was referred back to myself in January 1901 by the late Mr. L. de Nicèville with a note asking whether I could let him know what insect acted in this peculiar manner and for what reason.

Protection and Remedies.

These will be the same as already given on p. 36 of these notes for the Sissu Apoderus.

Points in the life history requiring further observation.

1. The number of eggs laid by each ♀.
2. The food of the ♀.
3. Does the larva eat anything besides the little leaf roll prepared for it by the ♀?
4. Length of time spent in the larval stage.
5. Length of time spent in the pupal stage.
6. Is there more than one generation in the year, *i.e.*, is the summer flush of leaves attacked in a similar manner?

Note.—In the same locality beetles of the genus *Apoderus* have been found rolling up the leaves of the wild pear (*Prunus Padus*) and the larger ones of the Himalayan Hazel (*Corylus colurna*) both towards the end of May.

In the middle of August a species of *Apoderus* was taken from teak leaves in Damoh in the Central Provinces, but I am unable to say whether it cut out and rolled up portions of teak leaves in egg-laying, or whether it laid its eggs on some other tree [1].

[1] Since this note went to press the writer has found several other species of *Apoderus* in the North and South Coimbatore forests in Madras. These were laying their eggs in and rolling up the leaves (and consequently defoliating the trees) of *Grewia tiliæfolia, Anogeissus latifoliæ*, etc. These insects will be treated of in a subsequent number of these notes.

CYRTOTRACHELUS LONGIPES.[1]

Plate IX, fig. *a—h.*

Reference :—Curculio longipes. Fabr. Ent. Syst. Tom. I. 395.

Classification :—Order, COLEOPTERA. Family, Curculionidæ.

Plant attacked :—*Melocanna bambusoides* (Muli Bamboo).

Description.

The *eggs* are elliptical in shape, whitish in colour, and about $\frac{3}{32}$nd inch in length (see Pl. IX, a).

The *larva* is described as a large whitish legless curved grub with slight fleshy tubercles on the underside of the body. It is shown on Pl. IX, b.

The *pupa* is white in colour and has the ordinary weevil shape.

The *beetle* is a large shining rufous-ferruginous coloured insect with a black patch on the thorax and black longitudinal patches on the sides of the elytra and another black longitudinal one running down the median suture of the elytra. The insect has a longish thick rostrum and long legs.

♂ Rostrum long, thick, straight, quadrangular, deeper than wide at its base and dilated and truncate at its tip, furnished on its upper surface with two lateral rows of tubercles; scrobe short, placed laterally. Mandibles thick. Antennæ fairly long and stout; scape arched backwards slightly; second joint of funiculus slightly longer than others; club fairly large, triangular, with apex at outer end; pubescent on outer surface. Prothorax slightly longer than broad, convex, smooth and shining, rounded at sides, narrowing ventrally and having a

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[1] This insect was found attacking the muli bamboo in the Chittagong Division by Mr. J. P. Gregson, Extra-Assistant Conservator of Forests, Bengal, and its life history was worked out by him in 1899. During 1900, whilst holding charge of the division, I made frequent observations on the attack, going carefully through the stages of the life history with Mr. Gregson. I was thus able to corroborate his careful and excellent observations.

circular raised collar at its dorsal anterior edge which is produced laterally on either side. Elytra longer than thorax, narrowing behind and finely but distinctly striated, the intervals between the striæ being fairly broad. Looked at superficially the upper integument appears to be without punctures. Legs long, thick and flattened; the front ones larger than the hind but only slightly so than the middle pair; femora thickened; tibiæ, more especially the anterior ones, ciliated on their inner edge and arched at their extremities and prolonged into a curved stout spine; tarsus long, the first joint longer than the second, the third heart-shaped; the segment of the body exposed by the elytra (pygidium) triangular, convex, and ending in a point posteriorly. Body oblong-elliptical, glabrous.

♀ much larger than ♂ with a longer rostrum. Front legs much larger than either of the hinder pairs, their tibiæ being very thickly ciliated on their inner edges. Pygidium blunter at posterior extremity than in ♂. Length ♂ $1\frac{3}{8}$th inch; ♀ $1\frac{3}{4}$th inch (to end of rostrum in each case). Length of rostrum in ♂ $\frac{7}{16}$th inch; in ♀ $\frac{1}{2}$ inch. (See Pl. IX, c, d.)

Life History.

The beetles appear on the wing during the latter part of May or beginning of June at about the time the monsoon rains burst over the Chittagong Hill Tracts. They pair soon after emergence, and the ♀ then seeks out young sprouting bamboos in which to lay her eggs such as that figured in Pl. IX, e. Shoots attacked are always under 3′ in height. The insect grasps the fleshy shoot, generally about 3 inches below the top, with her long front legs, and cutting an oval incision in it through the outer spathe just above an internode with her lengthy proboscis deposits two eggs at its base, covering them over with bamboo chips which are of the same colour. These eggs, which can be seen *in situ* from the outside, have been observed to be laid towards the end of June though as the beetles are to be found through July and on to about the middle of August, it is not improbable that the ♀ lays other eggs on adjacent shoots. As far as present observations show, it is, however, apparent that only one of the eggs comes to anything, as only one larva is to be found in any one attacked shoot. Dying shoots are common at the beginning of July, and numbers were examined by Mr. Gregson in 1899, and again by him and by myself in 1900. The larva, on hatching out, probably bores through the tissue horizontally until it reaches the centre of the shoot and then invariably bores downwards, eating away the soft central portion and increasing in size at a rapid rate. It continues feeding downwards until it reaches the base of the shoot, by which time it is full fed. The grub then retreats back up its gallery, probably enlarging the upper portions, which will be now too small for it until it reaches about the place it started from. It then cuts this portion off, gnawing it through all round below him (see Pl. IX, f). The top drops to the ground, and the now fully mature larva burrows into the soft rain-loosened earth, carrying the top or a portion of it with him, thus completely sheltering itself from atmospheric influences. Larvæ in various stages of growth are to be found in the shoots in the middle of July, and they mostly become full-grown by the end of the month. About the middle of August young shoots are to be seen on all sides with their tops fallen and in a dying or dead condition. The larva changes to the pupal state within the fallen buried end of the shoot at a depth of 3 to 4 inches, or even more, below the surface of the ground, the depth depending upon the consistency of the soil. The top of the shoot soon rots, only the harder fibres persisting (see Pl. IX, g, h). Inside this fibrous covering, which is generally caked with earth, the pupa remains during the following cold and hot seasons, emerging as a beetle at the commencement of the ensuing rains. The warm rain moistens the ground and thus softens the pupal 'case,' the fibres of which will only require wetting to crumble to dust after the heating up they have undergone during the hot months of the year, even in the shadier portions of the forest. The beetle then doubtless pushes its way out and makes its way up through the subsoil and humus. In the case of a specimen kept I noted that the beetle when ready to emerge gnawed its way out of its fibrous covering cutting a hole at one side (see Pl. IX, g). It will be seen that the pupa is thus safeguarded against enemies, since its covering resembles nothing so much as a decaying lump of vegetation mixed with earth mould. From the above account it becomes apparent that some ten months of the insect's life history are passed in the pupal stage, about 5 weeks in the imago and egg-laying stage (excluding the period the insects remain alive after egg-laying, which period requires further observation to ascertain definitely the number of eggs laid by the beetle) and three to four weeks in the larval or destructive stage.

Locality from where reported.

This weevil is plentiful in the Chittagong Hill Tracts in the bamboo jungles adjacent to the Karnafuli river.

It has also been reported from the Cape of Good Hope.

Relations to the Forest.

C. longipes has proved a most serious pest to the *Melocanna bambusoides* bamboo killing off young shoots over a fairly wide area both in 1899 and 1900. In these years large numbers of young bamboo shoots were observed springing up in the forests at the commencement of the rains. By August some 30 to 40 per cent. on areas inspected round Kaptai and elsewhere had been killed off, in the damper localities the attack being even more severe. The infestation appeared to diminish as the moister localities near the river were left behind, and almost disappeared as one went up the slopes of the hills. I am of opinion that the severity of the attack was probably due to the great clearance made in the portions of the forest which lay in the path of the great cyclone of October 1897 which swept up into the Hill Tracts from the Bay of Bengal, destroying some valuable teak plantations near Kaptai and laying low most of the trees it met with far up into the hills. As a result of this clearance of large tree growth in the forest, the muli bamboo commenced to shoot up in dense masses during the rains of 1898, and this was followed by the heavy and localized attacks of the beetles in 1899 and 1900. I have no information as to whether they were continued the following year, as I was unable to visit the area in question.

Mr. Gregson states in his note that shady places under thick growth are preferred to others. By this I understand him to mean thick *undergrowth* in moist places, not high forest. In such places the shoots undoubtedly come up thickly and are most succulent, and as such are doubtless preferred by the beetles for egg-laying.

Protection and Remedies.

In the case of plantations the most obvious remedy is to collect the female beetles when egg-laying ; a surer method, dig up the pupal cases and burn them. A better remedy, however, and one which would be practicable over larger areas would be to collect all the fallen and evidently attacked tops, each of which contains, as we have seen, a larva, and burn them. This done carefully would do a great deal towards stamping out the attack.

Points in the life history requiring further observation.

Owing to Mr. Gregson's excellent observations, these, as far as is at present known, would appear to be few.

1. The number of eggs laid by the ♀. This is a very important point, and would be easily discoverable were some beetles obtained as soon as they issued in June and kept in a box with fresh bamboo shoots, each shoot upon which eggs had been laid being removed.
2. What other species, if any, of bamboo are attacked by this beetle.

RHYNCHOLUS SP.

Plate X, fig. 1, a, b.

Reference :—Provisionally determined as *Rhyncholus* sp. new to the Britis Museum Collection.

Classification :—Order, **COLEOPTERA**. Family, ~~Cossonidæ~~. Curculionidae

Trees attacked :—*Pinus excelsa* (Blue Pine), *Picea Morinda* (Spruce) and perhaps *Cedrus Deodara* (Deodar).

Description.

I have as yet only found the beetle.

Beetle.—Long, narrow, black, shining, with elbowed antennæ, the club of antenna being pale yellow and tibiæ and tarsus rufous-brown with reddish yellow hairs. Head large; rostrum not longer than head, stout, cylindrical, slightly depressed downwards; scrobes narrow, starting near centre of rostrum and oblique. Antennæ start from lower half of rostrum, short, fairly stout; scape club-shaped at upper end; funiculus 7-jointed, 1st joint long, 2nd to 7th very short, increasing in size upwards; club smallish, oblong-oval, 1st joint long and reversed cone-shaped; others short, spongy, pale yellow in colour. Eyes medium sized, oval. Prothorax long, slightly conical and rounded on sides, truncate at upper and basal ends, with a slightly transverse depression just below the upper edge. Scutellum very small. Elytra long, cylindrical, slightly flattened, slightly wider than prothorax behind, depressed behind, and projecting down laterally below the abdomen towards their extremities on either side, the extremities being pointed and having a crescent-shaped interval between them, the points of the elytra forming the outer horns of the crescent. The elytra bulge laterally on either side into a small projecting point just before the depression commences. Legs short, femora thickened in middle and flat, arched beneath; tibiæ straight, flattened, and toothed at their base; tarsus short, filiform; 3rd joint not longer than the others and not bilobed; 4th long with small claws. Intercoxal joint large and rounded anteriorly. Body long parallel, and more or less cylindrical, thickening to a certain extent posteriorly. Rostrum, head, prothorax, and body above and below thickly punctured, the punctures being lighter on dorsal surface of head. Elytra channelled by longitudinal, deep, striæ, and punctured. Length $\frac{5}{32}$nd to $\frac{3}{16}$th inch. (See Pl. X, fig. 1, a.)

Life History.

This beetle is a wood-borer, and appears on the wing in the spring about the second week in May, from which date it may be found till the end of June in considerable quantities boring into the wood of blue pine and spruce to lay its eggs. I am of opinion that the beetles found during these six weeks are those of one and the same generation, which is probably the first one of the year. I am at present unable to say whether there is another generation, or more than one, at a later period in the year. The beetles of the May-June generation attack the trees in swarms, and may be found at this period either in or beneath the bark, or on or in the sapwood. They bore either horizontally or at an angle into the dead bark of the standing tree, and, on reaching the sapwood, either continue their burrow into it or more usually move about for a time between the sapwood and bark cutting a long groove in the latter before going into the wood. Having selected a suitable spot, they then bore into the sapwood usually at an angle. This tunnel is carried for about 1 inch or less into the wood, and the insect then turns and burrows up the long axis of the tree for as much as a couple of inches. The eggs appear to be laid at the end of this long gallery. The latter is not always straight, but may bend yet again and go further into the solid wood. Pl. X, fig. 1, b (1) shows a curved boring of this beetle.

I have not yet found larvæ, and am not at present aware how they feed.

Localities from which reported.

The insect was first found in 1901 in dead blue pine at Kathian, Jaunsar Division, North-West Himalayas. The following year it was found plentifully in blue pine and spruce at elevations of between 5,500 and 7,500 feet in the same division.

Relations to the Forest.

The information on the life history of this beetle is at present too meagre to enable its relation to the trees it attacks t) be definitely stated. That it is capable of swarming in large numbers has been ascertained, and the value of the wood attacked is considerably diminished by the tunnelling work of the insect Whether, however, the injury it is capable of doing is confined to this or no, I am unable to say. It is often to be found in company with the *Hylastes* sp. described below.

Points in the life history of the insect requiring further observation.

1. How the eggs are laid and when and how the larva feeds.
2. Length of time spent in the larval and pupal stages.
3. What becomes of the mother beetle after laying her eggs?
4. The number of generations passed through by the insect in the year.
5. Does the beetle confine itself to attacking dead wood, and does it infest other trees than blue pine and spruce?

Rhyncholus sp. in de da r.

NOTE.—At the end of June I obtained some specimens of a *Rhyncholus* probably closely allied to, if not the same insect as, the above. It was discovered boring into the wood of a newly felled deodar tree in company with a species of *Platypodæ*.

HYLASTES SP.

Plate X, fig. 2, a, b.

Reference : – Provisionally named *Hylastes sp.* new to the British Museum collection.

Classification :—Order, COLEOPTERA. Family, Scolytidæ.' Sub-Family, Tomicini.

Trees attacked :—*Pinus excelsa* (Blue pine), *Picea Morinda* (spruce).

Description.

Beetle—Cylindrical, black, and shining. Head prolonged into a short broad rostrum held vertically downwards and slightly less broad than the head. Antennæ inserted near the extremity of the rostrum in a deep socket. Antennæ elbowed, the scape long and terminating in an oblong oval thickening; funiculus with 7 joints, the first and second long, thick, the others shorter, with a short oval club consisting of four articulations and yellow in colour. Longish oval eyes with the antennal edge entire. Prothorax not broader than long. Scutellum very small and triangular. Beetle thickens out posteriorly both horizontally and vertically. Elytra long, cylindrical, their rounded apices forming the posterior declivity; strongly striate and punctate. Tibiæ fairly large and with a toothed serration on their outer edge. Third tarsal joint not longer than the others.

The male beetle is slightly smaller than the female. Pl. X, fig. 2, a, shows a dorsal and side view of this insect.

Length of ♀ beetle $\frac{1}{8}$th inch.

Life History.

This beetle tunnels into the heart-wood of blue pine and spruce. The insect enters the tree from outside by boring a tunnel, which may go horizontally into the wood (in standing trees) or may be at an angle. On reaching the wood, they usually mine out a gallery at an angle to their entrance one. This latter tunnel may be straight or may wind about [see Pl. X fig. 2, b (1)]. Towards its extremity on either side short galleries at right angles to the previous one are eaten out and the eggs laid in them [see Pl. X, fig. 2, b (2)].

I have not yet found the larvæ.

The beetle is to be found egg-laying from the second week in May to the middle of June, this being probably the first generation of the year. Observation is still required to find out whether there are any subsequent generations in the year.

The male and female pair during the above period, and they perform this act within the tree in the tunnel. I am unable at present to say which of the two bores the tunnel, but the first portion of it as far as the pairing place is the work of one beetle only. The subsequent boring is the work of the ♀.

The ♂ climbs on to the back of the ♀ to fertilize her.

Locality from where reported.

This insect was found in the blue pine and spruce forests of the Jaunsar Division, North-West Himalayas, at elevations of between 5,500 and 7,500 feet.

Relations to the Forest.

Present observation of the habits of this beetle has only shown it to be a wood-borer, and the wood is apparently only infested when the tree is nearly or quite dead. The insect has at present always been found associated with the *Rynchololus* sp. in spruce and blue pine, but it is by no means so numerous. It bores farther into the wood than the latter, reaching the heart of the tree. Its life history requires to be more fully worked out before its full relations to the trees it attacks can be ascertained.

Points in the life history requiring further observation.

1. How the larvæ feed, and length of time spent in this stage.
2. Length of time spent in the pupal stage.
3. What becomes of the mother beetle after laying her eggs.
4. The number of generations passed through by the insect in the year.
5. Does the beetle attack green wood, and does it infest other trees besides the blue pine and spruce.

A further note on the life history of

SCOLYTUS MAJOR, MS.

Plate XI.

References: —Provisionally named *Scolytus major*, MS. *Scolytus* sp. See No. 1 of these Notes, pp. 45—48, and Pl. IV, fig. 4, *a*, *b*, *c*.

Tree attacked:—*Cedrus Deodara* (Deodar).

This beetle infests trees of all ages from the largest to quite young saplings. In these latter it is to be found near the base of the stem. It is therefore always found in company with the smaller Scolytus, *Scolytus minor*, MS., being only absent in the tops of young saplings. In poles and saplings, when possible, it enters the tree beneath a branch as described below in the case of its smaller companion. Failing branches, it chooses some flake of bark or inequality on the stem and burrows beneath it. It is generally the more numerous of the two beetles.

The number of developing eggs is between 60 and 70. At times the number may be more or less. The first eggs laid by the beetle hatch out before it has finished the egg gallery, the time passed in the egg stage being probably from 4 to 7 days.

The *egg* is spherical in shape, yellow in colour and shining. It is wrapped up in what appears to be filamentous wood shavings.

The *larva*, on first hatching out, is a minute little white dot. The curved shape is, however, easily recognizable by the time it has bored about ¼ inch away from the egg gallery. The larval life of the first generation is about 4 weeks from leaving the egg to pupation.

Pupation takes place partly in the wood and partly in the bark except in the case of the smaller saplings, when it may occasionally take place entirely in the wood, the larva boring into the sapwood at or near the end of its gallery. The larva pupates about the last week in June.

Plate XI shows a complete plan of the galleries made by this insect: *a a* is the egg gallery, *b b*... are the larval galleries, *c c*...the enlarged pupating chamber in the wood at the end of the larval tunnel.

The *pupa* is white and has the ordinary beetle form, the legs, antennæ, and wings being free and folded close on the breast.

The beetle does not die when it has finished egg-laying, but is to be found in the egg gallery or entrance hole until the larvæ are full grown (in the case of the first generation). I have not yet ascertained how long after this period it remains alive. When the mother beetles die, they do so in the entrance holes, the posterior end of the abdomen protruding from, or being close to, the exterior opening of the entrance hole. In this way predaceous insects are prevented from entering the egg gallery which, together with the entrance hole, is kept quite free of wood dust.

The young beetles on maturing bore a horizontal tunnel to the outside of the tree and escape.

Relations to the Forest.

The further study I have been able to make on the life history of this beetle has shown that it is a most dangerous pest, since it will attack the largest deodar trees. It evidently prefers freshly-felled timber, failing which it attacks sickly trees and on occasions, undoubtedly, green saplings. The point to draw attention to here, however, is its preference for freshly-felled trees. In some deodar fellings inspected towards the end of June (1902) the cut trees lying on the ground still unconverted were covered, in the instances examined, from top to base between the bark and wood with galleries of this and the smaller Scolytus containing mature larvæ, the mother beetles being in most cases still alive. (Plate XI shows a portion of a pole attacked in this way). The trees had been felled at the end of April and beginning of May just about the time the beetles of the last generation of last year (1901) were issuing to lay the eggs of the first generation of the present one. These eggs were deposited in the bark of the felled timber in bole, top, and large branches. From measurements taken at the time I have made the following calculation :—

The cut portion of a tree measured had a diameter of 3 feet at base, 10 inches at top (a length of 16 feet had broken off in the fall and is taken separately), and a length of 90 feet. On every portion of 1′ × 1′ there were on an average 23 beetle galleries, *i.e.*, egg galleries. Now I have shown that between 60 and 70 eggs of the larger Scolytus and between 40 and 50 of the smaller one hatch out into larvæ which tunnel into the wood, and that the larger beetle is more numerous than the smaller, in this case in the proportion of 15 to 8 on the areas taken.

Therefore on every 1′ × 1′ of surface of bole we have—

Egg galleries of larger Scolytus
× hatched out larvæ . = 15 × 60 = 900
Do. smaller do. = 8 × 40 = 320

giving a total of 1,220 hatched out eggs per 1′ × 1′, or multiplied by 44·5, the number of 1′ × 1′ surface pieces in the bole, a total of 54,000 larvæ.

The 9″ × 2″ × 16′ of top gave another 2,300 larvæ.

The larger branches were much broken in the fall of the tree in most cases, and their contents, for they were covered with the *Scolytus* egg and larval galleries, may be taken as a set-off to attacks of predaceous insects on the above and over estimate of larvæ hatching out from the eggs. We are left with a total of 56,300 beetles, the product of the first generation of the year raised in a single tree, capable of producing 40 to 60 larvæ a piece for the second generation of the year. If we only take 50 per cent. of these as arriving at maturity and safely passing through the winter, the increase of beetles from one single tree is still enormous, the calculation coming roughly to 1,550,000 beetles. It should be noted here that if the trees are felled in spots reached by the midday sun, it will be found that the beetles will attack the portion of the bole nearest the ground and its sides only, leaving untouched the upper surface, the bark of which, exposed to the full sun's rays, will dry very rapidly and will in consequence be unsuitable for their purpose. In such cases the tree will not raise so many beetles as in the case above quoted. We have now to consider another important point. If fellings are still being carried out towards the end of July and in August, the beetles of the first generation will lay in the felled trees, but should the cutting operations have ceased, the Scolytus will search out and attack sickly trees. There are always such in a forest—trees whose vitality has been lessened for the moment either by fires, drought, or attacks of defoliating insects and aphids. With time such trees would, in many cases, recover but the bark beetles, taking advantage of their reduced vitality, attack and kill them.

In the case of some young trees examined with Mr. Oliver he drew my attention to a white fungus near the base of the tree. Dr. Butler, who has examined it, says it is a species of *Trametes*, and would undoubtedly cause the death of the tree. In many cases I have, however, found young dead trees with the sapwood scored from top to base (see Pl. X, fig. 3, d) with the galleries of this Scolytus beetle and its companion *S. minor*, MS., whilst there was no trace of fungus present. In such cases *S. major* confines itself to the lower part of the young tree. Knowing as we do that neither of the beetles will lay their eggs in bark which is not absolutely fresh, we can but consider that the ultimate cause of death of these young trees was due to the bast layer having been entirely consumed by the beetles.

Protection and Remedies.

In the previous number of these notes such have been already considered for this beetle. I would, however, here add one important recommendation.

If possible, all trees should be barked as soon as felled, and a clause to this effect should, I suggest, be entered in the contractor's agreement. It will not be necessary to burn the bark. If it is exposed inside uppermost to the sun, the grubs and pupæ will be killed. So long as trees felled at the periods the insect is intent on egg-laying are left lying in the forest unbarked, the pest will continue to increase rapidly and the results can hardly be other than most serious to existing growth. Immunity from serious attacks of this and other pests has been due to the fact that the forests have always contained an abundant supply of food material for them. As this becomes curtailed, the pests, if allowed and, unknowingly, aided to increase, will become a most formidable danger.

SCOLYTUS MINOR, MS.

Plate X, fig. 3, a, b, c, d; Plate XI, d.

Reference:—This beetle is new to the British Museum collections. I have provisionally named it *Scolytus minor, MS.*, to distinguish it from its larger companion which I call *Scolytus major, MS.*

Classification:—Order, **COLEOPTERA**. Family, **Scolytidæ**. Sub Family, **Scolytini**.

Tree attacked:—*Cedrus Deodara* (Deodar).

Description.

The *larva* is a small white curved legless grub with a yellow head. Length 2·2 millim. (See Pl. X, fig. 3, a.)

The *pupa* is white resembling the beetle in shape with its legs, antennæ and wings lying against the breast of the insect, each enclosed in a thin membrane. (See Pl. X, fig. 3, b.)

The *beetle* has a great resemblance to the one already described as *Scolytus* sp. in these notes (No. 1, page 45), and which I now call *Scolytus major*, MS., but is considerably smaller. It is black, shining, cylindrical, legs brown to blackish and antennæ and tarsi rufous brown. Head not covered over by the prothorax, and with a broad rostrum. Antenna short, angled, the scape enlarged at the end; funiculus 7-jointed, 1st and 2nd joint long, 3rd to 7th only slightly increasing in size upwards; club longer than funiculus. Eyes narrow and long. Prothorax convex, longer than broad, sparingly punctured, the punctures being smaller and weaker on the anterior portion, which is very shining. Scutellum triangular. Elytra slightly longer than prothorax, punctured, but both here and on the prothorax the punctures appear to be more irregularly distributed than in the larger species above mentioned. Abdomen cylindrical; under-surface is flexed upwards at the posterior end. Length 2·5 to 2·8 millim. A reference to Pl. X, fig. 3, c, will show what this insect is like.

Life History.

At elevations of between 6,000 and 7,000 feet, this beetle's flight time is about the last week of April or the beginning of May.

At higher elevations, round 8,000 feet at the upper limit of deodar growth, it apparently first appears about the middle to the third week of the latter month. The beetle is to be found beneath the bark in all parts of the deodar trees, bole, top and side branches and in trees of all ages from the largest in the forest to small six-foot saplings. The insect invariably accompanies *Scolytus major*, MS., and it is only in the smallest saplings or the smaller branches of trees that it is found alone.

The beetle's method of attack from the outside and its operations within the tree are constant and are easily recognizable. As is usual with bark-borers, it bores a small 'shot hole' through the bark in order to reach the bast, and in saplings and poles this is always made on the main stem just beneath a branch at its point of junction with the stem. The main branches of a deodar are more or less horizontal, and the beetle takes advantage of the shelter thus afforded it to carry on its operations protected from the view of its foes, and more especially from the predaceous *Clerus* beetle to be described later. In cases of bad attacks when every nook beneath the branches is already occupied two holes instead of one will be occasionally seen in this position, but this is exceptional. Failing a branch, the beetle seeks out any inequality on the stem such as a small projecting flake of bark or small ridge to make its entrance tunnel beneath. In large trees it always bores in beneath a flake of thick bark, and the entrance tunnel is usually at an angle. Only very exceptionally in the case of this smaller *Scolytus* have I found its entiance hole without some kind of shelter over it. On reaching the cambium layer the beetle, which apparently pairs with the ♂ before entering the tree as I have never found more than one insect in any one tunnel, commences to bore its egg gallery in an upward direction, circling round the branch in doing so, in order to get immediately above it and then going vertically up the main stem in small curved zig-zags (see Pl. X fig. 3, *d* (1)). If the gallery is made in side branches, it will be in the direction of the longitudinal axis of the branch. On either side of this egg gallery the beetle gnaws out little indentations in the wood and places an egg in each. These notches do not begin until the egg gallery has been bored for a short distance, the portion left free of them varying in length according to the length of the egg gallery, but they are always made right up to its extreme end, *i.e.*, the beetle ceases boring as soon as she has laid her last egg. As the *Scolytus* carries on her gallery, she shovels back the wood-dust with her feet, a large quantity of it being also apparently passed through the alimentary canal since round masses of chewed wood are constantly being passed out at the anus. These are apparently covered with some siccable substance and are detached by, and remain fixed for a time to, the hind tarsus. They may contain an egg and be placed by the tarsus into one of the recesses. My observations have not been sufficiently extended, however, to enable me to make this statement definitely at present. When the beetle has finished its egg-laying, it does not die, as is the case with many bark-beetles, but remains in the gallery or entrance hole, both of which are kept absolutely free of wood-dust, etc. If dusc be pushed into this, she at once begins to shovel it out and get the tunnel clear again. In this the *Scolytus* differs from the blue pine Tomicus, which dies at the end of its egg gallery as soon as all the eggs are laid. I have found the *Scolytus* still alive in the tunnel when most of the larvæ from the eggs laid by her have become full grown and one or two changed to pupæ. This is probably with a view to protecting the egg and larva from predaceous insects, as, when the ♀ dies, she does so in her entrance hole, the top of the abdomen being generally visible from outside, and thus effectually blocks it up. It does not, however, prevent the flat pink *Clerus* larvæ from getting to her offspring as the former move about between the bark and sapwood with ease. The eggs would appear to take but a few days to develop since those at the bottom of the tunnel, *i.e.*, those first laid, hatch out into young larvæ before the mother beetle has finished boring the egg gallery and laying the eggs higher up. Between 40 and 50 larvæ hatch out, but the number is at times fewer.

The grubs bore away from the mother gallery in a direction which in the middle of the tunnel is at right angles to it, and trends away from the right angle in an upward direction above and in a downward one below the centre (see Pl. X, fig. 3, d (2)). A uniform and almost invariably constant pattern is thus obtained, which, as the borings both of beetle and larvæ go down into the sapwood as well as up into the bark, remains indelibly impressed on them (see Pl. X, fig. 3, d, and Pl. XI, d).

When full fed, the larva bores a small pupating chamber half in the sapwood and half in the bark, and pupates within it. In saplings the pupating chamber is bored at times entirely in the wood at a little distance from the end or at the end itself of the larval gallery (see Pl. X, fig. 3, d(3)). The beetle on maturing bores its way out of the tree by a horizontal tunnel to the outside.

The mother gallery of this small *Scolytus* is from ¾ths to 2½ inches in length (Pl. X, fig. 3, d, and Pl. XI, d), though it may be even shorter, and, as I have said, is composed of a series of continuous short zig-zag curves. The larval galleries branching off from this are about 1¾ to 2¼ inches in length and increase in breadth as they get further and further away from the main gallery. The egg galleries made in the bole of large trees are usually shorter than those made in their branches or in saplings and small poles.

The beetles which appear in May are those of the overwintering stage, having hibernated through the winter either as larvæ or beetles, and they lay the eggs of the first generation of the year. About a month is spent in the larval state at the higher elevations, the grubs which hatch out during the last week in May becoming full grown in the last week in June. The beetles from these issue in July.

I have not at present any notes on the further life history of the pest, but as the latter is up to this period identical with that of its companion, *Scolytus major*, it will probably be found to run through a second generation before the close of the year (see No. 1, p. 45).

Locality from where reported.

This beetle was discovered by the writer in 1901 in the Jaunsar Bawar and Tehri Garhwal deodar forests of the Jaunsar Division in the United Provinces.

Relations to the Forest.

From the descriptions given of its habits it is evident that this insect is capable of proving a serious pest to the deodar the more so as its attacks are almost invariably accompanied by the large *Scolytus*. I have seen numbers of young deodar saplings with the sapwood covered from top to base with the galleries of the beetle. A young sapling which has been treated in this way is shown in Pl. X, fig. 3, d. If the tree is older, the galleries at the base will be those of the larger species. The insect will not touch dead bark or dead trees since it requires the green cambium layer in which to lay its eggs. Sickly trees near an infected centre will however be at once attacked, and there can be no doubt that such trees are killed by the beetle in cases where they might have otherwise recovered from their temporary feebleness. When very numerous, the insect undoubtedly attacks young green trees.

A pest of this kind is to be seriously feared in areas of young pure deodar growth, as its attacks in a plantation of such would ruin the work of years. It is for this reason that its full life history requires to be most carefully worked out, and more especially the question as to the number of generations in the year settled.

Protection and Remedies.

Infected centres should be cut clean out and the saplings carefully burnt unless it is found easier to bark them, when the bark should be exposed to the sun inside uppermost. The ground round the roots should be removed for about 6 inches and the sapling cut at this level and not above ground, or some of the beetles will be left in the portion of the tree remaining above ground and escape to carry on the infection. The management of deodar woods is becoming more intense in the country, and pests of this nature will require the most careful attention. Up to the present they have found plenty of diseased and dying trees to breed in. Under systematic working these are disappearing, and the struggle for existence will send the beetles to young and valuable saplings in the young newly-formed plantatio ns or newly-planted up areas.

At Konain and Kathian in Jaunsar-Bawar, and at Deota in the Tehri-Garhwal forests, there are infected centres of this insect. I should recommend that careful search be made in these and other deodar areas and all attacked trees be treated as above detailed.

I inspected some fellings being made in the forests round Pajidhar and found that large trees cut in the spring, *i.e.*, in May, were covered from head to foot with the borings of this and the larger *Scolytus* beetle. Both main bole and all the branches were infested with the pests and in every case the galleries contained full grown larvæ. In other words, the trees as soon as felled had been attacked by a swarm of the *Scolytus* beetles. In a further note on the *Scolytus major* I have given a rough calculation, from measurements and countings made, of what this means in increase of beetles per tree per year (see p. 205).

If it be possible, I recommend that in future all deodar trees felled between the middle of April and middle of August should be at once barked. Exposing the bark to the sun's rays will be sufficient to kill all larvæ and pupæ present. A standing order that all deodar trees felled are to be immediately barked will be the simplest means of putting an end to this aid to the ncrease of these beetles.

2. All infested young saplings should at once be cut out and barked or burnt.

Points in the life history requiring further observation.

1. The number of generations in the year. This is a most important point. It probably varies with the elevation.
2. The length of time spent in the various stages of the metamorphosis of the succeeding generations.
3. In what stage and where the insect hibernates through the winter.

Some Natural Enemies of *Scolytus major* and *S. minor*, beetles.

CLERUS SP.

Plate X, fig. 4, a, b. Also see Pl. IV, fig. 5 (larva) in No. 1.

Reference :—Provisionally determined as *Clerus* sp.

Classification :—Order, COLEOPTERA. Family, Cleridæ.

Predaceous upon—

1. Bark Borers—

   Scolytus major and *minor*, MS.; *Tomicus* sp.; *Polygraphus major* and *minor*, MS.; *Pityogenes coniferæ*, MS.

2. Wood Borers—

   Diapus impressus, or close ally; *Platypus* or *Diapus* sp.; *Rhyncholus* sp.; *Hylastes* sp.

Description.

Larva.—General colour, a bright pink. Head brown, flat. Mandibles black. A brown dorsal patch on first segment of thorax and a pair of brown spots situated dorsally on each of the two following segments. These thoracic segments paler pink than following abdominal ones. Latter nine in number, bright pink to reddish pink in colour except last which is smaller and brown posteriorly where it ends in two small black processes. The larva tapers anteriorly and has three pairs of legs on the thoracic segments and no others. It is slightly lighter in colour beneath.

Beetle.—The shape of the head and prothorax of this beetle are ant-like, whilst the body is short and squarish and not unlike that of a longicorn beetle, having well marked 'shoulders.' Head and antennæ black. The antennæ are 11-jointed, the joints slightly increasing in width upwards, the last three forming a small club, the last joint of which is the largest. Prothorax black with hairs on the dorsal surface. Both head and prothorax are narrower than the elytra which are broad and rounded at their apices; in colour these are red for about the basal quarter of their length, this colour then changing to black; the black is twice crossed by white wavy bands, the first a narrow one just above the juncture of the black with the red colour and the other a broad one about $\frac{3}{4}$ of the length from the base. Legs black. Tarsus of front legs 4-jointed, of the hind pairs 5-jointed; 1st tarsal joint short. Abdomen on the under-surface is bright vermilion, its segments being very mobile. Body short, somewhat flattened, pubescent. Length varies from $\frac{5}{16}$ths inch to $\frac{1}{2}$ inch. Males may be of same size as the females or the latter may be much larger. Fig. 4 in Pl. X shows the imago of this insect.

Life History.

It is probable that this beetle is to be found on the wing more or less continuously from spring to the end of autumn in the localities which it affects. Its eggs are laid on the bark near or in the entrance holes of bark-beetles, and the young larvæ, on hatching out, find their way through this hole into the beetle gallery and thence into the larval galleries of bark and wood-boring grubs. Larvæ of all sizes are generally to be found in these situations in, as far as my present observations go, every month between May and October. The larvæ, as their description will have shown, are unmistakeable, but I am not at present able to say whether those noticed belong to more than one species of *Clerus* or not. The larvæ here alluded to were found feeding upon the grubs of the two species of *Scolytus* beetles already described, and are especially predaceous upon these, searching them out in their galleries between the wood and bark and devouring them. The length of time spent in the larval stage is unknown. When full fed, they go into the outer bark and pupate there. The beetle, on maturing, never enters the tree. It is a brightly-coloured very active insect running and flying well even in hot sunshine, and it lives outside the tree flying round or running about on the outer bark. Its food consists of bark and wood-boring beetles, and it searches for these on the bark and seizes them whilst they are engaged in either boring into or tunnelling their way out of the tree. In the case of the *Scolytus* beetles, on which it was preying when discovered, it is able apparently to live upon them longer than upon many other species, as these beetles remain alive after their egg-laying is over and the larvæ have hatched out. The mother beetles spend their time walking up and down the egg-gallery or going up the entrance hole to the outside, and the Clerids watch at the mouth of these holes and seize the beetles when they appear outside the bark. They catch their prey by sight only, and not by scent. Unless the bark-beetle is right in front of them, they will pass it by unnoticed. When the beetle, however, comes within their line of sight, they pounce upon it, just as a tiger does when seizing its prey, with one rush. If out of its hole, the bark-borer has not the remotest chance of escape. The Clerid seizes it with his forelegs and mandibles (see Pl. X, fig. 4, b,), picks it up off the ground, turns it round so as to have the ventral surface facing him with the head uppermost. (see Pl. X, fig. 4, c.) sits well back on its hind legs, and commences to feed upon its prey, whose struggles are quite ineffectual in that deadly grip. In commencing upon the beetle the Clerus invariably starts with the head; it gets its mandibles round the junction of the head with the prothorax, *i.e.*, round the neck, following the parallel of the tiger, and chews and sucks at the neck and head until it has finished them completely. It next goes to work on the prothorax, piercing with ease through the hard outer chitinous shell with its powerful mandibles and breaking it to pieces, the contents being entirely cleaned out and consumed, for the beetle is a neat feeder and entirely cleans the meat off the chitinous bone before rejecting it Having finished the prothorax, it throws away the mangled shell and turns its attention to the body consisting of the meso- and meta-thorax and the abdomen. In a bark-beetle this is often in the shape of a blunt elliptical cylinder with a flattish top where it joins the prothorax. The beetle holds this between its front legs flat top upwards and proceeds first to pull off the elytra, which are rejected: the under wings being released open out to their full extent but remain attached to the trunk. The Clerus then entirely cleans out this bottle-shaped cylinder as neatly as one could clean out a jar with a spoon. When entirely empty, it is thrown away and the insect starts in search of another beetle. A mangled prothoracic shell and the empty chitinous body cylinder with the outspread lower wings is all that is left of a *Scolytus major* beetle six minutes from the moment it was captured alive. I have seen three such eaten successively, and of 20 beetles put in with four Clerids only the above-mentioned portions remained when the box was inspected about 3½ hours afterwards. As has been already said, the resemblance between this insect and the tiger in their methods of rushing upon, seizing and starting to feed upon, their prey is remarkable, the difference being that the insect is more cruel than the mammal since it makes no pretence of killing the bark-beetle, but commences on it whilst it is alive and kicking, often bringing forward its middle pair of legs to assist in holding its struggling prey.

This insect is polygamous, excessively so, and in the case of some species kept for several days and fed daily with bark beetles of various kinds, I was able to note that whenever the one male, which was kept with three females with this purpose in view, was not actually eating a bark-beetle or searching for one to eat, he was pairing with one or other of the females. I have not as yet been able to ascertain how long these beetles live in this stage of their life history, but it is this excessive polygamy and the larvæ of all sizes to be found in the bark-borer's larval galleries that leads me to consider that the beetle's life is of some duration, or that at any rate beetles will be found from spring to autumn more or less continuously.

To sum up my observations on the habits of the ♂ I may say that, when not eating or searching for bark-beetles, it is pairing and *vice versâ*, and the ♀, at any rate up to the time she commences egg-laying, appears to be an equally large and voracious feeder.

Locality from where reported.

The insect was discovered in the forests near Deota and Pajidhar in Tehri-Garhwal, North-West Himalayas (Jaunsar Division). Elevation between 7,000 to 8,000 feet.

Relations to the Forest.

From the foregoing description of the habits of this beetle it will be seen that it is pre-eminently an insect of the greatest use to the forester. It is a very easy beetle to recognize both in its larval and adult conditions, and it would be advisable, I think, that officials in charge of forests which it affects should endeavour to make themselves acquainted with it. Its discovery is one of some importance. Although perhaps a different species, it will not improbably be found to be closely related to *Clerus formicarius*, which is known to be of the very greatest service in keeping down bark-beetles in European continental forests. So great is the value attached to this beetle that in 1892 a specialist was deputed from America to import it into that country in the hopes of bringing down to normal proportions some devastating bark-boring beetle attacks.

This Clerus was found upon the bark of deodar trees infested with the two *Scolytus* bark-borers, and observations would tend to show that these latter beetles are to be found throughout the months from May to October. The reason is that they do not die off as soon as their egg-laying is finished, and it is possible that the first beetles from the larvæ hatching out from the eggs laid by them commence to issue before the mother beetles have all died off. In this way there would be a continued supply of *Scolytus* beetles for the Clerids.

But though this may be the case, I have ascertained that the Clerus does not confine itself to the *Scolytus*. I have fed it with the following beetles, all of which it eat with avidity :

Platypus or *Diapus* sp., (*Platypodæ*) from deodar wood.

Tomicus sp. the Blue Pine Tomicus.

Polygraphus major and *P. minor* from deodar and Blue pine.

Pityogenes coniferæ from deodar and Blue pine.

It has also been found on the *ban* oak (*Quercus incana*) where it feeds upon the Platypus, *Diapus impressus*, or a closely allied species.

It would thus seem to be fairly omnivorous as far as coniferous bark-beetles are concerned. It will not eat dead beetles.

Protection.

The fact that the larvæ of this beetle pupate in the outer bark and that the beetle never goes into the tree renders its immunity from destruction great. Under the prescriptions for getting rid of bark beetles (see p. 206 *ante*), we have to bark the trees when they are full of grubs and expose the bark to the sun. This kills all the bark beetle larvæ. To a certain extent many Clerid larvæ will also suffer, but the mature ones will at once move into the outer bark and pupate there, and the barking will have no effect upon them. In the case of the beetles, the barking of the trees will have no effect whatsoever since they never go into the tree. We thus see that in the case of this insect remedies undertaken to get rid of its food beetles will not necessarily kill either it or its larvæ, though many of the younger ones may die off with the *Scolytus* larvæ. There will not for some time to come be much fear of the Clerids suffering from want owing to a bark-beetle famine occurring from these operations.

I have also found the Clerid on spruce feeding upon two species of wood-boring beetles, *Ryncholus* sp. and *Hylastes* sp.

Points in the life history requiring further observation.

1. Length of life of the beetle. Does it appear continuously in the beetle state from May to October?
2. Length of time spent in the larval and pupal stages.
3. The number of eggs laid by the ♀ beetle.
4. The number of generations passed through during the year.

BRACON SP.

Classification:—Order, HYMENOPTERA. Family, Braconidæ.

Predaceous upon *Scolytus minor*, MS.

Some nearly mature species of a *Bracon* fly were found in a deodar sapling at the end of the first week in June in the pupating chambers at the end of the larval galleries of the bark-borer *Scolytus minor.* The tree was growing at a low elevation and the eggs were probably laid at the beginning of May. The insects were too immature to identify further with any certainty. These flies are evidently parasitic upon the larvæ of the small Scolytus beetle. The eggs are laid by the female insect, who probably pierces through the bark and deposits them in the larval tunnel or she may place them in the entrance tunnel. The young maggot feeds upon the larvæ and does not kill it until it has reached its full growth and gnawed out its pupal chamber.

I have no further observations on the habits of this insect at present.

SCOLYTUS DEODARA, (n. sp.)
MS.

The Deodar Branch Girdler.

Plate X, fig. 5, a, b; Plate XII, figs. 1 and 2.

Reference :—Provisionally named as *Scolytus deodara*, MS.

Classification :—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Scolytini.

Tree attacked :—*Cedrus deodara.* The deodar.

Description.

Larva.—When just hatched, the larva is a minute white circular ball.

Beetle.—This *Scolytus* is intermediate in size between *S. major* and *S. minor*, MS. The beetle is black in colour, moderately shining, cylindrical, the elytra being slightly tinged with rufous-brown, as are the legs; antennæ yellowish brown and tarsi yellow. Head projecting beyond prothorax with a broad rostrum. Eyes transverse, almost vertical. Behind the eye the head is thickly striated with close-set vertical striæ which are produced down on to the ventral surface. This is not present in *S. minor*. Antennæ short with a 7-jointed funiculus and a long club. Prothorax not longer than broad, no so thickly punctured as head, and punctures lighter and fewer behind. Elytra fairly thickly striated and punctured and sparsely covered with golden yellow hairs, more especially on their lateral portions, as are the prothorax and head. Abdomen flexed upwards posteriorly. Length 3·2—3·5 millim.

Pl. X, fig. 5, a, shows a dorsal and side view of this insect.

Life History.

This beetle is a branch girdler and makes its first appearance in the year about the third week in June. The period probably varies and is dependant upon the first burst of rain. It lays its eggs in deodar branches either on large trees or on saplings.

The branches are always of a fair thickness, being as much as $\frac{3}{4}$ inch in diameter at times, there being several forks or side branches above the spot attacked. The beetle bores into the branch to the cambium layer and then mines in this horizontally round the stem until it has completely girdled the branch, the gallery being kept so horizontal that the insect always exactly meets, or very nearly so, its hole of entrance. The groove goes deeply into the sapwood as well. (See Pl. XII, fig. 2, A, 1.) At the upper edge of the gallery small nicks are cut on the shady side of the branch and eggs laid. More than one egg is laid and the number may be as many as eight, perhaps more. Pl. X, fig. 5, b, shows a branch girdled by this insect at (1). After laying her eggs, the beetle leaves the branch by the hole of entrance which is just above the groove and may possibly attack others in the same way before she dies. This point has not been fully observed as yet. Owing to the deep groove cut by the beetle and the heavy weight of the needle-bearing branch above it, the latter very soon bends over and hangs down (until it does this, there is nothing to show that the branch has been attacked save the small entrance hole from which resin exudes), attached by a few shreds of bark and wood to the branch below the cut and a certain amount of resin exudes round the groove. This pendant position of the fresh green branches renders fresh attacks at once perceivable, and the amount of damage done by these beetles, once their life history is understood, is very easily discoverable. Pl. XII, fig. 1 shows a dead top, girdled the previous year, hanging down in this manner. The young larvæ hatch out, from the eggs laid in the nicks above the girdle, in a few days since quite young larvæ are to be found just boring away from the cut whilst the cut branch is still quite fresh and green. The girdle is of course made by the beetle to prepare a sufficiency of food material in the withering condition required by the larvæ developing from the eggs. The larvæ bore straight up the girdled branch in the cambium and sapwood eating out slightly winding galleries about $1\frac{3}{4}$ to 2 inches in length which are filled all the way up with wood dust and excrement (see Pl. X, fig. 5, b (2)). When full grown, they eat out in the sapwood a chamber slightly larger than the gallery and pupate in this. The beetle on maturing bores its way out by a horizontal hole through the bark. At present I have never obtained more than one beetle from any one attacked branch, although more than one larva hatches out and bores up the stem (Pl. X, fig. 5, b). The life cycle of the first generation of the year takes from 6 to 7 weeks from egg to beetle. From branches found freshly girdled on July 3rd the writer bred out beetles in the latter part of August. The larval stage of this generation probably lasts about 4 weeks. It is possible that the beetle commences egg-laying so late in the year, *i.e.*, after or at the commencement of the first rains in order that the girdled branch may remain fresh for a sufficiently long time to enable the larvæ to become full grown and change into the pupal state before it withers to any great extent, since it is evident that the grub requires fresh cambium and sapwood for its food. Occasionally the same branch will be found to have been girdled twice probably by different beetles, but this is not common. Pl. XII, fig. 2, A, shows an instance of the branch being girdled at 1 and 2.

I am of opinion that there is likely to be at least one more generation of this insect in the year, the August beetles probably girdling branches and laying eggs in them as soon as they issue. The exact number of generations in the year has however yet to be worked out.

Localities from where reported.

These beetles or the results of their work have been observed to be plentiful in the pure deodar woods in the Jaunsar and portions of the Simla Hill States Divisions in the N. W. Himalayas. Their attacks have been more especially noticeable at Kathian and Deota in the Jaunsar Division and in the Cheog Forest near Simla and in the deodar forest at the head of the Simla waterworks.

Mr. Lace, whilst in charge of the Chamba Division, Punjab, noticed that deodar branches were girdled by an insect, and the beetles he obtained appear to be the same as the one under consideration.

Relations to the Forest.

This scolytid attacks deodar trees of all ages. Large trees may be observed to have a curious irregular shape owing to numbers of the branches having had their ends 'cut' by this beetle. The work of the insect can be always recognized as, if the end of the branch is examined, a portion of the groove made by the beetle will always be observable at its extremity. This curious raggedness in the shape of the tree becomes even more marked in the case of smaller trees, and the number of branches thus treated must seriously interfere with and retard their growth. But the attacks become more serious still when we come to the sapling stage. Here we find that the beetle often attacks and girdles the leading shoot (see Pl. XII, figs. 1 and 2, B, 3) and this with subsequent girdling of other side shoots leads to misshapen trees which can be easily recognized in the plantations. It need hardly be stated that this is the most serious result of the insects' attacks. Fig. 1 in the plate shows a young sapling with its leading shoot cut off by this insect, whilst fig. 2, B, shows the top of another sapling in which two side shoots have taken the place of the girdled leader at 3.

I have noticed that whilst the insect appears to be invariably at work in pure deodar forests, it is much rarer in mixed forests —a point worthy of some consideration.

The insect is exceedingly wasteful in its method of egg-laying. Large branches are girdled, often 2-3 feet in length and with several forks or side branches to them. From the whole of this large cut branch but 1½ to 2 inches are grooved up from the base by the larvæ hatching out from the eggs laid. The rest of the branch thus destroyed is, as far as this scolytid is concerned, entirely wasted.

It will be generally found that the upper part is attacked by a small polygamous scolytid beetle, Hypoborus (?) sp., described at p. 278 of these notes.

Protection and Remedies.

It has been already stated that the branches usually hang over to one side after being girdled, and when this is the case there is no difficulty in observing the beetles' operations

Even if the branch remains still erect, the entrance hole, as evidenced by the exudation of fresh resin on the bark, can be seen.

In small plantations and wherever practicable it is recommended that all such freshly attacked branches should be collected and either burnt or the bark peeled off from the girdle downwards for several inches. This will expose the eggs or young larvæ, and they will be killed off. Branches not actually freshly attacked which may contain pupæ should be burnt. If this is systematically done in a plantation and, owing to the attack being so easily recognizable, the work should not be difficult, it should be possible to keep this pest within bounds and protect many promising young saplings at any rate until their leading shoots get beyond the beetles' attacks.

Collecting all dead branches in the winter months and burning them may also kill off the overwintering beetle, or whatever stage it is in, inside them.

Points in the life history requiring further observation.

1. The number of generations in the year. If there is a second one, the length of time spent in the larval and pupal stages.
2. In which stage of its life history does the beetle pass through the winter? This will not unlikely be the pupal, but may be the beetle stage. Is this stage spent inside the girdled branch which will by then be dead, either fallen to the ground or still attached to the tree? If so, the collection and burning of all dead branches during the cold weather months is strongly to be recommended.
3. How many eggs are laid at the girdle, and how many of them normally develop into larvæ? Of these larvæ how many ordinarily reach the beetle stage?

At present observations would seem to show that only a few of the larvæ which hatch out really reach the beetle stage. Further observations are required on this point.

4. Does the beetle attack any other trees besides the deodar?

TOMICUS SP. = T. Ribbentropi Stebbing: Ind. For. Mems. Vol. 1, Pt. 2, 1909, p 12-13.

The Blue Pine Tomicus.

Plate XIII, fig. 1 a, b, c, d.; Plate XIV; Plate XV, fig. 1.

Reference :—Provisionally determined as *Tomicus sp.* near to *T. typographus.*

Classification :—Order, **COLEOPTERA.** Family, **Scolytidæ.** Sub-Family, Tomicini.

Trees attacked :—*Pinus excelsa* (blue pine); *Picea Morinda* (spruce).

Description.

The *larva* is a small, white, curved, legless grub, about 4·5 millim. in length, with a yellow head and greatly developed thoracic segments. See Pl. XIII, fig. 1, *a.*

The *pupa* is white in colour and has the ordinary beetle shape.

The *beetle* is at first light yellow and rests for some time in the pupal chamber, whilst its outer parts are slowly hardening, the colour changing as this process takes place to dark yellow-brown the insect finally becoming dark-brown. When ready to issue from the wood, the beetle is shining, oblong, hairy beneath, with scattered hair on the dorsal surface. The head is hidden beneath the thorax and is scarcely visible from above; the thorax is 2½ millim. long by 1½ millim. broad; its dorsal surface with a fine sparse punctation over the posterior half, whilst covered in front with small tubercular projections; elytra cylindrical, with impressed striæ, the intervals being punctured; the elytra slope down at the apex, the sloping portion being excavate; apical excavation shining and irregularly punctate, with five teeth on either side, the third of which is the largest, the fifth being little more than a raised lump or projection. This beetle would therefore appear to differ from *T. typographus* in this respect as the latter has only four teeth on either side. Under surface of abdomen is flat. Tarsal joints 4 in number and simple. Length of beetle 5·2 to 5·5 millim. (⅕th inch or a little over).

Pl. XIII, fig. 1, *b*, shows the pupa and *c*, the mature beetle.

Life History.

The Blue Pine Tomicus beetles appear on the wing towards the end of April at elevations of about 7,000 feet, the date of first appearance varying with the elevation at which the insect is living, being later at higher elevations. These beetles lay eggs from which the beetles of the first generation of the year mature about the middle of June. At the lower elevations it is probable that a second lot adults make their appearance about the end of August. I have obtained a third brood about the middle of September, whilst in favourable seasons and localities a fourth, or portion of a fourth, generation is completed before the winter sets in and puts an end to its activity.

The beetles are found in April boring into the trunks of blue pine (*Pinus excelsa*) of all ages from the pole stage upwards. When it has reached the bast, the insect gnaws out an irregularly shaped pairing chamber, often as much as ½ × ¼ inch in size. (See Pl. XIV, Pl. XV, fig. 1.) When this is ready, coupling takes place, several female beetles entering by the same tunnel and being fertilized by the male. Usually from 2-5 egg-galleries are excavated, grooving both bark and sapwood, radiating from the pairing chamber (Pl. XIV, e, Pl. XV, fig. 1, e) and more or less in the long axis of the tree. These galleries, which contain generally only one air-hole (Pl. XIV, a) *i.e.*, a hole bored horizontally through the bark to the outside to admit air into the egg-gallery, are from 2½ to 3 inches in length and are bored by the female beetles. On the right and left, but apparently chiefly on the right, the ♀ eats out little recesses, laying in each an egg, from 20 to 30 being generally deposited in each gallery; the galleries are blocked up with wood-dust. As it is probable that only one egg-gallery is bored by each ♀, it would appear that the ♂ beetle pairs with 2-5 females. Pl. XIII, fig. 1, d shows the pairing chamber, *p*, and three partially completed egg-galleries, *e*, with a beetle in the shorter one. In the two longer galleries the notches in which eggs have been placed may be seen on the left edge. The first larvæ make their appearance before the egg-laying is over and at once commence to eat out winding galleries in the bast which have a general direction at right angles to the direction of the mother-gallery. The greater number of the larvæ appear to develop from the eggs laid on the right hand of the gallery (see Pl. XIV, Pl. XV, fig 1, *l*,) as the mother bores away from the pairing chamber, but I have not yet been able to account for this. As the larvæ increase in size so does the diameter of the tunnels they are boring; they go deeper into the bark, and the whole plan of the mother and larval galleries remains indelibly impressed on the bark, long after the beetles have matured and left the tree. The larval borings do not groove the sapwood, consequently this latter only bears the impression of the pairing chamber and the egg-galleries with the notches cut by the beetles for the reception of their eggs. In the case of an old attack, therefore, if one wishes to find out whether the eggs hatched out and the larvæ became full grown, it is necessary to inspect the bark on the inside in addition to the sapwood. The mother-galleries are often as much as three inches in length and those of the larvæ, which are often very winding, $1\frac{1}{2}$ to $2\frac{1}{2}$ inches. Plate XIV shows a piece of blue pine bark, $\frac{2}{5}$ths natural size, riddled by this beetle: *p* = pairing chamber; *e* = egg-galleries and *l* the larval galleries. The larvæ pupate at the end of their galleries in the bast during the first days in June. Towards the middle of the month the new beetles, now mature, leave the tree through round holes bored horizontally through the bark from the pupating chamber and immediately attack fresh trees and lay their eggs in them. The larvæ from these eggs soon make their appearance and the resulting beetles issue about the beginning of August. A I have said, a third generation (tihs would probably be only the second at higher elevations) of beetles appears in the middle of September and from eggs laid by these the larvæ of a fourth during October. In favourable years some of these latter develop into beetles which hibernate through the winter either in the pupal-chamber or, not improbably, if fully mature, in the thick bark of the trees. The remainder of the larvæ pass the winter at the end of their galleries, in which they gnaw out a small chamber and then envelope themselves in a thin papery cocoon. Those which, as above described, go on to the beetle stage are the beetles of the fourth generation and are the ones which appear in the spring (April) and lay the eggs of the first generation of the year. The hibernating larvæ change early in the year into pupæ and these into beetles, the latter appearing also about the beginning of May, and this leads to the generations overlapping to some extent.

