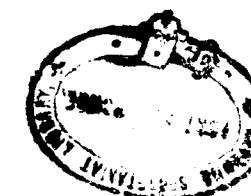


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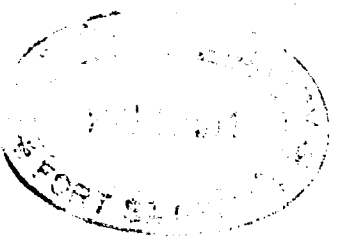
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ON SOME IMPORTANT INSECT PESTS OF
THE CONIFERAE OF THE HIMALAYA WITH
NOTES ON INSECTS PREDACEOUS AND
PARASITIC UPON THEM.

INTRODUCTION & PART I.—DEODAR PESTS.

- MEMOIRS (ZOOLOGY SERIES).**
- VOLUME I.—Part I.**—A Monograph on some Undescribed Scolytidae of Economic Importance from the Indian Region I, by E. P. Stebbing, F.L.S., F.Z.S., F.R.G.S., F.E.S. Price 0-4-0.
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VOL. II

FOREST ZOOLOGY SERIES

Part I .

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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M. E. Stebbing del. et pinx.

CEDRUS DEODARA SAPLING INFESTED BY SCOLYTUS MAJOR, STEB.

THE INDIAN FOREST MEMOIRS

VOL. II]

1910

[PART I

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

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

INTRODUCTION.

IN all the great States of the World where the Forests of the country are systematically controlled under the ægis of a State Forest Service the damage that has to be faced in woodland crops from the attacks of Insect Pests has sooner or later made itself felt in a more or less drastic manner. Wherever there is proper conservancy, and the nearer that conservancy approaches to efficiency and intensity of management, it has inevitably resulted in the danger from insect invasion becoming enhanced.

Whilst this danger in forests of broad leaved trees is at times severe, as has been often exemplified in the oak and beech forests of Europe, and in broad leaved forests in America, it is in Coniferous areas that such attacks are the most to be dreaded.

Experience has shown that in countries where very large tracts are covered with a single species of a Conifer such, *e.g.*, as is the case in America and to a lesser extent perhaps in India, uncontrolled fellings have resulted in the most disastrous infestations of bark boring beetle (*Scolytidæ*) pests.

But such visitations are not necessarily the concomitant of bad Forestry only. They may result from bad fires in the area or severe snow-break and they very often follow, as is well known in European Continental Forests, heavy windfalls, the result of severe storms. For instance on February 1st, 1902, the Forests in the Vosges Mountains in France were visited by a severe hurricane which blew down

in a few hours 1,233,283 cubic metres of Coniferous trees in the Crown and Communal Forests. The losses sustained were estimated at 9 million francs. Whilst the Forest officers were grappling with the ruin and subsequent disorganization caused by this storm an invasion of bark beetles made their appearance. The tree crop on the ground consisted of spruce and silver fir and the beetles which appeared were the dreaded *Tomicus typographus* (in the spruce) and *T. curvidens* (in the silver fir). As a result of the depredations of these beetles 14,603 trees had to be felled and barked to stamp out the attack in the State and Communal Forests. I was fortunate enough to be on furlough at the time and thus to be able to personally examine this attack and its results in May 1904 in the company of the Forest officers in charge of the area: for it took over two years to stamp the beetles out.*

The experience gained by a perusal and study of the literature of the attacks of pests in Continental Forests added to that of the remarkable but calamitous infestations to which American forests have been subject has led me to form the opinion that it will be in our Himalayan coniferous forests that we in India shall have our first experiences of serious insect invasion. The attack of bark beetles experienced in the North Zhob and Suliman Mountain Chilgoza (*Pinus Gerardiana*) forests in the years 1903-1906 is a case in point and enables us to form a very fair estimate of what such attacks will entail in our Himalayan Forests.†

The sudden appearance of Deodar bark beetles in the Simla Catchment Area in 1908-1909 forms another instance.

Again in the Bré forests in South Chamba State numbers of trees were killed out by bark borers on an important Catchment area in 1907-1908 without the true source of the damage done being understood.

The Himalayan Coniferous Forests as is well known are of vital importance to the country owing to their value on two quite distinct counts—

1. The protection they afford to the Catchment areas of the great rivers of North India.
2. Their value as timber producing sources.

I have therefore deemed it of the first importance to make as early and complete a study as possible of the more serious of the pests to which the Coniferous trees of the region are subject, my object being to place in the hands of the Forest officer responsible for the conservancy and protection of these valuable forests, probably amongst the most valuable in the country, a monograph in which he will find clearly delineated the life histories of the pests he is most likely, so far as our present

* Insect attacks in the Forests of the Yogan Mountains. *Indian Forester*, Vol. XXXI.
† The Chilgoza Bark boring Beetles of Zhob (Baluchistan), Forest Bulletin No. 3 (1906).

knowledge goes, to have to fight against and control in the not distant future. For year by year the intensity of management and control of the Himalayan Coniferous areas is becoming more minute and close and with this the yearly increasing danger of insect invasion.

The observations contained in this monograph comprise the investigations carried out personally during the last nine years into the insect pests of the Deodar (*Cedrus deodara*), Blue Pine (*Pinus excelsa*), Spruce (*Picea morinda*), Silver fir (*Abies webbiana*), and Chir Pine (*P. longifolia*). I have also added some observations made into the pests of the Chilgoza (*P. Gerardiana*) Pine and the Khasya Pine (*Pinus khasya*).

Previous to the year 1900 a few scattered observations on and specimens of Himalayan insect pests had reached me from various sources but few papers and no publications specially devoted to the subject had seen the light. For instance in my *Injurious Insects of Indian Forests*, published in 1898 by the Government of India, which was compiled mainly from the *Indian Museum Notes*, on the subject of the pests of the Deodar, I was only able to allude to one insect, a caterpillar (Tineidæ?), which had been reported as infesting the cones*! We now know that there are two such larvæ, the caterpillars of the moths *Euzophera cedrella* and *Phycita abietella*. But these insects do not constitute the most serious of the Deodar pests, as this Memoir is intended to show.

Again in the same small volume an unidentified species of *Polygraphus* (now known as *Polygraphus major* Steb.) was the only insect reported as infesting the *Pinus excelsa*,† a *Chermes*,‡ thought to be identical with the European *Chermes abietis-laricis* (*C. viridis*) but now known to be a distinct species named *Chermes himalayensis*, Steb., on the Spruce, whilst no pests of the Silver Fir had been reported. The *Pinus longifolia* had been stated to be infested with unidentified Buprestid larvæ and by unidentified *Scolytidæ*, by a weevil *Astycus lateralis* and by several *Orthoptera*, *Caloptenus* sp., *Chrotogonus* sp., *Catantops indicus* and *Edalus* sp.; the *Pinus Gerardiana* by unidentified *Scolytidæ* and the *Pinus Khasya* doubtfully by a species of *Scolytid* named by Blandford *Pityogenes scitus*.

So far as my available information goes this was the extent of our knowledge when in the summer of 1900 Mr. B. Ribbentrop, C.I.E., Inspector General of Forests, went up to the Bashahr State beyond Simla to study an attack of beetles in the Deodar forests of that locality reported by Mr. Minniken, Deputy Conservator of Forests. Notes were published on this attack both by Messrs. Ribbentrop, Minniken and

* *Injur. Ins. Ind. For.*, p. 124.

† *Id.*, p. 83.

‡ *Id.*, p. 32.

myself in the *Indian Forester*,* the insect being determined that year as a species of **Scolytus**. On my appointment as Forest Entomologist to the Government of India at the end of that year it was placed in my power to visit the Deodar forests of Jaunsar and Tehri Garhwal, Simla and Bashahr State in 1901, and make a study of both this insect and of the blue pine bark beetle **Polygraphus** which had been mentioned in *Injurious Insects*.† Immature specimens of this insect had been taken by Messrs J. S. Gamble, F.R.S., C.I.E., Conservator of Forests and Director of the Imperial Forest School, and F. Gleadow, Deputy Director of the School in 1891.

These were sent to the Indian Museum from where they were forwarded to Mr. W. F. Blandford, Lecturer on Entomology at the Royal Indian Engineering College, Coopers Hill. Beyond recording the fact that they were immature **Polygraphi** Mr. Blandford was unable to state whether the species was new or not.‡

It was during this and the following year that our startling ignorance on the subject of our Coniferous insect pests, and more especially on the bark beetle pests, admittedly amongst the most dangerous of the insect enemies to which Coniferous forests are liable to suffer, made itself fully apparent to me and the foundations of the investigations were laid which have resulted in its becoming possible to write this Memoir.

The only other investigation which to my knowledge was started in 1899-1900 in connection with the Himalayan Coniferæ was an enquiry into the insect pests which destroyed the cones of the deodar. To such an extent had this taken place in Simla in the year 1899 that Mr. Ribbentrop and his Assistant Inspector General of Forests, Mr. F. Beadon-Bryant, now Inspector General of Forests, set themselves the task of endeavouring to breed out the insects which were responsible for the damage. This investigation, in which I was able to join towards its close, resulted in the correct determination of the deodar cone pests. Subsequently it was discovered that the cones of the blue pine, silver fir and spruce were also infested by one or more of the same caterpillars and the beautiful photographs illustrating these attacks shown here were taken for me in 1901 by Mr. J. H. Lace, now Chief Conservator of Forests, Burma, and at the time Assistant Inspector General of Forests who afforded valuable help in aiding in breeding out the moths.

During the years which have followed this inauguration of the work I have been

* *Indian Forester*, Vol. XXVI.

† *Vide also* Departmental Notes I, pp. 45, 203.

‡ *Injur. Ins.*, p. 63; *vide also* Depart. Not. I.

§ Blandford, XX. On some Oriental *Scolytidæ* of Economic Importance, *Trans. Ent. Soc. Lond.*, Part IV, Dec. 423 (1898).

assisted by many Brother Officers whose kindly and valuable aid I would wish to here fully recognise.

After careful thought I have deemed it best to treat each tree separately in this Memoir detailing successively the pests infesting the various parts of the tree commencing with the main stem followed by the branches, twigs, buds, cones, and finishing up with the roots and timber of the tree. Before dealing with each tree a synopsis is given showing in detail the names of the insects infesting each part whilst at the end of the monograph an appendix will be placed showing in their correct classificatory position family by family the various insects dealt with. It is hoped that whilst the tabular statement prefacing each tree dealt with will give assistance to the Forest officer searching for information on a particular attack of a pest, the appendix will prove useful to the Scientist who wishes to ascertain the families and genera which contain the most serious pests to the Coniferæ of the Indian Himalayan area.

It has been inevitable that a certain amount of repetition had to be faced in drawing up this Memoir since several of the pests treated of have been already dealt with in monographs and bulletins. In the greater number of instances, however, additional information is furnished on these insects. A large amount of information on pests not previously treated of will be found included whilst the life histories of such important pests as the Spruce and Silver Fir Chermes and the Blue pine Aphis, the Silver fir needle weevil (**Polydorsus**), the Deodar longicorn bast eater and looper defoliator and others are treated of here in detail for the first time.

Before dealing with the insects in their special places in the monograph it will be of interest to glance briefly at the chief pests, numbering several **Scolytidæ**, of the seven trees dealt with.

Probably amongst the worst pests of the Deodar so far as present investigation has shown us are three **Scolytus** beetles: the two bark borers **Scolytus major** Steb. and **S. minor** Steb. and the leading shoot and branch girdler **Scolytus deodara** Steb. The greater interest and significance attaches to these insects not only owing to the fact that the genus only infests broad-leaved trees in Europe though it has been reported as infesting **Coniferæ** in America, but also in that I have taken it in no other tree save the Deodar in spite of the fact that I have visited the forests of every part of India. So far as present observations go the genus **Scolytus** in India is confined solely to the Deodar in the North-West Himalaya, a distribution which would seem to be a most curious one.

Other serious pests on occasions are a Buprestid insect (**Chrysobothris** sp.) and a longicorn one (**Trinophylum cribratum**) both of which at times make their appearance in large numbers in the trees. The blue pine **Polygraphus**, **P. major**, is also

occasionally a pest which has to be reckoned with in young deodar areas as has the looper defoliating caterpillar. As affecting the natural regeneration of the tree the Cone tunnellers **Euzophera cedrella** and **Phycita abietella** are of considerable importance.

Turning to the Blue Pine we find the tree to be infested with a large **Tomicus** (**T. Ribbentropi** Steb.) resembling the European **T. typographus** in many respects and also by the **Polygraphus major** mentioned already and by a smaller **Polygraphus** (**P. minor** Steb.). Of these the **Tomicus** is a serious pest to old trees whilst **P. major** is equally dangerous to young growth. The blue pine is also infested by an **Aphis** which at times causes either partial or almost total defoliation of the tree.

The Spruce is also infested by the Blue pine **Tomicus** beetle as also by the smaller **Polygraphus P. minor**. In addition there is a serious wood borer of this tree in the Himalayan **Sirex imperialis** which takes the place in this region of the well known **Sirex gigas** of Europe. The buds of the spruce are infested by a species of **Eucosma** which riddles and kills them. Finally both the Spruce and the Silver fir are infested by a **Chermes**, **Chermes himalayensis**, Steb. (**Chermes abietis-piceæ** Steb.) which takes the place in the Western Himalayas of the **Chermes abietis-laricis** or **Chermes viridis** of the spruce and larch areas of Europe.

The Silver Fir needles are attacked by a weevil **Polydrusus** sp. (which also infests the deodar and spruce) and also by the larva of a sawfly and the caterpillar of a species of **Dasychira**. The bast of the tree is attacked by small bark beetles—a species of **Dolurgus** in the main stem and the branches by **Eccoptoptera sexdentata**. Mots. and **Cryphalus indicus**, Steb. The cones of this tree as well as those of the blue pine and spruce are infested by one or both of the cone tunnelling moths **Euzophera cedrella** and **Phycita abietella**.

The Chir pine (**Pinus longifolia**) is infested by a number of serious pests due probably to the low hot elevation and valleys in which it thrives.

Amongst the worst of the pests is a Cryptorrhynchid weevil **Cryptorrhynchus Brandisi** Steb. which infests trees of all ages. Almost as bad a pest in old trees is the **Tomicus** beetle **Tomicus longifolia**, Steb. which is often accompanied by the **Brandisi** Steb. which infests trees of all ages. Almost as bad a pest in old trees is **matium barbatum**. This tree is also infested by a serious wood borer **Platypus Wilmoti**, Steb. *in litt.* Young growth also suffers severely from a red coloured hairless Noctuid caterpillar which feeds in the bast layer and girdles the tree.

The Chilgoza pine (**P. Gerardiana**) in Bashahr is infested by **Polygraphus major** Steb. of the Blue pine and by a small **Pityogenes** bark borer, **Pityogenes coniferæ**, which also infests this tree in Zhob and the Suliman Mountains and the deodar and blue pine in the Western Himalaya. In North Zhob and the Suliman Mountains

the chilgoza is infested by a distinct species of **Polygraphus**, **P. Trenchi**, Steb., by a species of **Phloeosinus** (**P. Zhobi** Steb.), and by a **Tomicus**, **T. Blandfordi**, Steb. It is also attacked by a longicorn beetle in this region.

I have added here a few pests of the Assam **Pinus Khasya** which is distributed through the hills on the Eastern side of the great Himalayan Range. The two beetles of importance are curious since they have close affinities to other Himalayan coniferous pests. Perhaps the chief pest of the **P. Khasya** is a Cryptorrhynchid Weevil, **Cryptorrhynchus Schlichii**, Steb. *in litt.*, which is closely allied to the species infesting the Chir pine whilst a small **Pityogenes P. scitus** Blandford is closely allied to the **P. coniferæ**, Steb. of several Himalayan conifers in the Western parts of the Range.

Not less interesting or of less importance than a knowledge of the pests of the coniferous pests. Perhaps the chief pest of the **P. Khasya** is a Cryptorrhynchid parasitic insects which affect them.

Perhaps amongst the most important of the predaceous insects of the bark beetles in the Western Himalaya is the Clerid beetle **Thanasimus himalayensis** Steb. which takes the place of the well known **Clerus formicarius** of the European Coniferous Forests and the Histerid **Niponius canalicollis**, Lewis, discovered respectively in 1902 and 1901. Both these beetles feed upon most of the bark and wood boring **Scolytidæ** which infest the Coniferæ of the Western Himalaya, the former attacking the beetles outside the tree, the latter following the insects into their galleries in the tree. The distribution of the **Niponius** insect is of considerable interest since it is also found attacking the **Polygraphus Trenchi** and **Phloeosinus Zhobi** bark borers in the North Zhob and Suliman Mountain Ranges in the far North-Western corner of the Continent.

Several other Histerids, species of **Platysoma**, **Platysoma dufali**, Mars., **Platysoma** sp. n. **Paromalus** sp. n. are also predaceous upon various bark and wood boring **Scolytidæ**.

Of parasitic insects we know at present little owing to the difficulty of getting such identified and described. Several species of **Ichneumonidæ** and **Braconidæ** have been taken in the tunnels of bark borers, *e.g.*, **Scolytus major**, **S. minor**, **Tomicus longifolia**, in those of the **Cryptorrhynchus Brandisi** weevil and of the deodar buprestid **Chrysobothris**.

The above brief résumé of some of the more important pests and their predaceous and parasitic foes will show I think that the Department has made a considerable progress in its knowledge of the insects of the Coniferous trees of the Himalayan Region and we will now turn to a more detailed consideration of each insect under the tree and part of the tree it affects.

PART I.—INSECT PESTS OF THE DEODAR. (*CEDRUS DEODARA*.)

LIST OF INSECTS ATTACKING THE DEODAR (*CEDRUS DEODARA*) SHOWING PARTS OF THE TREE INFESTED BY THEM.

- I.—Insects infesting the bast layer of the main stem and larger branches of old trees.
Coleoptera.—*Scolytus major*; *Scolytus minor*; *Chrysobothris* sp.; *Trinophylum cribratum*.
- II.—Insects infesting the main stem of saplings and poles.
Coleoptera.—*Polygraphus major*; *Pityogenes coniferæ* (upper portions only).
- III.—Insects infesting the crown and leading shoots of saplings and seedlings.
Coleoptera.—*Scolytus deodara*; *Pityogenes coniferæ*; *Hypoborus*? sp.
- IV.—Insects infesting the Twigs and Buds.
Coleoptera.—*Curculio* sp.; *Polydrusus* sp.; *Cryphalus*? *deodara*; *Scolytid* sp.; Looper Caterpillar (*Geometrina*? sp.).
- V.—Insects infesting the needles.
Hymenoptera.—*Cephus* sp. Sawfly larva.
Lepidoptera.—Looper caterpillar (*Geometrina* sp.).
- VI.—Insects infesting the Cone.
Lepidoptera.—*Euzophera cedrella*; *Phycita abietella*.
- VII.—Insects infesting the Root.
Coleoptera.—*Melolontha* sp.; *Elatér* sp.; *Lepidoptera*.—*Agrotis ypsilon*; Another deodar root feeding caterpillar.
- VIII.—Insects infesting the wood.
Coleoptera.—*Crossatarsus coniferæ*.

LIST OF INSECTS PREDACEOUS AND PARASITIC UPON THE DEODAR INSECT PESTS.

- I.—UPON *SCOLYTUS MAJOR* AND *SCOLYTUS MINOR*.
 - (a) Parasitic Insects—
 - (1) *Ichneumon* sp.—Grub feeds as an external parasite on larvæ of *S. major*.
 - (2) *Bracon* sp.—Grub probably feeds as an external parasite on the larva of *S. minor*.

(b) Predaceous Insects—

- (3) *Thanasimus himalayensis*, Steb.—The grub feeds upon the *Scolytus* larvæ and the beetle upon the bark boring beetles.
- (4) *Niponius canalicollis*, Lewis.—The grubs feed upon the larvæ of the bark borers. It is possible that the mature beetle feeds upon the *Scolytus* eggs.
- (5) *Platysoma* sp. n.—The grubs feed upon the bark borer grubs and perhaps to some extent on the eggs.

II.—UPON *CHRYSOBOTHRIS* sp.

- (a) Parasitic Insect—
Ichneumon sp.—The grub feeds as an external parasite upon the buprestid grub.

III.—UPON *EUZOPHERA CEDRELLA* AND *PHYCITA ABIETELLA*.

- (a) Parasitic Insect—
Ichneumon? sp.—The grubs appear to be parasitic upon the caterpillars of the two deodar cone borers *Euzophera* and *Phycita*.

General Remarks.

The most serious pests infesting the Deodar so far as is at present known are two bark boring beetles of the family Scolytidæ, *Scolytus major* Steb. and *S. minor* Steb., both monogamous species. The credit of the discovery of the larger of these beetles belongs to Messrs. Bert Ribbentrop, C.I.E., formerly Inspector General of Forests to the Government of India, and Minniken, formerly Deputy Conservator of Forests, Bashahr Division, Punjab.

About July 1900 Mr. Minniken reported to the Inspector General of Forests that a serious attack of beetles was infesting a portion of the forests in the Bashahr Division. In the autumn Mr. Ribbentrop marched up to Bashahr from Simla and investigated the attack and instituted measures for combating it. I received specimens of the beetles for identification from Mr. Ribbentrop and it proved to be a new species of *Scolytus*. It may be mentioned here that the steps taken on the advice of Mr. Ribbentrop in cutting out and barking all the infested trees on the attacked area in Bashahr stamped out this beetle and nipped what might have proved a very serious infestation in the bud. This I was able to verify in the company of Mr. Minniken the following year.

A year later I found that a second and smaller species of *Scolytus* was usually found associated with the larger one in the trees.

The only other bark borer at present known to infest the tree is a *Polygraphus* (*P. major* Steb.) which infests young plants, saplings and poles when its real food plants, the blue pine and spruce, are scarce in the deodar tracts.

A third Scolytus infests the tree, *S. deodara* Steb., its life history being totally different from that of its confrères. The female beetle girdles the leading shoot of saplings and the side branches of poles and old trees laying its eggs in the portion above the girdle: a method of procedure which when the insect is plentiful, which present observations would seem to show is not usual, is apt to have disastrous effects in young plantations, leading to badly formed double-topped trees such as has been observed in Jaunsar. The photograph shown (in *Departmental Notes*, Plate XII) of the characteristic appearance of a young tree with its leader cut down by this insect was taken by Mr. J. W. Oliver, late Conservator of Forests and Director of the Imperial Forest School, Dehra Dun.

