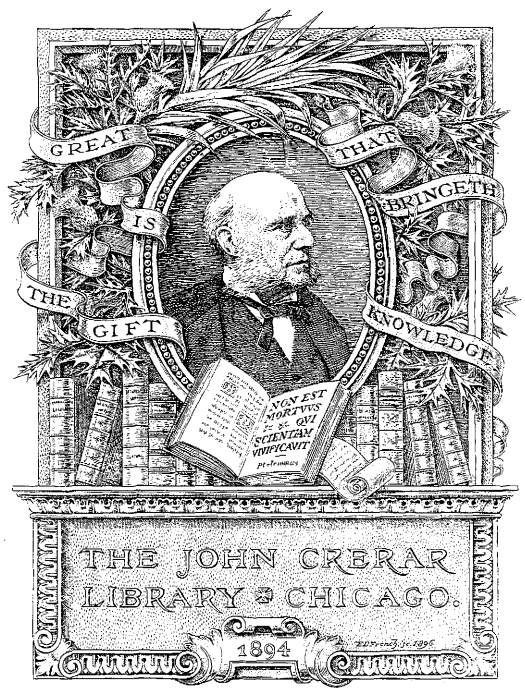

GREAT IS THAT BRINGETH
THE GIFT KNOWLEDGE
NON EST MORTUUS QUI SCIENTIAM VIVIFICAVIT
THE JOHN CRERAR
LIBRARY · CHICAGO.
1894

THE

JOURNAL OF ECONOMIC BIOLOGY

EDITED BY

WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S.,

Foreign Member of the American Association of Economic Entomologists; Joint Honorary Secretary of the Association of Economic Biologists; Honorary Consulting Biologist to the Land Agents' Society, the Midland Re-afforesting Association, and the Warwickshire Agricultural Society; and late Special Lecturer on Economic Zoology in the University of Birmingham.

WITH THE CO-OPERATION OF

A. H. REGINALD BULLER, D.Sc., PH.D.,

Professor of Botany in the University of Manitoba, Winnipeg.

GEO. H. CARPENTER, B.Sc., M.R.I.A.,

Professor of Zoology in the Royal College of Science for Ireland, and Consulting Entomologist to the Royal Dublin Society.

PERCY GROOM, M.A. (Cantab. et Oxon.), D.Sc., F.L.S.,

Assistant Professor of Botany, Imperial College of Science and Technology, London.

ROBERT NEWSTEAD, M.Sc., A.L.S., F.E.S.,

Lecturer in Entomology and Parasitology in the Liverpool School of Tropical Medicine, and Hon. Lecturer on Economic Entomology in the University of Liverpool.

AND

A. E. SHIPLEY, M.A., Hon. D.Sc. (Princeton), F.R.S.,

Fellow and Tutor of Christ's College, Cambridge, and Reader in Zoology in the University.

VOLUME V.

1910.

LONDON:

DULAU AND CO. LTD., 37, SOHO SQUARE, W

1910.

CONTENTS OF VOLUME V.

LIST OF ILLUSTRATIONS IN VOLUME V.

THE
JOURNAL OF ECONOMIC BIOLOGY.

ON SOME COCCID PESTS OF ECONOMIC IMPORTANCE.

By
E. ERNEST GREEN, F.E.S., F.Z.S.,
Entomologist to the Government of Ceylon.

With Plates I and II.

The insects described below have been received from several sources and countries, but—being all of some economic importance, can be conveniently discussed together.

Aspidiotus oceanica (Lindinger).

Pl. i, figs. 1-9.

Furcaspis oceanica, Lindinger; Zeitschr. wiss Insektenbiol., 1909, Bd. v, p. 149.

Female puparium (Pl. i, figs. 2, 3) irregularly subcircular to oval, usually tapering behind: slightly convex above. Pellicles concealed, but their position (towards anterior extremity) marked by a central nipple-shaped boss and concentric circles. Colour dull to bright castaneous: the area covering the pellicles often paler, with the exception of the extreme centre, which is usually darker with a central white spot. Undersurface (Pl. i, fig. 3), with a median cavity covered by the dense whitish ventral scale, which is confined to the central area, exposing a broad marginal zone of the dorsal scale; some more or less conspicuous, curved, branching, whitish ridges radiating from below the edges of the ventral scale towards the margin. Length, 2.5 to 3 mm. Breadth across the widest area, 1.75 to 2 mm.