It is probable that when the circumstances of its environment are unfavourable, such as damp, very cold, weather, shady places at high elevations, etc., the normal number of generations passed through during the year is two. Similarly, in very favourable situations and in warm, dry years it is not improbable that the insect will be found to pass through four life cycles.

Localities from where reported.

This *Tomicus* was first reported from the Chogaun forest, in the Bashahr State forests, Punjab, by Mr. Minniken, the Forest Officer in charge, in August 1900.[1] On May 8th, I found the insect in abundance in some Blue pine trees near Konain in the Jaunsar forests, United Provinces and Oudh, and from this date till the middle of July either the insect itself or evidences of its attack were found in more or less abundance throughout the portions of the Jaunsar, Simla Hill States, and Bashahr Divisions visited, the march taking me (after leaving Jaunsar) *viâ* Morach through the Jubal and Bashahr States to Kotgarh and thence on up through the Sutlej Valley Forests to Kilba and the Rogi Cliffs.

Relations to the Forest.

This insect both in the larval and beetle state does serious injury to the Blue pine and to a lesser degree, as far as present observation has shown, to the spruce (*Picea Morinda*). By the latter statement it is not meant that the actual damage done to the tree itself is less, for the bast of some trees has been found completely riddled by the beetles, but that only trees here and there have been noticed attacked by the insect up to the time

[1] Mr. Minniken reported the attack to Mr. Ribbentrop, at the time Inspector-General of Forests to the Government of India, and the latter went up and studied it during September. It is alluded to in a note published by Mr. Ribbentrop at p. 561 of the *Indian Fsoreter,* Vol. XXVI.

of writing, whereas the Blue pine has been found infested in blocks.[1]

The *Tomicus* is not usually to be found in young poles and I have not noticed it attacking young growth. In older poles it is often present, but it apparently prefers the older trees whose bark is thicker; when attacking poles it confines its operations more especially to the lower three-quarters of the bole, leaving the upper quarter and the branches to its companions, *Polygraphus major*, MS. and *Pityogenes coniferæ*, MS.[2]

The injuries to the tree are confined to the bast layer, and when it is badly infested, this part of the tree is completely riddled and destroyed, resulting in death. Attacked trees can be recognised by the shot-hole borings in the bark, each having a little saw-dust at their entrance which has been ejected by the beetles when making the burrow. If trees with large numbers of these holes on their outer bark be cut into the cambium layer will be found to be swarming with either larvæ, pupæ, or beetles.

The European beetle *Tomicus typographus* is considered to be one of the most destructive of all forest insects in Europe, and when conditions are favourable to it, I am of opinion that its Indian confrère is not one whit the less dangerous. Sickly trees, ringed trees, and newly felled ones are at once attacked by it, and its powers of rapid multiplication, which have been shown to be very great owing to the number of eggs laid by the ♀ beetle and the number of generations it is capable of passing through during the year, enable it to spread rapidly over large areas. When particularly abundant in a locality, I have found it attacking green healthy trees. It does not attack barked trees, and it has not been found in stools or stumps.

Its favorite resorts at present in the areas visited would appear to be the forests where the system of ringing the Blue pine to give more light to and so encourage the young Deodar has been carried out on a large scale. In such areas I have found

[1] Since this note went to press investigation of dead and dying trees has shown that the Tomicus is probably nearly, if not quite, as injurious to the spruce.

[2] See pages 234 and 242 of these notes.

the beetle in enormous numbers. Spruce treated in this way have also been noticed as badly infested. On an area[1] containing some fine spruce through which a severe fire had passed several years previously I noticed a number of fine, large, dead trees which had been badly scorched by the fire. An examination showed that the *Tomicus* had subsequently come in and attacked the trees in large numbers, killing off those which might otherwise have recovered.

Protection and Remedies.

I have already alluded to the system in force for a time in these forests of girdling dominant Blue pine and to a less extent spruce, with a view to giving more light to, and so encouraging the growth of, the young and more valuable deodar beneath them. The large number of girdled and slowly-dying trees thus existing in the forest has undoubtedly favoured the increase of this *Tomicus*, which now exists at various centres in the forests in large, and it would appear, rapidly increasing, numbers. The insect will not attack barked trees or trees whose bark is already dead. A girdled tree dies slowly and its bark remains fresh for some time, perhaps a year or two. If the girdle has not been cut entirely, the tree will remain alive for several years. In every case, however, the pine will be in the exact condition preferred by bark-beetles, and, as long as the bark remains fresh enough, the *Tomicus* will attack it. The one girdled tree may thus rear up several generations, from four to a dozen or more, of the pest before the bark is either entirely riddled or has died to such an extent as to be no longer to the taste of the beetles. The same would, I think, apply if the trees were only topped instead of being girdled as they would run the risk of becoming diseased and would then not improbably be at once attacked.

If, on the other hand, the tree is felled outright instead of being ringed or topped, its bark will become dry and distasteful to the *Tomicus* within at the latest six months, and that tree will support at the most but two generations of the beetles and most probably not more than one.

[1] On the northern slope of Hattua, above the Simla-Thibet Road, a few miles from the Narkanda Bungalow.

In May 1901 I was able to inspect some Blue pine which had been felled outright in June 1900 and left with the bark on. The bark was now quite dry. These trees were not noticed to have been attacked at the time of felling but examination showed that they had been badly infested by the July beetles, and perhaps by the later generations. The greatest number reared, however, was not more than two life cycles.

My recommendations for future treatment, with the object of reducing the numbers of these beetles in the forests and preventing further spread from the infested centres, an occurrence which is undoubtedly taking place, are as follows:—

1. That in future, when it is considered necessary to remove the Blue pine or Spruce from around the Deodar, the former trees should not be girdled but felled outright and at once barked and the inside of the bark exposed to the sun's rays.
2. That all still green girdled standing trees be treated in this way.
3. The trees should be barked during the second or third week in May, the beginning of July, the middle or third week in August, and the beginning of October. The reason for this is that the larvæ will then be still young and may be killed by the drying up of the bark. Since, however, the generations overlap (owing to the first laid eggs developing sooner than those deposited at later dates), there will certainly be either pupæ or beetles which will not be affected, and these will issue in due course.
4. There will be no harm in felling the trees at earlier dates, provided the barking is done at the periods specified.
5. That both girdling and topping trees should be discontinued.
6. At all infested centres I recommend that a system of "trap trees" be prepared. For this purpose sickly trees, suppressed trees, etc.,

should be chosen in suitable localities where they can be easily reached and watched. These trees should be felled, the bark being left on. The beetles will resort to them in large numbers for egg-laying, choosing them in preference to adjacent standing trees. When egg-laying has ceased, these trees should be barked.

As we do not yet know exactly how many generations there are in the year at different elevations, I recommend that the system of "trap trees" be kept up and watched carefully from the middle of April to November.

7. As far as possible, apparently uninfested forests should be inspected for attacks of the pest (I have already discussed how such can be recognized). When badly infested trees are found, they should be treated as above.

If the above methods are put in force, it should be possible to reduce the numbers and spread of the Blue Pine Tomicus and bring them down to the normal condition, in which state it may be left to be dealt with by various predaceous insects which feed upon it, several of which have been discovered and will be described in these notes.[1]

In conclusion, I may mention that in the Chogaun forest in Bashahr, from which the attack was first reported in 1900 by Mr. Minniken, the latter informed me that he cut out in that year many of the badly infested trees and sent them down a rough timber slide to the Sutlej River, down which they were floated to the timber markets. Trees that can be so treated should be first barked or they will be liable to spread the pest, the time spent between felling and reaching the river being in all probability quite sufficient for this purpose. The attack in this area was again very bad in June 1901 and had by no means been stamped out.

[1] Since this note went to press, several fresh predaceous beetles, especially *Histeridæ* and Ichneumon and Bracon flies, have been discovered attacking this Tomicus or its larvæ. It is hoped to treat of these in a future number of these notes.

Points in the life history requiring further observation.

1. The number of eggs laid by the females of the various generations.
2. The number of days which the different stages take to develop, *i.e.*, the time spent in the egg, larval, pupal, and imago stages of the various generations of the year.
3. The range of the insect in India.
4. Whether the *Tomicus* attacks other trees besides the Blue Pine and Spruce.

The principal Insect Allies of the Blue Pine Tomicus.

POLYGRAPHUS MAJOR, MS.

Plate XIII, fig. 2, a, b, c.

Reference:—This insect is new to the British Museum. It may possibly be identical with the beetle mentioned on pp. 63, 64 of my *Injurious Insects* which was determined as near to *P. pubescens* of Europe.

Classification:—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Hylesini.

Trees attacked:—*Cedrus Deodara* (Deodar); *Pinus excelsa* (Blue Pine).

Description.

The *larva* when young is a minute, yellowish-white, curved and legless grub of the ordinary Scolytid type. When full grown, it is white in colour and about 3 millim in length.

The *pupa* is whitish-yellow and of the ordinary beetle type.

The *beetle* on emergence from the pupal state is bright yellowish-brown, the tint darkening as the outer parts harden. When ready to leave the tree, it has a moderately shining black head and thorax and dark chestnut-brown elytra covered with a yellow pubescence. The insect is oblong in shape and hairy above and below. The head is not entirely covered by the thorax and has a short, broad rostrum and clubbed antennæ, the forehead bearing a dense tuft of yellow hair. The antennæ have a short funiculus of 5 joints, together shorter than the long solid club. The thorax is broader posteriorly than anteriorly and a small channel marks its juncture with the elytra; the thorax is punctured all over, the elytra being striate and punctured. Legs black, with yellow hairs on them, tarsal joints filiform, yellow, and four in number, the 3rd joint simple. Insect black and shining on ventral surface; 5 abdominal segments visible. Length 3 to 3·3 millim. Plate XIII, fig. 2, a, shows a dorsal and side view of this beetle.

Life History.

The beetles are to be found towards the end of April boring into the trees for the purpose of egg-laying, both blue pine and spruce being affected. The first brood of beetles from these eggs appears during the latter part of June (probably earlier in favourable situations), the generation taking from six to seven weeks to pass through. The beetles maturing in June at once commence egg-laying and a second brood of adults makes its appearance during September, whilst a third generation or a portion of it is passed through before the winter cold puts an end for the time being to the insect's activity. In favourable situations and years it is not improbable that this number of generations is increased, the spring and summer life cycles being gone through at a quicker rate.

The beetle bores its way in from the outside, and on reaching the bast gnaws out in it and the sapwood a chamber of irregular stellate shape (see Pl. XIII, fig. 2, b, c (p)). From this chamber usually three, occasionally four or five, arms or branches take off (fig. 2, b, c, (e)). These branches are the egg galleries and they are bored deep in bast and sapwood, being usually curved and about an inch in length on large branches. The female beetle, as she bores out her tunnel, gnaws out little indentations at the side, placing an egg in each. These appear to be made more on one side than the other as she bores away from the pairing chamber (see Pl. XIII, fig. 2, b (e)), the notches being closer together on this side whilst only a few scattered ones are on the other. From 8 to 15 eggs appear to be laid in each gallery. The larvæ, on hatching out, feed in the bast at first, but as they get older they go into the sapwood and feed there. They bore winding galleries in a direction approximately at right angles to the egg gallery, their tunnels averaging ½ to ¾ inch in length. When full grown they eat out a small chamber in the wood at the end of the larval gallery before changing to the pupal stage. The pupal stage is passed in this, and the beetle when mature bores its way out by a horizontal gallery direct to the outside. Occasionally the larva feeds almost entirely in the bark, but it will bore into the sapwood to make its pupal chamber. This latter is occasionally merely a saucer-shaped indentation in the wood and not bored right in, but the latter is the most usual. I have never as yet found more than two beetles in any one gallery or set of galleries. When the ♀ has finished egg-laying, she bores a short off-shoot gallery off the egg gallery at the end of which she dies or the egg gallery may be prolonged, the end portion, at the head of which she dies, containing no indentations for eggs. In the smaller branches the beetle bores much deeper and the egg galleries are usually much longer. The insect hibernates through the winter either as a larva or perfect beetle.

Relations to the Forest.

This *Polygraphus*, whilst assisting the Blue Pine Tomicus in its attacks upon the older trees in the forest, goes further and infests young growth which I have not as yet found affected by the larger beetle. It prefers the younger portions of the tree where the bark is soft and still thin. The crowns of older trees and the old side branches, and more especially stems and branches of young saplings, are the places it attacks and breeds and feeds in. This preference for the younger parts of trees leads it to infest young saplings whenever, from any cause, they have become weakened in vitality. Young trees broken by snow were found in the spring to be full of beetles, engaged in egg-laying, the insect having subsequently spread to apparently healthy trees alongside. Attacked stems, etc., are at once recognized by the fact that the entrance holes on the outside are surrounded by a circle of white resin which renders them very conspicuous. The thin bark also turns yellow and crinkles up. On cutting into a stem with this external appearance at one of the holes either beetles, or larvæ, or both, will be found burrowing in the bast and sapwood, the galleries being flooded with turpentine in which the insects wallow about. The branches are often so riddled as to be merely a mass of interlaced galleries, the whole of the bast layer disappearing.

In the case of older trees, whenever the bole is found to contain the blue pine Tomicus, *Polygraphus major* will almost invariably, if not always, be found in the crown and side branches. When found in company with the Tomicus, it is generally at the boundary line where the latter's attack ceases and that of the Polygraphus begins. On these thicker portions of the tree the pattern made by the beetle is a very easy one to recognize, see Pl. XIII, fig. c.

This Polygraphus is undoubtedly a serious pest in the forest, and its habit of attacking young growth renders it the more necessary that its life history should be well understood and that a constant watch should be kept on its operations, so that any undue increase on its part may be taken in hand at once.

I found it also infesting the *Pinus Gerardiana*, near Kilba, in the Sutlej Valley, Bashahr State.[1]

[1] Since this note went to press, I have discovered this Polygraphus seriously infesting young deodar saplings in a plantation at Pajidhar in the Jaunsar Division, North-West Himalayas. There were some blue pine in the plantation, and both were badly attacked by the Polygraphus. A fire had passed through a portion of this plantation in January and the trees, weakened but not killed by it, had been attacked by the beetles in May, eggs being laid in the trees. The larvæ on hatching out had entirely riddled the cambium both in the deodar and blue pine, the attack being more severe in the latter. It appeared probable at first that the deodar might have been infested by the Polygraphus after all the blue pine had been occupied, but examination showed that the deodar saplings had been attacked by the beetle in previous years. In some of these cases the trees had killed the beetles by an outflow of turpentine either in the tunnel when entering the tree or in the just commenced egg gallery. In others the galleries in the sapwood were half-grown over, the green cambium edge on either side being plainly visible. Only one or at most two egg galleries are bored from the pairing chamber in the sapwood of the deodar instead of the three which are usual when the insect attacks the blue pine. The larvæ usually mine in the bast only going into the wood to pupate. When this attack was discovered (June 25), the beetles of the first generation were maturing, some having already issued and commenced laying the eggs of the second generation in the deodar saplings which were still alive. The Polygraphus beetles were mostly in the lower $\frac{3}{4}$ of the main stem of the saplings and not in the tops, the latter being full of the *Pityogenes coniferæ* beetle.

The fact of galleries being found partially or nearly entirely grown over by the cambium shows—

(1) That the trees must have been attacked by the beetles before the growing season of the preceding year. This is of great importance since it proves that the beetle will attack deodar even when blue pine saplings are available close by.

(2) That the trees must have been in good health afterwards to have enabled the cambium layer to have sufficient vitality to perform this work.

(3) The number of these galleries found was few showing that the beetle had not attacked in sufficient numbers to kill the tree.

The fact that this beetle attacks deodar in addition to blue pine and that it can infest green saplings renders it a very serious pest in the forest.

Points in the life history requiring further observation.

1. The number of egg galleries bored from each pairing chamber and the number of eggs laid in each. Does the number vary in different trees attacked, and is it constant for any one species of tree?
2. Does each ♀ bore only one egg chamber?
3. The exact number of generations in the year. Are there ever four or five?
4. Time passed in the various stages of each generation or life cycle.

POLYGRAPHUS MINOR, MS.

Plate XIII, figs. 1, d, 3. Plate XV, figs. 2, 3, 4.

Reference :—This beetle is new to the British Museum collection. I call it provisionally *Polygraphus minor*, MS.

Classification :—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Hylesini.

Trees attacked :—*Pinus excelsa* (Blue pine); *Picea Morinda* (Spruce).

Description.

The *larva* is similar to that of the above-described Polygraphus (*P. major*, MS.) but smaller.

The *beetle* also resembles the latter in shape but is smaller. It is oblong, pubescent, with thorax broader behind than in front and head exposed, the latter when seen from above being striated. Head and thorax black, the latter punctured and covered with scattered short hairs. The division between thorax and elytra is well marked. Elytra black with rows of grey-brown hairs running down them. Antennæ as already described for the other Polygraphus and yellow in colour. Tarsal joints 4 in number and yellow. Ventral surface shining, sparsely covered with yellow hairs, 5 abdominal segments being visible. Length 2·5 to 2·75 millim.

Pl. XIII, fig. 3, shows a dorsal and side view of this insect.

Life History.

This beetle was first discovered at the beginning of May boring into blue pine in company with the *Tomicus sp.* It appeared to be in a younger stage of development than the larger beetle, and it is possible that it seeks out trees already attacked by it. The insect remains in the trees longer than the Tomicus and will attack trees whose bark has lost the freshness the latter requires. The beetles infest the bole of the tree and are only rarely found in the tops and branches in company with the *Polygraphus major.*

It is probable that this insect has three to four generations in the year in favourable seasons, the first flight of beetles, from the eggs laid at the beginning of May or late in April, appearing towards the end of May (I have found pupæ and lightish brown immature beetles in the galleries on the 22nd May). These at once lay eggs and a second generation of beetles appears about the beginning of July. Immature beetles were found on 22nd June at about the same elevation as those found on 22nd May. A third brood of beetles from eggs laid by these latter makes its appearance at the end of September and beginning of October and at once lays eggs. These latter develop into larvæ, a portion of which may reach the beetle stage and hibernate as such through the winter. It would appear, however, that a large number pass the cold weather as larvæ enveloped in a thin, white, papery cocoon at the end of their larval galleries which they slightly enlarge. Early in April these probably turn into pupæ, the resulting beetles emerging from the tree towards the end of the month.

The number of generations and time spent in each require further study and corroboration.

The ♂ bores into the bast through the bark of the tree and excavates in it a pairing chamber, being joined there by the ♀. At present my observations have shown me that there are always two beetles to be found in this chamber whilst it is under construction. After pairing has taken place, the ♀ bores an egg gallery away from the chamber in the bast and lays her eggs in this. In Pl. XIII, fig. 1, d, the small chamber, p^1, containing a beetle is the pairing chamber from which an egg gallery is just being started. The usual number of egg galleries bored away from the pairing chamber appears to be five (see Pl. XV, figs. 2, 3, 4, *p. e.*). It often happens that in leaving the pairing chamber the ♀ bores the egg gallery for some distance in the thick bast layer without breaking through the inner surface. In such cases the number of egg galleries bored away from the pairing chamber appear to be smaller than they really are. The larval galleries are situated entirely in the bast and take off approximately at right angles but curve away later on (see Pl. XV, figs. 2, 3, 4, l.). The sapwood is not touched either by the egg or larval galleries. I have not yet determined how many females pair with the male.

Relations to the Forest.

This Polygraphus confines itself almost entirely to the bast and bark of the tree, making no, or very little, impression on the sapwood. Its galleries run in the bast nearer to the outside of the tree than those of the Tomicus which groove deep into the sapwood. Like the latter, however, it apparently appears to prefer the thick bark and bast layer of the main trunk of the older trees. It is always in greater numbers here, though it is to be found more rarely in the softer portions affected by the larger species of the genus (*P. major*). It has also been found in company with *Hylesinus* (?) sp. Its presence can be detected by the small shot holes appearing on the outside of the bark, these latter being much smaller than those of the Tomicus. It also attacks the spruce in a similar manner to the blue pine [1] in company with the Blue Pine Tomicus.

Points in the life history requiring further observation.

1. The number of ♀'s pairing with ♂, and number of eggs laid.
2. The number of generations and the time passed in the various stages of each.

[1] Since the above notes were written, I have also found the insect boring into the main trunk of a newly-felled deodar, the bast and sapwood of which had already been riddled by *Scolytus major* and *S. minor* (see pp. 203—212) *ante*. This was at the end of June, the beetles being those of the second generation of the year about to lay the eggs of the third generation. This discovery is interesting and important for the following reasons:—

(1) It shows that *P. minor* as in the case of its confrères, *P. major* and *Pityogenes coniferæ*, attacks deodar in addition to blue pine and spruce.
(2) That in attacking deodar it bores into the main trunk as it does in the case of the other two trees it affects.
(3) That it will attack less fresh deodar than will the Scolytus beetles as is the case when it accompanies the Tomicus in blue pine.

I also found one or two half mature specimens in the deodar saplings at Pajidhar which had been attacked by the *P. major* and *Pityogenes coniferæ*. They were at the base of the saplings attacking the harder thicker bark which had formed on the older trees. I found none, however, in the neighbouring blue pine.

PITYOGENES CONIFERÆ, MS.

Plate XIII, fig. 4, a, b, c, d, f.

Reference :—This beetle has also proved to be unrepresented in the British Museum.

Classification :—Order, COLEOPTERA. Family, Scolytidæ.

Trees attacked :—*Pinus excelsa* (Blue pine); *Cedrus Deodara* (Deodar); *Pinus Gerardiana*, F.

Description.

The *larva* is a minute, curved, white, legless grub. (See Pl. XIII, fig. 4, a.)

The *pupa* is white and has the ordinary beetle form. A ventral view is shown in fig. 4, b.

The *beetle* is small, oblong, shining, with head entirely concealed beneath the thorax, and not visible from above. Thorax black, slightly longer than broad, punctured all over and covered with scattered canary yellow hairs. Elytra rufous-brown, lightly punctured and with scattered yellow hairs; they are channelled and slope down posteriorly, the truncate end being sculptured and bearing small projections which are much larger in male than in the female (*cf.* fig. 4, c and d.) Antennæ and legs rufous-brown in colour. Ventral surface black, shining, and covered with scattered yellow hairs. Tibiæ are spined, Length 2·35 millim. Pl. XIII, fig. 4, c, shows the ♂ and d, a dorsal and side view of the ♀ of this small beetle.

Life History.

This beetle would appear to have at least three (and more probably four) generations in the year. Mature insects are to be found boring into Blue pine trees towards the end of April in company with the *Polygraphus major* beetle, preferring the softer portions of the old trees, saplings, and young growth. The first brood of beetles of the year from the eggs laid by the April beetles (which are the over-wintering ones) appear in June (probably much earlier in favourable localities), a second generation in August-September, whilst mature beetles, probably of a third (or fourth ?) generation of beetles were taken from trees as late as November 17th. These beetles hibernate in the trees during the winter. The exact number of generations requires further careful observation, as they will almost certainly vary with the elevation, aspect, etc., and I am rather inclined to think that they overlap.

The galleries made by this beetle consist of a central breeding chamber (fig. 4, f (p)) having several arms or egg galleries gnawed out in the bast and sapwood. Occasionally the pairing chamber is entirely in the bast from which several, from four to as many as six, short egg galleries take off, the whole having an irregular stellate appearance. The eggs are laid in small depressions made usually on the outside curve (but they may be on the inner one) of the winding egg gallery (see fig. 4, f (e)). The pairing chamber is as much as 3 millim. across and the egg galleries vary in length up to 13 millim. (*cf.* Pl. XII, fig. 4, f, (p) (e).) As many as four beetles have been found in the pairing chamber, and it is probable that each ♀ beetle bores one of the egg galleries. About 10-12 eggs are laid in each gallery. The larvæ on hatching out bore away from the mother gallery, changing to pupæ at the end of their tunnels. They bore mainly in the bast layer, but often when about to pupate bore down into the sapwood and change to pupæ there (see fig. 4 f (m)).

Relations to the Forest.

This little beetle confines its operations to the smaller branches of the Blue pine[1] where the bark is still quite soft. It infests these places in enormous numbers, working in company with the larger Polygraphus. It is to be found in the side branches and upper portion of the leading shoot of older saplings. In smaller ones it infests every part and it then becomes a serious pest, as it would appear to have the power of increasing in large numbers. In the case of the snow-broken Blue pine saplings alluded to as attacked by the larger Polygraphus (see p. 236 *ante*), this beetle was in countless numbers wallowing in the large amount of turpentine contained in the more succulent portions of the young trees. Its attack can be recognized from the outside by the small pin-holes seen in the bark, each surrounded with a small white ring of resin (see Pl. XIII, fig. 4, f (n)) ; the bark when very young turns yellow under the attack and shrivels up. The arms of the stellate galleries run longitudinally up and down the stem rather than horizontally, and the appearance of the pairing chamber

[1] I have since found it in company with *Polygraphus major* infesting deodar saplings. It was very numerous in the tops of saplings already described as attacked by its larger companion at Pajidhar (see footnote on p. 237). In a few cases it was found in the main stem, low down, and the gallery had then only 4 arms or egg galleries to it, the pairing chamber being made entirely in the bast as also were the larval galleries and pupating chamber, only the egg galleries grooving down into the sapwood. In the tops, however, and leading shoots the attack corresponded in all respects to that in the blue pine. I was unable to count the number of egg galleries bored as the bark and sapwood were riddled by the interlacing galleries. All the stages of larva, pupa and beetle, were found, and also mature beetles just boring into the stems to lay eggs. This would seem to confirm my theory that the generations in one year of the life history of this insect overlap one another since it would seem probable that the larvæ were those of the second generation, the first lot of grubs appearing somewhere about the beginning of May. This would mean that the August-September larvæ are those of the third generation, and the November beetles those probably of a fourth which lay the eggs of the first at the end of April in the following year. The Pityogenes was equally numerous in the neighbouring blue pine saplings. As in the case of the *P. major* the fact that this beetle attacks the deodar in addition to the blue pine greatly adds to the importance of the pest and renders it essential that its life history should be understood.

and egg galleries are not unlike those of its larger companion, with which they are often found mixed up and interlaced. The latter are, however, larger, have longer arms and the egg galleries are fewer in number, and go much deeper into the sapwood, this being more especially noticeable in the case of the smaller branches attacked.

I have not yet found this insect infesting spruce but it or a very close ally occurs plentifully in the branches of the *Pinus Gerardiana* in which its life history appears to be the same as that already given for the blue pine. It was found in this tree towards the end of June near Kilba, Bashahr State.

Points in the life history requiring further observation.

1. The number of ♀'s pairing with each ♂ and the number of egg-galleries bored by each.
2. The number of generations passed through during the year and the time occupied in the various stages of each.
3. Whether the insect attacks the spruce.

Localities from which the species of Polygraphus and Pityogenes have been reported.

The range of these beetles, as far as has yet been ascertained, is the same as that already given for the Blue Pine Tomicus (*Tomicus sp.*).

Protection and Remedies.

The recommendation already made for the treatment of the *Tomicus* attacks apply equally to those of its three allies. In addition it should be mentioned that when young growth is badly attacked by the larger *Polygraphus* and the *Pityogenes*, the signs of whose attacks, as already explained, are easily discernible, it will be advisable to cut out all badly infected plants and saplings and burn them. This should, of course, be done at a time when they are full of larvæ or pupæ and *before* the beetles begin to mature and issue.

CERAMBYX SP.

Order, COLEOPTERA. Family, Cerambycidæ.

Trees attacked :—*Pinus excelsa* (Blue pine) ; *Picea Morinda* (Spruce).

Following close upon the Tomicus attacks and appearing sometimes with them, when these latter insects have weakened the tree by their onslaughts, numerous Cerambyx larvæ are to be found at work, making broad, shallow galleries in the bast and outer sapwood. These larvæ are white in colour, resembling those already described on page 50 in No. 1 of these notes (see Pl. IV, fig. 3, a) and were from 1 inch to 1¼ inch in length at the time they were found. No perfect beetles have yet been obtained. These longicorn larvæ are dangerous in the forest since their attacks further weaken the trees and minimise or entirely put an end to any chance they might have had of recovering from the bark beetle infestation. Further information is required on the following points :—

(1) As to how long the insect spends in the larval and pupal stages.

(2) At what time the mature beetle appears.

HYPOPHLŒUS FLAVIPENNIS,

MOTS.

Plate XIII, fig. 5.

Classification:—Order, COLEOPTERA. Family, Tenebrionidæ.

Description.

The *beetle* is small with a large exposed head, brown in colour, as is also the prothorax which is narrower in front than behind and longer than broad. Elytra yellowish, oval, finely but broadly striate with scattered punctures; they leave one segment of the body exposed. Antennæ are shorter than prothorax, 11-jointed. Legs short. Last joint of tarsus longer than rest together. Length $\frac{5}{32}$nds inch. Pl. XIII, fig. 5, shows a dorsal and side view of this insect.

Life History, etc.

I am at present unable to say what part is played in the tree by this beetle, which is a small heteromerous one. I am not aware that it has ever been reported as injurious. It may possibly be a sap-feeder, but further observation on its habits is required, as also on those of its larva.

The beetle was sent in company with the Tomicus from the Chogaun forest in Bashahr in 1900, it having been taken from the galleries of that beetle (or perhaps from those of its companion Polygraphus ?). The following year, at the end of June, I found it in the same neighbourhood but at a lower elevation in bark-beetle galleries in the *Pinus Gerardiana*, the beetles from whose galleries I obtained immature specimens of it being species of *Polygraphus* and *Pityogenes*.

This is at present all the information I have on the subject.

Some Insect Enemies of Tomicus sp. and its Allies.

NIPONIUS CANALICOLLIS,

LEWIS.

Plate XIII, fig. 6.

Reference :—Ann. Mag. Nat. Hist. Ser. 7, Vol. viii, November 1901.

Classification :—Order, **COLEOPTERA**. Family, **Histeridæ**.

Predaceous upon *Tomicus* sp. (Blue Pine Tomicus) ; *Polygraphus major*, MS., and *P. minor*, MS.

Description.

The larva of this insect has not yet been discovered.

The beetle is cylindrical, oblong, black and shining, the tarsi being palish ; head somewhat robust and sulcate between the cephalic projections ; antennæ elbowed, ending in a club at their tips ; the thorax has a very conspicuous median channel which sometimes reaches the base, but is always somewhat shortened in front ; on either side of the channel the surface is uneven and the punctures irregular in size and form. The elytra have few striæ and leave two segments of the body exposed below their tips. The tibiæ are rather slender, they and the thighs being black.

Length 3½ to 4½ millim. Pl. XIII, fig. 6, shows a dorsal and side view of this beetle.

Life History.

Neither the larval nor pupal stages have yet been observed.

The beetle was first discovered early in May (1901) in the tunnels of bark-borers in the blue pine. Subsequently mature insects were also found in the blue pine trees towards the end of June, these possibly being those of a later generation. The number of generations the beetle passes through during the year is, however, as yet undetermined. Fully mature beetles were found in the trees in the middle of December, amongst imagoes of the Blue Pine Tomicus and the two species of Polygraphus beetles described above. It may be that the number of its generations corresponds to those of its hosts.

Relations to the Forest.

This beetle is a predaceous one and is therefore most useful in the forest since it feeds upon the blue pine bark-borers. It is more especially abundant in the tunnels of the two Polygraphus beetles, and it is constantly present here when no Tomicus beetles are to be found. It is probable, however, that on occasions, at any rate, it also attacks and feeds upon this latter insect, as when some living species of the Tomicus, Polygraphus and the Niponius were sent to me, many of the Tomicus beetles arrived in a half-eaten state. I have not found it attacking the Pityogenes beetle, and the tunnels of this latter are too small for it to enter.

This predaceous insect is found all through the area I have given as occupied by the Tomicus and Polygraphus pests. It has yet to be ascertained whether the adult also feeds upon the eggs, larvæ or pupæ of its hosts, or whether these stages are preyed upon by its own larval stages.

It has also to be ascertained whether it follows the bark borers into the tree, or whether all the stages in its life history are spent there.[1]

CUCUJUS (?) SP.

Plate XIII, fig. 7.

Reference :—Provisionally named Cucujus (?) sp.

Classification :—Order, COLEOPTERA. Family, Cucujidæ

Predaceous upon *Tomicus* sp. (?), *Polygraphus major* and *P. minor* ; *Pityogenes coniferæ* ; *Scolytus major* and *S. minor.*

Description.

The larva has not yet been observed.

The beetle is oblong, shining, somewhat flat, the elytra being broader than the thorax at their point of juncture with it. Head black and exposed, and punctured, not being

[1] Since this note went to press, I have found pupæ and mature insects of what I think is this *Niponius* in *Polygraphus major* galleries in deodar saplings (see foot-note on p. 237). The beetles were, I think, feeding upon the nearly mature Polygraphus insects. This would seem to prove that the larvæ feed inside the tree in the larval galleries of the host.

covered by the thorax. Antennæ moniliform, placed in front of eyes, yellow in colour, as also are the legs. Thorax black, rounded in front, squarish behind, very convex and uniformly punctured all over. Elytra rufous brown and punctured, rounded at their tips and leave one black segment of the body exposed. Under-surface black, shining, pitted; 5 visible ventral segments of the abdomen. Tarsi 5-jointed. Length 3·5 millim. Pl. XIII, fig. 7, shows this beetle.

Life History.

This beetle is usually to be found in company with *Niponius canalicollis* in the galleries of the above described bark beetles attacking the blue pine and spruce. Mature beetles were first discovered towards the beginning of May and again towards the end of June. Later on perfect insects of this species were again found in the tunnels of the two species of Polygraphus beetles about the 3rd week in September, whilst in December (on the 15th of the month) numbers of them were taken from trees together with the *Tomicus*, *Polygraphus*, and *Niponius canalicollis* beetles and sent to me.[1]

It would appear that this beetle passes the winter in the imago stage, or that, at any rate, a portion of the last generation of the year does so.[2]

Relations to the Forest.

This insect is as useful in the forest as its companion *N. canalicollis*. It more especially, if not entirely,[2] confines itself to preying upon the two species of Polygraphus, which attack and infest the blue pine and spruce.

I am unable to say at present whether it attacks any of the stages of the Tomicus or Pityogenes insects, but I have

[1] These and previous consignments from September onwards were, at my request, very kindly obtained and sent to me by Mr. J. C. Tulloch, Deputy Conservator of Forests in charge of the Jaunsar Division.

[2] Subsequent observations made since this note went to press have shown me that this beetle is exceedingly plentiful in the Jaunsar coniferous forests. In the galleries of the blue pine Tomicus, the Polygraphus and Pityogenes beetles and even in the galleries of the *Scolytus major* and *S. minor* beetles in Deodar this beetle swarmed between May and July 1902 and through the later months also. It was always to be found in the imago form. Its larval stage has not yet been discovered.

never found it in the latter's galleries, and the smaller Polygraphus is almost invariably, as far as my observations go, present with the Tomicus. I have found it swarming in numbers in trees deserted by the Tomicus but still containing numbers of the smaller Polygraphus beetle. It appears to be more abundant, or, at any rate, more "en evidence" than the *N. canalicollis*, and at times it swarms in the galleries in enormous numbers.

This beetle occurs all through the area over which the two Polygraphus beetles have been found.

The number of generations in the year, the date of appearance of the larval and pupal stages, where they are passed, and the food fed upon in the larval stage have yet to be observed.

POLYGRAPHUS MINIMUS, MS.

Plate XVI, fig. 1.

Reference:—Provisionally named *Polygraphus minimus*, MS.*

Classification:—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Hylesini.

Tree attacked:—*Pinus excelsa* (The Blue Pine).

Description.

The *larva* is a minute white curved grub.

The *beetle* is very small, black, moderately shining, with elytra covered with scattered longish white hairs. Head small, vertical in front, with a very short rostrum. Antennæ short; scape thick, straight; funiculus 5-jointed; club compact, flattened, ovate; eyes oval. Prothorax cylindrical, narrower in front than behind, and uniformly pitted. Elytra fairly long, rounded at the posterior declivity, not wider than prothorax behind, pitted. Thighs of legs long-oval. Tibiæ finely toothed on their external edge; tarsus filiform, the first three joints of equal size, the third not bilobed. The three intermediate segments of the abdomen of same size and short. Antennæ and legs yellowish-brown. Length 1·1 millim. Pl. XVI, fig. 1, shows this insect.

Life History.

This is the third and smallest of the *Polygraphus* beetles found in the Blue Pine. Present observations would seem to show that it is unlikely to do much damage to the tree. It was found in the third week in May making minute galleries in the bark of the bole of both dying and newly-dead trees. The inner bark where it adjoins the sapwood is the part attacked. It is thus a companion to the Blue Pine Tomicus and the smaller Polygraphus (*minor*). I have found it in a newly-felled tree in company with both. It remains, however, after the Tomicus attack is over, and thus appears to be able to lay its eggs in bark which is not absolutely fresh. The beetle was egg-laying when first found, some of the minute larvæ having

* See Stebbing 1914 Indian Forest Insects p. 499 — corrected to Crypturgus pusillus Gyll. PNC 12.10.1954.

already developed from the eggs. I am unable to say whether these larvæ were the first or second generation of the year.

A small chamber is grooved in the inner bark, and in this the male pairs with several females. These latter then bore their egg-galleries away from the central chamber. The larvæ on hatching mine away at various angles from the egg-galleries of the mother beetles. The ♂ would appear to pair with from 4—6 ♀ beetles. The beetles appear to require moist bark to bore in, as they are only to be found either in bark still alive, though nearly dead, or in moist places in newly dead bark. I have never found them in dry bark.

In the third week in June another generation (second or third?) is commenced, as beetles were found, matured from the eggs and larvæ discovered in the third week in May, laying eggs in a similar manner to the May beetles. No larvæ had developed. A spring generation would thus appear to take from four to five weeks from egg to fully developed beetle.

This is as far as I have carried the life history.

Locality from where reported.

This minute Scolytid is plentiful in the Jaunsar and Tehri-Garhwal blue pine forests in the North-West Himalayas. It was discovered in 1902.

Relations to the Forest.

As far as present observation goes, this Polygraphus would appear to do little damage to the tree, since it has only been found in the bole of trees from the pole stage upwards. It comes in after the Blue Pine Tomicus, and probably waits until that insect has undermined the vitality of the infested tree. It remains in the tree, however, longer and will undoubtedly attack bark that is no longer fresh.

Protection and Remedies.

These will be the same as already given for the Blue Pine Tomicus and the other Polygraphus beetles. In getting rid of them this beetle will be likewise killed off.

Points in the life history requiring further observation.

1. The number of generations in the year.
2. Where does the insect lay the eggs of the first generation of the year?
3 In which stage does it pass through the winter in?

POLYGRAPHUS LONGIFOLIA,
MS.

THE LONG-NEEDLED PINE POLYGRAPHUS.

Plate XVI, fig. 2, a, b.

Reference:—Provisionally determined *Polygraphus longifolia*, MS. new to the British Museum.

Classification:—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Hylesini.

Tree attacked:—*Pinus longifolia*.

Description.

Beetle.—A small insect with black shining head and prothorax and brown elytra, the latter covered with a whitish-yellow, fairly close, pubescence with scattered longer yellow hairs near the apices of the elytra. This beetle has the same Polygraphus characters already described for the other species of the genus. There is a brush of yellow hairs on the forehead, and the head and prothorax are pitted with not very close-set punctures. The elytra distinguish this beetle from *P. minor*, M.S. which it somewhat resembles in size and build. The antennæ are brown with a yellow club. Legs brown; tarsi yellow.

Length about $\frac{1}{12}$th inch. Pl. XVI, fig. 2, a, shows this beetle.

Life History.

This insect probably makes its first appearance in the year some time towards the end of April or beginning of May, since mature and nearly mature beetles of what was evidently the first generation of the year were discovered in a young sapling in the middle of June, whilst the insect was found egg-laying at the beginning of July, the eggs being those of the second generation of the year.

The beetle attacks sickly and dying saplings and branches, laying the eggs in the bast layer. It is often found in company with the small *Cryphalus longifolia* beetle.

The *Polygraphus* bores straight through the bark, often ¾ inch thick, down to the bast layer, its hole of entrance being easily visible from outside, as it does not attempt to hide it by tunnelling in beneath a flake of bark or in the shelter of a crevice. On reaching the bast, the beetle bores out a heart-shaped chamber in it and the sapwood. (See Pl. XVI, fig. 2, b (*p*)). This may be the pairing chamber, but as yet I have never found more than one beetle present either in the chamber or egg-gallery. From the base of the heart a longish egg-gallery is bored about 4½ to 5 inches in length, and on each side, at some distance apart, little cavities are gnawed out and an egg laid in each, see Pl. XVI, fig. 2, b(*e*). The larva on hatching out of the egg bores away from the egg-gallery mostly in the sapwood and in a direction which is more or less at right angles to it (fig. 2 b(*l*)). The shape of this gallery is very constant and easily recognizable. The length, however, varies. The sapwood of dead saplings and branches is often completely covered with the patterns of this and *Cryphalus longifolia* described later on in this number of the notes.

I have not as yet ascertained when the beetles of the second generation mature and issue, nor whether, which is most probable, there is a third generation in the year.

Localities from where reported.

The writer first discovered this beetle in the *Pinus longifolia* forests round Taklesh in the Bashahr State, North-West Himalayas. The next year (1902) it was found in Tehri-Garhwal (Jaunsar Division), North-West Himalayas.

Relations to the Forest.

Present observations show that this insect attacks saplings and the branches of large trees. It requires fresh cambium to lay its eggs in and will not touch dead bark. *Pinus longifolia* has a very thick bark which even young saplings develop at an early age. This bark, however, appears to be no deterrent to the beetle, which will often bore into the tree through the thickest ridge of bark on it. The beetle is one which is capable of doing damage in young plantations and to natural regeneration, should the trees of such become reduced in vitality through any cause. In Tehri-Garhwal in the Jaunsar Division, on an area of young growth under high forest swept over by fire in January 1902, I found some of the saplings attacked by the first generation of the beetle and in such cases the young trees had died, whereas the greater number, owing to the strong vitality of the pine and a favouring aspect, had recovered and were quite green at the top though scorched by the fire below.

Protection and Remedies.

Cut out all infected saplings and burn them if they cannot be barked. If barked, expose the inner surface of the bark to the sun's rays. This will be sufficient to kill the larvæ and pupæ present. In the case of serious attacks in the branches of older trees the latter should be felled and treated in the same way since they form centres from which the beetle will spread to young saplings. It will also not unlikely be found probable that old trees, whose branches are badly attacked by this *Polygraphus*, will have their main bole attacked by the large Tomicus (see page 282) of this pine.

From the evidences to be found in young dead trees, and more especially branch wood, in the *P. longifolia* forests, there can be little doubt that this beetle at times swarms in large numbers, and its life history consequently requires to be fully worked out.

Points in the life history requiring further observation.

1. When the insect first commences work in the spring. As the *P. longifolia* lives at low elevations, this is not unlikely to be early.
2. Length of time spent in the various stages of egg, larva, pupa, and beetle of the first generation.
3. The length of time spent in the various stages of the second generation.
4. Is there a third (and fourth ?) generation ? If so, the dates of appearance of egg, larva, pupa and beetle.
5. In which stage of its metamorphosis does the beetle pass through the winter ?

HYLESINUS (?) SP.

THE BLACK HYLESINUS.

Plate XVI, fig. 3 a, b.

Reference :—Provisionally named as *Hylesinus* (?) *sp.*

Classification :—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Hylesini.

Tree attacked :—*Pinus excelsa* (Blue Pine).

Description.

Beetle.—Cylindrical, black, shining, with head and thorax pitted and elytra striated and pitted. Head short, vertical, with a very short rostrum as wide as head. Antennæ brown, scape thickens anteriorly into a knob; funiculus of 7 joints, 1 and 2 long, the first longest and thickest, 3 to 7 short and increasing in width upwards: club nearly as long as funiculus, articulated, oblong, and yellow at upper end. Prothorax slightly convex, narrower in front than behind, thickly pitted, the pits being close together and smaller in front. Elytra longish, cylindrical, rounded at their posterior declivity, not, or only a very little, wider than the prothorax and truncate at their base. Legs fairly stout, with largish tibiæ, curved, and toothed on their exterior edges. Tarsus yellowish-brown, with the first joint a little longer than the second, third a little larger, and bilobed. The second abdominal segment nearly as long as the third and fourth united. Length ⅛th inch. Pl. XVI, fig. 3, a, shows a dorsal and side view of this insect.

Life History.

This beetle was discovered in the blue pine. It bores into the bole of large trees, coming in much later than the Blue Pine Tomicus. The beetles were found boring egg-galleries (?) in the bark in the third week of June when the adults of the first generation of the Blue Pine Tomicus, which were plentiful in the tree, were nearly mature, some having already left the bark. It is thus evident that it requires less fresh bark than its companion, but I have no evidence that it will breed in dead bark. In thus attacking the main trunk it differs from

Polygraphus major, MS., which it resembles in size though not in colour or habits. The beetle is polygamous and as many as eight egg-galleries (?), (*e*), give off from the central pairing chamber, (p), (see Pl. XVI, fig.3, *b*(p), (*l*)) though there may be only 5. I am not, however, able to say whether each is made by a separate ♀ although several of the galleries were found to contain each a beetle. Although the beetles appeared to be boring the egg-galleries, I have not as yet seen any eggs or larvæ, and do not know how or where the latter feed. When the beetle first appears and the number of generations in the year is unknown. The insects found would not unlikely be those of the first generation of the year engaged in laying the eggs of the second generation. The difference in the life history between this and the larger Polygraphus may be summed up as follows :—

P. major was at the time only just maturing as a beetle (first generation) in the branches of the Blue Pine. It was numerous in the tree from which *Hylesinus* sp. was obtained.

P. major does not attack the main trunk of the tree. The tunnels (egg-galleries) of *Hylesinus* sp. differ entirely from those of the large Polygraphus.

Locality from where reported.

This beetle was found in Tehri-Garhwal (Jaunsar Division) in the North-West Himalayas in 1902.

Relations to the Forest.

Until more is known about the life history of this Hylesinus it is impossible to say what damage it does to the trees it infests. The chief point to be ascertained is, whether fresh bark is a necessity to the insect for egg-laying or not. When eggs or young larvæ have been discovered we shall be in a position to form a conclusion on the subject.

Points in the life history requiring further observation.

1. How the beetle lays its eggs, the number laid, and the time passed in the egg stage.
2. Length of time passed in the larval state and the food of the larvæ.

3. Period passed in the pupal state and method of pupation of larvæ whether in the bark or the wood of the tree.
4. Length of time passed in the imago form.
5. The number of generations in the year. If more than one, the information under 2, 3 and 4 and latter part of 1 will be required for each generation.
6. Where the beetle passes the winter.

CRYPHALUS BOSWELLIÆ, MS.

The Boswellia Cryphalus.

Plate XVI, fig. 4, a, b, c.

Reference :—Provisionally named as *Cryphalus boswelliæ*, MS. new to the British Museum.

Classification :—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Tomicini.

Tree attacked :—*Boswellia serrata.*

Description.

Larva.—A small white curved legless grub (see Pl. XVI, fig. 4, a).

Pupa.—White, unenclosed in any cocoon or covering, the antennæ, wings, and legs being quite free and held close to the sides of the beetle (see Pl. XVI, fig. 4, b).

Beetle.—Colour black. Head and thorax pitted. Elytra with striæ and wide rows of bluish white punctures between them. Mandibles short. A brush of yellow hairs round the mouth. Scape of the antennæ, which are dark brown, long club-shaped; funiculus four-jointed, the first joint thick, elongated, the 2nd to 4th only slightly increasing in size; club flattened, oval. Eyes long, narrow, transverse. Prothorax not wider than broad, narrower in front than behind, with only pits and not tubercular projections anteriorly. Elytra cylindrical, rounded on their posterior declivity, not wider or only very slightly so than prothorax, slightly bending inwards at their base. Legs dark-brown. Tibiæ curved and finely toothed on their exterior edges; tarsus yellow, with the first three joints of equal length. A very short yellowish pubescence over the prothorax and elytra in this beetle. Length just over $\frac{1}{16}$th inch.

Pl. XVI, fig. 4, c, shows a dorsal and side view of this insect.

Life History.

The flight time of this beetle is about the beginning of August and probably for some time later. The insect in all stages of its life is to be found at the beginning of the month. In branches of the *Boswellia* which appeared to be dying but were still green larvæ were plentiful and also pupæ and light-coloured beetles, the latter not quite mature. The larvæ are to be found in irregular-shaped cavities in the bast and sap-wood which usually contain a certain amount of moist wood-dust. In the pupal and beetle stages this latter becomes dry. In other branches darker coloured beetles were present, and these were apparently the mature beetles of this generation which had already begun egg-laying. The ♂ and ♀ beetles were found together gnawing out irregular-shaped chambers beneath the bark in the bast and sapwood. These beetles had apparently only just matured and had at once commenced egg-laying, the eggs being those of a second or third (?) generation.

This is all that has been at present observed about this insect.

Locality from where reported.

This beetle was found in the Bhamburda reserve near Poona in the Bombay Presidency.

Relations to the Forest.

The smaller green branches of *Boswellia serrata* are bored into by the insect for the purpose of laying its eggs in them. The larvæ on hatching out feed upon the surrounding cambium layer and destroy it. If at all plentiful, the bark is eaten right round and the twig, being girdled, dies.

Further observation is required to ascertain whether the insect is at all numerous and whether it infests young plants. In this latter case it might on occasions become a serious pest.

Points in the life history requiring further observation.

1 The number of generations passed through by the insect in the year. This is important. If more than one, we require to know the length of time spent in the various stages of the metamorphosis in each generation.
2. Does the insect attack young plants?
3. Where does it pass the cold-weather months?

CRYPHALUS TECTONÆ, MS.

THE TEAK CRYPHALUS.

Plate XVI, fig. 5.

Reference:—Provisionally determined as *Cryphalus tectonæ*, MS. new to the British Museum.

Classification:—Order, **COLEOPTERA**. Family, **Scolytidæ**. Sub-Family, Tomicini.

Tree attacked :—*Tectona grandis, L.* (Teak.)

Description.

Larva.—The grub of this beetle is very small, white, curved, and has no legs.

Beetle.—Smaller than *Cryphalus boswelliæ*, MS. Cylindrical. Head, prothorax, and elytra a reddish brown in colour and covered with rather scattered short yellow hairs which are set in rows on the elytra. The prothorax set with tubercular projections anteriorly and lightly pitted posteriorly. Elytra fairly finely striated and fitted with parallel rows of short yellow hairs running down them. Antennæ and legs bright yellowish brown. Under-surface set with longish tufts of white hairs placed irregularly. Length 1·2 millim.

Pl. XVI, fig. 5, shows the imago of this beetle.

Life History.

This minute beetle was discovered boring into the smaller branches of the Teak tree in Berar. The flight time of the insect is about the latter half of July in this part of India. The beetle would appear to have the same habits as other minute *Cryphali* in the continent. It bores into a branch until it reaches the cambium layer and then mines out in this and the sapwood a small chamber, being then joined by a companion. They then together eat out the egg gallery which is simply an irregularly-shaped small chamber made in the bast and sapwood in which the eggs are laid amongst a small mass of wood-dust.

In one case I found a larva, and it would seem therefore probable that the beetles commence egg-laying about the beginning of July in Berar, and that very few days are passed in the egg stage, the larvæ hatching out within a very short time.

This is at present all that has been observed on the habits of this minute beetle.

Locality from where reported.

This insect was discovered in the Melghat Teak forests in Berar.

Relations to the Forest.

Very little is known about this Cryphalus. I am unable to say whether it is at all abundant or otherwise in the Teak forests of the country. It has at present only been found on old trees.

Owing to its method of attack under which the cambium of the young shoot is destroyed by it and its larvæ, it is obvious that if it attacks young growth and were to infest it in any numbers it would be capable of doing serious injury. It will perhaps be found most abundant in localities where the Teak is of inferior growth.

Points in the life history requiring further observation.

1. The number of generations in the year and the length of time passed in the different stages of the metamorphosis of each.
2. The number of eggs laid by the beetle.
3. In which stage the cold weather is passed through.

CRYPHALUS MORINDA, MS.

The Spruce Cryphalus.

Plate XVI, fig. 6.

Reference :—Provisionally named as *Cryphalus morinda*, MS. new to the British Museum.

Classification :—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Tomicini.

Tree attacked :—*Picea Morinda* (Spruce).

Description.

Beetle.—About the same size as *Cryphalus boswelliæ*. Really black in colour but so thickly set with a dense close golden pubescence as to have that colour. The upper three quarters of the prothorax slopes rather abruptly in front and is thickly studded here with prominent tubercular spikes. Posterior quarter is finely pitted. Elytra finely pitted. Antennæ and legs yellow-brown. Underside of insect black, set with long white hairs. The ordinary characteristics of a *Cryphalus* as given under *C. boswelliæ* are present. Length $\frac{1}{16}$th inch. Plate XVI, fig. 6, shows this insect.

Life History.

The flight time of this beetle is from about the middle to the third week in June. The tree attacked is the spruce, the insect boring into the twigs. The needles on the branches attacked were noticed to be quite dry, but the bark itself was still green, though dying. The beetle commences work by boring in through the bark till it reaches the cambium layer. In this it then bores a small chamber which also goes slightly into the sapwood. Whilst this is being prepared, another beetle joins the first, and in the narrow small elliptical chamber two beetles will generally be found at work as soon as the boring is sufficiently large to hold both. In this elliptical chamber the eggs are laid. This is at present all that is known about the life history of this minute insect. It is of importance to note that at present never more than one pair of beetles have been found together in any one gallery, and it is therefore, I think, not improbable that the male pairs with but one female and is not polygamous.

Locality from where reported.

This insect was found by the writer in the Spruce forest between Goara and Sarahan (Simla-Thibet Road) in the Bashahr State.

Relations to the Forest.

Very little is known about these small insects in India, and it is at present impossible to state what relation they really bear to the forests. I cannot at present say whether this beetle is abundant or not, nor whether it attacks young growth as well as old trees. It has only been found in the latter up to date. It is probable that it usually searches for branches which are weak in health, but examination of dead branches shows that those which it attacks in any numbers it invariably kills. The cambium is entirely eaten away and it is not unlikely that the larva is responsible for a good deal of the damage done. A certain thinning out of the smaller branches must take place on the tree under the attacks of this insect.

Points in the life history requiring further observation.

1. How the larva feeds! Does it simply enlarge the elliptical chamber bored by the parents, or does it bore a gallery off this?
2. The number of generations in the year. If only one, the length of time spent feeding by the larvæ hatching out from the eggs laid by the June beetle and the time passed in the pupal stage.

   If more than one generation, their number, and the length of time spent by the different stages of the metamorphosis in each.
3. The number of eggs laid by each beetle.
4. In which stage is the winter passed through?

CRYPHALUS LONGIFOLIA, MS.

The Long-Needled Pine Small Cryphalus.

Plate XVI, Fig. 7, a, b, c.

Reference :—Provisionally named as *Cryphalus longifolia*, MS. new to the British Museum.

Classification :—Order, **COLEOPTERA**. Family, **Scolytidæ**. Sub-Family, Tomicini.

Tree attacked :—*Pinus longifolia*.

Description.

Beetle.—A minute insect, yellow to dark-brown in colour and clothed with a fairly dense mass of long whitish or whitish-yellow hairs. Antennæ and legs bright yellow. Head hidden by the thorax. Mandibles short. Scape of antennæ thickened anteriorly, funiculus of four joints, the first large, longish; club flattened and oval. Prothorax wider than long, convex dorsally, armed with small spiny tubercles anteriorly. Elytra cylindrical, rounded at their posterior declivities, not wider than the thorax. Tibiæ finely toothed on their outside edges. Tarsus with joints 1 to 3 of equal length. Body cylindrical. Length 1 millim. or a little over. Pl. XVI, fig. 7, a, shows a dorsal and side view of this insect.

Life History.

This small beetle was found boring into the branches of old trees and also in the tops and branches of saplings in the first week in June. The insect was engaged in laying its eggs, and these were not unlikely those of the second generation of the year, since the elevation at which it lives is a low one. It infests green sickly branches and also those which are half dry.

In boring into a branch this Cryphalus never goes in direct from the outside, but always searches out some small flake of bark beneath which to bore its entrance hole. The bark of the *Pinus longifolia* is rough even on small twigs, and so it has no difficulty in making its entrance into the branch unobserved. On reaching the bast layer a small irregular-shaped chamber is bored by the beetles, indenting both sapwood and bast (see Pl. XVI, fig. 7, b, c (p)). I have always found two beetles at work making this excavation, and never more than two, the male helping the female. I am unable to say whether pairing takes place before or after this chamber is complete, but as soon as there is room in it for the two beetles, two will be found together. Round the sides of the chamber little indentations are cut (fig. 7, b (e)). By the time the shallow excavation is complete it has become full of white powdery wood-dust and the eggs are laid either loosely in this or in the indentations. At this period only one beetle is present in the egg-chamber. Galleries were found in this condition at the beginning of July. Further than this I have not as yet been able to carry the life history, but from an examination of old twigs and branches it appears that the larvæ mine out winding galleries in the bast and sapwood as shown in fig. 7, c (*l*).

There is at least a third and possibly a fourth generation of the beetle in the year. From some branches taken to Dehra the writer bred out beetles in the middle of September and others may have issued in August since dead beetles were found in the breeding box which, owing to absence on tour, was not opened in that month.

Locality from where reported.

The beetle was first discovered in company with the long-needled pine Polygraphus at Taklesh in the Bashahr State, being obtained the following year numerously in the Jaunsar Division, both situated in the North-West Himalayas. Elevations between 2,000 and 3,000 ft.

Relations to the Forest.

This beetle, though very minute, has the power of increasing in large numbers and must therefore be included amongst the pests of the pine. The tops of saplings and branches are the parts of the tree it infests, the cambium layer being entirely riddled by the borings of the beetles themselves and the subsequent minings of the larvæ which practically girdle the top or twig attacked, consequently ensuring its death. As I have already mentioned, it is often accompanied lower down the top or branch by the Polygraphus and by an even worse Scolytid pest described below under the name of *Cryphalus* (?) *major*, MS.