There are two other bast feeding insects which recent observations in the Simla Catchment Area in 1908 and in the Bré Forests in Chamba in 1909 have shown to be serious pests of the tree. I allude to the Buprestid beetle *Chrysobothris* sp. and the longicorn *Trinophylum cribratum*.

Small saplings suffer from the attack of the small Scolytid *Pityogenes coniferæ* which is a bast feeder and occasionally infests the stem in large numbers.

The Deodar also suffers from a looper caterpillar whose attacks often result in complete defoliation.

Seedlings suffer from the attacks of at present little known larvæ of Scarabæidæ (*Melolontha* sp., *Serica* sp.) Elateridæ (*Elater* sp.) and the cut worm *Agrotis ypsilon* whilst the cones are infested by the grubs of two small Pyralid moths *Euzophera cedrella* and *Phycita abietella* the discovery of which as I have elsewhere explained is due to the observations of Messrs. Bert Ribbentrop and F. Beadon-Bryant, now Inspector General of Forests to the Government of India.

One of the most important of the wood borers infesting the tree is the small Platypid *Crossotarsus coniferæ* which tunnels down into the heart wood of newly felled green trees and standing sickly ones to lay its eggs.

I.—INSECTS INFESTING THE BAST LAYER AND SAP WOOD OF THE MAIN STEM AND LARGER BRANCHES OF THE TREE.

1.—SCOLYTUS MAJOR, Steb.

The larger Deodar Bark-borer.

References.—Ind. For. Mem., For. Zool. Ser. Vol. I, Pt. II, p. 21; Ind. Forester, Vol. XXVII; Depart. Notes I, pp. 45, 208; Bark bor. beet. att. in Simla Catchment Area, Forest Pamphlet No. 2, 1908.

Nature of Attack.

The female beetle bores through the bark of the deodar and eats out a gallery in the bast and sap wood in which she deposits her eggs; the larvæ on hatching out

bore away from the female gallery eating out galleries in the bast layer, these galleries grooving the sap wood. When sufficiently numerous the beetles and their larvæ remove the whole of the bast layer of the tree which then dies.

Distribution.

The known distribution of the insect and of its companion the smaller deodar bark-borer (*Scolytus minor*, Steb.) is throughout the Jaunsar and Tehri Garhwal Deodar Forests and the Simla, Bashahr, Kulu and Chamba Deodar Areas. It is probably distributed throughout the Deodar tracts of the Western Himalaya.

Description.

Egg.—The egg is spherical in shape, yellow in colour and shining. It is very small, being about 1/20th inch in diameter.

Larva.—The larva is small, curved, legless and white in colour. It is largest across at the head end. When full grown it is from 1/5th to 1/4th inch in length.

On first hatching out the grub is a minute white dot. The curved shape is however easily recognisable by the time it has bored about 1/4 inch away from the egg gallery. Plate I, figs. 1, a1, a, show the larva natural size and enlarged.

Pupa.—The pupa is white and has the general shape of the beetle; but all the parts are soft, the legs, antennæ, and wings being held pressed against the breast as shown in fig. 1b. Length 1/6th inch. Plate I, fig. b1, b.

Beetle.—Black, shining, elytra dark red brown.

Front of head flat, impressed over mouth; a faint median elevate longitudinal line on front, which does not reach the mouth or vertex bounded on either side by an area very finely longitudinally striate; rest punctate, punctures finer on vertex, a shallow depression medianly on vertex just above basal margin.

Prothorax constricted and impressed on anterior lateral margin; very smooth and shining except for a rather thickly punctate and slightly rugose area behind anterior margin, this punctured area stretching down diagonally on either side and being intercepted medianly by a narrow longitudinal smooth space, a prolongation from the smooth area on disc. The whole of the latter finely pitted the punctures rather scattered and more abundant laterally; a few longish scattered hairs laterally in anterior portion.

Elytra impressed medianly at base, slightly narrowed behind, the outer margins of apical fourth finely serrate, apices separately rounded; striate punctate, the striæ

not prominent and punctures shallow not very conspicuous and confluent at apices; covered with irregular scattered hairs, most abundant laterally.

Abdomen with anterior margin of 1st segment prominent and produced forwards and thickened, rugose, shining, 2nd segment concave, 3rd and 4th with a small lateral tubercle on posterior margin, 5th flat, apical edge incurved medianly. Legs brown to blackish. Antennæ and tarsi rufous brown.

Long. 4.25 to 4.5 millim. Plate I, figs. *c*, *d*, show the dorsal and side view of the beetle and c 1 the beetle natural size.

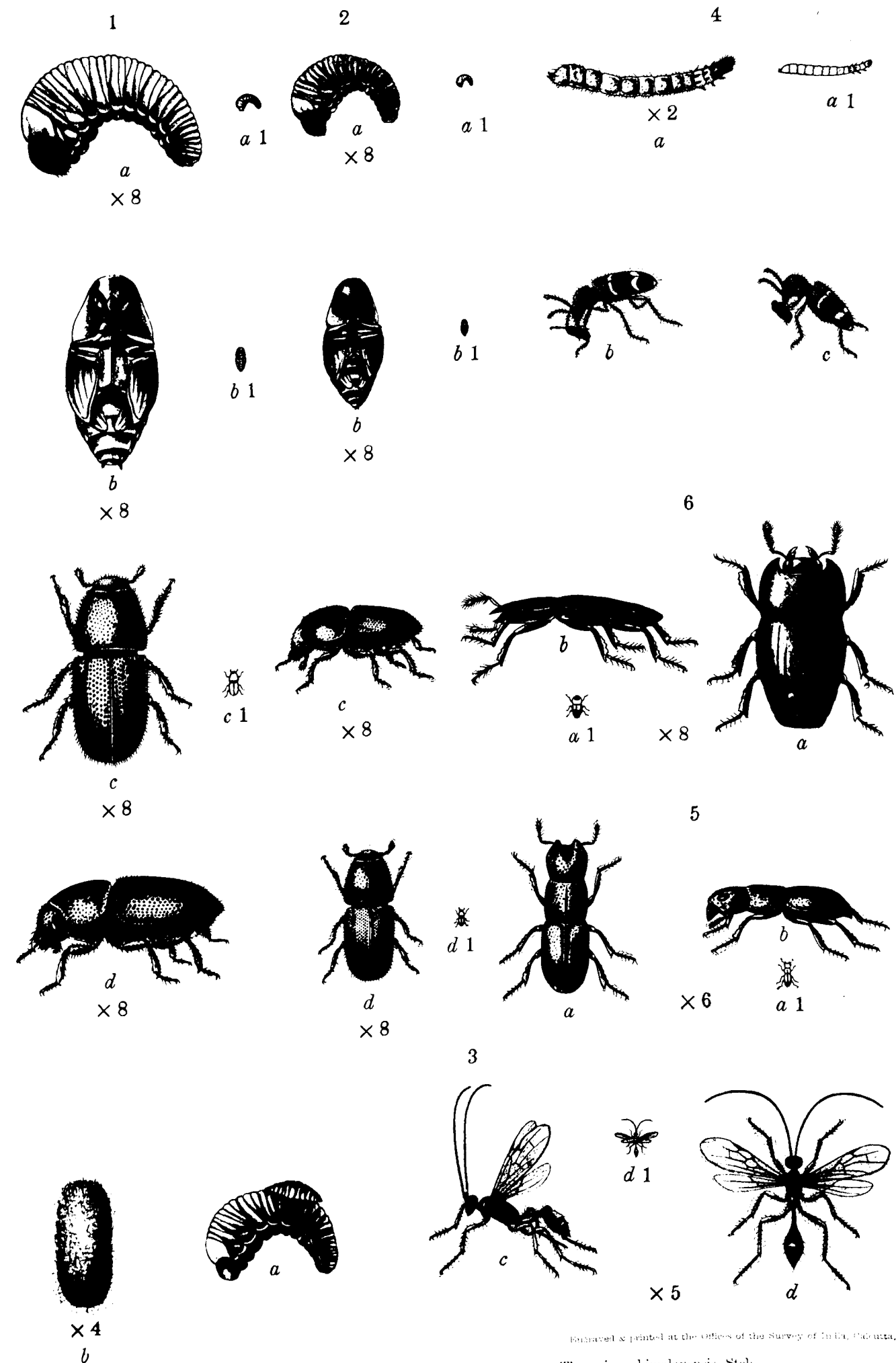
Life History.

The Deodar bark-borer passes through the winter either as a larva at the end of its gallery in the bast layer of the tree or as a mature beetle in the thicker parts of the old bark of deodar trees. The beetle bores into this old bark to obtain a shelter from the cold of the winter months and hibernates in this position. As soon as the first warmth of spring makes itself felt the overwintering larvæ change to pupæ in their galleries and then, in a week or 10 days, become mature beetles and bore their way out of the tree and seek other trees in which to lay their eggs. A little before the latter beetles issue the mature beetles which have passed the winter in the old bark of deodar trees come out and seek suitable trees in which to oviposit. The eggs laid at this period are those of the first generation of the year. The exact time at which egg laying begins varies according to whether an early or late spring is experienced. When a very early spring has followed a dry winter the beetles commence operations early in April and female beetles which have wintered as such may be found boring into trees to lay eggs about the second week of the month. After a long cold wet winter followed by a late spring the *Scolytus* beetle will not commence laying the first eggs of the year before the fourth week or end of April.

The beetles pair outside the tree. The insect's method of attack from the outside and its operations within the tree are constant and are easily recognisable. As is usual with the bark-borers of this family (*Scolytidæ*) the female commences by boring a small "shot-hole" through the bark in order to reach the bast layer. This may be made anywhere on the tree (save in the smaller branches of the crown which are not attacked), but the insect usually chooses a projecting flake of bark in order to screen itself. In the case of small saplings it usually bores in beneath a branch at the juncture of the latter with the main stem. On reaching the bast layer the beetle carries its gallery in an upward direction parallel to the long axis of the tree. The gallery is made mainly in the bast layer, but it also grooves more or less deeply the sap wood: it is deeper and stronger at its commencement than at the upper end.

PLATE I.

1. *Scolytus major*, Steb.,
a, larva; *a1*, larva, nat. size; *b*, nymph; *b1*, nymph, nat. size; *c, d*, dorsal and side view of beetle; *c1*, beetle, nat. size.
2. *Scolytus minor*, Steb.,
a, larva; *a1*, larva, nat. size; *b*, nymph; *b1*, nymph, nat. size; *c, d*, side and dorsal view of beetle; *d1*, beetle, nat. size.
3. *Ichneumon* sp.,
a, grub on *Scolytus* grub; *b*, cocoon; *c, d*, side and dorsal view of fly; *d1*, fly, nat. size.
4. *Thanasimus himalayensis*, Steb.,
a, larva; *a1*, larva (small), nat. size; *b, c*, beetle consuming a *Scolytus* beetle.
5. *Niponius canalicollis*, Lewis,
a, b, dorsal and side view of the beetle; *a1*, beetle, nat. size.
6. *Platysoma* sp.,
a, b, dorsal and side view of beetle; *a1*, beetle, nat. size.



J. B. Singh, del.

1. *Scolytus major*, Steb.
2. *Scolytus minor*, Steb.
3. *Ichneumon* sp.

4. *Thanasimus himalayensis*, Steb.
5. *Niponius canalicollis*, Lewis.
6. *Platysoma* sp.

The gallery so made is the egg gallery; it is from 2 to 3 inches in length and is carried upwards in a series of serpentine curves, first to one side and then to the other (*cf.* frontispiece and Pl. II). The egg galleries made in the boles of large trees are usually shorter than those made in saplings, poles and branches. On either side of the egg gallery, as she gnaws it out upwards, the beetle bites out small indentations in the wood, in each of which she places an egg surrounded by small fine particles of wood dust; these egg notches do not begin quite at the bottom of the egg gallery, a small portion of it being left entire; they are however always made right to the extreme upper end, the number cut on either side being identical. As the gallery progresses upwards the beetle keeps it quite free from particles of wood by shovelling out with her legs all the wood dust, etc., eaten out in constructing it. These she ejects through the entrance hole in the bark; a portion of these wood particles is also passed through the body of the insect and ejected. The white and yellow wood particles thus ejected can be easily seen in little heaps on the outer bark. When the beetle has finished egg laying she does not die, as is usual amongst bark-borers, but remains in the egg gallery or entrance tunnel in the bark, both of which she keeps quite free of wood dust. The mother beetle may be found alive in the tunnel when most of the larvæ from the eggs she has laid have become full grown and are pupating. The beetle probably remains alive in order to protect the eggs and larvæ from predaceous insects such as the Niponius beetle shown in Pl. I, fig. 5 who could otherwise enter the exposed gallery from the outside and destroy the eggs and larvæ it contains. When she finally dies it is usually in the entrance tunnel in the bark which she thus blocks up effectually, as with a cork. The egg gallery takes from 5—7 days to make. The larvæ hatch from the eggs within a couple of days; young larvæ from the eggs first laid may be found already hatched out and at work boring their galleries whilst the mother is still at work completing the egg gallery above and egg laying.

Between 70—85 eggs are laid in the egg gallery, approximately 35—42 or 43 on each side. The larvæ on hatching out bore in the bast and sap wood; they carry their galleries in a direction away from the egg gallery, those in the centre eating away in a direction more or less at right angles, whilst the galleries of those above and below trend away from the right angle in an upward or downward direction. In this way an invariably uniform and constant pattern is made which remains indelibly impressed on the sap wood (*cf.* frontispiece and Pl. II). The presence of the beetle in a forest is thus recognized and identified with ease from these patterns which it leaves behind it in the trees it has attacked.

The larval galleries curve irregularly to a slight extent and increase in size with the growth of the grub; at the end when the larvæ are full grown they are about the

same width as the egg gallery or slightly wider and are from $2\frac{1}{2}$ to $2\frac{3}{4}$ inches in length. The galleries made by the larvæ from the first laid eggs are the strongest marked and often the longest. When full fed the larva changes to a pupa at the end of its gallery. In the case of large trees the gallery may be slightly enlarged at the extremity, a small depression being eaten out in the bark or sap wood. In poles, saplings and the upper parts of large trees the grub appears to invariably bore down into the sap wood at the end of its larval gallery, eating out a small tunnel or chamber of sufficient size to take its entire body; having done this it backs out from the chamber so made, turns round, and backs down into it again and then pupates. The larva takes about 4 weeks to reach full growth. The beetle on maturing crawls out of the chamber and bores its way straight through the bark of the tree and flies off to find a mate and, if a female, to lay eggs in a fresh tree. The time passed in the pupal stage is about 2 weeks, the total period of a generation from egg to mature beetle being about 6—7 weeks.

The above describes the life history of one generation or life cycle of the insect but does not account for the life of the species throughout the year. It has been found that it passes through several of these generations in a year, the actual number depending upon the climatic conditions of the early and late parts of the season.

In ordinary years the insect passes through 3 to 4 generations (the last a partial one) in the course of a year as follows:—

GENERATION I.			
4th week in April	.	.	Eggs.
1st week in May to 1st week in June	.	.	Larvæ.
1st week in June to end of June	.	.	Pupæ.
3rd week in June to 1st week in July	.	.	Beetles.
GENERATION II.			
4th week in June	.	.	Eggs.
1st week in July to 1st week in August	.	.	Larvæ.
1st week in August to 3rd week in August	.	.	Pupæ.
2nd week in August to 4th week in August	.	.	Beetles.
GENERATION III.			
3rd week in August	.	.	Eggs.
4th week in August to 4th week in September	.	.	Larvæ.
4th week in September to 3rd week in October	.	.	Pupæ.
2nd week in October to 4th week in October	.	.	Beetles.
GENERATION IV (a partial generation).			
3rd week in October	.	.	Eggs.
4th week in October to 2nd to 3rd week in April of following year	.	.	Larvæ.
(Most of these larvæ will be overwintering larvæ.)			



M. E. Stebbing del. et pinx.

INNER SURFACE OF BARK OF CEDRUS DEODARA SHOWING THE EGG AND LARVAL GALLERIES OF SCOLYTUS MAJOR, STEB. WITH LARVÆ IN SITU AT THE ENDS OF THEIR GALLERIES.

If beetles of this generation mature it will probably be from eggs laid in the 1st or 2nd week of October when the generation would be as follows:—

1st week in October	Eggs
2nd week in October to 2nd week in November	Larvæ
2nd week in November to 4th week in November	Pupæ
3rd week in November to 3rd week in April of following year	Beetles.

(These beetles will hibernate in the thick outer bark of old standing trees.)

Damage Committed in the Forest.

This beetle is a most dangerous pest to the deodar and is, as far as is at present known, one of the worst insect foes the tree has to contend with. Trees of all sizes are attacked by the beetle from the largest tree in the forest to the smallest sapling. It usually confines its attacks to sickly trees and trees broken by snow or from other causes, in all of which the vitality has become lessened and the upward flow of sap consequently decreased; it also invariably lays its eggs in newly felled unbarked trees when such are available. In forests where such trees are not available or where circumstances have favoured the insect, such as a long drought and warm winter followed by an early spring, the latter will increase in such numbers that the ordinary supply of trees suitable for egg laying becomes insufficient: the beetle will then attack green standing healthy trees. When this happens it is usually found that the insect chooses those which are growing on exposed aspects, especially dry southern aspects where the soil is poor, and those growing in open forest. Once, however, a centre of attack has started the insect, by means of successive generations, spreads outwards from the centre in more or less concentric rings, each generation attacking the trees nearest to those in which it was reared. In this way in serious attacks of the insect whole areas of forest may be killed off in a few months owing to the incredible swiftness with which the beetles multiply. That this latter is very rapid will be understood when it is stated that a tree of 3 feet diameter at base and 100 feet bole produced, as a result of a single generation reared in it. 56,300 beetles allowing for 50 per cent. casualties. Observations have shown that in a dry year the casualties are from 15 to 20 per cent. only. Plate III shows the effects of the insects' attacks on young deodar in the Simla Catchment Area in 1908. The trees shown were killed by the beetle.

Protection and Remedies.

Once the life history of this beetle is well understood the introduction of certain measures to check its further increase on a large scale becomes possible. It is obvious that any measures which will result in the killing off of the grubs before they change

to pupæ and beetles will result in the disappearance of the insect from the area as a pest since there will be no further egg-laying on a large scale. Our present knowledge of the life history enables us to cope with the pest in this manner. I have shown already that 3 full generations and a partial 4th may be expected in an ordinary year.

I have also given the approximate periods at which the larvæ of each generation will become full grown. In order to deal with an attack which threatens to assume serious proportions it will be necessary therefore to take steps to destroy the larvæ of each generation as it appears.

The beetles may be attacking trees in any one or all of the following conditions:—

(a) Newly felled or fallen green trees (wind or snow breaks).

(b) Standing sickly trees.

(c) Standing green trees in the neighbourhood of a "centre" of infection.

Accordingly the first step to be taken is to mark down all infested trees whether felled or fallen, standing sickly or standing healthy trees.

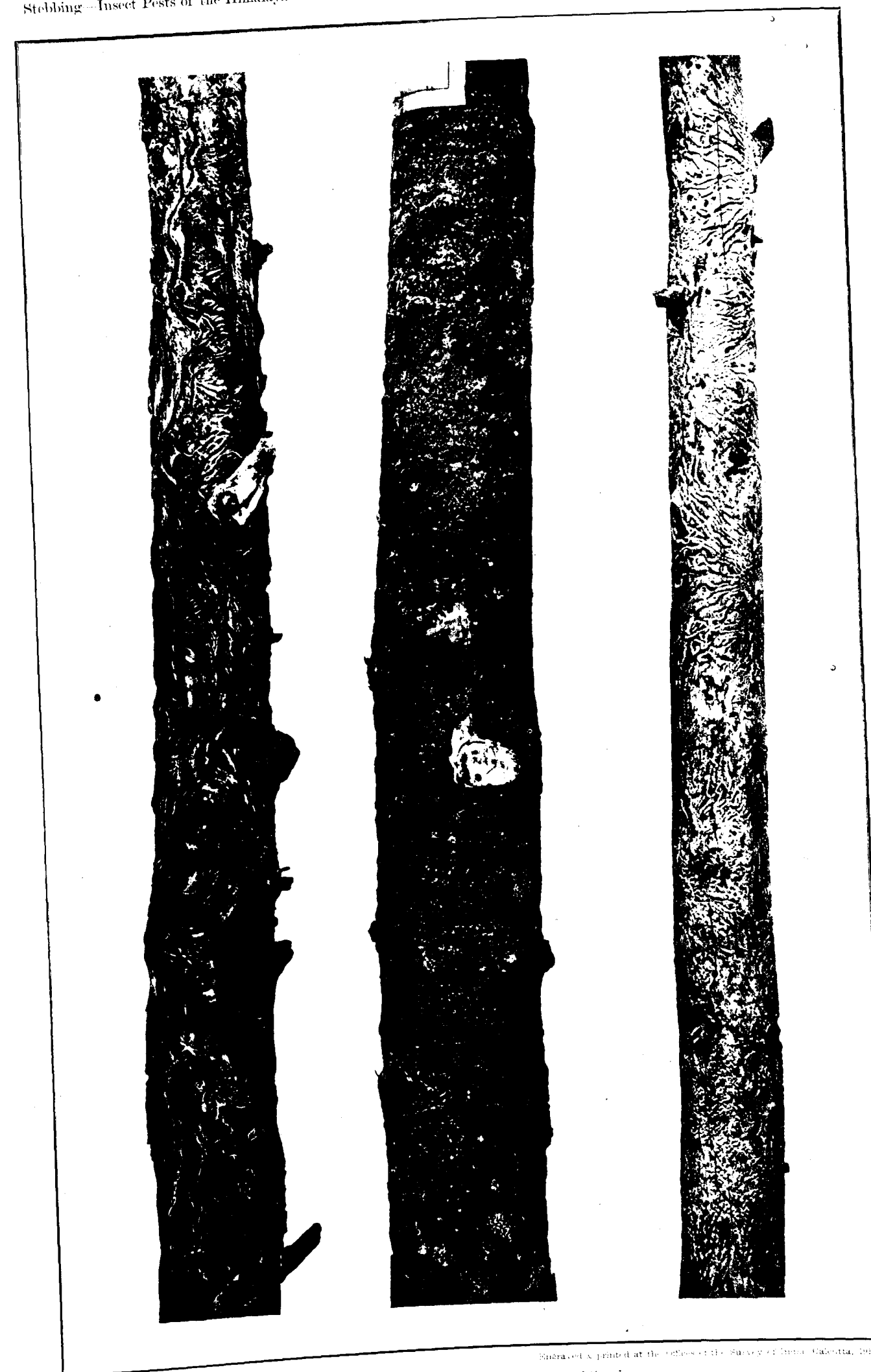
(a) *Newly felled or fallen trees.*—The first of these are known and can be easily marked down. The second should be searched for and marked down. This will involve going over the whole area carefully.