Male puparium (Pl. i, figs. 4, 5) irregularly oval, usually narrower behind; resembling that of the female, but smaller and proportionately narrower. Undersurface (Pl. i, fig. 5), with a median channel partly covered by the ventral scale which forms a narrow zone bordering the channel; median area whitish. Length, 1.5 mm. Breadth, 0.75 mm.

Adult female (Pl. i, fig. 6) blackish (in alcoholic examples), probably purplish in life. Body subcircular, the pygidium forming a projection behind. After oviposition, the ventral segments contract and the pygidium is more or less withdrawn into the ventral area. Marginal area of body, with scattered longish whip-like hairs (Pl. i, fig. 9). Antennae rudimentary, with four or five stout bristles (Pl. i, fig. 9 *a*). There is a submarginal scattered group of minute conical papillae (Pl. i, fig. 9 *b*) on the undersurface, on each side, between the antenna and the anterior spiracle (Pl. i, fig. 9 *c*). Anterior spiracles with, posterior spiracles without, parastigmatic pores. Pygidium (Pl. i, fig. 7), with the lateral margins strongly and densely cristate and serratulate. Six terminal lobes; their extremities rounded and entire; the outermost slightly the broadest, with straight sides; the median pair slightly narrowest, both this and the second pair slightly constricted at the base. Squamae broad, their extremities (in fresh examples) tridentate (Pl. i, fig. 8), but often so imperfect that their form is difficult to determine. Paraphyses slender, eight to ten on each side, often obscure and inconspicuous. Anal aperture moderately large and conspicuous, placed about midway between base and apex, partly encircled by a chitinous thickening. No circumgenital pores. Dorsal pores few, small and inconspicuous, subcircular to oval. There are from one to three long stout whip-like hairs on each side at the base of the pygidium. Marginal spines small and inconspicuous. Derm of pygidium minutely longitudinally wrinkled. Length of extended insect, 1 to 1.25 mm. Breadth, 0.75 to 1 mm.

Adult male unknown.

Habitat.—On fronds of the Coconut Palm (*Cocos nucifera*): Yap, Caroline Islands. The insects are crowded upon the upper surface of the fronds and scattered more sparingly on the undersurface, on each side of the midrib.

The insect closely resembles, and is indeed very nearly allied to *Aspidiotus cladii* of Maskell—a species that appears to be confined to plants of the order *Cyperaceae*. It may be distinguished from *cladii* by the usually more elongate puparium of the female: by the greater size of the adult insect; by the form of the pygidial lobes which—in that species—are relatively narrower and are more or less emarginate: by the second lobe being single instead of duplex (as in *cladii*): by the greater density and extent of the lateral cristate area: and by the well defined anal aperture (which is obscure and difficult to locate, in *cladii*).

A. oceanica also bears a superficial resemblance to *Chrys-*

omphalus propsimus of Banks, which occurs on Coconut Palms in the Philippine Islands, but that species is amply distinguished by the presence of circumgenital pores and by a stout chitinous spine on each side of the thorax.

The specimens were submitted with a note to the effect that "the Coconut estates of the South Sea Islands are suffering enormously from the ravages of an insect which endangers (according to scientists) all the coconut plantations of the Caroline Island Yap."

I have no particulars as to whether the pest is attacking the mature trees or whether it principally affects the younger plants. If the latter is the case, it should be possible to check the attack by the application of one of the recognized washes: but it would be extremely difficult to spray effectively the crowns of full-grown palms.

Asterolecanium pustulans, Ckll., var **seychellarum,** nov.

Pl. i, figs. 10-12, Pl. ii, figs. 13, 14.

Asterolecanium pustulans, Ckll.: Journ. Inst. Jam., 1892, i, p. 143.