Protection and Remedies.

All young saplings infested should be cut out and burnt. In nurseries and small plantations attacked branches should be pruned close to the stem and burnt. The attack is easily discernible when the beetle is present in numbers (more especially when in company of either of the above-alluded-to beetles) as the needles turn yellow and there is an exudation of resin from the entrance holes.

Points in the life history requiring further observation.

1. Number of generations in the year.
2. Length of time spent in the various stages of the metamorphosis—egg, larva, pupa, and beetle — in each generation.
3. In which stage is the winter passed ?

CRYPHALUS (?) MAJOR, MS.

THE LONG-NEEDLED PINE LARGE CRYPHALUS.

Plate XVII, fig. 1, a, b, c, d, g.

Reference :—Provisionally named as Cryphalus (?) major, MS.

Classification :—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Tomicini.

Tree attacked :—*Pinus longifolia.*

Description.

Beetle.—General colour black or brown; surface densely clothed with light yellow hairs. The club of antenna is oval, narrower above, and with 4 articulations. Funiculus is five-jointed. Thorax slightly broader than long.

The male and female are, I think, of different colours. ♂. Yellowish-brown in colour. Thorax with prominent spiky spines on its upper two-thirds. The lower third and elytra pitted. Insect covered with whitish hairs.

♀. Black, shining, the upper two-thirds of prothorax covered with a dense felted mass of yellow hairs and with a few spiky spines. Lower third of prothorax and the elytra pitted and clothed with dense short yellow hairs and a few lighter coloured longer ones. Length $\frac{1}{16}$th inch. In the specimens obtained the ♀ appears to be somewhat larger than the ♂. Pl. XVII, fig. 1, a, b, shows the ♂ and ♀ of this insect.

Life History.

This beetle is the larger of the two species of Cryphalus which have been found attacking the *Pinus longifolia*. It is often to be found in the smaller twigs of the tree in company with its more minute companion *Cryphalus longifolia*, but it goes lower down these branches and also attacks the main stem as well as the side branches of saplings. It apparently prefers dying but still green trees.

The insect was found at the end of the first week in June burrowing into branches of old trees in which it was laying its eggs. A shallow irregularly-shaped chamber is first bored in the sapwood beneath the bark, both ♂ and ♀ beetles taking their share in this work, both having entered the tree by the same hole. (See Pl. XVII, fig. c, d, (p)). After the preparation of this chamber, it is probable that fertilization takes place and the ♂ beetle then leaves the tree to die. When attacking small branches the ♀ now bores a tunnel vertically down into the sapwood, either at the centre or in a corner of the pairing chamber, fig. 1, c, d (f), until it reaches the pith of the branch; she then mines out a gallery (fig. 1, c, d (e)) running in the longitudinal axis of the branch and at right angles to her former direction and about ½ an inch in length on either side of the vertical bore. The eggs, I think, are probably laid in this tunnel, and the larvæ perhaps mine up and down both ways, but this latter has to be corroborated by further observations. In one or two instances it was noticed that the ends of the gallery in the pith were blocked up with plugs of what appeared to be chewed up pith in which the eggs may have been laid. When the female is disturbed in the pairing chamber, in which she apparently lives for some time after egg-laying, she at once retires down into the gallery in the pith by the vertical boring (f). In the case of larger branches only the hole at one side of the pairing chamber and the egg galleries, which are usually curved and branching, deeply groove the sapwood (see Pl. XVII, fig. 1 d). Indentations at irregular intervals are cut in the sides of the egg-gallery in which the eggs are laid. The larvæ feed almost entirely in the bast in which the larval galleries are bored. Figure 1, g, shows a portion of a branch badly attacked by this pest in which the galleries are so interlaced as to render it difficult to decipher them. This is the usual appearance of old attacks in the forest.

As this Cryphalus lives at a somewhat low elevation in hot valleys (the altitudes at which it was found were between 2,500 and 3,000 ft.), it is probable that the June beetles observed egg-laying were laying the eggs of the second generation of the year. Just a month later, however, in the first week in July, beetles were observed again egg-laying, this time all the pairing galleries and many of the mother egg-galleries having been already prepared. No ♂ beetles were found at this period. This means that either the June-July generation is run through in all its stages in a month or what is perhaps more probable that there are several generations of these insects in the year and that the different life-cycles overlap.

From some branches taken down to Dehra (elevation 2,000 ft.) the writer obtained beetles in the middle and third week of September and others about the end of the first week of October.

Locality from where reported.

Found plentifully in the *Pinus longifolia* forests in the Tons Valley, Jaunsar Division, N. W. Himalayas.

Relations to the Forest.

This is a more dangerous pest than its smaller companion Cryphalus since its galleries and boring operations are on a more extensive scale. Saplings and branches of older trees heavily attacked by the beetle lose their needles, which first turn yellow and then drop off. An examination will show circular entrance holes large in comparison to the minute ones made by the smaller Cryphalus, and these will be seen to be equally numerous on the outer surfaces of the thicker bark as in the interstices between the flakes. The beetle would seem to prefer dying or sickly trees for its operations, and it was noticed in some abundance in portions of a forest which had been overrun by fire the previous season. The tops of many young saplings were infested with the small Cryphalus and less numerously with this one. Lower down, however, the larger one was much more numerous, many of the stems being entirely riddled by the beetles.

The beetle, since it is, as far as present observations go, invariably accompanied by *Cryphalus longifolia* and, often, by *Polygraphus longifolia* MS. as well, must be considered a serious pest in young plantations, and its life history requires fully working out.

Protection and Remedies.

Cut out and burn all young infested saplings. They may be easily recognised as the somewhat heavy foliage of the long-needled pine turns a bright yellow under heavy attacks and the trees thus become very conspicuous.

Areas which have been overrun by fire or on which sickly trees are noted to exist should be carefully watched, the trees being inspected as often as possible for external shot holes. Trees with these appearing on them should be allowed to remain for a week or two until the beetles about have all oviposited in them when they should be cut out and burnt.

During severe attacks trap trees (see p. 231) should be prepared.

Points in the life history requiring further observation.

1. Where the eggs are laid. Is it in the tunnel in the pith, in the case of the smaller branches, or are they laid in the angles of the irregular star-shaped pairing gallery?
2. Where do the larvæ feed? Is it in the bast and sapwood or in the sapwood alone or in sapwood and pith?
3. Number of generations in the year.
4. Length of the various stages in each life-cycle—egg, larva, pupa, and beetle.
5. In which stage is the winter passed?

CRYPHALUS (?) DEODARA, MS.

The Deodar Branchlet Cryphalus.

Plate XVII, fig. 2, a, b.

Reference:—Provisionally determined as *Cryphalus* (?) *deodara, MS.*

Classification:—Order, COLEOPTERA. Family, Scolytidæ. Sub-family, Tomicini.

Tree attacked :—*Cedrus Deodara* (Deodar).

Description.

The *larva* is a minute, white, curved, fleshy grub of the usual Scolytid appearance.

The *beetle* is oblong, rather shining, dark fulvous-brown to almost black in colour and covered with scattered whitish yellow hairs. Head black, concealed by prothorax which forms a hood over it. Antennæ the same colour and of usual Cryphalid form. Prothorax not broader than long, the anterior portion rather thickly studded with raised projections, the posterior half being punctate. Elytra finely punctate with longitudinal channels between the punctures. Insect entirely black beneath Legs rufous brown. Length about 1·8 millim. (see Pl. XVII, fig. 2, a).

Life History.

The insect was discovered in all the stages of larva, pupa and beetle at the beginning of June in deodar branchlets. The beetles, just about mature and apparently ready to leave the tree, were by far the most numerous. Although the twigs contained several almost mature and mature beetles, yet externally there was no entrance hole visible on the bark, and a close inspection showed that the branchlet was girdled at or near its base. The following is the probable procedure of this beetle: The eggs are laid early in the spring sometime towards the end of April. To perform this operation the beetle seeks out a small green twig and girdles it at or near its base, the girdle being, in every case examined, complete [see Pl. XVII, fig 2, b (1)]. This girdle is made with the object of preventing further sap proceeding up the branchlet, which accordingly begins to die and thus provides a suitable supply of food for the young larvæ hatching out from the eggs laid by the beetle in the branch above the girdle. The reason why I think it probable that the branch is girdled and the eggs laid in the spring is that the young new needles of the year had developed on the ringed twig to a certain extent before they began to wither and die. Further, the wood of the twigs was still comparatively fresh instead of being dead and rotten as would have been the case had the ringing been done the previous year. The eggs are laid near the girdle and the larvæ mine up the twig [fig. 2, b (2)]. On becoming mature, the beetle bores its way out of the branchlet by a short gallery at right angles to its long axis [see fig. 2, b (3)].

An examination of many of the persistent dead twigs showed the plan of action of the beetle. Low down near the base was the girdle above but near to which the egg or eggs are laid. Inside the twig galleries will be found running up and down the wood, made by the feeding larvæ, and on the outside one or more holes of exit show where the beetles have left the stem. The larva apparently mines all round in the outer wood of the twig leaving a central core and this, in old twigs, remains often as a small hard splinter, whilst the shell of bark and wood powder crumbles to dust under one's fingers. In small twigs I never found more than one beetle, but in the larger, several were present, and in large, dry attacked twigs I noticed several holes of exit. From this I conclude that in small twigs but one egg is laid, while in the case of larger ones several eggs are deposited under the small flakes of rough bark. Whether these are laid by the same beetle or not has yet to be determined. In Plate XVII, fig. 2, b (4), a small branch is shown which has been girdled in several places by this beetle. The needles had turned yellow and were dropping off.

Area from which reported.

This insect was discovered by the writer at the beginning of June in the Nagkela Forest, Kotgarh, Bashahr Division, at an elevation of about 6,000 feet in the North-West Himalayas.

Subsequently it was noticed in several other parts of the division.

It was also independently found about the same time by Mr. R. McIntosh, Deputy Conservator of Forests, at Konain in the Jaunsar Division some hundred odd miles to the south-east.

Relations to the Forest.

As far as present observation goes, this beetle does not bore into the main stem or main side branches of the deodar, but confines its operations to the small upright needle-bearing branchlets borne on the latter on which a new flush of needles appears in the spring. Under the attack the needles on the infested branchlets turn yellow and wither and the dying twigs thus become very conspicuous on the trees. Save for this withering, the twigs show no other sign of external damage when first looked at. If taken hold of, however, they usually come off in the hand, snapping either from ½ to an inch or less (or it may be at the juncture itself) from the juncture with the main branch. A close inspection shows that the twig breaks at the point at which it has been ringed. Above the ring the newly-attacked branch is seen to be dying, and on cutting it up larvæ or beetles will be found within it. This girdling results in short, dead stumps of twigs or the dead unfallen twigs themselves being present all up the main branches, and previous attacks can be at once recognized by this characteristic. When the twigs are girdled right at the base, these visible signs are not, however, so apparent. The foliage is seen to be much thinner on the branch, and if such branches are looked at closely the scars will be seen. When the dry twigs are in exposed situations, they soon get knocked off by the wind or blows from adjacent branches; when however, they are on portions of the main branch which are more or less sheltered, they may be found persisting in numbers.

The result of this attack, more especially when combined with that of the branch-boring *Hypoborus* (?) sp. beetle described below, entails a loss to the tree of young needle-bearing twigs with the consequent decrease in the area of foliage—always a serious matter in the case of a conifer. As I have already said, the yellow rosettes of needles on the branches attacked are evidence of this beetle being at work, but an inspection is always necessary, as there are other insects whose attacks appear to produce much the same result on the tree if only cursorily examined.

Prevention and Remedies.

In the case of ornamental trees and small valuable plantations it would be comparatively easy to get rid of this pest. The attack should be carefully watched, and when the twigs are full of larvæ, *i.e.*, about the middle of May, they should be broken off and burnt. Any subsequent generations would be treated in the same manner. At present, however, it has only been found on the larger branches of old trees, and further observation is required as to whether it confines its attacks to the branchlets on old trees only.

Points in the Life History requiring further observation.

1. The number of generations in the year. It is probable that there are more than one.
2. Exactly where the eggs are laid. It is probably on the bark, as there are no entrance holes into the attacked twigs.
3. Where the winter is passed and in which stage.
4. Is the attack confined to the upright branchlets on the main side branches of the Deodar, or does the beetle also attack young growth?

HYPOBORUS (?) SP.

Plate XVII, fig. 3, a, b, c, d.

Reference:—Provisionally named as *Hypoborus* (?) sp.

Classification:—Order, COLEOPTERA. Family, Scolytidæ.

Tree attacked:—*Cedrus Deodara* (Deodar).

Description.

The larva is a very small white, legless grub. (See Pl. XVII, fig. 3, a.)

The beetle is small, oblong, black, rather shining, with head entirely concealed beneath the prothorax and not visible from above. Antennæ yellowish brown, scape thickened, longish, funiculus 5-jointed, the first long and thick; club oval, flattened, with 4 fine transverse sutures. Eyes long, narrow, transverse. Prothorax convex with a few tubercular projections anteriorly on its upper surface, and pitted on the rest of the surface posterior to this. Covered with fine bristly white hairs. Elytra cylindrical, rounded at their posterior declivity, not larger than the prothorax and pitted, the pits being arranged in longitudinal rows not close together. Third joint of tarsus slightly longer than the two above it. Body cylindrical, pubescent.

Length a little over $\frac{1}{16}$th inch. Pl. XVII, fig. 3, b, shows a dorsal and side view of this beetle.

Life History.

This small Scolytid bores into branches and twigs of the deodar, which from any cause are in a sickly or dying condition, and lays its eggs in the green bast layer. It will not touch dead twigs. The insect is almost invariably found in branches girdled by the Deodar Branch Girdler (p. 220), the girdled and dying branch being in just the condition it prefers for egg-laying.

In attacking a stem a beetle, probably the ♂, bores horizontally through the bark down to the cambium layer hollowing out a small circular or irregular-shaped chamber in the bast and wood [see Pl. XVII, fig. 2, c (p)]. The ♀ beetles enter by the same hole and are fertilized by the ♂. At this stage four beetles will be found in the chamber beneath the bark, and it is probable that the ♂ therefore fertilizes at least three females. After pairing the female beetles do not apparently bore any definite egg gallery away from the pairing chamber but merely enlarge this by eating out the bast and sapwood on one side, laying eggs in the portion so treated. The whole of the large irregular gallery thus made by the beetles, which often completely encircles the stem beneath the bark, thus effectually girdling the branch is filled with the moist chewed and passed wood refuse and excreta which fill it entirely and amongst which the eggs are evidently laid. The pairing chamber (p) in the figure shows this. The egg stage is evidently a very short one, probably a day or two only, since I have often found young larvæ in the chamber amongst the beetles and wood-dust. The larvæ bore away from the central chamber, either up or down the stem, their galleries being blocked up with wood-dust and excreta, fig. 3, b (*l*). When full-fed they hollow out at the end of the gallery a largish chamber in the sapwood and pupate in it [fig. 3, b (m)]. When boring their egg-chambers, the beetles commence work in opposite angles of the pairing cavity. The first beetle to enter the branch generally does so just below the juncture of two branches. In the subsequent boring operations the branch is often completely girdled below the fork, the chamber being extended up one or both of the arms above it.

This insect is to be found boring into deodar branches in the first week in June, and the beetles evidently take some time over egg-laying since the first developed larvæ are to be found in the chambers whilst the beetles are still at work. It is not yet known whether this is the first or second generation of the year. There is evidently a later one, as on October 24th I obtained some nearly mature beetles from girdled deodar branches collected in the Jaunsar Division at the end of June. These beetles had evidently matured from the larvæ hatching from the June eggs. These October beetles hibernate through the winter in this state.

Locality from which reported.

This insect was discovered by the writer in the Jaunsar Division in the North-West Himalayas.

Relations to the Forest.

The beetle appears to be fairly numerous and is of some importance in the forest owing to the fact that it only attacks and lays its eggs in the green cambium of the deodar. It is thus a source of danger to young plants whose vitality has become temporarily reduced. It is an active scolytid flying readily, a habit somewhat unusual in the family. It apparently moves about in swarms since it can often be found plentifully in sickly branches or tops of young trees and in the branches girdled by the girdling scolytus. In this latter case it must be carefully distinguished from the *Scolytus deodara* the beetle which is the real author of the girdled branch (see p. 220). The small entrance holes of the *Hypoborus* will be found higher up the girdled branch generally situated at the nodes and encircled by a small ring of resin. In the case of old attacks they can be distinguished from the exit holes of the Scolytus beetles by the much larger size of these latter. It is important to remember that the girdling scolytus beetle only rings the twig, lays her eggs at the girdle, and then leaves the branch. If this is borne in mind, there will be no difficulty in attributing the damage done in either case to the proper quarter. Of course when the smaller beetle attacks and lays its eggs in branches already girdled by the Scolytus girdler, it does no damage.

Protection and Remedies.

The danger from the attacks of this insect is to some extent minimised by the fact that whenever possible it appears to oviposit in the branches girdled by the deodar branch girdler. When, however, young growth is attacked, infested trees should be cut out and burnt as soon as the needles on the infested tops and branches are seen to be turning yellow.

Points in the life history requiring further observation.

1. When does the insect make its first appearance in the year?

2. How many female beetles are fertilized by the ♂ and the number of eggs laid by each.
3. The length of time spent by the larvæ tunnelling in the twig.
4. The length of time spent in the pupal and beetle stages.
5. The number of generations in the year.

TOMICUS LONGIFOLIA, MS.

THE LONG-NEEDLED PINE TOMICUS.

Plate XVII, fig. 4.

Reference :—Provisionally determined as *Tomicus longifolia*, MS.

Classification :—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Tomicini.

Tree attacked :—*Pinus longifolia*.

Description.

Beetle.—Smaller than the Blue Pine Tomicus (*Tomicus* sp.) and of a very dark ferruginous brown in colour with rufous brown longish hairs scattered irregularly over prothorax and elytra. The insect has the characters common to Tomicus beetles, and from these it is recognized as such. There are five teeth on either side of the apical excavation at the apex of the elytra, the 2nd and 3rd from the top being the largest. The specimens obtained were however in too poor a state of preservation to make further description possible.

Length $\frac{3}{16}$ inch or a little more. Pl. XVII, fig. 4, gives a side view of the teeth at the side of the apical excavation showing how this insect differs from the Blue Pine Tomicus.

Life History.

I have as yet only found dead specimens of this beetle in galleries beneath the bark of dead trees. It differs from the Blue Pine Tomicus both in appearance and in its method of tunnelling in the bast and sapwood of the tree.

This Tomicus bores a straight horizontal entrance hole into the tree until it reaches the cambium where a large pairing chamber is excavated. From this four long egg galleries take off. In the specimens examined, two of them went up the tree and two down parallel to its long axis. These egg galleries, which, like the pairing chamber, are bored in the bast and sapwood, contain one or two 'air holes,' *i.e.*, holes bored to the outside of the tree by the female to let air into the tunnel.

The eggs are placed in indentations in the sides of the egg galleries, and the larva apparently bores its gallery mainly in the bast and not in the sapwood.

I know nothing further about the life history of this insect.

Points in the life history requiring further observation.

1. At what time are the first eggs of the season laid? They will probably be deposited in fresh living bark of sickly or felled trees.
2. The number of beetles with which the ♂ pairs.
3. Is more than one egg gallery bored by any one female?
4. The number of eggs laid by each ♀.
5. Length of time spent in the larval stage.
6. Length of time spent in the pupal stage.
7. The number of generations in the year.
8. Where the insect passes the winter and in which stage of its metamorphosis, egg, larva, pupa, or beetle.

ECCOPTOPTERA SEXDENTATA,

MOTS.

THE SILVER FIR BRANCH GIRDLER.

Plate XVII, fig. 5.

Classification :—Order, COLEOPTERA. Family, Scolytidæ.

Tree attacked :—*Abies Webbiana, Lindl.* (The Silver Fir.)

Description.

Imago ♀. The specimens obtained were not quite mature though fully developed. The beetle is bright yellow brown in colour all over but darkening slightly on dorsal surface of the elytra. Head projects beyond thorax. Antennæ angled and knobbed; funiculus 7-jointed, the joints increasing in size upwards, the top one being large; club blunt-oval. Head and prothorax one-third total length of insect. Elytra are toothed at their extremities, truncate and together with the prothorax uniformly pitted all over. Longish scattered yellow hairs are present on the dorsal surface of the insect. Front coxæ contiguous; tibiæ toothed on their outer edges. When fully mature, the beetle would doubtless be a dark brown or black in colour. Length 3 millim. Pl. XVII, fig. 5, shows a dorsal and side view of this insect.

The male insect is quite different in appearance.

Life History.

The flight time of this beetle is probably about the first fortnight in July. The ♀ lays her eggs in the pendulous side branches of the silver fir. These branches are ringed by the insect. I am not at present able to say whether the ♂ beetle helps the ♀ in this work, as I have not yet found the former. The girdle is made about a third of the length of the branch down from its upper extremity, the ringing being done just above a node, *i.e.*, the point of juncture of small offshoot side branchlets. The egg or eggs are apparently laid above the ring, generally just above it. The object of the girdle is to kill the portion of the branch above and thus provide a supply of dying wood for the larva to feed upon. The larva on hatching out bores up the branch mining out a fairly deep gallery in the sapwood. This gallery may be straight or may curve about but always goes up the branch. The wood consumed by the larva is passed out at its anal extremity and fills up the part of the gallery it has already gnawed out. When full fed, the grub enlarges the top of the tunnel forming a pupal chamber and presumably pupates in this. It is in this enlarged chamber at the head of the gallery that the beetles were obtained, in every case the gallery below the chamber being invariably blocked up with the wood excreta of the larva. There are no offshoots to the tunnel. In some cases I noticed that branches were ringed in several places at successive nodes. In each case a gallery was present above the girdle. Whether this was the work of the same beetle or of different ones I was not able to determine. In none of the galleries from which beetles were obtained was any opening to be seen on the outside of the branch, the girdle and the dying or dead condition of the branch being the only external evidence of the beetle's work. Branches attacked in previous years showed, however, in the cases where the dead portion above the girdle had not already been knocked or dropped off, a small round hole of exit communicating with the outside from the pupal chamber, and it is evident that the beetle leaves the branch by boring horizontally through the bark.

I am at present unable to state whether this beetle has more than one generation in the year. I found on the 5th July two newly-ringed branches, and it is probable that the beetle lays her eggs soon after issuing, about the middle of the month.

Locality from which reported.

This beetle was found in Silver Fir (*Abies webbiana*, Lindl.) in a forest near Baghi in the Bashahr State in the North-West Himalayas, at an elevation of about 8,000 feet.

Relations to the Forest.

The damage done is to the side branches of the silver fir. The beetle rings these at a point generally about two-thirds to three-quarters up from where they leave the main trunk. The portions above the ring die and the effect, whilst causing a certain loss of branches, and consequently leaf-area to the tree, gives it a scraggy appearance, the ends of numbers of the branches being in a dead or dying state.

Protection and Remedies.

When attacks of this nature take place in nurseries, plantations, *etc.*, a feasible plan of getting rid of the beetles is to carefully collect all the portions of the twigs and branches above the rings and burn them. If this operation is done carefully and at the proper time, *i.e.*, when they contain larvæ or pupæ, it will stamp out the pest.

Points in the life history requiring further observation.

1. Exactly where the eggs are laid by the female above the girdle. Is more than one egg laid above any one ring?
2. Length of time spent by the larva feeding in the branch. From the amount of wood consumed and the size of the gallery made, I am of opinion that it will not improbably be found that several months are spent in this stage.
3. Length of time spent in the pupal stage.
4. Number of generations in the year.
5. The male beetle has still to be found. Does it help the female in the girdling work?
6. In which stage does the insect pass through the winter?

HYBLÆA PUERA,

CRAM.

Plate XVIII, fig. 1.

References:—Cram. Pap. Exot., pl. 103, figs. D, E; C. & S. no. 2232; Moore Lep. Ceyl., iii, pl. 154, figs. 2, 2(*a*) (larva); Noctua saga, Fabr. Mant. Ins. ii, p. 137. Noctua unxia, Hübn. Eur. Schmett., Noct., fig. 513.; Heliothis apricans Boisd. Faun. Ent. Madag. p. 98, pl. 15, fig. 7; Hmpsn. Faun. Br. Ind. Moths, II, 371 no 2204; Steb. Inj. Ins. Ind. For., 115—117. fig. 71.

Classification:—Order, LEPIDOPTERA. Sub-order, HETEROCERA. Family, Noctuidæ.

Tree attacked:—*Tectona grandis* (Teak).

Description.

Larva.—The general appearance of the larva is black above and yellow or green beneath. The dorsal colour, however, of the last 11 segments varies from black to a dark purple-grey. A broad reddish or flesh-coloured stripe runs down the median dorsal surface, bordered on either side by a narrow, white line. Another lateral white line is usually present on each side just above the junction of the upper black with the lower yellow colour. The head and first segment are black. On the dorsal surface of the last segment but one there is a white transverse mark which is very constant, being invariably present in the very numerous specimens examined. Body covered with scattered hairs. The larva tapers towards both ends. Length 1 to 1¼ inches.

I am at present of opinion that it is probable that the young larvæ are of a uniform purple-grey or black in colour, as I have not yet seen quite small larvæ with the flesh-coloured dorsal stripe or yellow ventral colouring. It may be, however, that the young dark-coloured larvæ seen are those of the black variety of Hyblæa described below.

The larva spins a rough, loose, silken cocoon to pupate in.

Pupa.—A bright chestnut brown in colour with a yellowish tinge. Darkens slightly after a day or two, but the colouring remains uniform throughout. The pupa is thickish with blunt ends. Length ½ inch or, at times, a little over.

Moth.—Head very small and antennæ minutely ciliated in male. Head and thorax greyish red-brown; abdomen black-brown with orange segmental bands. General colouring of upperwings greyish red-brown whilst the under-wings are black-brown with orange and scarlet blotches. Fore-wing greyish red-brown, irrorated with a few dark specks. Hind-wing black-brown, with a curved orange band with scarlet edges from upper angle of cell to near anal angle; a band on the margin from vein 2 to anal angle. Underside of fore-wing black, with orange fascia in cell and far beyond it; the costa and apex pale brownish with dark specks; the inner margin yellow. Hind-wing pale brownish with dark specks; orange towards anal angle, with two large black spots.

Expanse of wing 32—40 millim. Fig. 71 in *Injurious Insects* shows the larval, pupal and imago stages of this moth.

Life History.

This insect, whose larvæ defoliate the teak tree, passes through a large number of generations in the year, the number at times reaching seven life cycles according to Mr. T. R. D. Bell. It thus resembles in this respect its companion *Pyrausta machœralis* with whom it is generally found on the trees. The time of appearance of the larvæ is not fixed in any way, as there is a continuous series of generations as long as the leaves remain upon the trees. It is probable that these generations overlap to a certain extent, but I do not know whether this is so marked as in the case of the Pyrausta.

The larval stage lasts about 19 days and the pupal from 8 to 11. These periods will of course vary in different parts of the continent, and on the Bombay side it is considered that from egg to moth takes about six weeks.

The stage in which the insect passes through the winter has not yet been observed, but the first larvæ make their appearance in South India, and probably also on the Bombay side, in April-May, this being the period at which they are also first seen in Burma. In the drier teak forests the attacks would not begin before July, and the number of generations passed through in the year will be reduced to 3 or 4. Mr. Bourdillon considers that in Southern India, either very dry or very wet weather is detrimental to the spread of the insect.

The larva feeds upon the leaves, and, when full grown, pupates in various ways upon them—

1. Either amongst the dead leaves on the ground in which it spins a flimsy cocoon, changing into a pupa within this.
2. Pupates upon a leaf on the tree and may drop to the ground with it if it is a dying or dead one.
3. Occasionally spins its cocoon over the mid-rib of the leaf, dragging the sides of leaf together by means of silken threads.
4. Folds the edge of a leaf, which it may cut into a short way for the purpose, over and binds it together with silk, pupating within it.

A very interesting case of the pupation of this pest was noticed in the Yeni Reserve, Pyinmana, Upper Burma, by Mr. Cubitt. The attack of the larvæ took place in a high teak forest having an undergrowth consisting almost entirely of a dense mass of young bamboo (*Cephalostachyum pergracile*) about 4′ 6″ in height. On becoming full fed, the larvæ let themselves down by silken threads on to the undergrowth and the pupation took place in the bamboo leaves. These latter were not merely rolled up at the edges, but were folded like a sheet of note paper more or less transversely and usually 2″ from the apex. In this instance the larvæ did not pupate upon the ground, probably owing to the undergrowth having been too dense for them to get through with ease. Another point noticed by Mr. Cubitt was that only the tallest trees in the teak forest were attacked and defoliated: poles and saplings invariably escaping except perhaps in their upper branches. I can give no explanation for this, as the larvæ usually attack young and old trees indiscriminately.

Localities from where reported.

This insect has a wide distribution, present reports showing that it is to be found practically wherever teak forests occur in India and Burma. The writer has found the insect in Bombay, Berar, Central Provinces and Madras (Coimbatore and South Malabar forests).

Hampson gives the distribution as :—

West Indies; South Africa; throughout India, Burma and Ceylon; Java; New Guinea; Cape York.

Relations to the Forest.

This insect, together with its companion *Pyrausta machœralis*, form perhaps two of the most serious pests the teak tree has to contend with in India, since almost every year, and on occasions several times during the year, one or other or both together, partially or entirely strip the leaves from the trees. The method of feeding of the *Hyblæa* caterpillar on the teak leaf is very characteristic, and apparently would not appear to vary: it is quite distinct from that of the *Pyrausta*. The larvæ attack and consume all the green tissue of the leaf, only leaving untouched the main rib and chief side ribs. Young poles and saplings have been seen with their entire crop of leaves treated in this remarkable manner, only the mid-rib and chief side ribs of the leaf, with here and there attached to the rib a small green portion of the leaf tissue, remaining uneaten (see Pl. XVIII, fig. 1, and compare with fig. 2 in the same plate). This method of attack is so marked that there is no difficulty in recognizing at once the presence of the larvæ in a forest, even if the caterpillars are not themselves visible. These latter, after the fashion of most Noctuids, have a habit of concealing themselves during the heat of the day, probably doing a great deal of their feeding at night. It will of course be understood that it is only in the more severe attacks that one finds almost the entire crop of the leaves treated in this manner. In lesser attacks only a portion of the leaf may be eaten and the larvæ may then go on to another one. In every case, however, the tissue will be eaten down to the rib and the rib left untouched.

Opinions seem to conflict at present as to whether this insect is more injurious in pure than in mixed teak forests. In Burma Mr. S. Carr, Deputy Conservator of Forests, states that "the damage is certainly more severe in pure teak than in mixed forest because more trees are attacked." My own observations in the case of young pure teak plantations have shown me that the insect is capable of doing a large amount of damage in such and undoubtedly does so at Nilambur. In older mixed forests, in some parts of the continent, on the other hand, the insect is able to increase at times equally in the mixed as in the pure teak since it does not confine itself to the teak tree alone, but is fairly omnivorous feeding in Kanara on species of Dherries (***Leguminosæ***), while in Berar I noted that it often completely defoliated a Bauhinia. There may be two principal attacks of this pest during the year, the first occurring about May in the damper teak forests and July in the drier ones. Mr. S. Carr states that in the Southern Burma Plantations of the Rangoon Division this attack lasts from May to July but remarks, "though the attack extended over a considerable period, there is nothing to show that it was caused by more than one generation of the larvæ." From what we know of the life history of the insect, I think it probable that it will be found that at least two generations of the insect are passed through in this period. The second serious defoliating attack takes place between September and November or December Unfortunately the attacks have been by no means noted so exactly as in the case of the *Pyrausta* ones, and we have much to learn about the periodical increases of this pest. One fact is certain, however, and that is, that it is to be found in the teak forests between the end of April to November and December, and there appears to be no reason against any one of the seven generations increasing above the normal and in such numbers as to be capable of stripping the forests entirely. I noted that the young teak from 1-5 years old in the Karimpoya Plantations at Nilambur were being very seriously defoliated towards the end of August. Numbers of the young saplings were leafless or rapidly becoming so, resulting in complete stoppage of growth of the young plants in the middle of the growing season—a most serious matter. I also noticed that here and there young saplings had dried up and died and a careful inspection revealed no external or internal reason for this state of affairs. It may have been due to constant defoliations by this insect and *Pyrausta*, the successive flushes of leaves having been regularly eaten off.

Further observations require to be made and records kept of the results of the constant defoliation due to the attacks of these two pests, but two resultant causes to the trees are—

1. The entire loss of leaves stops growth, and, if occurring in the flowering season, when the trees are in full flower, not unlikely has a serious effect upon the production of seed and the consequent natural regeneration of the forest.
2. A serious loss of increment in the annual amount of wood put on by the tree and therefore a serious delay in time in reaching the required cutting standard of girth.

It would appear not unlikely that the successive stoppages in growth resulting from these attacks will give several rings of wood per year instead of the one annual one only. Enquiries are being conducted with the view of ascertaining this point.

Protection and Remedies.

I have given a full note upon possible protective methods under *Pyrausta machœralis* below.

In the case of the Hyblæa the matter is not so easy, since we have no information at present as to where and in which stage the insect spends the winter. It would appear that a very considerable number of the larvæ of the spring to autumn or active generations pupate in the leaves of the trees (contrary to the practice of many Noctuids which pupate in the soil), but it may be found that a portion at least pupate in the soil. Mr. Bourdillon, writing of the attacks of this pest in Travancore, says that the first sign that the caterpillars are going to be numerous is indicated by the edges of the teak leaves being folded over here and there for a length of a third of an inch and a depth of a ¼ inch. Inside a minute caterpillar will be found. The ragged appearance of the teak leaves is therefore the first warning of an impending severe attack. It will generally, I think, be found that the larvæ feed in this manner at first, if not also in the later stages of their existence ; the ribs in the rolled-over portion are never however eaten. In nurseries it will be possible to cut off the rolled-up edges in which the larvæ have pupated and burn them.

Points in the life history requiring further observation.

1. The exact number of days passed in the egg stage in the various generations.
2. Where the eggs are laid. Is it upon the leaves as in the case of *Pyrausta* ?
3. Where the larvæ of the various generations pupate. Do they pupate in the soil as well as in the leaves ?
4. The time spent in the moth stage.
5. Where and in which stage is the winter passed through ? Is it as hibernating larvæ or pupæ in an earthen cocoon in the soil ?
6. The periods in the year during which the most serious defoliating attacks of the pest are experienced in different parts of the country. [With reference to this point see remarks on page 311 under *Pyrausta.*]
7. The effect of the attack upon—
    1. The flowering and seeding of the teak trees.
    2. The increment and annual rings. Are false rings found ?

Parasite upon *Hyblœa puera.*

Tachinidæ.

A fly belonging to this family, the species being as yet undetermined, was bred out of some *H. puera* larvæ obtained by the writer from the Karimpoya Teak Plantations, Nilumbur, on the 28th August. The fly issued from the small, blunt, elliptical black pupa case between the 5th and 10th September, a small lid or cap at one end splitting off. Further information is required on the life history of this parasite.

HYBLÆA PUERA, var. NIGRA, MS.

THE BLACK HYBLÆA.

Plate XIX, fig. 1, *a*, *b*, *c*.

Reference :—Provisionally named as *H. puera*, var. nigra, MS.

Tree attacked :—*Tectona grandis* (Teak).

Description.

Larva.—Head large, hard, shining, black ; prothorax black, duller than head, also hard and chitinous ; each with a few black hairs scattered over them. Rest of segments a soft velvety black with a few scattered white hairs taking off from small tubercles situated on the body. Last segment small, chitinous, dull black with large black anal claspers. The short transverse white streak present on the dorsal surface of the 11th segment of the true *H. puera* larvæ is present here. Ventral surface in full grown specimens orange, the thoracic and pro-legs being of the same colour. A black irregular wavy line runs down just above the pro-legs on either side from segments 4 to 11 inclusive. Thorax on ventral surface black as also is 12th segment. Stigmata white, small, elliptical, placed just above junction of the black and orange colour. A few scattered hairs on the under-surface. The body is thickish in middle, tapering to either end. In younger specimens the body beneath is almost a greenish white, a narrow white line separating the black from the under-surface colouring. Length $1\frac{1}{4}$ to $1\frac{3}{8}$ inches. Pl. XIX, fig. 1, *a*, shows a dorsal and side view of this larva.

Pupa.—The larva spins a loose white silk pupal covering before changing to the pupa.

The pupa is at first a bright canary yellow or yellow green anteriorly, the head and thoracic portion being considerably thickened and enlarged. Dorsally 4 body segments can be seen below the thorax, the last tapering to a point. Ventrally nine segments can be counted. These are a pale yellowish brown in colour, the constrictions between the segments being pale yellow. The whole pupa subsequently darkens, becoming shining black, the constrictions between the abdominal segments being banded with red, the segments themselves being finely striated transversely. The antennæ, eyes, proboscis and legs of the future moth can be distinctly seen upon the outside of the pupal case forming swellings and ridges. The pupa tapers from the anterior end downwards. Length $\frac{3}{4}$ inch. Width across upper end $\frac{7}{32}$ inch. Pl. XIX, fig. 1, *b*, shows the pupa in its silken cocoon spun amongst the leaves.

Moth.—Has a great resemblance to that of *Hyblæa puera*, but is much stouter in build. Mr. N. Brodie, C.S., considers it to be a "curious variety, most of the ♀'s having a triangular brown patch at the tips of the forewing, like those possessed by *constellata*, but the shape of the forewing and the presence of the two black spots on the underside of the hind-wing at the anal angle instead of one shows it to be *puera*." Pl. XIX, fig. 1, *c*. shows the male, and *d* the female of this insect. The moth varies in size but the specimens I obtained have about the same wing expanse as *H. puera*.

The above descriptions of the pupa and moth show that they differ from those of *Hyblæa puera* to a certain extent. On the other hand, the larva is similar in possessing the white transverse dorsal streak upon the 11th segment and yet totally dissimilar in colouring on the dorsal surface. It is also longer.

The dissimilarity in the larva, pupa and moth have led me to place this insect temporarily as a variety of the true *Hyblæa puera*.

Life History.

As far as is at present known, this variety has only been reported from the Nilambur Teak Plantations and from the plantations in the Rangoon Division in Lower Burma. It was apparently plentiful at Nilumbur during July since specimens sent for identification to Mr. N. Brodie at Calicut proved to be this insect. I found it very plentiful towards the latter part of August in the Panangode, Aravallikavu and Edakode Plantations. In the latter it had, in company with Pyrausta, completely defoliated portions of some young 8-year old plantations—not a leaf being left upon the trees. The caterpillar is larger than the ordinary *H. puera* one and is a voracious feeder. Its method of pupation is the same as already described for the latter. In the figure 1, *b* the pupa is shown spun on to a leaf. The pupal state lasts from 7-9 days in the case of the August generation, and a generation would appear to take about 5-6 weeks to run through. In fact, the life history, method of feeding, etc., appear to be identical with the true *Hyblæa*, the only difference between the two insects being in the size and markings of the larva, pupa and moth. This is however very marked.

In Burma from where it was also reported for the first time this year it was very plentiful in July but does not have appeared to have reoccurred in August.

Locality from where reported: Relations to forest, etc.

This variety of *Hyblæa* has been reported from the Nilambur Teak Plantations in India. It has also been sent from the Rangoon Division in Burma by Mr. S. Carr where it apparently defoliates teak in company with *Hyblæa puera* and *Hyblæa constellata*. Its method of attacking the foliage and behaviour in the forest, etc., are the same as already described under *H. puera*.

Points in the life history requiring further observation.

1. The number of generations in the year (this is important) and the length of time spent in the various stages of egg, larva, pupa, and imago in each.
2. Where the eggs are laid. Is it on the branches and round the axils of the buds as is usual with noctuid moths?
3. Where the insect passes the winter and in which stage.
4. Does it feed upon other trees besides teak? I believe this to be the case.

Parasites upon *Hyblœa puera*, var. *nigra*, MS.

1. Ichneumonidæ.

The caterpillars obtained in August were found to be parasitised to a certain extent by several different insects as well as by a fungus.

(1) A small hymenopterous grub was watched feeding as an external parasite on one of the full-grown larvæ. The cater-

pillar was killed by it, the hymenopterous larva becoming full fed in four days. I have not yet obtained an imago from the pupa.

(2) Two species of Ichneumon flies both bred out of larvæ which had pupated. These are as yet unnamed.

2. *Fungi.*

The caterpillars are attacked by a disease which in its effects appears to produce the same results as the 'flacherie' of the silkworm. The disease in question is produced by a fungus which I hope to submit to Dr. Butler for identification. The larvæ become flaccid and wet, cease feeding, and die before pupating.

HYBLÆA CONSTELLATA,
GUEN.

References: -Guen. Noct. ii, p. 391; Moore, Lep. Ceyl. iii, pl. 154, figs. 3, 3*a*; C. & S. no. 2230.

Classification: --Order, **LEPIDOPTERA**, Sub-order, **HETEROCERA.** Family, **Noctuidæ.**

Tree attacked:—*Tectona grandis*, Lin. (Teak).

Description.[1]

Larva.—Mr. Carr thus describes it:—" About 1 inch or rather longer. Dark greyish below, velvety black above with, in some cases, a tendency towards a purplish or bluish tinge. Along middle of back a very faint line is sometimes to be found with a faint line of tiny, whitish, spots on each side; at junction of back and belly a number of uneven whitish yellow blotches forming a broken streaky line; head black; emits a black fluid from both ends when disturbed and frequently drops to the ground; rather more hairy than No. 1." Mr. Carr's No. 1 I identify as similar to my *Hyblæa puera*, var. *nigra* larva.

Pupa.—Mr. Carr describes the pupa as similar to that of its companion identified as *H. puera*, var. *nigra*.

Moth.—Easily distinguishable as *H. constellata* by its dark olive-green head and thorax, and by having the fore wing with the outer margin excised below the apex and excurved at the centre, whereas in the other two above described species the outer margin of fore wing is not excised below the apex and is evenly curved. The abdomen is black, with orange segmental rings and crimson at sides towards the extremity. Fore wing dark

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[1] This is as far as I am aware, the first time this insect has been reported as seriously defoliating teak. The specimens were collected and the observations made by Mr. S. Carr, F.C.H., Deputy Conservator of Forests, in the Rangoon Division. Unfortunately the moths sent were not actually bred from described larvæ. Three different *Hyblæa* moths have been sent to me, and as the descriptions of two of the larvæ show them to be those of *H. puera* and *H. puera*, var. *nigra*, I take the third larva present to be that of *H. constellata*. This requires further verification however.

olive-green with dark specks; often with two antemedial yellowish white diffused patches; a subapical bar, and brown apical patch in the upper angle. Hind wing black-brown, with two orange spots beyond lower angle of cell and two towards anal angle. Underside of fore wing black, with the costa and inner margin orange; the base of cell, a band at end of it, and one beyond it orange. Hind wing orange, suffused with crimson and with numerous black spots; a black spot at anal angle.

Expanse 34-40 millim.

In general build and appearance it resembles the figure of *Hyblæa puera*, var. *nigra*, shown in the plate.

Life History.

This insect was found by Mr. S. Carr seriously defoliating teak plantations in the Rangoon Division in June-July 1902 Mr. Carr states that it defoliates the trees in a similar way to the larvæ of the moth *Pyrausta machœralis*, *i.e.*, by eating only the soft parenchyma and thus skeletonizing the leaf. This statement is one of considerable importance and requires careful extended observation since it has been up to now supposed that this method of defoliation was peculiar to *Pyrausta machœralis*. Mr. Carr mentions observing large numbers of small yellowish moths about the same time in the plantations, and these are not at all unlikely to have been those of *P. machœralis*, in which case this skeletonizing may have been done by the larvæ of these moths, they having all pupated before they were noticed at work. Further, it may be that the *H. constellata* larvæ feed upon the soft parenchyma in their younger stages of growth. This point requires careful observation and a careful comparison of leaves defoliated by the two larvæ.

The June attack was a serious one as it spread over 900 acres of plantation. The damage was said to be unevenly distributed and appeared to be the result of numerous separate attacks, each commencing at a centre of its own and extending irregularly in all directions to a distance limited only by the life of the caterpillars. The larvæ of this June attack are said to have pupated on the leaves, enormous numbers of pupæ being seen; besides teak leaves, the leaves of the wild plantains and the spring leaves of canes were made use of. No cocoons were found on the dead leaves upon the ground.

Locality from where reported.

Mr. S. Carr has recently reported this moth from the Rangoon Teak Plantations as a serious teak defoliating pest. Hampson gives the distribution as:—China; throughout India, Ceylon, and Burma; Malacca; Borneo; Australia.

Its relations to the forest and methods of protection against it are the same as already given for *Hyblæa puera*.

Points in the life history requiring further observation.

1. The number of generations in the year. This is important.
2. Is the larva described above the larva of the moth *H. constellata?*
3. Where the eggs are laid.
4. Where the insect passes the winter and in which stage.
5. Length of time passed in the various stages of its metamorphosis.
6. Does it attack other trees besides teak?

PYRAUSTA MACHŒRALIS,[1]

WLK.

Plate XVIII, fig. 2 ; Plate XIX, fig. 2.

References :—Wlk. Cat. xix, p. 1013 ; C. & S. no. 4152. *Scopula damastesalis*, Wlk. Cat. xix, p. 1013 ; Hmpsn. Ill. Het. ix, pl. 173, figs. 1-8 ; Cotes, Ind. Mus. Notes iii, p. 94 (larva), C. & S. no. 4147 ; *Botys egenalis*, Led. Wien. Ent. Mon. vii, pp. 372-468, pl. 10, fig. 7; *Botys suavalis*, Wlk. Cat. xxxiv, p. 1448; *Asopia rufipicta*, Butl. P. Z. S. 1880, p. 682 ; *Paliga fuscicostalis*, Swinh. A. M. N. H. (6) xiv, p. 146; *Ebulea fimbriata*, Moore, Lep. Ceyl. iii, p. 346; C. & S. no. 4135; *Paliga rubicundalis*, Warr. A. M. N. H. (6) xvii, p. 96; Hmpsn. Faun. Br. Ind. Moths. iv, 432, no. 5321 ; Steb. Inj. Ins. Ind. For. p. 119, fig. 72.

Classification :—Order, LEPIDOPTERA. Sub-order, HETEROCERA. Family, Pyralidæ.

Tree attacked :—*Tectona grandis* (Teak).

Portions of the following descriptions and notes on the life history are from an excellent and valuable paper on this insect by Mr. R. S. Hole, Deputy Conservator of Forests. Mr. Hole, I believe, intends to publish his paper *in extenso* in a future number of the Journal of the Bombay Natural History Society.

Description.

Egg.—The eggs are small, round, greenish, gelatinous bodies, which are usually laid singly on the backs of the young teak leaves close to a rib or small vein.

Larva.—The full grown larva is elongate. Its length varying from 0·83 to 0·98 inch and its mid diameter from 0·08 to 0·11 inch. It is sap green in colour, paler below, with a series of paired dorsal purplish spots which are bounded upon either side by a yellow line, the lines running down the whole dorsal length of the grub and nearly meeting posteriorly. On

[1] This insect is unfortunately generally known in India as *Paliga damastesalis* under which name it is constantly alluded to in *Indian Museum Notes* and later in *Injurious Insects.*

each side, below the yellow dorsal lines, are a series of light coloured lateral marks tipped with purple, these being more or less indistinct, except on the 3rd and 4th segments where they are conspicuous. Head yellow. A few erect hairs on each segment.

The larva on emerging from the egg is about $\frac{1}{12}$th inch in length and is active from the first. The colour is then a dirty white which gradually changes to pale green. The purple spots are usually not distinct until after the first change of skin, which takes place when the larva is 5-6 days old. Before the moult the marks appear as pale spots with dark specks. After the moult the larva appears with its normal markings. In three or four days a second moult takes place. Three or four days after this second moult the larva stops feeding and becomes torpid, preparatory to constructing its cocoon. The construction of the cocoon usually occupies one day, and pupation takes place inside the cocoon two days after the larva has stopped feeding. (During the winter hibernation the larva remains in the cocoon 22 weeks, after which pupation takes place as usual). Just before each change of skin the larva becomes torpid and contracts in size, the colour fading to pale yellow, in which the purple markings are very distinct (see Pl. XIX, fig. 2).

Pupa.—The larva changes into the pupal state within a loose silken cocoon. Pupa is slender. Colour yellowish-brown, dark on back, pale to white in front, with a few scattered bristles. On the top of the head, between the eyes, are two small dark bristles. At the point of tail there is a minute hook, with two outwardly-pointed branches. Length 0·52 to 0·43 inch and the mid diameter 0·09 to 0·13 inch.

Moth.[1]—Bright yellow; palpi white below; frons white at sides. Fore wing with fulvous-yellow subcostal fascia; an antemedial line oblique from costa to vein[1], where it is dentate inwards; a speck in cell and discocellular lunule; a postmedial crenulate line highly excurved between veins 6 and 2, along

[1] Description from Hampson Faun. Br. Ind. Moths, p 433.

which it is retracted, and dentate on vein 1; a more or less prominent crenulate submarginal line.

Hind wing with crenulate postmedial line bent outwards between veins 5 and 3, along which it is retracted; both wings with marginal dark line and two lines through the cilia. Mr. Hole notes that in the large number of specimens examined by him in the Central Provinces he has been unable to trace the crenulate postmedial line between veins 5 and 3.

The form *suavalis-fuscicostalis* has the marginal area of fore wing and of hind wing to vein 2 suffused with fuscous; *rubicundalis* from the Khásis has all the markings pink.

Expanse of wing ♂ 22, ♀ 24 millim.

Fig. 72 in *Injurious Insects* shows the pupa and moth of this insect.

Life History.

This insect has a large number of generations, which may be as many as seven, in the year. The time usually required to pass through one complete generation in the Central Provinces has been found by Mr. Hole to be 30 days, as follows :—

From appearance of moth to emergence of larvæ from eggs laid by the former . .	7 days.
Larval stage	16 „
Pupal do.	7 „
TOTAL .	30 „

In the Central Provinces the moths make their first appearance in the first week of April from the larvæ which hibernate through the winter. The larvæ from the eggs laid by these moths would therefore make their appearance upon the teak leaves about the beginning of the month, and the moths of the first completed generation of the year at the end of the first week in May, allowing 16 days for the larval stage and 7 days for the pupal one as given above. This coincides with what is probably the first appearance of the insect in Burma, Colonel Bingham having collected larvæ towards the end of April from which the first moths were obtained on May 6th. In the Kanara Teak forests of Bombay also Mr. Bell states that the insect has about seven generations in the year, lasting from a month to 6 weeks each, so that the pest evidently makes its appearance early in the year in that presidency. Again, in Madras Mr. Van Haepter, Ranger in charge of the Nilambur Teak Plantations in South Malabar, reports that the caterpillars first appear in April, in which month they often entirely defoliate the teak trees.

Mr. Hole notices, however, and the provision applies to other similar localities, that in the dry teak forests of the Jubbulpore and Damoh Divisions in the Central Provinces, larvæ do not appear before June and July since the trees are leafless in April-May. Mr. Bell is, however, of opinion that the larvæ may feed upon other trees besides teak on the Bombay side, and this may be the case in the Central Provinces, though Mr. Hole states he has not been able to prove it to be so.

From the time of the first appearance of the larvæ to the time when hibernation commences, one generation succeeds another without interruption, and there can be no doubt that these generations overlap since some moths will appear earlier in the spring from the hibernating larvæ than others, the caterpillars from the eggs of the former thus getting a start over the latter. All observations recorded tend to prove this to be the case. Mr. Bell writes :—" There are no set times of appearance here in Kanara ; there are always a few teak trees in leaf all the year through, and there are always a few larvæ to be found in consequence." Mr. Hole has found this to be the rule in Damoh and Jubbulpore, and the writer, during the latter portion of July 1901, spent in Berar and the same period and all August of 1902 spent in the Teak forest of the Southern Circle (Coimbatore and Nilambur) in Madras, found a similar state of affairs. This means that all the stages of development of the insect, *i.e.*, egg, larva, pupa, and moth are to be found, if looked for, at the same time: the eggs on the leaves, the larvæ feeding upon the leaves, the pupæ spun up in the leaves or in dried leaves on the ground, and the moths flying about the forest and settling upon the leaves to lay their eggs.

In the Central Provinces Mr. Hole notices that the larvæ begin to hibernate about the end of October. To do this the full-fed larvæ leave the trees on which they have been feeding and proceed to construct cocoons usually, if not always, in the ground. The cocoons are made of silk and bits of earth bound together and are usually found in clusters under stones and large boulders. When there are no stones, the cocoons may be found at a depth of several inches in the soil. At the end of the hibernation in the following April the larvæ change to pupæ. This hibernating stage lasts therefore in the drier forests of the Central Provinces (Damoh and Jubbulpore) for twenty-two weeks. This period is, however, not so long in the damper forests of Kanara and the west coast of Madras (Nilambur), as in these localities the insect is to be found active till the end of December and November respectively. The hibernating period would hence appear to be from 14 to 15 weeks in the first and 18 to 19 weeks in the second case.

Method of pupation.—Mr. Hole has made a series of experiments on this head, and he has found that nearly 50 per cent. of the larva appear to ordinarily pupate on the leaves, whilst the remainder pupate either amongst the dried leaves in the soil, letting themselves down from the trees by silken threads, or in crevices of the bark, etc. In pupating on the leaf on the tree the larva may simply spin a loose silk web across the mid-rib or a lateral vein on a curved portion of the inner face of the leaf, or it may spin together a portion of the edge which thereby becomes rolled over.[1] Or the web may be spun between the lower surface of one leaf and the upper one of another in the angle made at the point where these two surfaces happen to touch one another. It pupates in the same way amongst the dried leaves on the ground. It only pupates in the ground after the hibernating stage, which stage is, as already described, spent in the ground. Mr. Hole describes the cocoon within which pupation takes place as 'thin and made of white silk, and of a shape to fit the depression in which it is constructed.'

[1] This insect has been called the Teak-leaf roller. Mr. Hole from his observations considers this to be a misnomer. It is, however, too early to condemn the name until full observations on the method of pupation have been made in Bombay, Berar, Madras and Burma, where the insect is, in many parts, exceedingly plentiful.

We may thus say of this moth that in dry teak forests it probably runs through as many as four generations in the year, whilst in the damper forests of this tree it will have seven generations, hibernating as a full-grown larva at the beginning of November or later towards the end of December. At the same time, however, it must be noted that the actual hibernation of the full-grown larva in the ground has as yet been only noted in the Central Provinces teak forests, and observations as to whether the insect acts in this manner have still to be made in the other parts of India where teak grows. It need hardly be stated here that this point is an exceedingly important one since it may possibly prove to be the easiest stage in which to attack the insect.

Localities from which reported.

This insect has a wide distribution, and, as this latter shows, must have other food-plants besides teak. In India reports show that it is present wherever the teak tree grows, and this would appear to apply to single scattered introduced trees since there are a few such in Dehra Dun, and the insect is present upon them. The distribution in India may be given as the teak forests of Bombay, Berar, Central Provinces, Madras and Burma.

Hampson gives the distribution as—

Formosa, Khasis, Nilgiris, Ceylon, Burma, Java, Australia.

Relations to the Forest.

This Pyrausta is at present one of the most serious defoliating pests known in Indian forests. Another which is equally bad is its companion *Hyblæa puera.* The method of feeding of the caterpillar is eminently characteristic and apparently never varies. The damage committed by the depredations of these grubs can therefore be at once recognized once it has been seen. The caterpillar only feeds upon the soft green parenchyma of the leaf, the veins and vascular tissue being left untouched. The leaves are thus "skeletonized" (see Pl. XVIII, fig. 2), and during severe attacks whole leaves will be found to be entirely treated in this way. In less severe attacks only portions of the leaves may be so treated; the larvæ, having an abundance of food, have no need to finish entirely one leaf before searching for another, as is the case when they are very numerous in the forest. In some leaves it will be found that only the epidermis of the leaf is destroyed, the leaf not being pierced completely through. This is the work of the young larva whose mandibles are not as yet sufficiently strong to cut right through the leaf parenchyma. The skeletonized leaves become brown in colour and before they fall give the forests a dull brown appearance which is in strong contrast to the surrounding green foliage of other under foliated species of trees. As Mr. Hole remarks, from a distance such forests have the appearance of having been touched by an early frost or scorched by a severe fire. In Pl. XVIII, fig. 2, which shows a portion of a leaf attacked in this way, a few small holes in the leaf tissue, where the veins of the leaf have been destroyed, will be noticed. These Mr. Hole explains as being gnawed out by the larva near to where it is feeding, so that by this means it can readily gain access to either side of the leaf. From this description of the damage done it will be readily seen that it is very easy to distinguish the work of, and therefore the presence of, Pyrausta in the forest from that of its companion *Hyblæa puera* which has been already described.

Mr. S. Carr has recently, however, found in the Rangoon plantations a caterpillar, believed to be that of the moth *Hyblæa constellata*, which is said to skeletonize the leaves in a similar manner. This is up to date the only report of this method of defoliation not being peculiar to *Pyrausta* and further careful comparison and observations are required.

From the notes on the life history given for this insect, it is obvious that it is a most dangerous pest when present in large numbers in any forest, since each successive flush of leaves is eaten off by later generations of the caterpillars.

The consensus of opinion seems to be agreed upon the point that the insect is more plentiful and increases more readily in pure teak areas than in mixed. The life history, again, shows that this is likely to be so since the moths lay their eggs on the leaves of the trees. In a pure teak area this will be a comparatively simple business, but the reverse is the case when we consider a heavy attack of the pest on scattered trees. Most, if not all, the trees will be entirely leafless and the moths will have to fly some distance, during which flight they will be subject to various kinds of predaceous animals and insects, before they will find teak foliage on which to oviposit. Observations made in the Nilambur Plantations, together with information gained there, have shown me that the insect there undoubtedly favours the large pure teak areas in contradistinction to the mixed teak forest. The trees in both young and old forest appear to be equally exposed to this defoliation. On the 26th August[1] portions of the Edakode Plantation at Nilambur, and more especially the young 1894 trees, were entirely defoliated by *Pyrausta*, the leaves still remaining on the trees being completely skeletonized and brown.

