VOL. II FOREST ZOOLOGY SERIES Part II

THE

INDIAN FOREST MEMOIRS

On some Important Insect Pests of the Coniferae of the Himalaya with Notes on some Insects Predaceous and Parasitic upon them.

By E. P. STEBBING, F.L.S., F.Z.S., F.R.G.S., F.E.S

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ON SOME IMPORTANT INSECT PESTS OF THE CONIFERAE OF THE HIMALAYA WITH NOTES ON INSECTS PREDACEOUS AND PARASITIC UPON THEM.

PART II.—PINUS LONGIFOLIA PESTS.

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THE INDIAN FOREST MEMOIRS

VOL. II 1910 [PART II

Insect Pests of the Chir Pine (Pinus longifolia) in the North West Himalaya

With Brief Notes on the Insects Predaceous and Parasitic upon them

By E. P. STEBBING, F.L.S., F.Z.S., F.R.G.S., F.E.S.

GENERAL REMARKS.

THE wood of the Chir pine (**Pinus longifolia**) is well known in Northern India where, owing to the ease with which it can be worked up, it is used for a variety of purposes. The tree is also tapped scientifically by the Forest Department for resin which is converted into turpentine and used in the preparation of soap.

The *Pinus longifolia* grows in the lower ranges of the outer Himalaya at elevations between 2,000 and 5,000 feet and is easily regenerated naturally.

It has been recognized for some time that the wood of this tree is subject to the attacks of insect borers which are known in Kumaun, equally with the bamboo borers, as 'Ghoon,' a word commonly applied in India to the bamboo borers **Dinoderus pilifrons** and **D. minutus**.

The 'Ghoon' of the **Chir** pine is, as we shall see, a very different beetle belonging to the family of wood borers known as **Platypidæ**.

The ringal bamboo borer of Kumaun is probably **Dinoderus pilifrons**, but I have not definitely determined this.

This question of the wood borers of **Pinus longifolia** and ringal bamboos in Kumaun was alluded to by Mr. Norman Troup in a Note in the **Bombay Natural History Journal.*** Mr. Troup stated that the people of the district were well aware that the wood suffered from borer attacks but that trees felled during the period of the month when the nights were dark and moonless did not suffer from such attacks. In a paper in answer to Mr. Troup's Note entitled *The 'Shot-Borers' of Bamboos and 'Wood-Borers' of Pinus longifolia* published in

* Vol. XVII, p. 526 (1906).

the same Journal I pointed out, as a result of investigations made in the Chir forests of Jaunsar and Tehri Garhwal, that the wood borers of the Chir belonged to quite a different family of beetles to those infesting the bamboos in that part of the Himalaya and that this would probably prove to be the case in Kumaun. A recent tour in Kumaun has enabled me to personally verify and prove this statement. Whether the tapping of the **P. longifolia** for resin leads to the tree being more freely attacked, or more subject to attack, by its insect foes I am not at present prepared to state. I know of no recorded investigations supporting the statement made in **The Indian Trade Journal** for September 17th, 1908, that "Results of tests on the wood of **Pinus longifolia** show that tapping of the trees for resin agrees with the results already obtained in America, namely, that the tapping does not weaken the timber, but, if anything, strengthens it, while the removal of resins makes little or no difference to the liability to or immunity from the attacks of insects."

The wood borer *par excellence* of the Chir is a member of the family **Platypidæ** which, so far as present observations have been carried in India, appears to contain representative, which only bore into green fresh timber and always tunnel right down to the heart wood in it. This insect I place in the genus **Platypus** and have named it **P. Wilmoti**, after the late Inspector General of Forests, Mr. S. Eardley-Wilmot, C.I.E. In my above quoted Note I on a superficial examination relegated the insect to the allied genus **Crossotarsus**. Of insects which bore into the sap wood only for pupating purposes there are four; two buprestids (**Capnodis** and **Anthaxia Osmastoni**, n. sp.), a longicorn beetle **Nothorrhina muricata** and a weevil **Cryptorhynchus Brandisi**, Steb. There is also a termite, **Termes** sp., or white ant which riddles the wood of dead trees in the forest. Of the bast eating insects there are some most dangerous forms. Amongst beetles the buprestid **Capnodis** and the longicorn **Nothorrhina** and the Cryptorhynchid weevil are very serious pests as they riddle the bast layer and sap wood and kill the tree. Of **Scolytidæ** there are several forms amongst which a **Polygraphus, Hylastes** and **Cryphalus** and a large **Tomicus** (Ips) are very serious pests. This list is not complete without the addition of a noctuid moth larva (Family **Noctuidæ**) which feeds deep in the bast and sap wood of young seedlings and saplings, proceeding often in a spiral manner up the tree, thus girdling and killing it. The leading and other shoots are also tunnelled into and destroyed by a Pyralid caterpillar. They are also crippled by galls or pseudo-cones made by a species of **Cecidomyia**. When it is stated that either of the buprestid, longicorn, weevil, **Polygraphus, Tomicus** or Noctuid insects could alone kill the tree, if present in sufficient numbers, it will be seen that the Chir pine has a formidable array of enemies to contend with.

The life histories so far as at present known are detailed in the following pages, notes being also given upon some beneficial insects predaceous and parasitic upon the pests of the tree.

I have also briefly alluded to a fungus **Peridermium (Æcidium) complanatum**, Barclay, var. **corticola** which I found killing off a number of the young plants in the Kalimath plantations at Almora.

LIST OF INSECTS ATTACKING THE CHIR PINE (PINUS LONGIFOLIA) SHOWING PARTS OF THE TREE INFESTED BY THEM.

I.—Insects infesting every part of both young and old trees.

Coleoptera.—Cryptorhynchus Brandisi, n. sp.

II.—Insects infesting the bast layer and wood of the main stem and larger branches.

Coleoptera.—Anthaxia Osmastoni, n. sp.; Capnodis indica; Nothorrhina muricata; Polygraphus longifolia; Tomicus (Ips) longifolia.

III.—Insects infesting the bast layer and sap wood of branches only of larger trees and main stem of seedlings and young saplings

Coleoptera. Cryphalus longifolia; Noctua? sp.

IV.—Insects destroying the leading and other shoots.

Lepidoptera. Pyralid sp.; Cecedomyia? sp.

V.—Insects infesting the wood of the main stem and large branches.

Coleoptera.—Rhyncholus sp.; Hylastes longifolia; Plytypus Wilmoti

VI.—Insect infesting the dead wood of the tree.

Termes sp.

LIST OF INSECTS PREDACEOUS AND PARASITIC UPON THE PINUS LONGIFOLIA INSECT PESTS.

I.—Upon Cryptorhynchus Brandisi.

(*a*) Parasitic Insects—

(1) Ichneumon sp.—Grub feeds as an external parasite on weevil larva.

(2) Cuckoo-Wasp.— Ditto ditto.

(*b*) Predaceous Insects—

(1) Elaunon bipartitus—Predatory on weevil grubs and pupæ.

II.—Upon Tomicus (Ips) longifolia and Polygraphus longifolia, also upon Rhyncholus sp.

(*a*) Parasitic Insect—

(1) Chalcid sp.—Grub feeds as an external parasite on the scolytid beetle grubs.

(*b*) Predaceous Insects—

(1) Xiponius canalicollis, Lewis.—The grubs feed upon the larvæ of the scolytid bark borers.

(2) Paromalus ? sp. or Platysoma ? sp.—The grubs feed upon the bark borer grubs and perhaps on the eggs.

III.—Upon Cecedomyia ? sp.

Parasitic Insect—

(1) Trigonomerus sp.—The grubs feed as external parasites upon the larvæ of *Cecidomyia* sp.

I.—INSECTS INFESTING EVERY PART OF BOTH YOUNG AND OLD TREES.

1.—CRYPTORHYNCHUS BRANDISI, n. sp.

THE CHIR PINE WEEVIL.

Nature of Attack.

The grubs feed in the bast layer and outer sap wood of the tree, eating out longish irregular galleries. When full fed they gnaw out elliptical depressions in the sap wood and pupate in these. The beetle on maturing bores its way out through the bark and escapes from the tree. When numerous the insect is capable of killing the tree.

Previous Records.

This insect would appear to be unrecorded from the Indian Region : specimens submitted to the British Museum in 1907 proved the species to be new to the collections.

Distribution.

The weevil is spread throughout the **Pinus longifolia** forests of the North-West Himalaya. In the Eastern Himalaya and Bhutan and neighbouring mountain ranges to the East the **P. longifolia** is replaced by the **P. khasya** which is attacked in a similar manner by an allied species of Cryptorhynchid weevil.

Description.

Larva.—A fat yellowish white rather curved grub. Head well marked dark yellow.

PLATE XV.

FIG. 1.—*Cryptorhynchus Brandisi*, n. sp.—Side view of larva.

1*a*. Cocoon made by larva.

1*b*. Ventral view of pupa.

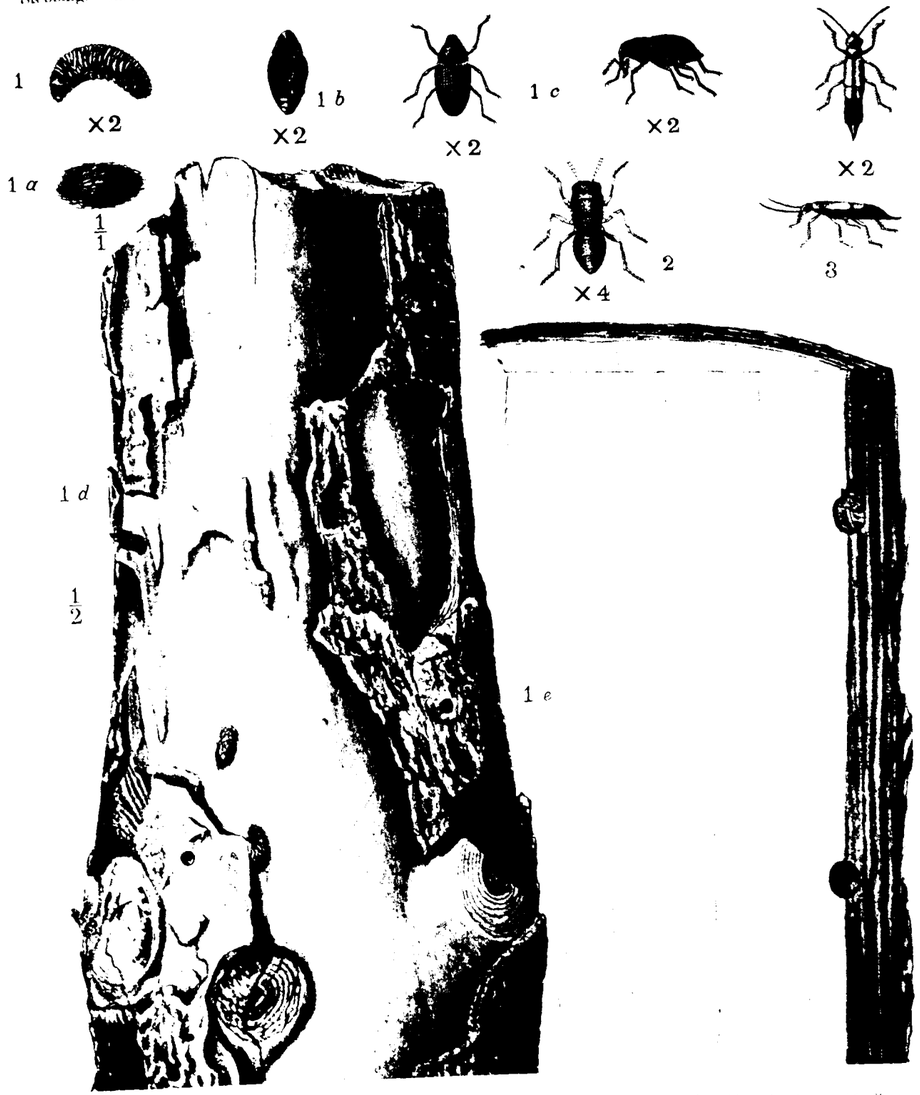
1*c*. Dorsal and side view of beetle.

1*d*. Portion of the stem of a young Pinus longifolia pole showing the attacks of the larvae in the bast and sap wood. Two cocoons are shown *in situ* on the sap wood (about $\frac{1}{3}$rd up) and the exit holes of the matured weevils in the bark.

1*e*. Pupating chambers, with a mature weevil in one of them, in the bark and sap wood of a portion of a Pinus longifolia stem.

FIG. 2.—Dorsal view of the parasitic *Cuckoo Wasp*.

„ 3.—Dorsal and side view of the predaceous beetle, *Elaunon bipartitus*, Kirby



J. B. Singh, del.

1. Cryptorhynchus Brandisi, n.sp.
2. Cuckoo-Wasp.
3. Elaunon bipartitus, Kirby.

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Prothracic segments swollen and corrugated with a horny plate dorsally. Body corrugated, the segments tapering to a blunt point posteriorly. Length ½ inch. Plate XV, fig. 1; Plate XVI (*near upper part of stem*).

Cocoon.—Blunt elliptical with rounded curved sides. It is made of shredded bark and wood strips loosely bound together so as to fit fairly tightly into the elliptical shaped hole gnawed out in the sap wood and bark for its inception. Plate XV, figs. 1*a*, 1*d*.

Pupa.—Yellowish white, thick and blunt ended. Somewhat ovate. Wings and legs are pressed against the chest. Also antennæ (fig. 1*b*).

Beetle.—Greyish brown. Elongate ovate. Head small, blackish brown; the rostrum fairly long and bent vertically downwards. At rest it is tucked under the body. The antennæ are situated towards the lower part of rostrum and fit into grooves on it. Eyes large, strongly facetted.