Test of adult female (fig. 2) broadly ovoid, sometimes approximately circular: terminating in a slightly prominent point behind: moderately convex: posterior half with more or less distinct median and lateral carinae: transversely rugose. Fringe moderately long: rather loose: usually interrupted at irregular intervals: the second (nymphal) series broken up into more or less distinct bundles: third (larval) series usually obsolescent. In very fresh (younger) examples, there are traces of curling discal filaments: but, in older examples, the disc is usually bare. Colour greenish yellow: the dried body of the insect showing as a brown anterior patch through the transparent scale: fringe slightly tinged with pink or orange. Average length, 1.25 mm. Breadth, 1 to 1.12 mm.

Male puparium undetermined. A smaller, flatter scale, with more distinctly orange fringe, and proportionately more oblong, may be either the male puparium or the test of the nymphal female.

Adult female insect (Pl. i, figs. 11 and 12) broadly oval. Antenna consisting of a densely chitinous circular plate bearing three or four stout curved bristles. Rostrum slightly in advance of a median transverse line. Abdominal extremity (Pl. ii, fig. 13) with short broad anal lobes, each bearing a longish stout seta: a pair of inner lobes, rather more densely chitinous than and as large as the outer (anal) lobes, each bearing one stout spine and several smaller spines. Anal ring with six stout hairs, not reaching the margin. Chitinous lip of anal aperture broadly transverse. Area of anal pit

demarked by slight chitinous thickenings of the derm. A single marginal series of paired pores (Pl. ii, fig. 14); closely set, and continuous almost to the anal lobes. Ventro-marginal simple circular pores large and well defined: with a scattered inner series of similar but smaller pores. Disc of dorsum irregularly strewn with paired pores distinctly larger than those of the marginal series, with a slight tendency to arrangement in longitudinal and transverse series on the abdominal area. Length, 0.65 to 0.85 mm. Breadth, 0.5 to 0.75 mm.

Adult male unknown.

Habitat.—On stems and branches of *Hevea brasiliensis*. Seychelle Islands. Submitted by Mr. R. Dupont, Superintendent of Botanic Stations.

The insects occupy small depressions on warty swellings of the bark (Pl. i, fig. 10). When they occur in considerable numbers, the bark assumes an unhealthy hidebound and nodular condition that must greatly interfere with the processes of tapping, and may even check the elaboration of latex.

Typical *pustulans* is recorded only from the tropical and subtropical regions of the Western Hemisphere. The variety under consideration differs from the type merely in superficial characters of the secretionary covering. In typical *pustulans* the test is opaque; not markedly rugose, but distinctly granular, with numerous curling glassy filaments on the disc.

In the Seychelles, the pest is kept in some check by a parasitic fungus. The earlier specimens that were submitted to me were so thoroughly infected that—out of many hundreds of individuals—I was unable to find a single insect in a fit condition for description.

The habit of pitting the bark of the plants upon which they subsist is common to the four species *variolosum, pustulans* (and its variety), *ventruosum* and *thespesiae*. They may be separated by the following characters:—

I. ♀. Puparium *flat* or *concave* above. Marginal series of paired pores double. No discal paired pores ... ... *ventruosum,* Mask.

II. ♀ Puparium markedly *convex* above.

A. Marginal series of paired pores *double*. Discal paired pores present; of same size as marginal pores ... ... *thespesiae,* Green.

B. Marginal series of paired pores *single*.
1. *No* discal paired pores ... *variolosum*, Ratz.
2. Discal paired pores *present*: larger than marginal pores.
a. Puparium *opaque*: disc with curling glassy filaments: distinctly granular: not markedly rugose ... *pustulans*, Ckll.
b. Puparium *transparent*: discal filaments obsolete: rugose: not markedly granular ... *seychellarum*, Green.

Eriococcus paradoxus, Maskell.

Eriococcus paradoxus, Mask.: Tr. Roy. Soc. S.Austr., 1888, p. 104.
Eriococcus paradoxus var. *indicus*, Mask.: N.Z.Trans., 1897, xxix, p. 318.
Eriococcus paradoxus var. *simplex*, Mask.: N.Z.Trans., 1897, xxix, p. 244.

Mr. E. P. Stebbing, Zoologist to the Imperial Forest School, Dehra Dun, has submitted to me examples of the Coccid referred by Maskell to his *Eriococcus paradoxus*, under the varietal name of *indicus*. An examination of this material shows me that the species is distinct from *E. paradoxus*, and that both of these insects are wrongly included in the genus *Eriococcus*. They are typical examples of the genus *Cerococcus* of Comstock.