The number of insects present and the number of generations gone through appear to depend mainly upon two things—

1. A sufficiency of food material and its collection together in pure blocks.
2. On a damp humid climate, with wet, cold weather or early spring rains. In such a climate the trees will have a full crop of leaves on them in May when the first generation of larvæ make their appearance.

In the drier teak forests, when the trees are leafless at this period, the number of generations is restricted. The evidence as to the number of severe defoliating attacks in one year experienced in any one block of forest is conflicting at present, as no real records have ever been kept and *Hyblæa puera*, whose attacks have not been up to date distinguished from those of the *Pyrausta*, appears through much the same period. Evidence points, however, to at least two more or less clear complete defoliations in the year due to the *Pyrausta*, and this may be extended to three. The periods at

[1] A day or two later in the preceding year (1901) I noticed heavy defoliation of young teak by *Pyrausta* in patches of forest on either side of the G. I. P. railway line while the train was running between Hoshangabad and Barkhera. The forest in the distance was completely brown. Mr. Hampson has since informed me that by the end of September in that year 90 per cent. of the trees in the Kora Range in the Seoni Division were defoliated by this insect, 80 per cent. completely so.

which the most severe attacks are experienced vary. In Bombay (Kanara) October and December are given as the worst months, in the Central Provinces and Berar partial defoliations may take place in July, with a complete one in September-October. In Madras, in the Nilambur Plantations, on the other hand, the first complete defoliation takes place in April, the second in October, with probably a more or less complete one in August.

Protection and Remedies.

In the Forest.

In considering methods of protection against pests which act upon such a wholesale scale as the one under consideration, the question as to whether the remedies, advocated as practicable ones with the view of decreasing the numbers of the insect by minimizing its facilities of increasing in large numbers, are worth putting into force, is one which must be left to the consideration of the forester. In the present case I have no hesitation in advocating the formation of mixed teak forests in place of pure with a view to keeping down the abnormal increase in the numbers of this insect. As an example favouring this opinion, I would point to the Nilambur Teak Plantations, which annually suffer very seriously from the attacks of this pest and its companion *Hyblæa*. I was informed there, and my observations in August would seem to confirm the statement to some extent, that the young plantations from 1 to 15 years in age suffered the most severely. It may be that the trees being so much smaller, the attack has been the more noticeable. If this is the case, I would advise planting up the areas with a mixed forest instead of with pure young teak plants as at present, the less valuable crop to be cut out as soon as the forest has gone through about a third of the 92 years rotation fixed for it. I have no doubt that this would interfere with the great and unchecked increase at present taking place in the numbers of this insect in the plantations. If it is considered inadvisable to interfere with the present system, I would suggest that one of the annual coupes be planted up in this manner and a record kept of the attacks of the pest in it (see note on this subject under *Points in the life history*, etc.).

2. A suggestion was made by Mr. Gordon Hadfield[1] that the plantation elephants should be driven up and down the teak lines, as he noticed that the insects pupated amongst the leaves on the ground. This suggestion I consider a most excellent one as, if put into force towards the end of a heavy defoliating attack, numbers of the pupæ would be undoubtedly got rid of in this way. The best time, however, at which this method of protection should be put into force will be after the insect has hibernated in the ground for the winter months, *i.e.*, between December and April. I would suggest that during this period every plantation should be visited, if possible twice, and the elephants taken up and down the plantation lines. Mr. Hole has made a similar suggestion for the Central Provinces, proposing that pigs should be allowed into the forest for this purpose. It would undoubtedly be of great use.

3. It has been observed on more than one occasion that during severe attacks of these pests, birds, such as crows, mynas, bulbuls, *etc.*, are to be found in numbers feeding upon the larvæ, and the suggestion was made by Mr. Tireman at Nilambur that it might be feasible to introduce a large number of crows and mynas into the plantations. I think the experiment would be well worth trying, and I noticed that crows were to be had in plenty upon the beach at Calicut only some 40 odd miles away.

4. Mr. Hole has noticed that the larvæ suffer from the attacks of an ichneumon and a fungoid disease. Both of these require careful working out, and more especially the latter, as if cultures can be made it would give us perhaps the best of all weapons for combating the attack.

In the Nursery.

1. In 1901 I recommended that the teak plants in the central nursery at Poona should be sprayed with the Paris green arsenate (see p. 146, No. 1) in order to kill off *Hyblæa* and *Pyrausta larvæ*. I have since heard that this was successful and

[1] *Vide* Report and Working Scheme of the Nilambur Teak Plantations by Mr. P. M. Lushington, Deputy Conservator of Forests, p. 45.

the treatment, which is quite simple and feasible, should be made use of in young nurseries of teak when these pests make their appearance.

2. Whilst an attack is in progress, the dried leaves in the nursery should be left *in situ* until the larvæ have pupated. They should then be swept up and burnt to kill off all the pupæ in them.

Points in the life history requiring further observation.

1. Mr. Hole's excellent series of observations made in the Central Provinces require confirmation in other parts of India, and especially the one relating to the hibernation of the larvæ in the soil during the cold-weather months. This latter may be said to be more especially important at the Nilambur plantations.

2. Observations are required as to the exact periods in the different teak forests when the worst attacks, *i.e.*, those resulting in complete defoliation, are experienced.

With the above object in view I would suggest that registers be opened showing the name and locality of the particular forest; its nature, whether pure or mixed ; climate, whether moist or dry. Then, month by month, the attacks of the Pyrausta should be entered, the defoliation being shown roughly as so much per cent. of the foliage eaten, *e.g.*, 40 per cent., 60 per cent. or complete defoliation. At the end of the year a short summary of the weather experienced, whether very dry or unusually wet, should be added.

Such registers kept up for the teak forests of the country during a period of five years would be invaluable and would enable us to understand the circumstances which lead to bad attacks of the pest, and perhaps allow us to prepare for them.

The Registers should of course distinguish between the attacks of Hyblæa and Pyrausta, separate columns being opened for mixed attacks of both.

HYPSIPYLA ROBUSTA, MOORE,[1]

THE TOON-TWIG BORER.

Plate XIX, fig. 3, *a*, *b*, *c*.

References:—Moore, Lep. Ceyl. iii, p. 365, pl. 184, figs. 4, 4*a*. (larva); Rag. Mon. Phyc. p. 139, pl. vi, fig. 12; C. & S. no. 4598; Hypsipyla pagodella, Rag. Nouv. Gen. p. 10; C. & S. no. 4566; Hmpsn. Faun. Br. Ind. Moths, iv, 89, no. 4384; Magira robusta, Steb. Inj. Ins. Ind. For. 122, pl. viii, fig. 2.

Classification:—Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family, Pyralidæ.

Trees attacked:—Cedrela Toona, Roxb. (Tun); Swietenia Mahogani, Linn. (Mahogany).

Description.

The *eggs* of this insect do not appear to have been yet described in India.

The *larva*, when young, is a reddish-yellow in colour, the segments being covered with minute black tubercles. When full grown, the colour changes to blue, the head being black and the segments of the body covered with black tubercles from which spring short stiff hairs. Length 1 inch.

Hampson describes the larva as purplish grey with a few short hairs; somites spotted with black and with a lateral series of red spots; head and dorsal patch on 2nd somite black.

Pupa is enclosed in a dense closely-fitting elongate silken cocoon, these cocoons at times being found collected together bound up in a thick felted mass of white silk (see Pl. XIX, fig. 3, *a*.) The *pupa*, when removed from the cocoon, is seen to be red in colour and ¾ inch in length.

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[1] This insect is the one which is unfortunately commonly known in India under its old name of *Magiria robusta*, Moore. This name is no longer correct.

The life history of the pest in the Changa Manga Plantation in the plains of the Punjab was worked out in 1898-99, by Mr. Coventry, a detailed account being published in the *Indian Forester*, Vol. XXV, No. 9 (1899). I have reproduced most of these excellent observations here, including some notes on a subsequent correspondence I had with the author on the subject.

The *moth* has a pearly lustre. It is brown in colour with faint black markings on the veins. It is thus described in the Fauna of British India by Hampson :—

Pale rufous-brown irrorated with black and grey. Fore wing with the costal half strongly suffused with grey; the veins all streaked with black; some olive-yellow on base of costa and median nervure, on extremity of median nervure and discocellulars; traces of a dark sinuous medial line, with a dark patch beyond it on inner margin, and of a very highly dentate oblique dark postmedial line bent outwards between veins 5 and 2. Hind wing semi-hyaline white; the costal area suffused with fuscous; the base of cilia pale rufous. Pl. VIII, fig. 3, in *Injurious Insects* shows the larva, pupa, and moth of this insect. Exp. ♂ 26-32, ♀ 28-42 millim.

Life History.

This insect, according to Mr. B. O. Coventry, passes through two generations in the year in the plains of the Punjab, and this number is not unlikely to be exceeded in the moister and warmer parts of the country. Its life history in the Punjab plains is here described.

The eggs of neither generation have yet been obtained. The larvæ first appear at the beginning of April as soon as the tún trees come into flower. They feed upon the petals, young fruits and ovules of the tree, becoming full fed about the middle of May. Mr. Coventry states that these larvæ very rarely attack the shoots of the tree and only do so when there are no flowers or fruits upon it. My own observations made in the same plantation (Changa Manga) in April 1901 showed me that the caterpillars were to be found in the shoots in some numbers on trees on which the flowers and fruits were very seriously attacked. This may have been due to the fact that the grubs were exceedingly numerous during that year. The more forward of the larvæ commence pupating about the beginning of May, and pupation takes place in two ways. Those insects that have been feeding upon the flowers and fruits march down on to the trunks of the trees and collect together in numbers beneath loose flakes of bark and pupate in this position. Thick felt-like masses of a silken material containing numerous pupæ, enclosed in the silken cocoons, embedded in them are thus obtained (see Pl. XIX, fig. 1, *a*). The larva gives out a silken thread as it moves about, and the inflorescences, fruits, and branches and bark of the trunk thus become covered with dense masses of silken threads in which excreta, partially-eaten petals and fruits become entangled. In a severe attack the larvæ are to be found in swarms upon the bark of the trees during the first part of May searching for pupating places. Once they have pupated, however, they are no longer to be seen on the outside, and it is only by stripping off the flakes of bark that the pupæ will become visible. Pl. XIX, fig. 3, *a*, shows a mass of these pupæ on the underside of a piece of bark. The larvæ which tunnel into the stem change into the chrysalis state in the burrows they make in the terminal shoots. They also spin a silken cocoon before pupation. Fig. 3, *b*, in the plate shows a hollowed-out twig with the packed excreta of the larva exposed at the top; 3, *c*, a cocoon *in situ* in a hollowed-out branch.

The pupal stage lasts about a week or ten days, the first moths appearing at the end of the first week in May and continuing to be found on the wing throughout June and July. Mr. Coventry in his note considers that these moths are all those of the first generation, and they are taken to be such here. The following are suggestions for further observations on this point:—

1. Is it not possible, since moths are to be found on the wing during some 12 weeks, that there may be more than one or even a series of generations of the insect overlapping one another between April and the end of July?
2. Or, do the moths from those larvæ which tunnel into the shoots take longer to develop and issue than in the case of those coming from the larvæ which feed upon the flowers and fruits? It is not at all improbable that the caterpillars feeding upon the succulent terminal twigs take longer to mature than do their comrades on the fruits.

It seems hardly probable that the insect should hurry through its pupal or resting stage (during which period it is perfectly protected against birds, etc.) in a few days only to spend some 6 to 8 weeks on the wing.

The larvæ of the second generation appear at the beginning of August. They confine themselves entirely to tunnelling into the young terminal twigs of the tree, since there are no longer either flowers or fruits to attack. At the end of September they become full-fed. The pupal stage lasts through the first half of October, the moths emerging about the middle of the month.

This is as far as the life history has been carried. Mr. Coventry suggests with some probability that, as the tún tree loses its leaves at the beginning of November in the plains of the Punjab, the eggs are not unlikely to be laid on the stems of the trees, spending the winter in this condition. I consider with him that this is more likely to be the case than that the ♀ moths live through the cold Punjab winter and lay their eggs in the spring.

In feeding upon the inflorescences and fruits the petals of the flowers are eaten by the caterpillars and the young fruits are entirely consumed. Older fruits, however, whose outside has become harder, are burrowed into and the contents devoured, leaving nothing but an empty shell with a round hole in it. Having devoured the contents of a fruit, the larvæ leave it and proceed to attack the next in the same way, the inflorescences and bunches of fruits thus becoming a tangled mass of white silk.

In attacking the tún shoots, the larva almost invariably tunnels in at the axil of a leaf or of a smaller offshoot, the young bud being eaten. The entrance hole can be recognized by the gummy exudation which takes place from it. Once inside the shoot it mines up the pith, destroying all the interior, the attack causing the death of the branch, which withers up.

As I have already mentioned, the life history will vary slightly with the climate and elevation of the localities at which the tree is growing (vide *Injurious Insects*, p. 123).

Locality from where reported.

This insect is widely distributed in India, it having been reported from the Punjab (Changa Manga Plantation), United

Provinces (Lucknow and Dehra Dun), Bengal (the Duars) and Madras (Nilambur). I have found it common in Bengal where-ever the tree exists.

Hampson gives Simla, Dharmsala, Sikhim, Ceylon as the distribution.

Relations to the Forest.

Both young and old tún trees and also coppice shoots are most seriously injured by this pest. In the case of old trees, the shape and shade density of the tree is greatly interfered with as year after year the young twigs die down under the attack. This is very apparent in tún avenues. In many parts of Bengal, and more especially on several tea gardens where the tree has been planted in avenues to shelter the roads, I have noticed that the trees, under the persistent attacks of this borer, have grown up straggly and rugged in growth, the object for which they were planted being greatly impaired by the insect. Further, the branches being weakened appear to suffer severely in storms, a tún avenue being generally littered with branch wood after high winds. I do not consider that the tree planted pure is to be recommended as an avenue one.

In addition to the small branches, the seed crop suffers severely from the pest, and in bad years the entire crop is sacrificed, the bunches of fruits containing no seeds, but consisting simply of empty shells each with a round hole on one side of it.

With young saplings and coppice shoots the attack is even more serious, since terminal and side shoots over a foot in length turn brown and wither, their interiors being entirely eaten out by the burrowing larvæ The trees thus become forked and much branched at an early age, and the height growth is interfered with and short ill-shaped and ill-grown trees are the result.

Protection and Remedies.

It is generally difficult to prescribe remedies for insects whose whole life history is still unknown, and this one forms no exception to the rule. We know when and where to find larvæ, pupæ, and adults of both generations, but where the eggs are deposited is still unknown. It is necessary to find out where these are laid, as it is in the quiescent or cold-weather stage that such insects are usually most easily attacked.

Mr. Coventry in his note writes as follows :—

"*Remedy.*—On a large scale little can be done against this pest; but where young plantations exist, much good can be done by cutting back the attacked shoots carefully above a bud, at about the middle of September or just before the larvæ pupate. The shoots containing the larvæ should be burnt. The bud below the cut will develop and produce a shoot which will replace the old terminal shoot, and it will have the whole of April, May, June, and July in which to put on growth before it is likely to be again attacked . . . . . During the first generation a great many larvæ might be destroyed by collecting them from trunks of trees about the beginning of May before they pupate, or pupæ could be collected and destroyed by peeling off the pieces of bark containing them and burning them. In any case, if timber trees are required, it will be necessary to prune them, otherwise the boles are forked very low down."

During severe attacks it would also be advisable to collect and burn as many of the infested fruits as possible. Small boys could be put on to this work in plantations.

The above remedies would both undoubtedly do good, but as the life history shows, they would have to be done quickly, and would therefore in large plantations prove costly.

It is an axiom in combating insect attacks that the longest stage in their life history should be the one during which methods of destroying them are undertaken. In this case the longest stage is undoubtedly the winter one. If the stage proves to be the egg one, it should prove comparatively simple to introduce some method of getting rid of them, since there will be some five months during which the operations can be carried out. If the eggs are laid upon young growth, pruning will have the additional advantage, as Mr. Coventry suggests, of removing all badly-shaped saplings and obtaining in their place straight trees.

Points in the life history requiring further observation.

1. Where the moths found on the wing during May June, and July lay their eggs.
2. Is there more than one generation between April and the end of July? If so, how many?
3. The number of generations in the year in the warmer and moister parts of India.
4. Where the October moth lays her eggs, and when? Is the winter passed through in the egg stage?

A further note on the life history of
MONOPHLEBUS STEBBINGI,
GREEN.
The Sâl Tree White Scale.

Plate XIX, fig. 4 *a*, *b*, *c*, *d*, *e*, *f*.

(See pp. 135—141 in No. 1.)

Tree attacked :—*Shorea robusta* (Sâl).

Description.

Egg.—The eggs are laid by the female in a fine-meshed thin cottony sac or bag as shown in Pl. XIX, fig. 4, *a*. The eggs are dry, shining, and pink in colour and separate, not being joined together by any siccable substance. They are oval-elliptical in shape and $\frac{1}{24}$th inch in length (fig. 4, *b*).

♂.—*pupa ?*.—I have found some small light-brown empty pupal cases which I take to be the pupal cases of the ♂ insect. They are $\frac{1}{6}$th inch in length with an elliptical opening at one end by which the insect had crawled out. Pl. XIX, fig. 4, *c*, shows this pupa case and 4, *d*, a drawing of the mature winged ♂ insect which issues from it.

Life History.

Egg-laying.—The ♀ scales were found laying eggs towards the end of April and beginning of May. Before the eggs are laid, the under-segments of the body are seen to be developing a white woolly hair. This increases in amount, especially towards the anal extremity, and within this white woolly mass the eggs are laid. At first this white cottony material is quite short, and, looked at from the dorsal surface of the insect, is seen to only project a little way from the tip of the abdomen. It, however, soon increases in amount until the insect appears to have a small wad of pulled out cotton wool attached to its abdominal segments and protruding out all round in a cloud from the three ventral posterior segments of its abdomen. The eggs, as stated above, are laid within this material, from 400 to 450 or even more being laid by one scale.

Present observations show that, when intent on egg-laying, the female scale leaves the part of the tree on which she has been feeding and usually searches out some nook or cranny beneath the rough bark or a sheltered spot beneath stones, refuse, wood, etc., on the ground, and conceals herself before laying her eggs. After the eggs in the cottony sac have been extruded from the body little but the skin remains, the insect dies, and the dried shrivelled skin remains as a partial covering to the eggs. Egg-laying would appear to last from a fortnight to three weeks, after which period both the large white ♀ scale and the winged ♂ almost entirely disappear from the forest, the latter entirely. What I take to be the ♂ pupal cases were discovered on a sâl tree felled in January 1901; they were on the outside of the bark, where it was almost in contact with the ground. Amidst a mass of cottony material mixed up with dried leaves, twigs, etc., the following were found:—

(*a*) Dead ♀ scales about $\frac{1}{4}''$ in length and immature.

(*b*) Immature and mature dead winged ♂ insects and portions of their wings, bodies, etc.

(*c*) Also amongst the cottony material small, dried, dark orange larvæ were found of the same shape as the ♀ scale, $\frac{1}{8}$th to $\frac{1}{6}$th$''$ in length. These may have been immature ♀'s or they may have been male larvæ.

(*d*) Small, light-brown pupal cases of ♂ (?) insect, $\frac{1}{6}$th$''$ long, with an opening at the top by which the insect had crawled out.

(*e*) What looked like shrivelled pink egg skins.

In one or two instances I found portions of ♂ insects half protruding from the light brown cases, and this latter fact leads me to conclude that the winged males come out as such from these shells. Further, it may be that the pink shrivelled egg cases were those of the eggs of last year from which the males of this year had developed, and that the males hibernate through the rains and portion of the winter in the egg stage.

Beneath this tree, under the rough flakes of bark, a number of newly-deposited egg clusters were also found.

I have not yet found the insect which develops from these, or from portions of these, egg clusters, *i.e.*, the insect which forms the second stage (if there is one) in the life history of this monophlebus.

I have said that the conspicuous white female scales disappear from the forests about the beginning or middle of May, the exact time depending upon the nature of the weather experienced during the winter. Mr. Milward has noticed, however, that it is generally possible to find a few specimens right on into September. This year, when the attack was practically over, on May 7th and later dates, I found in several places some young scales, canary yellow to brown in colour and from $\frac{1}{12}$th to $\frac{1}{8}$th″ in length, in fact in the stage and age of those usually found in February. They were clustered thickly on the new shoots of some sâl trees and on the top shoots of some sâl saplings and sâl and *koura* coppice.

As compared with the previous year, the scale matured at a much earlier date during 1902, the insect being at least a month earlier in all its stages of development. This was undoubtedly due to the fact that the winter was a very dry and rainless one, and consequently the young scales did not perish in the large numbers which a rigorous winter must usually kill off. Until its third moult, it increased in size apparently unchecked, and was found throughout the Dun and Saharanpur forests in enormous numbers. By the time it is ready to undergo its third moult, it being then about half-grown, it has left the leaves and small twigs and descended to the larger cortex-covered branches, and throughout the attacked areas these branches were encircled with long rows of the white cast papery skins of the third moult, which remained gummed to the branches by the thick sugary secretion given out by the insects. These rows corresponded to the position the insects take in feeding, collecting in clusters all down the stems. Pl. XIX, fig. 4, *e*, shows a number of these cast skins attached to a branch. It was at this stage that a check came this year (1902) to the attack. The enormous increase of the scale led to a similar increase of a coccinellid beetle which feeds upon the monophlebus in both its larval and imago stages. The life history of this insect (see page 326) corresponds with that of the monophlebus in that the lady-bird reaches its imago and egg-laying stage at the same time that the sâl tree white scale begins egg-laying. An examination of various forests in April and May showed that enormous numbers of the scales had been killed off by the larvæ and adults of the coccinellid. These operations were easily discernible. As they simply sucked the scales dry, the dead shrivelled skins were to be found attached to leaves, branches, and bark of the trees or on stones, dead leaves, fallen logs, and refuse on the ground beneath. Badly infested forests were full of the dead shrivelled skins of the victims of the beetle. Leaves and branches, etc., were stained with yellow blotches of the soft body contents of the coccid. I considered that it was probable that at least 50 per cent. of the scales were killed off by the beetle between March and May, and the estimate is in all probability a low one.

Figure 4, *f*, in the plate shows the way the mature female scales collect together on the stem when feeding.

Distribution.

As regards distribution, the scale may be said to have been almost general throughout the Dehra Dun (being present in Tirsal forest, where it had not been previously noticed, and also in the Moti Chur forests and in Thano) and Saharanpur Divisions. It was numerous in the Kalesar forest of the Simla Division until decimated by the coccinellid and equally plentiful in the small outlying Dhawala forest (Saharanpur Division) on the opposite side of the Jumna.

It was also present in the sâl forests to the east of the Ganges, though I am not aware in what abundance.

Relations to the Forest.

There can be no doubt that this insect, owing to the capabilities it possesses of increasing rapidly in enormous numbers, must be looked upon as one of the most serious pests the sâl areas of the Siwaliks have to meet. The attack of 1902 was colossal in its magnitude, and both young and old growth must have suffered severely, both wood increment and natural regeneration being interfered with.

The attack of the year has brought several features in the life history of the pest into startling prominence :—

(1) That a dry winter greatly aids the scale by permitting a far greater number of young larvæ to reach maturity than is apparently the case in normal seasons.

(2) That the monophlebus has a powerful enemy in the predaceous coccinellid beetle, an enemy against whose attacks it is entirely unable to defend itself, except in one particular way, *i.e.*, by laying an enormous number of eggs so as to allow for a heavy mortality amongst its offspring.

(3) That even in the event of a heavy attack by the coccinellid beetle, the scale is enabled to grow to half-size before any appreciable difference in its numbers becomes apparent from the work of the beetle.

Protection.

The discovery of the coccinellid beetle has given one of the means by which this scale can be most effectively combated, and it has now become imperative that the former's life history should be fully worked out, and further observations on this head are required (see p. 330).

Points in the life history requiring further observation.

1. When the large number of eggs laid in the cottony sac by the mature ♀ at the latter part of April and first part of May develop?

2. What stage of the insect arises from these eggs? Is there a second stage in the life history passed through in the rains, and is this a sub-cortical one?

3. Where the ♂ larva lives and feeds. The observations on the life history of the ♂, as far as at present recorded, require corroboration.

Infestations accompanying Monophlebus Stebbingi.

(I) FUNGUS GROWTH.

It has been stated that a copious sugary secretion is given out by the scales, which coats leaves, twigs, and branches of the trees, giving them a black and burnished appearance. In this sugary secretion a black fungus develops and doubtless helps further to close up the stomata and pores of the part of the tree it infests. Dr. Butler, Cryptogamic Botanist to the Government of India, informs me that this fungus belongs to the genus *Capnodium* which is almost always associated with scale insects. The Capnodium was present in three imperfect forms—

(*a*) *Cladosporium Fumago*, Fr. and Lk.
(*b*) *Trifosporium sp.*
(*c*) *Coniothecium sp.*

the three being conidial stages in the various species of *Capnodium.*

(2) FORMICIDÆ (ANTS).

Observation has shown that ants infest the trees upon which the monophlebus is feeding and suck the sugary secretion emitted by the latter. These ants may be observed marching up and down the trees or waiting just beneath a scale insect, and, as it emits a drop of the clear sugary excretion, they suck it up. The ants taken were submitted to Mr. Wroughton, Inspector General of Forests, and he determined them as belonging to two genera :—

(1) *Polyrhachis*, probably *P. simplex* (Mayr) (=*spinigera*, Mayr). This ant forms a nest in the form of a silk bag fitted into a hole in the ground beneath large stones.

(2) A *Camponotus* belonging to the larger group *maculatus* and probably *compressus.*

A predaceous insect enemy of Monophlebus Stebbingi.

COCCINELLA SP.

THE SÂL TREE WHITE SCALE LADY-BIRD BEETLE.

Plate XIX, fig. 5, *a*, *b*, *c*, *d*.

Reference :—Provisionally named *Coccinella* sp., new to the Indian Museum.

Classification :—Order, COLEOPTERA. Family, Coccinellidæ.

Predaceous upon *Monophlebus Stebbingi*, Green.

Description.

Larva.—When young the larva is black in colour with 3 pairs of stout legs on its thoracic segments. During its first two moults it appears to retain this colour and is longish and narrow with a well-developed head and mouth parts. As it gets older it becomes more oval and is then white and black or reddish with white markings or a greyish purple in colour. It will often be found to be covered with a certain amount of the white powdery substance which covers the scale insect *Monophlebus stebbingi* upon which it feeds. The young larva has a number of tubercles on its dorsal surface. When full-grown the larva is ⅓ inch long and has a well-developed head which is narrower than the first ten segments of the body which follow. Of these latter the middle ones are the broadest the grub tapering to each end. On each of these ten segments there are four dorsal tubercles, two on each side, so that the larva has four rows of tubercles down its dorsal surface. The last two segments make up the dark reddish-black coloured pad-like apparatus which terminates the body, the end of which forms a kind of sucker, which is very adhesive and enables the larva to cling to the smoothest bark by means of it. It uses it during feeding and also for fixing itself to leaves, twigs, or rough bark before changing to the pupal stage. The arrangement of its segments make its body extremely pliable, and it can roll itself up almost into a ball. In addition to the four rows of tubercles the segments are fringed on either side by projecting teeth resembling a saw-edge, giving the insect a serrate edge all round. The ventral surface has the same colour as the dorsal, but is smooth and has no tubercles. Just before pupating the larva often changes from the white and black or greyish purple colour to a brick red. Pl. XIX, fig. 5, a, shows a dorsal and side view of this grub.

Pupa.—When pupating the grub attaches itself to the upper or under-surface of a leaf or to a twig or rough bark by means of the adhesive pad at the posterior end of its body, projecting at an angle from the point of attachment and assuming a curved position, its dorsal surface being convex and ventral one concave. It has the appearance of standing up on its tail. (See fig. 4, d (1). The larva remains in this position for about 24 hours and then the outer skin splits down dorsally from the anterior end to the end of the tenth segment and the skin gets drawn or shrivels back on either side and the bright red, almost spherical, pupa is disclosed. The pupa nestling in the surrounding purple and white speckled old larval skin looks not unlike a small wild strawberry fruit sessile upon the leaves. In the crimson pupa the two small black eyes of the future beetle and developing wings and dorsal abdominal ridges of the segments can be seen under the bright orange red skin The anterior or head end of the beetle faces away from the point of attachment and is at the other end of the pupa. The colour varies from bright to dull red, crimson or orange red. Size about ¼ inch. In the plate fig. 4, b, shows a pupa on a leaf and d (2) on a branch.

Beetle.—When the beetle is ready to issue the pupal skin splits down dorsally and ventrally at its anterior end and the beetle crawls out. It is a small oval insect and is at this period bright orange red in colour and thickly covered with a fine white down. The elytra and thorax soon harden, lose the white down to a great extent and are then a darker red in colour. The head is prominent with black prominent eyes, and short antennæ ending in a small club. There is a black spot at the base of the prothorax. The elytra are dark red and are six-spotted. Posteriorly on each there is a crescent-shaped black patch, the convex side being outwards and the patch being set at an angle pointing upwards. Above these there are two smaller spots situated on each wing case, the outer ones being placed slightly anteriorly to the median ones and being slightly smaller. Length ¼ inch. The ♀ beetle darkens in colour after pairing, the elytra becoming almost black and the spots scarcely visible. Pl. XIX, fig. 4, c, shows a dorsal view of this lady-bird beetle.

Life History.

This insect was found in all its stages of larva, pupa and imago in the Siwalik sâl forests in the middle of April 1902. Probably it is usually a few weeks later in normal years as the year in question was particularly favourable to insect development. The exact length of time spent in the larval stage has not yet been definitely observed, but it is probable that at least 3—4 weeks are passed in this state. In the year in question the larvæ commenced pupating about the end of March. Eight and nine days is the length of time spent in the pupal stage, larvæ which changed to this state on 16th April, issuing on 24th and 25th of the month. Numerous others were bred out on other dates, and this period appears fairly constant. The beetle appears to pass some days, perhaps as much as a fortnight, in this stage before pairing. The ♂ insect dies within 24 hours of fertilizing the female. The latter then commences egg-laying and apparently conceals herself to perform this operation. The eggs have not yet been found, but beetles were discovered near the cottony masses in which the monophlebus eggs are laid beneath rough bark of fallen trees and they may lay their eggs in the same places as the scale. The insect in both its larval and beetle forms feeds upon and destroys the scale insect *Monophlebus stebbingi.* The larva is a very active grub running over the leaves, twigs and bark of the tree at a great pace in search of its prey. During this portion of its existence the insect is not gregarious, the grubs never being found together. The larva is a very voracious feeder and attacks and feeds upon the large soft-bodied white scales with the greatest avidity. Its method of feeding is as follows: The moment the grub sees a scale it goes straight for it and fixes its mouth parts in the soft skin of the coccid, often on the ventral surface between the first and second pair of legs and a little to one side. At the same moment it attaches itself to the twig by means of the adhesive pad at the end of its body. The scale at first makes no movement, but after a minute or two it commences to move its legs and antennæ about, at first lazily as is its habit when walking, but later on more vigorously As it begins to do this a bright canary yellow stream of liquid material pours down from the scale on to the twig. This exudation from the wound continues for about 3-4 minutes after which it stops, the rest of the material going into the coccinellid larva who has now got his mouth parts firmly fixed into the coccid. The latter makes vigorous attempts to get away and being so much larger than its enemy, often even as much as thrice its size, it at times stretches out the lady-bird larva to its full length, the segments under the tension becoming considerably elongated. The latter, however, keeps its position on the twig by means of its sucker pad with the greatest ease. Practically only its mouth, first pair of legs and adhesive pad are used in its feeding operations, the other two pairs of legs being held backwards almost against the side of the body. Under the sucking process the formerly fat white juicy scale insect shrinks to a shrivelled, wizened, dried up mass of skin. The larva's mouth consists of a tube ending in a swollen knob where it joins the head, which is greenish yellow in colour. This is probably in the nature of a sucker as well since it exerts considerable leverage upon the scale. Larvæ watched have spent between 8 and 9 hours clinging to and feeding upon one scale, at the end but a shrivelled black skin remaining. The vitality of the coccid is very great since at the end of 6 or 7 hours of this continued sucking it is still alive slowly moving its legs or antennæ.

When about to pupate the larvæ would seem to become gregarious as the pupæ are often found in numbers close together on the upper or under side of the leaves or twigs. This may have been due to the enormous number of the insects present in the forests in April, but the gregarious collections of pupæ were too marked to have been entirely due to accident. The beetles are very gregarious. During the heat of the day, when not feeding, they are to be found in large numbers collected close together on the underside of leaves—Sâl leaves, Bauhinia, and other large leaves being the ones chiefly made use of. The beetles also feed upon the white female scales, attacking them in the same way as their larvæ anywhere on the upper or under surface of the body. They pierce through the skin and a drop or two of the yellow liquid comes out, but never more. They do not kill the scale outright as they appear to be full fed in half an hour by which time they have absorbed but a small quantity of the scale's body substance. Whilst feeding, the scale either continues to remain with its beak buried in the tissues of the sâl twig or it may move about with the beetle attached to it, but it does not appear to be inconvenienced to any great extent and only shows signs of pain when the beetle first pierces through its skin. The scales are evidently killed off in time by constant tapping by different beetles. Scales so tapped show numbers of small white and yellow spots, the places where the beetles have pierced them. They also are much shrivelled, are dirty brown or whitey black in colour and move slowly.

The ♀ beetle appears to commence egg-laying at the time this operation is being performed by its host, the sâl tree white scale.

Locality from where reported.

This coccinellid was found plentifully during 1902 in the Siwalik sâl forests of the United Provinces.

Relations to the Forest.

During the last few years the scale insect *M. stebbingi* has appeared in large and increasing numbers and has proved a serious pest in the Siwalik sâl forests. During the present year, owing perhaps to a very dry and mild winter, the attack assumed large dimensions, the young coccids being in enormous numbers almost throughout the entire Siwalik and some adjacent sâl areas. When about half-grown the scales were attacked by the larvæ of this coccinellid, which owing to the large increase in their food-supply and to the favourable winter, had themselves increased in incredible numbers. By the middle of April the forests were full of larvæ, pupæ and lady-bird beetles; the former were to be seen running agilely over the trees in quest of their prey whilst the two latter were to be found collected in masses on the leaves. The writer made a tour round the whole of the Siwalik forests and everywhere this insect was swarming, the leaves being weighed down by the red masses of the beetles clinging during the heat of the day to their under surfaces. As a result of this great increase of its enemy the scale was decimated and everywhere, once the state of affairs taking place was understood, the sucked out and dry shrivelled skins of the scales could be found plentifully. The numerous empty white skins of the third moult of the ♀ scales proved that they had reached this stage in their life history in safety and in enormous numbers—numbers which were no longer present in the forest in the middle of April though it must be allowed that the insect was still plentiful. There is no doubt that it is the coccinellid larva that is the chief decimating agent, but it is probable that the attacks of the beetle, taking place as they do when the ♀ scale has reached maturity and is pairing, so weaken it as to have an injurious effect upon the eggs laid. This point requires further observation.

As is to be expected from the above it was particularly noticeable that in those forests where the beetle was swarming in the largest numbers the living scales were by no means numerous, whilst dried, dead, shrivelled skins were to be found on the rough bark or in its interstices, and littering the ground amongst dead leaves, stones and other refuse.

Protection.

This coccinellid has proved itself a valuable insect in the forest. It would not seem to require much protection in either its larval or beetle stages. It is probable, however, that its pupal stage, which is so easily discernible, must suffer from attacks of birds unless its colouring and peculiar shape serve to protect it from these. It is necessary, however, that we should know exactly where the insect lays its eggs, as it would not improbably be possible to collect these and place them in safety till the following year, should it prove that the beetle has but one life cycle in the year. It is more than probable that the insect could be used as a cure for other serious attacks of scales and aphids, and it would therefore be of great utility to collect and preserve the eggs.

Points in the life history requiring further observation.

1. Where the eggs are laid.
2. Is there more than one life cycle in the year?
3. Does the coccinellid feed upon other insects besides the sâl tree white scale?

PARASITES AND ENEMIES OF COCCINELLA SP.

1. Parasite on the Larva.

A parasite infests the larva. Numerous larvæ were observed in the first stage of pupation attached to the twigs or leaves. A close examination showed a number of minute holes on the external surface of the skin, as many as five or more in number. These were evidently the exit holes of hymenopterous or dipterous parasites, the whole of the inside of the larva having been eaten out. It is evident that the larva of the parasite allows the coccinellid grub to reach maturity and pupate before finally killing it, so it is probable that the former will have destroyed a good many scales before it is killed off itself. There is no doubt, however, that a parasite of this kind must do a great deal towards keeping the predaceous lady-bird beetle in check and reducing its numbers.

2. Enemy of the Pupa.

I have observed that the pupa of the coccinellid is killed off by the larva of its own species. Larvæ were found with their three pairs of legs round the red pupal case and their jaws buried in the skin, which they had pierced and from which they were sucking out the entire contents. Examination showed me numbers of pupæ treated in this way, all of them having a round hole about their centres. Grubs subsequently kept had no hesitation in feeding upon the pupæ. It may be that there was a shortness in the supply of the *Monophlebus* scale or that the larva is a generally predaceous one. I think the reason may probably be the former as it was only the later and last of the larvæ that were seen acting in this way, but this point requires further careful observation.

MONOPHLEBUS STEBBINGI, VAR. MANGIFERÆ, GREEN.

Reference :—Green in litt.

Classification :—Order, HEMIPTERA. Family, Coccidæ. Sub-Family, Monophlebinæ.

Tree attacked :—*Mangifera indica* (Mango).

Description.

This insect is very similar in appearance to *Monophlebus stebbingi*, Green (see No. 1 of these notes, pp. 135, 136). The females are identical, and Mr. Green states that the males only differ in the presence of a very small fourth tassel on each side. Fig. 4, d, in Pl. XIX shows the appearance of the ♂ of this scale, and fig. 6 shows the ♀.

Life History.

This scale was first noticed upon the mango trees at the beginning of March and disappeared about the middle of May. The females (described as large white flat insects) were to be seen walk ng about on the ground and crawling up the trees. It is probable that they must have been present in the plantation in January and February, if not earlier, but being then small and yellow or brown in colour they were not noticed clustered first round the mid-ribs of the leaves and then on the young twigs. A careful inspection of the trees at this period will probably disclose numbers of the insects. The mature females (the white insects) are found clustering round the twigs below the fruit where they suck out the sap of the twig causing the fruit to fall off. As in the case of the white sål scale, the empty papery skins of the different moults are found sticking to the bark of the twigs, etc., fixed to them by the sugary secretion excreted by the ♀ scale. (*cf.* Pl. XIX, fig. 4, e.)

The winged males are found on the leaves. They are said to be present only where the mango trees live in very moist soil. This statement is not understood and further observation is required upon this point.

There is apparently some confusion between the damage done by this insect and that of 'a flying insect' called locally in the Punjab 'Tela' which is said to secrete a gum on the flower heads of the mango thus preventing fertilisation. This insect is said to appear earlier than the scale. The 'Tela' insect may be plentiful in the gardens before the scale is noticed, and may do injury to the trees, but I think it is more than probable that the gum which prevents the fertilisation of the flower heads is the excretion of the young larval scales, which would be very plentiful on the trees at this period and would excrete large quantities of sugary secretion (see p. 137 in No. 1).

Locality from where reported.

This insect was reported from the Shalamar mango garden in the Punjab in the spring of 1902, by Mr. F. Beadon Bryant, Conservator of Forests, Punjab. It was said to have attacked the garden in the previous year and to have diminished the outturn of fruit of the trees.

A *Monophlebus* was also reported by the Manager of the Public Gardens in Bareilly in April. It was said to be attacking the mango trees there. Mr. Green informs me that this is likely to prove identical with *M. stebbingi* var. *mangiferæ*, Green.

Protection.

The Conservator in forwarding the insect asked whether 'grease rings' would be useful in getting rid of the pest. From what is known of the life history of its close relation I am of opinion that a good deal might be done to reduce the numbers of the insect by these means. A thick band of the material, about 18 inches deep, should be painted on the trees at about 5 feet from the ground towards the middle to the end of March, depending upon whether the winter has been a dry and favourable one (when the insect will develop quicker) or cold and wet. These bands should be kept sticky until the middle of May. The insects at all times walk about a great deal, but more especially after fertilisation when they cease feeding and, leaving the upper parts of the tree, walk down the trunk to seek places where they can conceal themselves to lay their eggs. The grease bands would thus catch and kill them at this period and prevent egg-laying. When the attack is over the bands should be carefully scraped and the scrapings burnt to kill any eggs which may have been laid on them before the ♀ died.

The grease bands should be composed of a mixture of tar and glue mixed in such proportions as to ensure a sticky band.

A second plan for getting rid of the scale will be by the importation of the coccid lady-bird beetle (*Coccinella* sp.) which is predaceous upon the allied scale *M. stebbingi* in the Siwalik forests (see p. 326 of this number). This should be quite feasible and will be attempted at the next attack.

Points in the life history requiring further observation.

1. When the scale first makes its appearance on the mango trees.
2. Whether there is a heavy excretion of sugary liquid in January and February.
3. Whether any lady-bird beetles accompany the scale insect. (Their larvæ would be small fast-running brown or black grubs.)
4. Does the scale make its appearance at any other time of the year?
5. The amount of injury done to the trees by this insect.

G. I. C. P. O.—No. 3079 R. & A.—9-3-1903—1,000—J. W. DeB.

PLATE VII.

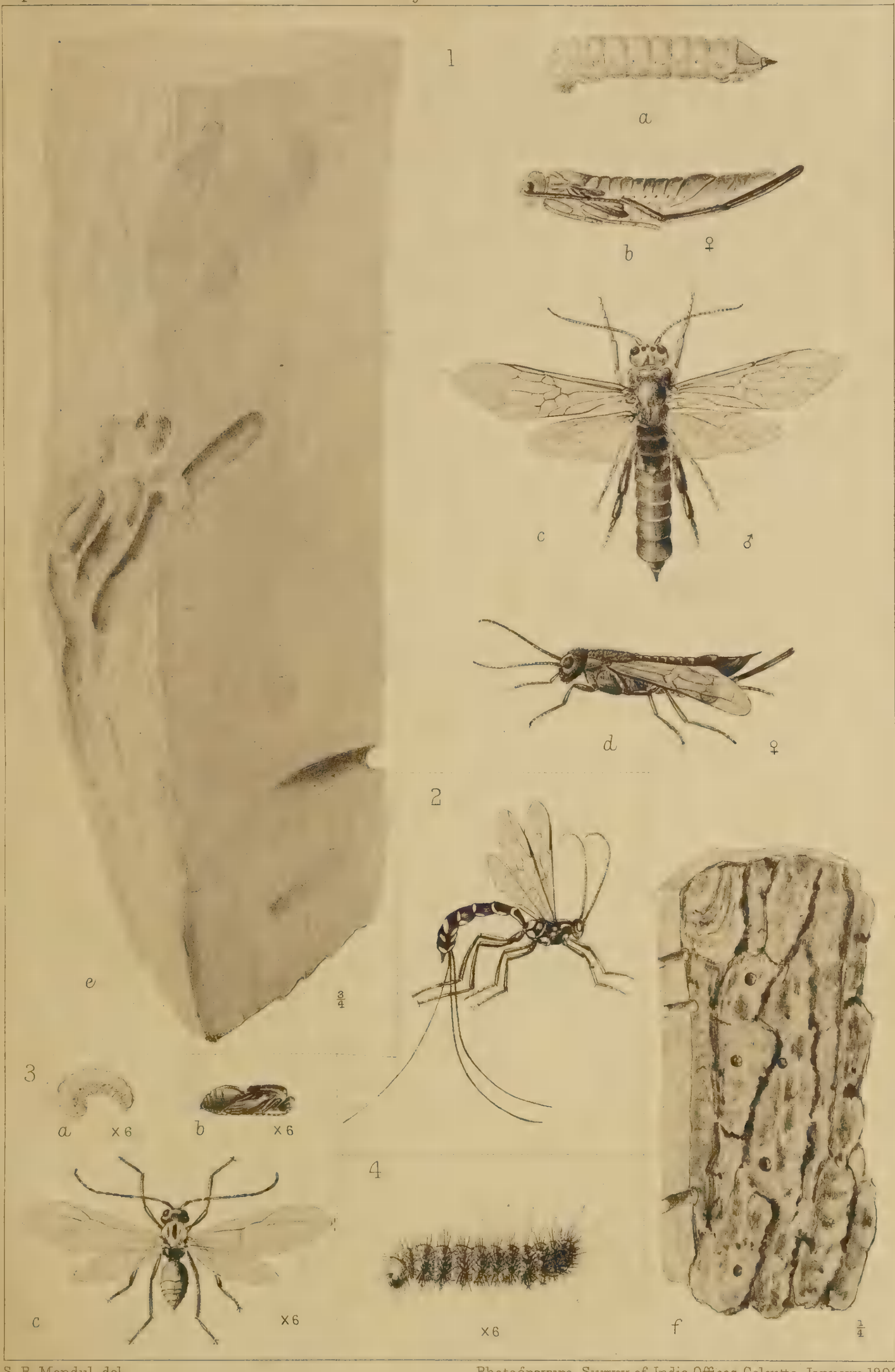
FIG. 1. SIREX SP. *a*. Full-grown larva; *b*. ♀ pupa; *c*. imago, ♂; *d*. imago, ♀; *e*. A piece of spruce-wood showing vertical and horizontal sections of the larval tunnels; *f*. Piece of bark showing exit holes (the larger ones) and sections of the galleries (the larger ones) made by the adults on escaping from the tree.

" 2. THALESSA or RHYSSA SP. Side view of imago, ♀.

" 3. CALLIRHYTIS SEMICARPIFOLIÆ, Cameron. *a*. Full-grown larva. *b*. Nearly mature pupa. *c*. imago

" 4. *Heterocerous larva.* Found in company with *C. semicarpifoliæ.* Side view.

☞ NOTE.—When the figures are not drawn actual size, the actual size is represented either by a hair line or by a figure showing the number of times it has been enlarged.



S. B. Mondul, del.

Photogravure, Survey of India Offices, Calcutta, January 1903.

1. SIREX SP.
2. THALESSA OR RHYSSA SP.
3. CALLIRHYTIS SEMICARPIFOLIAE, CAMERON.
4. HETEROCEROUS LARVA.

PLATE VIII.

FIG. 1. DINODERUS PILIFRONS, Lesne. *a, a.* Dorsal and side view of beetle; *b.* Piece of bamboo riddled by larval and beetle tunnels.

" 2. BOSTRICHUS PARALLELUS, Lesne. Dorsal and side view of beetle.

" 3. PLATEROS sp. Dorsal and side views of the ♂ and ♀ beetles.

" 4. HALTICIDES. Dorsal and side view of the beetle.

" 5. MYLLOCERUS ACACIÆ, MS. Dorsal view of the ♂ beetle and side view of the ♀ beetle.

" 6. CYPHICERUS SP. Dorsal and side view of the beetle.

" 7. APODERUS INCANA MS. *a.* Dorsal and side view of the ♀ beetle; *b.* Portion of a branch of *Quercus incana*, the leaves of which have been attacked by *Apoderus incana*.—[From a drawing by the Author]; *c.* A rolled-up leaf of *Quercus incana* containing an egg showing the method of rolling adopted by this beetle.

[From a drawing by the Author.]

S.B.Mondul, del.

Photogravure, Survey of India Offices, Calcutta, January 1903.

1. DINODERUS PILIFRONS, LESNE.
2. BOSTRICHUS PARALLELUS, LESNE.
3. PLATEROS SP.
4. HALTICIDES.
5. MYLLOCERUS ACACIAE, MS.
6. CYPHICERUS SP.
7. APODERUS INCANA, MS.

PLATE IX.

CYRTOTRACHELUS LONGIPES—

a. Eggs.

b. Larva (side view).

c. Beetle, ♂.

d. Beetle, ♀ (dorsal and side view).

e. Young bamboo shoot in which eggs are laid by the female.

f. Top of bamboo shoot cut off by full-grown larva. The larva pupates within this.

g. Pupal covering with hole cut from within on one side to permit beetle to emerge.

h. Appearance of pupal covering after emergence of beetle.

S. B. Mondul, del.

Photogravure, Survey of India Offices, Calcutta, January 1903

CYRTOTRACHELUS LONGIPES.

PLATE X.

FIG. 1. RHYNCHOLUS SP. *a.* Dorsal and side view of beetle; *b.* Piece of Blue pine wood showing gallery made by the beetle.

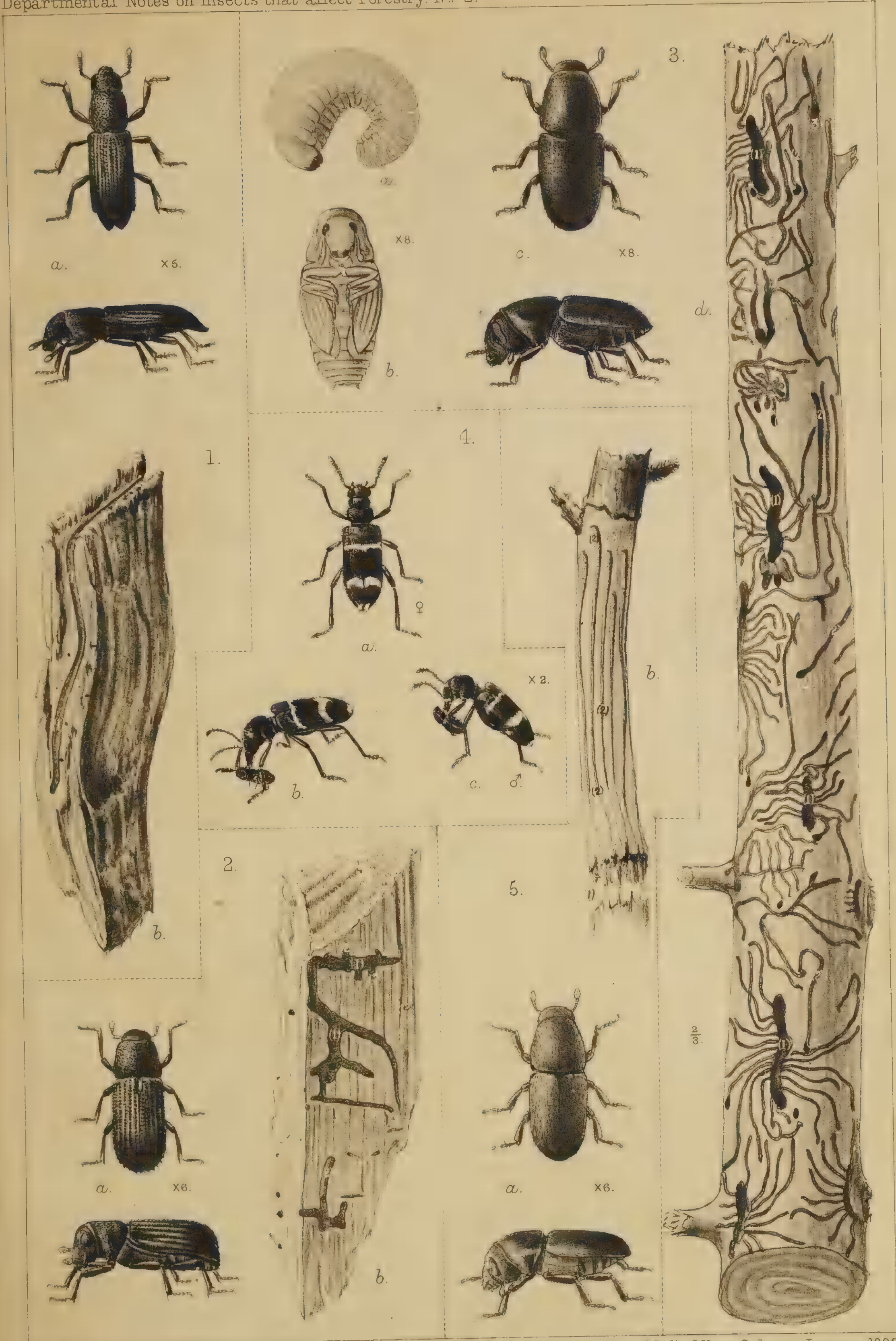
„ 2. HYLASTES SP. *a.* Dorsal and side view of beetle; *b.* Piece of Blue pine wood showing the egg-gallery made by the ♀ beetle.

„ 3. SCOLYTUS MINOR, MS. *a.* Larva, side view; *b.* pupa, ventral view; *c.* dorsal and side view of beetle; *d.* portion of a young deodar sapling showing egg-galleries of mother beetles, (1) larval galleries, (2), and pupating chambers, (3), made by the larvæ in the wood at the end of their tunnels—two-thirds natural size.

„ 4. CLERUS SP. *a.* Dorsal view of ♀ beetle; *b.* a beetle seizing a *Scolytus major* bark-borer; *c.* A ♂ beetle feeding upon a *Scolytus major* bark-borer. [*b* and *c*, after drawings from life by author.]

„ 5. SCOLYTUS DEODARA, MS. *a.* Dorsal and side view of beetle; *b.* Portion of a deodar branch with lower bark removed. The branch was girdled at (1) by this beetle, the eggs being laid in little indentations just above the girdle. The larvæ hatching from these eggs bored the galleries (2) up the stem.

[From a drawing by the Author.]



S. B. Mondul, del.

Photogravure. Survey of India Offices, Calcutta, January 1903.

1. RHYNCHOLUS SP.
2. HYLASTES SP.
3. SCOLYTUS MINOR, MS.
4. CLERUS SP.
5. SCOLYTUS DEODARA, MS.

PLATE XI.

Portion of a deodar log from a tree whose death was attributed to the attacks of the Scolytid bark-borers *Scolytus major*, MS. and *Scolytus minor*, MS. (slightly under ½ natural size)—

a, a, a. Egg-gallery made by mother beetle of *Scolytus major*.

b, b. Larval galleries made by the larvæ hatching out from the eggs laid in small notches at the sides of the egg-gallery.

c, c. Pupating chambers in wood at the end of larval galleries bored by larvæ before changing into the pupal state.

d. The smaller egg and larval galleries of *Scolytus minor*, MS.

[Photograph by Mr. J. H. Lace, Conservator of Forests, Bengal.]

Slightly under ½ nat. size.

J. H. Lace, Photo.

Photogravure. Survey of India Offices, Calcutta, February 1903.

EGG AND LARVAL GALLERIES OF *SCOLYTUS MAJOR, MS.* AND *SCOLYTUS MINOR, MS.* IN DEODAR WOOD.

PLATE XII.

FIG. 1. A young 8′ deodar sapling showing the leading shoot girdled 16″ from the top by the Deodar branch girdler, *Scolytus deodara*, MS. The top is dead and fallen over to the left in the picture.

[Photograph by Mr. J. W. Oliver, Director, Imperial Forest School.]

FIG. 2. A. A deodar branch girdled in two places at 1 and 2 by the Deodar branch girdler, *Scolytus deodara*, MS.; B. Top of a 10′ deodar sapling showing the leading shoot girdled at 3 some years previously by the Deodar branch girdler. Two side shoots were taking the place of the girdled leader.

[Photograph by Mr. A. Jackson, Deputy Director, Imperial Forest School.]

J. W. Oliver, Photo.

H. Jackson, Photo.

Photogravure.

Survey of India Offices, Calcutta, January 1903.

Fig 1. A YOUNG 8 FOOT DEODAR SAPLING WITH TOP GIRDLED 16" DOWN BY SCOLYTUS DEODARA, MS., THE DEODAR BRANCH GIRDLER.

Fig 2. A DEODAR BRANCH GIRDLED IN TWO PLACES AT 1 AND 2 BY THE DEODAR BRANCH GIRDLER (S. DEODARA). B LEADING SHOOT OF A 10" DEODAR SAPLING GIRDLED AT 3 BY S. DEODARA. TWO SIDE SHOOTS ARE TAKING THE GIRDLED LEADERS PLACE.

PLATE XIII.

FIG. 1. TOMICUS SP. *a.* Larva; *b.* Pupa; *c.* Dorsal and side view of beetle; *d.* Inner surface of a piece of Blue pine bark showing pairing chamber, *p*, and four uncompleted egg-galleries, *e*.

„ 2. POLYGRAPHUS MAJOR, MS. *a.* dorsal and side view of beetle; *b.* portion of a Blue pine branch showing the pairing chamber, (*p*), egg-galleries, (*e*), and pupating chambers of the larvæ, (*m*), of this beetle; *c.* inner surface of a piece of Blue pine bark showing the pairing chamber, (*p*), egg-galleries, (*e*), and larval galleries, (*l*), of this *Polygraphus.*

„ 3. POLYGRAPHUS MINOR, MS. Dorsal and side view of beetle.

„ 4. PITYOGENES CONIFERÆ, MS. *a.* larva; *b.* ventral view of pupa; *c.* side view of the ♂ beetle; *d.* dorsal and side view of ♀ beetle; *f.* portion of a Blue pine branch, showing pairing chamber, (*p*), egg-galleries, (*e*), pupating chambers of larva, (*m*), and entrance holes of beetle, (*n*), on the outer side of bark.

„ 5. HYPOPHLŒUS FLAVIPENNIS, Mots. Dorsal and side view of beetle.

„ 6. NIPONIUS CANALICOLLIS, Lew. Dorsal and side view of beetle.

„ 7. CUCUJUS (?) SP. Dorsal and side view of beetle.

S. B. Mondul, del.

Photogravure, Survey of India Offices, Calcutta, February, 1903.

1. TOMICUS SP.
2. POLYGRAPHUS MAJOR, MS.
3. POLYGRAPHUS MINOR, MS.
4. PITYOGENES CONIFERAE, MS.
5. HYPOPHLOEUS FLAVIPENNIS, MOTS.
6. NIPONIUS CANALICOLLIS, LEW.