Prothorax greyish marked with small spots; triangular, smooth, slightly punctate.

Elytra channelled constricted on a curve to apex, grey brown in colour, pubescent; apical margins reflexed; longitudinally punctate, the punctures in parallel rows. Legs elongate fairly robust, punctate. Length ½ inch. Fig. 1*c* shows a dorsal and side view of the beetle.

Life History.

Egg laying.—The female beetle crawls into the deep crevices in the bark of the tree and lays her eggs probably singly in the smaller crevices of the thin lower layers of bark or pierces down to the cambium layer and places them there. The young larvæ on hatching out remain in the thinnest portion of the cambium layer at first eating out a small gallery in an irregular fashion.

Larval gallery.—As it increases in size the grub eats out a deeper gallery in the thick cambium and bark, the gallery also grooving the sap wood. This gallery has always a very irregular shape and gradually increases in diameter as the grub grows larger. The gallery may be very irregular and winding proceeding round the circumference of the tree or it may proceed up or down the tree in a more or less winding vertical manner, the tunnel having small horizontal bends in it at intervals due to the fact that the larva has for a time taken to boring horizontally instead of vertically. It may be possible that these horizontal portions in the gallery are made just before one of the moultings of its skin which take place periodically during the growth in size of the grub. When the grub has reached its full size and just before pupating the gallery is often curved at right angles to its previous direction and the larva then eats out the pupating chamber in the sap wood and bark. In Plate XVI a grub is shown in this position at the top of the stem.

As has been said the gallery increases in size with the development in bulk of the larva so that by the time the grub approaches full growth the gallery is from 3 to 4 times the breadth of its occupant. The larval gallery is always filled with loosely packed ejected wood

dust and wood excreta containing short strands of ligneous wood fibres. Owing to the irregular method of feeding of the grub the length and breadth of the larval galleries varies very greatly, but galleries have been measured as long as 9 inches in length whilst others have wound about in an area of bark 6″—8″ square. Plate XV, fig. 1*d*, in which most of the bast is shown as removed, and Plate XVI show the larval galleries in the cambium and sap wood.

Pupation of Larva.

The position of pupation appears to vary according to the size of the tree attacked and consequent thickness of the bark present. In the case of old trees where the bark is very thick the insect eats out an elliptical pupating chamber which is made entirely in the inner bark of the tree and does not groove the sap wood. This chamber or cradle is lined with particles of bark fibres forming a rough loose cocoon in which the larva pupates. In the case of young trees on the other hand the larva eats out an elliptical depression in the sap wood about $\frac{1}{2}$ to $\frac{3}{4}$ inch in length and having the appearance of a small cradle. The other half of this ellipse is eaten out in the cambium layer (see fig. 1*e* in which a newly matured beetle is shown *in situ* in a cradle) and bark and the two halves are then lined with a thick interwoven mass of stringy wood fibres which fit rather tightly into the cradle (fig. 1*d*). In this cocoon the larva changes into the pupal stage.

Emergence of the beetle from tree.

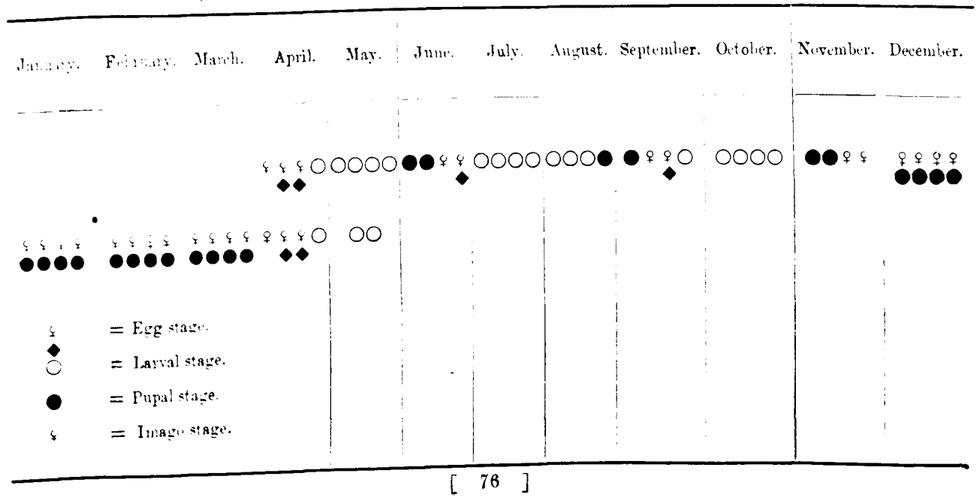
When the beetle is fully mature and consequently ready to leave the tree it bites out a circular hole at one end of the cocoon fig. 1*d*, the lower of the two cocoons shown and crawling out of this bores a large circular hole through the thick bark of the tree and thus escapes from it. These holes have a very considerable diameter and are very easily seen even in the thick bark which this tree puts on (*vide* Plate XV, fig. 1*d*, and Plate XVI). Observations of attacked trees have shown that the newly mature weevils do not always get out of the tree in safety owing to the outflow of resin which at times catches the beetles whilst engaged in boring their way through the bark and drowns them. Instances of this have been observed *in situ* in the trees.

Number of Life cycles or generations passed through in the year.

It is difficult at present to state with any certainty the number of generations which this weevil passes through in the year since the insect is so often found in the tree in all three of its stages of larva, pupa and beetle. I am inclined to consider, however, that the insect has normally three generations in the year, but that these generations overlap very greatly, thus giving rise to the appearance of their being an almost continuous succession of larvæ and pupæ in the trees throughout the year. An examination of infested trees at the commencement of the winter (about the middle of November) will show that almost mature and immature beetles are present in the pupal cradles and that these pass through the winter in this position. The larvæ in the trees which have not as yet pupated will probably all pupate before the severe cold commences so that the winter is

probably chiefly passed in the pupal or mature beetle condition. We have no data at present as to when this insect commences work at the beginning of the season, but it would probably be sometime in April at the latest, the pupæ maturing and the mature beetles egg laying sometime during this month. Observations carried out by myself in 1908 in Kumaun have shown that a generation of beetles matures and issues about the first week in June and probably lays eggs about the middle of that month. The larvæ arising from these eggs have been found to give rise to the full grown larvæ, pupæ and immature beetles reported by Mr. Milward as infesting trees in the Almora Plantations at the beginning of September (this being the first report of this insect occurring as a pest), the generation of beetles maturing about the middle of September and laying eggs towards the latter part of that month. The larvæ hatching from these eggs were found half grown in the middle of October in the trees examined by myself in Jaunsar in 1906 and this forms the over wintering generation of the insect. We thus have three generations in which the mature beetle (*i.e.*, egg) and pupal stages are from a week to a fortnight in duration whilst the larval stage, that is the period during which the chief damage is done to the tree, lasts roughly from 6 to 8 weeks. The winter hibernation probably lasts for some four months from December to the end of March. Of course elevation and severe or mild winters will greatly modify the duration of this period and consequently the data of appearance of the various generations which, *du reste*, necessarily overlap owing to the insect commencing the year in both the pupal and perfect insect stages; the eggs laid by the latter as soon as the weather is favourable thus having the start over the ones laid by the beetles who have to first mature from the pupal stage through which the winter has been passed.

The life history may be reproduced diagrametically as follows :—



Relations to the Forest.

The damage arising from the presence of this insect in a forest is two-fold—

(*a*) It attacks young green standing growth of all kinds from the moment that the seedlings have developed a bark thick enough for the larvæ to feed in. This bark in the case of the **Pinus longifolia** is developed at a very early age, often in trees as young as 3 –4 years old.

(*b*) The beetle attacks with equal facility green trees of all ages up to old standing trees of large size, laying its eggs either deep down in crevices in the thick bark at the base of the tree or anywhere in the bole higher up and in the crown. A standing green apparently healthy tree of 14 feet girth was found attacked in this manner in Jaunsar in November 1906.

The beetle must be looked upon, as is the case with many of the weevil family, as particularly hardy and resistant to outside influences; and this is so both in the larval and mature beetle stage. The larvæ once hatched would seem to have more than the usual chances of reaching maturity since they are to be found wallowing in the outflow of resin poured out by the tree in answer to their operations in the bast layer; the resin appears to be particularly palatable to them.

The powers of multiplication of the beetle also seem to be considerable.

The danger of an insect of this nature gradually increasing in numbers and acquiring a hold over a forest is of course much greater in the case of pure forests than in that of mixed ones and this danger is existent in this instance since the **Pinus longifolia** is to be found pure over considerable areas in the North-West Himalaya.

Protection and Remedial Measures.

Protection and remedial measures against this weevil although a somewhat difficult matter are quite feasible when the pest has to be dealt with in plantations. The first step to be taken is to accurately determine the dates during the year at which for any particular locality the trees contain larvæ, pupæ and immature beetles. Having decided upon these periods the whole of the infested trees should be cut out and burnt. Badly infested trees can be easily recognized owing to the fact that their needles commence to turn yellow and the tree to fade. In the case of young plantations a little careful observation on the part of Forest Guards should make it possible for them to be able to mark down attacked trees upon which the needles have not yet turned yellow since the bark of the trees is invariably coated with a mass of resin exuding from the exit holes of mature beetles which have found their way out of the trees. It is by means of these resin masses, which in the case of badly infested older poles and large trees thickly coats the bark more especially in the regions where the side branches take off from the main stem, that infested trees can be easily recognized.

PLATE XVI.

Portion of a young *Pinus longifolia* pole showing the larval galleries of the weevil *Cryptorhynchus Brandisi* in the bast layer and outer sap wood. In the upper portion a larva is shown *in situ* in a gallery. Just above the nibbled a pupal chamber in section is visible. Another, with the exit hole of a matured beetle in the bark is seen at the base.

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Young green Pinus longifolia stem showing the attacks of the Weevil Cryptorhynchus Brandisi in the bast and sap wood.

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As in the case of young trees in plantations so in that of older trees in the forest the only plan to prevent the attack spreading to uninfested trees is to cut out the attacked ones, strip off the bark and burn it. This operation must, to be satisfactory, be done at the periods when the insect is in the larval and immature beetle stage as shown in the table of the life cycles. This would be towards the end of May, middle of August or during the long winter period of hibernation. In fact where possible I should always advise remedial measures against this pest being undertaken during the period of hibernation in the winter. At this season there are no beetles on the wing in the forest so that it is possible to ensure killing off the whole of the insects which are responsible for the dying condition of the trees and of thus clearing effectually a plantation or an area of forest from the pest.

It must be borne in mind, however, that it will be of little use cleaning one set of infested areas of the beetles if other affected areas in the neighbourhood are left untended. And this applies more particularly to the Kumaun **P. longifolia** forests. In this region there are a number of district forests which are not under the Forest Department and through which annual fires are allowed to run unchecked and mutilation of the forest growth on the area takes place. It is in such areas that the weevil has the greatest scope for increasing rapidly, for it finds here large numbers of trees weakened by fire and mutilation which serve it as exceptionally fine breeding places. I personally examined several areas of this kind in all of which I found the weevil in abundance. It is probable that the greatest difficulty to be faced in endeavouring to prevent the spread of this pest on a large scale throughout the **P. longifolia** forests confronts the Forest Officer in the presence of these areas of fire swept and mutilated forests in the Naini Tal and the Kumaun Districts. Not only do these areas serve as breeding grounds of the weevil, but as we shall see later, they are equally favourable to the multiplication of the Buprestids **Capnodis** and **Anthaxia**, the **Nothorrhina** longicorn beetle and the dangerous **Noctua** moth bast eating caterpillar.

The condition of the Baldhoti and Kalimath Plantations in 1908, especially the latter, and of the district pine forests form definite examples of the dangers existing from and the difficulties to be faced in connection with the state of the district **P. longifolia** forests. I was given to understand by the Commissioner of the Kumaun Division that District Officers were engaged in forming plantations of **P. longifolia**. There can be little hope of either these or those formed by the Forest Department proving successful unless the destruction going on in the civil forests is put an end to and an effective check on the increase of the beetles thus established.

Points in the life history requiring further observations.

The chief point to be established at various elevations in which the **P. longifolia** flourishes is the exact dates at which the trees are found to be full of larvæ and immature beetles as this is intimately connected with the remedial measures to be introduced to combat the insect.

It is also of importance that the number of eggs laid by the female beetle should be ascertained.

PARASITIC AND PREDACEOUS FOES OF CRYPTORHYNCHUS BRANDISI.

PARASITIC INSECTS.

2. ICHNEUMON sp.

Nature of Attack.

The ichneumon grub is parasitic upon the weevil larva, feeding upon the fatty tissues of the latter and causing its death from exhaustion when they have both reached full size.

Previous Record of the Insect.

I have no previous record of the insect.

Description.

Larva.—A minute white grub—almost translucent in colour with head pale canary yellow.

Fly.—Small yellowish in colour with four iridescent wings. Body curved and armed with 3 long fine hairs or styles at posterior end.

Life History.

I have taken this insect but sparingly at present. The only stages observed are those of the larva and mature ichneumon fly which were found in the characteristic pupal chamber made by the weevil larva. It is probable that the fly lays its eggs close to those laid by the weevil in crevices of the bark of the tree or in the neighbourhood of or on the newly hatched weevil grub. I have not yet discovered whether the ichneumon grub feeds on the weevil larva as an external or internal parasite. The weevil grub is evidently not killed until it has finished the construction of the pupal chamber. It then dies and the hymenopterous parasite pupates. The mature fly evidently issues from the tree at the same time as the weevil beetles since both were found maturing or mature and leaving the tree at the Baldhoti Plantation near Almora in the first week of June.

There is a good deal still to be learnt about this most useful parasite. Exactly where the eggs are laid and whether more than one ichneumon larva parasitises each weevil grub are important points to ascertain. Also whether the insect, as is probable, passes through the same number of life cycles as its host.