(b) *Standing sickly trees.*—The whole area must be gone over and all trees found should be noted and marked with a tar ring. It is not to be expected that the whole of these trees will have been found in time to catch the next generation of the beetle to issue after the attack was first discovered. If this generation is not caught it should be possible to mark them all down in time to catch the larvæ of the second or third generations.

In the case of (a) and (b) the stems or trees will be left in the forest until they are known to be full of grubs according to the data given under the Life History. (b) should then be felled and (a) and (b) barked and the bark turned up so as to expose it to the rays of the sun. This will be strong enough to kill off the larvæ. All saplings or branches which are too thin to be barked should be burnt. If however (b) are not badly infested with the beetle they should be left standing to serve as 'trap' trees for succeeding generations.

(c) *Standing green infested trees.*—It will be found that newly attacked green trees are much more difficult to deal with, as their removal must depend entirely on the degree in which they are attacked and on their nearness or otherwise to "centres" of infection. It will also be found very difficult to discover them until they are commencing to fade when the bright yellow needles attract attention to them. It may prove advisable to leave those discovered when but slightly attacked standing over one, two, or even three generations of the insect since there is a likelihood of

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Dead fir saplings infested by *Scolytus major* and *S. minor*.

[to face page 15]

their serving as an attraction to further beetles to lay their eggs in. They thus serve as “traps” and if used as such properly they may attract a large number of beetles which would otherwise oviposit elsewhere in uninfested trees. In all cases where such trees are not very seriously attacked I would recommend that they be not felled before the larvæ of the *second* generation of the beetle after finding them are reaching full growth. They will thus serve the purpose throughout the area of “trap trees.”

Trap trees.—In order to ascertain the extent and intensity of an attack I recommend that suitable green trees be chosen here and there in the forest, preferably along a road or foot-path, and felled. These trees should be felled just before the periods at which the beetles are to be expected on the wing in the forest. It will be found that the beetles will resort to these felled trees to oviposit which will thus serve as “traps.” As soon as they are full of fully grown larvæ they should be barked and the bark exposed to the sun or burnt, as may be deemed most advisable. If a trap tree is not seriously infested by the generation of the beetles issuing soon after it has been felled it may be left for a following one. The trees should be so felled as to lie in a position sheltered from the sun during the hottest portion of the day. They must not however be felled in dense shade as the beetles will not resort to such trees to oviposit. In choosing these trees it must be borne in mind that they must be healthy and full of sap. It will be useless felling nearly dead trees for such a purpose as they would rapidly dry and would not be sought out by the beetle. The beetles require fresh sappy cambium to lay their eggs in.

To recapitulate:—

The periods to fell trap trees are as follows:—

1st generation	.	.	.	.	.	.	.	4th week in April.
2nd „	.	.	.	.	.	.	.	4th week in June.
3rd „	.	.	.	.	.	.	.	3rd week in August.
4th „	.	.	.	.	.	.	.	1st to 3rd week in October.

The periods to fell and bark sickly trees containing full grown grubs, to bark fallen or trap trees, and expose the bark to the sun or burn it are as follows:—

1st generation	.	.	.	.	.	.	.	1st week in June.
2nd „	.	.	.	.	.	.	.	1st week in August.
3rd „	.	.	.	.	.	.	.	4th week in September.
4th „	.	.	.	.	.	.	.	2nd to 3rd week in November.

It must be remembered that these periods will necessarily vary a little with differences of elevation, aspect, and climatic conditions, the various stages in each generation being more forward in a dry year than in a cold wet one.

To ascertain whether the time has arrived to bark sickly fallen and trap trees

strip off a piece of bark and examine the larval galleries to ascertain whether they have nearly reached their full length. If they have, the time has arrived to bark the trees and burn the bark.

2.—SCOLYTUS MINOR, Steb.

The smaller Deodar Bark-borer.

References.—Depart. Not. I, p. 207; Ind. For. Mem., For. Zool. Ser. I, Pt. II, p. 22.

This insect greatly resembles the larger *Scolytus*, the eggs, lavæ and pupæ presenting no differences of importance.

The beetle has the following differences in external characters:—

Smaller than *major* which it greatly resembles, the elytra usually darker in colour to nearly black.

The front of head presents differences. In the female there is no median longitudinal line or striae area or median depression near basal margin on vertex; the front is uniformly and rather coarsely rugose (at times almost tuberculate), except on vertex which is punctate; a few yellowish hairs over mouth.

Prothorax constricted and rounded anteriorly, the thickly rugose and punctate area on the anterior margin broader than in *major* and not interrupted by a longitudinal median smooth area, the disc less shining than in *major* and the punctures finer and more numerous. Elytra differ from *major* in having the punctations not confluent and very much smaller, they are more regularly spaced but wider apart in the rows becoming finer apically; the serrate margins of apical fourth more marked.

The 1st segment of abdomen less rugose punctate than in *major*, the posterior margins of 3rd and 4th segments thickened throughout their entire length without a median or posterior tubercle. Long. 2.5 to 3 millim. Plate I, figs. 2 *a1*, *a*, *b1*, *b*, *c*, *d1*, *d*, show the larva nymph and beetle, natural size and enlarged.

Save in size and the appearance of the front of the head and the disposition of the punctures on the thorax this species is scarcely distinguishable from *major*. The difference in size and the other points of divergence appear however to be constant.

Life History.

The method of oviposition and the plan of the egg and larval galleries resembles that of *S. major*, the differences being that the egg gallery is shorter in length, being rarely over an inch long and usually even shorter, and the number of eggs laid averaging about 35 to 40, *i.e.*, from 17 to 20 are deposited on either side of the egg gallery.

The period taken to pass through one life cycle and the number of generations passed through in the year resemble those of *S. major*.

PARASITIC AND PREDACEOUS FOES OF SCOLYTUS MAJOR AND S. MINOR.

PARASITIC INSECTS.

3.—ICHNEUMON sp.

Parasitic upon *Scolytus major*.

Nature of Attack.

The Ichneumon grub feeds as an external parasite upon the Scolytid larva reducing the latter to such a state of emaciation that it finally dies when the parasite has reached full growth (*cf.* Plate I, fig. 3*a*).

Distribution.

This parasite is I think distributed through most of the area occupied by the Scolytid. I have only found it at all plentiful however in trees which have been very badly infested by the *Scolytus*.

Description.

Larva.—The larva is a tiny white grub pointed at both ends, segmented and about one-twentieth of an inch in length (Plate I, fig. 3*a*).

Cocoon.—Elliptical with blunt ends yellowish in colour and of papier-maché consistency, see fig. 3*b*.

Fly.—Small black with long brownish yellow legs and two pairs of veined iridescent wings. Body thin and curved downwards in apical segments. Figs. 3*c*, *d*, *d1*, show the fly enlarged and natural size.

Life History.

I first found this larva during a visit paid to the Simla Catchment Area Forests in August 1908. I took from one of the galleries a nearly full grown *Scolytus* grub fixed to the side of which as an external parasite was a small white hymenopterous grub pointed at both ends. It was about a third the size of the *Scolytus* larva and was stuck to it feeding as an external parasite as shown in the figure (Pl. I, fig. 3*a*).

When full grown the *Scolytus* grub eats out in the bast and sap wood a pupating chamber in the manner already described and then dies of exhaustion. The parasitic grub then spins a small oval papery cocoon in the pupating chamber of the *Scolytus* larva and pupates here. The fly matures in about a fortnight and crawls

out of the tree by one of the neighbouring exit holes of the newly matured *Scolytus* beetles.

After pairing the female ichneumon fly searches for a tree into which the *Scolytus* beetles are tunnelling to oviposit, crawls down one of the entrance holes and deposits her eggs in the egg gallery of the *Scolytus* near the latter's eggs. The parasitic grubs on hatching out each crawls to one of the young *Scolytus* grubs and fixes on to it.

So far as my observations go the parasite appears to pass through as many generations in the year as its host. Whenever I have found a tree badly infested with *Scolytus* tunnelling in to oviposit I have invariably observed some of these flies hovering over the trunk searching for a suitable entrance hole to crawl into.

4.—BRACON sp.

Parasitic upon *Scolytus minor* Steb.

Some nearly mature species of a *Bracon* fly were found in a deodar sapling at the end of the first week in June in the pupating chambers at the end of the larval galleries of the bark-borer *Scolytus minor*. The tree was growing at a low elevation and the eggs were probably laid at the beginning of May. The insects were too immature to identify further with any certainty. These flies are evidently parasitic upon the larvæ of the small *Scolytus* beetle. The eggs are laid by the female insect, who probably pierces through the bark and deposits them in the larval tunnel or she may place them in the entrance tunnel. The young maggot feeds upon the larva and does not kill it until it has reached its full growth and gnawed out its pupal chamber.

I have no further observations on the habits of this insect at present.

PREDACEOUS INSECTS.

Three insects are known to prey upon the *Scolytus* bark-borers, all beetles. One is a brightly coloured beetle which attacks the bark-borers outside the trees, the others follow them down into their tunnels and feed upon them there. The larvæ of two of them are pink and prey upon the eggs and grubs of the *Scolytus* in their galleries.

5.—THANASIMUS HIMALAYENSIS, Steb.

(*The bark beetle predaceous Clerid.*)

Reference.—Departmental Notes, Vol. 1, pp. 213—218.

Nature of Attack.

This insect may be called the predaceous bark-beetle eating Clerid (it belongs

to the family Cleridæ), for it feeds upon all the important Himalayan coniferous bark-beetle pests at present known. It occupies a similar position in the Himalaya to that held by its confrère *Clerus formicarius* in Europe.

Distribution.

Throughout the coniferous forests of the North-West Himalaya.

Description.

Larva.—An elongate pink worm-like flat grub consisting of a head and twelve body segments. The head is brown and mandibles black; there is a brown patch just behind the head on the upper surface and a pair of brown spots on each of the two following segments. Each of the first 3 segments has a pair of legs and the grub tapers in front. Length $\frac{3}{4}$ to $\frac{7}{8}$ inch. See Plate I, figs. 4a, a1.

Beetle.—Head and antennæ black; body short and squarish with well marked "shoulders." The prothorax is black and has some hairs on it. The body, which is covered by the elytra or wing cases on top, is broader than prothorax and head; the wing cases are rounded at extremities; the basal third being red, the rest black; the black area is traversed by two white wavy bands. The abdomen beneath the elytra and on the under surface is bright vermilion. Length about $\frac{1}{2}$ inch. Pl. I. figs. 4b, 4c, shows this beetle (X 2).

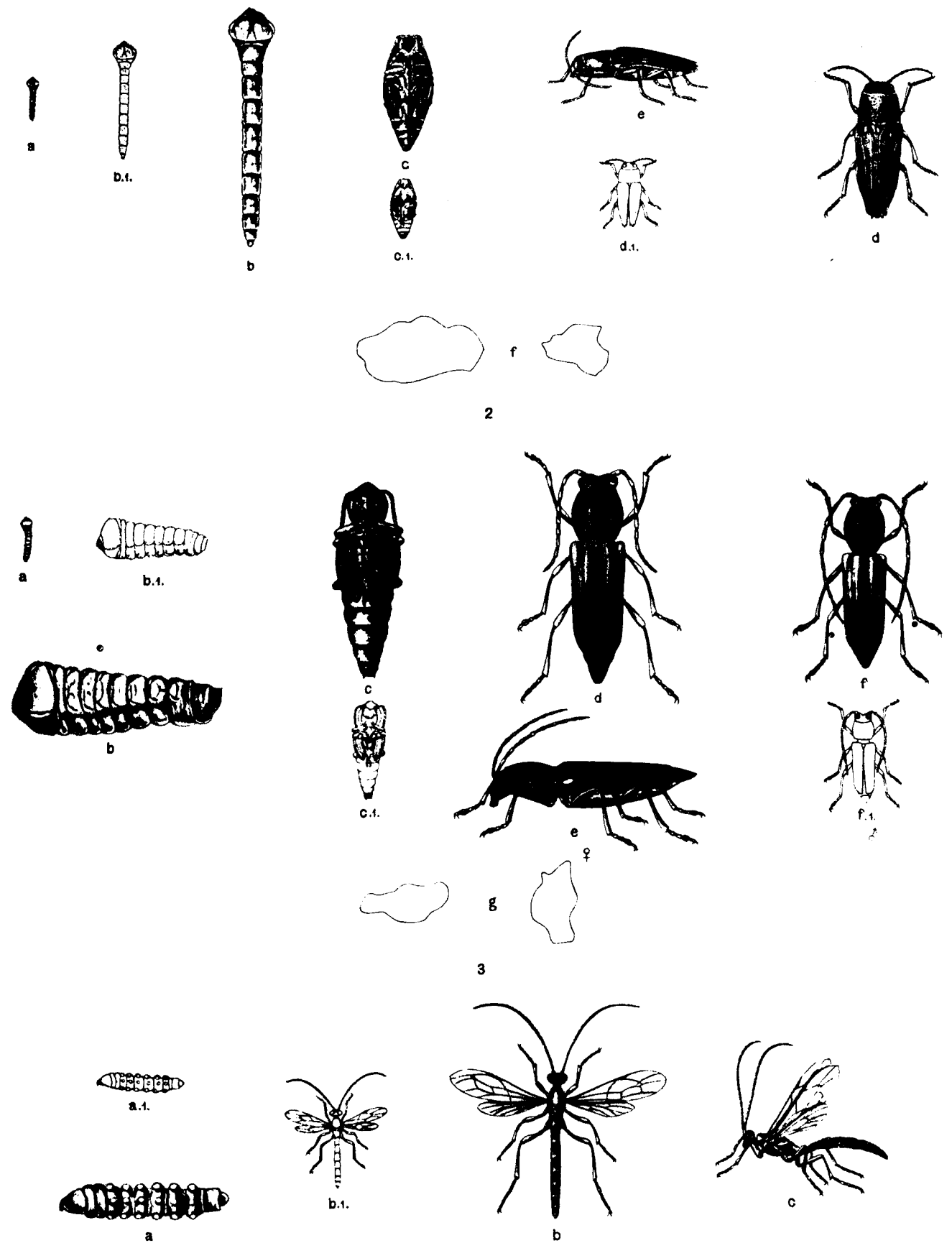
Life History.

The larvæ of this beetle are to be found in the tunnels of the *Scolytus* larvæ where they feed upon them, moving from one gallery to another between the bark and cambium layer.

The beetles are to be found on the wing in the forest flying about over or running along the trunks of infested trees. Owing to their bright red bodies they are most conspicuous and so easily seen when on the wing. They are very active and seize with their powerful mandibles the *Scolytus* (or other bark-beetle) beetles they find on the trunk or just boring into the tree. Having caught a beetle they hold it between their fore legs, tear off the head, and then suck out the contents of the rest of the body (*cf.* Plate I, figs. 4b, 4c). They are voracious insects and consume a large number of beetles. The *Thanasimus* is thus of great service to the Forester and should be carefully made known to forest guards and others in order that it may not be ignorantly destroyed as a pest.

- Fig. 1. *Chrysobothris* sp.,
a, young larva; *b*, larva; *b1*, larva, nat. size; *c*, nymph; *c1*, nymph, nat. size;
d, *e*, dorsal and side view of beetle; *d1*, beetle, nat. size; *f*, galleries of
 young larvæ in bast.
- „ 2. *Trinophylum cribratum*,
a, young larva; *b*, larva; *b1*, larva, nat. size; *c*, nymph; *c1*, nymph, nat. size; *d*, *e*,
 female beetle; *f*, male beetle; *f1*, male beetle, enlarged; *g*, galleries of young
 larvæ in bast.
- „ 3. *Ichneumon* sp.,
a, larva; *a1*, larva, nat. size; *b*, *c*, dorsal and side views of fly; *b1*, fly, nat. size.

PLATE IV.



Engraved & printed at the offices of the Survey of India, Calcutta, 1900.

J. B. Singh, del.

1. *Chrysobothris* sp.2. *Trinophylum cribratum*.3. *Ichneumon* ? sp.

to be predaceous upon several bark-boring beetle pests in the Himalayan region, is evidently of considerable importance in the forest.

8.—CHRYSOBOTHRIIS sp.

The Deodar Buprestid Beetle.

Nature of Attack.

The egg is laid on the bark in a crevice or depression. The grub on hatching but bores down to the bast and eats out in it and the sap wood an irregular winding gallery. When numerous these galleries coalesce and girdle the tree and the tree dies.

Distribution.

The grubs of this insect have been taken in deodar trees in Jaunsar and Tehri Garhwal, Simla and Bashahr forests and in the Chamba Deodar tracts. It is probably distributed throughout the Western Himalaya where the deodar exists.

General Appearance.

Young Larva.—A tiny white grub with a greatly enlarged prothoracic segment. The head small and yellow. The body segments much narrower than the thoracic segment (*vide* Pl. IV. fig. 1a).

Full grown Larva.—The larva is yellowish, flat, elongate and narrow with a large prothoracic segment immediately following the small yellow head; the segments following this large prothoracic segment are very much narrower in width and are more or less equal to one another in size save the last two which taper. Its length is about $1\frac{1}{4}$ inch and it is usually found in its gallery with its lower segments curved round so as to lie against the ones above them. Pl. IV, fig. b1, shows the larva natural size and *b* enlarged.

Pupa.—Elongate ovate yellowish in colour. More ovate than the beetle which it generally resembles; the antennæ, legs and wings are pressed against the chest. Fig. c1 shows the pupa natural size and *c* enlarged.

Beetle.—The beetle is elongate, cylindrical and dark greenish black in colour. The thorax is squarish with a coppery sheen on it; the wing cases or elytra are constricted towards the apex and rounded on sides; the apex ends in three teeth of which the middle one is the largest and the inner one very small; the surface of elytra is pitted and there are several prominent elevated lines or ridges upon them, the one prolonged into the median tooth being the most prominent. The under surface is lighter in colour. Length about $\frac{1}{2}$ an inch. Figs. d1, *d*, show the beetle natural size and enlarged and *e*, a side view.

Life History.

The egg is laid by the female in June either on the bark or down on the inner surface of the bast since the young larval gallery appears to commence here. The grub feeds in the bast at first eating out irregular chambers as shown in Pl. IV, fig. 1f; as it gets larger it goes deeper and grooves both the outer bark and the sap wood. This gallery has no definite direction. Sometimes it is carried up the tree, at others down or across, especially when the larva is young, see Pl. V. It curves about, the total length being from 2 to $2\frac{1}{2}$ inches and breadth at its widest part about $\frac{1}{8}$ th to $\frac{1}{4}$ th inch. When the grub is full grown it bores down into the sap wood at an angle for about $\frac{1}{2}$ an inch and then eats out a pupal chamber in the wood somewhat larger than the size of the future beetle; the section of the entrance tunnel in the wood is narrow elliptical and the presence of these elliptical holes in the sap wood is very characteristic of the beetle, the entrance holes becoming clearly visible when the decayed bark above has fallen off in patches. The larva changes to a pupa in the pupal chamber and the beetle, on maturing, crawls out of the tunnel, eats its way through the bark if it has not fallen off already, and escapes from the tree. A characteristic feature of their attack is shown in Pl. VI. The bark covering the larval galleries beneath apparently rapidly decays and falls off or more often is pecked off by wood-peckers to get at the grubs beneath and thus an attacked tree shows at the spots infested irregular shaped areas of the whitish yellow sap wood. This feature is very often present in the case of saplings and young poles and enables attacked trees to be readily recognized.

The larva of this beetle has been known to infest deodar for some years past. I took it in deodar trees in Bashahr towards the end of June 1901; in newly felled trees at Pajidhar in the 3rd week in June in 1902 (the grubs being from a day or two to a fortnight old only); and again in November 1906 in the tops of converted green trees felled in that year near Konain in Jaunsar.

During the past year (1908-09) it has been proved that this insect passes through only one generation in the year. The mature beetles leave the trees during June, pair, and the female lays her eggs in the bark of any newly felled unbarked trees she can find or in standing sickly trees in snow breaks and wind thrown trees.

The young larvæ hatch out from the egg in about a week and at once eat their way down to the bast and eat out there little irregular shaped patches in the bast (*vide* Pl. IV, fig. 1f). The grubs on increasing in size go down deeper and groove both the bast and sap wood. Plate V exhibits a photograph (taken by Mr. W. F. Perrée, I.F.S.) of the inner surface of the bark of a deodar tree showing the larval galleries with larvæ *in situ* in them. It is probable that many of the grubs become full fed in the autumn and change into pupæ or nymphs in late October or November in the

small pupal chambers which they eat out in the sap wood. The winter is then passed through here either as a nymph or immature beetle.

It is probable that many of the grubs who pass the winter in the bast owing to their not having attained full growth and consequently not having tunnelled down into the sap wood to prepare the pupal chamber perish in severe cold winters.

This is not the case in open dry ones as was proved in the Simla Catchment Area in 1908 when immature living grubs were found in the trees at the beginning of April.

Damage Committed in the Forest.

The damage committed by this insect when numerous in a forest is very serious. The larvæ require absolutely fresh green bast and therefore the eggs are very often laid in green, or apparently green standing, trees.

The irregular method of feeding of the grubs renders the insect more destructive than would ordinarily be the case as they girdle a tree much more rapidly, even when but a moderate number of insects are present, than is ordinarily the case with bark-borers. Instances have been seen where trees, only attacked at the base, have been ringed by a comparatively few larvæ and so killed. Within the limits defined by their several life histories bark-borers of the *Scolytus* type go into a tree anywhere and thus require to be unusually abundant before their operations ring and kill a tree.

The *Buprestid* attacks trees of all sizes but it was perhaps found to be most abundant in the Simla Catchment Area in snow bent and broken green saplings of which there were a number in the forest.