PLATE XIV.

Portion of the inner bark of a Blue pine severely attacked by *Tomicus* sp. (the Blue pine Tomicus).

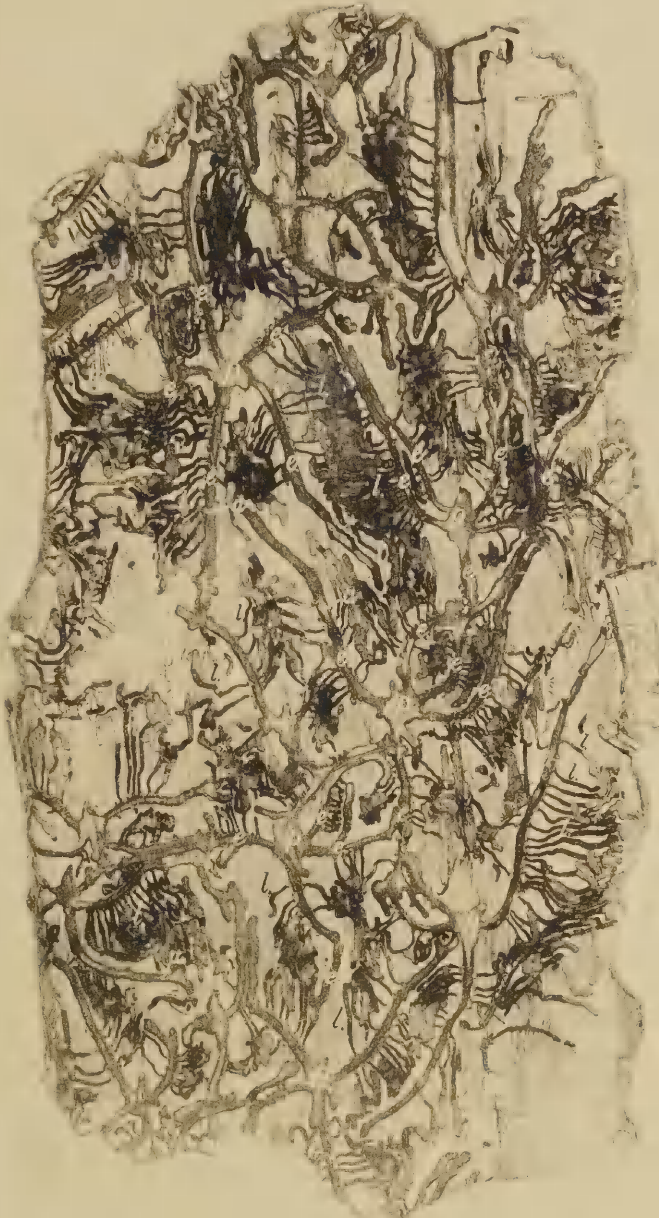
p, pairing chamber of ♂ and ♀ beetles ;

e, egg-galleries made by female beetles ;

a, air-hole made by female beetle to let air into the egg-gallery ;

l, larval galleries.

[Photograph by Mr. J. H. Lace, Conservator of Forests, Bengal.]



⅔ nat size.

J.H.Lace. Photo.

Photogravure, Survey of India Offices, Calcutta, March 1903.

GALLERIES OF THE BLUE PINE TOMICUS, *TOMICUS SP.*,
IN THE BARK OF THE BLUE PINE, *PINUS EXCELSA*.

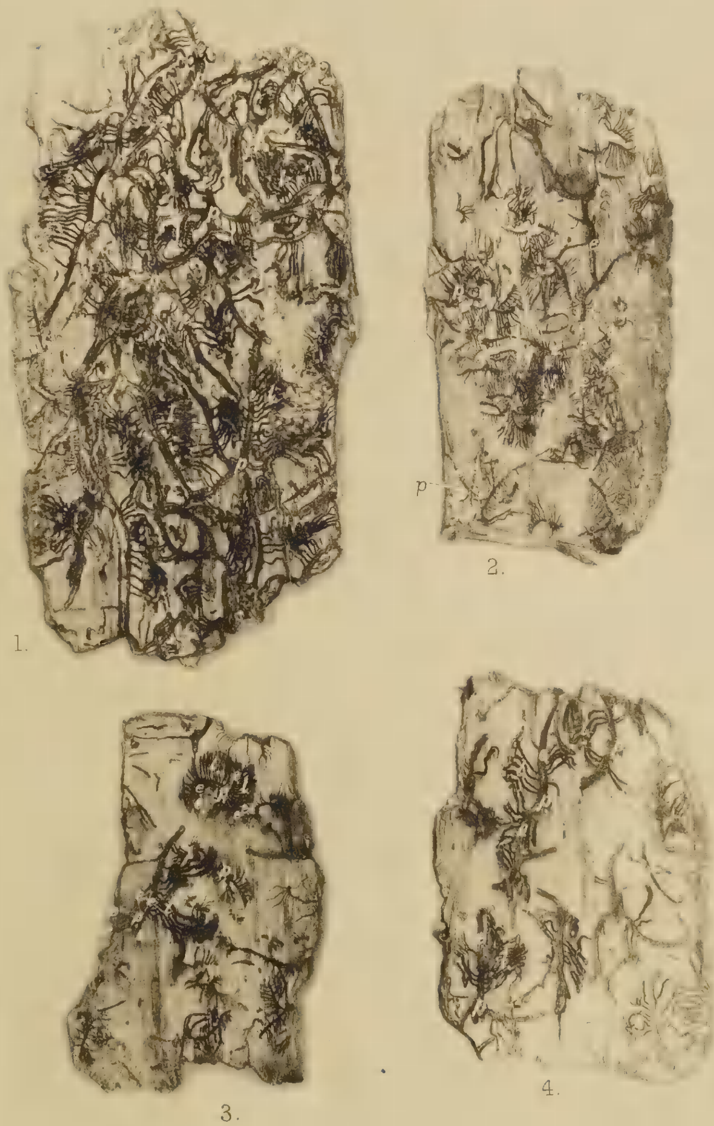
PLATE XV.

FIG. 1. Galleries of the Blue pine Tomicus, *Tomicus* sp., in Blue pine bark; *p.* pairing chamber; *e.* egg-gallery; *l*, larval gallery.

" 2. Galleries of *Polygraphus minor*, MS., on inner surface of Blue pine bark; *p.* pairing chamber; *e*, egg-gallery; *l*, larval galleries.

" 3. Galleries of *Tomicus* sp. and *Polygraphus minor* in Blue pine bark; *p*, pairing chamber; *e.* egg-gallery; *l*, larval gallery.

" 4. Galleries of *Tomicus* sp. and *Polygraphus minor* in Blue pine bark showing how they at times run into one another so as to be indecipherable.



J.H.Lace Photo. Photogravure, Survey of India Offices, Calcutta, March 1903.

Fig 1. GALLERIES OF THE BLUE PINE TOMICUS, *TOMICUS* SP., IN BLUE PINE BARK.

Fig 2. GALLERIES OF *POLYGRAPHUS MINOR* MS. IN BLUE PINE BARK.

Fig 3. GALLERIES OF *TOMICUS* SP. AND *POLYGRAPHUS MINOR* IN BLUE PINE BARK.

Fig 4. ONE EGG GALLERY OF *TOMICUS* SP. & GALLERIES OF *P. MINOR* IN BLUE PINE BARK.

PLATE XVI.

FIG. 1. POLYGRAPHUS MINIMUS, MS. Dorsal and side view of the beetle.

" 2. POLYGRAPHUS LONGIFOLIA, MS. *a.* Dorsal and side view of the beetle; *b.* Portion of a *Pinus longifolia* branch showing pairing chamber, (*p*), egg-gallery, (*e*), and larval gallery, (*l*), of this beetle.

" 3. HYLESINUS? sp. *a.* Dorsal and side view of beetle; *b.* Inner surface of a piece of Blue pine bark showing pairing chamber, (*p*), and egg-galleries, (*e*).

" 4. CRYPHALUS BOSWELLIÆ, MS. *a.* Larva; *b.* Pupa, ventral view; *c.* dorsal and side view of the beetle.

" 5. CRYPHALUS TECTONÆ, MS. Dorsal and side view of the beetle.

" 6. CRYPHALUS MORINDA, MS. Dorsal and side view of the beetle.

" 7. CRYPHALUS LONGIFOLIA, MS. *a.* Dorsal and side view of the beetle; *b.* Portion of a branchlet showing, (*p*), pairing chamber with, (*e*), the indentations made to enlarge it to deposit the eggs; *c.* Portion of a branch showing, (*p*), the pairing and egg chamber; *l*, the larval galleries.

S. B. Mondul, del.

Photogravure, Survey of India Offices, Calcutta, February, 1903.

1. POLYGRAPHUS MINIMUS, MS.
2. POLYGRAPHUS LONGIFOLIA, MS.
3. HYLESINUS ? SP.
4. CRYPHALUS BOSWELLIAE, MS.
5. CRYPHALUS TECTONAE, MS.
6. CRYPHALUS MORINDA, MS.

PLATE XVII.

FIG. 1. CRYPHALUS? MAJOR, MS. *a.* Dorsal and side view of male beetle; *b.* Dorsal and side view of the female beetle; *c.* Attacked *Pinus longifolia* branchlets, showing, (*p*), the pairing chamber, (*f*), the horizontal tunnel down to the pith, and (*e*), the egg gallery; *d.* Larger branchlet showing the same as *c.*; *g.* Piece of a larger *P. longifolia* branch severely attacked by this beetle, showing how the galleries run into one another and become indecipherable on such occasions.

" 2. CRYPHALUS? DEODARA, MS. *a.* Dorsal and side view of beetle; *b.* Deodar branchlets showing method of attack of this insect: (1) the girdle, (2) section of branch showing the larval tunnel, (3) horizontal gallery and exit hole made by beetle on maturing, (4) branchlet girdled in several places at (1) by this beetle.

[From a drawing by the author.]

" 3. HYPOBORUS? sp *a.* Larva; *b.* Dorsal and side view of the beetle; *c.* Branch with bark removed showing, (*p*), the pairing chamber, (*l*), larval galleries, and, (*m*), the pupating chambers of larvæ.

" 4. TOMICUS LONGIFOLIA, MS. Side view of hinder part of abdomen showing the size and number of teeth at the side of the apical excavation.

" 5. ECCOPTOPTERA SEXDENTATA, Mots. Dorsal and side view of the beetle.

S. B. Mondul, del.

Photogravure, Survey of India Offices, Calcutta, February, 1903.

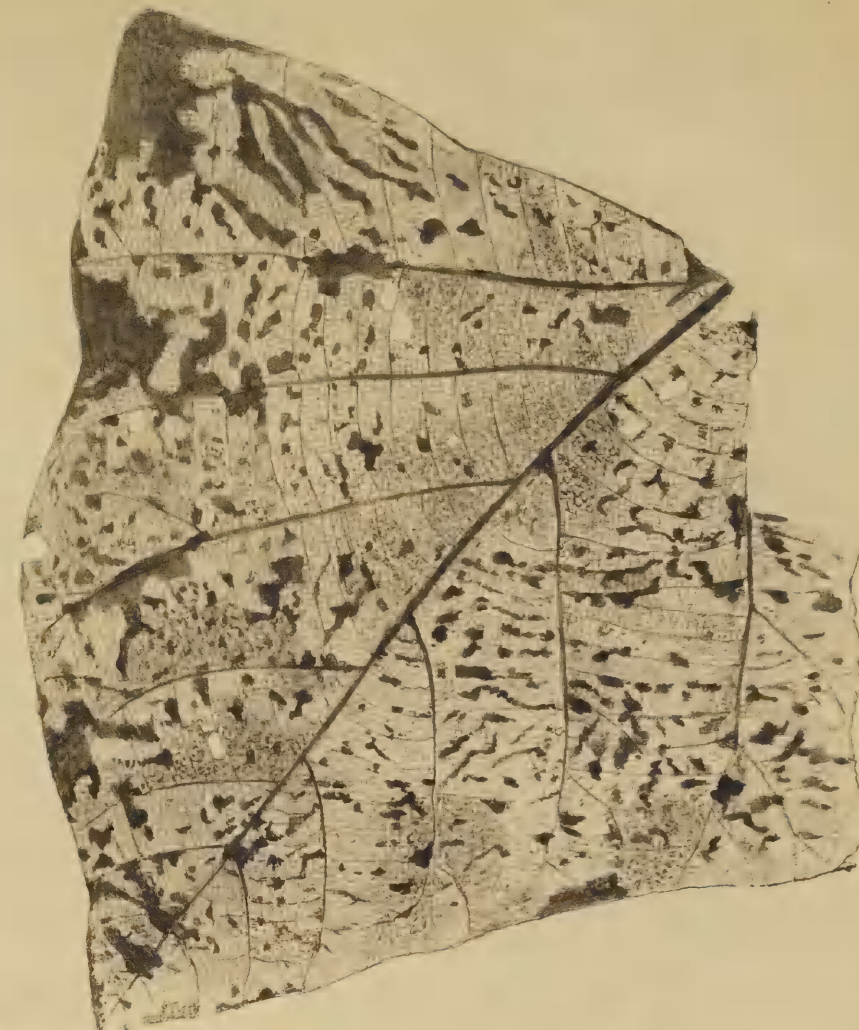
1. CRYPHALUS ? MAJOR, MS.
2. CRYPHALUS ? DEODARA, MS.
3. HYPOBORUS ? SP.
4. TOMICUS LONGIFOLIA, MS.
5. ECCOPTOPTERA SEXDENTATA, MOTS.

PLATE XVIII.

FIG. 1. Teak leaf showing the characteristic method of defoliation of the larva of *Hyblæa puera*, Cram.

" 2. Portion of a Teak leaf showing the skeletonizing method of defoliation of the larva of *Pyrausta machœralis*, Wlk.—

[Drawn from a phctograph by Mr. R. S. Hole, Deputy Conservator of Forests.]



S. B. Mondul, del.

R. S. Hole. Photo.

Photogravure. Survey of India Offices, Calcutta, March 1903.

Fig. 1. TEAK LEAF SHOWING CHARACTERISTIC METHOD OF DEFOLIATION BY THE LARVAE OF *HYBLAEA PUERA* CRAM.

Fig. 2. PORTION OF A TEAK LEAF SHOWING THE SKELETONIZING METHOD OF DEFOLIATION OF THE LARVAE OF *PYRAUSTA MACHŒRALIS,* WLK.

PLATE XIX.

Fig. 1. Hyblæa puera, var. nigra, MS. *a.* Dorsal and side view of the larva ; *b.* Pupa in silken cocoon attached to a portion of a teak leaf ; *c.* male moth ; *d.* female moth.

„ 2. Pyrausta machœralis, Wlk. Dorsal view of the larva.

„ 3. Hypsipyla robusta, Moore. *a.* Under surface of a piece of tún bark showing a matted felt-like mass of cocoons of this insect ; *b.* A tún branch hollowed out by the larva showing the mass of excreta and wood-dust which fills the boring ; *c.* A cocoon *in situ* in a hollowed-out twig.

„ 4. Monophlebus Stebbingi, Green. *a.* Female insect showing cottony sac in which the eggs are laid ; *b.* egg ; *c.* Ventral and side view of the male pupa (?) case ; *d.* Mature male insect ; *e.* A sâl branch showing the cast larval skins attached to it by the sugary secretion ; *f.* A sâl branch showing the way the ♀ scales cluster together round it whilst feeding.

[From a drawing by the author.]

„ 5. Coccinella sp. *a.* Dorsal and side view of the larva ; *b.* pupa sessile upon a sâl leaf ; *c.* mature lady-bird beetle ; *d.* sâl twig with, (1) pupating larva, (2) sessile pupa, upon it.

„ 6. Monophlebus Stebbingi, var. Mangiferæ, Green. Dorsal view of mature female scale.

S. B. Mondul, del.

Photogravure, Survey of India Offices, Calcutta, March. 1903.

1. HYBLAEA PUERA, VAR. NIGRA, MS.
2. PYRAUSTA MACHOERALIS, WLK.
3. HYPSIPYLA ROBUSTA, MOORE.
4. MONOPHLEBUS STEBBINGI, GREEN.
5. COCCINELLA SP.
6. MONOPHLEBUS STEBBINGI, VAR. MANGIFERAE, GREEN.

DEPARTMENTAL NOTES

ON

INSECTS THAT AFFECT FORESTRY,

BY

E. P. STEBBING, F.L.S., F.Z.S., F.E.S.,

FOREST ENTOMOLOGIST TO THE GOVERNMENT OF INDIA.

No. 3.

WITH PREFACE AND INDEX TO VOLUME I.

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PREFACE.

THE object of issuing the Departmental Notes on Insects that affect forestry in India in their present form is to enable the Officers of the Department and others interested in the culture of trees to keep up to date with our knowledge of the subject and to assist the advancement of the work by studying the still unknown portions of the life-histories of the various pests detailed and of others still unrecorded. To this end, criticism and discussion are cordially invited.

Several of the insects dealt with are new to science, and most of the information on their habits, etc., is new. It has not been considered necessary here, however, to give in full detail the reasons for the statements made with reference to some of the new and more complex of the life-histories. The author hopes to publish elsewhere full and detailed technical papers dealing with the matter from the scientific standpoint.

It is proposed to give information in these notes upon—

i.—Hurtful Insects.

ii.—Useful Insects.

Owing to queries received on the subject it should, perhaps, be pointed out that the descriptions of the insects do not aim at being scientific ones, they having been drawn up merely as simple aids to identifying the insects by fellow-workers in the field. It is hoped that the new species will be described with the help of scientific confrères. The writer trusts in time to himself deal with the *Scolytidæ*, of which considerable collections of unknown species have already been made.

E. P. STEBBING

DEHRA DUN;
The 24th April 1905.

Determination of insects alluded to in Nos. 1 and 2.

Scolytus sp., p. 47 = . .	Scolytus major, Steb., p. 203.
Predaceous clerid larva, p. 49=	Larva of Clerus sp., p. 213.
Sirex sp., p. 151 = . . .	Sirex imperialis. (Kindly identified for me by Col. C. T. Bingham.)
Thalessa or Rhyssa sp., p. 158=	Rhyssa sp. nov.
Bostrichus parallelus, p. 174 =	Bostrichopsis parallela, Lesne.
Clerus sp., p. 213 = . .	Thanasimus himalayensis, Steb. Jour. As. Soc. Bengal, LXXII, Pt. II (1903).
Coccinella sp., p. 324 = . .	Vedalia Guérinii, Crotch.

A further Note on

BRACHYTRUPES ACHŒTINUS, Stoll.

(*Vide* No. 1, pp. 6-9, pl. I, fig. 1.)

Vernacular names. Hind., *Jhingur*; Bengal, *Wechingri* Bombay, *Khaheri.*

This cricket would appear to be common in most parts of India. In addition to the localities already given, the United Provinces, Bombay and Madras Presidencies should be added.

The insect has been reported by Mr. R. S. Pearson as feeding upon teak seedlings in nurseries in the Panch Mahals, in the Bombay Presidency. The method of attack was similar to that already described in No. 1 of these notes.

The following was the method adopted to get rid of the insects :—

Boys were provided with pots of water (a length of bamboo with the top node cut off and the bottom one left on is equally serviceable) and instructed to search for the burrows of the crickets. When found a little water was poured down each. The crickets at once came to the surface and were killed.

SIREX ? sp.

Plate XXII, fig. 1.

Classification :—Order, HYMENOPTERA. Family, Siricidæ.

Tree attacked :—*Santalum album* (Sandal wood).

The identification of insects in their larval or grub stage is by no means easy and very often impossible. Perhaps the two families of insects where such identification is possible to a certain extent are the *Cerambycidæ* and *Siricidæ*. To this latter family the sandal-wood-borer under consideration belongs

The following is the description of the larva:—

A thick pale, whitish-yellow grub, convex above and flat beneath. Head small, orange-yellow; mandibles black, rest of mouth-parts brown. Thoracic segments enlarged, the anterior one being hood-like dorsally with a narrow neck of the same circumference as head where it joins on to this latter. Thoracic legs well marked and 3-jointed. There are no abdominal legs, but slight protuberances are present. Abdominal segments nine in number, the terminal one being enlarged, pointed posteriorly and ending in a brown spike which is black at its extreme tip; round its base is a circle of minute brown spikelets. Head, prothorax, and last two segments of abdomen shining. The segments of latter are bulged out at the sides, giving the grub a crinkled edge on either side. Length 1¼ inch. Grub probably not full size. Plate XXII, fig. 1, shows a dorsal and side view of the grub.

Life-History.

Little is known at present about this insect. No member of the family has ever previously been recorded as attacking the sandal tree. The larva was found in the heart-wood of a tree in the first week of August in the North Coimbatore sandal-wood areas and was not, I think, full grown. Unfortunately the wood in which it was found had been so chopped about that its gallery could not be satisfactorily traced in its entirety.

Sirex larvæ usually only bore into dying or dead wood, but require this to be in a sound condition. The female does not usually require bark to lay her eggs in, but drills a hole in the wood itself and oviposits. These habits render this pest to be feared and make the working out of its life-history imperative, since it is capable of committing damage to the sandal-wood after it has been cut and barked, when no further damage is to be feared from the longicorn borers described on p. 379 and 383.

We require to know how long it spends in the larval stage feeding on the wood, how long in the pupa and adult or fly stage, and when the insect makes its appearance in this latter stage (the adult will probably be a fly not unlike the one shown in Pl. VII, fig. 1 *e* of No. 2 of these notes). Also whether it attacks the trees while they are still quite green or only after the wood has already begun to dry.

When we have answered some of the above questions, more especially the last, we shall be in a position to state what remedies it will be possible to undertake against the pest.

Parasite of *Acronycta anœdina*, the Horse chestnut defoliator.

OPHION AUREOLATUS, Cameron.

Plate XX, figs. 1, 1*a*, 1*b*.

Classification :—Order, HYMENOPTERA. Family, Ichneumonidæ.

Parasitic upon the larvæ of *Acronycta anædina.* (See No. 1, p. 91.)

Description.

Cocoon.—The grub spins a cocoon consisting of a yellow matted silk felt in which it pupates. This cocoon is spun inside the lepidopterous pupa and is shown in Plate XX, fig. 1. Fig. 1*a* shows the lepidopterous pupa with a fly emerging.

Imago.—A moderately large bright yellow fly with two pairs of large membranous wings with well-marked veins in them, the upper ones considerably larger than the lower. Antennæ and legs long and slender. The abdomen is joined to the thorax by a very slender peduncle, the body swelling out and thickening considerably in the vertical plane behind this. The segments comprising this thickened portion are curved abruptly and vertically downwards. Horizontal length, ¾ inch. Length taken round curve of dorsal surface of abdomen, 1 inch. Plate XX, fig. 1*b*, shows this insect.

Life-History.

The life-history of this ichneumon probably corresponds, as far as dates of appearance go, to that of its host *Acronycta anædina*, the larvæ of which moth seriously defoliate the horse chestnut in Jaunsar. The caterpillars were excessively numerous in the years 1899 and 1900, and in the latter year large numbers of them were parasitised by this ichneumon. I found very few larvæ on the trees in 1901, their numbers having been practically decimated for the time being by the parasite. Mr. B. B. Osmaston collected a large number of cocoons of *A. anædina* in August 1900 and made them over to me at Chittagong in December of that year. I took them to Dehra Dun and bred out flies in February 1901, the dates of issuing of some being the 4th, 17th, 27th and 28th of the month. The lower elevation and warmer locality doubtless account for the flies having issued so early in the year. They probably normally issue from the caterpillar pupæ at the beginning of July, which is the period when the moths appear on the wing and lay eggs. The ichneumon fly lays its eggs in the caterpillar and the young grub on hatching out feeds inside the moth larva but does not kill it until it has changed into the pupal stage. Thus the caterpillar completes all the defoliating damage it is capable of accomplishing before it is killed by the parasite. The ichneumon grub becomes full fed about September, and appears to pupate during this month inside the caterpillar pupa. It remains in this condition all through the winter, the fly issuing during the next summer. The anterior end of the larval pupal case splits down to allow the fly to emerge. Fig. 1 shows the pupal cocoon of the fly and 1*a* a fly just emerging from the moth pupal case.

Locality from where reported.

Mr. B. B. Osmaston took this fly in 1900 in the Jaunsar Forests, North-West Himalayas.

Relations to the Forest.

From the above account of its habits it will be seen that this insect is a most useful parasite. Although the grub does not kill off the larva it feeds upon until the latter has accomplished all the damage it is capable of doing, the trees thus suffering heavily during the year of infestation, it nevertheless, when rumerous, infests the caterpillars to such an extent that it is practically able to reduce to normal proportions any large increase in the numbers of the *Acronycta* pest. The 1899 and 1900 attacks proved this, the parasite having infested the caterpillars to such an extent during this latter year that it was almost impossible to obtain any moths from the cocoons. In 1901 the insect was very scarce, but few larvæ being found upon the trees. This fact probably reacted upon the ichneumon flies, whose numbers would be in their turn reduced the succeeding year owing to the few caterpillars available in which to deposit their eggs.

Points in the life-history requiring further observation.

1. Where the ichneumon fly deposits her egg. Is it on the external surface of the caterpillar, or does she make a small incision in the skin and place it in this?
2. The number of eggs laid upon any one caterpillar. I have never obtained more than one fly from any one pupa.
3. The number of eggs laid by one ichneumon.
4. The exact length of time spent by the ichneumon grub feeding within the *Acronycta*. Does it pupate immediately after the *Acronycta* caterpillar has done so?
5. Exact period of issuing of the flies.

Some Parasites of *Hyblœa puera* and its variety *nigra*.

GLYPTA sp.

Plate XX, fig. 2.

Reference :—Determined as an undescribed species of *Glypta* by Dr. W. H. Ashmead, of the U. S. Museum.

Classification :—Order, HYMENOPTERA.

Parasitic upon *Hyblæa puera*, var. *nigra*, Steb.

Description.

A small blackish fly with a slender body and many-jointed antennæ. The wings are membranous, irridescent and have a well-developed series of veins in them. A male specimen of this insect is shown in Plate XX, fig. 2.

Life-History.

This ichneumon fly was bred out of some caterpillars of this variety of the Hyblæa which were obtained from the Edakode plantations at Nilumbar on 26th August 1902. The larvæ were kept about three days when they pupated. This ichneumon issued on the 6th or 7th of September, so that its pupal stage would appear to be about a week and may prove to be less. Its larval stage is probably shorter than that of the Hyblæa. The larva feeds upon the caterpillar as an internal parasite, and does not kill the latter off until it has pupated.

PIMPLA sp.

Plate XX, fig. 3.

References :—Determined as an undescribed species of *Pimpla* by Dr. W. H. Ashmead, of the U. S. Museum.

Classification :—Order, HYMENOPTERA. Family, Ichneumonidæ.

Parasitic upon *Hyblæa puera*, var. *nigra*, Steb.

Description.

Resembles the last to some extent. The fly is slender, elongate, blackish. The body in the female, one of which is shown in Plate XX, fig. 3, terminates in a longish exserted ovipositor.

Life-History.

This fly was bred by the writer from the same set of caterpillars as the Glypta, and its dates of pupating and issuing are much the same as the other. Its grub does not kill the caterpillar until the latter has pupated. It feeds upon it as an internal parasite.

The ichneumon fly probably lays its eggs in the young Hyblæa larva.

Note.—I found another form of Ichneumon parasite present upon one of these caterpillars. This was a minute grub which was feeding externally upon the latter instead of internally, as in the case of the two above described ones. The Hyblæa caterpillar was full-grown, but its body was very flaccid and it died within a few hours of my first observing the small predaceous grub which was at that time small, pale, white, translucent and $\frac{1}{12}$th inch in length. It was first observed on the 26th August. On the 27th it was twice the size it had been the day previously with black specks on its upper surface. It was very active, wriggling about a good deal. It had eaten about $\frac{1}{4}$ of the caterpillar, working from the middle.

The following day the grub was about $\frac{1}{4}$ inch in length, torpedo-shaped, with a pointed yellow head and greyish dorsal surface. Under the microscope it was seen to be a pale yellow green with small white bodies apparent under the skin which appeared to consist of fatty substances It was active and was still feeding upon the caterpillar. It appeared to be nearly full-grown. This interesting larva pupated and then died, and so I was unable to make any further observations upon it. There is no doubt that it commences to feed upon the Hyblæa caterpillar whilst the latter is still alive.

MASICERA sp.

Plate XX, figs. 4, 4*a*.

Reference :—Determined as an undescribed species of *Masicera* by M quillett, of the U. S. Division of Entomology.

Classification :—Order, DIPTERA. Family, Tachinidæ.

Parasitic upon *Hyblæa puera*.

Description.

Imago.—This insect has a great resemblance to a large house fly.

It is depicted in Plate XX, fig. 4. The insect is brownish-yellow in colour with a blackish head and very short antennæ. The wings are fairly large, and the body stout and hairy. Wing expanse ¾th inch. Fig. 4*a*, shows the black eliptical oval pupal case made by the grub of this insect.

Life-History.

This insect was bred by the writer from some caterpillars of *H. puera* collected in the Karimpoya Plantation at Nilumbur, in Malabar, on the 28th August 1902. These caterpillars were kept for three days and pupated on the 1st September. The fly issued on the 7th or 8th of the month, thus spending a week in the pupal stage.

I am unable to say how long the grub spends feeding within the Hyblæa caterpillar. Only one egg appears to be laid in each larva.

Points in the life-histories of these parasites requiring further observation.

1. In each case where does the fly lay its eggs? Is it on the outside or within the caterpillars?
2. Is more than one egg laid upon each caterpillar by any one fly?
3. How long is spent in the grub stage feeding within the Hyblæa larvæ?

4. Does the fly on emerging at once pair, and do the females soon afterwards lay eggs in the Hyblæa caterpillars? This is possible, since at the period I took the caterpillars they were of all sizes on the teak trees.
5. How many eggs are laid by each fly?
6. How many generations in the year are passed through by—

   (*a*) each of the ichneumon flies?
   (*b*) the tachnid fly?

7. Are these parasites plentiful in years of bad defoliation by Hyblæa caterpillars?
8. Are these parasitic flies present in other parts of India where bad defoliating attacks are experienced from *Hyblæa.* They have at present only been reported from Nilumbur as noted above.

NOTE.—It should prove easy for those interested to breed out these flies by keeping some nearly full-grown Hyblæa caterpillars in a box and feeding them till they pupate. The flies will issue from the pupæ if the caterpillars were parasitised.

Most of my infected caterpillars died, as also did the parasites inside them, owing to the fact that they had to be transported some 2,000 miles up north from Nilumbur just at the time the latter were pupating.

ORYCTES RHINOCEROS, Linn.

The Rhinoceros, or Date-palm beetle.

Reference:—Linn. Syst. Nat., ed. 10, 1758, 346; ed. 12, 1767, 544. Steb. Inj. Ins. Ind. Forests, 37.

See also Circulars on Agricultural Economic Entomology issued by the Trustees of the Indian Museum No. 4—Oryctes Rhinoceros (1903.)

Classification:—Order, **COLEOPTERA.** Family, **Scarabæidæ.**

This is the common date and cocoanut palm-borer of Southern India. Its grubs have been reported as feeding upon the roots of young Casuarina seedlings and other trees.

Larva.—A large stout curved grub. Head flat, purplish-brown. Mandibles brownish to black, large and stout; antennæ 5-jointed, basal joint enlarged. On first three segments behind head are three pairs of light-brown, stout, long, 3-jointed legs. Body yellowish-white, last two segments blackish. The head is smaller in transverse diameter than the rest of the body. Body is very thick, corrugated, curved, and swollen out so as to be almost bag-shaped behind. On each side of the third to tenth segments is a large dark-brown spiracle. Body above and below is thickly covered with brown spiky hairs except on last segment, where they are small and scattered.

Length, taken round curve, 4 inches. Breadth $\frac{3}{4}$ inch.

Beetle.—Black, shining, massive and large, with a prominent horn which curves backwards on its head, from which it gets its name of rhinoceros beetle. The elytra are very convex above; the insect being flat beneath. Shanks (tibiæ) of legs armed with spikes, the front ones having each three spikes on their outer edges. A large roughly heart-shaped depression on front portion of thorax. A series of broad striæ and punctures on elytra. Dark rufous beneath with hair of same colour in parts. The beetle is easily recognisable by its form, by its antennæ ending in a series of terminal plates, by its spiked tibiæ and 5-jointed tarsi and great size. Length $1\frac{3}{4}$ inch. Breadth across elytra $\frac{3}{4}$ths inch.

Life-History.

This beetle is to be found on the wing during the greater part of the year. It may hibernate, either as a larva or pupa or perhaps beetle, from November to about March. I have obtained living beetles towards the end of March and as late as the beginning of November. The adult insect spends some time in this state and apparently can do with little food in this stage of its existence, as beetles have been kept for over two weeks without food of any kind.

The insect lays its eggs in dead and decaying palm trees or in masses of palm and other refuse situated in or near palm topes. The grubs on hatching out feed in the decaying trees or in adjacent refuse heaps, and evidently also consume the roots of seedling plants. Mr. C. B. Dawson, District Forest Officer, Kistna, reports that the large grubs feed upon young Casuarina seedlings, being attracted to them owing to the moisture in the sand in which they are planted. These young seedlings are watered whilst in the nurseries and thus the moist layer of sand filled with the young roots would quickly attract grubs of this kind. It is, I think, improbable that the beetles lay their eggs in the nurseries. The young larvæ on hatching out would require something softer and of a more decaying nature as food at first, and would only attack rootlets when their mandibles were stronger and more fully developed.

It is not yet known how long the larva spends in this stage of its existence. It will certainly be several months, since the full-grown grub is of very large size, and it may be considerably over a year. This latter would seem the most probable (unless the insect has several generations in the year, which is unlikely) as from the fact that beetles are to be found almost, if not quite, continuously from March to November, it is evident that the generations overlap, *i.e.*, that at any period it is possible to find eggs, grubs, pupæ and beetles. This, of course, adds immensely to the insect's capabilities of doing damage. The time spent in the egg and pupal stages is still unknown.

Result of attacks.

Young Casuarina seedlings attacked by the grubs at first show signs of wilting and then die off. Only seedlings and very young saplings are attacked.

Protection and remedies.

The following are remedies which have been already recommended for trial:—

1. Employ boys or women to carefully remove the soil round seedlings which are seen to be wilting, and take out and kill the fat grubs found at the roots. This should be done when seedlings are seen to be dying off in any considerable number even at the expense of killing adjacent young plants by thus disturbing their root system. The grubs will go from one plant to another, and one grub may thus destroy a number of seedlings.

2. If feasible, a simple and effective plan is to flood the plantation for a few hours so as to drown all the grubs in the soil. Those that come up to the surface should be collected and killed.

3. Remove all diseased, dead and decaying date and cocoanut palms in the vicinity of nurseries and young plantations. Also, and this is an important point, all refuse heaps of rotting vegetation, etc. If, for the preparation of the nursery, special soil pits of manure, litter and leaves are prepared they should be carefully inspected for these grubs, as the beetles will be certain to lay in such a place. A good instance of the danger of such was noticed in a Calcutta garden in June 1903. The heap of rich soil and humus used for manuring the flower beds contained numbers of the larvæ of this insect which were spreading from them into the beds of young seedlings, whose roots they were devouring. There were palm trees close by.

Points in the life-history requiring further observation.

1. Length of time spent in the grub stage.
2. Length of time spent in the pupal stage.
3. Length of time spent in the beetle stage.

A predaceous Enemy of the Wood-borers *Rhyncholu* sp. and *Hylastes* sp.

NIPONIUS CANALICOLLIS, Lewis.

Reference:—Lewis A. M. N. H., Ser. 7, Vol. viii, Nov. 1901. Steb. Dep. Not. Insec. aff. For. No. 2, p. 248.

Classification:—Order, COLEOPTERA. Family, Histeridæ.

Predaceous upon *Rhyncholus* sp. and *Hylastes* sp. in spruce. Already reported as predaceous upon the Blue pine bark-borers *Tomicus* sp. and *Polygraphus major* and *minor*.

(*Vide* No. 2 of these Notes, p. 248.)

Description of Pupa.

Pupa.—Longish, straight, white with a vertical head and free limbs, wings etc. Length 4 millim.

Life-History.

A further addition is here made to the notes on the life-history of this Niponius. In the last number of these notes we saw that it preyed upon *Tomicus* sp. and *Polygraphus major* and *minor*. The beetles had been found in the Blue pine chiefly, but also in one instance in some deodar saplings where it was feeding upon *P. major*.

I have now found it preying upon the two wood-boring beetles *Rhyncholus* sp.,, and *Hylastes* sp., following them into their tunnels in the wood. It was taken in the middle of June in tunnels in a large dead spruce which was being riddled by the above-mentioned Scolytid borers, the former being especially plentiful. Since these two borers are usually found together it is probable, I think, that this *Niponius* also attacks the *Hylastes*: but it may confine itself to the *Rhyncholus* beetles, which it resembles in build. I think there is no doubt that it follows these beetles, into the tree by entering by their galleries, feeding upon them and laying eggs in such a position as will enable the young larva on hatching out to feed upon the *Rhyncholus* and *Hylastes* larvæ.

Niponius canalicollis has now been found in Blue pine, deodar and spruce wood. The insect either spends a long time in the beetle stage of its existence, or what is, I think, perhaps more probable, passes through a number of generations in the year corresponding to those of its hosts. I have invariably found beetles present in the tunnels of various bark-boring and wood-boring *Scolytidæ* from the beginning of May up to the middle of July.

Points in the life-history requiring further observation.

1. Where the eggs are laid. Is it in the tunnels of the *Rhyncholus* and *Hylastes* beetles?
2. What the larvæ feed upon and length of time passed in this stage and in the pupal stage.
3. The length of time spent in the beetle stage.
4. The number of generations in the year.
5. Where and in which stage the winter is passed through.

Histeridæ predaceous upon various Scolytid bark and wood-borers.

PLATYSOMA DUFALI, Mars.

Plate XX, fig. 5.

Classification :—Order, COLEOPTERA. Family, Histeridæ.

Predaceous upon *Tomicus* sp. (The Blue Pine Tomicus), ? Polygraphus minor, in Blue pine.

Description.

Beetle.—Elongate, narrow, compact, black and shining. The head is provided with stout mandibles and angled brownish antennæ ending in a club. Thorax wider than long, smooth and shining. Elytra elongate smooth and shining in centre, with several well-marked longitudinal striæ down either side; the elytra leave the last two segments of the body exposed, these segments being heavily punctured. Under surface of body and legs brownish. Length $\frac{5}{32}$nds inch. Plate XX, fig. 5 shows a dorsal and side view of this insect.

Life-History, etc.

This insect is to be found in the beetle stage at the end of May at elevations of about 8,000 feet in the North-West Himalayas. It was taken from the galleries made between the bark and sapwood by the Blue pine Tomicus beetle where it appeared to be feeding upon the larvæ of this bark-borer. It may also attack the larvæ of *Polygraphus minor*, of which some were also present in the tree.

There is still much to be learnt about this insect—where its larval and pupal stages are passed, whether the larvæ also feed upon the Tomicus and Polygraphus larvæ, the number of generations of the insects in the year and the time taken to pass through each.

PLATYSOMA sp. nov.

Plate XX, fig. 6.

Reference :—Provisionally determined as an undescribed species of Platysoma by Mr. G. Lewis.

Classification :—Order, COLEOPTERA. Family, Histeridæ.

Predaceous upon *Tomicus* sp. (The Blue Pine Tomicus) and *Rhyncholus* sp. in Blue pine. (And perhaps on Polygraphus minor, Steb.)

Also upon *Scolytus major* and *S. minor*, Steb. in Deodar, and *Rhyncholus* sp. and *Hylastes* sp. in Spruce.

Description.

Beetle.—Flat, compact, somewhat elongate, black and shining ; all parts of the insect fit well together. Head is transverse and narrow and provided with stout black mandibles and two elbowed antennæ, each of which ends in a club. Thorax is wider than long, smooth in the centre with a few scattered punctures, these latter more numerous and larger at sides between the two broad shallow striæ. Elytra twice as long as thorax, glabrous medianly with very fine punctures, the sides with three longitudinal prominent striæ, the surface being punctured between them ; the elytra leave two segments of the abdomen and a portion of a third visible dorsally—these segments are constricted posteriorly, the surfaces being finely punctured. Length $\frac{3}{16}$ths to $\frac{3}{10}$ths inch. Plate XX, fig. 6 shows a dorsal and side view of this beetle.

Life-History, etc.

This beetle is to be found in the adult stage towards the end of May. The writer discovered it in some numbers in the galleries of the Blue pine Tomicus beneath the bark of a newly felled tree. The galleries contained pupæ and mature beetles of the Tomicus, and the Histerid was apparently feeding upon them. The width of body of the predaceous beetle exactly fits the Tomicus galleries.

In the third week of the month the beetle was found in some numbers beneath the bark and in the wood of dying girdled blue pine trees. The trees were infested with the Rhyncholus wood-borer (see No. 2, p. 198), and the Platysoma was found in their galleries and also on the sapwood beneath the bark.

This beetle was again found fairly plentifully in the adult stage towards the end of June beneath the bark of recently felled deodar trees which had been attacked by the two *Scolytus* beetles, *S. major* and *S. minor*. These latter with their larvæ were very numerous in the bark and sapwood (see No. 2, pp. 203—212), and the Histerids were feeding upon the larvæ and possibly upon the adults.

A few days later I discovered the same *Platysoma* beneath the bark of a large dead spruce tree, the wood of which was being attacked by the borers *Rhyncholus* sp. and *Hylastes* sp. The Histerids appeared to be feeding upon these.

Locality.

This *Platysoma* appeared to be common throughout the Jaunsar and neighbouring Tehri-Garhwal forests in the blue pine, deodar and spruce zones (about 5,500 to 9,000 feet).

Further observations required.

I have not yet found the larval or pupal stages, and I do not know how many generations this insect passes through in the year. It is evidently not uncommon in the localities above mentioned; but there still remains much to be observed on its habits, and it will be of especial interest to obtain the other stages of its metamorphosis and to ascertain its real importance in the forest.

PAROMALUS sp. nov.

Plate XX, fig. 7.

Reference :—Provisionally determined as an undescribed species of Paromalus by Mr. G. Lewis.

Classification :—Order, COLEOPTERA. Family, Histeridæ.

Predaceous upon Rhyncholus sp.; Hylastes sp. In Spruce and Blue pine.

Description.

Beetle.—A small, compact, elliptical, shining black beetle chiefly remarkable for having a number of spiny hairs projecting from the extremity of the ventral surface of the abdomen.

Head not as wide as thorax, with a prominent depression on either side commencing in outer upper angle and sloping backwards and inwards to lower third but not meeting the hind margin. Thorax with front margin deeply concave. A longitudinal depression on either side of the median line, the surface with prominent and fairly numerous punctures. Elytra nearly cover the whole body, only two narrow segments of the abdomen being visible behind dorsally; the surfaces thickly punctured, the punctures, however, less numerous on either side of the median line. Under-surface black, abdominal segments reddish with numerous reddish projecting spiny hairs. Legs reddish; with four teeth on outer edge of the front tibia. Length $\frac{3}{32}$nd inch. See plate XX, fig. 7.

Life-History, etc.

This beetle is to be found in the mature state in the middle of June at about 7,000 feet in the North-West Himalayas. It was discovered beneath Spruce bark in company with the Scolytid wood-borers *Rhyncholus* sp. and *Hylastes* sp., and it is probable that it preys upon them or their larvæ. It was also found some days later beneath blue pine bark amongst a large number of different bark- and wood-boring larvæ. It is an active little Histerid with a quick walk. Nothing further is known about this insect. Its larval and pupal stages have yet to be discovered, and the number of generations passed through in the year to be observed.

A further Note upon the Life-history of *Dinoderus minutus*, Fabr.

THE BAMBOO-BEETLE OR "SHOT-BORER."

(Plate XX, figs. 8, 8*a*, 8*b*, and Plate XXI.)

(*See No. 2, p. 172 of these Notes.*)

In a previous number of these notes allusion was made to the fact that this minute beetle had been so often confused with its close ally *D. pilifrons* that it was impossible to make any definite statements upon the subject of its life-history. Since writing hose words the writer has been able, during nearly a year's residence in Calcutta, to study with a certain degree of thoroughness the habits of this pest. Lengths of bamboo (Dendrocalamus strictus) cut in the forests of the United Provinces were kept under observation in specially constructed boxes between April and the middle of November, and the operations of the beetles with which they had become infested closely watched. The first interesting and important fact discovered was that the bamboo-boring beetle of Calcutta, or the chief one, was *Dinoderus minutus*. In no instance was *D. pilifrons* found in the bamboos. During my observations I examined thousands of the beetles, but *minutus* was the only one present. This would seem to point to the fact that whilst *pilifrons* attacks the bamboo in Upper India *minutus* takes its place in Calcutta—or, perhaps, it may be said in the hotter, damper parts of the country. A second most important fact is that in no instance have these two beetles been found working together, and the statements extant to this effect would seem to be the result of defective identification. In addition to the observations made upon the life-history and habits of this insect in Calcutta experiments were also conducted, with the object of ascertaining whether it was possible to protect bamboos by impregnating them with various substances. The results attained will be alluded to later on.

Description, Life-History.

Although the results of the work of the bamboo-beetle are well-known, the real author of the depredations is far from being a well-recognised enemy owing both to its small size and to its secretive habits. The damage is committed by a tiny beetle (Plate XX, fig. 8*b* shows a dorsal and side view of this beetle) and its grubs which are just of slightly smaller diameter than the holes with which the bamboos are seen to be riddled. The beetle, which has a black head and thorax and reddish-coloured, shining wing covers, bores its way into the bamboo and lays its eggs in the interior, each beetle laying about 20. From these eggs small, white, roundish dots of grubs (see fig. 8) issue within a few days of their being deposited. These tiny larvæ burrow up and down in the interior of the bamboo and reduce its structure to powder. About four weeks are spent in this stage, and the grubs then enlarge the ends of their burrows and change to pupæ (fig. 8*a*) which, after some eight days or so, turn into the beetles. On becoming mature the beetles bore their way out of the bamboos and thus add further to the tunnels already made in them. On emergence the insects fly off to attack fresh bamboos, or they may bore into the one in which they have themselves matured. There are thus three separate forms of attack :—

(*a*) The female beetle bores into the interior of the bamboo and lays its eggs there. This is the first attack on the bamboo.

(*b*) From the eggs hatch out little grubs which feed upon the wood of the interior of the bamboo, and thus undermine its strength.

(*c*) The beetles on maturing from the grubs bore their way out of the bamboo.

It used to be thought that each of the shot-borers made its way out by a separate tunnel, driven direct from the place where the grub had pupated to the outside. This is not, however, the case, as the matured beetles appear to issue either all from the same exit-hole or from one or two only, these being often the former entrance-holes of the mother beetles, which are considerably enlarged. Beetles of the new generation appear to also make use of these old holes to enter the bamboo to egg-lay, boring away from the old gallery when they have got inside. When bamboos are in lengths it will be found that the beetles tunnel in them parallel to the long axis and form galleries which open at one of the ends. The bamboo is thus often completely hollow in parts without there being much outward evidence of its having been badly attacked. This is more especially the case when the beetles have entered and left by the same holes made at one of the ends of the bamboo (*cf.* the lengths of bamboo shown in Plate XXI). A feature which greatly adds to the insect's power of doing serious damage is to be found in the fact that in the warmer parts of the country it passes through at least five, and perhaps more, generations or life-cycles in the year. It has been shown that the insect lays about 20 eggs, and therefore one female beetle may produce the following progeny in the year, on the supposition that only five generations are passed through :—

1 Female beetle.

1st generation .	1 × 20 =	20	beetles, say, ½ males and ½ females (the latter are, however, usually in excess of former).
2nd " .	10 × 20 =	200	beetles, sny, ½ males and ½ females.
3rd " .	100 × 20 =	2,000	Ditto.
4th " .	1,000 × 20 =	20,000	Ditto.
5th " .	10,000 × 20 =	200,000	Ditto.

If there is a 6th generation the number of females increases to 2,000,000.

Taking only 50 per cent. of the 5th generation beetles as maturing and laying eggs, we still have 1,000,000 insects as the progeny of the one mother beetle in the spring. This great prolificness easily explains why bamboos suffer so greatly from the shot-borer's attacks throughout the country.

The result of my observations in Calcutta showed me that at least five generations of the beetles issued between the last week in April and the end of October as follows :—

The 1st taking about seven weeks, from end of April to the third week in June, to run through all its stages :

the 2nd about 4-5 weeks, from the third week in June to near the end of July; the 3rd 4 weeks, from the end of July to the beginning of September; the 4th less than 4 weeks, from 1st week in September to end of the month; the 5th from end of September to end of October. It is probable that many of the beetles of this generation were caught and killed off by the cold snap experienced towards the end of the month.

Protection.

As detailed in a note published elsewhere * my experiments and observations were initiated in order to enable me to advise the Superintendent of the Government Telegraph Workshops as to how to protect a large number of bamboos which he was converting into field telegraph poles.

I may requote here from my previous note :—

Towards the end of April of this year Mr. Williams, the Superintendent of the Telegraph Workshops at Calcutta, informed me that bamboos which he was converting into field telegraph posts for use on frontier expeditions and elsewhere were being attacked and riddled by insects. The specimens he sent me I identified as the common bamboo-boring beetle (*D. minutus*). As the question of the preservation of bamboos against this insect had been engaging my attention for some time, I immediately paid a visit to the workshops and examined the bamboos. I found that they were being experimentally treated in the following manner before being fitted up as telegraph posts :—

(1) Five days' soaking in river water;
(2) five days' soaking in a solution of copper sulphate, after which they were dried in a covered shed for several days; and then
(3) soaked for 24 hours in common Rangoon oil.

This latter has the effect of darkening the bamboos and the smell of the oil remains in them for some considerable time,

* A Note on the Preservation of Bamboos from the attacks of the bamboo beetle or "Shot-borer." Appendix Series, Indian Forester Vol. XXIX, No. 12 (1903).

although not so offensively as to prevent their being made use of. The treatment lasted about 14 days, upon the expiration of which period the bamboos were at once sent to the workshops to be fitted. Mr. Williams had reported that within three weeks of this treatment some of the bamboos had been again attacked by the borers. As some 9,000 had been through the treatment, many of which had been already fitted, the case afforded a good opportunity for experiment. Having carefully examined all the bamboos and their method of treatment I was able, through the courtesy of the Superintendent, to obtain a number of specimens both untreated and in the various stages of treatment. With them it was my intention to initiate a series of experiments to determine the exact effect of any one or more of these preservative liquids as a deterrent to the attacks of the beetles. The bamboos had been cut in the Garhwal Forests (United Provinces) and were obtained by the Telegraph Department at Najibabad, near Bareilly, having been floated down from the forests. They were, following the usual custom, passed through fire and straightened by the merchants before being sold. The telegraph specification required them to be 8 feet long or over, with a diameter at the small end of not less than $\frac{7}{8}$ths inch and not more than $1\frac{1}{4}$th inch. It was known that the bamboos to be obtained were to be cut in the cold weather of 1902-03. Male bamboos (*i.e.*, solid bamboos) only were to be sent. The bamboos were despatched in convenient lots from Bareilly and no special protection was given to them on the journey down. They arrived in Calcutta mostly in February and March, but some in April. They were not subjected to any treatment before the end of February, and consequently some of the bamboos were in the works for nearly a month before being operated upon. The bamboos had therefore either become infested on the way down or in Calcutta itself. When the treatment they were to be subjected to had been decided upon, no time was lost in putting them through it. It was as the last of the bamboos were being put through the preservative treatment, that I visited the works. From previous observations I was of opinion that the beetles then appearing in the works were those of the 1st generation in the year, *i.e.*, they had developed from eggs laid probably at the end of February or beginning of March. I wished to try and find out—

(1) How many more generations of the beetle appeared in the year.

(2) Whether the oil treatment was of any use.

Experiments.

The bamboos picked to experiment with were good examples of their class of treatment, and on receipt they were placed in boxes constructed of tin foil and provided with close-fitting tops of wire gauze. The boxes were so made that there was no chance of anything inside getting out or anything from without getting in: and they answered admirably. The whole experiment was personally carried out by myself in order to ensure accuracy in the observations. In each box were placed specimens of differently treated bamboos. The experiments were commenced on the 29th April. The following are the results obtained:—

(1) That neither the five days in water nor that immersion followed by a further five days in $CuSo_4$ are of any use as a protection against the beetles. It is true that the first experiments seemed to prove that these soakings were effective, since the bamboos in these boxes had remained unattacked. attribute this, however, solely to the fact that the pieces of bamboos, selected at haphazard in the Telegraph Workshops and placed in the closed boxes in April, when the beetles were egg-laying, did not happen to have had eggs deposited in them and, consequently, when they were placed in the beetle-proof boxes and protected against the beetles they showed no attacks. All the subsequent experiments with these classes of treatment showed that they are no protection against the beetles.

(2) That the bamboos which had gone through all the stages of the treatment and had received a proper soaking in the oil tank remained unattacked and, in addition, were proof against further attacks by the beetles.

(4) That bamboos cut in the forests between December and February can, even if not treated till between two and three months after cutting (by which time it is probable that many of them will contain eggs) be preserved by the oil-treatment from further attacks of the April, June, July, September and October generations of beetles, each of which attacks means their subsequent riddling by the larvæ arising from the eggs laid by the beetles.

(5) That the oil-treatment, therefore, considerably prolongs the period of usefulness of the bamboo, this period being, as far as the experiments at present show, at least a year.

Plate XXI, 1-4, shows lengths of bamboos which had been put through the preservative treatment and converted into telegraph posts. It was subsequently shown that the reason why these lengths were attacked by the beetle was due to the fact that they were the top ones in the oil tank and had never received a thorough soaking in the oil. In fig. 1 the entrance holes blocked by ejected bamboo wood dust are clearly visible while 2-4 show the damage done to the internal structure of the bamboo by the borings of the beetle and its grubs. Fig. 5 shows a section of a larger bamboo opened out flat to show the attacks of the beetle and grubs. Fig. 6 shows a well-soaked bamboo which had been enclosed for several months in the special boxes made for the purpose, together with several lengths of attacked bamboos. It remained entirely unaffected.

Recommendations.

(*a*) I am inclined to recommend that the soaking for five days in water should be continued, since a thick shiny gelatinous substance exudes from the bamboos during this process, and this exudation probably enables the bamboo to absorb a larger quantity of oil than would be otherwise the case.

(*b*) That the soaking in the copper sulphate solution be discontinued, since the experiments have shown it to have no preservative effect against the beetles.

(*c*) That the bamboos be allowed to dry in a covered shed for several days after the water process.

(*d*) That, after drying, the bamboos be soaked for 48 hours in common Rangoon oil.

Cost.

The Superintendent of the Telegraph Workshops stated that the cost of the treatment as carried through by him, *i.e.*, five days in water, five days in $CuSo_4$ followed by several days drying and then two separate soakings (at an interval of a couple of months) of 24 hours each in Rangoon oil, amounts to R3-5 per 100 6-foot lengths, or 6·3 pies per length. This included the labour.

Omitting the $CuSo_4$ treatment and a second soaking in the oil, together with the additional handling involved, should effect a saving in this price, although of course the longer period of soaking in oil will enable the bamboos to absorb more of this substance than they would in the shorter one of 24 hours only.

Concluding Remarks.

In the note previously alluded to I was able to show that, as a result of the oil treatment, the bamboos which had been converted into field telegraph posts remained unattacked up to the third week in November (1903), *i.e.* up to the cold weather, and that during this latter period the beetles hibernate for a couple of months at least. Bamboos are so largely used in India that the prolongation of their usefulness by even a year only would effect a considerable monetary saving. On my return from furlough I wrote, in October 1904, asking the Superintendent of the Telegraph Workshops how the bamboos had fared during the year. He replied that there was no evidence of their having been attacked. Now it is practically a certainty that, had the bamboos remained untreated in 1903, those which escaped serious attack during that year would have been reduced to powder by the end of 1904. Subsequently, at the end of March 1905, I was able to personally visit the workshops. I found that the bamboos treated in 1903 were still unattacked, and that another 30,000 were being put through the treatment and converted into telegraph posts. The treatment is now carried out on the recommendations made, *i.e.*, a first soaking in water and a subsequent one of 48 hours in the crude oil. I had already been told by Mr. Truniger, C.I.E., the officer in charge of the field telegraph with the Thibet Mission, that the bamboo field telegraph posts sent up to him (part of the batch of 9,000 converted in 1903) had remained unattacked by the beetle and had answered most satisfactorily, the oil exerting apparently no deleterious effects upon the structure. These posts were returned to store in Calcutta this year (1905), and a careful examination of them failed to show me any traces of beetle attacks: and not only this, but the bamboos appeared to have worn remarkably well. As a result of the experiments and observations made to date we may thus consider that the oil treatment prolongs the effective life of the bamboo by at least two and-a-half years.

C 2

APATE JESUITA, Fabr.

References :—Lesne. Ent. Soc. F. Vols. LXV, LXVI.
Bostrichus jesuita. Steb. Inj. Ins. Ind. For. p. 42.

Classification :—Order, COLEOPTERA. Family, Bostrichidæ.

Tree attacked.—Casuarina equisetifolia.

This insect has been reported as tunnelling into Casuarina in Nellore.

Beetle.—Black with parallel sides and a uniform breadth throughout of three-sixteenths inch, perhaps a little less anteriorly and a little more posteriorly. Body more than twice length of prothorax; latter rounded and pitted above; elytra with longitudinal ridges running down their dorsal surfaces with punctures between; elytra deflexed at their apices. Abdomen red beneath. Legs black, short. Antennæ with a club. Length $\frac{1}{16}$ths inch.

Life-History.

This beetle is a wood-borer and bores into the wood of the tree for egg-laying purposes.

It was reported as boring into the trees in June, and therefore the eggs of one of the generations of the year are laid in that month. Nothing further appears to be known about its life-history.