3. CUCKOO-WASP.

The small cuckoo-wasp figured in Plate XV, fig. 2, was taken by myself from one of the pupating chambers of the weevil in a young tree. The fly was just mature. It would appear probable that the insect lays its eggs in the weevil grubs and that the young cuckoo-wasp larvæ feed upon and eventually kill the weevil grubs.

The point is one of great interest since it is the first record I have of the cuckoo-wasps being of use in the Indian forest as parasites of noxious tree pests.

4. ELAUNON BIPARTILUS, Kirby.

Nature of Attack.

Predaceous upon the weevil **Cryptorhynchus Brandisi.**

Previous Records of Insect.

I have only taken this insect in the Kumaun P. longifolia forests.

Description.

Beetle.—Elongate narrow. Brown; the elytra bright canary yellow. Antennæ and legs slender, yellow. Length 1 inch. Plate XV, fig. 3, shows a dorsal and side view of the beetle.

Life History.

The grub of this beetle is, I think, predaceous upon the grubs of the Cryptorhynchid weevil.

I took a number of fully mature beetles from the dying tree felled in the Baldhoti Plantation on 8th June and others subsequently in the young dying trees in the Kalimath Plantation. The beetles were found between the bast and sap wood.

I know nothing further about this insect.

II.—INSECTS INFESTING THE BAST LAYER AND WOOD OF THE MAIN STEM AND LARGER BRANCHES.

5. ANTHAXIA OSMASTONI, n. sp.

Nature of Attack.

The grub feeds in the bast layer of the tree forming galleries which destroy it and slightly groove the sap wood. When full fed the grub bores a short tunnel into the sap wood and pupates there.

Previous Records of Insect.

This buprestid is new to science. I take pleasure in naming it after that excellent Forester and Naturalist Mr. B. B. Osmaston, I.F.S., Conservator of Forests.

Thompson * alludes to a small species of buprestid shining olive in colour with yellowish white spots which attacks chir wood, sometimes rendering it unfit for beams. I cannot trace this insect and know of no buprestid which could act in this manner.

Description.

Larva —Short, elongate, with a small brownish yellow head, back mandibles and a large flat spherical segment following the head. The segments following this one are all very much smaller in diameter and of approximately the same size save the last which tapers posteriorly. Length 2 inches (Plate XVII, fig. 1).

The shape of the larva is most characteristic and renders it easily distinguishable from the longicorn one (**Nothorrhina**) with which it is occasionally found in the tree.

Beetle.—Small, oblong, flattened. Head and thorax golden green with a coppery reflexion; elytra greenish-blue basally, merging into dull bluish-green in apical half. Head flat, granulose. Prothorax rugose punctate, sides curved with a prominent depression on either side in basal half. Scutellum triangular, punctate, golden green. Elytra rugose, flat, except near the base where they are irregularly elevate above a transverse basal depression; ides sinuate at level of coxæ and constricted in apical third; apex rounded. Length about $\frac{1}{3}$rd inch (8 millim.) (near *A. Baconis*), *vide* Plate XVII, fig 1*a*.

Life History.

Little appears to be known upon the life history of this small buprestid. Grubs of various sizes were taken by myself in the bast layer of trees in the middle of October in Jaunsar in 1906, and it is probable that these grubs hibernate through the winter in this position in their larval galleries and pupate sometime during the spring. The perfect beetle was found mature and issuing from the trees or ready to issue at the end of May (in Kumaun in 1908).

Thus it appears probable that the life cycle takes a year to pass through from egg to perfect beetle as is the case with the small Deodar buprestid already described at page 24 in Part I of this Memoir.

The egg is probably laid by the beetle in crevices in the bark of the tree sometime in June. The grub on hatching out at once tunnels down into the bast layer and feeds in this, at first eating out a small gallery of irregular shape; as it grows larger, the gallery increases in size and goes down into the bast and also grooves the sap wood

* Thompson—Report on Insects destructive to Woods and Forests by R. Thompson, Assistant Conservator, Garhwal Forest (Allahabad Government Press, North-Western Provinces, 1868).

PLATE XVII.

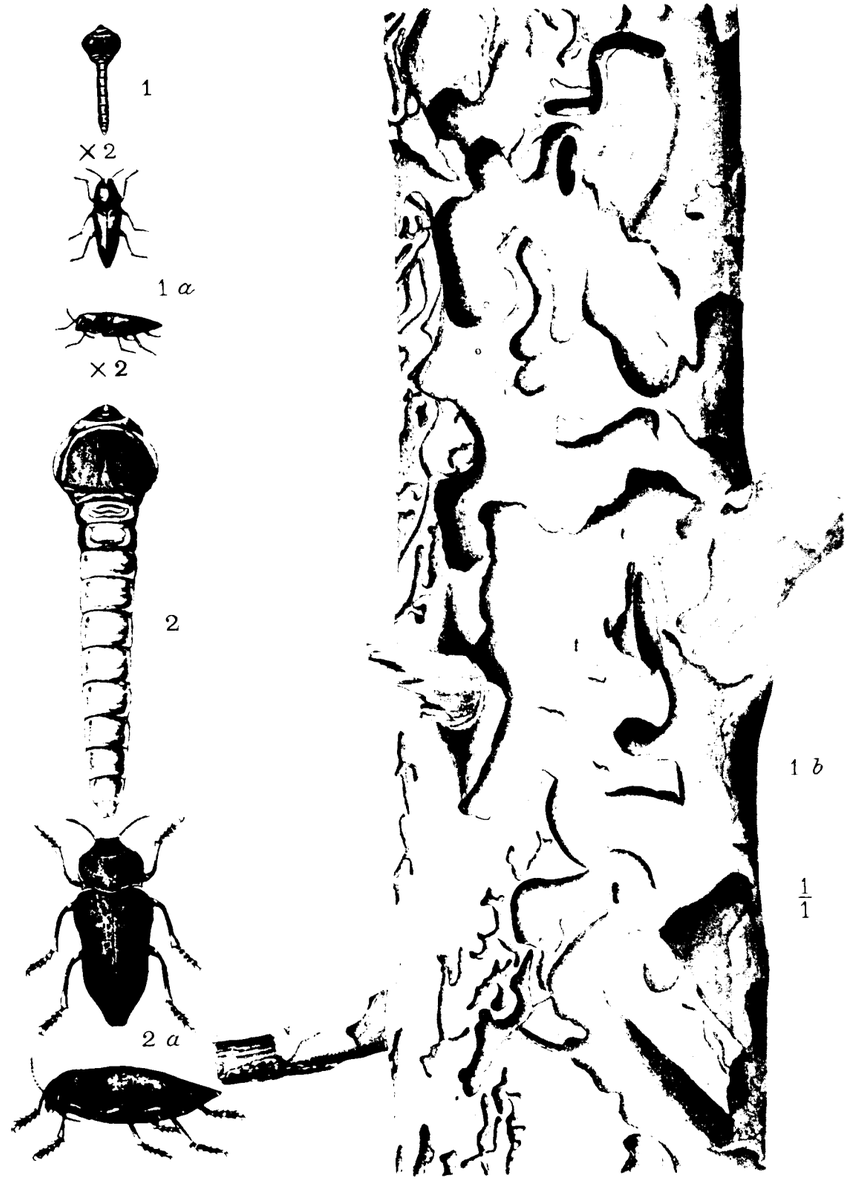
FIG. 1.—*Anthaxia Osmastoni*, n. sp.—Dorsal view of the larva.

1*a*. Dorsal and side view of the beetle.

1*b*. Portion of a Pinus longifolia stem showing the larval galleries of *Anthaxia Osmastoni* (the smaller ones) and *Capnodis indica* (the larger ones) in the sap wood. The entrances to pupating chambers are seen at the top of the stem.

FIG. 2.—*Capnodis indica*.—Dorsal view of the larva—

2*a*. Dorsal and side view of the beetle.



J. B. Smith, del.

1. Anthaxia Osmastoni, n. sp.
2. Capnodis indica.

[to face page 12]

(the smaller galleries in Plate XVII, fig. 1*b*). When full fed the grub bores a short elliptical tunnel down into the sap wood and then cuts out an elongate pupating chamber parallel to the long axis of the tree (*vide* upper portion of stem shown in fig. 1*b*).

The larval gallery in the bast is blocked with excreta and wood dust, but that in the sap wood is free of both. The beetle on maturing crawls up this empty larval tunnel and on reaching the bark bores its way through it and escapes from the tree.

6. CAPNODIS INDICA, Thoms.

Nature of Attack.

This buprestid attacks the tree in a very similar manner to the last. It is a much larger insect, however, and the larval galleries are consequently broader and longer and the damage done to the tree is greater (*vide* Plate XVII, fig. 1*b*).

Previous Records of the Insect.

A species of **Capnodis, C. indica,** is very plentiful in the Western Himalaya, and I am of opinion that the large buprestid grubs shown in Plate XVII, fig. 2, and taken in **Pinus longifolia** which are undoubtedly **Capnodis** ones may be those of this species.* This is the first report of these grubs feeding in and destroying the bast of this tree.

Distribution.

Capnodis indica is reported as spread throughout the Western Himalaya being replaced by **C. miliaris** in Baluchistan and the Suliman Range to the West.

Description.

Larva (full grown).—Elongate cylindrical whitish yellow with a small head and 12 segments following it which gradually taper posteriorly from the 2nd. The prothoracic segment is of great width and size and has a hard thick orange plate on its dorsal surface. Length 2½ inches (*vide* Plate XVII, fig. 2).

Beetle.—A stout broad insect. Black with spots and patches of golden metallic colour, studded with punctures on head, thorax and elytra. Thorax wider than broad, outer margins rounded. Elytra with the outer margins wavy, acuminate at tips. Legs stout. Length 1¼ inches. The shape of this beetle is very characteristic and renders it easily recognisable. Plate XVII, fig. 2*a*, shows a dorsal and side view of the beetle, natural size.

Life History.

Full grown larvæ of this buprestid were taken in pine trees in Kumaun in the first week in June. The beetle is usually to be found on the wing during July, August and perhaps

* I have since confirmed this supposition.—E. P. S.

September. This is all that is at present known upon the life history of the insect. The grub probably spends the period between sometime in July or August and the following May in the larval stage feeding during this period entirely in the bast and sap wood in which it eats out long irregular larval galleries (as shown in Plate XVII, fig. 1*b*, the large wide galleries) which are packed with wood dust and excreta. On reaching full size the grub bores down into the sap wood and eats out a pupal chamber in it and pupates in this. On maturing the beetles leave the tree, pair, and the female seeks a suitable tree in which to lay her eggs in crevices in the bark.

7. NOTHORRHINA MURICATA, Dalm.

THE CHIR PINE LONGICORN.

Nature of Attack.

The larvæ feed comparatively close together in the tree and eat out irregular winding galleries in the bast and sap wood, gradually, when numerous enough, removing all the cambium layer, girdling the tree and thus killing it.

Previous Records of the Insect.

There appear to be no records extant of the infestation of the **Pinus longifolia** by this beetle. Mr. Gahan, to whom I submitted the beetles for identification, wrote: "The beetle is a species of *Nothorrhina* in which I find no characters that will enable me to distinguish it from the European *N. muricata*, Dalm. Your species are somewhat larger than any we possess and I have not previously seen any from India." This is then yet another instance of a common and what may easily prove to be a serious pest having been as yet unreported from the country.

Distribution.

As at present known the insect is common throughout the *Chir* pine tracts of the North-West Himalaya.

Description.

Larva.—A thick whitish elongate grub with a pale brown prothorax, broader than the other segments. The latter are well marked and tuberculate. Head small, yellow, mouth parts black. Length ¾ to 1 inch. (Plate XVIII, fig. 1, shows a side view of the larva.)

Pupa.—Elongate, white, slender, narrow, tapering posteriorly. Antennæ, wings and legs are pressed against the chest. Plate XVIII, fig. 1*a*, shows the ventral surface of the pupa. Length ⅞ to 1⅛ inch.

Beetle.—Elongate, rather slender, the pygidium exposed in the ♂, the antennæ in latter not reaching to middle of body. Black; prothorax dark brown with a reddish tinge laterally and a central red spot; antennæ brown. Head with 3 impressed foveæ placed triangularly between the eyes; punctate. Prothorax squarish, raised medianly, finely punctate, coarsely rugose laterally, posterior angles constricted. Elytra broader than prothorax behind, widest

PLATE XVIII.