Eriococcus paradoxus, Mask., should therefore be called *Cerococcus paradoxus* (Mask.), and *Eriococcus paradoxus indicus* (Mask.), will become *Cerococcus indicus*, Green.

Of *Eriococcus paradoxus simplex*, I am unable to speak with certainty, as I have not seen the insect. Maskell's description states that it differs from the type in the absence of paired glands. A study of the early stages of the insect would be necessary to decide whether it, also, can be included in the genus *Cerococcus* or even whether it is an *Asterolecaniid*.

I append a diagnosis of the new species.

Cerococcus indicus, n.sp.

Pl. ii, figs. 15-22.

Test of adult female subcircular: strongly convex: covered with a coarse filamentous tomentum which—in early adult individuals—it of a rusty orange colour, but—in old examples—is dull reddish brown. The insects are so crowded together (Pl. ii, fig. 15) that the form of the individual test is obscured; but there are indications which suggest that—in an isolated individual, with free

room for development—there might be some segmentation of the tomentum into more or less definite tufts. Diameter of fully developed test approximately 2.5 mm.

Male puparium oblong oval: moderately convex: hinder third depressed and covered by a circular operculum. Fresh examples sparsely covered with rust-coloured filaments: older examples often naked. Length, 1.25 mm. Breadth, 0.75 mm.

Adult female (Pl. ii, fig. 16), broadly oval: abruptly constricted and tapering behind. Posterior extremity (Pl. ii, fig. 17) with the usual conical fleshy lobes, each supporting a longish stout seta at its apex and two or more stout curved blunt spines on its inner margin. In older examples the setae are often turned back and lie along the margin (Pl. ii, fig 18). The triangular median plate is well developed, approximately equilateral. Antennae (Pl. ii, fig. 19) small and rudimentary: truncate: with a few short stout hairs at the apex of each: joints obscure, apparently two or three. Limbs rudimentary; each consisting of a short stout claw on a broad chitinous base (Pl. ii, fig. 20). Paired pores very numerous and crowded: of two sizes: arranged more or less concentrically in a series of whorls on the dorsum (Pl. ii, fig. 21). On the terminal segments, the larger paired pores occur only on the lateral margins. There are four groups of small thick-rimmed simple circular pores on the marginal area, opposite the stigmatic openings. Cribriform plates (Pl. ii, fig. 22) conspicuous; two groups on each side of a median line, one to three in anterior groups, three to six in posterior groups: each plate concave, with a dense patch of pores in the centre. Anal ring with eight stout hairs: two similar hairs on the dorsal lip of the anal aperture. Length, 1.25 to 1.75 mm. Greatest breadth, 1 to 1.5 mm.

Adult male and early stages not observed.

Habitat.—On *Helicteres isora:* Saharampur, N.W.P., India. Reported by E. P. Stebbing to be a pest of some importance in the forests of the Siwaliks.

Differs from *Cerococcus paradoxus* in the arrangement of the paired dorsal pores which—in that species—are less numerous and arranged in transverse bands. Distinguishable from *hibisci* in the coarser and denser tomentum of the female test.

Lecanium imbricans, Green.

Lecanium imbricans, Green: Ind. Mus. Notes, 1903, v, p. 94.
Hemilecanium theobromæ, Newst.: Journ. Econ. Biol., 1908, iii, No. 2, p. 39.

Having recently received fresh material of *Lec. imbricans,* including specimens of the young larvae, I have now convinced

myself that it is co-specific with *Hemilecanium theobromae* of Newstead. All the characters are identical, including the remarkable groups of glandular pores found in all stages of the insect from the newly-hatched larva upwards. It may very possibly be considered that these characters warrant the exclusion of the species from the genus *Lecanium,* in which case Prof. Newstead's generic name may be adopted. The insect would then be known as *Hemilecanium imbricans* (Green).

Mr. R. D. Anstead, Scientific Adviser to the United Planters Association of Southern India, gives me the following particulars of the pest, as it occurs in India.

"I found it on three neighbouring estates in South Mysore, in the district of Balur. It was attacking the following trees:—*Ficus glomerata, Ficus infectoria,* and *Cedrela toona* (Red Cedar).