In all probability the beetle does not attack the tree until it is either felled or has from some cause become sickly. The damage is done to the timber, and if the insect is numerous and the wood is required for planks or beams, it would probably cause a considerable loss.

The length of time spent in the larval and pupal stages and the number of generations in the year have yet to be ascertained.

CARYOBORUS GONAGRA, Fabr.

Reference :—Fabr. Ent. Syst. Suppl. 159 ; Steb. Injur. Insects Ind. For. 49.

Classification :—Order, COLEOPTERA. Family, Bruchidæ.

Tree attacked :—(*Bauhinia racemosa.*)

Description.

Larva.—The larva is a small whitish curved grub.

The *beetle* is greyish or yellowish-brown. It is somewhat elongate, with a small head consisting chiefly of two large prominent eyes ; antennæ brown. Thorax triangular, narrower in front than behind, hind margin produced backwards into a point medianly. Elytra wider than thorax, with parallel sides, constricted behind, the apices separately rounded ; surfaces striate with longitudinal rows of fine pits down them and covered with short hair. The elytra rest flat upon the large thick body, which is greyish in colour. The most striking characteristics about the insect are the largely developed prominent thighs (femora) of the hind legs ; these, as is the case with all the legs, are covered with the fine hair. Abdomen truncate behind. Length ♂ $\frac{1}{8}$th ; ♀ $\frac{1}{4}$th inch.

Life-History.

The beetles emerge from the Bauhinia pods at the end of February and beginning of March. The exact position where the eggs are laid has not yet been reported, but it is probable that they are laid on the flowers or young forming pods since the tree flowers between March and June. The larva on hatching out burrows into the pod and lives in one of the seeds, the interior of which it entirely cleans out leaving intact only the external thin brown skin. When full-fed it changes to the pupal state within this brown seed-skin, and this stage would appear to be a short one as larvæ are found in the seeds at the beginning of January. On maturing the beetle bores through the skin and the pod-covering and escapes. This exit hole is usually made near the base of the seed-skin and near one edge of the pod-covering. I have never yet found more than one of these beetles in any one pod, although there are always several other holes in the pod, the work of other beetles, one of which may perhaps be the male insect. The beetles do not all mature and issue at once, as from pods kept in Calcutta adults issued during the latter portion of February, all through March and April, and on into May.

Locality from where reported.

This insect was reported from the Central Thana district by Mr. G. M. Ryan.

Relations to the Forest.

This insect belongs to a family of seed-eating beetles and it is probable that a certain proportion of the seed of the Bauhinia is lost every year from its attacks. The more serious aspect of the case is that these beetles at times multiply to such an extent that they kill off the whole of the seed of the year. The beetle does not confine its attacks to the *Bauhinia,* as it has already been reported as infesting the Indian Laburnum (Cassia Fistula) seed. It is not unlikely that it will be found to attack the seed of other trees, as it appears to be rather wide-spread. I was able to identify the insect at the British Museum with the valuable assistance of Mr. Gahan. Two other smaller beetles, *Tribolium castalium* and *T. confusus* are found in the *Bauhinia* seeds, these being predaceous upon the *Caryoborus.* A microlepidopterous grub is also present.

Points in the life-history requiring further observation.

1. Where the eggs are laid. Is it in the flowers or on the young forming fruits?
2. Length of time spent in the egg stage.
3. Length of time passed in the larval and pupal stages.
4. Length of time spent in the beetle stage.
5. In which stage the winter is passed through.

CARYOBORUS sp.

Plate XXII, figs. 2, 2*a*.

Reference :—Provisionally determined as Caryoborus sp.

Classification :—Order, COLEOPTERA. Family, Bruchidæ.

Tree attacked :—*Albizzia Lebbek* (*Siris*).

Beetle.—Resembles the last in shape but is greyish in colour; the elytra leave the last two segments of the body disclosed. The antennæ are short, the thorax small and triangular and the elytra greyish with longitudinal darker markings. The insect is of stout, thick build. Plate XXII, fig. 2, shows a dorsal and side view of the beetle.

Life-History.

The larva of this beetle feeds upon and destroys the seeds of Albizzia Lebbek. These seeds are large, flat and squarish, and are contained in a pod of 9-12 inches in length. The grub completely hollows out the interior of the seed, leaving only the outer skin intact. When full-fed it pupates within the seed. Mr. G. M. Ryan, who forwarded specimens of this insect and the attacked pods, states that the damage done is very considerable. Fig. 2 *a* shows a seed with a mature beetle half-emerged from it.

The beetle issues from the pods, which persist on the tree for a long time, in the hot weather about March-April in the Bombay Presidency and evidently lays its eggs on or in the flowers or young-forming pods in April and perhaps on through May. Only one grub is found within each seed. The pods mature about October and the insect perhaps passes the cold weather season as a pupa within the hollowed-out seed.

The *Siris* tree is very common all over India and Burma, and it is therefore necessary to ascertain whether this insect attacks the seed in this way all over the country.

PLOCEDERUS OBESUS.

DAPORET.

Reference :—Daporet, Dig. Cat. 3 ed., 347. Stebbing, Injur. Ins. Ind. For. 68, Plate III, fig 3. a. b. c.

Classification :—Order, COLEOPTERA. Family, Cerambycidæ. Sub-Family, Lamiides.

Trees attacked :—Sal (*Shorea robusta*); Jhingham (*Odina Wodier*).

Description.

I add the following to supplement the description of the various stages of this insect given on pp. 68-69 of *Injurious Insects.*

Larva.—The larva when quite small is elongate, never curved, white in colour with soft yellowish head and mandibles and twelve segments of nearly equal size. As it increases in size the head becomes yellowish brown, the mandibles large, powerful and black, and the body-segments roundish, wrinkled and thick, the hind ones tapering slightly, the prothoracic one being the largest and hardest. Length 2½ to 3 inches.

The *pupa* is yellowish-white and has the shape of the mature beetle ; the elytra, however, are soft, white and curled down on to the breast, the antennæ are held pressed over the back and the legs are pressed against the sides. The eyes are large, prominent and black, the tips of the mandibles also black and the jointed palpi prominent. Length 1½ inch.

Cocoon.—The pupa lies free in a curious, calcareous whitish cocoon, which to some extent resembles a pigeon's egg. These cocoons are to be found lying at the ends of the larval tunnels in the wood of infested trees.

The *beetle* is chestnut-brown in colour above and lighter-coloured below, the legs and antennæ being of the same colour as the upper surface ; the head, upper and lower edges of thorax and outer and inner edges of elytra black. The head slopes forward at an angle, the eyes are kidney-shaped, the antennæ taking off from the inner angle of the eye; the first joint of the antennæ is large and swollen, the remainder long and swollen at the nodes, where they are black; they are longer than the total length of the insect in ♂, of the same length or slightly shorter in ♀. The thorax has a transverse ridge at upper and lower edges and the vertex is covered with small raised irregular transverse ridges; the outer edges are produced into a spine medianly. The elytra have a distinct shoulder to the upper outer angle, the tips being truncate and spined. In the ♀ the last segment of the body projects beyond the elytra. The legs have 4 jointed tarsi, the 3rd joint is deeply cleft in a heart-shaped manner, the 4th joint being inserted in the cleft near the upper end of the third. Length $1\frac{1}{4}$-$1\frac{1}{2}$ inch.

Life-History.

The following observations made in the Siwalik forests in the United Provinces practically complete the life-history of this insect for Upper India.

The beetles appear on the wing in March and soon after pair and lay eggs in the bark of either sickly or freshly felled trees. From these eggs small grubs hatch out in April and feed for a time in the bast layer, making winding galleries in the bark and sapwood. As the larvæ increase in size and their mandibles become stouter they bore down through the sapwood and spend the rest of this stage of their existence in the heart-wood of the tree. About August-September the larva is full-fed and changes into the pupal state within the curious calcareous cocoon peculiar to this insect (see *Injurious Insects*, p. 68 and Pl. III, fig. 3*c*). This takes place at various depths in the tree. If some of these cocoons are broken open at the end of November, the fully developed beetle will be found inside them, mature but not ready for flight as its outer covering is still soft. The pupal state is evidently a short one, but the beetle on maturing rests within the cocoon between December and March, whilst its outer parts are slowly hardening. If the insect is examined in December, it will be seen that the elytra are still quite soft, and that the legs and antennæ are by no means ready to perform their respective functions properly. The beetle can walk but only in a weak halting manner. It is probable that this habit of the beetle of maturing and resting for some months is the cause of the statement so often made that the insect appears *on the wing in November* and March in this part of India. It is improbable that the insect would appear when the sharp winter of the North-West has set in, although it can be easily obtained at this season. The writer has had numbers brought to him during the winter months Fuel choppers continually come across them, and it is probable that the beetles obtained in this way have given rise to the statement. From the above it will be evident that this insect takes a year to pass through all the various stages of its life-history from egg to mature beetle.

Relations to the Forest.

The damage done by this insect is more especially to the timber of the tree it attacks. Trees cut down in cold weather fellings will have eggs laid in their bark in March-April, and unless the wood is removed before the ensuing rains the larvæ hatching from the eggs will riddle it and render it useless for any save firewood purposes; the weight of fuel obtained from such trees is very considerably lessened owing to the large winding borings of the larvæ and the enlarged pupal cavity they eat out. The damage thus caused to the timber is of more importance than the damage done to the standing trees in the forest, though it must be remembered that the insect will oviposit in sickly standing trees, and thus injure them and even cause their death.

Since this beetle will oviposit in Sal trees, although it prefers Jhingham (*Odina Wodier*) in the Dun Forests, it is desirable that its life-history and capabilities of doing damage should be well understood.

Protection and Remedies.

Observation has shown that P. obesus is undoubtedly exceedingly plentiful in the country and attacks a variety of trees; it is therefore advisable, wherever possible, to see that practical protective measures against it are enforced. Feasible ones in the case of fellings made in compact blocks, either of high forest or coppice areas, are :—

(1) Bark all felled trees before April or during that month.

(2) Remove fuel stacks of unbarked wood and unbarked logs from the neighbourhood of the forests by the end of April.

If the above operations are strictly enforced, the danger of this beetle increasing in such numbers as to form a menace to the forest will be slight.

Points in the life-history requiring further observation.

Does the insect take less or more than one year to pass through the various stages of its life-history—

(1) At the upper limits of Sal (*Odina Wodier*), etc., growth at high elevations?

(2) In the hotter and damper parts of the country?

CASUARINA INSECT-PESTS OF MADRAS.

For some years past reports have been received from officers in charge of the Casuarina Plantations created along the Eastern sea-board of Madras that the trees, both in nurseries and in the plantations, suffered from the attacks of insect-pests. At first these reports appeared to be conflicting, since by some it was stated that the roots were the part of the tree affected, whilst others described attacks to the bark and wood of the stems and branches. From the various grubs sent me on several occasions it soon became apparent that several different kinds of insects were responsible for the damage done, those most often sent being the caterpillar of a moth and the grubs of two different families of beetles. In spite of several attempts it was not, however, until recently that perfect insects were procured, thus enabling the pests to be identified.

The insect which would appear to be at present the best known and to cause the greatest damage is the caterpillar of one of the wood-boring families of moths, the insect being a species of *Arbela* (see p. 438). This has been reported from Chatrapur, Godavari, Cuddalore, Nellore (South Arcot) and North Arcot.

Next in importance are some Longicorn beetle borers (*Stromatium sp.* and *Lamia* (?) *sp.*) (see pp. 374, 376) which are injurious in North Arcot, Godavari and Cuddalore.

Of some importance would appear to be the larvæ of the well-known rhinoceros beetle (*Oryctes rhinoceros*) (see p. 346), the date-palm borer, whilst a bostrichid beetle, *Apate jesuita* (p. 364), apparently riddles the wood in Nellore.

During a tour in the first-half of July (1903) I was able to pay my first visit to a Casuarina plantation. I inspected three plantations near Chatrapur, in Ganjam, and personally investigated, in company with Mr. C. E. C. Fischer, the attacks of the *Arbela* caterpillar. Two other insects were discovered to be doing damage to the tree. One, a Psychid caterpillar belonging to a species of *Clania* moth (p. 423) not previously reported, was very fairly plentiful and was defoliating the trees; the other, a Fulgorid, was collected upon the green branches where it was engaged in sucking up their sap. Two coccids were also present one a *Monophlebus,* the other an *Icerya.* These insects will be dealt with in this number of these notes, and will be found described under the several orders to which they belong.

STROMATIUM sp. prox. BARBATUM.

Reference:—Provisionally determined as Stromatium sp. prox. barbatum.

Classification:—Order, COLEOPTERA. Family, Cerambycidæ

Tree attacked:—Casuarina (*Casuarina equisetifolia*).

This is the beetle whose whitish grubs have been reported as committing, in company with the *Arbela*, serious damage to the Casuarina plantations in North Arcot.

Beetle.—♀. A somewhat elongate, narrow, lightly-built beetle of the usual longicorn shape, dark brown with a purplish tinge often merging into a lighter shade towards the tips of the elytra. Antennæ and legs yellow. Former not as long as body. No sculpture on thorax or elytra; both pitted and covered with a fine yellow pubescence. Abdomen yellow beneath. Length seven-eighths inch (varies—may be smaller.)

♂.—Smaller than ♀. Antennæ longer than body. Body narrower and slimmer than in ♀; elytra more lightly coloured on upper half. Length five-eighths inch.

Greatly resembles *Stromatium barbatum*, the Kulsi Teak borer. (*Vide* Injurious Insects, 75, fig. 48.)

Life-History.

Grubs of this insect have been found in the trees in December boring and feeding in the cambium layer and sapwood. In June beetles, said to be the adults of these larvæ, were obtained from the trees. We do not yet know how long these grubs spend feeding in the tree in this stage. It is, however, almost certainly the greater part of a year and may be longer. The pupal stage is probably short.

The damage is done by the grubs destroying the bast layer of the tree. When they are numerous the tree is practically ringed beneath the bark and dies.

Results of attack.

In December 1900 the Divisional Forest Officer, Mr. C. D. Thornton, reported that grubs, identified as longicorn ones "had nearly ruined the Casuarina trees in the Anunundi

Plantation.........The grub is found in the cambium layer, under the bark of old trees, on which it feeds."

At my request for more specimens the beetles here described were obtained and sent me in June (1903), by the District Forest Officer, North Arcot. At present we have no further information about this insect. This beetle has a strong resemblance to the Kulsi Teak Borer, *S. barbatum*, which riddles young teak in Assam.[1]

[1] *Vide* Author's Inj. Ins. Ind. For. pp. 73-76.

LAMIA (?) sp.

Reference :—Provisionally determined as Lamia (?) sp.

Classification :—Order, COLEOPTERA. Family, Cerambycidæ.

This is the beetle whose thick white grubs have been reported as boring into the wood of the roots of Casuarina trees at Cuddalore.

Larva.—A thick whitish-yellow grub with blackish brown head and black mouth parts (mandibles) followed by a largely developed segment which is slightly darker yellow than the following ones. These latter taper slightly to the tenth which is half the size of the prothoracic segment. Last two segments smaller ending in a blunt point. Length $1\frac{1}{16}$th inch. Breadth across the big segment behind the head (prothoracic segment) $\frac{5}{16}$th inch.

Beetle. — ♀. Black, moderately shining. Abdomen very dark red beneath. A short thick beetle with a vertical head. Prothorax sculptured and spined above and at sides, widest in middle. Joined on to the elytra (wing covers) by a short neck. Elytra wider than hind portion of prothorax, parallel to near apex where the outer edges turn inwards, the elytra thus terminating in a blunt point. Elytra entirely cover the base of body. They are corrugated and spined at their basal portions and pitted strongly for the rest of their length. First joint of antenna is swollen and well marked. Length thirteen-sixteenths inch.

Life-History.

We know little at present about the life-history of this insect. The grubs attack and live in the cambium layer and sapwood of the roots of the tree and are said never to be found in the stem. Grubs were found in this position on the 1st June, and one mature beetle was obtained from the Talaukoda Plantations near Cuddalore. There are no records as to the amount of damage this beetle commits. Since it lives in the cambium layer of the roots it is likely to prove a very serious pest when present in any numbers in a plantation.

Protection and remedies.

Until more is known about the life-histories of these two Cerambycid beetles, it is difficult to prescribe remedies against them. Badly infested trees should, however, be cut out whilst the insect is still in the grub stage and the bark stripped off so as to expose the cambium and sapwood of the tree to the sun. In this position the grubs and pupæ will soon be killed off and will never reach the beetle stage. This must be done whilst the insect is still in its larval stage. If left too late the beetles will begin to emerge and many will escape and lay eggs in adjacent trees.

The same applies to trees whose roots are attacked. The earth should be removed round the larger of these latter, since it is in these that the grubs will be found, and the bark be then stripped off.

Points in the life-histories requiring further observation.

1. Where the eggs are laid by the beetles.
2. When do the young larvæ hatch out?
3. Length of time spent by the larvæ feeding in the cambium layer and sapwood.
4. Length of time spent in the pupa stage.
5. When does the beetle emerge? Is it only towards the end of May and beginning of June, or do beetles appear at other periods in the year?
6. Does the *Lamia* grub also attack the stem of the tree?

Sandal-Wood-Boring Insects of Madras.

References have been made at various times to the damage done to the sandal-wood trees in Madras by wood-boring insects. In 1891, a considerable loss was experienced in Mysore owing to their depredations. As is well known, the wood of this tree is particularly valuable, and when it is mentioned that the least blemish (and the old gallery of a wood-boring insect is considered a very serious one) reduces its value from 1st class (R850 per ton) to 3rd (on R750) or 4th (R700) or lower, it will be readily understood that it is of the first importance to know something about the life-histories of these insects and what measures are feasible to counteract their attacks.

The insect which up to the present has been quoted as chiefly responsible for these attacks[1] is the caterpillar of the moth *Zeuzera coffeæ*, Neitner, a species which also infests the coffee. Careful observations on the ground have shown me that this belief is erroneous. Such species as have been sent to the Indian Museum for identification of the pest have been naturally small, and consisted probably entirely of branch-wood or small tops. These are the parts of the trees which the caterpillars of the *Zeuzera* prefer. It is, however, the heart-wood of the main stem and the large branches that is of commercial value, and this is attacked by quite a different class of borer. It is a beetle grub belonging to the family *Cerambycidæ*, which contains some of the largest wood-boring insect grubs known. I can find no account of these having ever been reported as damaging the wood, and yet they are undoubtedly the main cause of the loss experienced. One specimen of yet another class of borer, the sirex already described on p. 337, was found in the heart-wood of a tree. These borers were taken in the North Coimbatore forests.

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[1] Indian Museum Notes, Vol. III, 1, 1.

STROMATIUM ? sp.

Plate XXII, fig. 3.

Reference :—Order, COLEOPTERA. Family, Cerambycidæ.

As has been already mentioned the identification of insects in their larval or grub stage is by no means easy. I am of opinion, however, that the one found boring in sandal-wood stems may prove to be that of a species of *Stromatium*,* a genus belonging to the *Cerambycidæ* family of beetles. Throughout the sandal-wood areas of the North Coimbatore forests this insect was by far the most aggressive pest of the tree. I have as yet been unable to obtain any beetles of this sandal-wood-boring grub, of which the following is a description :—

Larva.—White with a pinkish tinge, thickish, tapering slightly behind. Elongate, consisting of a small head and 12 following segments. Mouth parts black. Thoracic segments (the 3 segments following the head) yellowish. Length 1 inch to 1½ inch. Plate XXII, fig. 4, shows this grub.

Life-History.

Grubs differing in size but from two-thirds to nearly full-grown were found in galleries in the stems of the trees in the first week of August. No small larvæ were found. From their total size and the length of the galleries bored, and from the fact that no young larvæ were found in the stems examined, I should think it improbable that they spend over a year in this stage and the period may be a few months only. Neither the pupal nor beetle stages of the pest have been yet found.

Method of attack.—The larvæ are to be found either in the main stem or the small branches. An examination of these latter shows that the grub has often started in the branch and then bored down it to the main stem and then down the latter. This is not invariably the case, as at times the larval gallery is entirely confined to the main stem. From this it is evident that the eggs are laid by the beetle on the bark of

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* *Vide* Injurious Insects of Indian Forests, pp. 73-76, figs. 47, 48, 49.

either a branch somewhere close to the main stem or on the main stem itself. These observations are the result of an examination of a number of trees and saplings, some of which were entirely cut up for inspection purposes. The tunnel is tightly packed with the digested wood particles which are passed out by the larva as it proceeds down the stem. These galleries are chiefly confined to the heart-wood of the tree, both in the branch and main stem, and the grub always bores downwards.

Before changing to the pupal state the larva enlarges the gallery slightly, and fills the extreme end with particles of wood refuse and chips. It then turns round in the free space and changes into a pupa. The beetle on maturing bores its way out of the tree by a horizontal hole driven direct through the heart-wood, sapwood and bark to the outside. The position of this exit gallery with reference to the larval gallery inside makes it evident that the larva turns round in the pupating chamber before changing to the resting stage. Whilst boring its gallery the larva may eat out one or two offset galleries to the outside. These are always at right angles to the main gallery and are for aëration purposes only. When the larval gallery is confined to the main stem there will usually be only one of these. If the gallery has started in a branch there will often be two. The insect would appear to confine itself to saplings and young poles.

Between Dhimbun and Kollegal a number of trees and saplings were found to be attacked. The following is a description of a badly infested one which, together with others, was entirely cut up. It is quoted as indicative of what this borer is capable.

The tree had a diameter of 2 ½ inches at the base and a bole of 15 feet to the point where the crown commenced. This bole had been attacked in several places, the last gallery running down to within 3 feet of the base of the tree. Both new and old galleries were visible upon splitting up the stem. These were as follows, beginning at the lowest one :—

1st—New Gallery.—Contained a living grub just about to pupate in the heart of the stem. Gallery about 18 inches in length bored downwards and confined to the stem only. Gallery slightly winding.

2nd—Old Gallery.—The eggs were probably laid upon the bark of a side branch. The gallery commenced in this. The young larva on hatching out had bored straight to the heart of the branch and then bored down its centre till it reached the main stem, down the heart-wood of which it carried its tunnel. Length of gallery in main stem 7 inches. The larva had pupated at the end of the gallery, the extreme end of it being packed with wood chips. The rest of the gallery, with the exception of the pupal chamber, was blocked with a dark red hard mass (the heart-wood is reddish) consisting of chewed wood. A large hole starting at one side near the upper end of the pupal chamber was bored horizontally through the wood to the outside. This exit-hole was very visible on the outside of the stem.

3rd—Old Gallery.—This one also commenced in a side branch, the larva working down the branch into the main stem and then down the centre of this latter, finishing up close to where No. 2 joined the main stem. It did not join this latter. Length about 1 foot. An air-hole had been bored to outside. Exit-hole of beetle bored in the same way as in No. 2.

4th—A New Gallery.—Contained a living larva which was about to pupate. It had enlarged the end of its gallery for this purpose. About 3 inches of the gallery was free of the compressed wood excreta. Length of gallery $11\frac{1}{2}$ inches. Was confined to centre of the stem and contained one air-hole bored to outside about half-way down. In this case the egg must have been laid by the mother beetle either on the outside of the bark in a crevice or in the softer layer of tissue below.

5th—Old Gallery.—This gallery started at the point where the main stem branched into two or three forks, *i.e.*, where the crown commenced. It began about $1\frac{1}{2}$ inch up one of the forks and then came down the main stem, its total length being from 15 to 16 inches. One air-hole present. This gallery ended near where No. 4 commenced.

6th—New Gallery.—A tunnel containing a living larva which ran down one of the forks and ended very near where No. 5 joined the main stem. The grub inside was not more than $\frac{1}{2}$-$\frac{2}{3}$rds grown, and the gallery appeared to be still in course of construction. It was apparently on its way to the main stem.

From the above we see that there were no less than five tunnels in the main stem (two of which contained living grubs) and one unfinished one in a fork of the crown near where it joined the bole. The tree was alive but badly stag-headed. It was growing near Osahatti, in the sandal-wood coupe No. 7.

Results of Attack.—Only living trees are attacked by this pest, and it would appear to confine itself to saplings and young poles. The sandal is not necessarily killed by the action of the boring grubs; in fact, unless these latter are numerous the tree is probably but little inconvenienced and the cambium layer soon covers over the old air and exit-holes made by the pest. In such cases there is no evidence externally that the tree has been attacked. When it is felled and converted, however, the heart-wood is found to contain the old galleries, made by the boring grubs which infested the tree when young, and the value of the wood is thereby greatly lessened, no matter how fine in quality it may be. At other times, however, the tree shows externally plenty of evidence of old attacks. The air-holes and exit-holes are plainly visible, and if the sandal is from any cause sickly and unable to cover these over they begin, under the action of the sun and rain, to "weather," become greatly enlarged and even at times coalesce. When the latter takes place the tree will be found to have its centre exposed on one side, perhaps for a distance of several feet, and a considerable amount of "heart" wood will have rotted away under the "weathering" action.

The plantation at Bailur was visited and inspected. The poor character of the growth here was due to other causes, but it was apparent that a number of the trees had been attacked some years previously by a cerambyx borer, not improbably the *Stromatium.* About 4,000 badly shaped or dying and dead trees had been cut out the year previous to my visit (1901) or it is not unlikely that the evidence of the pest's work would have been still greater.

Summarising the above we see that this pest may—

(1) Kill saplings (probably not often);

(2) Bore up the heart-wood of young living trees. That subsequently the vitality of these latter is sufficient to grow over the air and exit-holes, thus hiding all trace of the attacks which are only discovered when the wood is converted for sale.

(3) The exit and air-holes may "weather" to such an extent that they coalesce, and thus 50 per cent. or more of the heart-wood of the tree may be destroyed.

During a visit I paid to the Sandal Koti at Bangalore, I was able to inspect the damage done to the wood by these insects. Unfortunately I arrived a week too late to be present at the actual sorting of the year's outturn which was stored in the godown. Had I been present at this it would have enabled me to have inspected many hundreds of logs, and it would have been possible to form some conclusion as to the insects' abundance or otherwise in Mysore. I was shown the various classes of wood and the system of classification was described. Wood with holes and galleries in it, even though its quality may be otherwise absolutely 1st class, is relegated to the 3rd or 4th classes, and therefore it is quite possible to calculate the actual monetary loss occasioned by the work of this longicorn. My inspection showed it to be sufficiently high to render the full working out of its life-history a matter of the first importance.

NOTE.—In a tree with a diameter of 6 inches at the base I found another kind of longicorn larva which is not a *Stromatium*. The tree, a large one standing in the Odayarpalaiam compartment of the Doddasanpige Forest, had a dead 5 foot top. Below this in the green wood I cut out a longicorn grub, about 1¼ inch long, white but with much larger thoracic segments than has a Stromatium larva. A second one was found lower down in the bole. Nothing further has been ascertained about this grub. It would not appear to be so numerous as the *Stromatium*, as only three specimens of it were found. The heart-wood of this tree, a particularly fine one, was greatly reduced in value by the numerous old and new galleries it contained.

This longicorn may be identical with the well-known "white borer" of the South India Planters. This latter grub is the white larva of the cerambycid beetle *Xylotrechus quadripes*.* The grub is shown in Plate XXII, fig. 4.

Distribution.

This borer and the *Zeuzera coffeæ* (*vide* p. 435) exist in the sandal-wood areas of North Coimbatore. The Deputy Conservator of Forests at Bangalore, to whom I explained with diagrams the nature of the damage done, told me that he thought these two were also present throughout Mysore. He could not tell me anything about the sirex borer. From an examination of the sandal billets in the sandal Koti at Bangalore, I think that there can be little doubt that the Deputy Conservator is correct. I have at present no information as to whether these borers exist in Coorg.

Protection and Remedies.

The question of methods of protection against these internal boring pests is a difficult one, and the drastic one of cutting out and burning all infested trees is often the only one that can be recommended. The matter is rendered more difficult in this case owing to the scattered way in which the sandal grows.

We require to know a good deal more about the Stromatium's life-history and, firstly, the period at which it lays its eggs and how long they take to develop and hatch out the grubs. If the beetles all issue at approximately the same time and lay their eggs on the bark within a period of a fortnight or so, it would be quite possible to make an attempt to check the pest in localities where it is seen to be bad by scraping down the bark of the trees with a blunt instrument. This would get rid of the eggs and save the tree. I recognise that there would be difficulty in doing this owing to the fact that the sandal usually grows in the midst of thorny scrub bushes. In the case of severe attacks, however, it would be quite feasible and the value of the tree would justify the expense. It is, therefore, of great importance that the periods of emergence of the beetle and egg-laying should be ascertained. Trees infested are not so

* *Vide* Note in Injur., Ins. Ind. Forests, p. 80.

easily recognisable as in the case of the red borer, as the white one packs its tunnel with wood excreta as it progresses forward and does not eject this. It will be remembered, however, that it also bores air-holes to the outside, and these can be recognised in the same way as those of the red borer. Further we have seen that a tree infested in previous years is liable to be attacked again in a succeeding year. So it would be well to remove those in which air-holes and fresh exit-holes are present.

A study of the predaceous and parasitic insects which prey upon the larva should also prove most useful.

Points in the life-histories requiring further observation.

1. Exactly where and when the beetles emerge and egg-lay.
2. The period occupied in egg-laying. This period will coincide with that during which the beetles are to be found upon the wing.
3. The period passed in the egg stage.
4. The period spent by the grub boring in the wood. Is this less than a year?
5. Length of time passed in the pupal stage. Since I found grubs full-fed and about to pupate in the first half of August, one of two things may occur—
   (*a*) The pupal stage may be a short one, and the beetles may emerge in September or October and lay their eggs upon the bark at once, and the cold weather may be passed through in this stage—the larvæ hatching out in February or March, probably the former, or
   (*b*) The insect may remain in the pupal stage throughout the cold weather, or
   (*c*) The beetle may become fully developed before the cold weather, but remain in the pupal chamber throughout the cold weather emerging about February.
6. Length of time spent in the beetle stage.
7. What predaceous and parasitic animals prey upon this borer?

CALANDRA SCULPTURATA, Gyll.

Plate XXII, figs. 5, 5*a*, 5*b*, 5*c*.

Classification :—Order, **COLEOPTERA.** Family, **Curculionidæ.**

Tree attacked :—*Quercus incana.*

Description.

Larva.—A small, white, short, stunted, legless grub, almost as broad in the centre as long, with a small pale-brown head. Length $\frac{3}{16}$th inch.

Pupa.—White, of usual weevil type and about same length as larva.

Beetle—Has the regular weevil shape. On first emerging from the pupal state it is red in colour but soon changes to a dark red brown. The whole surface is covered with small punctures. The proboscis is curved and about $\frac{1}{16}$th inch long. The antennæ are elbowed and spring from near the base of proboscis. Thorax covered with punctures, irregularly scattered. The tibiæ of the legs are ribbed and bear a hooped spine, and the punctures are in longitudinal rows. The elytra do not quite cover the abdomen and have broadly rounded ends. They are ribbed and the punctures are arranged in longitudinal rows, about fourteen rows on each elytron. The elytra are about half the length of the body, Length $\frac{3}{16}$th inch exclusive of proboscis; proboscis slightly over $\frac{1}{16}$th inch. Plate XXII, figs. 5, 5*a*, 5*b*, 5*c*, show the larva, pupa and imago of this weevil, and also an attacked acorn.

*Life-History.**

This weevil first begins to emerge from the acorns about the middle of June and continues doing so until the end of the month. Mr. B. O. Coventry, who discovered it and studied its life-history, is of opinion that it probably immediately lays eggs in the young new acorns from the preceding year's flowers, which are present on the trees at the time of emergence of the

* This weevil was reported by Mr. B. O. Coventry, F.C.H., and the notes given here on its life-history are from observations made by him. See *Indian Forester*, Vol. XXVIII. No. 10.

insect, and that a second generation of the weevil appears in the autumn. This may prove to be the case, since the acorns ripen between August and October but remain on the tree through the ensuing winter. The pupal stage in the spring only lasts a few days.

The eggs are evidently laid on the acorns, the weevil not improbably drilling a hole into the fruit with its proboscis and placing them in it. As many as six or seven beetles have been obtained from one nut. The larvæ feed inside reducing the kernel to a powdery mass, no external opening being visible in the outer skin of the fruit. Mr. Coventry thus describes the pupation :—" On removing this shell or skin the pupæ are seen lying each in a separate compartment of its own. The kernel of the acorn, though reduced to a fine powdery condition, is still firm and fills the shell so that when this latter is removed the inside appears solid, with the pupæ lying in little compartments on its surface (see fig. 5*c*) With slight pressure, however, it falls to pieces, and it is seen that each compartment is really a small cradle-like cocoon covered above by the shell of the acorn." When ready to emerge a hole is bored through the shell to the outside—and this, presumably, by the first mature beetle since all the others issue by the same exit-hole. The acorns fall to the ground during the attack about the time the larvæ become full-fed. The beetle is said to be very lively, but feigns death when disturbed.

Locality from where reported.

Mr. Coventry found this weevil at, Mussoorie, in the North-West Himalayas, in June 1902.

Relations to the Forest.

This beetle is a most serious pest to the acorns of the *ban* oak (*Quercus incana*) in which it lays its eggs, the larvæ burrowing and feeding in and destroying the fruits. Mr. Coventry states that the insect is largely responsible for the absence of natural reproduction of this tree from seed in the Mussoorie Hills. He writes as follows on this subject :—" On 11th June 1902 I collected a large number of acorns of *Q. incana* at Mussoorie with the object of ascertaining what proportion of them was sound, as I could not account for the general absence of natural regeneration from seed of this species. The result of the investigation showed that about 80 per cent. were unsound. Some of the acorns were collected from trees and others from the ground, where they had quite recently fallen. The unsoundness of the acorns was found to be due to the attack of a weevil beetle."

Protection and Remedies.

The best protective measure to take for pests of this nature is to collect and burn, when at all feasible, the whole seed crop during a bad attack, as recommended on pages 160-161 of No. 2 of these notes in the case of the *Quercus semicarpifolia* attacked by the fly *Callirhytis semicarpifoliæ.* If this were done in patches of forest only it would have the effect of greatly diminishing the numbers of the weevils on those areas, and the next crop of acorns would thus be attacked by a very much smaller number of beetles. Children could be put on at small cost to do the collection work over certain areas, and this work should be begun as soon as the acorns begin to drop.

Points in the life-history requiring further observation.

1. Do the June beetles immediately lay eggs in the young acorns to be found on the oak trees at the time they mature and emerge?
2. If this is the case, is a second generation of the insect gone through by the autumn?
3. If mature beetles issue in the autumn, do they pass through the winter in this stage or do they at once lay eggs in the ripe acorns to be found on the trees at this period of the year? If eggs are laid, is the winter passed through in the egg stage or do grubs emerge and spend the winter feeding inside the acorns?
4. The length of time spent in the grub and beetle stages.
5. The number of generations in the year.

SPHÆROTRYPES SIWALIKENSIS, n. sp.

THE SAL-BARK-BORER.

Plate XXIII, figs. 1, 1*a*, 1*b*, 1*c*.

Classification :—Order, **COLEOPTERA**. Family, **Scolytidæ**. Sub-Family Hylesini.

Tree attacked :—(*Shorea robusta*) Sal.

Description.

Larva.—White curved, legless, thick, robust and much corrugated, with a small brownish yellow head; very convex dorsally, flat ventrally and elliptical in section (see fig. 1, *a*).

Pupa.—Almost spherical in shape, white, has the appearance of beetle but is soft, and legs and antennæ and wings are compressed against the sides and breast.

Beetle.—Elongate, globular, very convex above. Black, with often a reddish tinge on the thorax and basal portion of elytra. Head black, with black prominent eyes; antennæ yellow, angled, ending in a club; thorax with anterior margin half the width of the posterior, the margin produced forward into a lobe in the middle, with a transverse depression below it; sides rounded, posterior margin produced backward medianly into a sharp point, a fine raised longitudinal black line down centre, the rest of surface being covered with slightly raised irregular elevations. Elytra longitudinally striate with the intervals consisting of rows of prominent rounded serrate elevations, like blunt teeth; the elytra taper slightly towards apex, the basal margin being angularly convex and serrate; the basal fifth is often red in colour and much less deeply striate, and the elevations are less prominent than on the rest of surface. Under-surface black, the abdominal segments thickly clothed with longish yellow hair. Legs brown, tibiæ serrate on edge, tarsi lighter coloured. Length $\frac{1}{7}$th to $\frac{1}{9}$th inch. The black elevate line down prothorax, and the remarkably deeply striate and corrugate elytra serve to distinguish this insect, a dorsal and side view of which is shown in Pl. XXIII, figs. 1*a*, 1*b*.

Life-History.

This beetle makes its first appearance in the year about the middle of March in dry warm years, the beginning of April probably in cold wet ones. It is gregarious, flying to and attacking trees in swarms. The ♀ beetle, having paired with the male, bores horizontally through the bark till she reaches the cambium layer and then mines out a short gallery, which grooves both bast and wood, parallel to the long axis of the tree. In this she lays her eggs in little indentations made on either side all the way up. The larvæ on hatching out bore away from the mother gallery at angles which deviate more and more from the right angle the nearer they approach to the extremities of the tunnel (see fig. 1). On becoming full-fed the larva, whose gallery is eaten out in both bark and wood, enlarges the end of its tunnel into a kind of chamber and pupates in this. The beetles on maturing leave the pupal chamber and the tree by boring a straight horizontal tunnel through the bark. Length of egg gallery $= \frac{7}{8}$ to $1\frac{1}{2}$ inch. Length of larval tunnel is roughly about an inch. Number of eggs laid = 35-40. The plan of the egg and larval galleries is always constant and remains in the bark and sapwood of attacked trees, forming a record of the beetles' presence in the past in that forest. Fig. 1c, depicts the inner side of a piece of Sal bark showing the plan of one whole set of galleries complete and portions of two others.

The ♀ beetle remains alive for some time after egg-laying and keeps her entrance tunnel and egg-gallery completely free of all wood-dust and dirt. She finally dies in the entrance tunnel a little distance down from its mouth. The eggs laid by the March beetle are those of the first generation of the year. Larvæ hatch out within 3 to 4 days of the eggs being laid, and are full-fed about the end of April. The beetles mature some time during May, and either one or, more probably, two more generations are passed through between this and the third week in September. From this latter date up to the beginning of May I have a complete record of the beetles' life-history. The following are notes for 1901-02 :—

On September 22nd, 1901, larvæ in the tunnels were nearly full-grown, as evidenced by the length of the larval tunnels. The mother beetles were still alive in the egg-galleries or in the entrance tunnel in bark.

Pupæ also present and one or two mature beetles.

On October 4th beetles were issuing.

On October 26th larvæ present in galleries and mature beetles. These are those of the fourth (or fifth) generation.

About the middle of November mature beetles issued.

December 16th.—Tunnels contain only full-grown larvæ, pupæ and mature beetles. These were hibernating through the winter. The pupæ in severe winters would probably get killed off.

January 18th, 1902.—Larvæ and mature beetles found hibernating in galleries.

February 25th.—Mature beetles cut out from the bark of standing, living but stag-headed Sal trees. These beetles had issued from the trees in which they had matured some time in November and then bored a short way into the thick bark of neighbouring Sal trees, and were hibernating through the winter in this position.

March 15th.—Mature beetles taken on wing. The insects had begun egg-laying. The winter and spring of 1901-02 were exceptionally dry and were thus entirely favourable to insect-life.

April 16th.—Egg galleries of $\frac{3}{4}$ to 1 inch long with larval galleries of $1\text{-}1\frac{1}{4}$ inch long containing young larvæ. Dead beetles in entrance holes. In many instances these galleries had evidently been made by beetles which had hibernated in the bark, as although externally the entrance hole was seen to be old and the entrance burrow also for a short way in, its continuation down into the bast was fresh as also were the egg and larval-galleries. The larvæ in these galleries were, of course, those of the first generation of the year.

Locality from where reported.

The insect is fairly plentiful in the Sal forests of the Dun plateau, N.-W. India. Elevation 2,000-2,500 feet. It was discovered by the writer in September 1901.

Relations to the Forest.

Although the range of this beetle, as far as at present reported, is limited, it is probable that it will be found widely extended throughout the Sal forests of the submontane regions of the Himalayas from West to East, and research may show it to be present in the Sal tracts of other parts of the country. Its life-history, as at present observed, shows that it possesses the power of rapidly increasing in numbers owing to the practice of passing through several generations in the year. It requires fresh cambium to deposit its eggs in, and will necessarily go to green trees to find this if the supply of newly-felled or dying ones were, for any reason, to become diminished in the forest.

In order to enable me to study the life-history of the pest, whose traces were plentiful in dead bark and wood in the forests, the Divisional officer, Mr. Milward, had felled for me two large healthy living trees in August 1901. As the above record shows, by September 22nd they contained numbers of larvæ both in the bole and in the larger branches of the crown. By the time the bark was dry one of the trees was covered from top to bottom with the egg and larval-galleries of this Scolytid. The galleries were not quite so numerous on the other tree. Subsequently beetles were found attacking standing living stag-headed trees. Other trees were felled for me in the spring of the following year. Throughout my observations were greatly assisted by the Range officer.

Protection and Remedies.

All trees felled should be at once barked or, if they are left as trap trees with the bark on, they should be barked as soon as they are full of larvæ and before these have pupated and begun to issue as beetles. In leases given for the felling of Sal trees in coupes a clause should be inserted enforcing the barking of the trees as soon as felled.

In the Siwalik Sal areas there is a considerable sale of Sal posts (termed locally "tors"). These are cut during the cold weather months and should be all taken out of the forest by the end of March. Provided this proviso is strictly adhered to there will be little chance of these posts assisting in the multiplication of the beetle. The tors will not be attacked if stacked in the sun two or three miles or even less from the forest, as the beetle will not lay in rapidly drying bark which would not provide sustenance for the larvæ when they had hatched out from the eggs.

There can be little doubt that this beetle may prove a source of serious danger to coppice coupes if it once becomes numerous in adjacent areas of high forest undergoing improvement by the removal of all stag-headed and sickly trees. As the older areas became cleaner the issuing swarms of bark-borers would be forced to attack the green trees. It is more than probable that coppice areas would be chosen. The attack would be certain to begin in patches, the insect working outwards from a centre. If patches of trees in coppice or pole forest appear to be dying the bark should be carefully examined. If covered with small shot holes on the outside, especially beneath the projecting edges of flakes and in crevices, portions should be stripped off and examined on the inside. If, as will be the case when the beetle is numerous, the whole inner bark and sapwood are found to be riddled with galleries containing larvæ, pupæ or beetles, the whole patch affected should be cut out and the trees either barked at once and the bark burnt or, if the barking is not possible, the whole of the cut out material should be stacked and burnt. Trap trees should be left and watched.

Points in the life-history requiring further observation.

1. The exact length of time spent by the various stages of the insect in each generation. Is this about six weeks in the case of the summer generations?
2. The number of generations in the year. Are the following periods approximately correct:—

   1st generation.—Middle of March to middle or end of May?

2nd generation.—June to middle of July. ?
3rd generation.—Middle of July to end of August ?
4th generation.—September to middle of October ?
5th generation.—Middle of October to end of November ?

(This latter would probably be only a partial generation, the greater number of larvæ hibernating as such or as pupæ and only a few beetles maturing and hibernating in holes in the thick bark of other trees.)

3. Does the insect attack other trees besides the sal ?
4. Does the beetle attack the sal in the Central Provinces, Chota Nagpur, N. Madras (Ganjam), N.-E. Bengal (Eastern sub-montane Himalayan forests, Jalpaiguri, Buxar-Duars) and Assam ?

SPHÆROTRYPES COIMBATORENSIS, n. sp.

Plate XXIII, figs. 2, *2a*, *2b*.

Classification :—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Hylesini.

Tree attacked :—*Anogeissus latifolia*.

Description.

Larva.—When first hatched the larvæ are minute little white legless grubs, very convex dorsally and slightly so on their under surface. Pl. XXIII, fig. 2, shows a partially grown larva of this beetle.

Beetle.—Small, black, globular, constricted behind. Head black with a depression below forehead; antennæ yellow with an elongate club consisting of several divisions. Thorax narrower in front than behind, the greatest width ⅔rds down; anterior margin with a transverse prominent depression below it; posterior produced backwards medianly into an elongate point; surface covered with minute elevations and a few sparse short yellow bristles and a longitudinal median elevate line, often not very prominent. Elytra with basal margins convexly rounded and minutely serrate, constricted behind with apex angled; they leave uncovered the last segment of abdomen; broadly striate, the interstrial portions set with small sharp elevations, much smaller than in *P. siwalikensis;* the striæ and elevations less well defined on the basal edge of elytra, the striæ curved backwards to meet in apical margin. Under-surface slightly convex, black; abdominal segments set with short sparse whitish bristles. Legs black, tarsi yellowish. Length $\frac{1}{6}$-$\frac{1}{8}$th inch. The differently shaped and relatively larger (in proportion to the elytra) thorax and the distinctly different appearance of the striæ and elevations on the elytra serve to easily distinguish this insect from *P. siwalikensis*. Plate XXIII, figs. *2a, 2b,* show a dorsal and side view of this beetle.

Life-History.

This insect lays its eggs in the cambium layer of trees. To enter the tree a circular hole is bored through the bark and a short horizontal tunnel carried down to the cambium. This is made by one beetle only, whether by the female or male has yet to be observed. On reaching the bast a short gallery about $\frac{1}{4}$th inch long, with parallel sides, is grooved out and in this two beetles, a male and female, are always to be found: and this is probably the pairing chamber. After pairing the male leaves the chamber by the hole of entrance and the female commences boring her egg-gallery. This is straight and is merely a continuation of the pairing chamber, and is always parallel to the longitudinal axis of the tree. Small recesses are eaten out on either side close together all up this gallery, and an egg laid in each. The first eggs hatch out before the female has completed her gallery and egg-laying, so the egg stage is evidently a short one—lasting but a few days at most. The female blocks up each recess with saw-dust after laying an egg in it, perhaps to provide a first meal for the young newly-hatched larva. The egg-gallery is kept quite free of saw-dust. An examination of old galleries showed that the larvæ bore away from the egg-gallery in a radiating manner, the pattern formed by their collective galleries approaching an ellipse. When full-fed the larvæ enlarge the end of their galleries and pupate in these chambers. When mature the beetle bores its way straight out of the tree by a hole through the bark. The length of the egg-gallery is $\frac{5}{8}$th inch to 2 inches with a breadth of $\frac{1}{4}$th inch or less. Length of larval galleries $\frac{1}{3}$rd to $1\frac{1}{4}$th inch. Breadth $\frac{1}{8}$th at top and $\frac{1}{16}$th inch at base, where they take off from egg-gallery. The number of eggs laid by the beetle averages 24. The plan of the gallery is very like that of *P. siwalikensis* shown in fig. 1*c*.

I consider it probable that there are at least three generations of this beetle in the year—and perhaps four. Some green *Anogeissus* poles felled in April and left lying in the forest were examined on August 6th. They were found to have been attacked from top to bottom by this beetle since they had been felled. The insects had laid their eggs in the felled poles, the larvæ had hatched out, become full-fed, pupated, and emerged as beetles. All this was plainly decipherable, but the examination showed that, whilst the work was so recent as to have been evidently done during the year, it was not fresh enough to have been that of the beetles then swarming in the forest. The exit holes made by the beetles had had time to dry and shrivel round their edges, and the boring was no longer fresh and clean. I consider it probable that the poles had been attacked in April, soon after being felled, and eggs laid in them. The beetles maturing from these eggs probably issued some time in June and at once laid eggs in other trees, the poles in which they themselves had matured having become too dry to afford food of the nature required by the larvæ. These would be the eggs of the second generation, and beetles from them would appear in August. This theory was entirely supported by the writer finding beetles and larvæ in some newly-felled poles on the 6th of that month. The insects had settled upon these poles, which were unbarked, in a swarm and the bark was pitted with their entrance holes. Beneath they were to be found in various stages of egg-laying. In some cases but one beetle was present, having just bored down to the cambium layer. In others two were to be found in the chamber, whilst in others again the egg-gallery had been commenced, or in some cases partially completed, the eggs first laid (at the bottom end) having already hatched out. These beetles were evidently not those of the generation which had attacked the April poles, since they had obviously but just left the tree in which they had matured, and we have seen that the exit holes in the April poles had dried-up edges. I therefore conclude that they belonged to an intermediate generation, probably the second of the year, and were laying the eggs of a third.

The beetles evidently leave the trees together when mature and fly off in a swarm in search of trees in a suitable condition for egg-laying.

Locality from where reported.

This insect was discovered by the writer in the North Coimbatore Hill Forests in the Madras Presidency. Elevation about 1800 feet.

Relations to the Fores

As far as observations have been at present carried, it would appear that this beetle is capable of making itself felt as a serious pest in the forest. It has evidently the power of swarming in considerable numbers and requires fresh bark in which to lay its eggs. At present it has only been found in newly-felled poles ; but it is more than probable that it would attack young growing saplings, especially sickly ones, were the former not available. Poles inspected, which had been attacked by the insect and from which the beetles on maturing had left, were found to have their bast layer completely riddled by the pest, whilst the bark externally showed, in addition to the entrance holes, numerous elliptical rings of exit holes placed close to one another, as shown in fig. 1c. An examination showed me that this insect appears to be fairly free from parasites, as a close inspection failed to disclose any larval remains in the larval galleries and pupating chambers. In the cases where larvæ have been so attacked it is generally possible to find at least the skin of the head and perhaps a portion of the thorax and abdomen present in the pupal chamber or larval gallery. Further, the holes in the elliptical ring on the bark usually corresponded in number with the larval galleries on the inner side of the bark and in the sapwood.

Further observations are required on this point.

Previous to finding this insect the writer saw in the Coimbatore Forest Museum a portion of an *Anogeissus* post marked "attacked by insects." The post showed a series of plans of the old egg and larval galleries evidently caused by a Scolytid insect. They resemble closely the ones described here, and the post had probably been attacked in the forest by this beetle.

Protection and Remedies.

Newly-cut poles should be at once removed from the forest or barked. If neither is possible and a stream is close by they should be put into this for a couple of weeks. This will probably be sufficient to render the bark distasteful to the insects. in the case above described the trees had been cut for road-making purposes. Care should be taken to see that poles cut in excess of the requirements are not left unbarked in the forest, as was the case in this instance. The last part of April and first half of May, the last half of June and the first half of August are probably the flight times of the beetle, *i.e.*, the egg-laying periods, with perhaps the middle portion of September if there is a fourth, or portion of a fourth, generation.

In plantations, coppice areas, etc., all infested trees should be at once cut out and either barked, if this is possible, or burnt. The periods for treating the plantations would be the three weeks succeeding the completion of egg-laying in the different generations.

We do not yet know whether the insect attacks old trees.

Points in the life-history requiring further observation.

1. Further particulars regarding the April generation. The information about it has at present been collected from careful inspections of old attacked poles. It is fairly reliable, since there is no doubt about the time at which these poles were felled.
2. Is there a generation between the April one and the beetles found egg-laying in August? If so, the length of time spent in the various stages of egg, larva, pupa, and beetle by it.
3. The length of time spent in the various stages of the April and August generations.
4. Is there a fourth generation of the insect? If so, is it a complete one or do the larvæ hibernate as such in their galleries through the cold weather months?
5. Does the insect only attack young trees, or does it infest old ones as well? Will it attack healthy living trees if no suitable felled ones are available?

Parasitic and Predaceous Enemies of Sphærotrypes siwalikensis and S. coimbatorensis.

ICHNEUMON SP.

Plate XXIII, fig. 3.

Classification :—Order, HYMENOPTERA. Family, Ichneumonidæ.

Parasitic upon Sphærotrypes siwalikensis. (The Sal Barkborer).

Description.

Pupa.—Small slender, white, resembling to some extent the mature fly but with the antennæ, legs and wings closely pressed against the body.

Imago.—The fly is small, blackish in colour, with 2 pairs of membranous wings. The antennæ and legs are long and slender. The insect is shown in Plate XXIII, fig. 3.

Life-History.

This insect is parasitic upon the sal *Sphærotrypes*, and the dates of its autumn generation appear to coincide with those of its host, pupæ being found at the beginning of October and the imago emerging later on in the month. It is probable that this imago lays its eggs in or near the galleries containing the over wintering larvæ and that the ichneumon larva lives upon them, spending the winter as a grub. Or the winter may be passed through in the egg stage.

Locality, Relations to Forest, etc.

The insect was found in the Dun Sal areas of North-West India.

It is likely to prove, if at all abundant, a most useful insect in the forest, since it helps to keep down the numbers of the Scolytid.

The number of generations in the year and how and where each is passed through require further observation Do they coincide with those of its Scolytid host?

NIPONIUS ANDREWESI, Lewis.

Plate XXIII, figs. 4, 4a.

Reference :—Lewis, Ent. Mthly. Mag. 2nd ser., Vol. iv, p. 183 (1893).
Classification :— Order, COLEOPTERA. Family, Histeridæ.

Predaceous upon Sphærotrypes siwalikensis and S. coimbatorensis.

Description.

Larva.—Elongate pink or red with a yellowish head followed by 12 segments, the last constricted.

Beetle.—Somewhat elongate with stout mandibles; black, shining; the two exposed posterior segments of the abdomen are a deep red in colour, as are all the ventral portions of the segments and the legs. The head is rather densely punctate; the thorax about as broad as long with two large excavations, one on each side midway between the front and base, less densely punctured than head and punctures vary in size. The elytra are more evenly punctured than the thorax, the basal margin being slightly elevated, without dorsal striæ. Length 4½ millim. Plate XXIII figs. 4, 4*a*.

Life-History.

The life-history of this beetle and number of generations passed through in the year is likely to correspond to some extent to that of its hosts, the Sal and Anogeissus Scolytids.

In the Dun Sal areas pink larvæ of various sizes were present in the larval galleries of the Sal bark-borer on September 22nd, and were feeding upon the scolytid larvæ. On October 4th full-grown larvæ and white pupæ were present. Through November and on throughout the winter months pink larvæ were to be found in the galleries, and also pupæ encased in silk web coverings which I consider were those of the Niponius. These were usually in depressions eaten out in the bark. In February the hibernating places of the mature beetles were discovered. They bore into the thick bark of old trees and spend the winter here as is the habit of the Sal Scolytid. This is a most interesting discovery. In March larvæ of all sizes are present in the trees. It is possible that they do not confine themselves to the Sphærotrypes larvæ: but further observations are required on this point.

have no further observations on the life-history between April and September in the Dun areas.

In Madras, however, I found the mature beetle in the tunnels of the *Anogeissus* bark-borer in August. The scolytids were burrowing into some freshly cut poles (*vide* page 397) for egg-laying purposes, and the Niponius was present feeding upon the scolytid beetles.

In Bombay the beetle has been taken in Kanara, caught at light.

Localities from where reported.

This insect was first taken by Mr. T. R. D. Bell in Kanara, Bombay Presidency. It was subsequently found by the writer in the Dun Sal forests of Northern India and in the Talamalai Reserve in the North Coimbatore forests in Madras.

Relations to the Forest.

The life-history of this Niponius requires further study. It is likely to prove a most beneficial insect in the forest. Its distribution appears to be wide, as the above localities in which it has been taken show. It is not improbable that research will prove that it feeds upon other scolytid beetles in addition to the two species already discovered to form its food.

Points in the life-history requiring further observation.

1. Where the eggs are laid. Is it in the entrance tunnels of the bark-borers or in the egg-galleries?
2. The food of the larvæ. Do they feed upon the scolytid larvæ? I think this is practically certain.
3. The length of time passed in the egg, grub, pupa and beetle stages of this insect.
4. The number of generations passed through during the year. Does this correspond with the number passed through by its hosts? As larvæ of various sizes are to be found in the galleries they may feed upon other insects besides the host, and the generations passed through may therefore be more numerous.

CRYPHALUS INDICUS, n. sp.

THE SILVER FIR CRYPHALUS.

Plate XXII, fig. 6.

Classification:—Order, COLEOPTERA. Family, Scolytidæ; sub-Family, Tomicini.

Tree attacked:—*Abies webbiana* (The Silver Fir).

Description.

Egg.—White, oval, translucent.

Larva.—Small white, curved and legless, with a yellowish head and brown mandibles.

Beetle.—Cylindrical, black. Head hidden beneath thorax. Antennæ reddish-yellow, angled, the scape club-shaped, the funiculus 4-jointed, the first joint thick, others subequal, club oval, divided into four divisions by 3 transverse lines. Thorax not longer than broad, very convex, narrower in front than behind, the anterior three-fourths furnished with prominent acute tubercular projections set backwards, the basal portion, especially laterally, clothed with long yellow hairs. Elytra cylindrical, constricted and rounded posteriorly, very slightly wider than thorax; coarsely and irregularly rugulose and puctate and covered with a squamulose pubescence consisting of longitudinal rows of short silvery and reddish hairs. Legs reddish brown, pubescent; tibiæ curved and toothed on outer edge; with a yellow dense pubescence upon them; tarsi yellowish, first three joints equal. Length $\frac{3}{32}$ nd inch. Plate XXII, fig. 6, shows this beetle.

Life-History.

The flight time of the first generation of the year of this beetle is about the middle of May at elevations of 8,000 feet. In the fourth week of the month the writer discovered it attacking and laying eggs in green silver fir branches. Either masses of eggs or young larvæ were found in the egg-chambers, the beetles having evidently been some days at work. Infested branches contained numerous beetles and appeared to die upwards from the lowest part affected.

The beetle enters the branch by boring a horizontal gallery through the bark to the bast, preferably just at or below node though, if the nodes are already occupied, it will go in anywhere else. On reaching the bast the insect eats out in the bark and sapwood a shallow chamber in which the eggs are deposited amongst a mass of chewed wood-dust. These eggs are laid in little masses apparently stuck together on one or two sides of the chamber. In the case of Indian cryphalids it appears to be usual for the male insect to help the female in preparing this chamber; but I am not aware whether this is the case in this instance, as the attack was too far advanced when discovered. As soon as the eggs are laid the female appears to leave the chamber, going out by the hole at which she entered. The larvæ on hatching out feed upon the bast layer at the edges of the chamber, not boring definite tunnels away from it but just eating away the edges in an irregular manner.