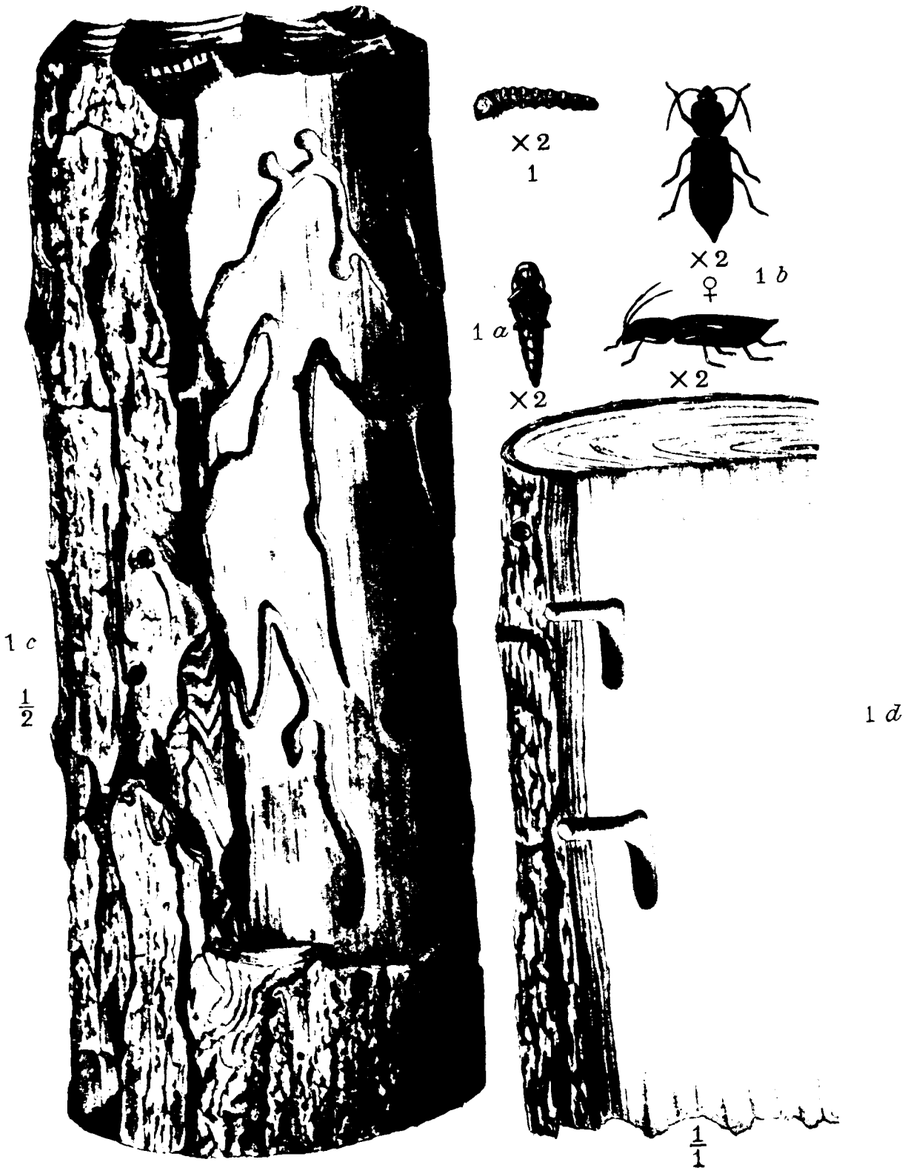
FIG. 1.—*Nothorhina muricata*.—Side view of larva.

1*a*. Ventral view of pupa.

1*b*. Dorsal and side view of the female beetle.

1*c*. Section of a stem of Pinus longifolia showing the larval galleries in the sap wood, with the entrances to the pupating chambers at the end of two of them, and two exit holes made by matured beetles through the bark on leaving the tree.

1*d*. Section of a stem showing two pupating chambers in the sap wood with the entrance tunnels leading down to them.



J. B. Singh, *del.* **Nothorrhina muricata in Pinus longifolia.**

[*to face page 14*]

in apical fourth, constricted from here to apex, latter separately rounded; rugose punctate with 4 elevate longitudinal carinæ. Under surface reddish-brown; abdominal segments reddish-yellow, darker at sides.

Length about $\frac{1}{2}$ inch. Plate XVIII, fig. 1*b*, shows the beetle.

Life History.

From observations made into the life history of this insect it would appear that it passes through but one generation or life cycle in the year.

The beetle appears on the wing in the forest sometime in June, probably being first found about the middle of the month. The eggs are laid in crevices of the thick bark of the tree in June, July and the grubs on hatching out bore down to the bast layer and at first feed entirely in this, eating out a winding gallery. With the growth of the grub this gallery increases in depth and width and grooves the sap wood as well as removing all the inner bast layer of the bark. As will be seen from the illustration (fig. 1*c*, Plate XVIII) these galleries differ to some extent in appearance being taken either straight up parallel to the long axis of the tree or winding about indefinitely with a good deal of horizontal direction. The larval galleries are always packed with a mass of wood excreta and dust ejected by the grubs which fill them and owing to their darker brown colour render them conspicuous objects in the inner bast and on the outer sap wood. The winter is passed in the semi-grown larval stage, the grub remaining at the end of its tunnel in a semi-comatose condition and not feeding during the colder and frosty months of this season. With the advent of spring the larva wakes up, recommences feeding and carries the larval gallery in the bast and sap wood for some distance further. When full fed it bores down into the sap wood eating out a tunnel about $\frac{3}{4}$ to 1 inch in length. This tunnel is carried down either at right angles or at an acute angle to the surface of the sap wood and ends in a chamber of two or three times the diameter of the tunnel which is eaten out parallel to the long axis of the tree; this chamber is the pupal chamber and the larva changes to a pupa in it. Fig. 1*d* in Plate XVIII shows two such tunnels and pupating chambers in a portion of the stem of a tree. The head of the pupal chamber is always blocked with a mass of wood fibres and the larva may close the entrance to it with a similar mass before pupating.

This change takes place sometime towards the end of April, and about six weeks is spent in the pupal and immature beetle stage. When mature the beetle crawls out of the pupal chamber and up the tunnel made by the larva in the sap wood, this tunnel as well as the pupal chamber being always quite free of wood dust and larval excreta, and bores its way through the bark and so escapes from the tree. One such exit hole is shown in the bark in fig. 1*d* and two others in fig. 1*c*.

On escaping from the tree the beetles mate, and the female lays the eggs of the next generation on the bark of fresh trees.

Damage Committed in the Forest by the Buprestid and Longicorn Beetles.

It will be seen from a study of the life histories of the buprestid and longicorn beetles infesting this tree that there is a very considerable similarity in the method of attack of all three beetles. The egg is laid in crevices of the bark of the tree and the grub on hatching out feeds in the bast and sap wood. If the insects are plentiful in a tree they will in time destroy all the bast or cambium layer and the tree will die; and this is the danger to which a **P. longifolia** is subject from these insects. Both the **Anthaxia** and **Nothorrhina** insects are common and are to be found at times in numbers in the trees. All these species attack the tree from the sapling stage upwards. Only green, sickly or newly felled trees are infested, the latter two being preferred and sought out.

Dead trees are not attacked. Present observations would seem to show that the *Nothorrhina* beetle is the commoner of the three.

Protection and Remedial Measures.

Protection and remedial measures against these insects are very similar to those already detailed for the Cryptorhynchid weevil pest. The best time undoubtedly to undertake them would be the winter months when all these insects are in the larval stage in the bast layer of the tree.

A simple plan to ascertain the abundance of the insects in the forest is to fell a few trees or better still ring them and leave them as trap trees on the area. A monthly examination of these trees will show how plentiful the insects are in the locality. If the trees are seen to be heavily attacked by buprestid and longicorn larvæ it will mean that the insects exist in the forest in some numbers.

Points in the Life History requiring further observation.

The number of eggs laid by these beetles is at present unknown. Also the exact number of months spent in the larval stage and the length of the pupal stage. Is the winter always passed through in the larval stage? Do the beetles only appear on the wing in the forest for a definite period of about a fortnight sometime during June or early July or do they issue irregularly from the tree all through the summer months?

This would seem to be possible in the case of the **Capnodis** beetle.

8. POLYGRAPHUS LONGIFOLIA,* Steb.

THE LONG NEEDLED PINE POLYGRAPHUS.

Reference. Steb. Departmental Notes on Insects that affect Forestry, I. 255.
Steb. Ind. For. Memoirs, For. Zool. Ser. I, Pt. I. p. 10.

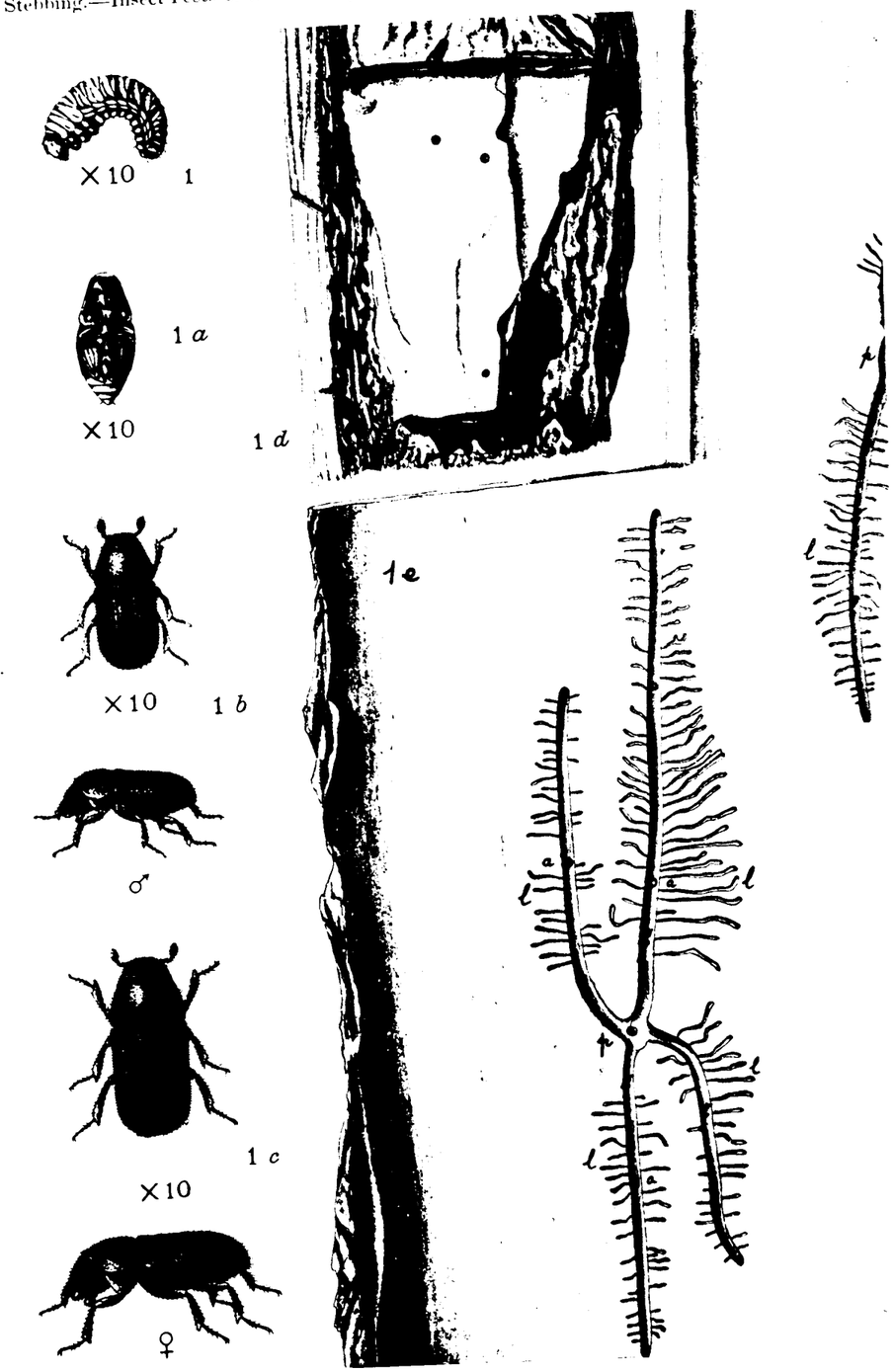
Nature of Attack.

The male beetle bores down through the bark and eats out a small pairing chamber in the bast and sap wood.

* I have described in my Memoir *On some undescribed Scolytidæ of Economic Importance from the Indian Region* (Ind. For. Memoirs, For. Zool. Ser. I. Pt. I, p. 8) a second species of Polygraphus *P. Himalayensis*, Steb., infesting the *Pinus Longifolia*. I have only taken this species sparingly, however, in Jaunsar in the main stem of old trees. I do not at present rank it as a pest.

PLATE XIX.

FIG. 1.—*Polygraphus longifolia*, Steb.—Side view of larva.
1*a*. Ventral view of pupa.
1*b*. Dorsal and side view of male beetle.
1*c*. Dorsal and side view of female beetle.
1*d*. Entrance holes made in the outer bark (upper bark scale removed) by the male beetles.
1*e*. Pairing chamber (*p*), egg galleries (*g*), aëration holes (*a*), and larval galleries (*l*) of *Polygraphus longifolia* in the inner surface of the bark of a *Pinus longifolia* tree.



J. B. Singh, *del.*

Polygraphus longifolia, Steb. in Pinus longifolia.

[*to face page 16.*]

Three females enter by the male tunnel and after pairing with the male eat out egg galleries in the bast away from the pairing chamber laying eggs at the sides of the tunnels so bored. The larvæ on hatching bore away more or less at right angles to the egg gallery. When numerous the insects remove all the bast layer of the tree and the latter dies (*cf.* Plate XIX, fig. 1*e*).

Previous Records of the Insect.

This insect was alluded to in **Departmental Notes**, having been taken by the writer in Bashahr in 1901 and in Tehri-Garhwal in 1902. I know of no other record of this insect.

Distribution.

I have taken this insect in the **P. longifolia** forests of Bashahr, Tehri-Garhwal, Jaunsar, Chamba and Kumaun, all in the North-West Himalaya.

Description.

Larva.—White curved and corrugated with no legs. Head small yellow shining. Length $\frac{1}{10}$th inch. (Plate XIX, fig. 1.)

Pupa.—White tinged with yellow, pointed posteriously with small flaps showing wing outgrowths and short legs and antennæ all pressed against lower surface. Length $\frac{1}{10}$th inch (fig. 1*a*).

Beetle.—Oblong. Head black. Prothorax and elytra dark chestnut brown. Antennæ and legs yellow, the legs except tarsi with a slightly chestnut tinge. Head with a sparse short circular yellow brush of hair on front; the vertex almost smooth with a fine shining short median longitudinal line meeting prothorax posteriorly and a few fine scattered punctures on surface.

Prothorax about $\frac{1}{2}$ as broad as long; punctate, the punctures not dense.