A characteristic of this insect appears to be that it always attacks the trees on the sunny side, *i.e.*, the **southern**: if the tree is bent over, as the snow breaks often are, it invariably attacks it on the **upper** side. This is in exact opposition to the habits of the bark-boring insects which always attack on the **northern** or, in the case of bent or felled trees, on the **under** side. This habit renders the two pests, when working together as they were in the Simla Catchment Area in 1908, more deadly, as they kill the trees quicker.

Protection and Remedies.

The methods of dealing with the Deodar bark-borer (*Scolytus*) beetle when it has appeared in a forest in considerable numbers or of ascertaining whether it is in the forest in any numbers have been already fully explained on page 16.

These methods may be introduced to combat the attacks of the Deodar buprestid beetle.

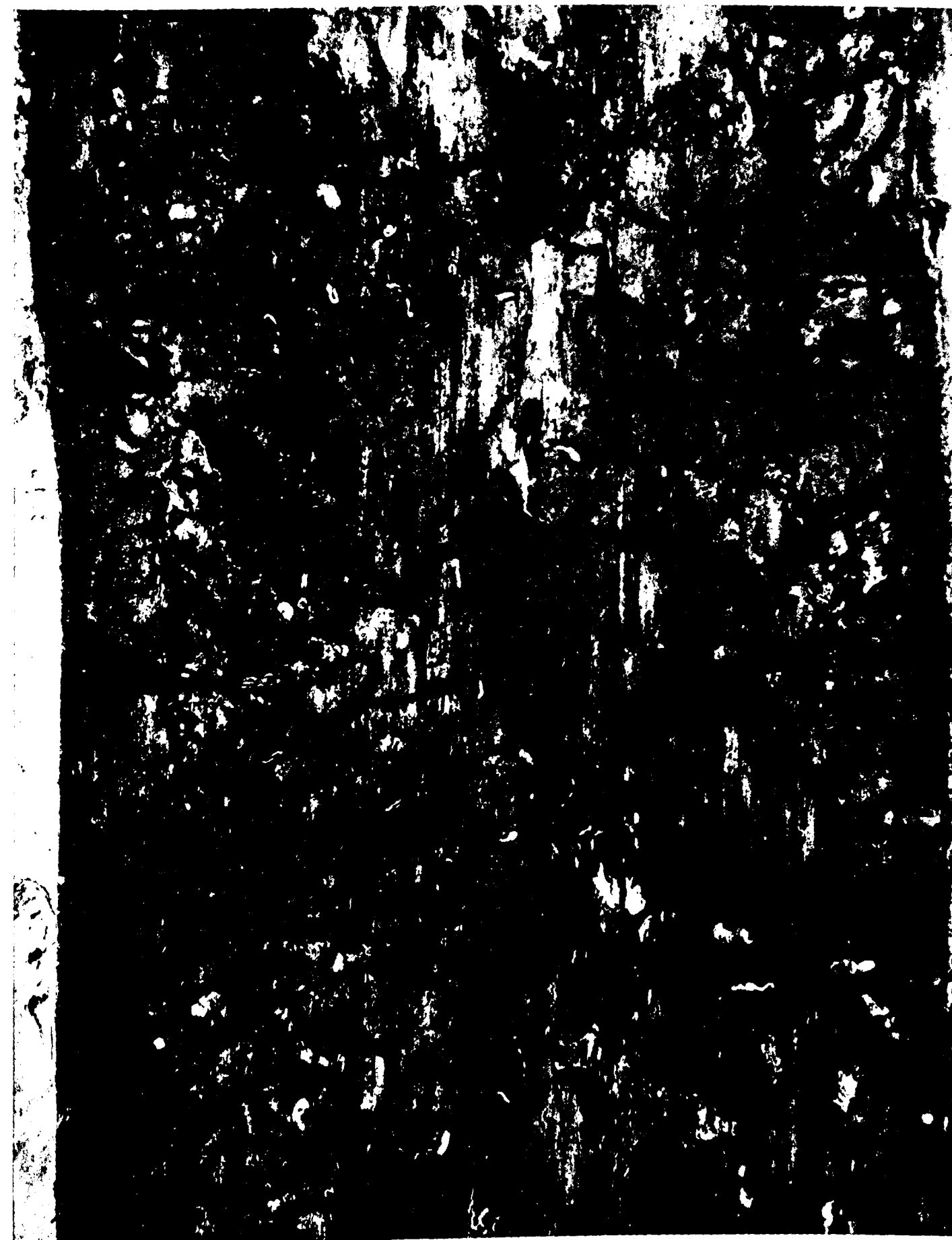


Photo. W. R. Barré.

Larvæ and larval galleries of *Chrysobothris* sp. on the inner surface of deodar bark.

It will often be found that the Scolytus and Buprestid are present in the tree together and the barking of the tree and burning of the bark carried on to get rid of the Scolytus will equally kill off the Buprestid grubs provided it is done **between the months of July and October**. If done earlier you may not catch all your buprestid larvæ since the beetles **will not have finished egg laying**. If done later than October merely barking the tree will not suffice since many of the grubs will have already tunnelled down into the sap wood and will be safe in their pupal chambers. Taking off the bark and burning it will not be sufficient then. It would be necessary to burn the whole infected tree.

Points in the Life History requiring further Observation.

1. The exact periods between which the beetle appears on the wing in the forest.
2. The exact time of pupation of the grub.
3. Does the insect most usually pass the winter as a nymph or pupa in its pupal chamber in the sap wood?

PARASITE OF THE DEODAR BUPRESTID BEETLE (CHRYSOBOTHRIS sp.).

9.—ICHNEUMON sp.

Parasitic upon **Chrysobothris** sp.

Nature of Attack.

The hymenopterous grub feeds as an external parasite on the grub of the buprestid gradually as it reaches full size reducing the beetle grub to a state of emaciation and exhaustion from which it dies.

Distribution.

This fly has been bred out from deodar trees in the Simla Catchment Area Forests. I have not taken it anywhere else at present.

Description.

Larva.—Elongate, white, the thoracic segments having the greatest diameter the prothoracic segment being constricted anteriorly. The six median abdominal segments furnished with a circular ring of 4 swollen tubercles situated medianly, dorsally, ventrally and laterally; the remaining segments taper posteriorly. Pl. IV, figs. 3*a*, *a1*, show the larva enlarged twice and natural size.

Fly.—Elongate black with long antennæ and two pairs of iridescent veined wings and elongate legs. Body elongate and curved downwards. Plate IV, figs. 3*b*,

b1, show the fly enlarged twice and natural size and *c* a side view of the fly enlarged twice.

Life History.

It was noticed in August 1908 that small elongate hymenopterous grubs were present in some of the young buprestid galleries in the deodar trees. These grubs were feeding parasitically on the buprestid grubs. In the photograph shown in Pl. V some of these long white grubs pointed at both ends are to be seen in the galleries.

When full fed sometime in the autumn the parasitic grub spins a flat elliptical papery like cocoon and pupates within this as shown in the figure. The winter is passed in this stage cocoons having been taken in April. The fly on maturing eats through from the papery cocoon and the bark and escapes. It issues at the same time as the buprestid beetles issue and evidently lays its eggs near those of the *Chrysobothris*, probably laying them singly in crevices close to those of the *Chrysobothris*.

This insect is of course a valuable ally to the forester and its appearance both in the grub and imago stage should be known to the Forest Officer.

10.—WOOD-PECKERS (*DENDROCOPUS HIMALAYENSIS*, Harjitt and *GEVINUS SQUAMATUS*, Blyth.).

The common hill wood-peckers, the Pied wood-pecker (*Dendrocopus himalayensis*) and the Scaly Bellied green wood-pecker (*Gecinus squamatus*) and doubtless other species feed with avidity on the grubs of this buprestid beetle, pecking off the bark in little round or elongate patches as shown in Plate VI to get at the grubs in their galleries beneath. The yellow sap wood exposed in this way all up the length of one side of a standing tree or along the uppermost part of the bark of a felled or fallen tree is easily visible and is most characteristic of the attack of this beetle and of its presence in the forest.

11.—*TRINOPHYLUM CRIBRATUM*, Bates.

The Deodar longicorn bast-eater.

References.—Bates, P.Z.S., 1878, p. 720; *id.* Scientific Results, Second Yarkand Mission, Col., p. 22, pl. 1, fig. 19 (1890).
Gahan, F.B.I., Cerambyc, p. 156, No. 162.

Nature of Attack.

The grub feeds entirely in the bast and outer sap wood mining out elongate curving galleries which increase in width with the growth of the grub. When numerous these galleries remove most of the bast layer and the tree dies.

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Portion of a deodar pole showing the bark removed by wood peckers to get at the grubs of *Chrysobothris* sp.

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Distribution.

The beetle is probably to be found throughout the entire area occupied by the deodar in the Western Himalayas.

Gahan in the **Fauna** gives Murree; Kashmir; Assam, Sylhet—a somewhat curious distribution.

Description.

Young Larva.—The young larva is a tiny white grub of about $\frac{1}{2}$ an inch in length with a large prothorax, brownish weak mandibles and narrow body segment—*vide* Pl. IV, fig. 1a.

Full grown Larva.—The full grown larva is white to whitish yellow in colour with a brown head and powerful black mandibles. The prothorax is greatly enlarged and is hard. The succeeding segments are rather corrugated, taper posteriorly. Segments 2—10 have each a stigmata placed laterally near the ventral surface. Length 1 inch. Fig. 2 *b1* shows the grub natural size and *b* enlarged.

Pupa.—The pupa is elongate white to whitish yellow in colour and has the appearance to some extent of the future beetle. The antennæ are pressed against the sides and the legs and wings against the chest. Fig. 2 *c1* shows the pupa natural sized and *c* enlarged.

Beetle.—The following is Gahan's description in the **Fauna**:—

Chestnut brown in colour, more or less nitid, sparsely furnished above with short semi-erect fulvous brown hairs. Head and basal joints of antennæ finely rugulose-punctate. Prothorax closely and rather strongly punctured; marked with a feeble sinuate groove or depression near the apex and another near the base; the disc slightly depressed along the middle with a very narrow impunctate space behind.

Elytra closely and strongly punctured, less strongly near the apex. Body beneath reddish brown, sparsely pubescent, less closely and rather finely punctured; prosternum transversely depressed a little behind the front margin; abdomen narrowed posteriorly, first segment longest, second to fourth successively shorter. Legs reddish brown, minutely and sparsely punctate.

Length 11—13; breadth $3\frac{1}{2}$ to 4 millim. Figs. 2*d*, *e*, show the dorsal and side view of the female, fig. *f* the male (all enlarged) and *f1* the male, natural size.

Life History.

It has been known for some years that deodar trees and especially felled or blown down green deodar trees soon become infested with longicorn larvæ.

In 1901 I found trees of this species infested with both buprestid and longicorn

grubs in Bashahr.* The following year in Pajidhar in Jaunsar in a recently felled large green deodar I took on June 24—28 young buprestid and longicorn larvæ, some perhaps a fortnight old, others probably but a couple of days old.

The longicorn grubs had made little shallow galleries as shown in Pl. IV, fig. 2*g*, on the inner surface of the bark all over the main stem.

At Konain in Jaunsar again I took numerous partially grown grubs in November 1906 in the tops of green trees felled and converted during the year.

I had never found the beetle in the tree however.

The life history of this longicorn beetle has been worked out during the past year (1908-09) in the Simla Catchment Area Deodar Forest with the aid of the Forest Ranger and Pandit Gokal Dass, Extra Assistant Conservator of Forests. This area was visited by a bark beetle attack (*Scolytus* and *Polygraphus*) which began in October 1907 and is mentioned elsewhere in this Memoir. To combat this attack trap trees were felled over the area about 22nd May 1908 and a few days subsequently.

On the 9th and 10th August 1908 I inspected a number of these trap trees and found them to contain young longicorn grubs. It was therefore obvious that the beetles must have appeared on the wing in the forest sometime between the commencement of June and end of July and oviposited in the felled green trees.

The trees containing the grubs were kept under surveillance by the Divisional Officer and Range Officer during the rest of the year and up to June 1909 in which latter month pupæ and beetles were obtained in considerable numbers from them. We are thus now in possession of the complete life cycle of the insect.

I may mention here that the longicorn appears to be often accompanied by the buprestid *Chrysobothris* sp. already described.

The beetle issues from the trees and appears on the wing in the forest in June, pairs, and the female then searches out newly felled trees or sickly standing trees in the forest and oviposits on them. The eggs are laid singly in crevices in the bark, on the lower part of felled trees and on the northern or shady sides of standing trees, the number laid by each female being unknown.

On hatching out the young larvæ at once bore down into the cambium layer and feed in this for a time. As they grow bigger the gallery grooves both bast and sap wood. These galleries curve about in an irregular manner and increase in width and depth with the growth in size of the grub. Pl. VII shows a photograph of the inner surface of a piece of bark stripped from an infested tree in September. The photograph was very kindly taken for me *in situ* in the forest by Mr. W. F. Perrée, at the time Assistant Inspector General of Forests.

* Dept. Not. I, p. 49.



Photo. W. F. Perrée.

Larvæ and larval galleries of *Trinophylum cribratum* on the inner surface of deodar bark.

[to face page 30.]

It shows very well the stage in the development of the larvæ some three months after oviposition and also shows the amount of cambium they are capable of destroying in this period when numerous in a tree. It will be noticed that the larval galleries are blocked for their whole length, with the exception of the space occupied by the grub itself, with wood refuse and excreta of the grub.

The larvæ continue feeding in the bast and sap wood until the first snap of cold of the winter when they cease feeding and hibernate at the end of their galleries through the winter months. A few may have bored the pupating chamber in the wood but the majority are still far from full grown.

Sometime in April the larvæ recommence feeding and lengthen their galleries to some extent. In May they commence tunnelling down into the sap wood boring out in the wood a short gallery of $\frac{1}{2}$ to $\frac{3}{4}$ " in length and squarish in section. This tunnel may go in at an angle or be straight. It is always kept quite free of wood dust and excreta. When this depth in the wood has been reached the larva turns and bores out an elliptical elongate chamber parallel to the long axis of the tree and of wider diameter than the entrance tunnel to it. When this is complete it turns round and changes into a nymph.

The period passed as a nymph and immature beetle is about a month to six weeks and the beetle is then ready to leave the tree. It crawls up the entrance tunnel in the sap wood, gnaws through the outer bark which covers it and escapes from the tree to mate and if a female lay eggs in fresh trees.

From the above it is apparent that the deodar longicorn beetle has only one life cycle or generation in the year and passes through the winter as a grub, perhaps the easiest stage and period to attack it in.

Damage Committed to the Forest.

This longicorn must be looked upon as one of the serious pests of the deodar. Like its companions the **Scolytus** and **Polygraphus** and **Buprestid** insects it is ever ready to take advantage of any sickness or injury to a tree or any reduction in vitality resulting from a fire having passed over the area. It is probable that it only attacks green trees when it is in large numbers and when the supply of newly felled and sickly trees is small. It will not however oviposit in dry trees since it requires for its larvæ that the cambium should be in a state of considerable freshness.

The danger to be feared from this and the other pests is when a sudden storm leads to a large number of wind-falls in the forest during the egg laying season of the insects or when heavy snow breaks are experienced during the winter resulting in a

large number of partially broken down and sickly trees being present in the forest. To such places this longicorn will invariably repair to oviposit.

Protection and Remedial Measures.

These are the same as already detailed for the Buprestid pest.

At present my observations have not resulted in discovering any parasitic foes of this longicorn. I am not aware whether the ichneumon fly which parasitises the Buprestid grubs also infests the longicorn grubs.

II.—INSECTS INFESTING THE MAIN OF SAPLINGS AND POLES.

12.—POLYGRAPHUS MAJOR, Steb.

This insect will be dealt with fully in a subsequent Section (Insect Pests of the Blue Pine). It will therefore be only necessary here to detail the localities in which it has been taken attacking the Deodar and to mention the slight differences in its attack on the harder bark and wood of this tree as compared to those of its natural food trees, the Blue Pine and Spruce.

Distribution.

I have taken this insect in deodar in Jaunsar and Tehri Garhwal, in the Simla District and in Chamba deodar tracts. In each case the insect would appear to have attacked the deodar owing to the scarcity of blue pine on the areas.

Life History.

The bark and wood of young deodar, for the insect confines itself to young growth and young poles, are much harder than those of the blue pine and the beetle has thus greater difficulty in tunnelling into it. Observation seems to show that the number of egg galleries taking off from the central pairing chamber are most often two only, the galleries being shorter than in the case of those made in the blue pine. The larval galleries are also smaller. Plate VIII shows the inner surface of a piece of deodar bark with 3 egg galleries taking off from the pairing chamber. The number of generations passed through by the insect in the deodar coincides with those of the Scolytus beetles *S. major* and *S. minor*.

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bing.—Insect Pests of the Himalayan Coniferae.



Egg and larval galleries of *Polygraphus major*, Steb., on the inner surface of Deodar bark.

[to fu

Damage Committed in the Forest.

Stress must be laid upon the fact that in the absence of its natural food plant, the blue pine and to a lesser extent perhaps the Spruce, this insect is a serious menace to young deodar crops. The girdling of blue pine and spruce to let up the more valuable deodar to which I allude later on under those trees is a practice which must inevitably result in a great increase of this insect in the forest. Without being unduly pessimistic such an increase cannot be viewed without anxiety.

13.—PITYOGENES CONIFERÆ, Steb.

References.—Steb. Dep. Not. 242; Bark Bor. Beet. Zhob. 14; Ind. For. Mem. Zool., Ser. I, Pt. II, p. 18.

Nature of Attack.

The insect infests the main stem of saplings and poles and the crown of larger trees. The male beetle tunnels through the bark down to the sap wood and eats out in this a pairing chamber. As many as five, and occasionally six, female beetles successively join the male in the pairing chamber and after pairing bore away from the chamber, the galleries of the female beetles radiating from the pairing chamber in a stellate manner. Each female beetle lays eggs in little notches cut in the sides of her gallery, the greater number being laid on one side only. On hatching out the grubs bore away from the gallery in the bast only. When the insect infests young saplings or poles or branches in numbers it kills them.

The insect infests the blue pine, chilgoza pine and spruce as well as the deodar.

Distribution.

This insect is distributed throughout the coniferous tracts of the Western Himalaya. I have also taken it in the **Pinus Gerardiana** forests of North Zhob in Baluchistan and the Suliman Mountain Range. It is evidently a hardy little insect and capable of very rapid increase under favourable circumstances.

Description.

Larva.—A minute curved rather corrugated white legless grub with a canary yellow head. Plate IX, fig. 1*a*, shows the grub.

Pupa.—White having the shape of the beetle. (fig. 1*b*).

Beetle.—♀—Sub-elongate. Black, shining; the elytra often orange or red brown with black basal and lateral edging. Head black with a strongly marked deep square depression on upper part of forehead and two small posterior ones on either side of a post-median raised space which is moderately shining and finely punctate.

winding round the twig. At the end of the larval gallery a little enlargement is made and the larva changes into a pupa in this, the latter turning in due course into a beetle and boring its way out of the branch.

This little beetle confines its operations to the smaller branches of the coniferous tree attacked where the bark is still quite soft. It infests these places in enormous numbers, working in company with the larger *Polygraphus* (**P. major**). It is to be found in the side branches and upper portion of the leading shoot of older saplings. In smaller ones it infests every part and it then becomes a serious pest, as it would appear to have the power of increasing in large numbers. Its attack can be recognized from the outside by the small pin-holes seen in the bark, each surrounded with a small white ring of resin (see fig. 1e at upper end); the bark when very young turns yellow under the attack and shrivels up. The arms of the stellate galleries run longitudinally up and down the stem rather than horizontally, and the appearance of the pairing chamber and egg galleries are not unlike those of **P. major**, with which they are often found mixed up and interlaced. The latter are, however, larger, have longer arms and the egg galleries are fewer in number, and go much deeper into the sap wood, this being more especially noticeable in the case of the smaller branches attacked.

I have found this *Pityogenes* in company with *Polygraphus major* infesting deodar saplings. It was very numerous in the tops of saplings at Pajidhar in Jaunsar in June 1902. In a few cases it was found in the main stem, low down, and the gallery had then only four arms or egg galleries to it, the pairing chamber being made entirely in the bast as also were the larval galleries and pupating chamber, only the egg galleries grooving down into the sap wood. In the tops, however, and leading shoots the attack corresponded in all respects to that in the blue pine. I was unable to count the number of egg galleries bored as the bark and sap wood were riddled by the interlacing galleries. All the stages of larva, pupa and beetle were found, and also mature beetles just boring into the stems to lay eggs. This would seem to confirm my theory that the generations in one year of the life history of this insect overlap one another since it would seem probable that the larvæ were those of the second generation, the first lot of grubs appearing somewhere about the beginning of May. This would mean that the August-September larvæ are those of the third generation, and the November beetles those probably of a fourth which lay the eggs of the first at the end of April in the following year. The *Pityogenes* was equally numerous in the neighbouring blue pine saplings. As in the case of the **P. major** the fact that this beetle attacks the deodar in addition to the blue pine greatly adds to the importance of the pest and renders it essential that its life history should be understood.

PLATE IX.