From observations of the habits of other species it is not unlikely that there will be at least one more generation of this insect in the year, the beetles from the May larvæ probably appearing in July and ovipositing in fresh twigs and branches. This fact and the rest of the life-history of the beetle has, however, yet to be observed.

Locality from which reported.

This insect was found by the writer infesting living silver fir trees in the Jaunsar forests, North-West Himalayas. Elevation about 8,000 feet.

Relations to the Forest.

C. indicus has only been found as yet in green silver fir branches. It is probable that it always infests such. In several instances the beetles have been found killed in their entrance tunnels by an outflow of resin from the living branch. If the beetles are at all numerous the branch is often killed; and this may be the case when only a few insects infest it, since the feeding of the larvæ by continually enlarging the original egg-chamber often completely rings the branch, eating the cambium away all round. The needles on infested branches turn bright yellow and die, and thus the presence of the pest can be easily recognised at a distance. A closer examination will show on the branches small round holes surrounded by small circular rings of resin.

It is not yet known whether this insect infests the leading shoots and branches of young saplings.

Protection and Remedies.

In ornamental plantations remove all infested branches and burn them. This should be done in the early part of June.

If young growth is affected, all trees found attacked by the pest should be promptly cut out and burnt.

Points in the life-history requiring further observation.

1. Length of time spent in the larval and pupal stage of the first generation of the year.
2. If there is a second generation where are the eggs of it laid.
3. In which stage and where does the insect pass the winter?
4. Does this Cryphalus infest young growth?

XYLEBORUS sp. prox. PERFORANS, Wollaston.

Plate XXII, fig. 7.

Reference:—Provisionally identified as Xyleborus sp. very near, if not identical with, X. perforans, Wollaston. Xyleborus perforans. Stebbing, Injur. Insects Ind. Forests, p. 65.

Classification:—Order, COLEOPTERA. Family, Scolytidæ. sub-Family, Tomicini.

Tree attacked:—*Shorea robusta*, Gærtn. (Sal).

Description.

Beetle.—Elongate, cylindrical. Reddish. Head black, punctured with scattered projecting yellow spiny hairs; head entirely hidden by the hood-like thorax; antennæ yellowish, elbowed; funiculus 5-jointed, ending in a pyramidal club. Thorax much longer than broad, constricted and rounded in front, the hind margin almost truncate; the surface in the posterior half slightly longitudinally ridged medianly, where it is smooth and finely punctured; anteriorly set with small dense tuberculations and punctures, the tubercles merging into punctures on the sides posteriorly. Elytra cylindrical, rounded behind; finely striate with large rather scattered punctures and sparse spiny hairs; the elytra slope downwards posteriorly, the sloping portion set with sharp teeth and scattered, elongate, yellow, spiny hairs. Under-surface lightercoloured, punctate with sparse spiny yellow hairs. Legs reddishbrown; tibiæ straight, toothed on outer edges. Length $\frac{3}{32}$nd to $\frac{1}{8}$th inch. Plate XXII, fig. 8, shows this beetle.

Life-History.

This Scolytid is a dry wood-borer. It bores into the wood of the Sal tree and lays its eggs there. It usually appears to tunnel straight into the wood; but at times, after reaching a certain depth in the sap-wood the beetle turns and carries the gallery at right angles to its former direction. If the bark is still on the log this gallery may go at times through the bark in this manner instead of in the sapwood. It is carried for about a couple of inches, and then the beetle again changes the direction and bores down to the heart-wood. The insect does not appear to require fresh bark or wood for its operations, but at the same time it is not found in very dry wood. In the latter old galleries of previous years were discoverable, but no new ones or beetles. From this it would seem to be possible that these wood-borers—and the same has been noted in several other instances—confine their attacks to a certain condition of the wood during its seasoning process. When the wood has reached a certain degree of dryness they will no longer attack it. The beetles when discovered on the 24th April were egg-laying, these eggs being in all probability those of the first generation of the year. I have no further record at present of the other stages in the life-history nor as to how many generations of the pest are passed through in the year.

Locality from where reported.

This beetle was found by the writer in the Kalesar Sal Forest of the Simla Division, Punjab, towards the end of April 1902. This piece of forest is in the plains at the foot of the Hills on the west bank of the Jumna River.

Relations to the Forest.

This *Xyleborus* is another addition to the lengthening list of the Sal wood-borers. It was found in a wood depôt attacking logs which had been felled in the cold weather of 1900-01. Further observations are required on its life-history before it will be possible to estimate the damage it is capable of committing to stores of wood.

It has been noted above that the beetle is very near, and may be identical with, *X. perforans*, Wollaston. The discovery of this insect boring into Sal wood, a wood which is spread fairly widely throughout India, is therefore of some importance. This *Xyleborus* has acquired a world-wide reputation. It has been know for over 30 years as a destructive beer-cask borer in India and occasionally causes considerable loss by riddling the staves, thus causing a leakage of the beer[1]. About 1892 it

[1] *Vide* Injus. Ins. Ind. Forests, p. 65.

appeared in connection with another industry, that of the sugar-cane in the West Indies where, under the well-known name of the "shot-borer" it has committed serious havoc. In 1900 a *Xyleborus* was reported in this connection from Bengal, and it is considered to be either identical with, or closely allied to, *X. perforans.*

Whether an insect known to be a dry wood-borer will at the same time bore into and egg-lay in living plants is a point open to very considerable doubt, and a careful examination of all the specimens so reported would appear to be required to set the matter at rest. As the writer pointed out, however, in an article on sugar-cane pests written in 1900, and published in the *Indian Museum Notes*[1], if these should on further examination prove to be identical, it will greatly aid its increase should the dry wood it affects be lying in the neighbourhood after the removal of the green crop.

Points in the life-history requiring further observation.

1. Number of eggs laid and method of feeding of the larvæ in the Sal wood and length of time spent in the larval stage.
2. Length of time spent in the pupal stage.
3. When do the beetles arising from the eggs laid in April emerge?
4. Is there more than one generation in the year? If so, how many?
5. In which stage and where does the insect hibernate in the cold weather months?

[1] Insect pests of the sugar-cane in India.—*Indian Museum Notes*, Vol. V, No. 3.

CHRAMESUS ? sp.

Plate XXII, fig. 8.

Reference :—Provisionally determined as *Chramesus ?* sp.. new to the British Museum collection.

Classification :—Order, COLEOPTERA. Family, Scolytidæ.

Tree attacked :—*Quercus incana* (*Ban* oak.)

Description.

Beetle.—Small, globular, very convex above, flat beneath, widest across middle of its length. Head small, black, with a yellowish brush of hair in front; antennæ brown, angled, ending in an elongate club, having several transverse bands across it. Thorax black, pentangular in shape, anterior margin straight, slightly ridged, with a transverse depression behind the ridge; posterior margin produced backwards medianly into a point, the margin slightly elevate; surface covered with small irregular elevations. Elytra very convex, purplish or black in colour, the basal edges curving convexly inwards; striate, the basal end rough with close-set elevations, the interstrial spaces with series of fine raised points; the striæ curve inwards towards apex; surface of elytra covered with a yellowish bloom of short hair. Under-surface flat, black; five abdominal segments visible, clothed with spiny yellow hair thicker on sides than in middle. Legs black, tibiæ not toothed, tarsi brown. Length $\frac{1}{8}$th inch.

This beetle is figured in Plate XXII, fig. 8.

Life-History.

The flight time of this beetle is about the first week in May at elevations of 6,500 ft. or thereabouts. It bores into the wood of dying or newly dead oaks for egg-laying purposes. The insect bores straight through the bark and into the sapwood and then turns to one side or the other and carries its gallery right down into the heart-wood at an angle. I have not yet found any larvæ. It is probable that these May beetles were laying the eggs of the first generation of the year. At the beginning of July I was able to inspect a felled dead oak which had been attacked by the May beetles the preceding year. At the time of attack the tree was girdled but still alive. The July inspection failed to show any live beetles in the tree or any larvæ or pupæ, and I concluded the wood was then too dry for the insect. An inspection of old holes and tunnels showed that most of them contained a dead beetle at their mouths. From this I infer that the beetles after egg-laying and protecting the larvæ go back to the mouth of the tunnel and die there when the grubs pupate, thus effectually blocking it up against the entrance of predaceous insects. This insect probably belongs to the class of beetles known as "ambrosia" beetles, the larvæ feeding not on wood but on a kind of fungus growing in the walls of the beetle's tunnel.

Locality from where reported.

This beetle was discovered by the writer at Kathian in the Jaunsar Barwar Forests, N.-W. Himalayas.

Relations to the Forest, etc.

This insect is a wood-borer and is capable of drilling beautifully circular holes through hard oak timber. Beyond this and the fact that it flies about in swarms, when on the wing, which settle close together on *ban* oak trees and riddle the timber by closely placed galleries, little is known about its action in the forest.

Points in the life-history requiring further observation.

1. How the larvæ feed and length of time spent in this stage.
2. Length of time spent in the pupal and beetle stages.
3. Number of generations in the year.
4. Is the insect abundant ?

CROSSOTARSUS CONIFERÆ, n. sp.

Plate XXIV, fig. 1.

Classification:—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Platypini.

Tree attacked :—*Cedrus deodara*, Deodar.

Description.

Beetle.—Long, narrow. Head and prothorax black. Head shining, with a few large punctures on it dorsally. Antennæ brown with a dark brown club almost black on the upper edge. Thorax covered with close wavy transverse striations with a few punctures posteriorly; a median line in basal half. Elytra dark brown, deeply striate each ending on outside in a curved hook-like process and bearing long yellow hairs at their apices. Ventral surface shining; thorax and head light yellow brown with light yellow hairs at the sides and scattered over the surface. Five abdominal segments visible black in colour with yellow scattered hairs. Legs yellowish-brown; front coxæ large, middle ones round and smaller, hind ones large; all set with longish yellow hairs; 1st joint of posterior tarsus compressed and set with a single row of spiny hairs. Length 4·7 millim. See pt. XXIV, fig. 1.

Life-History.

The mature beetle is to be found boring into fresh deodar wood towards the end of June at elevations of about 7,000 feet. It bores down through the bark either straight or at an angle until it reaches the outer sapwood and then goes horizontally down into this for some distance, the tunnel curving towards its lower end where the eggs are laid. As yet it has only been found in fresh newly-felled deodar trees whose bark is still full of sap. In these the beetle burrows into the wood indiscriminately both at the thickest end of the tree (where the diameter was 3 feet across) and equally into the top and larger branches. The burrows made are cylindrical. I have not yet found the larvæ, and do not know whether the beetle frequents dry wood. The insect has the curious habit of moving up and down its tunnel, it being often found in the portion of the tunnel in the bark.

The insect belongs to the "ambrosia" bettles, *i.e.*, its grubs probably feed upon a fungus growth in the tunnel, made or induced and controlled by the parent, and this movement of the latter up and down the tunnel may be in connection with the development of this peculiar growth. Whilst in its boring the beetle's movements are active enough when outside, owing to its long weak tarsi, its walking powers are feeble.

Locality from where obtained.

This beetle was discovered by the writer in newly-felled deodar trees in the Tehri Garhwal forests of the North-West Himalayas.

Relations to the Forest.

This insect is a wood-borer. It has at present only been found attacking trees still having their bark on, this latter being quite fresh and full of sap. The insects riddle the wood by boring cylindrical holes down into it for egg-laying purposes.

We require to know more about its life-history before its exact importance in the forest can be stated. The insects would appear to have the power of swarming in considerable numbers.

Protection and Remedies.

Until further observations on its life-history are made, and the point settled as to whether it will attack unbarked wood, no definite proposals can be made under this head.

Points in the life-history requiring further observations.

1. Are the June beetles those of the first generation of the year, or do they lay the eggs of the first generation of the year, having themselves hibernated through the winter?
2. The number of eggs laid by the beetle.
3. Where and on what the larva feeds and length of time spent in this stage.
4. Length of time spent in the pupal stage.
5. The number of generations in the year.
6. Does the beetle only attack newly-felled unbarked trees, with the bark still on, or does it also infest dry barked wood?

CROSSOTARSUS PICEÆ, n. sp.

Plate XXIV, figs. 2, 2*a*.

Classification:—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Platypini.

Tree attacked :—*Picea Morinda,* Spruce.

Description.

Resembles last to some extent but differs in the thorax being shorter with no median line. In the female the head is large with a transverse median line and two longitudinal depressions behind it on vertex. The elytra are broad, slightly wider in front than behind terminating at apex in two processes which curve over to almost meet the centre portions of the apices. The abdomen is concave. In the male the head is smaller, the transverse line being absent; the elytra are narrower and parallel, the terminal hooks being shorter and only slightly curved inwards, and the body is not concave. Length 4·6 millim. Fig. 2 shows the female and fig. 3*a* the male of this beetle.

Life-History.

This insect bores into the wood of spruce. A number of dead insects were found in tunnels in the wood of a large dead girdled spruce, the tunnels having been bored above the girdle. I am at present unaware whether the insect bores into the wood whilst still fresh or only after it dies. This is all the information at present known about this beetle. The insect was taken in Tehri Garhwal, North-West Himalayas.

DIAPUS IMPRESSUS, Janson.

References :—Jan. Ind. Mus. Notes III. 1. 74. Stebbing. Injur. Ins. Ind. For. p. 62.

Classification :—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Platypini.

Tree attacked—*Quercus incana*, (*Ban* oak).

Description.

Larva.—White, legless, with a light orange-yellow head and black mandibles. It differs from a Scolytid larva in being almost straight instead of curved.

Beetle.—An elongate narrowish insect with long weak tarsi. Red-brown, shining, basal margin of the thorax and elytra brownish yellow, apical portion of the latter red-brown, legs and antennæ pale yellow; the knees brownish. Head vertical, a little broader than thorax, dull, sparsely punctured. Antennæ with the scape broadly pyriform. Thorax oblong, strongly emarginate at the sides before the middle, the basal margin bi-sinuous, a row of hirsute punctures close to the anterior margin, the base finely and closely punctured and with a slight median line. Elytra punctate-striate, the second stria from the suture and the outer marginal one broader and more strongly punctured, the first and second interstices from the suture strongly raised, the fourth slightly convex; the apex coarsely punctured, sub-truncate and unarmed in the male, in the female with five acute apical spines. Under-surface light orange-yellow between the second and third pair of legs, brown anteriorly to this, and dark-brown to black on abdominal segments which are very short. Abdomen densely pubescent at the apex in the male, in the female concave and rugulose. Anterior tibiæ crenulate on the outer side, the tarsi very slender and longer than the femora and tibiæ together. Posterior tibiæ triangular, the first joint of the tarsi rather longer than the tibiæ, broad, flattened, and ciliate, the remaining joint slender and together about half the length of the first.

Life-History.

Specimens of this beetle were taken as long ago as 1891 at Deoban, Jaunsar, where they were found boring into oak stumps. Nothing further has been heard of this beetle, nor does it appear to have been ever taken since.

DIAPUS sp. prox. IMPRESSUS.

Plate XXIV, figs. 3, *3a*.

Classification :—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Platypini.

Tree attacked :—*Quercus incana.*

Beetle.—This beetle resembles D. impressus but is much larger, being 5-5·4 millim. in length. The colour is darker red, the thorax being entirely of this colour as are the legs, with the exception of the tarsi which are lighter brown. The front of the head is only very finely pitted in the male but strongly punctured in the female. The thorax is strongly constricted at the sides behind the middle and has no median line. The apical margin of elytra is concave in male and in female truncate, with the outer edges produced into teeth curving inwards. The abdomen is concave behind in the female. Figs. 3, *3a* show the male and female of this insect.

Life-History.

This insect is to be found on the wing at the commencement of June at elevations of about 6,000 feet. At that period it tunnels into the wood of oak trees for egg-laying purposes. The beetle appears to choose trees the wood of which is nearly or quite dry, and bores down into the heart-wood through the thickest bark. Externally their presence can be recognised by the rings of sawdust surrounding the circular entrance hole. The tunnels are either quite straight or may be slightly curved : but, as far as present observations go, they do not appear to branch at all. Both beetles and larvæ were discovered at the bottom of the tunnels, no offset borings having been made to lay the eggs in. As in the case of the Deodar Crossotarsus the beetles appear to live for some time after laying their eggs, and are to be found moving up and down the tunnel the head pointing inwards. As in the case of this latter insect this Diapus is an ambrosia beetle. The sides of the tunnel throughout are discoloured by a fungus growth upon which the grubs were apparently feeding. The beetles appear to finally die near the entrance of the tunnels. The galleries are at times as much as 9-12 inches in length.

I have no further observations on the life-history of this insect at present, and do not know whether it has more than one generation in the year.

Locality from where reported.

This insect would appear to be fairly abundant in the oak forests of the Jaunsar Division, in the North-West Himalayas.

Relations to the Forest.

This *Diapus* is a wood-borer and, as far as is at present known, prefers wood which is nearly dry. It bores into felled and girdled trees and also into oak stumps, laying its eggs in the heart-wood. A curious point about the tunnel in the *ban* oaks is that a section always shows a little circular black line surrounding the hole and at a distance of about $\frac{1}{32}$nd inch from the opening. This goes right down through the wood forming, so to speak, a small black cylindrical rim surrounding the hole. This ring has probably some connection with the fungus growth induced by the beetles. A large tree which had been girdled some years before, but which was not dead in 1901, was felled in that year (in May). It was found badly riddled by the beetles in June 1902. They had bored in on all sides, as much in the upper side of the tree where the bark was exposed to strong sunlight as lower down the sides which were in shade.

Protection and Remedies.

Trees of which the timber is required should not be girdled and allowed to stand in the forest after death. Fallen logs and firewood stacks should be removed as soon as possible.

Points in the life-history requiring further observation.

1. Does this beetle attack freshly-felled timber or does it require dry or nearly dry wood?
2. The number of generations in the year. Do the June beetles lay the eggs of the first generation of the year (if more than one)?
3. Length of time spent by the larvæ in the tunnel.

4. Length of time spent in the pupal stage.
5. Length of time spent in the beetle stage. How long does the beetle live after egg-laying?
6. In which stage is the winter passed through? Do the beetles which were found in June hibernate as such through the winter?

DIAPUS TALURÆ, n. sp.

Plate XXIV, figs. 4, 4*a*, 4*b*.

Classification :—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family Platypini.

Tree attacked :—*Shorea Talura.*

Description.

Egg.—Very small, in shape like a hen's egg, translucent and colourless, shining. Length ·4 millim.

Larva.—Not full grown. White, legless, elongate and not curved. Length $\frac{1}{10}$th inch in largest specimens obtained. Fairly active.

Beetle.—Elongate, narrow, shining. Head and thorax dark chestnut-brown, almost black; basal margin, sides and apical portion of elytra chestnut-brown, rest pale yellow. Antennæ yellowish-brown, legs pale yellow. Head vertical, broader than thorax, shining and glabrous; eye vertical, pale silvery yellow. Antennæ set with long curved yellow hairs on scape and funiculus, scape subcylindrical, longer than funiculus. Thorax oblong with shallow depressions on anterior half, emarginate at sides before middle, basal margin bi-sinuous, finely pitted with a median line. Scutellum is large, triangular and separates the elytra at the base. Elytra smooth, finely punctate-striate, their apices produced into points in the female, concave in male. Last abdominal segment pubescent. The thighs of the middle pair of legs fit into sockets on the mesostermum. Length $\frac{1}{8}$th inch. Figs. 4, 4*a*, 4*b*, show the larva and male and female beetles.

Life-History.

This beetle is to be found on the wing at the beginning of August in Southern India and lays its eggs in wood at this period. On the 6th August beetles' eggs and newly hatched larvæ were discovered in the wood of *Shorea talura.* The beetles bore circular tunnels right down into the heart-wood of the *Shorea.* From the lower part of these tunnels small off-shoot galleries at right angles to the main one are cut out and the eggs laid in these. The main tunnel appears to be invariably bored right down into the heart-wood and, in the case of a felled tree, is bored vertically downwards through bark and sapwood. The larvæ are "ambrosia"-feeders feeding upon a kind of fungus growing on the walls of the parent beetle's tunnel.

Locality from where reported.

This insect was discovered in the North Coimbatore Forests of the Madras Presidency.

Relations to the Forest.

This beetle bores into comparatively fresh *Shorea talura* wood. The tree which it was found attacking had been felled in the preceding April for road repair work. Until more is known about its life-history its importance in the forest cannot be determined.

Protection and Remedies. Points in the life-history, etc.

These are much the same as already given for the Deodar Crossotarsus above. We require to know whether the insect infests dry timber and whether it exists in any abundance in the forest.

DIAPUS (?) HERITIERÆ, n. sp.

Plate XXIV, fig. 5.

Reference:—Provisionally named as *Diapus ? heritieræ.*

Classification:—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Platypini.

Tree attacked :—*Heritiera littoralis*, Sundri.

Description.

Beetle.—Elongate, narrow, shining. Head dark chestnut-brown or black ; thorax chestnut-brown ; elytra pale yellow, slightly tinged with chestnut on basal margin and merging into pale chestnut-brown in upper third, becoming chestnut-brown in apical fourth. Antennæ yellow, legs chestnut-brown. Head vertical, not broader than thorax, rugose, with scattered spiny yellow hairs on front. Thorax about a quarter as long again as wide, only slightly emarginate at sides below middle, anterior margin straight; glabrous, and finely punctate. Elytra striate-punctate ; 4 striæ prominent at base, the outer marginal one most prominent, the second from suture becoming less marked soon after leaving base, the first interstice from suture raised, the fourth strongly raised and convex, with scattered large punctures ; a depression between second and third striæ depressed at base; apex truncate, showing 8 well-defined ridges, the depressed portion in ♀ set with 5 teeth on side and 4 apical ones of which the outermost is prolonged and turned outwards ; ♂ unarmed ; the truncate portion and marginal edges of elytra set with yellow spiny hairs, denser apically. Under-surface brown, abdominal segments dark-brown to black, and are very short ; concave and rugulose in ♀. Anterior tibiæ toothed on outer edge. Length ♂ 4·7 millim., ♀ 3·9 millim. Fig. 5 shows the male of this insect.

Life-History.

This insect was first found by Ranger B. C. Sen Gupta, tunnelling into sundri (*Heritiera littoralis*) wood in June 1902. An examination of some pieces of attacked timber showed that the insect bored right down into the heart-wood, the gallery made by the beetle being quite straight. The following year the Ranger was able to make some further observations on its habits in the beginning of April. The following is a summary of his valuable investigations. He found two beetles of different sizes in the pieces of wood (probably ♂ and ♀). His study of the habits led him to conclude that the adults bore through the wood into the sapwood and lay their eggs. They probably do not go into the heart-wood at this stage as he found that in all the newly attacked wood the heart-wood was left untouched ; it was only after some period that the galleries were found in the heart-wood. Only a few eggs are laid in each tunnel ; the number, however, has not been observed. The larvæ did not appear to bore galleries in the wood but were to be found at the bottom of the parent's tunnel. This latter may branch (or curve ?) when it has been carried right down into the wood. The larvæ pupate at the ends of the galleries and the adults on maturing make fresh borings into the timber as long as it is sufficiently fresh for their purpose. The galleries are very small, (about $\frac{1}{13}$ inch in diameter) and the adult beetles continually move up and down the tunnels. This insect is another of the so called "ambrosia" beetles, and the reason for the non-discovery of larval tunnels is due to the fact that the larvæ probably live upon a fungus growth which develops on the walls of the tunnel of the parent beetle. Since the mature insect is found in April and again in June there are evidently two generations in the year and probably several. These beetles attack *sundri* wood as soon as it has been felled, and as long as it is fresh. They will not touch dry wood. Their old galleries can be seen in this latter, but no living beetles are ever found in them. They only attack the *sundri* in this locality. Other kinds of wood, green and half dry, are left untouched.

Locality from where reported.

This insect was found by Ranger B. C. Sen Gupta at Wazirpur, in the Backerganj District in Bengal. The wood in which the beetles were found was, however, brought in boats from the Sundarbans, the latter place probably being the true habitat of the insect.

Relations to the Forest.

This *Diapus* bores into the wood of both green and half dry sundri. It infests stacks of this wood in the Sundarbans, sometimes in large numbers, and at times, according to Ranger Gupta, completely riddles and spoils the timber. The presence of the bark on the wood is immaterial, since the insect will burrow down into unbarked timber with equal ease.

Although the beetles were found in the Backerganj District it was always in timber that had been brought from the Sundarbans forests, and the beetle is probably indigenous to these forests, from which all the sundri wood comes, and is carried about in the wood when it is exported. This export is always done in boats, the latter proceeding through the various mouths of the Hoogly river and their connecting network of canals to Calcutta, and the surrounding Eastern Bengal towns and villages.

Protection and Remedies. Points in the life-history, etc.

These are much the same as already given for the deodar Crossotarsus.

In these Eastern Bengal districts it would be quite feasible to keep the green wood under water for a few months, by which means it would escape the attacks of the beetles. As soon as it had lost its sap it would no longer be palatable to the *Diapus*.

CLANIA CRAMERI, Westwood.

The Casuarina Bag-Worm.

(*Vide* No. 1, p. 56.)

Classification: Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family, Psychidæ.

Tree attacked :—*Casuarina equisetifolia.*

This insect is to be found in the Casuarina plantations on the East Coast of Madras.

Egg.—The eggs are laid within the larval bag by the wingless ♀.

Larva.—Full-grown. The portion of the caterpillar seen outside the case when it is feeding or walking has a mottled appearance. It is shining, hairless, yellow to yellowish-white, with black spots and markings. Head large and prominent. Front legs black and yellow, long and stout. The front segments of the body are fairly large and thick, those behind (seen when the grub is taken out of the case) smaller. The case is formed of small pieces of the needle-like leaves of the Casuarina placed side-by-side, so as to form a cylindrical bag open at both ends. The head of the case is lined with a greyish thick silken bag which protrudes. It can be closed by the larva when the latter retires into the case. The case inside is lined with a shining layer of white silk.

Just after leaving the egg.—The little grub is very small and has no case. The head is black, shining, large. Mouth-parts brown, the segment immediately following black, with a white edging. The next two segments yellow with narrow black to brown transverse bands dorsally, the band being divided in the middle on the third segment. These three segments are each furnished with a pair of legs. Rest of segments orange-yellow and are held curved up over the back. All the abdominal legs are present, but are not functional and are never placed upon the ground, the minute caterpillar walking on the front ones, these being well developed and large even at this stage. The segments are covered with large scattered yellowish hairs. There is a patch of brown dorsally on the last segment. Length = $\frac{1}{16}$th inch. The first case is acquired about 20 hours after leaving the egg, and consists of a tiny conical roll formed of a fine flake of epidermis from a young shoot of the tree.

Pupa.—The pupa is reddish black anteriorly, the abdominal segments being a red brown and nine in number. The anterior portion of pupa is thickened, the body tapering to more or less of a point. The wing cases are short. A row of spiny protuberances run down the back of the pupa: by means of these it is enabled to pull itself forward and so escape from the bag-case of the larva. Length $\frac{9}{16}$ths inch.

Moth.—♂. Smallish, greyish brown with bipectinate antennæ in the male. Wings and body light brown Forewing with some of veins streaked with black. Hind wing greyer, the veins being streaked with brown. Thorax and abdomen covered with long hair, the under-surface of the latter being ashy in colour with a narrow central dirty-white band. Expanse of wings one inch.

♀.—The female never leaves the case. She is wingless and canary-yellow in colour, consisting of a simple sack-like body resembling a miniature Queen "white ant." Her body swells up after fertilization and shows five distinct segments. At the end of the anterior one is a small orange-coloured process resembling in shape a cock's comb with four divisions to the crest. Below this latter are two short brown processes thickened out and ridged at base. Beneath this, on the under-side, is a triangular-shaped black patch reaching down to the end of the first segment, the apex of the triangle being at the posterior end. The posterior segment ends in a bifurcated copulatory organ. There is no trace of wings or legs. Body tapers slightly to each end. Length $\frac{3}{4}$ths inch. Width across thickest part $\frac{3}{16}$ ths inch.

Life-History.

The writer noticed the larva of this insect defoliating Casuarina trees in Waltair at the beginning of July 1903.

On visiting the plantations at Chatrapur (Ganjam) the insect was found to be very fairly numerous. It escapes general notice, as all that is usually apparent to the observer is the greyish case hanging to the branches of the trees. This, as the caterpillar the case contains is not seen actively feeding, is not associated with any defoliation the trees may have undergone. Some of the larvæ found near the middle of the month were full grown, others had pupated, whilst one moth issued in the box they were kept in on the 13th. Others were bred out in the Indian Museum on the 18th, 25th; August 4th, 12th, 13th, 14th, 19th, 20th and 24th, respectively. The pupal stage would appear to last from 10 to 14 days, but further observations are required on this point. Female moths were obtained at the Museum through August.

Before pupating the caterpillar attaches its case to the branch or twig of the tree, and then closes up the silken bag-like mouth. It then turns round in the case so as to hang head downwards and becomes canary-yellow in colour, entirely losing its mottled appearance: its head and first segments also shrink greatly in size. When the male moth is ready to emerge, the pupa forces itself downwards through what was formerly the bottom or posterior part of the case until it projects about two-thirds of its length. The moth then bursts the upper end of the pupal case and emerges.

The female moth remains in the case and the male pairs with her in this position. A very large number of eggs are laid. From countings made of young larvæ which issued in the Museum I find the number of these latter issuing from eggs laid within the bag by one female to be between 550 and 600. The eggs hatch within a week of laying. The young larvæ on issuing from the egg are naked, *i.e.*, they have no bag. They are very active on leaving the old case and spread out over the tree, walking with great rapidity. In this defenceless state they must be very subject to attacks of all kinds of predaceous foes, and also be liable to be drowned during heavy rain storms. Within 20 hours they make their first covering or bag, this being formed of a small piece of the epidermis of the bark of a twig. This is added to as they grow large.

Larvæ a week old have a double coil of this epidermis forming their case. The first larvæ issued in the Museum cages on the 6th August: others on the 15th and 26th, these all being those of the second generation of the year.

The life-history of the larvæ which issued on the 20th August was watched up to the 19th November and the following notes made. By the 1st September a very large number had died off. The remaining ones were quite healthy: they had reached the stage at which they cut off the green needle-like leaves to use in enlarging their cases. The caterpillars had by now assumed their mottled appearance, though they were still only half inch in length. They, however, naturally varied greatly in size. The needles are cut off and placed longitudinally on the case side by side. The first of these larvæ pupated about the middle of October, and the cold weather is apparently passed in this stage.

The larva is a heavy feeder and eats the needle-like leaves of the Casuarina from top downwards to the base, or it may bite through the needle (leaf) half-way down, the upper portion falling to the ground, whilst it consumes the lower; it is a most wasteful feeder.

Results of attack.

This insect when numerous would be capable of entirely defoliating a plantation and, consequently, its life-history requires to be well understood. Unless the defoliation is very heavy, the insects' attacks will probably remain unnoticed; and since the larva is very quickly alarmed (when it immediately retires within its case), even if the defoliation is noticed, it would not ordinarily be placed to the credit of the apparently small dead bundles of sticks hanging from the branches. From the large number of eggs laid by the females which are more abundant than the males, as can be readily distinguished from the fact that their cases are larger, it is evident that in a dry, warm, favourable season the mortality amongst the young larvæ would be much less, and this would undoubtedly lead to very severe, if not total, defoliation in the plantations. It is not improbable that the death of trees attacked by the wood-boring *Arbela* caterpillar described on page 438 is accelerated by defoliation due to the larvæ of this *Psychid*, and it is of importance that its life-history should be fully worked out so that we may know how many generations it passes through in the year, *i.e.*, how many times in the year the trees run the danger of being defoliated.

Protection and Remedies.

Undoubtedly the best method of reducing the attacks of this pest is by the collection of the larval cases. Owing to the thin light foliage of the tree these cases, once they have been pointed out as the source of damage, are easily recognisable and very easily seen in the plantations. Their careful collection in years of serious infestation would well repay the expenditure incurred, and would practically stamp out the pest. The periods at which this collection should be undertaken depend upon the number of generations passed through in the year. For the June-July generations of larvæ the best time would appear to be the latter half of June, and for the October generation during December-January

Points in the life-history requiring further observation.

1. When the eggs of the first generation, *i.e.*, that producing the June-July caterpillars, are laid.
2. How long the eggs of the first generation take to hatch after they have been laid.
3. Time spent in the larval stage of the first generation.
4. The number of generations in the year. This is extremely important, as it is necessary to know how many times in the year the trees may be subject to this defoliation. Are there more than two?

DUOMITUS LEUCONOTUS, Walker.

Plate XXV, figs. *a-e*.

References:—Hampson, F. B. I. Moths, I, 308 No. 660; Stebbing, J. A. S B. LXXIII, Pt. II, 225 (1904).

Classification:—Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family Cossidæ.

Tree attacked:—*Cassia nodosa.*

Duomitus leuconotus is one of the wood-boring moths belonging to the family *Cossidæ*. Turning to Hampson's Moths, in Blanford's Fauna of British India, we find that but six genera of this family are at present known in India: *Cossus, Duomitus, Azygophleps, Eremocossus, Phragmatæcia* and *Zeuzera*. This paucity in the known genera of the family is carried into the described species of which a list of but twenty-five are known, the numbers per family being as follows: *Cossus* 6, *Duomitus* 6, *Azygophleps* 5, *Zeuzera* 5, *Phragmatæcia* 2 and *Eremocossus* 1. About the habits of the majority of these species little is known. It is probable that most, if not all, of the larvæ live and feed in the wood of trees, and some of them may spend several years in this manner before changing to pupæ. In most instances, however, neither the larvæ nor pupæ have yet been discovered and described. While, however, this is the rule in the family, there are two notable exceptions, in each of these cases the insects being of economic importance. *Duomitus niger*, an insect closely allied to the species we are considering in this paper, is the moth whose larva is known as the "Black-Borer" of Coffee-planters, and has proved a source of considerable loss on Coffee estates, whilst *Zeuzera coffeæ*, the moth whose larva is known as the Red-Borer (called by Hampson White-Borer),* commits great destruction in Southern India and is a pest well-known to Coffee-planters. The life-histories and habits of these two insects are more or less well known. Of the other representatives of the family in the

* The real "White Borer" is the larva of a Cerambyx beetle. *Vide* my "Note on the Sandal-wood-boring insects of Madras," published in the Appendix Series of the *Indian Forester*, Vol. XXIX, No. 7 (1903).

Indian Region we have, however, little on record save the descriptions of the moth, in some cases both the ♂ and ♀ of a species having been described, in others the description of the ♂ or the ♀ only being available. During the last few months (1903) I have had an opportunity here in Calcutta of working out a portion of the life-history of one of the other known species of Duomitus, that bearing the name of *D. leuconotus*, Walker, and my observations are recorded below.

Description. *

Neither larva nor pupa appear to have been previously described.

Larva (about half-grown).—General tint, a dark flesh-colour with brown head, yellow prothoracic segment edged in front with black, with a few black specks behind ; canary-yellow mesothorax and flesh-coloured metathorax. Following eight segments are flesh-coloured, lighter at junction of segments. Last segment is canary-yellow, becoming orange-yellow at extremity. The head is dark chestnut-brown anteriorly, shining, chitinous, ovate and large ; mouth parts black, antennæ short, 3-jointed, yellow-brown. Posteriorly the head shades off into pale-brown and yellow. It is followed by a large prothoracic shield which is hard and chitinous and shining, slightly convex. The chitin terminates at the sides, the under-surface of prothorax being canary-yellow in colour and soft. The large chitinous shield is ovate, anterior margin straight, posterior ovate-elliptical. At the posterior edge of the thoracic plate is an elliptical circle of small raised spikes or spade-like protuberances, doubtless used to shovel out of the way wood refuse and perhaps for scraping purposes. They are set backwards and are club-shaped. Behind these are a number of minute black spots placed in a crescent-shaped manner on the mesothorax, the angles pointing forwards. The mesothorax is much narrower and smaller and has a soft skin. The following segments are equal in size, about a third less in diameter than

* The description and life-history here given are abridged from a paper read by the Author before the Asiatic Society of Bengal and published in the Journal, Vol LXXIII, Pt. II, No. 2, p. 25, 1904.

the prothorax, and have a few scattered black tubercles on them, each bearing a thin white hair. The last segment tapers to a blunt point.

Mouth-parts pale-yellow beneath. Thorax beneath dark canary-yellow and rest of segments dark-yellow. Thoracic legs canary-yellow, pro-legs dark-yellow, flat and thick. Length $1\frac{1}{2}$ inch. Plate XXV, fig. *a*.

Pupa.—Sub-cylindrical, stout. Dark chestnut-brown to almost black. Black ventrally. Segmental bands orange, as also is front of thorax. Wing covers, eyes, antennæ and legs well marked on outer covering. Stigmata black, with a circular orange edging. Nine dorsal segments plainly visible, and 5 ventral ones.

Length 2 to $2\frac{1}{4}$ inches. Size very variable. See fig. 6.

The *moth* of which descriptions of both male and female are given by Hampson in the Fauna is a large, stout, striking-looking insect with a white thorax and greyish mottled wings (see figure in plate XXV). Hampson gives the wing expanse in the ♂ as varying from 98-128 millim., that of the ♀ being given as 180 millims. The specimens obtained by me this year show that there is a very much greater variation in size in both sexes. The following dimensions of 32 moths, all taken from the same tree, are, I think, well worthy of being placed upon record:—

Expanse of wings in ♂	Expanse of wings in ♀
80 millims.	116 millims.
110 ,,	88 ,,
108 ,,	88 ,,
90 ,,	77 ,,
83 ,,	100 ,,
78 ,,	100 ,,
90 ,,	115 ,,
95 ,,	98 ,,
82 ,,	84 ,,
73 ,,	96 ,,
70 ,,	108 ,,
85 ,,	125 ,,
74 ,,	80 ,,
99 ,,	120 ,,
72 ,,	80 ,,
70 ,,	85 ,,
♂—70 to 110 ,,	♀—77 to 125 ,,

The above figures show the very great variation in size to be found in both sexes.

Life-History.

The moths appear on the wing in the latter half of September, and are to be found during the remainder of that month and on up to about the third week in October. They are extremely sluggish during the daytime, but are powerful fliers at night. In the day they are to be found clinging to the bark of trees which their general colouration greatly resembles, thus serving to protect them from the attacks of enemies. The male lives but a few days and dies after pairing with the female. The latter lays her eggs, which are small, yellowish and deposited in irregular-shaped masses stuck together with some siccable material upon the bark of trees. She dies as soon as she has finished ovipositing. Examination of attacked trees has shown that these eggs are laid anywhere upon the woody parts of the tree, and that the young larvæ on hatching out bore straight through the bark to the sapw ood and feed in this for a time, subsequently going into the hard wood of the stem or branch. The mortality amongst the young larvæ must be very high, since it would be quite impossible for any one tree to support the large number of larvæ the eggs of a single moth give rise to, it being remembered that almost the whole of this stage is passed feeding in the wood. The larvæ almost certainly spends not less than two years feeding in the wood of the tree. The evidence for this assertion was found in the case of a tree which had practically been killed by the insects. Mature pupæ and moths were taken from this tree and also two half-grown (or less) larvæ. Since the moths only issue in September-October it is evident that these larvæ hatched from eggs laid at the very latest in the year before.

The larva bores in an irregular manner in the wood, the tunnel having apparently no regular or definite direction. The tunnel increases in diameter with the growth of the grub, finally measuring over half-an-inch across. It is packed with the wood sawdust and excreta of the larva. When full-grown the larva carries its tunnel to the outside, boring a hole through the bark, and this hole will be observable on the outside owing to the fresh sawdust to be seen just below it on the bark of the tree. Having thus prepared an exit, the caterpillar backs down its tunnel for a distance of 2-3 inches (this space being kept quite free of wood particles) and spins stout web-like series of strands of a coarse yellowish-brown silk across and below the mouth, thus effectually preventing any intruder entering the tunnel from outside getting near it. The larva then pupates. These strands of coarse brown silk are very characterstic of the pupation of this *Duomitus*. The pupal stage is probably a short one—at the most from six weeks to two months. Pupæ were found fully mature and also but newly changed from larvæ early in September, but they had all issued by the end of the third week in the following month. The hole bored to the outside by the larva is more or less vertical, only inclining to the horizontal just near the bark, so that the pupa, when the moth is ready to emerge, creeps up the tunnel and projects from it at an angle at right angles to the stem of the tree. In doing this the pupa bends over at an angle, the upper half being almost horizontal, whilst the lower portion remains in the almost perpendicular tunnel (see fig. *d*). The pupal skin then splits down at its anterior end, both dorsally and ventrally as far as the posterior edge of the last thoracic segments, and the moth crawls out. In the cleavage the head and antennal covering come away as one piece.

Distribution.

This insect was taken in Calcutta in 1903; Hampson gives the distribution as Simla, Sikhim, Calcutta, Ceylon.

Relations to Forest.

It has been seen that the larvæ live in the wood of living trees, and observations have shown that they will desert trees which have been cut down and the wood of which has consequently begun to dry. On the 22nd September of this year (1903) my attention was drawn to a small *Cassia nodosa* in the Indian Museum compound, which was evidently in a dying condition, the spring crop of leaves having all dropped and no new ones having replaced them. Examination showed that the tree was infested by the larvae of this moth, several holes with half-protruding empty pupal cases being perceivable. The tree was only 15 feet high with a girth of twenty inches at the base. It was much branched all the way up and had a whippy spreading crown. I had this tree cut down and placed in a large wire-gauze cage. In addition to two half (or less) grown larvæ and some live pupæ (taken to preserve in spirits) the following moths were obtained from the stem as they issued on the dates noted. [A portion of this stem, with the empty pupal cases *in situ* protruding from the bark, is now exhibited in the Insect Pest Gallery at the Indian Museum: the other half has been sent to the British Museum (*Vide* fig. *e*).]

Date of issue.			♂	♀
22nd September	1903	.	1	1
23rd ,,	,,	.	2	...
24th ,,	,,	.	...	3
25th ,,	,,	.	1	1
26th ,,	,,	.	2	...
27th ,,	,,	.	1	1
29th ,,	,,	.	4	...
30th ,,	,,	.	...	3
3rd October	,,	.	...	2
4th ,,	,,	.	2	1
8th ,,	,,	.	2	1
10th ,,	,,	.	1	2
16th ,,	,,	.	...	1
	TOTAL	.	16	16=32 moths.

In addition to these 32 moths there were two others which never acquired their proper wings, on issuing, probably due to the handling the chrysalids received. It is probable that at least 40 moths left this tree during September and October.

In addition to the small *Cassia nodosa* tree, which may be said to have been killed by this insect during 1903, a much larger tree, some 35 feet high and 3 feet in girth, has been attacked, more especially at its base, as evidenced by several empty pupal cases protruding from the bark surface.

Protection.

The moth was noticed in various parts of Calcutta during the above-mentioned weeks, and was evidently this year fairly abundant. We have yet to discover what other trees it infests in addition to the *Cassia nodosa* which Major Prain, who very kindly identified the tree for me, tells me was originally sent to the Museum from the Royal Botanic Gardens at Sibpur.

Points in the life-history requiring further observation.

1. Length of time spent in the larval stage.
2. Number of eggs laid by the female insect.
3. The different species of trees infested.

ZEUZERA COFFEÆ, Neitner.

THE RED BORER.

Reference:—Nietn. Edin. New Phil. Journ. XV, 1862, p. 36; C. & S. No. 1588; Moore, Lep. Ceyl. ii, pl. 143, figs. 1, 1a, b (larva) Steb. Injur. Ins. Ind. Forest, p. 104, fig. 168.
Zeuzera oblita, Swinh. Trans. Ent. Soc. 1890, p. 19
Zeuzera roricyanea, Wlk. Journ. Linn. Soc., vi, p. 177 (1862).

Classification:—Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family, Cossidæ.

Tree attacked:—*Santalum album.*—The Sandal.

This is the well-known red borer of the Madras Coffee districts and has always been supposed to be the chief sandal-wood-borer. I give the following description of the larva made from fresh living specimens:—

Large, stout, flesh-coloured to darkish red. Prothorax smaller and hood-like, yellowish with thin black blotches placed triangularly upon it. Mouth-parts black. Dorsal surface of last segment dark coloured. This segment is smaller than the others and tapers bluntly. Larva is lighter coloured below.

Life-History.

This has been already described in *Injurious Insects* (p. 104), and I need not recapitulate here. It may, however, be mentioned that the moths appear on the wing in February and the eggs are probably laid somewhere about this time.

Results of Attack.—The eggs are laid upon the bark of the branches or upon that of young saplings, and the boring caterpillar confines itself to these parts. It requires soft woody tissue for its food and does not bore into the hard heart-wood of older trees, as is the case with the *Stromatium* beetle (see p. 379 *supra*). It is a serious pest to young saplings, as these are either killed outright under its operations or are so weakened as to be thrown down by the wind. In boring the caterpillar hollows out a large portion of the interior of the branch and keeps the tunnel quite free from wood particles and excreta. Its work is thus unlike the longicorn borer. The difference between the work of the two grubs is most marked.

The red borer attacks and kills young saplings. If the trees get safely through this period of their life they will not be much harmed by it subsequently, as it will confine itself to attacking the branches only.

The white borer probably only kills the tree when present in numbers. It, however, invariably bores in the heart-wood, and thus spoils its quality and reduces its value.

In addition to the actual amount of injury these borers are capable of doing *per se* to the sandal, a further damage arises from the fact that the external holes form convenient methods of entrance to the interior of the tree for fungous spores and, consequently, serious fungoid attacks may follow the insect ones.

Distribution.

North Coimbatore Sandal-wood areas and, perhaps, throughout Mysore and Coorg.

Protection and Remedies.

In the case of the red borer undoubtedly the most effective check will be to cut out all infested saplings.

The operations of this caterpillar are easily recognisable from the outside owing to the fact that it keeps its burrow quite free of all wood particles, excrement, etc., and therefore small heaps of saw-dust like excrement are to be found at the foot of the tree and beneath the entrance-hole and air-holes. There will also usually be exudations of sap trickling down the bark from these holes. When these exudations are seen to be fresh and wet and when the saw-dust at the foot is fresh the borer will be found inside. Such infested trees need not be cut down at once as other moths may lay their eggs in them (it is often noticeable that for some reason or another a particular tree or trees are more favoured in this way). A careful watch must, however, be kept over them, and when the boring inside appears to have ceased the tree should be cut down chopped up and the borers or their pupæ killed. This should be done carefully. If a number of young plants are cut out for borers they should be stacked and burnt in one heap and not be cut up at all. Every part should, however, be thoroughly burned. This remedy should be vigorously put into force when bad attacks similar to that of 1891 in Mysore have to be coped with.

Points in the life-history requiring further observation.

1. The length of time spent in the larval stage. Is it under or over a year? I found some apparently nearly, if not quite, full-grown larvæ in the first week in August. These were brought to me as the sandal pest.
2. The period of emergence of the moth. Mr. Green has stated that in Ceylon the moth does not appear to issue at any one particular period of the year. A moth was bred out in the Indian Museum, Calcutta, on the 9th February.
3. What predaceous and parasitic insects prey upon this borer?

ARBELA TETRAONIS, Moore.

THE CASUARINA BARK-EATING CATERPILLAR.

Plate XXVI.

References :—Moore, P. Z. S. 1879, p. 411, pl. 34, fig. 3; C. & S. No. 1605, Hmpsn., Faun. Br. Ind. Moths, I, 315. No. 675.

Classification :—Order, LEPIDOPTERA. Sub-Order HETEROCERA. Family, Arbelidæ.

Tree attacked :—*Casuarina equisetifolia.* The Casuarina.

This is the insect whose caterpillar forms the well-known winding covered-way galleries on the outside of the bark of the stem and branches of Casuarina trees.

Larva.—Head black, with a few longish yellowish-white hairs on it. Following three segments, which each bears a pair of long legs, yellowish, this colour merging into pink on the third These three segments are swollen and larger than the head. The following segments are flesh-coloured except the last, which is yellowish. Five pairs of short sucker legs are present, one pair each on the sixth to ninth and a pair on the last segment. A few long scattered whitish hairs on each of the segments. These nine segments are narrower than the first three and taper off slightly behind, so that the twelfth segment has only about half the diameter of the fourth. Length one and-a-half inch. Width of thoracic segments $\frac{3}{16}$th inch. Plate XXVI, fig. *a*, shows the larva, side and dorsal view.

Pupa.—Yellowish-brown except in front, where it is very dark-brown to black. Shining, circular in section and of uniform thickness throughout, except for a slight swelling at the anterior (head) end which is furnished with two small spiny spikes. The wing covers are very short and reddish-brown. The last five abdominal segments have transverse circular rows of fine teeth on them, the first three segments bearing a double row on each placed close together, the last two having but a single encircling girdle situated near the centre of the segment. The last segment is blunt at the end and furnished with small knobs and spines. Length 1 inch; breadth $\frac{3}{16}$th inch. Fig. *b* shows two views of the pupa, fig. *c* an empty pupal case.

Moth.—♂. Forewings greyish, thickly irrorated with dull brown spots which tend to form transverse bands; three large velvety brown patches, one centrally, placed a little below costa, a second near the base of wing, and the third (the largest) a little beyond it. Hind wings grey, irrorated with a few ashy-coloured patches. Head and thorax covered with long silky-brown hairs. Body greyish. Expanse of wings = $1\frac{3}{4}$ inch. ♀ about twice the size of the ♂. Fig. *d* shows the ♂ moth.

Life-History.

The appearance of the moth on the wing is evidently variable. In the Godavari district moths have been reported as issuing during March, whereas in Ganjam a specimen was bred out by Mr. C. E. C. Fischer in 1903 as late as the 3rd July. In 1904 Mr. Fischer obtained moths between the 7th and 25th June. In Cuddalore, on the other hand, nearly mature pupæ were taken on the 1st June. From these data it appears that the moth is to be found on the wing between March and the beginning of July. I could find none at Chatrapur towards the middle of this latter month (in 1903) though numbers of the year's empty pupal cases were visible upon the trees. It is probable that the ♀ moths pair and lay eggs very soon after issuing, since the members of this family have no mouth and take no food in this stage of their existence. The eggs have not yet been found, but they are laid upon the bark of the boles and branches from a height of 2-3 feet upwards. In Chatrapur, which receives the South-West monsoon, the larvæ hatch out at the end of August and during September, but further south down the coast, where the rain comes in October or November, they may hatch out earlier. The present recorded months in which caterpillars have been obtained are from September to May in Chatrapur (with pupa in May-June and moths in June-July); December in North Arcot (with pupa in June); the same month in Godavari (with pupa and moth in March);

full-grown caterpillars and almost mature pupæ on the 1st June in Cuddalore, and what appear to be nearly mature caterpillars in June in Nellore.* In Chatrapur it has been ascertained that the larva passes eight months in this stage of its existence. It spends most of this time feeding upon the bark, which it eats off the tree in patches which are at times several inches wide. It does not move about the bark of the tree in the open but constructs for itself a kind of covered way, resembling a glorified termite (white ant) gallery, consisting of particles of its excrement bound together with a kind of close-woven felted silk. Externally the appearance is simply that of a mass of excrementous particles. These covered ways curl round and up or down the tree and are very conspicuous (*vide* fig. *e*), being about ⅓ to ½ inch in breadth and from 9 inches to as much as 18 inches in length. They are reddish brown to, in parts, black in colour and form raised galleries on the surface of the stem. Sometimes the gallery completely encircles the stem, the tree being then ringed; at others it is taken in a spiral manner up or down the tree. At times two or more covered ways join together, but they are more usually, except in very badly infested trees, separate. The bark beneath the gallery is always eaten, either only the upper green living tissues being consumed or the whole being removed down to the sapwood. Occasionally, as mentioned above, the bark is seen to be eaten off the tree in irregular-shaped patches on either side of the covered way. This may be done by the young larvæ living and feeding gregariously together before they construct covered ways for themselves, or the caterpillar may leave the covered way at night and eat off the bark in its vicinity.†
These galleries or covered ways have a more or less uniform width throughout their entire length, and from their appearance the larva would seem to add to them at the sides so that

* Larvæ have also been reported by Mr. H. A. Latham on Casuarina in South Canara in August.

† Mr. Fischer has since shown that from the very first the larva constructs a covered way made up of particles of its own excrement and bark joined with silk.

the internal chamber remains uniform in width throughout its length. When full fed the larva bores straight into the wood of the tree, generally retiring to the middle of its covered way before commencing to bore in. From the observations I have been able to make on attacked trees I have little doubt that the caterpillar only enters the wood to pupate, and does all its feeding upon the bark. The tunnel in the wood is always straight, and does not ramify as it would do if the grub were feeding in the wood.* There is generally a raised lump on the covered way, the result of the addition of the wood excrement thrown out, marking the place where the caterpillar has gone into the wood (*vide* fig. f). It enlarges the end of its gallery and changes to the pupal state. We do not yet know the time spent in this latter stage, but Mr. Fischer considers it to be from 3-4 weeks. In my description of the pupa I have shown that it is furnished with circular rows of spines; and by means of these, when the moth is ready to emerge, it wriggles and forces itself along the tunnel and pushes itself through the mass of excrement which forms the covered way, from which it remains protruding about a quarter of its length. After the moth has left the pupal case, the empty skin of the latter may

* In an article on the "Casuarina bark-eating caterpillar (*Arbela tetraonis*)," published amongst the Scientific Papers in the *Indian Forester*, XXXI, (1905) Mr. Fischer gives the following information upon this insect from observations published since the above was written:—"The earliest date upon which the larvæ were observed was 26th August. They feed on the bark, restricting themselves to the superficial layers when very young and gradually working in deeper as they grow . . . At an early stage the larva constructs at one extremity of the covered way a small chamber under the bark, preferring to locate it in the upper angle formed by the junction of a twig with the bole. Here the grub rests when not feeding. It emerges to feed upon the bark immediately surrounding the extremity of the 'run' which is built up further as the bark is eaten around it. It apparently feeds at night, as I have never found it by day outside the covered way, nor indeed anywhere but in the chamber described. The larva attains its full size in March or April, and then prepares the pupal chamber. Up to this stage it has penetrated the bark alone except when an existing hole has been used as a resting chamber. If such a suitable hole has been found this is probably merely trimmed, otherwise the larva . . . bores into the wood and excavates a pupal chamber about an inch in depth, and this it enters in May or June, pupating with its head towards the orifice which is concealed by the extremity of the covered way."

be seen projecting from the covered way. Therefore, when this latter is visible, it may be taken for granted that the insect which formed the particular covered way under inspection has left it.

Results of attack.

This insect appears to be fairly wide-spread throughout the Casuarina plantations, and it has been reported to commit considerable damage in some. Information is still far from complete, but damage is undoubtedly committed in Ganjam, North Arcot, Godavari, Cuddalore and Nellore.

In feeding upon the bark the insect in its younger stages only consumes the more tender and greener portions of the outer thin bark, but as it grows older it eats right down to the sapwood and even into it, either in a continuous ring or in small irregular patches. Thus the trees are often seen to have holes and pits through the bark reaching to the wood beneath. These "weather" and at times coalesce. In the plantations I visited I noticed that some trees were much more severely infested than others, and in these the action of the caterpillars had almost ringed the trees. There can be little doubt that when thus badly attacked the trees die. Both young and old trees are equally subject to attack and the larva feeds equally upon the thicker bark at the base of the tree and the thinner near the top. The covered ways are, perhaps, shorter in the lower portion of the tree.

Towards the end of 1900 the District Forest Officer of North Arcot reported that these caterpillars had nearly ruined the Anunundi Plantation. The plantation appears to be infested in patche. In the Agusti Nowgam Plantation near Chatrapur, in Ganjam, where the insect would seem to have only recently appeared (it being pointed out to the Divisional Officer by the Conservator in December 1902), the attack was confined to one patch of the area, the rest being entirely free. A private plantation, about a couple of miles away, was unattacked, whereas the Chatrapur Plantation, about 4 miles from the Agusti Nowgam one and a mile or so from the private one, was badly infested in parts. The attack doubtless spreads outwards from these infested areas and, in course of time, infects the whole plantation.*

Summing up, therefore, we see that the damage is done entirely by the caterpillar and that, as far as present observations have shown, this latter feeds entirely on the bark, only entering the wood of the tree to change to the chrysalis state.

* It has been already stated that the writer visited Chatrapur in July 1903. In his paper previously alluded to, Mr. Fischer tells the history of the progeny of the moths whose empty pupa cases were seen so plentifully in July. It is a most remarkable instance of a somewhat rare occurrence—the swarming in large numbers of one of the wood-boring, and usually far from common, species of moths. Considering the rareness of this Arbela in collections Mr. Fischer's observations are little short of wonderful. Stating that the larvæ from the eggs laid by the June-July moths commenced to issue at the end of August, he continued :—"It soon became very obvious that this fresh attack was far more intense than that of the previous year and had spread centrifugally from the site of the original attack !" The curative measures suggested by me that boys should be put on to search for the covered ways and take out the insects from them and kill them were at once put into force. Mr Fischer wrote, :—Almost from the beginning the impossibility of destroying all the larvæ became evident, as the flexibility of the topmost branches prevented their being climbed. The destruction was, however, persisted in for a time in the hopes of making a considerable impression on the invading hordes . . . . When, early in October, after the destruction of over 63,000 larvæ no appreciable diminution in numbers had been effected, the urgency for more drastic measures became apparent. Sanction was obtained to depart from the provisions of the working plan by abandoning the felling of the year's coupe and cutting out all infected trees wherever found throughout the plantations." The poles cut out were transported to a neighbouring lake and immersed for several days. Owing to want of labour some difficulty was experienced in getting this work done quickly, so that some of the larvæ may have got back on to standing trees at night. In all about 23,000 trees were felled. It was hoped that this action had stamped out the attack. "In August 1904, however, the first covered ways of the new generation were observed. At first this was put down to a few trees attacked last year being overlooked, but this was soon seen not to account for the entire fresh outbreak." A patch of Casuarina of about an acre in extent, belonging to villagers, is situated close to the plantations, and this was overlooked in 1903 though attacked by the Arbela. Mr. Fischer appears to think that the 1904 attack spread from this into the Government plantations and he is probably correct as the moths probably flew across the small intervening space to lay their eggs on the trees in the large forests. The new attack, he stated, was not, however, very severe and was soon restricted in its spread: and that this was so was undoubtedly due to his prompt action the year previously.