Elytra not quite twice as long as thorax, slightly dilated towards apex; striate-rugose, the rugosities absent in the apical fourth, most prominent basally where the elytra are clothed with a fine whitish yellow pubescence interspersed with a few long stiff yellow hairs, the rest with a fine short sparse pubescence. The male beetle is smaller than the female.

Length 2·75 to 3 millim. ($\frac{1}{8}$th inch). Fig. 1*b* in Plate XIX shows a dorsal and side view of the male beetle and fig. 1*c* the same of the female beetle.

Life History.

This beetle is a common pest of the pine in Kumaun and the areas to the west, Jaunsar and Tehri-Garhwal. The male beetle bores through the thick bark of the tree making a circular entrance hole which is usually very distinctly seen on the outside (*cf.* fig. 1*d* which shows several entrance holes and one in section). This entrance tunnel leads to an enlarged circular or heart-shaped chamber, the pairing chamber (*p* in fig. 1*e*), which is eaten out

either in the bark itself or, where the bark is thinner, in the bast and sap wood. It will not infrequently be found, however, that there is no evidence of this chamber in the sap wood.

From two to three (or at times four) female beetles enter successively the pairing chamber and after fertilisation eat out each a long gallery in the bast layer of the tree ; these are the egg galleries and they are carried in opposite directions or two up and one down (if three females pair with a male) parallel to the long axis of the tree ; *g* in fig. 1*e* indicates the egg galleries ; the egg gallery is either quite straight or it may have small zigzag curves in it or even small off set prolongations and may be as much as 3 inches in length. Two or more aëration holes (*a* in fig. 1*e*) are eaten out by the female beetle through the bark to the outside to allow of air entering the gallery, which is otherwise blocked up its whole length with the loosely packed wood dust and excreta of the beetle much in the same way as is the tunnel of **P. Trenchi** in *Pinus Gerardiana*.

The eggs are placed, as is customary with these beetles, in small notches eaten out in the walls of the egg gallery. The larvæ on hatching out make very irregular galleries carried in a direction more or less at right angles to the egg gallery (*l* in fig. 1*e*). The larval galleries are made entirely in the bast layer and they pupate here as well except in cases where small branches are infested when the pupating chamber is eaten out in the sap wood to some extent. The beetle lays as many as 60—70 eggs, half being laid on each side of the tunnel (fig. 1*g*).

The insect passes through three to four generations or life cycles in the year. The first eggs of the year would appear to be laid in the trees during April, the first generation of beetles issuing towards the commencement of June. The eggs laid by these beetles produce a second generation sometime in August which is followed by a third about the middle of October which lays the eggs which hatch out into the larvæ to be found in the trees in November. These larvæ either mature into beetles which hibernate in the trees or they themselves pass the winter hibernating in their tunnels. It is quite possible that in favourable years there may be a complete fourth and partial fifth generation of the insect in the year.

Relations to the Forest.

This **Polygraphus** must be classed as one of the more formidable of the Scolytid pests of the **chir** pine since it will infest trees of all ages from the small seedling and sapling to the oldest tree and it attacks green trees. I have taken it in small saplings newly killed in the Baldhoti Plantation in Kumaun and in a large standing green tree near Kathian in Jaunsar. In freshly blown down and newly felled trees I have taken the insect in large numbers occasionally having found it infesting the tree from crown to base of stem. It often accompanies the large Tomicus pest, **T. longifolia** (described later on), in its attacks on the tree.

I felled two newly dead trees in the Baldhoti Plantation on 7th June 1908. The one a sapling of 8″ girth had the yellow needles still on the branches. An examination showed that the tree had been attacked from crown to base of trunk by this beetle, the egg and larval galleries covering nearly all the branches and main stem (fig. 1*e*). The attack had probably commenced in the previous October and been continued by the April (1908) beetles laying the eggs of the first generation of the year. The second tree, one of 2′ 6″ girth, was a green standing tree showing evidences of being in a very sickly state, there being considerable masses of resin exuding in 'tears' down the bark. An examination showed it to be severely infested by the **Cryptorhynchus Brandisi** weevil, the **Nothorrhina muricata** longicorn and this **Polygraphus** beetle. The latter was not in so advanced a stage as it was found in the sapling, larvæ, pupæ and immature beetles being present in this tree. I have already alluded to the fact that I took the beetle fairly numerously from the base of a large green tree of 14 feet girth standing closely adjacent to the Range Office at Kathian in Jaunsar. This tree was situated at about the upper limit of this pine in Jaunsar.

Owing to the rough thick bark of the **Pinus longifolia** and the deep crevices in it it is by no means easy to detect the attacks of this insect without removing the bark. Often, however, the red and white sawdust ejected by the male when tunnelling down into the tree to prepare the pairing chamber, which either projects in a tiny cylinder from the surface of the bark or forms a little powdery mass just below it attracts the attention and indicates that beetles are at work in the tree.

Protection and Remedial Measures.

These need not be fully described here as they are very similar to those already advocated for the Cryptorhynchid weevil. In Plantations they can be put into force with considerable advantage. We know the approximate dates on which we shall find larvæ and pupæ in the trees, *i.e.*, middle of May, end of July, 3rd week to end of September and middle of November. Badly infested trees should be cut out and burnt at these periods. The best time would be the period of winter hibernation, but to be able to attack the insect at this period it would be essential that the badly infested trees were marked down in the autumn as during the winter months the insect is quiescent and there is little evidence on the external parts of the bark to show that it is badly infested.

Points in the Life History requiring further observations.

The chief point to be established is the dates at the various elevations where the tree flourishes at which the different generations issue from the trees.

Also the most normal number of generations issuing during the year.

9. TOMICUS (IPS) LONGIFOLIA, Steb.

THE LONG LEAVED PINE TOMICUS.

Reference.—Steb. Depart. Not., I. 282.
Steb. Ind. For. Mem., For. Zool. Ser. I. Pt. II, p. 13.

Nature of Attack.

The male beetle enters the tree by boring down through the outer bark to the sap wood in which it eats out a chamber of irregular shape and considerable size. Three or four females enter to him there and, after fertilization, eat out long egg galleries, two going upwards and two (if four) downwards, and lay eggs in the side walls.

The larvæ on hatching out eat winding galleries in the bast only, pupating at the ends of them when full fed. When the grubs are numerous all the bast layer of the tree is removed in this attack and the tree dies.

Previous Record of this Insect.

I first noticed old traces of the attacks of this insect in June 1902 in the Tons Valley, Jaunsar, and found one dead beetle. In October 1906 I took the insect numerously at Jermola and elsewhere in Jaunsar and Tehri-Garhwal and in May—June 1908 I took the insect in the Kumaun **P. longifolia** forests. In 1909 I found the Tomicus in the Ravi Valley in Chamba in Chir pine.

Distribution.

Probably throughout the North-West Himalaya **P. longifolia** forests. I have taken it in Kumaun, Jaunsar, Tehri-Garhwal and Chamba.

Description.

Larva.—Whitish yellow, curved, corrugated and legless. Head well developed, yellow, shining; 1st prothoracic segment with a dorsal horny plate to it. Length ½ inch. (Plate XX, fig. 1, shows a partly grown larva.)

Pupa.—Yellowish white, large and thick. The prothorax shows a well marked horny shield on the dorsal surface. The wings are bent on to the breast beneath as also the legs and antennæ. Length about ¼ inch. (Plate XX, fig. 1*a*, shows a side view of the pupa.)

Beetle.—Smaller than **Tomicus Ribbentropi.** Very dark ferruginous brown with longish rufous brown hairs scattered irregularly over thorax and elytra.

♀.—Head smooth, moderately shining, finely punctate. Three prominent tubercles on either side of face. Anterior half of prothorax strongly rugose-punctate, basal half smooth

PLATE XX.

FIG. 1.—*Tomicus longifolia*, Steb.—Side view of larva.

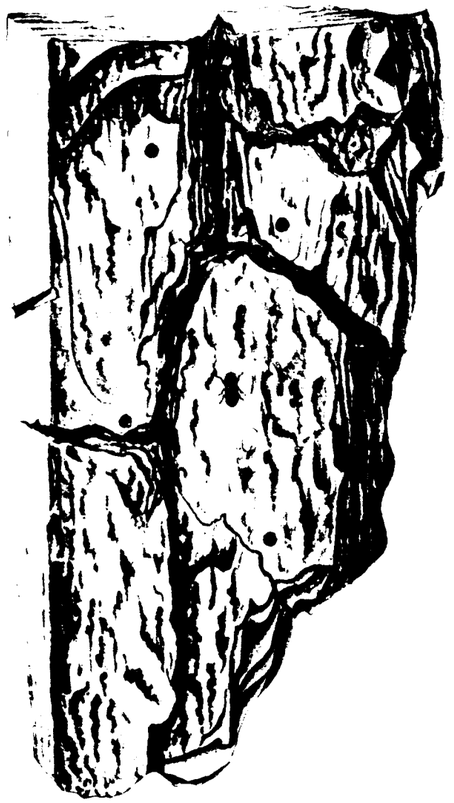
1*a*. Side view of pupa.

1*b*. Dorsal and side view of the female beetle.

1*c*. Side view showing the teeth of the apical declivity of elytra.

1*d*. Pairing chamber made by the male beetle in the sap wood, with a male beetle *in situ*.

1*e*. Entrance holes of *Tomicus longifolia* in the outer bark with a beetle just commencing to bore into the bark.



J. B. Singh, *del.*

Photo-Engraved & printed at the Offices of the Survey of India, Calcutta, 1917.

Tomicus longifolia, Steb. in Pinus longifolia.

[*to face page 20.*]

and shining medianly, punctate laterally, sides clothed with stiff yellow hairs. Elytra smooth shining striate punctate, the punctures large and evenly arranged in parallel rows; lateral margins of declivity armed with four teeth—1 small, sharp and prominent and set at a distance from 2, 2 and 3 placed close together on a bulging prominence of the margin of nearly equal size, save that 3 has its apex enlarged into a spade-like club with a constriction at its base, 4 smaller than 2 and 3 and set midway between 3 and the lower margin, *vide* Plate XX, fig. 1*c*. Elytra clothed with stout spiny yellow hairs.

Under surface smooth, shining, punctate, fairly thickly clothed with long yellow hairs save on the metathorax medianly. Fig. 1*b* shows a dorsal and side view of the female beetle.

♂.—Smaller than the female, yellowish brown. The rugosities on the thorax are finer. Length ♀, $\frac{1}{5}$th inch; ♂. $\frac{1}{6}$th inch. Easily distinguishable from the Blue pine **Tomicus** by its smaller size, difference in the apical teeth and different appearance of front of head.

Life History.

The life history of this **Tomicus** resembles to some extent that of **T. Ribbentropi**, Steb., of the blue pine and spruce but varies in some important particulars. In attacking the tree the male beetle bores through the thick bark down to the bast and eats out in the sap wood a squarish pairing chamber (*p*) in fig. XXI) about $\frac{1}{2}$ inch by just under $\frac{1}{2}$ inch. Fig. 1*d* in Plate XX shows a male beetle in this pairing chamber. A female enters by the same hole and after pairing bores away from the pairing chamber in an upward direction parallel to the long axis of the tree. A second, third and fourth follow, the third going in the same direction as the first, the second and fourth in opposite ones. The egg galleries so eaten out are very long, often as much as 3 -5 inches or even more in length (*cf.* Plate XXI (*e*)). The female as she eats out her egg gallery carries one or more, normally two, aëration tunnels to the outside, (*a*) in Plate XXI: these air holes do not pierce the bark entirely, a thin lamella of outside bark being left for protective purposes to prevent the ingress of outside intruders, chiefly enemies, into the tunnel.

The female egg tunnel is always kept entirely free from sawdust, excreta, and other wood particles. It grooves deeply the sap wood and is usually slightly serpentine in character. The eggs, some 10 to 60 in number, are laid in notches eaten in the side walls of the gallery, the larger number being usually laid on the wall remote from the adjacent egg gallery of the other female. On hatching out from the egg the larvæ eat out galleries which are very winding and appear to have no definite direction often being inclined at an acute angle to the egg gallery and occasionally curving back upon themselves as the grub approaches full growth; the grub thus eats out a much larger gallery than is required for its breadth. This larval gallery only grooves the inner bark and is tightly packed with wood excreta. When the insects have attacked a tree in numbers very little besides the long main egg galleries and a mass of intersecting larval galleries tightly packed with wood excreta remains.

This is well shown in Plate XXI which depics a severe attack of this beetle in the inner face of the bark of this tree. When full grown the larva enlarges the end of its gallery in the inner bark into a squarish irregular pupal chamber and pupates in this : this pupal chamber is the only portion of the larval gallery which is free from wood dust and excreta. On maturing the beetle bores straight through the bark to the outside of the tree and escapes. Observation would seem to show that the beetles mostly mature and leave the tree in swarms at about the same time. For instance in some green trees blown down during the rains of 1906 (probably towards end of August) and examined in middle of October 1906 the insect was found in the immature or nearly mature beetle stage in the upper parts of the main stem of the tree whilst in the thick lower parts of trunk and butt where the bark was still green and fresh the newly issued beetles were tunnelling in to lay the eggs of the last generation or partial generation of the year. No pupæ were found in these trees and only a few belated grubs.

Fig. 1*e* in Plate XX shows several of these entrance holes on the outer bark and a beetle just commencing to burrow into the tree (*nat. size*).