Fig. 1. *Pityogenes coniferæ*, Steb.,

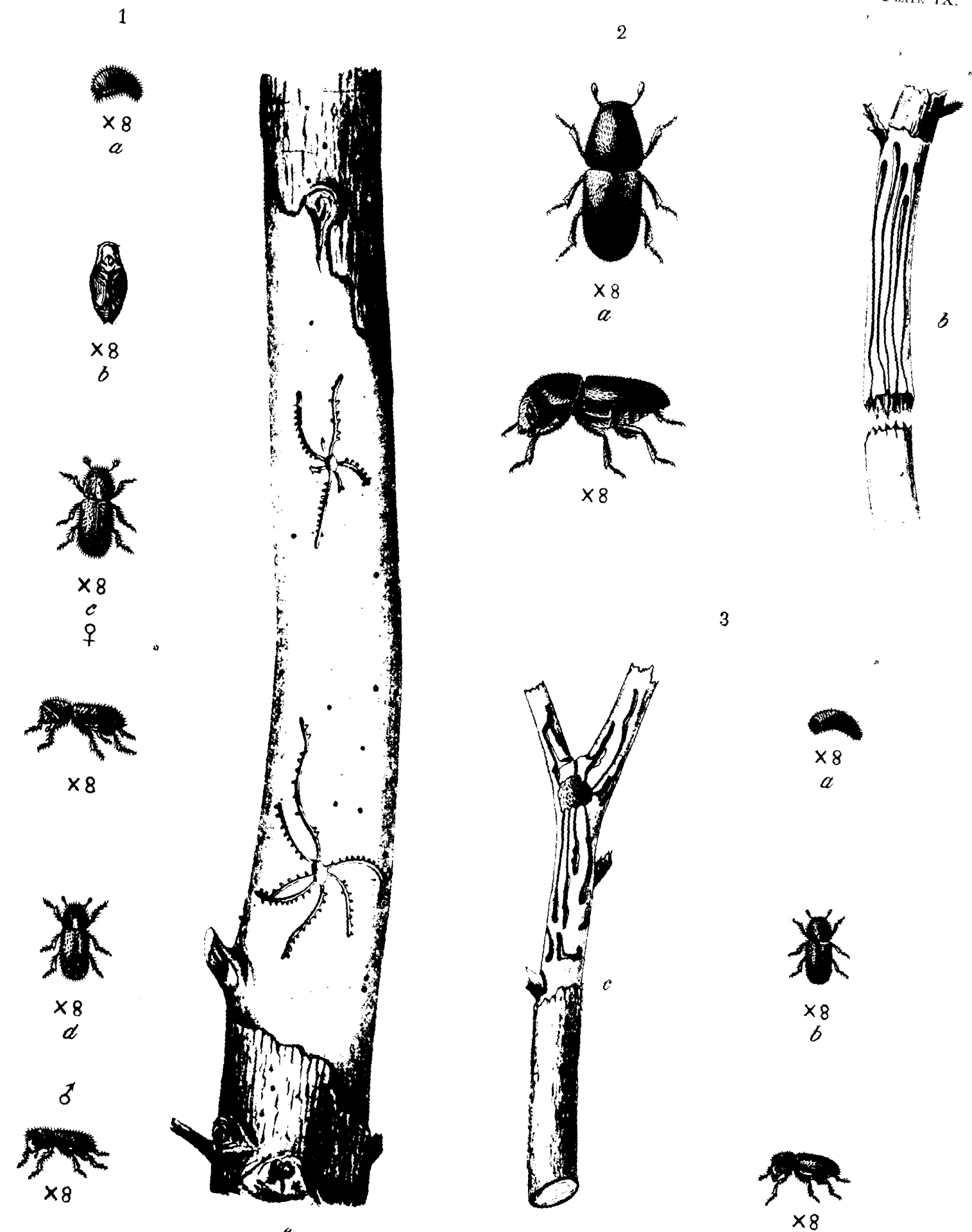
a, larva; *b*, nymph; *c*, dorsal and side view of female beetle; *d*, dorsal and side view of male beetle; *e*, deodar branch showing pairing chambers (made by male beetles) and egg galleries and egg notches made by female beetles.

„ 2. *Scolytus deodara*, Steb.,

a, dorsal and side view of beetle; *b*, girdled deodar twig showing the larval galleries and pupating chambers.

„ 3. *Hypoborus*? sp.,

a, larva; *b*, dorsal and side view of beetle; deodar twig showing pairing chamber, larval galleries and pupating chambers of larvæ.



J. B. Singh, del.

Engraved & printed at the offices of the Survey of India, Calcutta, 1919.

1. *Pityogenes coniferæ*, Steb. 2. *Scolytus deodara*, Steb.

3. *Hypoborus*? sp.

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I found that a number of the dead deodar trees killed during a bark beetle attack in the years 1907-1908 and examined in the forests at Bré in Chamba in 1909 had been badly infested by this beetle which had evidently swarmed in large numbers.

Natural Enemies.

The **Thanasimus** predaceous Clerid feeds upon this little **Pityogenes**.

Protection and Remedial Measures.

These are the same as already detailed for **Scolytus major**. The generations of this insect run more or less concurrently with those of the **Scolytus** and **Polygraphus** insects.

The life history of the insect may be considered to be now well known.

III.—INSECTS INFESTING THE CROWN AND LEADING SHOOTS OF SAPLINGS AND SEEDLINGS.

14.—SCOLYTUS DEODARA, Steb.

The Deodar Branch Girdler.

References.—Steb. Depart. Not., I, 220; Ind. For. Mem. Zool., Ser. I.

Nature of Attack.

The female beetle girdles the leaders of saplings and small poles and the side branches of old trees and lays her eggs in the portion of the branch just above the girdle.

The larvæ eat out galleries which serpentine up the girdled branch grooving the bast and sap wood of the withering branch. The insect must be looked upon as a pest of young deodar growth.

Distribution.

I have investigated the attacks of this insect in Jaunsar and the Simla Hill States and recently have been able to corroborate Mr. J. H. Lace's opinion that the insect existed in the Chamba State forests.

General Appearance.

Larva.—When just hatched the young larva is a minute white circular ball.

Beetle.—Intermediate in size between **S. major** and **minor**. Black, moderately shining, cylindrical, the elytra tinged with rufous brown. Head thickly striate

behind the eye with close set vertical striæ which are produced down on to the ventral surface, this striation not being present in *S. minor*. Prothorax not longer than broad, not so thickly punctate as is head, the punctures finer and fewer behind. Elytra fairly thickly striate punctate, sparsely covered with yellow hairs, especially laterally as are prothorax and head. Antennæ yellowish brown; legs rufous brown, tarsi yellow. Length 3.2—3.5 millim., *vide* Plate IX, fig. 2a.

Life History.

This beetle apparently makes its first appearance in the year in the forest about the middle to the third week in June, *i.e.*, not long before the first burst of the monsoon rains. Its method of egg laying is quite unlike that of the other two species of *Scolytus* known to infest the Deodar.

The female beetle selects the leader of a sapling or the branch of a large tree which may have a thickness of as much as $\frac{3}{4}$ inch in diameter and proceeds to girdle it. The beetle tunnels first into the branch down to the cambium layer and then eats out a deep groove in the bast and sap wood in a horizontal manner round the branch, this groove completely girdling the stem. The beetle manages to keep such an even course on its way round the stem that it usually hits off to within a fraction the point where it started from (*vide* Plate IX, fig. 2b). Small notches are cut on the upper side of the groove and an egg laid in each. These notches are usually cut only on the shady or northern aspects of the branch and the groove is usually deepest on this side so that when the weight of the branch causes it to break and bend over it falls on this side. The number of eggs laid in one girdled branch is as many as eight and may be a few more. I have not yet been able to ascertain whether the beetle girdles more than one branch. After laying her eggs the beetle leaves the branch by the hole of entrance which is usually just above the groove.

That the young larvæ hatch out from the eggs in a few days has been proved from the fact that quite young larvæ are to be found boring away from the girdle whilst the cut branch is still quite fresh and green. The girdle is of course made by the beetle to prepare a sufficiency of food material in the withering condition required by its grubs on issuing from the eggs.

The larvæ on hatching bore straight up the girdled branch (as shown in fig. 2b) in the cambium and sap wood eating out slightly winding galleries about $1\frac{1}{4}$ to 2 inches in length. These larval galleries are blocked throughout their entire length with wood dust and excrement (*cf.* fig. 2b).

When full grown the larva eats out in the sap wood a chamber slightly larger than the gallery and pupates in this. The beetle on maturing bores its way out by a horizontal tunnel through the bark.

The life cycle of the generation from the eggs laid in June or commencement of July takes about 7 weeks, beetles being obtained at the latter part of August from branches found freshly girdled on the 3rd July. The larval stage of this generation thus probably lasts from 4—5 weeks.

Occasionally it has been noticed that a branch has been girdled in two separate places, whether by the same beetle or not I cannot say. An instance of this is shown in Plate XII, fig. 2, in *Departmental Notes*.

During a tour in the Jaunsar Himalaya in the autumn of 1906 (end of September to middle of November) I found the beetles engaged in girdling branches and egg laying at the end of October. This proves that there are two generations, or the whole of a first and a partial second, in the year. I am inclined to think that the August beetles lay the eggs of the second generation of the year and that the beetles found in October are from the August eggs.

The insect is extremely wasteful in its method of ovipositing. Large branches are girdled often 2—3 feet in length and with several forks or side branches on them. From the whole of this large cut branch but $1\frac{1}{2}$ to 2 inches are grooved by the larvæ. The rest of the branch thus destroyed is, so far as this Scolytid is concerned, entirely wasted.

As a matter of fact however the upper portions of these branches are invariably infested by a second Scolytid; *Hypoborus*? sp., described on p. 36 of this Memoir.

This *Scolytus* differs from the other *Scolytidæ* known to infest the Deodar in the fact that it makes its appearance very late in the year. I have never yet found the beetles ovipositing before the middle to the third week in June whereas the other Scolytid pests known commence laying the eggs of the first generation of the year towards the end of April. This late appearance may be due to the fact that this insect is a branch girdler laying its eggs in the girdled portion of the tree. Since the monsoon bursts on the average about the end of June the girdled branch would dry less rapidly and consequently serve as food for the larvæ hatching from the eggs for a longer period if the eggs were laid just before the rainy season than if they were laid in the early summer when the branch would be exposed to the full rays of the summer sun.

The only other period of the year at which I have found branches freshly girdled by this beetle is at the end of October. It may be that the trees are girdled sometime during August (I have not been able to study the insect during that month) by beetles resulting from the eggs laid in June and if so this would indicate that the insect passes through two full and a partial third generation in the year, the partial third generation resulting from the eggs laid at the end of October the larvæ from which

either pass through the winter as such or develop into beetles which remain *in situ* in the branch until the following year.

Damage Committed in the Forest.

This Scolytid beetle attacks trees of all ages but it is chiefly harmful to young growth, saplings and young poles. These it more usually than not attacks at the top girdling the leading shoot and thus spoiling the shape of the tree. I have seen a sapling which had had its leader and two subsequent leaders (formed by side branches replacing the last leader) girdled by the beetle.

In large trees its work is also easily recognizable. They may be observed to have a curious irregular shape owing to numbers of the branches having had their ends 'cut' by this insect.

This curious raggedness in the shape of the tree is even more marked in the case of smaller trees and the number of branches treated in this manner must seriously interfere with and retard their growth.

In saplings the maximum amount of damage is observable as the girdling of the leading shoot and side shoots leads to misshapen trees which are easily recognizable in plantations. Fig. 1, Plate XII in *Departmental Notes*, shows a young sapling with its leading shoot cut off by this insect. The photograph was taken in the forest by Mr. J. W. Oliver. Fig. 2 shows the top of another sapling (from a photograph by Mr. H. Jackson) in which two side shoots have taken the place of the girdled leader.

The work of the girdler is easily seen. If the end of the girdled branch is examined a portion of the groove made by the beetle is always easily discernible.

Also owing to the deep groove cut by the beetle and the heavy weight of the needle bearing branch above it the latter very soon bends over and hangs down (until it does this there is nothing to show that the branch has been attacked save the small entrance hole from which resin exudes), attached by a few shreds of bark and wood to the branch below the cut, and a certain amount of resin exudes around the groove. This pendant position of the green branches renders fresh attacks at once perceivable in the forest and more especially is it visible in young plantations. Consequently the amount of damage being done by the beetles once the life history is clearly understood is easily discernible.

A curious fact I have observed about the insect is that it appears to be very local in its distribution occurring year after year in certain comparatively small areas of forest and being apparently almost entirely absent from other regions. This point is of importance since if it is true it should be possible to locate its *locale* and exterminate it.

A second point of importance is that insect has been found invariably in pure deodar forests, its greatest damage being committed in young pure plantations. It is much rarer in mixed forests, a point worthy of some consideration.

Natural Enemies.

I know of no enemies of this insect at present.

Points in the Life History requiring further observations.

1. It is necessary to definitely ascertain the number of generations this insect passes through in the year.

Is there an August-September generation? If so, this would be the second generation of the year.

2. I have never been able to find it before the 3rd week in June in the year. That this is its first appearance requires corroboration.

3. Its predaceous and parasitic enemies require investigation.

15.—HYPOBORUS? sp.

Reference.—Steb. Depart. Not. I, 278.

Nature of Attack.

This small Scolytid bores into green branches and twigs of sickly deodar trees, often attacking the upper portions of the branches girdled by the *Scolytus deodar* girdler. The galleries made by the beetle and its larvæ in the cambium often completely ring the branch.

Distribution.

I have taken the insect in the Jaunsar and Simla Forest Divisions of the North-West Himalaya.

Description.

Larva.—The larva is a very small white, legless grub. See Pl. IX, fig. 3a.

Beetle.—The beetle is small, oblong, black, rather shining, with head entirely concealed beneath the prothorax and not visible from above. Antennæ yellowish brown, scape thickened, longish, funiculus 5-jointed, the first long and thick; club oval, flattened, with 4 fine transverse sutures. Eyes long, narrow, transverse. Prothorax convex with a few tubercular projections anteriorly on its upper surface, and pitted on the rest of the surface posterior to this. Covered with fine bristly white

hairs. Elytra cylindrical, rounded at their posterior declivity, not larger than the prothorax and pitted, the pits being arranged in longitudinal rows not close together. Third joint of tarsus slightly longer than the two above it. Body cylindrical, pubescent.

Length a little over $\frac{1}{8}$ th inch. Pl. IX, fig. 3*b*, shows a dorsal and side view of this beetle.

Life History.

The male beetle bores horizontally through the bark down to the cambium layer usually just below the junction of two branches and hollows out a small irregularly shaped pairing chamber in the bast and sap wood. As many as 3 female beetles successively enter by the same hole and pair with the male.

After pairing the female beetles do not bore out a definite egg gallery away from the pairing chamber but merely enlarge this latter by eating out the bast and sap wood on one side or the other, successive beetles commencing work at opposite sides and laying their eggs in the area so enlarged. The whole of this irregularly shaped gallery made by the beetles, which often entirely encircles the branch beneath the bark and extends up the forks of the branches and thus effectually rings the tree, is filled with a wet mass of chewed wood refuse and excreta amongst which the eggs are laid (*vide* Pl. IX, fig. 3*c*). The egg stage is short, 2—4 days only, since young larvæ are often found in the chamber near the living female beetles and in the wood dust.

The larvæ bore away from the central chamber either up or down the stem, their galleries being blocked up with wood dust and excreta. When full fed they hollow out at the end of the gallery a longish chamber in the sap wood and pupate in it (fig. 3*c*).

I have taken mature beetle, ovipositing in deodar trees in the first week of June (1902) and this may be the first generation of the year.

At the beginning of November 1906 I took another generation of these beetles tunnelling into branches to oviposit. It is therefore probable that the insect passes through the winter in the larval or immature beetle stage.

I am unable to say whether the insect passes through a complete life cycle between July and end of October. It is possible that the June eggs give rise to a generation of beetles issuing in the latter part of July or in August and that these beetles lay the eggs which produce the October generation of beetles.

Damage Committed in the Forest.

Since the insect only feeds in green cambium and its method of oviposition often results in the branches being girdled it is capable of proving a serious pest to young

trees. The more so that whenever I have met it it has been in considerable abundance, the beetle apparently being a particularly hardy one.

The curious fact that it is almost invariably found infesting the upper part of branches already girdled by the *Scolytus* Deodar girdler is of importance since it is necessary to discriminate between this insect in this position and the real perpetrator of the damage, the *Scolytus* beetle.

The fact that it chooses this position also minimises to some extent the damage it does in the forest.

Protection and Remedial Measures.

When the insect is found infesting young growth the only safe plan of combating it is to wait till the insect is in the nearly full grown larval stage in the trees and then to cut out these latter and burn them. Infested trees can be easily recognized by the fact that the needles turn yellow and drop off and drops and rings of resin are to be seen beneath and encircling the minute shot holes made by the beetles entering the trees.

Points in the Life History requiring further observations.

1. The number of generations passed through by the insect in the year.
2. The number of eggs laid by each female beetle.
3. The length of time spent in the larval and pupal stages.
4. The stage or stages in which the winter is passed.

IV.—INSECTS INFESTING THE TWIGGS AND BUDS.

Curculio ? sp.

Reference.—This weevil remains as yet unidentified.

Nature of Attack.

The beetles feed upon the new green shoots of the year gnawing out patches from the epidermis and occasionally girdling the shoot. In this operation they bite off the needles near the base, the latter dropping to the ground. When numerous a considerable proportion of the new growth of the year may be removed from the tree.

Distribution.

I have only taken this weevil in Tehri Garhwal.

Description.

A small greyish brown weevil with short blunt proboscis, narrowish thorax; elytra broader than thorax and wider behind; longitudinally ridged and punctate. Long. $\frac{1}{3}$ rd inch.

Life History.

The weevil appears on the wing in the forest towards the latter part of June. I took a few couples *in coitu* upon deodar branches on the 24th of the month.

A couple were kept under observation for nearly a week. In this period they entirely destroyed two new green deodar shoots. They commenced by biting off the needles at the top of the shoot and then eating down the top of the stem to some distance. When the shoot began to get too thick for this operation they attacked the epidermis, first gnawing off the needles near the base until a patch of green epidermis was exposed and then stripping this off. In this manner the epidermis on the greater part of the shoot was removed.

I have no further observations on the life history of this pest which I have not as yet found numerous in Deodar areas.

Damage Committed in the Forest.

From its method of feeding it will be obvious that this weevil might become a dangerous pest to young growth if it suddenly increased in numbers in the forest. Consequently its life history requires to be closely studied.

Where it lays its eggs, where the grubs feed, the number of generations passed through in the year and its abundance in the forest all require careful study before suggestions can be put forward as to means of combating its attacks.

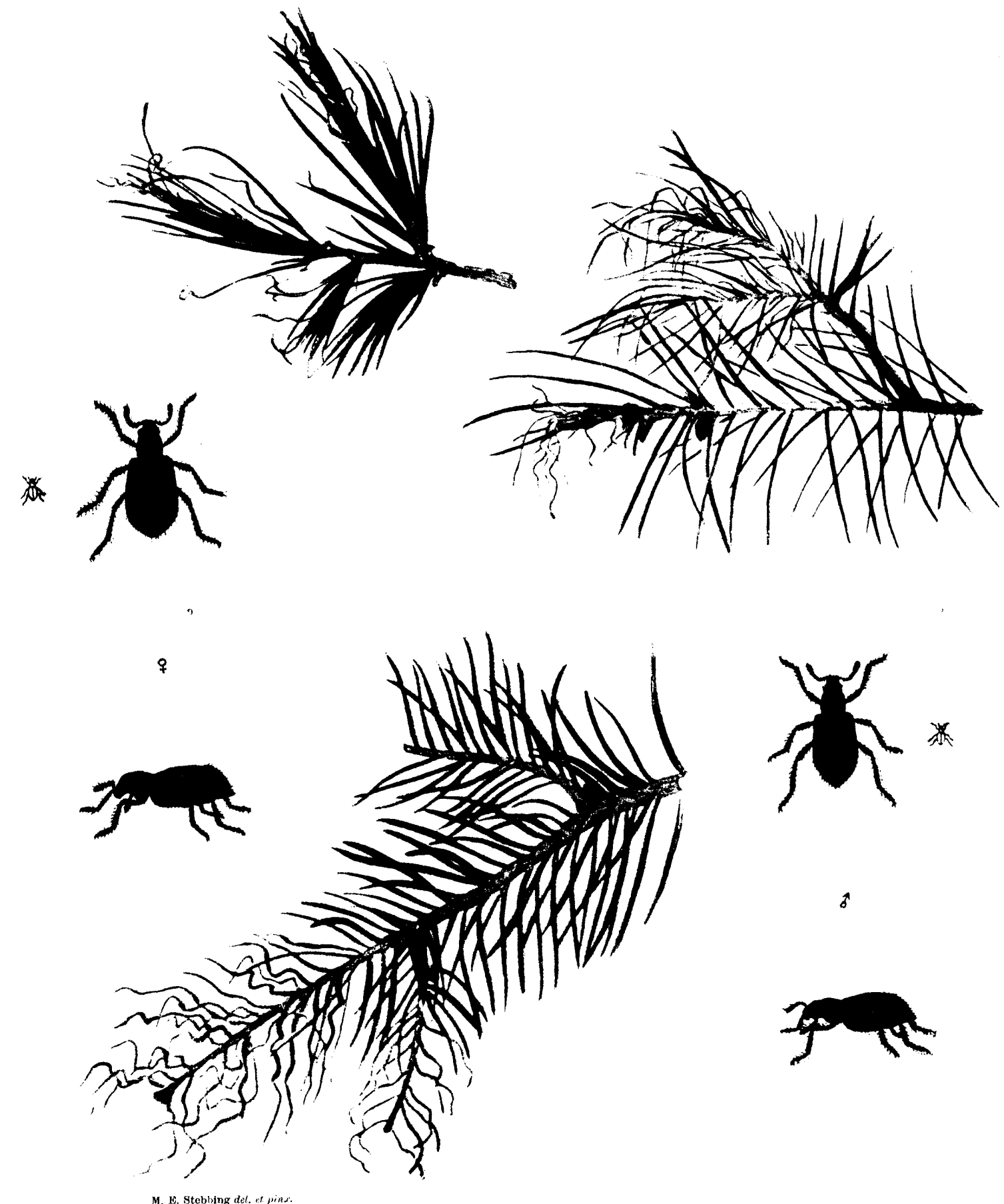
17.—POLYDRORSUS, sp.

This shoot eating weevil will be fully treated of under the Silver Fir (Part IV). The coloured plate (Pl. X) shows the beetle and its method of attack on branches of Deodar, Spruce and Silver Fir.

The beetle has been found feeding on the new green shoots of the year of the deodar and spruce but in a far lesser degree than on those of the Silver Fir which appears to be its natural or chief food plant.

In the case of the deodar the weevil gnaws patches out of the young tender-barked new shoots of the year or strips the epidermis off. This causes the shoot to wither and dry up and the needles to drop. The latter are occasionally also eaten down for some distance. Plate X, upper figure, shows a deodar shoot attacked by this weevil.

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M. E. Stebbing del. et pinx.

POLYDRORSUS SP. AND BRANCHES OF DEODAR, SPRUCE AND SILVER FIR,
SHOWING THE WEEVIL'S METHOD OF ATTACK.

18.—GEOMETRINA? sp.

*The Deodar defoliating Looper.***Nature of Attack.**

This looper caterpillar is commonly supposed to be a defoliator. Its main method of attack is however to eat down the sides of the green shoots biting off the needles or causing their death and final fall in his operations. Considerable tracts of deodar forest are completely denuded of their needles in this manner year after year in different localities in the Western Himalaya.