Mr. Fischer has discovered that the larva feeds upon the bark of many grove and avenue trees in the vicinity of the attacked plantations in Chatrapur. He mentions the following :—Acacia leucophlœa, Acacia arabica, Holarrhœna antidysenterica, Anogeissus latifolia, Millettia auriculata and Eucalyptus globulus (one).

Protection.—My inspection at Chatrapur enabled me to suggest a remedy to Mr. Fischer. We have seen that larvæ are to be found between December and June, and that during this period or portions of it they are to be found in covered ways on the bark of the trees, only leaving these to bore down into the wood to change into the chrysalis state. I would suggest that the larvæ be searched for and killed during the period they are feeding upon the trees. The covered ways are very visible, and each fresh one should be carefully pulled to pieces and the larva taken out and killed. Boys in charge of a watcher could be put on for this purpose. The watcher would first count the number of covered ways upon a tree and then send up the boy to take out the caterpillars, and the number of these latter should tally with the number of covered ways counted and the boy be paid accordingly. The covered ways should be pulled off the bark only after the caterpillar has been taken out. In the cases where they coalesce the operation should be done carefully, so as to make certain of taking all the caterpillars. If any of these latter escape they will soon construct a fresh covered way and continue their depredations. A kerosene tin with some kerosene mixed with water at the bottom will form a convenient receptacle in which to throw the caterpillars. This work should be started as soon as the new covered ways are seen to be making their appearance on the trees; and if done carefully and systematically throughout the plantations, I see no reason why it should not be possible to stamp out this pest or reduce its numbers to such proportions as will no longer endanger the plantations.*

* Since this was written Mr. Fischer has shown that this method is not sufficient when the attack is on the scale of the 1903-04 one. Such, however, will in all probability be very rare and ordinarily the above measures, if undertaken in a thorough and efficient manner, should suffice to keep the plantations clean.

Points in the life-history requiring further observation.

1. Where the eggs are laid and how. Are they laid singly or in patches. How many are laid by one moth?
2. When do the caterpillars first hatch out from the eggs in districts infected south of Ganjam?
3. Length of time spent in the larval state south of Ganjam.
4. Length of time spent in the pupal state.
5. The exact times of appearance of the moths in the different plantations on the East Coast of Madras.

DASYCHIRA sp.

Plate XXVII, fig. 1.

Reference :—Kindly identified by Mr. G. C. Dudgeon as *Dasychira* sp. The specimen bred out was unfortunately deformed, the species being therefore undeterminable.

Classification :—Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family, Noctuidæ.

Tree attacked :—*Abies Webbiana* (Silver Fir).

Description.

Larva.—About 1½ inch in length, densely clothed with long fine silky hairs of a delicate green colour. These hairs entirely conceal the head and abdominal segments of the caterpillar.

Pupa.—Formed within a covering composed of the green hairs of the larva spun together with pale green floss silk. The pupa is 1¼ inch long or a little over, thick anteriorly and tapering posteriorly, being ⅓rd inch across at its thickest part. In colour a dirty white except at upper end, where the white merges into a dark olive-green.

Moth.—A moderate-sized moth with the upper wings a dappled grey with black markings. Lower wings a dark french grey without markings. Pl. XXVII, fig. 1, shows the moth of this species.

Life-History.

The larva is full-grown towards the end of May, when it is to be found feeding upon silver fir needles. It pupates about this period, spinning a beautiful large silken cocoon of the finest floss silk with which its own hairs are woven up. A specimen which pupated in a glass-topped box 3½ inches × 2½ inches in size filled half the box with this silken covering. The pupal stage lasts about three weeks, the moth issuing about the middle of June.

It is possible that there is a second generation in the year, but this has not yet been observed.

A larva taken full-grown on the 22nd May changed to a pupa on the 24th, and issued as a moth on the 15th June.

Locality from where reported.

This insect was found by the writer in the Jaunsar forests, North-Western Himalayas. Elevation, 8,000 feet.

Relations to the Forest.

The larva feeds upon the needles of the silver fir, commencing at the apex and eating down to near the base. It appears to attack the needles in patches, feeding upon leaves contiguous to one another.

As yet it has only been found upon young saplings.

Points in the life-history requiring further observation.

1. Where the eggs are laid.
2. When the larvæ found full-fed towards the end of May hatch out from the egg. This will give the length of time spent in this stage.
3. When and where the June moth lays her eggs.
4. Is there a second generation of the insect in the year? If so, length of time spent in its larval, pupal and imago stages.
5. Where and in which stage the insect passes the winter.

COSMIA OCHREIMARGO, Hmpsn.

Plate XXVII, figs. 2, *2a*.

Classification :—Order, LEPIDOPTERA. Sub-Order, HETEROCERA.
Family, Noctuidæ.

Tree attacked :—*Quercus semicarpifolia* (Kharshu Oak).

Description.

Larva.—Head pale greyish-green, small, shining. Body a bright apple-green. Two greyish-green patches on dorsal surface of prothorax. Last segment greyish-green, as also are thoracic and pro-legs. Two minute black spots mark the spiracles (breathing openings) at sides of segments 1 to 11. Segments 2 and 3 have a transverse row of minute brown spots dorsally, and there are a few on the dorsal surface of segments 4-6. Length 1½ inch.

Pupa.—Dark-brown to black, stout, rather shining. Five abdominal segments visible. Skin anteriorly thick. Length ¾th to 1 inch. Width at thoracic end ¼th inch. The pupa is shown in Pl. XXVII, fig. 2.

Moth.—A stout yellowish-brown insect. Head yellowish-brown, hairy. Antennæ filiform. Forewing brown, irrorated with grey, 3 wavy longitudinal dark lines in outer half with faint whitish blotches between; 5 black spots near anal angle, placed one beneath the other. Under wing yellow with a palish broad brown band in upper half and two smaller blotches above it.

Under surface yellow, most of the interior of upper wing brownish black. *Vide* Pl. XXVII, fig. *2a*.

Life-History.

The caterpillars of this moth become full-fed about the middle of July. They feed upon the older and larger leaves of the trees, and probably spend some weeks in attaining their full growth. They are, consequently, when in numbers, a serious defoliating pest. The caterpillar pupates about the third week in the month, and the moth issues some time in August—probably during the first half of the month.

It was found somewhat plentifully upon the trees in July 1902, accompanying the Tineid and numerous Tortrix defoliators. The larva does not spin the leaves together to form a shelter, as is the habit of the Tortrices.

Locality from where reported.

This insect was found at Deoban (Jaunsar forests) in the North-West Himalayas. Elevation, 9,300 feet.

Relations to the Forest.

The caterpillars of the Tineid and Noctuid moths were to be found plentifully upon the Kharshu trees in July 1902 together with the several species of Tortrix, etc., described below. The defoliation caused by this coterie of larvæ was serious, some trees having lost all, or nearly all, the new foliage of the year. Every part of the tree was infested.

Points in the life-history requiring further observation.

1. When the eggs are laid and where.
2. The length of time spent by the larvæ feeding upon the trees.
3. The number of generations of the moth in the year.

BISTON SUPPRESSARIA, Guen.

Plate XXVII, figs. 3, 3*a*, 3*b*.

Reference:—Hampson, Fauna Br. Ind. Moths. III., 247, No. 3357.

Classification:—Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family, Geometridæ.

Trees attacked:—*Dodonæa viscosa* (sanatha); *Carissa diffusa* (gorinda); *Bauhinia variegata* (kuliar); *Acacia Catechu* (khair); *Acacia modesta* (phulai), *Rothra tinctoria* (kamila). Hampson also gives *Cassia auriculata* in the Fauna.

Description.

Larva.—Dark green, with dark bands on the segments and a slight sub-lateral line; the spiracles are white, ringed with red and with red centres; the tubercle on the first segment, and the legs, purple. The larva of the female is a paler green. Length 2-2¼ inch. Pl. XXVII, fig. 3, shows this caterpillar at rest on a branch.

Pupa.—Dark reddish brown, short and thick with a blunt posterior end. Length 1¼ inch. See fig. 3*a*.

Moth.—Grey irrorated with black; head ochreous, the proboscis well developed, frons not very hairy; thorax and abdomen with yellow bars. Fore wing with a waved yellow antemedial band; both wings with the outer margins non-crenulate and with irregularly sinuous indistinct yellow medial line excurved beyond cell of forewing; an ill-defined post-medial angled band, with some yellow spots beyond it and often some black suffusion at middle of outer margin of forewing; a marginal series of yellow spots. Exp. ♂ 60-70, ♀ 74-80 millim. Fig. 3*b* shows this insect.

Life-History.[1]

The moth appears on the wing early in September, but it is not at present known when the eggs are laid or where. The

[1] The notes on the life-history of this pest, together with excellent specimens of the larval, pupal and imago stages of the insect itself, were sent to me by Mr. H. A. Hoghton, Conservator of Forests, at the time Deputy Conservator of Forests in charge of the Rawalpindi Division. Mr. Hoghton's observations, extending over a period of three months, are most valuable and have enabled me to form a very fair idea of the life-history of this pest. The chief point remaining is to work out the March to June stages.

caterpillar was first noticed in the middle of July, but it is not unlikely that it is to be found at the beginning of the month or in the latter portion of June. It is a voracious feeder, and becomes full-fed and pupates about the middle of August. About three weeks are passed in the pupal stage, a moth having been obtained on the 10th September from a pupa found about the middle of August.

It is not improbable that this may prove to be the second generation of the pest in the year. If this is so, the larvæ of the first would appear some time during April, pupæ perhaps at the end of the month, and moths late in May. This first generation would thus correspond to that of the Sal looper pest *Boarmia selenaria* of the Siwaliks described in No. 1 of these notes at p. 100. The second generation of the year of this latter pest is as yet unknown, but information obtained is sufficient to make it certain that there is one. As in the case of *B. selenaria* the caterpillars of this insect are voracious feeders, and appear to practically live and feed upon every species they meet, thus completely defoliating whole areas.

Locality from where reported.

This insect has been reported from the forests of the Lower Murree Hills, in the Punjab. Elevation, 3,000 to 4,000 feet.

Hampson gives Kangra, Sikkim, Assam, Calcutta and Ceylon as the previously recorded localities in India.

Relations to the Forest.

This Geometrid appeared in large numbers in the brushwood forests of the Lower Murree Hills in July 1902 and committed a considerable amount of defoliating damage. Mr. Hoghton says that "the attack was first noticed about the middle of July, and by the first week in August sanatha (*Doponæa viscosa*), gorinda (*Carissa diffusa*) and kuliar (*Bauhinia variegata*) were almost completely defoliated in large patches, the warmer and drier southern slopes being most seriously affected. Khair and phulai (*Acacia Catechu* and *A. modesta*), also kamila (*Rothra tinctoria*) and some other species, were also attacked, but not to anything like the extent of the above............ Fortunately they seem to pay most attention to the sanatha, which is of little value and practically irrepressible." A pest of this nature with its great feeding capabilities cannot be looked upon as other than serious in small brushwood forests on dry slopes. The complete defoliation has naturally a much more serious effect on small growth than it would have on high tree forest, and it is probable that were the insect favoured by a series of dry favourable seasons it would commit a very considerable amount of havoc before it was finally again brought down to normal proportions by predaceous animals and insects, etc.

Protection and Remedies.

Mr. Hoghton attributes the attack he reports, and I consider correctly so, to a great deficiency in the rainfall during the preceding winter and up to the time of the appearance of the insects. This being so, however, it is curious that no mention is made of the pest having appeared earlier in the year as an insect of this kind, living at the comparatively low elevation of these hills, would almost certainly have done. One good feature noticed was the great flocks of birds which the presence of so large a number of caterpillars collected together. Mr. Hoghton remarks: "I was glad to see the starlings feeding upon them heavily. I have never before seen such large flocks of these birds in the Lower Murree Hills as I saw when visiting the Daleh Reserve on the 1st August."

No mention is made of any predaceous or parasitic insects having been observed preying upon either the larvæ or pupæ. We require to know something about these before it will be possible to consider remedies. Also where the insect spends the winter and in which stage. It may prove possible to introduce measures to get rid of the eggs if the cold weather is passed in this stage.

Points in the life-history requiring further observation.

1. Where the eggs are laid and when.
2. Length of time spent in the larval stage by the July larvæ.

3. What becomes of the September moth? Does it lay eggs at once, and do these eggs remain unhatched throughout the winter, or do they hatch out at once?
4. If the eggs laid by the September moth hatch out at once, is there an autumn (or third) generation?
5. Is there a spring or first generation, the caterpillars of which would appear at the end of March or early in April, the pupæ and moths in May-June?
6. What predaceous and parasitic insects attack the grub and pupal stages of the pest?

TINEA ? sp.

Pl. XXVII, fig. 4.

Reference :—Provisionally determined as a species of *Tinea.*

Classification :—Order, LEPIDOPTERA. Sub-Order, HETEROCERA.

Tree attacked :—*Quercus semicarpifolia* (Kharshu Oak).

Description.

Larva.—Pale-green or yellow-green in colour, smooth, somewhat shining, flat with yellowish-green head. Length just under $\frac{3}{4}$th inch.

Pupa.—Pale green. Anterior end whitish-green, almost translucent. Eyes black, prominent beneath pupal skin, as also are the rudimentary wings. 5-6 ventral abdominal segments visible. Length $\frac{1}{2}$ inch.

Moth.—Head black with black filiform antennæ. Wings orange-yellow with large black blotches forming a kind of chess board pattern in them. Lower wings light chrome yellow. Expanse of wings $\frac{1}{2}$ inch. Pl. XXVII, fig. 4, shows the moth of this species.

Life-History.

The moth appears on the wing at the end of July or early in August. Partially-grown and full-grown caterpillars were found upon the trees on the 10th July. They feed upon the young leaves spinning them together into a mass in which the excreta and portions of eaten leaf are mixed up in the silk. The larvæ confine themselves to the young leaves and the defoliation accomplished by them appears to be heavy. They pupate towards the middle of July, and about a fortnight is spent in this stage. In pupating the larva spins a loose white silken cocoon and then attaches himself by its anal segment to the leaf and changes to the pupal state. The pupa thus lies along the leaf attached at one end and enclosed in the silken cocoon or covering.

Locality from where reported.

This insect was found defoliating the Kharshu oak at Deoban, in the North-West Himalayas. Elevation, 9,300 feet.

Parasite upon Tinea ? sp.

METEONES sp.

Pl. XXVII, figs. 5, 5*a*.

Reference :—Identified as a species of *Meteones* by Dr. W. H. Ashmead; of the U. S. Museum.

Classification :—Order, **HYMENOPTERA**. Family, **Ichneumonidæ**.

Parasitic upon Tinea ? sp.

Description.

Pupal case glistening white, silky, elliptical, consisting of finely and closely spun white silk. Length $\frac{3}{16}$th inch. Pl. XXVII, fig. 5, shows a pupal case or cocoon spun on to the back of an oak leaf.

Imago.—A small fly. Head, thorax and body black, shining. Antennæ black. Wings with a black patch in the upper margin of upper wing. Transparent and irridescent. Length $\frac{1}{8}$th inch. Pl. XXVII, fig. 5*a*, shows the fly.

Life-History.

The grub feeds internally upon the Tineid caterpillar. When full grown it comes to the outside and spins on to the leaf an elliptical cocoon, attaching it by one end. It then pupates within this. The ichneumon fly leaves the cocoon by an opening at the unattached end. A fly was obtained on the 15th July. We have still to ascertain how long it spends in the larval or pupal stages, and how many generations it passes through in the year.

TORTRIX sp. (No. 231).

Reference :—Provisionally named Tortrix sp.

Classification :—Order, LEPIDOPTERA. Sub-Order, HETERCOERA. Family, Tortricidæ.

Tree attacked :—*Quercus semicarpifolia* (Kharshu Oak).

Description.

Larva.—Head dark brown to black, shining, with a white transverse stripe about $\frac{2}{3}$rds down from the anterior edge; this stripe is also present upon the under surface, forming a collar. Body a dark yellow-green, almost olive. Thoracic legs black and shining; pro-legs yellow-green. Ventral surface slightly lighter. Some scattered yellow hairs over body. Length $\frac{1}{2}$ inch.

Pupa.—A dark sepia brown in colour, moderately shining, thick-set anteriorly, tapering posteriorly. Eyes and antennæ of future insect clearly distinguishable beneath the pupal skin. Length just over $\frac{3}{8}$ths inch.

Moth.—Small, with a fairly large wing area. Greyish brown. Forewing truncate at outer angle, the brown merging into a golden yellow tinge here. Hindwing silvery, with a narrow fringe. Expanse of wings $\frac{3}{4}$ths inch. (Described from a poor specimen which got damaged after it had been bred out.)

Life-History.

This moth is to be found on the wing in about the second week of July or, perhaps, a little before. Caterpillars were found seriously defoliating the Kharshu oak at the end of June, and some were pupating on the 30th of the month. The larvæ roll up the young new leaves and feed inside the rolled up portion. Pupation takes place in the rolled-up leaves, or the larva may take advantage of a depression in a leaf and pull a corner of the leaf over this, fixing it down by means of silk. A loose white silk covering is spun within this shelter, and the caterpillar then changes to a pupa within it.

This caterpillar was accompanied in its attack by the smallest of the Tortrices here considered (No. 230), and also by No. 229.

Locality from where reported.

This insect was discovered in Tehri Garhwal, on the ridge above Deota, in the North-West Himalayas. Elevation, 9,200 ft.

TORTRIX sp. (No. 264).

Plate XXVII, figs. 6, *6a.*

Reference :—Provisionally named Tortrix sp.

Classification :—Order, LEPIDOPTERA Sub-Order, HETEROCERA.
Family, Tortricidæ.

Tree attacked :—*Quercus semicarpifolia* (Kharshu Oak).

Description.

Pupa.—Dark brown or yellowish; tapers posteriorly. Length $\frac{7}{16}$ths inch. *Vide* Plate XXVII, fig. 6.

Moth.—Head and thorax brownish; abdomen grey. Antennæ filiform. Forewing yellow; upper margin with a black edge swelling out into thickened patches in two places; costal angle black. A wavy transverse diagonal bar about centre of wing and a narrow one near outer edge. A spot equidistant between these. A faint patch near inner angle. Lower wing greyish; fringe narrow. Wing expanse $\frac{15}{16}$ths inch. Plate XXVII, fig. *6a*, shows the moth.

Life-History.

The moth appears on the wing during the first fortnight tc three weeks of July, and was very abundant in 1902.

The larva feeds upon the Kharshu oak and spins itself up into a leaf to pupate, at about the beginning of July. Pupation lasts about 8 days.

Pupæ were obtained from the leaves of the tree in the second week of the month; but no moths were bred from larvæ, so it is not certain as to which of the several Tortrix larvæ present on the trees changes into this moth. It must have played a large part in the very heavy defoliation the trees underwent as the moths were very plentiful, flying around the oak trees both during the day and night.

Locality from where reported.

This insect was found plentifully in the oak forests at Deoban, North-West Himalayas, in July 1902. Elevation, 9,500 feet.

TINEA? sp. (No. 230).

Plate XXVII, figs. 7, 7*a*.

Classification :—Order, LEPIDOPTERA. Sub-Order, HETEROCERA.

Tree attacked :—*Quercus semicarpifolia* (Kharshu Oak).

Description.

Larva.—Head small, gamboge-yellow in colour, with a canary-yellow transverse stripe separating it from the prothorax. General colour of rest of grub is either canary-yellow or light-green. Three longitudinal stripes run down the dorsal surface, hiding most of the ground colour; a narrow median one and two broader ones separated from it on either side by a narrow yellow stripe. Anal segment greenish-yellow. Pro-legs yellow, as also are the abdominal ones: but latter are lighter in colour. There are scattered yellow hairs on the segments and head. The larva varies much in colouration. In the bright green varieties the gamboge markings are fainter, the head is nearly black and there is a nearly black transverse dorsal patch on the prothorax. The anal segment is bright green. In others the gamboge is almost madder-brown in colour. Length, full grown ¾ths inch. This colouration of the larva is practically a mixture of the colours of the upper and under side of the oak leaves which are bright green (when young) on upper surface and a gamboge-yellow on the under.

Pupa.—Dark brown, shining, blunt at the anterior end, pointed at the other. Length ⅓rd inch. The pupa is shown in Pl. XXVII, fig. 7.

Moth.—Small, silvery-grey. Large palpi. Head black and blackish beneath; hind wings silvery grey, fringed. *Vide* Pl. XXVII, fig. 7*a*.

Life-History.

This insect probably appears on the wing some time about the end of July. The caterpillars are full-grown towards the middle of the month, when they pupate. The time passed in the pupal state is thus from 10 to 13 days. I do not know how long the moth spends on the wing in the forest before egg-laying, nor whether there is more than one generation in the year. It is probable that the eggs are laid upon the twigs of the tree in the axils of the buds. The caterpillars were found in company with other species defoliating the Kharshu oak. They feed by eating irregular patches out of the leaf, usually rolling up the edge of leaf and feeding within it. They apparently consume the young new leaves of the year, and in moving about spin quantities of silk which envelopes the twigs in a network. If disturbed the grub drops from the tree and remains suspended by its silken thread. In feeding upon a leaf it does not touch the mid rib. Its colouration undoubtedly serves as a protection to it whilst upon the leaves.

Locality from where reported.

This insect was discovered in Tehri Garhwal (on Deota Ridge), North-West Himalayas, at an elevation of about 9,000 feet.

YPSOLOPHUS ? sp. (271, A.)

Plate XXVII, figs. 8, 8*a*.

Classification :—Order, LEPIDOPTERA. Sub-Order, HETEROCERA.

Tree attacked :—*Quercus semicarpifolia* (Kharshu Oak).

Description.

Pupa.—Small tapering yellowish-brown. Length $\frac{3}{16}$ths inch.

Moth.—Small silvery-grey with long wing fringes. Pl. XXVII, figs. 8, 8*a*, show the pupa and moth of this insect.

Life-History.

I know little about this insect. It was bred out of some leaves in the breeding-box from which the *Meteones sp.* parasitic fly mentioned above was obtained. It was either in its minute caterpillar or pupa stage in the second week in July amongst the Kharshu leaves, and the moth issued soon after the middle of the month.

Relations to the Forest.

The larvæ of these small moths are all defoliators and were heavily defoliating the Kharshu oak in the Jaunsar Division in June-July 1902. They work together or almost so, some apparently maturing slightly before their companions, and the trees rapidly become leafless under their attacks. So numerous were the caterpillars that their droppings could be heard pattering down like a shower of rain. There can be little doubt that this heavy defoliation must have a serious effect upon the vitality of the trees, and it is extremely probable that it adversely affects the maturing power of the seed and consequently of the regeneration of this tree. These smaller caterpillars were more numerous upon the trees than their Noctuid companions.

Points in the life-history requiring further observation.

1. Where the eggs are laid. Is it in the axils of the buds ?

2. Length of time spent in the larval stage.
3. When does the moth lay its eggs? Is the winter stage passed through as an egg?
4. The number of generations in the year.

LASIOCAMPID LARVA.

Plate XXVII, figs. 9, 9*a*.

Amongst the other defoliating caterpillars of the Kharshu oak at Deoban I obtained a larva which evidently belonged to the *Lasiocampidæ*.

The following is a description of the caterpillar:—

Head large, black. Body black, covered with hair. Thoracic and pro-legs black. Hair arranged in whorls of pencils round the insect. On the first four segments the hairs are yellowish-brown in colour. On the following six the pencils are white, whilst on the last two the hairs are again yellowish-brown. In addition to the pencils there are longer projecting black hairs. Length ¾ths inch. The caterpillar is shown in Pl. XXVII, fig. 9.

I endeavoured to breed moths from these larvæ, but all my specimens were parasitised by the ichneumon flies described below. Fig. 9 shows the larva and 9*a* the dead skin of a larva and a cocoon of one of the parasitic flies alongside of it on the leaf.

The larva feeds upon the leaf by eating patches out of its sides or it consumes the whole of the leaf tissue leaving only the larger veins. It was taken on the 10th July.

Parasites upon the above Lasiocampid Caterpillar.

TRIBE HEMITELINI—GENUS NOVUM.

Plate XXVII, figs. 9*a*, 10.

Reference :—Provisionally determined by Dr. W. H. Ashmead, of the U. S. Museum.

Classification :—Order, HYMENOPTERA.

Parasitic upon the Lasiocampid *Kharshu* defoliating caterpillar.

Description.

Cocoon.—The grub leaves its host when full-fed and prepares a longish oval greyish-brown cocoon outside and pupates within this. See Pl. XXVII, fig. 9*a*.

Imago.—A small slender fly. Head yellow. Eyes black, large. Antennæ many jointed, not elbowed. Thorax and peduncle yellowish-black. Abdomen orange-brown. Legs long and slender, yellow. Wings membranous, irridescent, with a moderate number of cells in them and a black marginal patch (stigma) on upper one. Length $\frac{3}{16}$ths inch. The fly is shown in fig. 10.

EULOPHUS sp.

Plate. XXVII, fig. 11.

Reference :—Provisionally determined by Dr. W. H. Ashmead, of the U. S. Museum.

Classification :—Order, HYMENOPTERA.

Parasitic upon the Lasiocampid oak-defoliating caterpillar.

Imago.—Much smaller than above. A minute fly, very shining, and dark indigo-green in colour. Wings membranous and irridescent. See Pl. XXVII, fig. 11.

Life-History, etc.

Both of these parasitic flies were bred out of the Lasiocampid caterpillars described above.

The larva of the larger one on becoming full-fed quits the body of its host before it pupates and prepares a small greyish-brown longish oval cocoon, ¼th inch in length, near the dead caterpillar skin and attached to the food plant by some white silk strands. In this it changes to the pupal state. The cocoon opens by a little lid at one end to let out the fly when it is ready to issue.

In the case of the smaller one the minute larvæ appear to pupate within the insect, and not outside.

The larvæ of both these flies pupated during July, and the adults issued some time in August.

It is probable that these parasites assist largely in keeping down the lasciocampid larvæ.

FULGORID.

Classification :—Order, HEMIPTERA, Family, Fulgoridæ.

Tree attacked :—*Casuarina equisetifolia.*

The writer discovered this insect, which is a small black shining "hopper," clustered on the green branches of the tree at the beginning of July. It was found fairly plentifully both at Waltair and Chatrapur (Ganjam). The insect was in all stages of development, from minute little green specks to larger shining black insects $\frac{1}{16}$th inch in length, but still wingless, to full-fledged winged insects of a greyish-black appearance and $\frac{1}{3}$rd inch in length. The insects feed entirely by suction, and from youngest to oldest had their beaks, of which their mouth-parts consist, embedded in the bark of the branches from which they were engaged in sucking out the sap.

At present nothing more appears to be known about this pest, which has not previously been reported. Observations are required as to when it first makes its appearance in the year and as to how long it is to be found in this manner in all stages of its life-history upon the trees. There is no doubt that it might develop into a serious pest in nurseries and young plantations where, owing to its small size and inconspicuousness, it would probably escape notice for some time.

ICERYA sp.

Classification :—Order, **HEMIPTERA.** Family, **Coccidæ.**

Tree attacked :—*Casuarina equisetifolia.*

An examination of the pests at present known attacking the Casuarina in Madras would not be complete without a short mention of another insect discovered on trees in Waltair and Chatrapur. This is a member of the family Coccidæ, which contains so many pests to trees and plants. The insect is white, and in its older stages has a mass of white fluffy substance on its dorsal posterior surface, rendering it fairly conspicuous upon the branches upon which it lives by sucking out the sap.

MONOPHLEBUS sp.

Classification :—Order, HEMIPTERA. Family, Coccidæ.

Tree attacked :—*Casuarina equisetifolia*.

The genus *Monophlebus* may be said to be the forest genus of Coccids, since all the species at present known confine their attacks to woody plants. Both at Waltair, at Chatrapur, and in the Botanical Gardens, Calcutta, a species of *Monophlebus* has been obtained on the Casuarina. It feeds by sucking out the sap of the green shoots, going down to the more woody branches as it grows older. It was quite small at the beginning of July, but had grown considerably by the third week in August. Only the female has as yet been secured, so it is impossible to say what the species is. The female is an oval white fleshy scale, convex above and flat beneath, with three pairs of short black legs and a pair of black antennæ. The male will be a small two-winged black fly. It has not yet been taken, and it is therefore impossible to describe the species.

G. I. C. P. O.—No. 2565 For. Ento. —8-2-1906.—1,000—R. H. S.

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PLATE XX.

FIG. 1. OPHION AUREOLATUS, Cameron.—1, coccoon; 1*a*, coccoon with fly issuing; 1*b*, mature fly.

" 2. GLYPTA sp.

" 3. PIMPLA sp.

" 4. MASICERA sp.

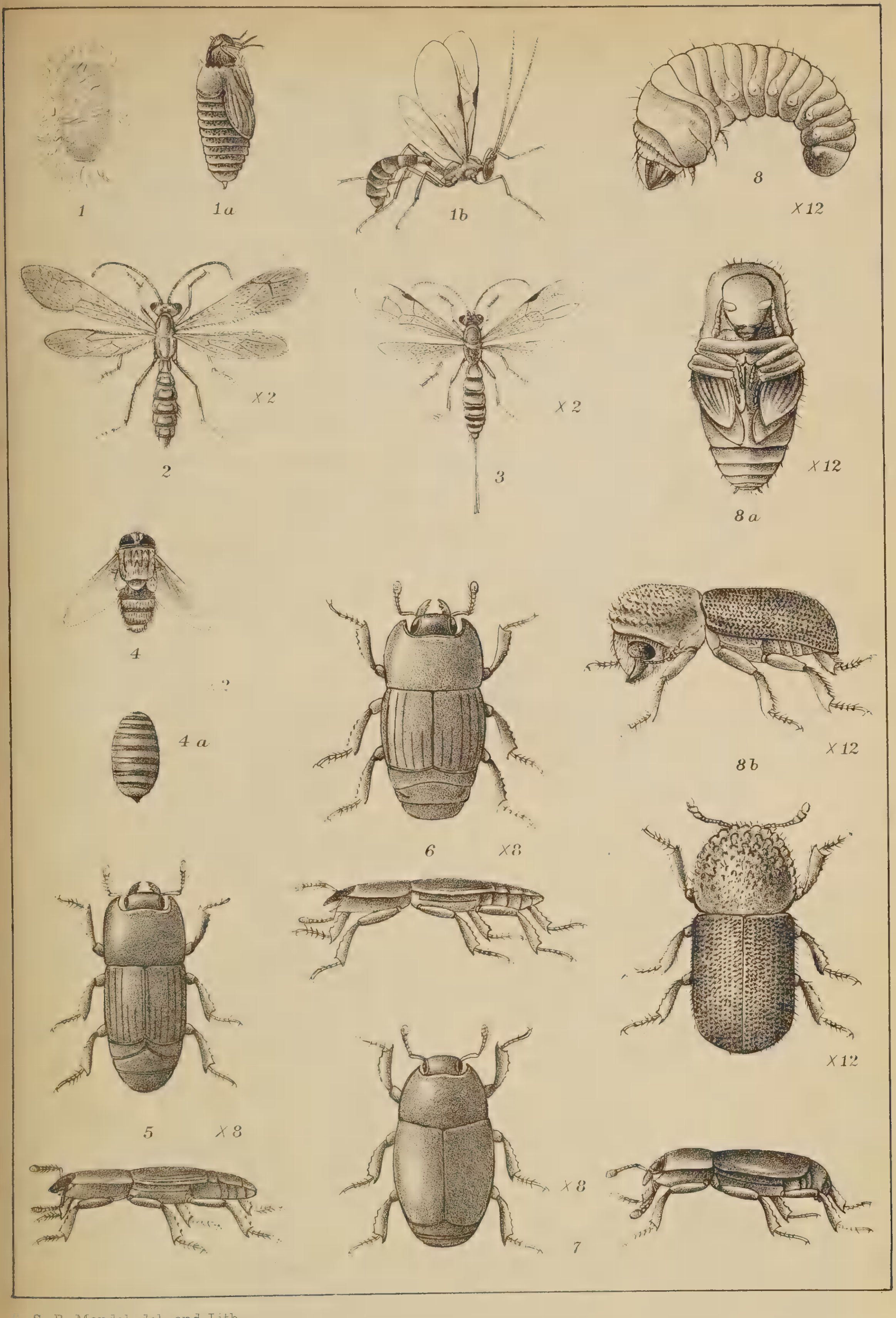
" 5. PLATYSOMA DUFALI, Mars.—Dorsal and side view of the beetle.

" 6. PLATYSOMA, n. sp.—Dorsal and side view of the beetle.

" 7. PAROMALUS, n. sp.—Dorsal and side view of the beetle.

" 8. Dinoderus minutus, fabr.—8, larva; 8*a*, pupa; 8*b*, dorsal and side view of the beetle.

N.B.—The small numbers against the insects denote the numbers of times they are enlarged.



S. B. Mondal, del. and Lith.

1. Ophion aureolatus, Cameron.
2. Glypta sp.
3. Pimpla sp.
4. Masicera sp.
5. Platysoma dufali, Mars.
6. Platysoma sp.
7. Paromalus sp.
8. Dinoderus minutus, Fabr.

PLATE XXI.

Bamboos tunnelled into by the Bamboo borer *(Dinoderus minutus)*. 1—4, attacked bamboos; 5, length of a larger bamboo opened out flat to show the attacks of the insect; 6, unattacked bamboo.

From a photograph by Captain A. McCormick, R.E.

Photogravure. Survey of India Offices, Calcutta, September 1905.

BAMBOOS TUNNELLED INTO BY THE BAMBOO-BORER.
(*DINODERUS MINUTUS*)

Captain A. Mc Cormick, R. E. Photo.

PLATE XXII.

Fig. 1. Sirex (?) sp.—Dorsal and side view of larva.

„ 2. Caryoborus sp. 2, dorsal and side view of beetle; 2*a*, beetle issuing from seed.

„ 3. Stromatium (?) sp.—Dorsal and side view of larva.

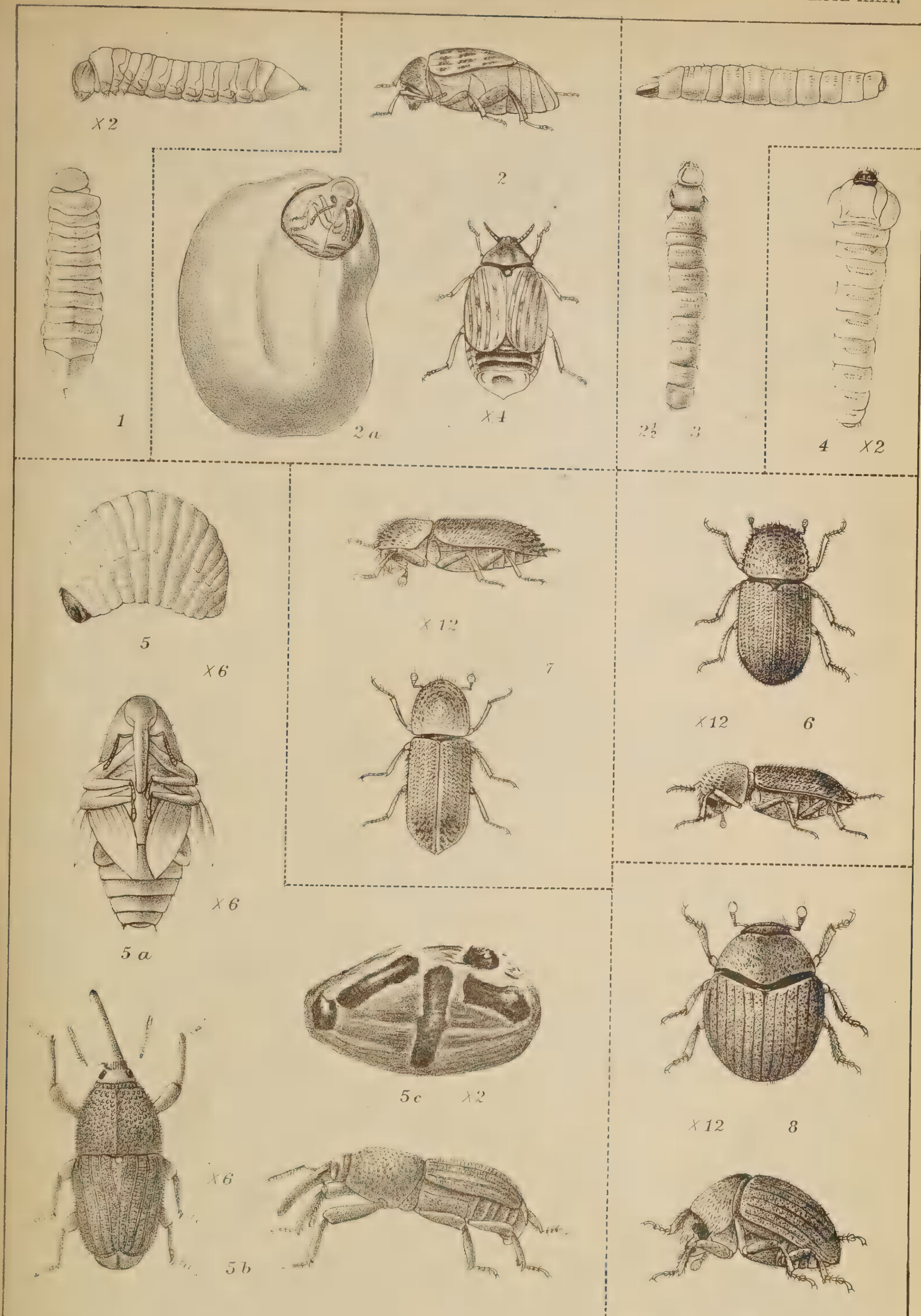
„ 4. Xylotrechus (?) sp.—Dorsal and side view of larva.

„ 5. Calandra sculpturata, Gyll.—5, larva; 5*a*, pupa; 5*b*, dorsal and side view of beetle; 5 *c*, acorn (with skin removed), showing attacks of grubs.

„ 6. Cryphalus indicus, n. sp.—Dorsal and side view of beetle.

„ 7. Xyleborus sp. prox. perforans, Woll. Dorsal and side view of beetle.

„ Chramesus (?) sp.—Dorsal and side view of the beetle.



S. B. Mondal, del. and Lith.

1. Sirex (?) sp.
2. Caryoborus sp.
3. Stromatium (?) sp.
4. Xylotrechus (?) sp.
5. Calandra sculpturata, Gyll.
6. Cryphalus indicus, n. sp.
7. Xyleborus sp. *prox.* perforans, Woll.

PLATE XXIII.

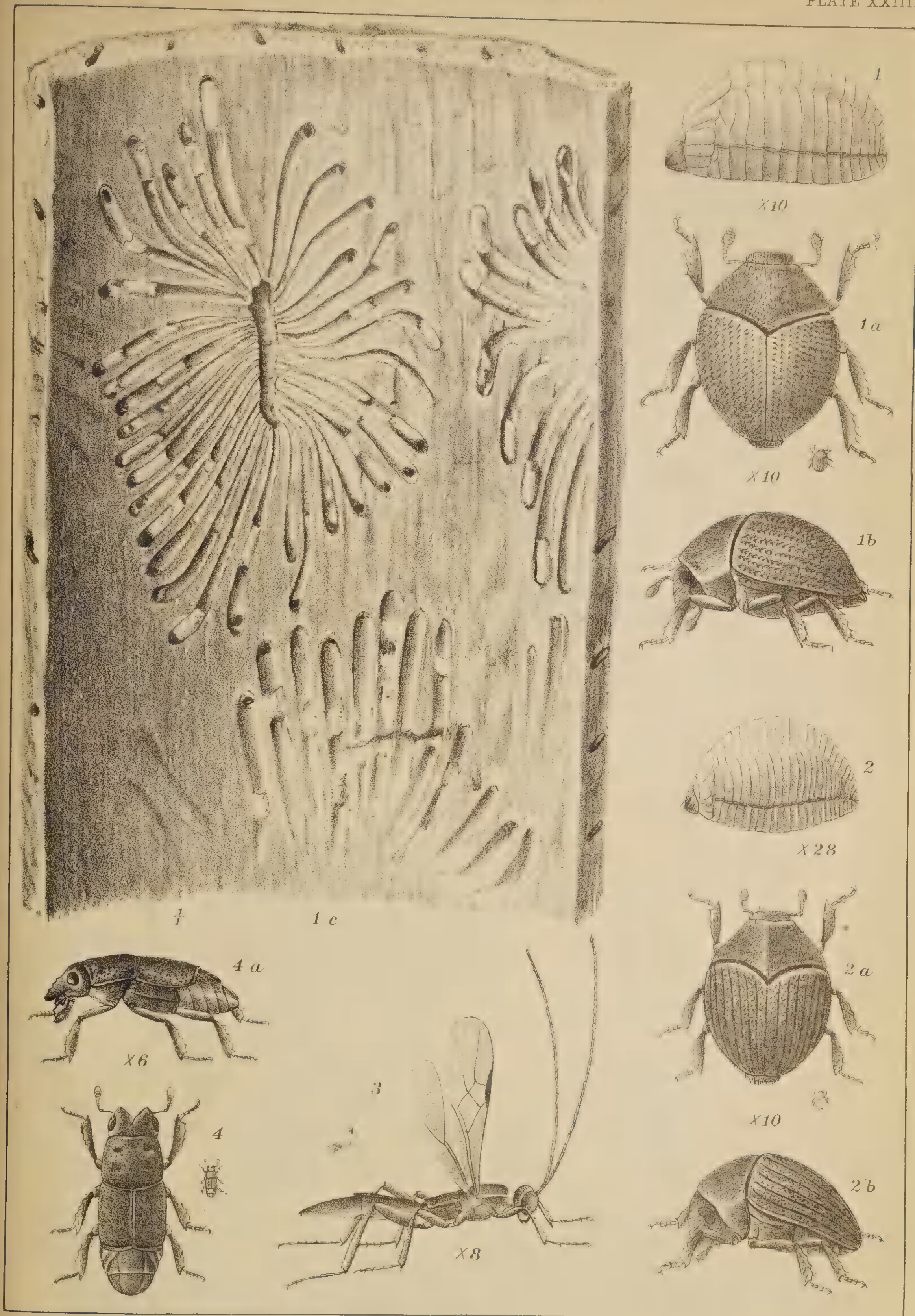
FIG. 1. SPHAEROTRYPES SIWALIKENSIS, n. sp.—1, larva; 1*a* dorsal view of beetle; 1 *b*, side view of beetle; 1*c*, inner side of a piece of sal bark showing the egg galleries, larval galleries and pupal chambers of the insect (in this drawing the one entire design, the work of one female beetle and its larval progeny, is shown complete).

" 2. SPHAEROTRYPES COIMBATORENSIS, n. sp.—2, larva; 2 *a*, dorsal view of beetle; 2 *b*, side view of beetle.

" 3. NIPONIUS ANDREWESI, Lewis. Dorsal and side view of beetle.

" 4. Ichneumon (?) sp.—Side view of fly.

N.B.—The insects are shown actual size and magnified.



S. B. Mondal, del. and Lith.

1. Sphærotrypes siwalikensis, n. sp.
2. Sphærotrypes coimbatorensis, n. sp.
3. Niponius Andrewesi, Lewis.
4. Ichneumon, (?) sp.

PLATE XXIV.

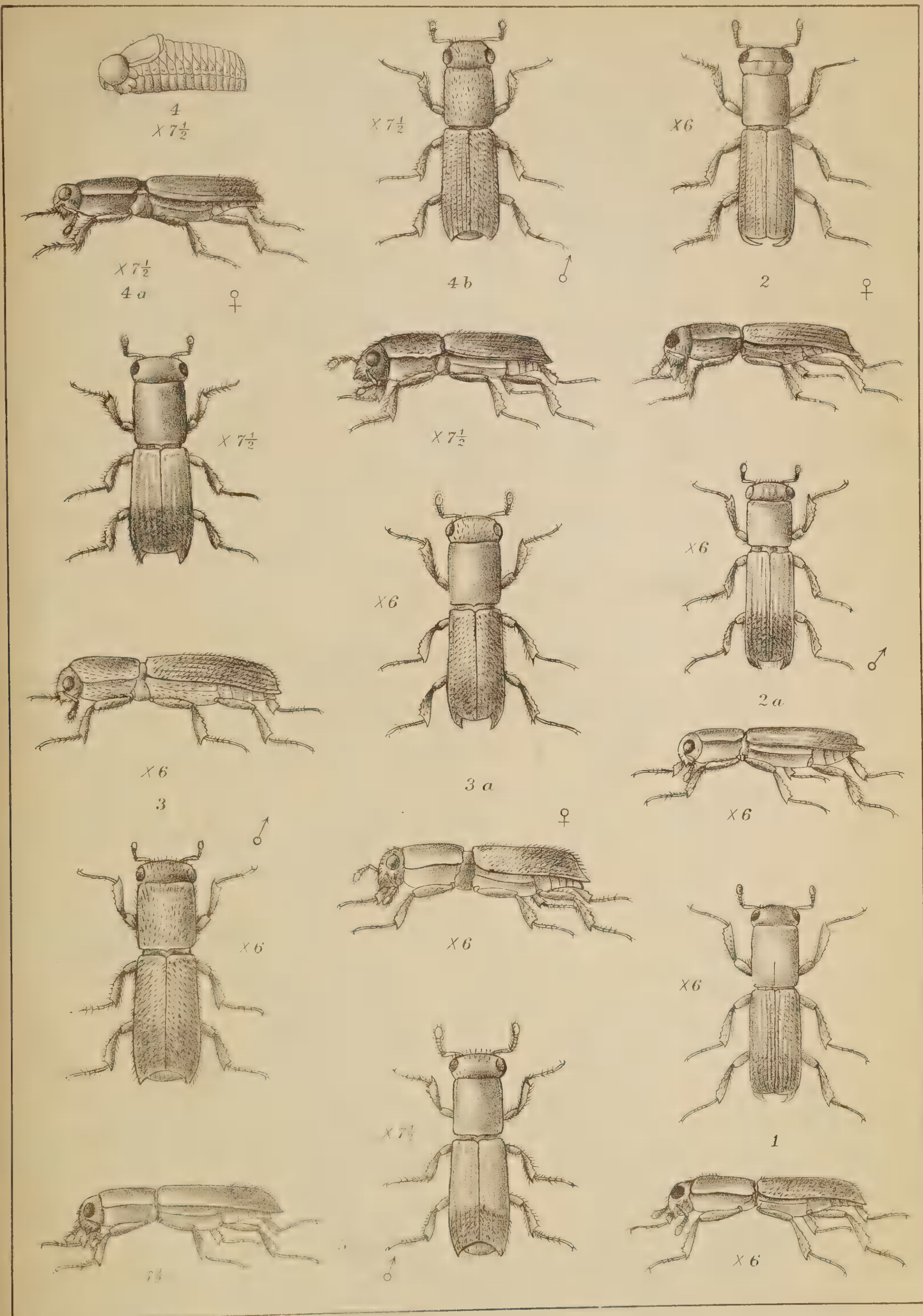
FIG. 1. CROSSOTARSUS CONIFERÆ, n. sp.—Dorsal and side view of beetle.

„ 2. Crossotarsus piceæ, n. sp.—Dorsal and side view of female; 2*a*, dorsal and side view of male.

„ 3. Diapus sp. prox. impressus.—3, dorsal and side view of male; 3*a*, dorsal and side view of female.

„ 4. DIAPUS TALURÆ, n. sp.—4, larva; 4*a*, dorsal and side view of female; 4 *b*, dorsal and side view of male.

„ 5. DIAPUS HERETIERÆ, n. sp.—Dorsal and side view of beetle.



S B. Mondal, del. and Lith.

1. Crossotarsus coniferae, n. sp.
2. Crossotarsus piceae, n. sp.
3. Diapus sp. near impressus.
4. Diapus talurae n. sp.
5. Diapus heretierae, n. sp.

PLATE XXV.

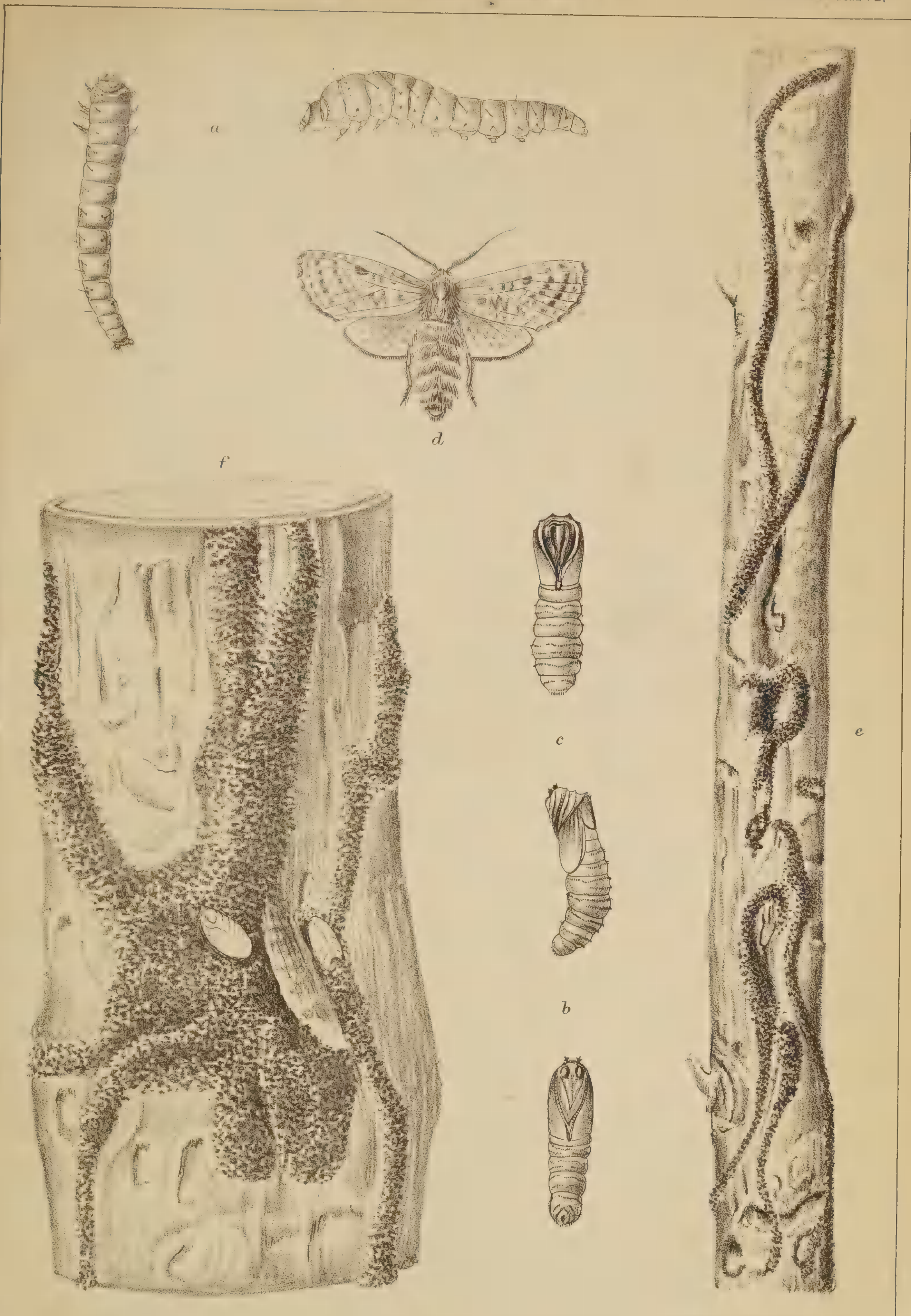
DUOMITUS LEUCONOTUS, Walker.—*a*, dorsal and side view of a half-grown larva; *b*, side view of pupa; *c*, moth; *d*, empty pupa, case protruding from tree showing method of escape of moth; *e*, portion of stem of a *Cassia nodosa* tree severely attacked by this pest; the upper part in section shows the pupal chambers in interior of the tree; on the bark at the side and below numerous protruding pupal cases may be observed (the stem is considerably reduced in size).

S. B. Mondal, del. and Lith.

Duomitus leuconotus, Walker.

PLATE XXVI.

ARBELA TETRAONIS, Moore (The casuarina bark-eating caterpillar).—*a*, a dorsal and side view of caterpillar; *b*, ventral and side view of pupa; *c*, ventral view of an empty pupal case; *d*, moth; *e*, covered ways made on bark of stem by the caterpillars (reduced); *f*, covered ways on a section of a stem about two-thirds nat. size.



S. B. Mondal, del. and Lith.

Arbela tetraonis, Moore

(The Casuarina Bark-eating Caterpillar).

PLATE XXVII.

FIG. 1. DASYCHIRA sp.

„ 2. COSMIA OCHREIMARGO, Hmpsu.—2, pupa; 2 *a*, moth.

„ 3. BISTON SUPRESSARIA, Guen.—3, larva on a twig; 3*a*, pupa; 3*b* moth.

„ 4. TINEA (?) sp.

„ 5. METEONES sp.—5, coccoon on leaf; 5 *a*, fly.

„ 6. TORTRIX sp.—6, pupa; 6*a*, moth.

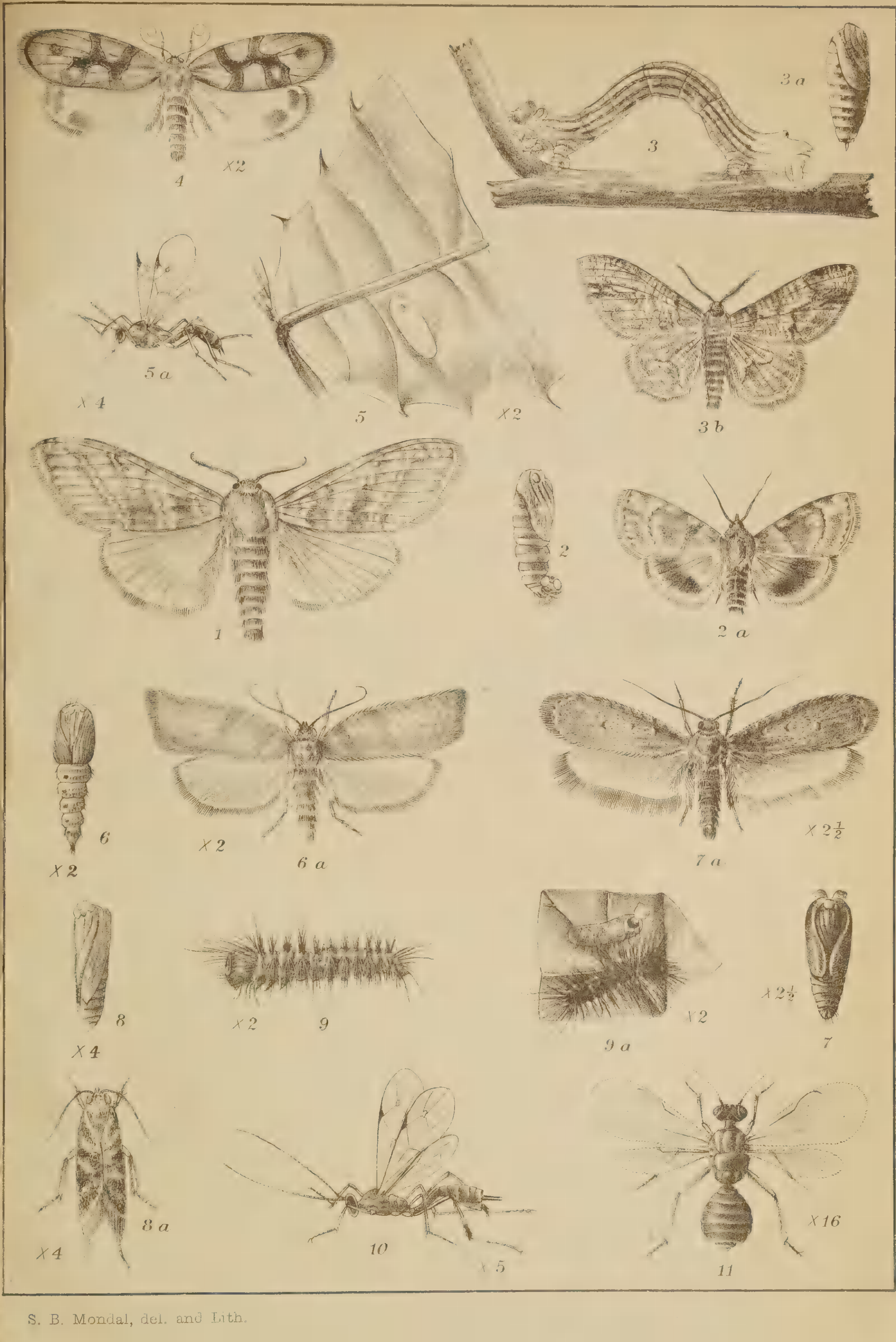
„ 7. TINEA (?) sp.—7, pupa; 7*a*, moth.

„ 8. YPSOLOPHUS (?) sp. 8, pupa; 8*a*, moth.

„ 9. LASIOCAMPID larva. 9, larva; 9*a*, empty larval skin on leaf with coccoon of a parasite of the tribe *Hemitelini*.

„ 10. HEMITELINI.

„ 11. ENLOPHUS sp



S. B. Mondal, del. and Lith.

1. Dasychira sp.
2. Cosmia ochreimargo, Hmpsn.
3. Biston suppressaria, Guen.
4. Tinra (?) sp.
5. Meteones sp.
7. Tinra (?) sp.
8. Ypsolophus (?) sp.
9. Lasiocampid larva.
10. Hemilelini.
11. Eulophus sp.