From observations made in October—November 1906 in Jaunsar and Tehri-Garhwal and others undertaken in May—June in Kumaun in 1908 and in Chamba in 1909 it would appear that the insect commences to lay the eggs of the first generation of the year sometime early in April (or perhaps towards the end of March) the beetles hatching out from these eggs appearing towards the end of May, a couple of days being passed in the egg stage, some five to six weeks in the larval, and 10 days to a fortnight in the pupal condition. Allowing from six weeks to two months to a generation a second generation of the beetles would issue towards the end of July and a third towards the end of September which would lay the eggs of a fourth generation which may either hibernate as larvæ in the trees or go on to the mature stage and hibernate through the winter as beetles. In favourable years this fourth generation may be completed and may lay the eggs of a partial fifth generation. For instance, on the 11th October at a fairly high elevation in Jaunsar I found the beetles of the third generation issuing and egg laying or nearly mature. On the 3rd November at a much lower elevation in the Tons Valley in Jaunsar (at Thadiar) I found the beetles of the fourth generation maturing. These beetles were issuing to deposit in the trees the eggs of the fifth generation of the year.

Relations to the Forest.

As far as present observations go this **Tomicus** only infests the **Pinus longifolia** in the pole and older growth stages. I have not taken the insect in seedlings or saplings nor in the thinner branches of the crowns of the larger trees. The insect must be classed as one of the more dangerous of the pests of the tree. It only infests green trees either newly felled or blown down ones or sickly standing ones in the forest. I have taken it attacking green trees in company with **Cryptorhynchus Brandisi** and **Polygraphus longifolia.** Its presence when in any numbers can be easily detected from the outside owing to the fact that it ejects

PLATE XXI.

Tomicus longifolia, Steb.

Pairing chamber (*p*), egg galleries (*e*), larval galleries (*l*), and aeration holes (*a*) of *Tomicus longifolia* in *Pinus longifolia*.

The galleries, drawn reduced, show their great length and the large surface of bast destroyed by one generation of beetles.

J. B. Singh, del. Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1914.

Tomicus longifolia, Steb, in Pinus longifolia.

[*to face page 22.*]

from the entrance hole small cylinders or heaps of light red and yellow sawdust, these little heaps being distinctly visible on the rough red bark of the tree. Once the insect has infested a tree in any numbers the death of the tree is a certainty. Owing to the long egg and larval galleries eaten out and the winding manner in which the latter are taken little of the inner bast layer of the tree is left intact, the untouched portions consisting merely of small ridges and rims of bast between the mass of excreta-filled galleries.

The attacks of such an insect are naturally the more to be feared in a pure than in a mixed forest.

Protection and Remedial Measures.

I need scarcely add anything here to the remarks made under **Cryptorhynchus** and **Polygraphus**. In the case of this insect, however, it is most important that the bark should be stripped from the trees as soon as possible after the latter have been felled. To leave them lying in the forest for several months after felling means that one or perhaps two complete generations of this pest may be bred out of the trees, this meaning half a million or more beetles issuing from each tree to carry on the infection in the forest.

To ascertain the abundance of the beetle in any forest it might be advisable each spring to fell a green tree or two and visit it sometime early in May. By stripping off a foot or two of the bark it will be possible to ascertain to what extent it has been attacked by the insect. This would enable the Range Officer to obtain a very fair idea of the damage he may expect to occur from this pest.

Points in the Life History requiring further observations.

The life history of this insect is now fairly well known. The exact number of generations appearing at different elevations and the exact periods at which they may be expected to appear in the forest in any particular locality require, however, accurate observation and record by local Range Officers.

BEETLES PREDACEOUS UPON TOMICUS LONGIFOLIA AND POLYGRAPHUS LONGIFOLIA. ALSO UPON RHYNCHOLUS SP.

10. NIPONIUS CANALICOLLIS, Lewis.

References.—Lewis. *A. M. N. H.*, Ser. 7, Vol. VIII (Nov. 1901).
Stebbing. Departmental Notes on Insects that affect Forestry, Vl. I, pp. 248-349.
Stebbing. Bark boring beetle Attack in the Coniferous Forests in the Simla Catchment Area, p. 10. Forest Pamphlet (Zool. Ser.) No. 1.
Stebbing. Ind. For. Memoirs—*Insect Pests of the Himalayan Coniferæ*, Part I, p. 24.

Nature of Attack.

Predaceous upon **Tomicus longifolia**, Steb., and **Polygraphus longifolia**, Steb., and **Rhyncholus** sp. in Pinus longifolia.

Previous Records of this Insect.

This insect is common throughout the coniferous areas of the North-West Himalaya. I have already described it as predaceous upon **Tomicus Ribbentropi**, Steb., **Polygraphus major**, Steb., and **Polygraphus minor**, Steb., in Blue Pine. Also on **Rhyncholus** sp. and **Hylastes himalayensis**, Steb., in Spruce. And on **Scolytus major**, Steb., and **Scolytus minor**, Steb., in Deodar.

Life History.

I have already discussed the life history of this beetle in **Departmental Notes** as quoted in the References given above. Also in Part I at page 24 of the present Memoir (under Deodar Pests).

I took some specimens of the mature beetle in a large newly felled *chir* tree near Chaubattia (June 4th) and some pupæ and mature beetles in a green dying tree in the Baldhoti Plantation near Almora on the 8th June.

The insect is undoubtedly a very valuable ally to the Forester in the North-West Himalaya as it is very plentiful apparently throughout the entire coniferous area of this region.

11. PAROMALUS? or PLATYSOMA? sp.

Nature of Attack.

Predaceous upon **Tomicus longifolia**, Steb., and **Polygraphus longifolia**, Steb.

Previous Records of the Insect.

This insect may be identical with any one of the three blue pine beetles of these genera **Platysoma dufali**, Mars., **Platysoma** sp. nov. or **Paromalus** sp. described in Departmental Notes, Vol. I, pp. 351, 352, 354.

I took it in the chir pine in Jaunsar, North-West Himalaya, in October 1906.

Description.

Oval square very hard and compact, flat. Black, shining, the elytra leave exposed the posterior two segments of the body. It resembles the beetle figured in Plate I, fig. 6, of Part I of this Memoir.

Life History.

The beetle was taken in numbers in a large standing green tree which was being badly attacked by **Tomicus longifolia** and **Polygraphus longifolia** in the middle of October. The beetles were evidently engaged in egg laying and the grubs probably feed on those of the **Tomicus** and **Polygraphus** beetles. I had already taken what I think is the same beetle in a newly dead tree a week previously. I think these latter beetles were just maturing, their grubs having fed upon those of the **Tomicus** and **Polygraphus** beetles. The stem and

bark of this tree were covered with the egg and larval galleries of these two latter beetles but the generations had matured and left the tree.

These genera of histerid beetles are undoubtedly of great importance in the forest.

CHALCID FLY PARASITIC UPON TOMICUS LONGIFOLIA, Steb.

12. CHALCID sp.

Nature of Attack.

Parasitic upon the larvæ of **Tomicus longifolia**. And **perhaps** on those of **P. longifolia**.

Previous Records of the Insect.

I have no previous records of this insect.

I took it in Jaunsar in the North-West Himalaya.

Description.

A minute black coloured four-winged fly.

Life History.

I know little of this insect at present. I found it maturing in the upper part of a large P. longifolia tree in which a number of **Tomicus longifolia** beetles were nearly mature. Some of these latter beetles had already left the tree as also had some of the ichneumon flies. I found them hovering over the lower butt of the tree into which the **Tomicus** beetles were tunnelling to lay their eggs, or crawling down the tunnels presumably to oviposit. The fly is very active on the wing in broad sun light and is difficult to catch. I took some specimens in the Tomicus galleries.

The larva spins a small flat oval elliptical papery cocoon in which it pupates. The grub probably feeds parasitically on the Tomicus grub.

I have no further observations about this insect.

III.—INSECTS INFESTING THE BAST LAYER AND SAP WOOD OF BRANCHES ONLY OF LARGER TREES AND MAIN STEM OF SEEDLINGS AND YOUNG SAPLINGS.

13. CRYPHALUS LONGIFOLIA, Steb.

References.—Dept. Notes, I, 267.

Nature of Attack.

The beetle infests the smaller branches and twigs of the Pinus longifolia and the main stem of seedlings and small saplings. The male and female beetles excavate in the bast and

sap wood a chamber of irregular shape in which pairing takes place. The female then continues the enlargement of the chamber to one side and lays her eggs in it. On hatching out the larvæ feed side by side in the same direction thus carrying on the enlargement of the chamber in one direction only, forming a single broad gallery of short length.

There are probably several generations in the year.

Previous Record of the Insect.

I first took this insect at Taklesh in Bashahr (June 1901) and subsequently in Jaunsar in the following year, also in June. In 1908 I noted numerous evidences of its presence in Kumaun in the top of the large tree inspected near Chaubattia.

I have no further notes on its life history to add to those already published in Dept. Notes (Vol. I, page 267).

14. NOCTUA? sp.

Nature of Attack.

The caterpillar of this moth feeds in the bast and sap wood of young seedlings and saplings eating out a deep gallery which usually cork-screws up the stem and often rings the tree, thus killing it.

Previous Records of the Insect.

I have no previous records of this pest having been reported. The moth is still unknown to me.

Description.

Caterpillar.—Dull, red brown, hairless. Thick set with blunt ends to it: tuberculate, with both thoracic and abdominal legs present. Length about 1 inch or a little more.

Life History.

The caterpillar lives entirely beneath the outer bark in the cambium layer of the tree. The bark of young trees of this pine is thick and the grub eats out a winding passage or tunnel which curves up the tree in an irregular cork-screw manner and not infrequently girdles it. The attack is easily recognisable once the bark is removed as the gallery is packed with the excreta of the grub consisting of little rounded red globules in masses. Resin is also present and the outer bark comes off easily as all the inner layers have been eaten away. The sap wood is also slightly grooved by the operations of the caterpillar.

I took what appeared to be nearly full grown larvæ in the Kalimath Plantation near Almora on June 9th, 1908, but unfortunately all my specimens died before pupating. I do not therefore know when the caterpillar pupates nor the length of the pupal stage nor when the moth issues and lays her eggs. The eggs are, however, almost certainly laid on the bark of the tree, probably in interstices.

Relations to the Forest.

So far as my present observations have gone this pest appears to confine itself to young seedlings and young saplings. It may of course infest the smaller branches of older trees and the leading shoots of such trees, but I have not as yet taken it in this position.

It is certainly a serious pest in young plantations. In the Kalimath Plantations I found a number of young dead trees easily recognized amongst the green living ones by the bright yellow colour of the dead needles still clinging to the leading shoot and side branches. An examination of the young trees showed that the cause of death was due to one of three pests in about equal proportions.

(1) The Cryptorhynchid weevil described already.

(2) This Noctua caterpillar.

(3) A fungus kindly identified for me by Dr. Butler, of the Agricultural Institute at Pusa, as **Peridermium (Æcidium) complanatum**, Barclay, var. **corticala.**

There can be little doubt that these three pests are present in considerable abundance in the **Pinus longifolia** forests of Kumaun, and it is of extreme importance that Forest Officers responsible for these areas and the plantations being formed of this species should make themselves thoroughly acquainted with the life histories of the weevil, caterpillar and fungus.

I recommend it as strongly advisable that a thorough inspection should be carried out of the whole of the **Pinus longifolia** plantations in Kumaun with the object of localising and stamping out the attacks of these pests. It is of little use laying out considerable sums of money in the formation of plantations in which the young trees are doomed to suffer extinction from one or other of these pests.

Protection.

A simple remedy and one easy of introduction since the young dying trees are easily recognized is to grub out each infected plant, taking care to remove with it all its roots and burn it at once on a neighbouring path in the plantation. The best time for this operation would, I think, be about the middle of May or at any time during the winter season.

IV.—INSECTS DESTROYING THE LEADING AND OTHER SHOOTS.

15. PYRALID sp.

THE CHIR PINE TWIG-BORER.

Reference.—Coventry, Ind. Forester, XXIV, p. 564.

Nature of Attack.

The larva tunnels down the shoot eating out the interior and completely destroying it.

Previous Records.

I took larvæ of this insect in Chir pine twigs in Jaunsar in 1901 and 1902. Mr. B. O. Coventry studied the attack and bred out a moth in 1903.

Distribution.

I have taken the insect in Jaunsar and Kumaun. It is probably common to the P. longifolia areas of the North-Western Himalaya.

Description.

Caterpillar.—The larva is, when full grown, about 1 inch long, bright pink in colour, with a brown head, smooth and shining, but becomes a dirty greenish colour just before pupating It is thicker at the centre of the body, tapering to both extremities, and is furnished with a few short stiff hairs. It is very sensitive when touched, wriggling away with great activity.

Pupa.—The pupa is red brown in colour, being paler on the ventral surface and with a dark line down the dorsal surface, the last segment being dark with a few bristle-like hairs. It is slightly over $\frac{1}{2}$ inch in length.

Moth.—The moth measures $1\frac{1}{3}$ inches across the expanded wings. The fore wings are of a purple grey colour with brown markings. The hind wings are hyaline with a brown tinge. Both fore and hind wings have a fringe of ciliæ.

Unfortunately the specimen of the moth obtained by Mr. Coventry was too rubbed to make identification possible. I have not since been successful in obtaining further specimens, nor have I been able to make drawings of the caterpillar and moth.

Life History.

The life history of the insect or the spring generation of the insect was worked out by Mr. B. O Coventry in 1903 and published in the **Indian Forester**, Vol. XXIV, page 564.

I give the following extracts from Mr. Coventry's account :—

"During the hill tour with the Forest School students in Jaunsar, April 1901, Mr. F. Gleadow drew my attention to a malformity of the newly-formed shoots of the young chir pines in a forest between Kathian and Thadiar. The malformed shoots (usually leading shoots) were bent down, brown and dry, with a "fox brush" like appearance. On examining them they were found to be hollow and full of dry resin and brown excreta of a lepidopterous larva; but no insect could be discovered. In 1902 the same conditions were observed, but again no insect could be found, and it was presumed that the season was evidently too late to catch the culprit at work.