Distribution.

The insect would appear to be chiefly confined to areas on which the deodar is growing pure and not in mixture with other species. I have taken it in Jaunsar, in the Simla forest areas and in Bashahr State.

Description.

Young Larva.—Head large in proportion to abdomen. Prothorax canary yellow with a curious striated series of wavy orange lines on it. Mouth parts yellow. A longitudinal broad white lateral line down side with 2 wavy black lines above it. An orange yellow dorsal patch on last segment of abdomen. Last pair of clasper legs are canary yellow in colour; the last pair but one yellow at base merging into dark green above. Colour is a light green of a shade similar to the young deodar needles.

Full grown Larva.—The larva is a looper with 3 pairs of pro-legs and two pairs of clasping legs on posterior segments (10 and 12). Colour green—of the exact shade of the old deodar needles, to which colour it darkens as it increases in size. A white longitudinal stripe down the lateral sides of body shading off into yellow on the ventral surface; 3 white parallel stripes running down the whole length of ventral surface. A brown patch on the dorsal surface of the last segment. Head brownish yellow. Two yellow brown patches on either side of prothorax. A few scattered black bristles on body. Length 1 inch to $1\frac{1}{4}$ inch. Plate XII fig. 5*a*, shows this caterpillar.

Pupa.—Dark brownish anteriorly or dorsal surface, the ventral surface canary yellow in colour.

Length $\frac{1}{2}$ to $\frac{1}{3}$ rd inch. *Vide* Pl. XII, fig. 5*b*.

Moth.—At present unknown.

Life History.

Several attempts have been made to breed out the moth of this insect but they have all failed. This is curious since one would think from its life history that it would be a comparatively simple matter. The insect appears to pass through but one generation in the year and the caterpillar pupates in the soil. Every year the caterpillars make their appearance in one or more localities in the Western Himalaya and entirely defoliate areas of pure deodar. On these occasions the larvæ are often to be seen swarming in millions on the trees in April, May and June. When they are full fed they let themselves down by means of silken threads to the carpet of needles on the forest floor beneath, enter these and the first quarter inch or so of the soil humus, and pupate there. On three different occasions (once in Chittagong in Eastern Bengal in 1900 and twice in Dehra Dun in 1901 and 1902) I have kept numbers of pupæ, collected in the Simla forests and sent to me, under observation in an endeavour to breed out moths. On neither occasion was I successful in obtaining a single moth and I can but attribute the want of success to the fact that the greater temperature to which the pupæ were inevitably exposed killed them off.

This year (1909) I am again carrying out the experiment in Dehra Dun but up to November 15th no moths had issued from the numerous pupæ under surveillance.

All reports on the subject of the caterpillar agree that the insect first makes its appearance in April.

The young grub on hatching from the egg confines its attack to the young new spring needles which it exactly resembles in colouration, protection from birds and predaceous and parasitic insects thus being doubtless afforded it.

When Mr. E. M. Coventry, I.F.S., in charge of the Simla Division, first reported the attack from the Kalela forest in 1900 and sent me pupæ in September of that year he was of opinion that the caterpillars defoliated the tree by actually consuming the needles. On the 31st May in the following year I had an opportunity of studying an attack of the caterpillars in the Kalela forest myself. The area examined was a pure deodar forest and was suffering from a very bad infestation, the caterpillars being in millions. Observations showed that the larvæ did not defoliate the trees but fed upon the new green shoots of the year thus destroying them. In attacking the shoot the grub gnaws through the bases of some of the needles thus causing them to drop. The bulk of the needles however dry up and remain on the withering part. If a branch is tapped at all hard showers of these withering needles drop down as well as hundreds of caterpillars suspended from silken threads. At a distance badly infested trees with these withered needles attached to the branches have the

appearance of having been scorched by fire. When the caterpillars have entirely eaten or destroyed the new growth of the year by which time they will have reached half to two-thirds their full growth they turn their attention to the older needles on the tree and feed upon them. The larva is provided with a plentiful supply of silk and, when searching for a new feeding ground, lets himself down from one part of the tree to another or from tree to tree by means of a silk thread. This silk is also used to spin needles together or to form silk bridges between branches. It is never however spun together in thick webs nor used to form any kind of protective covering to the larva whilst the latter is engaged in feeding upon the tree.

The caterpillars attack trees of all ages from the smallest sapling to the oldest trees and apparently feed voraciously for some two months; some develop at a much more rapid rate than others as it is usually possible to obtain larvæ of all sizes on the trees at the end of May.

The caterpillar becomes full grown about the middle of June and is then ready to pupate. To accomplish this he drops from the tree by means of a silk thread to the needle covered forest floor beneath and enters the outer humus covered layer of soil and changes into a yellow brown pupa in this. No cocoon or covering of any kind is formed by the caterpillar. It is possible after a bad attack to turn up the layer of needles and the top humus covering and find the pupæ in thousands at the foot of the deodar trees.

From the middle to the third week in June the larger bulk of the larvæ reach full growth and pupate and the insect then appears to disappear entirely from the forest. We know that this disappearance is only an apparent one since the pupæ are in the soil at the foot of the trees and have been found there in numbers by Mr. E. M. Coventry, myself and others in September.

Moths issue from these pupæ either in the autumn when the young buds of the deodar which will open in the following spring have formed on the tree and lay their eggs on the twigs near these or the moths emerge from the pupæ in the early spring sometime soon after the commencement of April and lay their eggs on the twigs at this period.

Since no cocoon of any kind is found it would perhaps be a reasonable surmise to suppose that the moths issue in the autumn and oviposit on the trees and that the winter is passed in the egg stage. Against this is however the fact that I have never obtained moths in Dehra in the autumn.

Relations to the Forest.

The attack of this caterpillar in pure deodar areas resembles in one way that of the larvæ of the moth *Pyrausta machœralis* in teak forest and is as easily recognizable.

When seen from a distance the forest exhibits dirty yellow or brown patches in it showing up against the clear emerald green of the surrounding trees or in cases of a severe attack the trees may have a wholly dirty yellow or brown appearance looking as if a fire had passed over the area and scorched them. This appearance is of course due to the dead needles still hanging on the dead and withered shoots which have been attacked and killed by the caterpillars. Such areas when visited and inspected closely are seen to contain millions of caterpillars which drop on to one and cover one as one walks along and a very short inspection will conclusively show that the area is on the way to entire defoliation. On such occasions the insects are so numerous that their droppings can be distinctly heard pattering down from the trees in a continuous hail.

The result of such wholesale defoliation cannot but be extremely harmful to the infested trees. The whole of the growth of the year is lost and this may occur several years in succession. When this is the case the attack results in the smaller branches and shoots entirely drying up and dropping off and I think it is probable that a considerable proportion of young growth is lost owing to the attacks of this pest.

So far as my observations go the insect would seem to persist in certain localities to the exclusion of others. For instance the Kalela forest was very severely attacked in 1900 and again in 1901 and I believe there have been several attacks since. The Theog forest near the Simla-Thibet Road was badly attacked in 1900 (when the Forester stated that the caterpillars could be collected by the maund), again in 1901 and 1902, and I think in 1906 and 1907. If other records were available it would doubtless be possible to show that other infested forests are in the same position. Such continual and repeated defoliation can but result in a deterioration of the forest. The more especially so when the forest in question is a coniferous one.

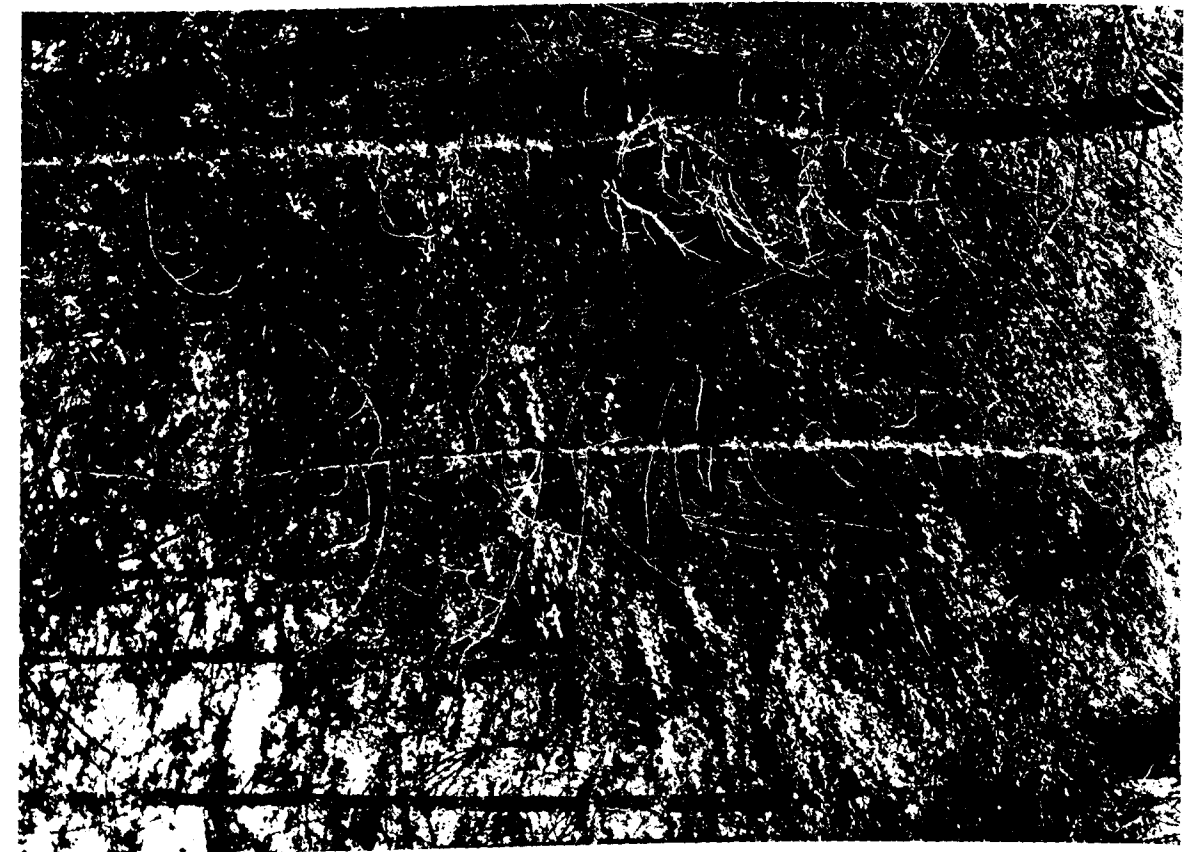
It is important to lay stress upon the following facts in connection with this attack:—

1. Badly infested forests have always proved to be areas of *pure* deodar. As one proceeds from such a forest into neighbouring areas where the tree is in mixture with blue pine or Silver fir and Spruce my experience has been that the caterpillars decrease in numbers or totally disappear. A good reason can be given for this since the larvæ would find it much more difficult to find a sufficient supply of food and would have to travel greater distances for it (when they had entirely stripped a tree for instance) than is the case when the trees are standing close together in a compact block.

2. Trees of all ages are attacked. This is an important factor in the case of this infestation since a casual infestation might lead to the inference that only suppressed and dominated trees or young useless growth were infested. Careful examinations

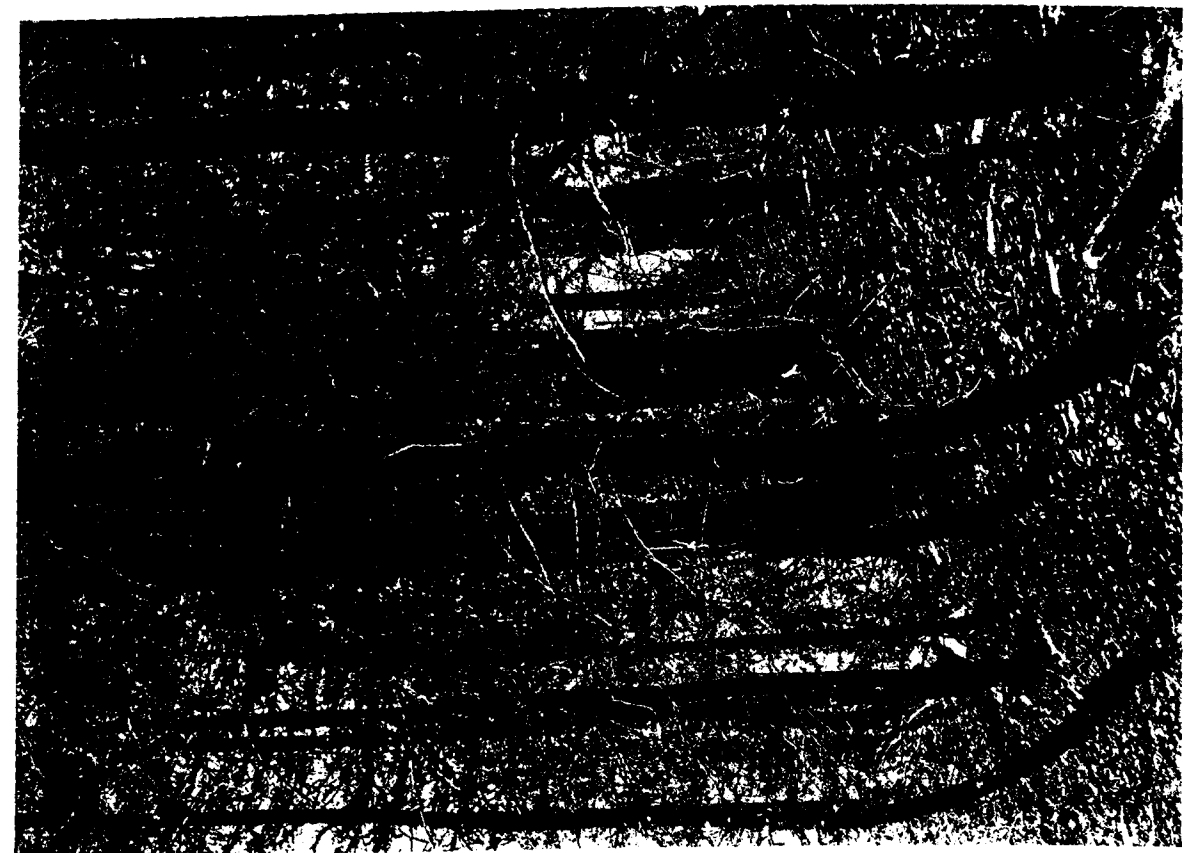
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PLATE XI.



Engraved & printed at the Office of the Survey of India, Calcutta 1910.

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Deodar-Pale forest defoliated by *Geometridia* sp.

Stebbing—Insect Pests of the Himalayan Coniferae.

Photo J. H. Luce.

have however shown that isolated trees in apparently sound robust health have been attacked and stripped by the caterpillars in a similar manner to suppressed trees and young saplings and poles.

Mr. J. H. Lace's beautiful photographs here depicted (Pate XI) of the defoliation committed in the Theog forest in 1901 show how completely the trees are defoliated under this attack.

Protection and Remedial Measures.

The life history of this insect shows us that the caterpillars appear but once in the year from April to June and that they are certainly to be found in the humus covering beneath the fallen needles between the end of June and September.

In areas which are known to be attacked year after year and in which as a result the trees are becoming more and more sickly and of decreased vitality (when it must be remembered they will be more subject to the **Scolytus** and **Polygraphus** bark boring beetles) I would suggest that fire should be judiciously employed to make a clean sweep of the insect. Such a remedy would be drastic and would have to be employed in a coniferous forest with the greatest circumspection and under the most careful supervision, small areas being dealt with at a time. There would however be plenty of time to do it and it might be best done at the end of the rains when the needles are still damp and the heat from such a fire whilst being sufficient to kill the pupæ would not have such a bad effect on the trees as if done at the end of June when the forest floor is like tinder. At present however we are doubtful how much time we should have in the autumn for such a purpose as we have not definitely ascertained when the moth emerges from the pupa.

I advocate the remedy however in the belief that once having been satisfactorily applied in a particular locality that area would escape severe attacks from the insect for a number of years since in the cold climate of the Himalaya insects do not increase and swarm with the same ease and at the short intervals which they are capable of in the hotter climate of the plains.

To prevent or minimise the attacks of this pest, as also of several others dealt with in this Memoir, the best remedy is to plant deodar in mixture. The planting of pure forests of this tree to any great extent in the Himalaya cannot, I think, but be viewed with alarm.

The tree is subject to the attacks of several most serious insect pests and it is not an uncommon event in the climatic conditions of the country to experience a series of dry open years entirely favourable to insect life owing to a more or less complete failure of the monsoon.

That such have been experienced in the past is of course well known and the sole reason why serious invasions of insect pests have not taken place within recorded

times is due I think to the fact that the forests are mostly mixed ones, large areas of any one species in a pure condition being the exception or entirely absent.

I think it is probable that the maintenance of pure forests of any coniferous species in the Himalaya will result sooner or later in severe insect invasion being experienced in such areas.

Points in the Life History requiring further observations.

1. At what period the moth emerges from the pupa?
2. The genus and species to which the moth belongs.
3. Where the eggs are laid?

V.—INSECTS INFESTING THE NEEDLES.

19.—CEPHUS? sp.

The needle fly miner.

References.—Stob. Insect Life, Jour. Bomb. Nat. Hist., XVI, 118; Man. Ind. For. Zool., p. 55.

Nature of Attack.

The eggs are laid at the base of undeveloped buds. The larvæ on hatching out feed on the inner side of the lowest part of the newly developed needle causing the basal portion to swell up. The growth of the needle is thus dwarfed, the needle turns yellow and brown. Whole rosettes of needles are at times treated in this way, the needles drying up and the rosettes persisting on the tree for a time. A considerable amount of defoliation is thus occasioned to the tree.

Distribution.

This attack was first studied in Jaunsar and I discovered the cause in May 1901 at Lambatach. I have since noticed the presence of the insect in the Simla Hill Deodar Forests.

Description.

Larva.—Extremely minute light yellow merging into orange on head and thoracic segments; spindle shaped, the head and posterior end drawn to fine points. Two antennæ visible on head and two small processes near anus. *Vide* Pl. XII, fig. 2a.

Cocoon.—The larvæ when mature spin a small oval elliptical white cocoon within the small cell at base of needle and pupate in this.

Imago.—A tiny brilliant metallic green blue shining fly with four fine pale yellowish wings and legs dark metallic blue. Length $\frac{1}{16}$ th inch (fig. 2b).

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Life History.

The first flies issue from the cocoon during the first fortnight of June and after pairing the female lays her eggs on the twigs apparently near unopened buds. The period of emergence is evidently variable as I have found fully grown larvæ in the cells in the third week of June. I have not been able to find a second generation of the larvæ on the deodar and it looks as if the insect passed through but one generation in the year, at any rate on the deodar.

The eggs which produce the July flies hatch out early in May at the time the little rosettes of tender new deodar needles are just bursting from the buds on the twigs. The young grubs crawl to the base of the new needles and take up a position on the inner side at the base and commence to feed on the tissues of the needle, chiefly I think by suction but not entirely so. The irritation set up by the grubs causes the bases of the needles to swell up, the lower part becoming convex on the outer surface and concave on the inner. A small chamber or cavity as shown in Pl. XII, fig. 2c, is thus formed in which the larva lives and feeds. The grub can be found here through most of May and till near the end of June.

Usually several of the needles of a rosette are infested and often the majority of them. As each infested needle swells at the base the swollen portions come into contact with one another and the base of the rosette takes on the appearance of a small green gall in which the larvæ are enclosed each in its own cell. The small gall has the appearance of a tiny melon, the upper portion of the needles projecting from the top and continuing to grow. Although the needles are thus in contact at the base they do not coalesce and each individual needle can be detached, when it is seen to have the appearance shown in fig. 2d of Plate XII, the little grub occupying the small chamber at the base.

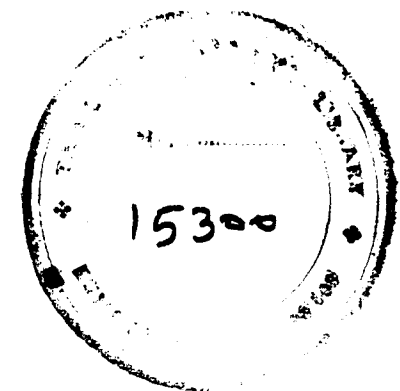
The larva on reaching full growth spins a papery cocoon and pupates within this.

The pupal stage is short, probably a week or ten days at most, and by the time the fly is ready to emerge from the cocoon the needles forming the little gall have dried, turned yellow and brown and have shrunk apart to a slight extent. This permits the fly to crawl out and escape. As I have said the period of emergence of the fly is variable, the first flies issuing in the first fortnight of June whilst the last of this generation do not appear till the beginning of July.

Damage Committed in the Forest.

So far as my observations have gone this insect appears to be somewhat local in its distribution, at any rate in areas where it occurs in any abundance. I have found forests as at Lambatach in Jaunsar for instance where it has proved to be in con-

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siderable abundance, whilst other localities appear to be entirely free of it.

The attack of the insect is serious in that it stops the growth of, and eventually kills, every rosette of young needles which it infests.

Considering the tiny size of the insect the number of rosettes infested and killed is at times almost incredible. Terminal shoots and side shoots are alike affected and when the attack is severe the stems are left bare or have portions of infested dry and brown rosettes still attached to them.

Protection and Remedial Measures.

This attack is easily recognizable once attention has been drawn to it. Its importance is of course chiefly as it affects young growth and in serious attacks on young trees the only way to combat it is to pick off all infested rosettes towards the middle of June and burn them or if this is not feasible to cut out heavily infested trees and burn them.

Points in the Life History requiring further observations.

1. The number of generations in the year.

Do the eggs laid by the July flies hatch out during the year they are laid and give rise to a second generation or do they remain *in situ* on the branches till the following May?

2. Is the whole of the life history passed on the deodar or is a second generation in the year passed upon some other host plant?

20.—TENTHREDININA? sp.

The Deodar Saw-fly.

References.—Steb. Insect Life, Jour. Bombay Nat. Hist, XVI, 121.
Steb. Man. Ind. For. Zool., p. 57.

Nature of Attack.

The grubs feed upon the needles of the tree eating them down from top to base and causing defoliation.

Distribution.

I have taken the larvæ in Jaunsar, the Simla Hill Forests and Bashahr State.

Larva.—Elongate. Yellowish green in colour with a small shining black head. The three thoracic segments following the head are slightly larger than the abdominal segments. The body is a darker green on dorsal surface than on ventral. There

are 3 pairs of pro-legs or thoracic legs yellow above and brownish black below and 9 pairs of yellow abdominal legs, only the 11th segment being legless. Length $\frac{3}{4}$ to 1 inch. Plate XII, fig. 1, shows two Saw-fly larvæ on a twig.

Fly.—I have not yet taken the fly of this insect. It will probably resemble the Spruce Saw-fly which will be figured in the Section devoted to the Spruce.

Life History.

But little is known upon the life history of this insect. To my knowledge there has not been a reported plague of saw-fly larvæ in the coniferous forests of the Western Himalaya during the last 10—12 years and there are no records to the effect that such has taken place.

With our knowledge of the damage these grubs are capable of committing and do commit in European coniferous forests it is extremely important that their habits should be studied and become known to the forest officer.

I have taken apparently full grown larvæ towards the end of June and beginning of July in Bashahr and Jaunsar, these being evidently those of a first or spring generation of the year which feeds upon the young new needles during May—June.

When attacking a branch the larva commences with the upper needles of the spring shoot and eats these down to their bases. It then consumes the tender upper parts of the green shoot and then goes on to the needles lower down. Where the shoot becomes thicker lower down the larva eats out patches from its sides, the resultant exudation of turpentine from the wounds thus made showing up attacked parts very plainly.

I have not yet succeeded in breeding out any flies. I do not know if there is more than one generation of the insect in the year. For further remarks regarding damage to forest by these pests and remedial measures refer to the Section under the Spruce Saw-fly.

VI.—INSECTS INFESTING THE CONE.

21.—EUZOPHERA CEDRELLA, Hmps.

Reference.—Hampson.

Nature of Attack.

The eggs are laid upon the flower or newly forming cone and the young grubs become enclosed in the developing cone and remain inside feeding in the seeds. When the insect is numerous the whole or the greater portion of the seed of the cones of a tree is riddled and killed.

Distribution.

Observations would seem to show that this insect is distributed throughout the whole of the area occupied by the Deodar and Spruce in the N.-W. Himalaya.

Description.

Half grown Larva.—Light reddish or red brown in colour dorsally, the ventral surface pale green; the first abdominal segment yellow. Head blackish yellow. Length 1 inch. (From Spruce and Deodar in July.) See Plate XII, fig. 3*a*.

Pupa.—More elongate and with sides more parallel than that of *Phycita* the wings making elongate bulges on the under side of the anterior half of the pupal case. Dorsal surface slightly spiny. Length 1 inch (fig. 3*b*).

Moth.—Small with palpi upturned and reaching vertex of head. Head, thorax and body greyish. Fore wing long and narrow, with apex somewhat rounded; dark grey to blackish in colour; a series of black spots near outer margin and an erect jagged white antemedial band. Under wings smoky grey with a dark line and fringe on lower margin. Expanse of wings about 15 millim. Plate XII, fig. 3*c*, shows the moth natural size and 3*d* enlarged.

22.—PHYCITA ABIETELLA, Schiff.

References.—Schiff. Wien. Verz., p. 138.

Tinea decuriella, Hubn. Samml. eur. Schmelt., fig. 74.

Tinea sylvestrella, Ratz. Fortz., i, p. 244, pl. 15, fig. 1.

Pinipestis abietivorella, Grote, Bull. U. S. Geol. Surv., iv, p. 701.

Hampsn. Faun. Br. In. Moths, IV, 91, No. 4387.

Nature of Attack.

This insect attacks the cones of the deodar in a similar manner to *Euzophera cedrella* with whom it is invariably found.

Distribution.

Throughout the area occupied by the deodar, blue pine, spruce and silver fir in the N.-W. Himalaya.

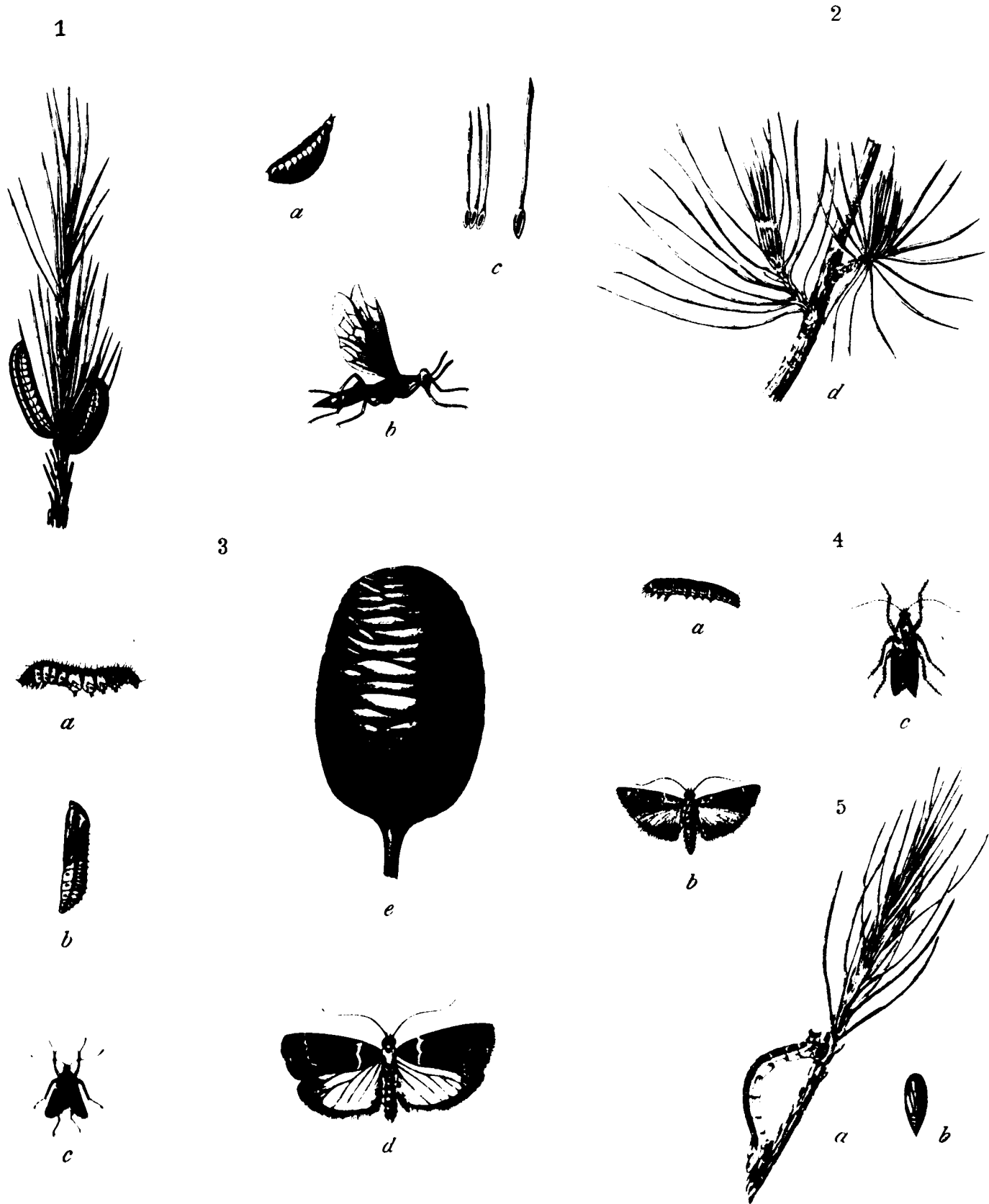
In the *Fauna* Hampson gives its distribution as the United States; Europe; Japan; Simla.

Description.

Partially grown Larva.—Reddish yellow or a dull greyish yellow in colour. Head small, black. Body covered with scattered bristles. Length 1 inch to 1½ inches. (In July.)

PLATE XII.

- Fig. 1. Deodar Saw-fly,
Deodar twig showing two larvæ feeding on the needles.
,, 2. *Cephus?* sp.,
 a, larva; *b*, fly; *c*, deodar needles showing the little larval chambers at base of
 needles; *d*, deodar twig showing the swollen bases of the needles in the
 rosettes.
,, 3. *Euzophera cedrella*, Hmpsn.,
 a, larva; *b*, pupa; *c*, moth, nat. size; *d*, moth, enlarged; *e*, deodar cone showing
 the exit holes of the larvæ.
,, 4. *Phycita abietella*, Hmpsn.,
 a, larva; *b*, *c*, moths.
,, 5. *Geometrina* sp.,
 a, larva on deodar twig; *b*, pupa.



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1. Deodar sawfly. 3. *Euzophera cedrella*.
2. *Cephus* sp. 4. *Phycita abietella*.
5. *Geometrina* sp.

Full grown Larva.—Purplish on dorsal surface becoming a pale greenish-yellow on ventral surface. Length $1\frac{1}{2}$ inches. (In September.) See Pl. XII, fig. 4a.

Pupa.—Small elongate, pointed at posterior end. Yellowish red in colour.

Moth.—The following is Hampson's description in the *Fauna*:—"Head, thorax, and abdomen grey and fuscous. Fore wing grey, thickly irroated and suffused with fuscous; a dark brown patch on base of inner area; a dark antemedial line with a grey band on its inner edge, angled outwards below costa and inwards on median nervure and vein 1; a large brown patch inside the grey band, less prominent towards costa; a prominent quadrate discocellular grey spot with a brown patch below it; a grey-edged dark postmedial line angled inwards at vein 6, then bent outwards and minutely dentate, some brown suffusion beyond the line; a prominent marginal series of dark specks. Hind wings semi-hyaline with a brown tinge; the cilia white, with a brown line at base. The prominence of the grey and fuscous markings of fore wings varies considerably."

Life Histories of *Euzophera cedrella* and *Phycita abietella*.

Present observations would seem to indicate that the life histories of these two insects are very similar to one another.

The moths make their appearance on the wing between the latter part of September and November and the eggs are laid either on the twigs near the young female flowers or, in the case of the deodar, in the young flowers themselves as they open in October.

The larvæ hatch out in the spring. Infested cones are first noticeable owing to small round holes surrounded with resin rings which begin to appear on the lower halves of the cones as early as May in the case of the deodar and during June in the blue pine, spruce and silver fir. Later on they are found in the upper half *cf.* Pl. XII, fig. 3e.

An examination of infested cones will show that the caterpillars feed in the seeds of the cone hollowing them out and leaving only the outer skin. The caterpillars or, in the case of the deodar, at least one of them does not confine itself to one seed only but tunnels through the structure of the cone to get from one seed to another. The turpentine which is largely exuded by attacked cones has apparently no detrimental effect on the grubs which are to be found wallowing in it. Towards the end of June the upright cones of the deodar and silver fir when infested by these caterpillars are seen to have their upper halves coated with white masses of exuded resin which is particularly noticeable on the dark purple coloured cones of the silver fir (*cf.* figure in the Section on the Silver Fir).

The long cylindrical cones of the spruce and blue pine in addition to the exuded

masses of resin commence to curl up in July and become gradually contorted into fantastic shapes.

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

This is not the case however with the deodar cone. This latter never drops whole from the tree, the scales dropping separately leaving the central cone erect on the tree. Old dry attacked cones still remaining on the tree inspected show several exit holes both at base and top evidently made by the full grown caterpillars. It is probable that the larvæ of *E. cedrella* pupate on the outside of the cone or neighbouring twig whilst those of *P. abietella* let themselves to the ground by a silk thread and pupate in the soil.

I think it probable that at least one of these cone-infesting larvæ migrates from cone to cone. I have usually found more than one grub in a cone though there may not be more than one of any individual species present, the moths having only laid one egg near or on each flower. The mature insects appear on the wing between September and October. Specimens I bred out at Dehra Dun* issued as follows: on 12th September two moths from silver fir; 19th September moths from blue pine and on 28th from spruce; on 4th October from deodar. All these were *P. abietella*. *E. cedrella* was obtained from spruce and deodar in October.

Damage Committed in the Forest.

Our knowledge is at present insufficient to enable us to say which of these two pests is the most aggressive, or whether there may not be others at work with them. The effect of their attacks is, however, most injurious since in bad years the majority of the seed crops are entirely lost. This was the case with the deodar crop in 1898, nearly the whole of which, according to Mr. Ribbentrop,† was lost from the trees round Simla, whilst Mr. Osmaston reported the destruction of cones the same year in the Jaunsar forests. The attack does not seem to have been noticed (or at any rate reported) on the spruce, silver fir, and blue pine during the year.

Observations made almost annually since then have shown that in any one year all the species of conifers subject to attack by these cone-boring caterpillars bear infested cones upon them, but that the attacks are most serious in heavy seed years.

* The warmer climate of Dehra, of course, affected the period of issuing of the moths.
† Vide "Notes on the Deodar," Indian Forester, Vol. XXV, Appendix.

In 1901 a serious attack of the pests infested the deodar and it was in this year that I discovered that the caterpillars also attacked the cones of the spruce, silver fir, and blue pine.

It was estimated that the insects caused the loss of the greater part of the seed of these four trees in parts of the Simla and Bashahr Divisions during that year. In 1906 the Deodar suffered badly from the insects in Jaunsar whilst in 1908 many trees in Simla and the Simla Catchment Area were badly attacked.

In 1909 numbers of deodar, spruce, and silver fir trees were noticed as seriously infested by the pest in the southern portions of the Chamba State.

Protection and Remedial Measures.

It is difficult to suggest remedial measure for combating attacks of this nature.

The obvious one is the collection of infested cones and burning them *before* the caterpillars leave them to pupate in the soil. This method is not so impossible as it may sound at first sight except in the case of the deodar since badly infested cones always drop from the trees whole towards the end of August or during September. Even in the deodar many of the infested cones drop and the collection and burning of these on areas where deodar regeneration is urgently required would therefore prove feasible and would well repay the cost since once the area was regenerated the attacks on the seed in that locality would not be of paramount importance for some years to come.

The use of fire in early September and under careful supervision as recommended for the destruction of the deodar looper pupæ on page 5 of this Memoir will, when possible, prove the best of all remedies.

Points in the Life History requiring further observations.

1. Where the eggs are laid. The discovery of this point is most important.
2. When the larvæ first hatch out, and where they spend the first stages of their life histories.
3. The number of different species of larvæ attacking the cones, and which species of cone they are most common in.
4. The length of the various pupal stages.
5. The length of time during which the moths are to be seen on the wing in the forests.
6. The stage in which the insects pass through the winter. Is it the egg stage?

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

HYMENOPTEROUS PARASITE ON THE DEODAR CONE CATERPILLARS.

23.—ICHNEUMON? sp.

I examined a number of infested deodar cones at Konain in Jaunsar on the 6th November 1906.

The cones were badly attacked by the two caterpillars of the moths *Euzophra cedrella* and *Phycita abietella*. In addition I found a considerable number of a hymenopterous grub which appeared to be parasitic upon the moth caterpillars, but whether on one or both of them I am unable to say.

I have not yet been able to make any further observations on the life history of this useful insect.

Larva.—Elongate segmented whitish yellow and pointed at each end. Just under $\frac{1}{2}$ " in length.

VII.—INSECTS INFESTING THE ROOT.

24.—MELOLONTHA sp.

The Deodar Cockchafer Grub.

Reference.—Depart. Not. I, 87.

Nature of Attack.

The larvæ of this beetle cut down young seedlings at the base at their junction with the soil or bite through the stalks and roots below the soil. The injury results in the death of the seedlings attacked.

Distribution.

I first noticed these grubs attacking patches of deodar sowings in the Taranda Forest, Bashahr Division, Punjab, in July 1901.

Recently (1909) the grubs have been reported in the same connection from the Jaunsar Division by Mr. H. G. Billson, I.F.S., Deputy Conservator of Forests in charge of that Division.

Description.

Larva.—The larva is a large heavy yellowish white curved grub with a light brown head bearing two antennæ and a pair of long curved very powerful mandibles.

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The body is thick and curved, the anterior segments being much corrugated whilst the posterior three segments are swollen up in a bag-shaped manner and are black in colour.

Length $1\frac{1}{2}$ to 2 inches. Pl. XIII, fig. 1, shows this grub.

Beetle.—Spruce, robust and thick having the usual cockchafer appearance.

Life History.

So far as is at present known it is the larva of this cockchafer beetle which is dangerous to deodar growth.

The grub cuts through seedlings and young plants at their bases and feeds upon them or bites through the roots beneath the soil.

Grubs apparently full grown were found engaged in this manner in some patches of deodar sowings in the Taranda Forest, Bashahr Division, in June—July 1902.

In June of the present year (1909) a report was received from Mr. Billson, Divisional Forest Officer, Jaunsar, that patches of young deodar seedlings were suffering from grubs in a similar manner. The grub proved to be a Melolonthid one and not improbably identical with the one I found in Bashahr in 1902.

The rest of the life history of this insect has yet to be studied. It is probable that the beetle will be found on the wing sometime during the summer months and it may be that the larvæ pupate at irregular intervals throughout the summer so that some beetles will always be found between June or July and October. This point has to be definitely ascertained.

Damage Committed in the Forest.

So far as observations have yet gone this insect is only destructive to seedling and perhaps very young sapling growth and the damage is done by the larva only.

Regeneration of the deodar is carried out to a considerable extent by sowing the seed in patches and it has been a common experience to find that the whole of these patches fail. The seed may germinate and the young plant come up and then apparently damp off. This apparent damping off is very often entirely due to the attacks of this cockchafer grub or the other root pests described here. It has in the past, however, been almost invariably attributed to drought or frost or bad seed.

The following description of a patch of sowing I examined at Taranda is typical of what occurs so often:—

There were probably 25 seedlings originally in the patch. At the time of inspection five green uncut ones were all that remained standing in the soil. Most had been cut off either at the apex of the stalk just below the crown of needles or some way down the stalk below the ground. These cut seedlings had been

[59]

Distribution.

This pest is according to Hampson universally distributed throughout the world with the exception of South America.

It has been reported in connection with the forests from the Rawalpindi (Gora Gali), Simla and Bashahr Divisions in the North-West Himalaya.

Description.

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

Larva.—The larva is a stout, naked, earth-coloured worm, varying from half an inch to two inches in length when full fed. In its early stages it is a semi-looper. Pl. XIII, fig. 3*a*.

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

Moth.—The moth is medium sized, the males having bipectinate antennæ, the branches being of moderate length. The insects are whitish brown, pale brown, or fuscous; palpi darker at sides; collar with dark line; abdomen whitish. The forewing suffused with brown, with double waved sub-basal ante and postmedial lines; the submarginal line dentate, with two black streaks on it below the apex and a marginal series of specks; the orbicular and reniform with dark centres and edges and with a black streak beyond the reniform; the claviform small and black; all these markings are much obscured in the darker specimens. Hind wing more or less suffused with fuscous brown with a dark marginal line. Expanse of wings 42—56 millim (fig. 3*b*).

Life History.

The following notes on the life history of this pest are from numerous reports of the insect contained in the pages of *Indian Museum Notes*:—

The eggs are laid in small batches and often in two or three layers covered sparsely with long scales from the abdomen of the female moth. These eggs are laid near the ground on twigs and branches of trees away from the food plant of the young larvæ which have therefore to seek their food plant when they hatch out. The eggs are also probably laid at times on the bare ground. The larva can be recognized by its colour and by the fact that it rolls itself up into a ball when disturbed. They are enormous feeders and devour and destroy young plants on a large scale. When full fed the

in some cases partially eaten or a few needles only had been consumed and then the seedling left to wither, whilst fresh ones were attacked. Others had been cut off in the soil by the larvæ and the roots entirely or partially consumed. On digging down into the soil two of the above described large larvæ were discovered, they being responsible for the damage done. Had this patch been inspected two days later there would probably not have been a single seedling left in it. Several patches in the neighbourhood were in this latter condition. Fig. 1a in Plate XIII shows a young seedling killed by this grub.

Natural Enemies.

I know of no natural enemies of this grub yet. It is not improbably parasitised by fossorial wasps.

Protection and Remedies.

I am discussing protection and remedies fully under *Agrotis* below. It may be added here however that when hoeing up the soil before sowing the seed all such grubs should be killed and poisoned baits should be made use of when the young seedlings are beginning to appear above the soil.

Points in the Life History requiring further observations.

1. The period spent in the grub stage. Is it more than one year?
2. At what period the grub pupates? Is it at varying intervals throughout the summer?
3. How long is spent in the pupal stage?
4. At what period or periods the beetles issue?
5. When the beetle oviposits?

25.—ELATER sp.

The Deodar Click beetle grub.

Reference.—Depart. Not. I, 89.

Nature of Attack.

The grubs cut through the roots of young deodar seedlings in the soil thus causing the death of the plant.

Distribution.

I have found these grubs at present only in Jaunsar and Bashahr State.

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Description.

Larva.—Brown in colour, hard, shining with three pairs of thoracic legs on the first three segments of the body behind the head. Length $\frac{1}{2}$ inch. Plate XIII, fig. 2.

Beetle.—Unknown.

Life History.

The larvæ taken by myself were found accompanying the Melolonthid grubs above described as destroying deodar sowings in the Taranda Forest in Bashahr.

The elater grubs, or 'wire worms' as they are called from their similarity to little bits of wire, were not very numerous. Their attack is however easily distinguishable from that of the cockchafer grub as the wire worm never comes above soil but only cuts through the roots beneath the surface. Young plants thus attacked are seen to be dead or dying without a cause. If however they are pulled upwards gently they will be found to come away in the hand the roots having been cut clean off.

These grubs often attack rows of young seedlings in the nursery in this manner.

No further observations have been made on the life history of this pest.

We require to know how long the grubs spend in this stage of their existence when they pupate and when the beetles issue from the soil, pair and oviposit.

To clear the soil from such pests digging in quicklime is recommended when it can be done with safety to clean the soil before putting in the seed.

Flooding nursery beds and allowing them to stand under water for a time is a good method.

All grubs appearing above the surface should be collected and killed unless the flooding is done so as to totally submerge the beds.

Watering the beds with a solution of copper sulphate is also at times effective.

26.—AGROTIS YPSILON.

The Cut Worm.