This year, May 1903, whilst aligning a road, with the junior class students, at Koti Kanasar, our work took us down into the chir pine zone, and here again the same malformity of the new shoots on the young chir pines was observed. On this occasion, however, I was successful in finding the culprit, namely, a lepidopterous larva, as was at first suspected. The first larva was discovered underneath the bark of the stem of the previous year's growth and not in the current year's shoot. It appears that the larva, after having tunnelled down the current year's shoot, which gradually dries and bends over as the damage extends, comes out-side and tunnels into an older stem, in which it tunnels up and down irregularly underneath the thin bark, feeding on the soft tissues between the bark, and the hard central core of wood. In this latter position the larva is difficult to detect, as the stem is covered with long green needles, and shows no apparent signs of being attacked; but a closer observation will show that there are small openings on the surface of the bark from which resin and excreta have exuded. The larvæ, however, were not easy to find, for although I carefully searched a fairly large number of attacked plants, I only succeeded in finding half a dozen larvæ, three of which were in the current year's shoots, which had only been partly destroyed, ... the other three being in the older portion of the stem under the bark. The probabilities therefore are that the larvæ, when mature, leave the plant and pupate in the ground.

It appears probable that the eggs are laid on the terminal buds or young shoots, but the young larvæ live in the current year's shoots, first of all in those which are very young, then attacking those which are more advanced, and finally attacking the older stem; eventually, when mature, leaving the plant and pupating in the ground: a larva found on 14th May pupated on the 28th May and the moth emerged on the 22nd June."

Relations to the Forest.

"I have not yet had sufficient opportunity of ascertaining the extent of the damage caused by this insect. The destruction of the leading shoot does not, as far as I have at present seen, lead to any permanent injury by causing the tree to fork, as is the case with the "Tun-borer." The destroyed leader becomes replaced by one of the shoots which would ordinarily have been a side branch. The destruction of the cambium and sap wood, in the older portion of the stem lower down, appears likely to result in serious damage by causing the whole of the plant above to die, but I have not yet been able to determine if this takes place or not, and it is to be hoped that those who have chir forests close at hand will try and obtain further information.*

* Recently Messrs. B. B. Osmaston, Conservator, and T. Carr, Deputy Conservator, informed me that a great deal of damage was done in Kumaun in May—June 1909 by an insect which from its methods of depredation was probably identical with this pyralid insect. The damage was widespread, but unfortunately no specimens of the insect were secured to enable its identification to be carried out. E. P. S.

Protection and Remedial Measures.

It is not possible at present to prescribe remedies for this pest as too little is known about its life history. That it is a serious pest which requires careful study cannot be doubted since a plague of these insects in a young pine forest might commit almost irreparable damage.

It is possible that it passes through two generations in the year, and if so, the autumn generation requires careful study and also where the insect passes through the winter requires to be ascertained.

From observations made in Kumaun in 1908 I am of opinion that the insect under favourable conditions may not improbably prove a pest of very considerable gravity.

16. CECIDOMYIA sp.

THE LONG-LEAVED PINE GALL FLY.

Reference.—Birbal and Stebbing, Ind. Forester, Vol. XXXI, p. 425 (1905).

Nature of Attack.

The fly lays its eggs in the axils of the bud scales at the end of the shoot. The grubs on hatching out feed here and set up an irritation which results in the formation of a gall or psuedo-cone and the growth of the shoot is stopped and destroyed.

Previous Records.

This insect was discovered by Babu Birbal, Curator, Imperial Forest School, and myself in 1904-05.

The galls or 'psuedo-cones' had previously been looked upon as a young stage in the growth of the cone.*

Description.

Larva.—When examined in September the grub is a minute colourless maggot pointed at both ends, with a few small tubercles on it.

When full grown the maggot is yellow to orange in colour, elongate-elliptical, flattish, the segments being set with numerous prominent tubercles; length 4·7 to 5·4 millim.

Plate XXII, fig. 1, shows a dorsal and ventral view of this grub.

Cocoon and Pupa.—When full-fed the larva leaves the gall and crawls to the outside and pupates there, forming a glistening white cocoon of a curious close matty substance. Within this the maggot pupates, the pupal skin being yellowish to yellowish-brown. The outer surface of the cocoon subsequently changes to yellow; length 3·2 millim. (*Cf.* figs. 1*a*, 1*f*.)

Imago.—A small delicate greyish fly with black eyes, long antennæ and very long legs.

Head small, black, with prominent eyes; antennæ long and furnished with whorls of

* *Vide* Ind. Forester, Vols. XXIX, 276, 407, 572; XXX, 308, 412.

PLATE XXII.

Cecidomyia sp.

FIG. 1.—Dorsal and ventral view of larva.

1*a*. Cocoon.

1*b*. Imago dorsal view.

1*c*. Antenna of male.

1*d*. Antenna of female.

1*e*. Branch of P. longifolia showing two pseudo-cones in October.

1*f*. Side and front view of fully grown galls. The small white ova-bodies seen on the scales and on the spiny tuft to left are cocoons.

Trigonomerus sp.

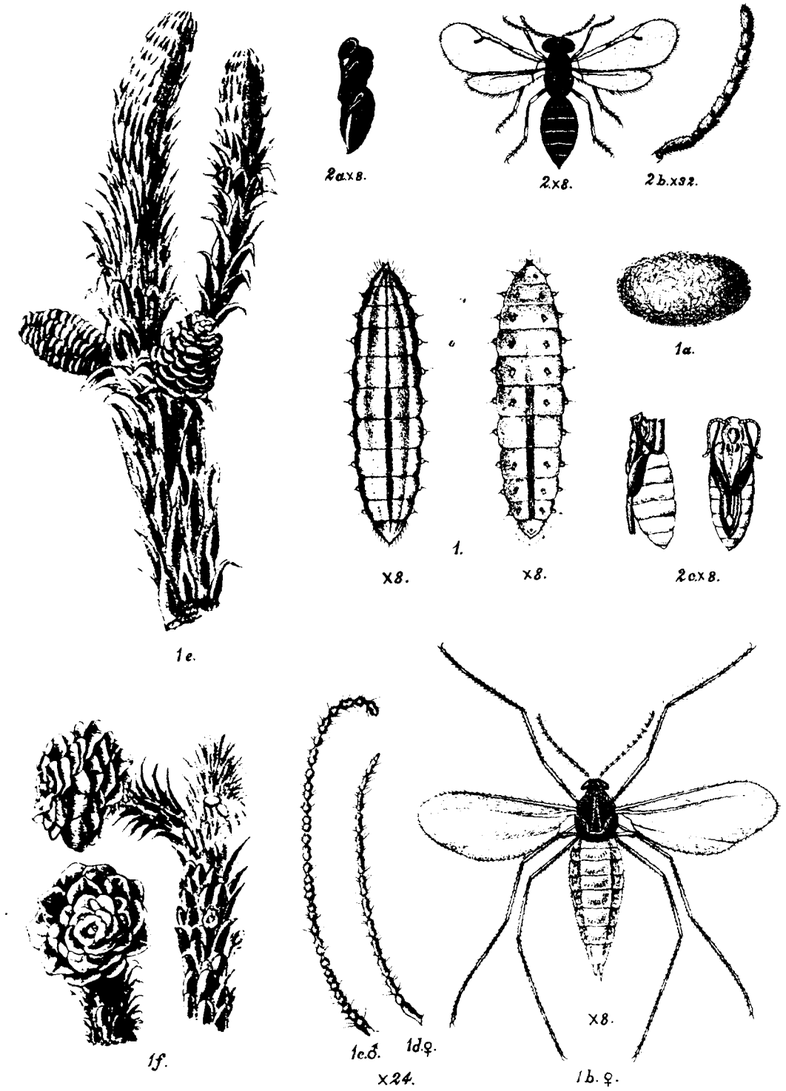
FIG. 2.—Dorsal view of imago.

2*a*. Side view of same.

2*b*. Magnified antenna.

2*c*. Ventral and side view of pupa.

The sizes of the magnifications, if any, are shown by small numbers against the figures.



1. Cecidomyia sp. in Pinus longifolia.
2. Trigonomerus sp. parasitic on Cecidomyia sp.

to face page 40.

simple hairs. The thorax is blackish-grey, broader than the head and bears the three pairs of long legs and a pair of delicate membraneous wings which have only two main nervures in them, the upper being the stouter; the halteres are long, the capitate body not being prominent. The abdomen is fairly stout, elongate, convex above, the first segments broadening out to fourth, which is broadest, and then constricting posteriorly; colour greyish with darker markings above; lighter coloured below. Legs grey and very long. Wing expanse 6·25 millim.

The antennæ in ♂ are 24-jointed, in ♀ 14-jointed, and shorter than in male. The male antennæ are curious in that many of the joints appear double or treble owing to constrictions in the joints themselves. Fig. 1*b* shows a dorsal view of this insect, enlarged. Fig. 1*c* shows an enlarged antenna of the male and 1*d* of the female insect.

Life History.

The eggs are evidently laid by the fly in the axils of the bud scales at the end of the shoot. In the long-leaved pine there is a terminal bud surrounded by 5 to 7 others. Three, four, or more of these may have eggs (or an egg) laid on them in this way. The larvæ on hatching out commence to feed in the green tissues and set up an irritation which evidently leads to the young needles swelling up and coalescing, thus forming the young gall. In September these galls are barely half an inch in length by one-third in breadth (*vide* fig. 1*e*, which shows two of the galls). Externally they have the appearance of small cones, the minute scales being narrow and triangular shaped, the beak bluntly pointed. Sections cut through them fail to show any system of compartments, but merely a mass of green resinous tissue of considerable density. In this mass the young larvæ are living and feeding. At this period the maggots are only just visible to the naked eye. During October they increase in size, become yellowish in colour, and are to be found feeding at the base of the scales, embedded in a mass of resin. By the end of the month the larger of the galls are about $\frac{3}{4}$ inch in length, the scales having swollen on one or more sides to a considerable extent, their upper margins turning slightly over and downwards. The cones are elliptical or ovoid in shape. During November the grubs complete their growth in size, and towards the end of the month commence to leave the cones. These latter are by now just under the inch in length and about $\frac{3}{4}$ inch in breadth, the size of course varying. The scales have swollen up to such an extent that their upper edges have deflected completely downwards, rolling up on to the under surface beneath (*vide* fig. 1*f*). A large amount of turpentine and resin is exuded at this period, the whole forming a sticky mass. The grubs now crawl out from the interior of the cone and proceed to pupate either on the gall itself or they crawl to any neighbouring dwarfed buds and pupate amongst the scaly needles or amongst the scales on the twig itself This wholesale exit on the part of the grubs is a most curious sight to watch and a peculiar feature of the life history of this insect. It is doubtless determined by the fact that if they remained within the gall the mass of resin it now contains would on congealing

eventually prevent the egress of the delicate flies. From Birbal's observations it apparently takes the grubs two days to perfect their cocoons, the external coating of which is not unlikely to be found to be some sort of exudation. The grubs began to issue from the galls on the 29th November and continued to do so until the 10th December, by which date all had pupated. They moved about very slowly, seeming to slowly glide or slide along in the turpentine which coated the galls. These latter covered with the bright yellow grubs present quite a remarkable sight.

The first flies issued on the 28th February and continued to issue until the 19th March, the pupal stage thus lasting some three months.

The gall quickly dries up after the grubs have left it, but persists on the tree for a considerable time.

The life of the fly after issuing is probably a very short one, and the eggs are deposited as above-mentioned, down at the base of the scales on the young buds of the year.

Although, owing to Babu Birbal's commendable persistency in continuing his investigations into the real nature of these cones (false cones as it turns out), we are now in possession of a considerable proportion of the life history of this insect, indefiniteness still enshrouds other portions. We have yet to find out when the eggs hatch out and how long the larvæ take to form the psuedo-gall. The long-leaved pine puts forth its new shoots in March in Dehra, and therefore long ere this the eggs must have hatched and the young larvæ have commenced to feed upon and abort the buds containing the new needles. The curious point, however, is that if the larvæ commence work, as is most probable, in April, how is it that the young cones are still so small in September, and also how is it that the maggots themselves are so tiny in this month? A possible explanation of the latter is as follows:—In the case of some cecidomyid flies the females lay a few very large eggs, out of each of which comes a larva. This latter produces in its interior young larvæ which, after consuming the interior of the body of the parent, escape by making a hole in the skin, and thereafter subsist outside in an ordinary manner. Whether such a state of affairs applies to the P. longifolia cecidomyid gall has yet to be ascertained.

INSECT PARASITIC UPON THE P. LONGIFOLIA CECIDOMYIA.

I have alluded above to the fact that two insects were found in the pseudo-cones. The second one proved to be a parasitic hymenopterous fly* belonging to the family **Chalcididæ.**

17. TRIGONOMERUS sp.

A small brilliantly coloured fly. Head metallic coppery-green with a brilliant irridescence, eyes large, blue-black, antennæ 10-jointed, dark brownish-black, thickly clothed with a

* This fly was very kindly identified for me by the late Colonel C. T. Bingham as an undescribed species of *Trigonomerus*.

short whitish pubescence, 1st joint longer than 2 and 3 together, scimitar-shaped, yellow, 2, very short, globular, 3. longer, broad, truncate at top, rest shorter than 3, subequal, except 9, which is slightly longer, truncate, 10 shorter than 9 and produced to a point at tip. Thorax metallic coppery with a brilliant irridescence and greenish sheen; deeply channelled, rugulose, with a few large shallow punctures. Wings yellow and irridescent. Body dark blue-black. Under surface coppery; body blue-black. Upper and under surface with a sparse short stiff white pubescence. Legs canary yellow, pubescent. Wing expanse, 2·34 millim.

Plate XXII, fig. 2, shows a dorsal view of this insect, 2*a*, a side one, and 2*b*, an antenna greatly magnified.

Pupa—Fig. 2*c* shows a dorsal and side view of the pupa of this insect. The pupa is whitish-yellow with black markings.

Life History.

Beyond the dates of emergence of this fly and its evident parasitic nature upon the **Cecidomyia** we know little about the life history of this useful insect.

Babu Birbal mentions obtaining four flies from the cones on the 29th November. As, however, only one of the flies was secured and subsequently identified, the rest getting away, the latter must be eliminated from the enquiry altogether. No further flies emerged until March, when they issued in conjunction with the Cecidomyia. I am quite unable to accoun for the emergence of the November fly, as it would appear, according to the dates of emergence of the others, to be quite abnormal, and moreover equally useless since in November-December there would evidently be no Cecidomyid eggs or larvæ for it to lay on or in.

V.—INSECTS INFESTING WOOD OF THE MAIN STEM AND LARGE BRANCHES.

18. RHYNCHOLUS sp.

Nature of Attack.

This beetle is a wood borer and apparently closely allied to the **Rhyncholus** of the blue pine and spruce to which its life history will probably closely approximate. The beetles bore through the bark into the sap wood to oviposit.

Previous Records of the Insect.

I have no previous records of this insect. The only specimens I have yet seen were taken from a large tree near Chaubattia in Kumaun, North-Western Himalaya.*

Description.

Beetle.—Elongate, narrow. Black shining.

Head large with a well marked rostrum, which is cylindrical and depressed downwards, carrying the elbowed antennæ. Prothorax long, shining and smooth. Elytra elongate narrow, wider than prothorax behind, depressed at apex and projecting below the abdomen at the sides towards the extremity; strongly punctate and striate longitudinally, the striæ deep. The body is elongate and thickens posteriorly. Length $\frac{3}{16}$th inch.

The insect resembles to some extent the **Hylastes** of the blue pine, described and figured in Part I of this monograph.

Life History.

I took what I think were probably the beetles of the first generation of the year tunnelling through the bark of a large tree whilst others were already in the tree egg laying in long tunnels in the sap wood. This was on June 11th, 1908. I have no further information on the life history of this insect.

I have already alluded (p. 98, Part I) to **Niponius canalicollis** as being predaceous to some extent upon this insect.

19. HYLASTES LONGIFOLIA, Steb.

Reference—Steb., Ind. For. Mem., For. Zool. Ser., Vol. I, Part II, p. 3.

Nature of Attack.

This insect is primarily a wood borer since the females carry their tunnels down into the wood of the tree before laying their eggs at the bottom of them. After pairing with the male, however, either in the thick bark or down in the cambium the female at first carries her tunnel in a zigzag manner horizontally in the bark and sap wood before finally going down into the wood.

* I took further specimens in Chamba in the following year.—E. P. S.

Previous Records of Insect.

I have no previous record of this insect. I first took it at Thadiar, Tons Valley, Jaunsar, towards the end of October 1906. It is possible that it may be one of the insects alluded to by Mr. Norman Troup* as infesting the wood of the chir pine in the Kumaun. Personally I did not take the insect in Kumaun.

Distribution.

Only taken as yet in the Tons Valley, Jaunsar, North-West Himalaya.†

Description.

Beetle.—Elongate cylindrical black shining, uniformly punctate. Smaller than himalayensis, Steb.,‡ of the blue pine.

Head with rostrum wide and scarcely constricted. Prothorax punctate, the punctures arranged in symmetrical longitudinal equidistant rows save near the apex where they are closer. Elytra with a slightly reddish tinge, slightly wider than thorax and nearly three-fourths as long again, as wide at apex as at base, apex bluntly rounded. Striate punctate, striæ deep; punctures small and very uniform, interstices prominent, smooth, shining. Under surface black, uniformly punctate, punctures large save on abdominal segments which are finely pitted. Both upper and under surface are distinguished by an absence of hairs. Length 2·6 to 3·05 millim

Easily distinguished from **himalayensis** by the different shape of the rostrum and the differences in the punctuation of head, thorax, and elytra.

Life History.

This beetle comes into the tree as the **Tomicus** beetle is leaving it, *i.e.*, it does not require the bark and wood to be as fresh as is the case with the Tomicus. This I have noticed to be the rule with the **Hylastes** which infests the blue pine and spruce. The insect will not, however, attack dry wood.

* Jour. Bo. Nat. Hist. Soc., Vol. XVII, p. 526 (1906).
† I have since taken the insect in June 1909 near Chamba in the Ravi Valley.—E. P. S.
‡ Depart. Notes I, 201. Ind For. Mem., Zool. Ser. I, Part II, p. 14 (1909).

The beetle bores through the bark down to the inner bark layer and makes a central pairing chamber from which radiate in a fan-shaped manner several (two or more) galleries (filled with white wood powder). These galleries after zigzagging in the bark for some distance are then carried down into the wood at an angle which may be very acute or otherwise. The zigzag gallery in the bark varies greatly in length; it may be very long or very short. This gallery grooves both bark and wood and is filled with white wood dust and so is easily seen in the dark red inner bark. After entering the sap wood the beetle may turn and bore in it in a direction parallel to the circumference of the tree for a time and then again turn and bore right down into the heart wood of the tree. This procedure agrees with **Hylastes** sp. in the blue pine and spruce. The deep tunnel in the wood is to lay her eggs in. The probable procedure is that the male bores down to the inner bark, the females pair with him there and then eat out their zigzag galleries in the bark subsequently going down into the wood.

I took a generation of this insect tunnelling into the trees to lay eggs towards the end of October 1906. I know nothing further about its life history nor the number of generations passed through during the year.

Relations to the Forest.

This beetle is a wood borer though by no means so dangerous a pest in this way as the **Platypus Wilmoti** described below. On the other hand, when the insect is numerous, it is capable of destroying a certain amount of the cambium layer of the tree owing to the habit of the females of carrying their galleries at first in the cambium layer and sap wood.

As regards protection some simple measures will be considered under **Platypus**

Points in the Life History requiring further observations.

There remains a good deal yet to be observed as to the habits of this insect.

1. On what the larvæ feed and the length of the larval stage. Are the larvæ 'Ambrosia' feeders, *i.e.*, do they feed upon fungoid growths growing on the walls of the tunnel?

2. The length of the pupal stage.

3. The number of generations in the year.

4. The exact method of pairing of the male and female and whether the plan of the galleries made in the bark and sap wood is fairly constant.

20. PLATYPUS WILMOTI, n. sp.

Reference.—Bombay Jour. Nat. Hist. Soc., Vol. XVIII, p. 39 (1907).

Nature of Attack.

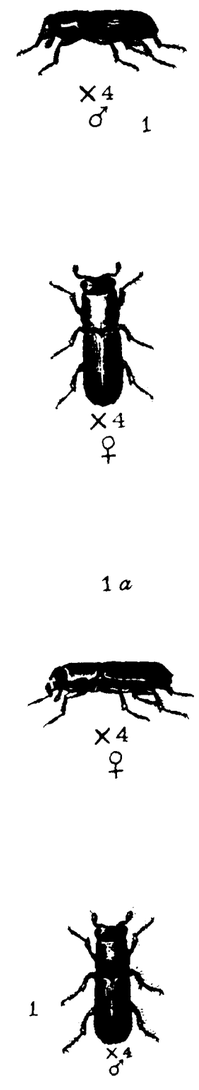
The beetle tunnels straight down through the bark of the green tree to the sap wood and then continues the tunnel with a slight curve in the sap wood straight down into the heart

PLATE XXIII.

FIG. 1.—*Platypus Wilmoti*, n. sp.—Dorsal and side view of male beetle.

1*a*. Dorsal and side view of female beetle.

1*b*. Section of stem of Pinus longifolia showing the entrance holes into the wood and the tunnels in the green heart wood of the tree made by this beetle for egg-laying purposes. The eggs are laid near the end of the tunnel in the heart of the tree.



Platypus Wilmoti, Steb. in Pinus longifolia.

[*to face page 36.*]

wood of the tree. The eggs are laid at the bottom of this long tunnel in the wood. When the insect is very numerous, the wood is destroyed for timber purposes (*cf.* Plate XXIII, fig. 1*b*).

Previous Records of Insect.

I first discovered this insect in the Tons Valley, Jaunsar, in October 1906. In a paper in the Journal of the Bombay Natural History Society for November 12th, 1907, I replied to Mr. Norman F. Troup of Kumaun who had asked in a previous number for some information on the subject of the shot borers of the **Pinus longifolia** which he imagined were identical with those of the bamboos (**Dinoderus**). From investigations of these 'shot borers' of the **Pinus longifolia** made the following spring in Kumaun, I was able to satisfy myself that the **Platypus** was the responsible agent.

Distribution.

Throughout the Pinus longifolia areas of the North-West Himalaya.

Description.

Larva.—White and elongate, straight, with a well developed head and prothoracic segments; abdominal segments tapering posteriorly. Length $\frac{1}{3}$ inch.

Beetle.—Elongate cylindrical. Rufous brown, shining; elytra slightly yellowish brown on sutural area. Head broadly transversal, prominent; as wide as prothorax; a median elevate longitudinal line on vertex, latter finely punctate; front concave, rugose, with a median small circular depression or pit. Thorax elongate, longer than broad, shining; sides constricted medianly, widest across posterior fourth, posterior angles rounded. Disk smooth with very fine punctures laterally and a very finely rugose area medianly. Elytra elongate with median basal depressions just below the scutellum, basal margin brown, as are the lateral surfaces; longitudinally punctate striate, punctures fine. Apical depression finely rugose with a spiny yellow pubescence. In ♀ a small projection just above apex on each elytron. Under surface shining, rugose punctate. Length 7·5—9 millim.

Plate XXIII, figs. 1. 1*a*, shows the dorsal and side view of the male and female of the beetle.

Life History.

This Platypus infests newly felled trees and also standing green ones. The insect in attacking a tree tunnels straight through the bark into the sap wood, carrying its tunnel for an inch or so into this latter before going off at an angle; from this latter point the gallery may have several sharp zigzags in it as shown in fig. 1*b*. When completed or nearly complete, a male and female beetle will be found in the tunnel, which is kept entirely free of wood dust, this latter being pushed up and ejected on the outer surface of the wood or bark.

As many as 20—30 eggs are laid by the beetle and from them hatch out minute white dots, the size of pins' heads, which ultimately grow into small elongate larvæ with yellowish heads. These larvæ do not feed on the wood, but on a kind of fungus with which the tunnel bored by the beetles is lined: from this habit they have been given the name of "Ambrosia" feeders. The life cycle of this insect is about 6 weeks from egg to beetle, in the case of the autumn generation. Eggs laid about the first to second week of October hatch out within a couple of days or so, and the larvæ are full grown by the end of the month or first week in November. The pupal stage is about two weeks and the mature beetles issue about the third week of the month should the weather prove favourable. I have not been able to work out the complete number of life cycles passed through in the year, but I am of opinion it may be found to be four or five. The first eggs of the year are laid about the middle of April, mature beetles from these issuing at the beginning of June; this is the first generation of the year. I found beetles of this generation issuing from a large dying tree in the forest near Chaubattia in Kumaun on 4th June 1908. The beetles of the second generation appear somewhere about the middle of July, those of the third at the end of August, whilst a fourth lot appear to oviposit in the second week of October. Should the year be a favourable one—I mean by this should the autumn be a dry and warm one and the winter set in late—a fifth generation of beetles may develop towards the end of November and hibernate as such through the winter. Should the year be unfavourable, the insect probably hibernates for the winter in the larval stage at the bottom of the tunnels in the wood.

Such is the life history of this pest as far as it has at present been worked out. As I have said, it only attacks the wood when fresh. In no instance have I found the insect alive in dry timber.

Relations to the Forest.

The damage committed by this Platypus is to the timber of the tree. From the account given of its life history we see that but little harm is done to the cambium layer. When the beetle is numerous the zigzag galleries eaten down into the heart wood have a serious effect in weakening the log for timber purposes and can conceivably render it useless for all save firewood requirments.

As Mr. N. Troup has shown the beetle is well known to timber dealers in Kumaun where it is considered to be a pest of considerable importance.

Protection and Remedial Measures.

There is little to be said upon this head at present until it has been definitely ascertained whether the insect will tunnel into unbarked timber. It is now certain that the beetle will only infest fresh timber, *i.e.*, newly felled trees or sickly standing green trees in the forest.

Practically the only way to stamp out a bad attack in seriously infested depôts would be to stack together all the badly attacked logs when the beetles have finished egg-laying and burn the lot.

Points in the Life History requiring further observations.

1. In what stage the insect passes the winter months.
2. The exact food of the larvæ.
3. The abundance of the insect in the P. longifolia tracts.

VI.—INSECT INFESTING THE DEAD WOOD OF THE TREE.

TERMES sp.

Nature of Attack.

This termite, so far as my observations have yet gone, only attacks the dead timber of the tree. The attack is concealed, but the insect does not make use of the covered ways of mud of the plains termite **Termes obesus.** It riddles the wood beneath the bark and there is no sign of its attack from the outside of the tree.

Previous Record of the Insect.

I have no previous record of this insect.

Distribution.

I first took this termite in Jaunsar in the North-West Himalaya in 1906. I subsequently took other specimens in Kumaun.

Description.

Worker. Small white with a moderately developed yellow head. Length $\frac{1}{6}$th inch.

Soldier. Larger than the worker. Head enormously developed, orange yellow in colour with long powerful well developed black mandibles. Body small white. Length $\frac{1}{5}$th inch.

Life History.

I know very little on the subject of the life history of this termite. From beneath the bark of a large standing dead P. longifolia tree I took a number of specimens of the insect in October 1906. The termites had eaten out deep vertical channels and tunnels in the wood of the tree. The thick bark still adhered to the tree and the work was being carried on beneath it.

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