References.—Rott. Naturf., xi, p. 141; *Noctua suffusa*, Fabr. Mant. Ins., ii, p. 157; Moore, Lep. Ceyl., iii, pl. 147. C. and S., No. 2001; *Phalena idonea*, Cram. Pap. Exot., iii, pl. 275 H., *Bombyx spinula*, Esp. Schmett., iii, pl. 63, figs. 6, 7; Hampen. Faun. Br. In. Moths, ii, No. 1023, p. 182; Ind. Mus. Not., Steb. Inj. Ins. Ind. For., 113; Dept. Not. I, 81.

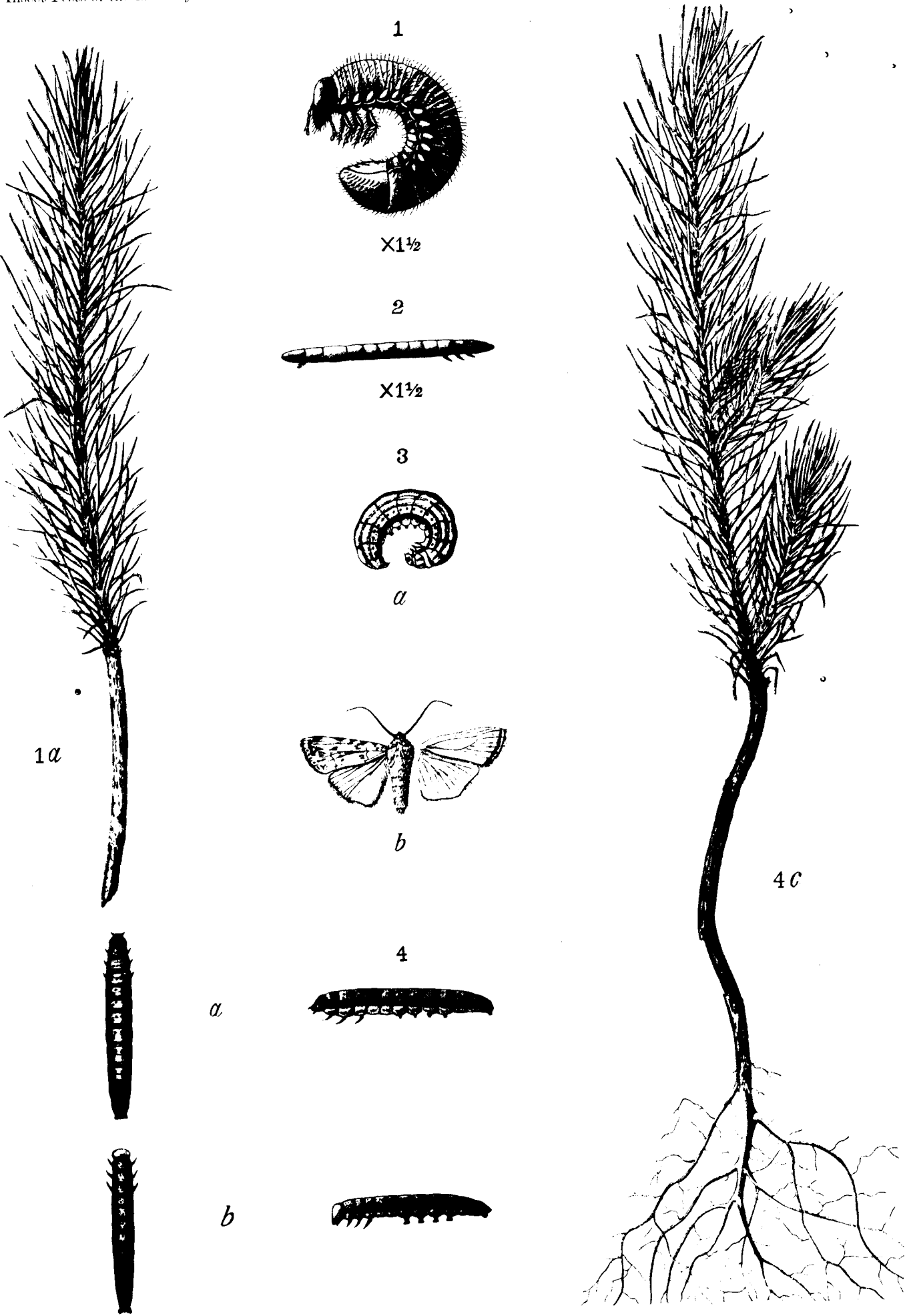
Nature of Attack.

The caterpillar is destructive to young seedling growth. It cuts through the stems of the seedlings close to the ground and either consumes portions of them on the seed bed or drags them to its tunnel in the ground and feeds upon them there.

[61]

PLATE XIII.

Fig. 1. Melontha sp.,
1, Grub; 1*a*, deodar seedling killed by grub.
„ 2. Elater sp.,
Grub.
„ 3. Agrotis Ypsilon,
a, larva; *b*, moth.
„ 4. A deodar root-feeding caterpillar,
a, dorsal and side view of caterpillar; *b*, dorsal and side view of caterpillar;
c, deodar seedling showing tap root girdled and killed by the caterpillar.



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1. Melontha sp. 3. Agrotis ypsilon
2. Elater sp. 4. A deodar root-feeding caterpillar.

[to face page 62]

caterpillar buries itself from 2 to 8 inches deep in the soil and there constructs a firm, irregular, oblong cell of earth, in which it pupates. The period spent in this state will probably vary in different parts of the country. The moths fly only in the dusk or at night, and except that they lay the eggs which give rise to the cut worms, do not themselves injure plants.

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

A larva sent from Kurseong, Eastern Himalaya, in May changed into a pupa on the 17th, and a moth on the 28th of that month in the Indian Museum, Calcutta; whilst another from the Jessore district, Bengal, changed into a moth in September. It is these September moths which give rise to the November larvæ. It would thus appear that there may be three generations in parts of Bengal. This very important point requires further observation. From the above it will become evident that the different generations have generally, if not always, different host plants. In its cold weather generation in the plains the cut worm is known to feed on opium plants. Later on in the rainy season legumes and pulses replace the opium in the fields and the later generation adapts itself to the changed food plant and feeds upon these.

It is probable that in the colder climates of the Himalaya the number of generations passed through by this insect is curtailed. The insect probably passes through the winter as half grown larvæ hibernating either below the surface of the soil or beneath blown down stems or logs, stones and other débris. They recommence feeding in May.

From the 3rd week in May through June and on into July Mr. B. O. Coventry, I.F.S., found them feeding on young deodar seedlings at Gora Gali. The caterpillars are excessively wasteful in their method of feeding, cutting off numbers of seedlings and consuming small portions of a few, only leaving the remainder to wither.

The caterpillars are nocturnal feeders resting in their burrows during the day time. In cloudy and rainy weather, however, they are to be found out on the surface at their destructive work. Mr. Coventry obtained pupæ about the middle of July and a moth from these pupæ in the middle of October. It is probable that these October moths lay eggs at once and either the winter is passed through in this egg stage or more probably the eggs hatch out and the immature grubs hibernate through the winter.

It would thus appear that in the Himalaya the insect passes through but one life cycle in the year as is the case in other cold parts of the world.

This very important fact requires to be definitely ascertained.

Damage Committed in the Forest.

This *Agrotis* cut worm is a serious pest in the nursery and to young plants either transplanted out in the forest or grown from seed in patches in the forest. The insect is perhaps to be dreaded more especially in dry warm years following open winters when the majority of the caterpillars pass safely through the young stages of their existence with but slight mortality amongst them. It is in such years that the caterpillars appear to suddenly increase in large numbers and young deodar growth suffers severely both in the nursery and out in the forest.

As we have said the caterpillar is an excessively wasteful feeder, cutting down many more seedlings than he can by any possibility consume. It is owing to the presence of these cut down and withering seedlings on the surface of the bed or soil patch that the presence of the caterpillar in the locality can be easily detected. Other portions also will be found protruding from the orifices of the larva's tunnels into the soil.

Mr. B. O. Coventry thus described the attack he discovered at Gora Gali:—

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

At a nursery in the Kalela forest, Simla Division, I found young deodar seedlings being attacked in a similar manner at the end of May 1901, and the pest was also destroying seedlings in the forest. Later on in June of the same year, when, with Mr. E. M. Coventry, I.F.S., we found the caterpillars in a nursery in the Nagkela reserve (Kotgarh, Simla Division), and also eating seedlings put out or sown in patches in the forest. There can be no doubt that *Agrotis ypsilon* commits very considerable damage yearly amongst deodar seedlings, checking very appreciably the young growth in those areas in which the insect has obtained the upper hand.

It is also I think this insect, together with its companions the Melolonthid and Elaterid grubs, which is responsible for the total failure, so often reported, of patches and strip sowings of deodar seed sown in carefully prepared areas out in the forest as also in the nursery beds themselves.

Protection and Remedies.

The following remedies, etc., for combating attacks of these 3 root feeding grubs were suggested in *Departmental Notes* and one or two have since been put in practice by Mr. Billson in the Jaunsar Division with successful results:—

The methods which can be adopted are of course chiefly applicable in the nursery although it might be possible under certain circumstances to carry them out in the forest.

- (1) Before the young seedlings have come up place bundles of any succulent crop plant which may be growing in the neighbourhood (in America cabbage, turnips and clover have been found most effective) at intervals on the seed beds, first sprinkling the bundles with Paris-green water. The young larvæ will feed on these and be killed off before the seedlings come up.
- (2) Crows, mynas, starlings, the cattle egret, and many other nesting birds all eat the grubs whenever they can find them, and they are particularly active in this respect in damp weather and after irrigation. Thus, whenever possible, the beds attacked by the pest should be flooded with water in the day time. The water will fill the burrows and force out the insects, which, if birds are plentiful, will be picked up and eaten by them. If birds are not numerous hand-picking must be resorted to.
- (3) Another good method of checking the pest is to dust the plants over a few times in the evenings with a mixture of quicklime and ashes, or better still, add the arsenic compound Paris-green to the two in the following proportion: One ounce of Paris-green with one ounce of unslaked lime and 3 lbs. of ashes. Powder the substances together very finely, put them into a calico bag and dust over the plants, loosening the soil around them first.
- (4) In nursery beds already attacked the surface of the soil should be carefully inspected, and all holes containing portions of leaves, stalks, etc., should be dug up and the larvæ at the bottom killed. This was the method resorted to at Gora Gali and gave good results.

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

Points in the Life History requiring further observations.

- I. In the warmer parts of India—
 - (1) The number of generations passed through during the year and the length of time spent in the various stages of these generations.
 - (2) The different food plants fed upon by the insects of the different generations.
- II. In the colder climate of the North-West Himalaya and other cold areas in the country—
 - (1) What becomes of October moth? Does it lay eggs at once and die, and do these eggs hatch out the same year?
 - (2) Does the insect hibernate through the winter in the soil as a half-grown larva?
 - (3) Are the larvæ found feeding in May—July the offspring of the October moth?

27.—ANOTHER DEODAR ROOT-FEEDING CATERPILLAR.

Amongst some consignments sent me on two different occasions during 1909 by Mr. Billson from deodar areas in Jaunsar were a number of caterpillars having a resemblance to the grubs of the families *Lymantridæ* or *Lasiocampidæ*. These grubs were reported as being very numerous in the deodar nursery and to have killed off a number of young plants.

The caterpillar has a greenish grey appearance, being lighter yellow beneath. The upper surface is speckled with black dots, the head being black. Length $1\frac{1}{2}$ inches. This caterpillar is shown in Plate XIII, fig. 4a.

A second caterpillar shown in fig. 4b has a yellow head, is darker in colour and less speckled. It may be a later or earlier stage of 4a.

The damage done by the caterpillars is extremely serious as they entirely girdle the tap root of the seedling below the surface of the soil as shown in fig. 4c thus killing the plant.

I have not yet seen the pupa or moth of this pest. The attack and injury are so serious that the life history should be worked out as early as possible.

VIII.—INSECTS INFESTING THE WOOD.

28.—CROSSOTARSUS CONIFERÆ, Steb.

The Deodar Wood-boring Platypid.

Reference.—Stebbing, Departmental Notes on Insects that affect Forestry, I, p. 411.

Nature of Attack.

The beetle bores cylindrical tunnels down into the wood of newly felled or

standing sickly green deodar trees laying its eggs at the end of the tunnel deep down in the sap wood. When numerous the outer surface of the log looks as if it had been fired into with No. 6 shot and the strength of the timber is greatly impaired by the numerous small tunnels in it.

Distribution.

I first took the insect in Jaunsar and Tehri Garhwal in 1902 and have since found it numerous in felled deodar logs in Chamba. It is probably distributed throughout the Deodar tracts of the North-West Himalaya.

Description.

Egg.—Ovate, elliptical, white, semi-translucent. Resembles a hen's egg *en miniature*. Length 0.75 millim.

Larva.—Young stage. Elongate, straight, white; thickest anteriorly, tapering posteriorly, head pale yellow. Length 1 millim.

Beetle.—Elongate, narrow, dark brown, shining. Head with vertex punctate. Thorax with close wavy transverse striæ, punctate posteriorly. Elytra deeply striate, their apices ending in a calliper arrangement (longer in the female than in male) and with long yellow hairs dorsally. Ventral surface shining, abdominal segments black. Legs yellowish brown. Long 4.7 millim. Plate XIV, figs. 1 and 2, show the male and female.

Life History.

The mature beetle is to be found boring into fresh deodar wood towards the end of June at elevations of from 6,000 to 7,000 feet. The beetle bores down through the bark making a cylindrical tunnel straight into the sap wood, this portion of the tunnel being either carried vertically downwards (in case of felled trees) or at an angle, perhaps more often the latter. When she has got down from half an inch to an inch into the sap wood the female is joined by a male beetle. This latter may have entered by crawling down the female tunnel or he may bore a separate tunnel to intersect the female tunnel in the sap wood. Pairing takes place here. From this point the female subsequently takes her tunnel for an inch or so at an angle to the previous direction and then zig-zags in another direction until she has attained the required distance down into the wood. She then turns and eats out the remaining portion or branch of the tunnel in a direction usually more or less parallel to the outer bark and at right angles to the long axis of the tree. This part of the tunnel is about 2 inches in length, is quite straight and has no enlargement at the bottom. Close to the end she deposits her first eggs. The number of eggs laid altogether by the

beetle has not yet been ascertained, but I recently (1909) found a little mass of 4 freshly laid eggs adhering together near the bottom of the tunnel with the female beetle a little higher up. The eggs are not stuck together by any siccable substance for the ones taken were found to be quite separate and easily parted on drying.

Only a few young larvæ have as yet been taken in these tunnels. They do not feed upon the wood but probably belong to the so-termed ' ambrosia ' beetles, feeding upon fungous matters, either growths on the walls of the tunnel, from the fresh sap which exudes down the walls, or perhaps induced there by the beetle itself, at any rate at first during the young stages of growth of the larvæ. That this latter may be the case the habit of the beetle in remaining alive in the tunnel and moving up and down it during a considerable portion of the period required by the larvæ in reaching full growth would seem to support. On the other hand the wet sappy state in which the walls of the lower or inner part of the tunnel are always to be found and the depth to which the female takes the portion of the tunnel in which she lays her eggs, where the walls remain moist for a period sufficiently long to enable the grubs to reach their full growth, would seem to indicate that the material upon which the larvæ feed is purely a growth of sap origin and that the reason for the beetle remaining alive is to be sought rather in the protection she affords to the eggs and larvæ when hatched out by blocking her tunnel against the entrance of predaceous insects and their grubs (in a similar manner to **Scolytus major** and **minor**), than in any attempt on her part to provide food for her offspring.

The female gallery is never carried into the hard rings of the heart wood though it reaches down to them and may have penetrated the tree to a depth of from 6 to 12 inches or more when the sap wood is very thick (*vide* Plate XIV). The insect burrows into the tree in an indiscriminate manner, the thickest end of the butt of trees 6 feet in diameter being attacked equally with the top end of the stem and the thickest of the branches. It will only however infest trees with absolutely fresh sap wood, and so far as present observations go it appears only to bore in through the fresh bark and will not attack barked logs.

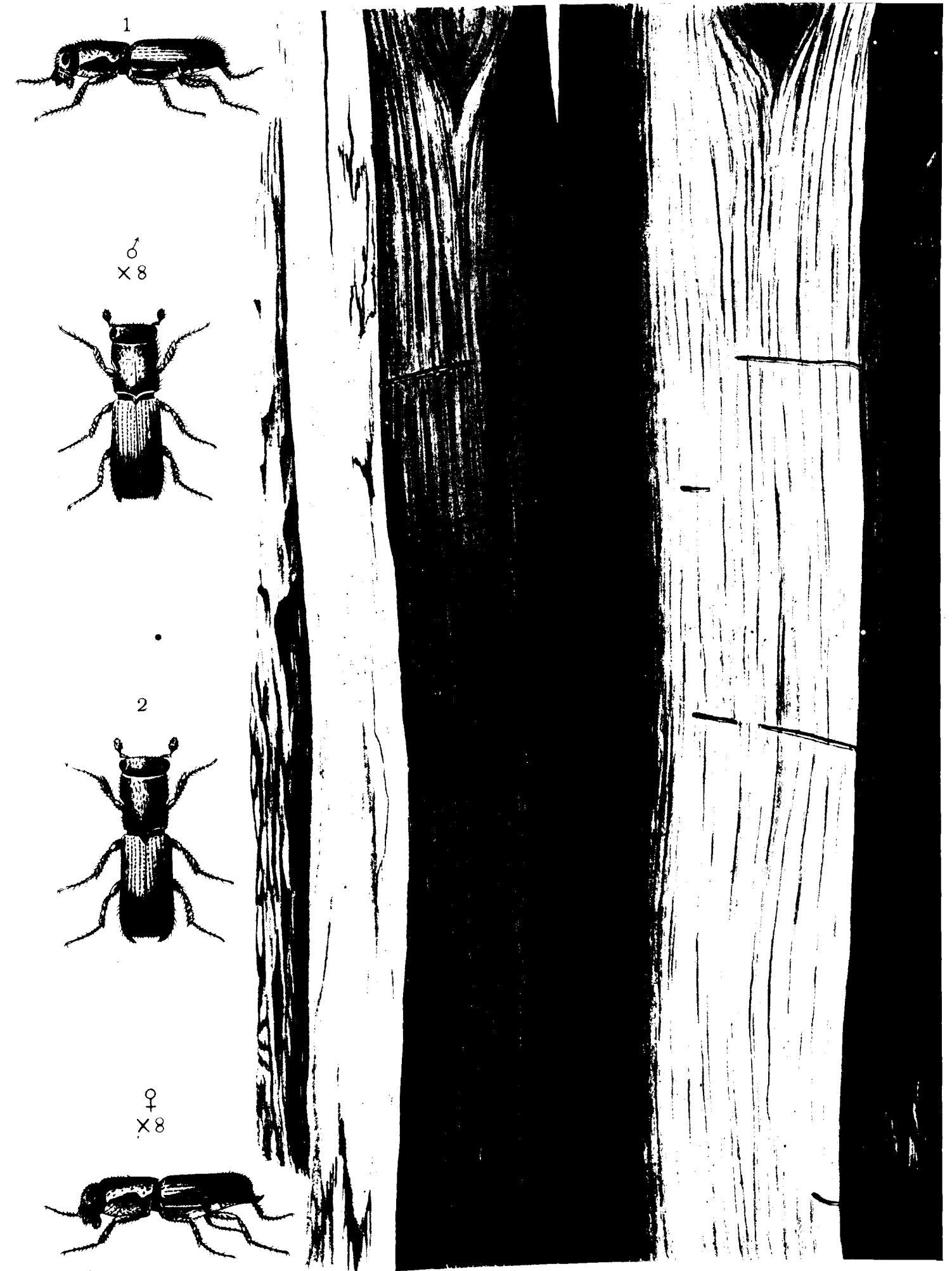
The beetles to be found at the end of June are laying the eggs of the second generation of the year.

A third generation of beetles have been taken in October laying eggs.

This **Crossotarsus** is more active than the ordinary Platypids and it walks at a comparatively good pace when outside its tunnel. It is active in daylight and tunnels into a log on the ground equally on the side on which the sun impinges as into the parts in shade.

PLATE XIV.

- Fig. 1. *Crossotarsus coniferae*, Steb.,
 1. Side and dorsal view of male beetle;
 2. Dorsal and side view of female beetle;
 3. Portion of a deodar log split open to show the tunnels into the wood made by the female beetle to oviposit.



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Damage Committed in the Forest.

When numerous this Platypid must be considered a pest of considerable importance to the timber of the tree since a badly attacked log shows numerous shot holes on the outside of the sap wood, sometimes to such an extent that it is obvious that its strength and durability are greatly undermined.

The insect burrows into trees of all ages and, failing a supply of felled trees or sickly or snow or wind breaks, it has been found to attack green standing trees in the forest.

Protection and Remedial Measures.

An obvious method of preventing this beetle increasing in a forest is to remove or bark all sickly trees and wind thrown or snow breaks and more important still to *bark* all trees as soon as felled for sale purposes.

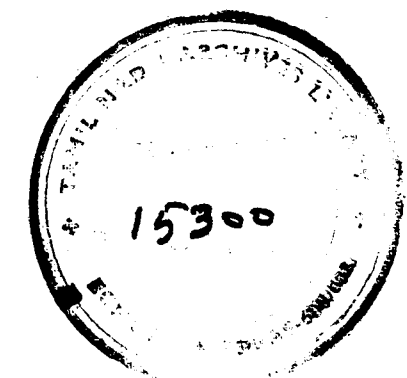
It is essential that this operation be undertaken as soon as the tree is down and has been logged since once the beetle has got through the bark into the sap wood the removal of the bark will in no way affect it. In fact it is likely to increase the injury to the timber since it is probable that the female will carry her tunnel deeper down into the wood to escape the heat of the sun and the consequent more rapid drying of the outer sap wood which the removal of the bark will ensure.

The beetle attacks trees in swarms so that a few days are sufficient for the insects to have penetrated an unbarked log throughout its entire length and the damage to the timber will then be irremediable since it must be remembered that this damage is entirely the work of the beetle and is carried out within a period of from ten days to a fortnight.

Points in the Life History requiring further observations.

The number of generations passed through in the year requires to be definitely ascertained. Whenever found the beetle has been seen to attack the deodar at the same time as a generation of the **Scolytus major** and **minor** beetles were infesting it and it may prove that the Platypid passes through an identical number of generations with the Scolytus.

It is also necessary to ascertain where the insect passes the winter.



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