The effect is to cover the underside of the branches, even the big primaries and form a dense silvery white mass. This rapidly kills the branches attacked and—finally—the whole tree.

The scale is accompanied by a sooty fungus, which grows in great quantities on the plants below and this rapidly kills out coffee. I could find no scale on the coffee or on any other plant except the trees named above. At present the infected branches are cut off at this time (Sepember to November) and simply thrown down. I have advised that they should be burned and the apparently cleaned tree whitewashed. All spraying is quite impracticable under the local conditions."

EXPLANATION OF PLATES I AND II.

Illustrating Mr. E. Ernest Green's paper "On some Coccid Pests of Economic Importance."

PLATE I.

Aspidiotus oceanica, (Lind.)

Fig. 1.—Part of Coconut leaf, with insects *in situ*, nat. size.
Fig. 2.—Puparium of ♀, dorsal view. × 20.
Fig. 3.— „ „ „ ventral view. × 20.
Fig. 4.— „ „ ♂, dorsal view. × 20.
Fig. 5.— „ „ „ ventral view. × 20.
Fig. 6.—Adult ♀ insect, optical section. × 30.
Fig. 7.—Pygidium of adult ♀, optical section. × 250.
Fig. 8.—Terminal margin of pygidium. × 1,000.
Fig. 9.—Antero-lateral area of adult ♀, showing marginal hairs, antenna (*a*), group of papillae (*b*), and anterior spiracle (*c*). × 100.

Asterolecanium pustulans var. seychellarum, nov.

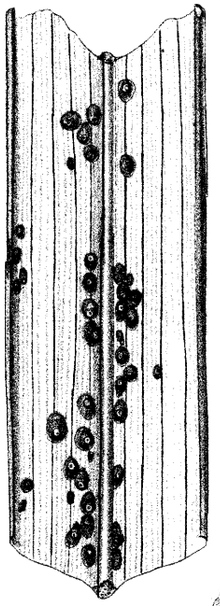
Fig. 10.—Portion of *Hevea* stem, with insects in situ, nat. size.
Fig. 11.—Test of adult ♀, dorsal view. × 35.
Fig. 12.—Adult ♀ insect, optical section. × 60.

Plate II.

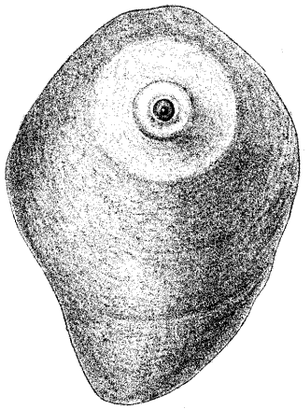
Fig. 13.—Posterior extremity of adult ♀, optical section. × 450.
Fig. 14.—Portion of marginal area, showing relative sizes of the marginal (*a*) and discal (*b*) paired pores. × 450.

Cerococcus indicus, n.sp.

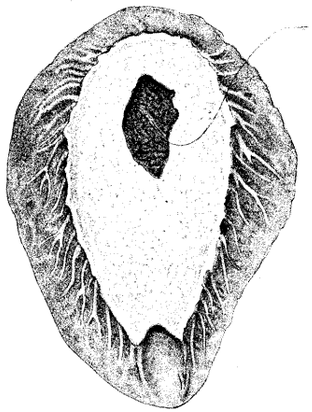
Fig. 15.—Insects on branch, nat. size.
Fig. 16.—Adult ♀, optical section. × 30.
Fig. 17.—Terminal segments of adult ♀, optical section. × 250.
Fig. 18.—Extremity of older sample. × 250.
Fig. 19.—Antenna. × 450.
Fig. 20.—Rudimentary limb. × 450.
Fig. 21.—Paired pores from dorsum, showing whorl formation. × 450.
Fig. 22.—Cribriform plates. × 450.



1.

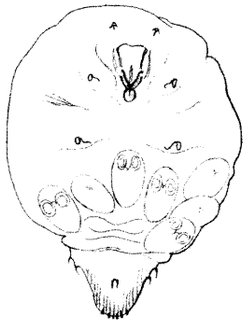


2.

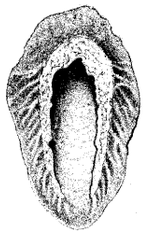


3.

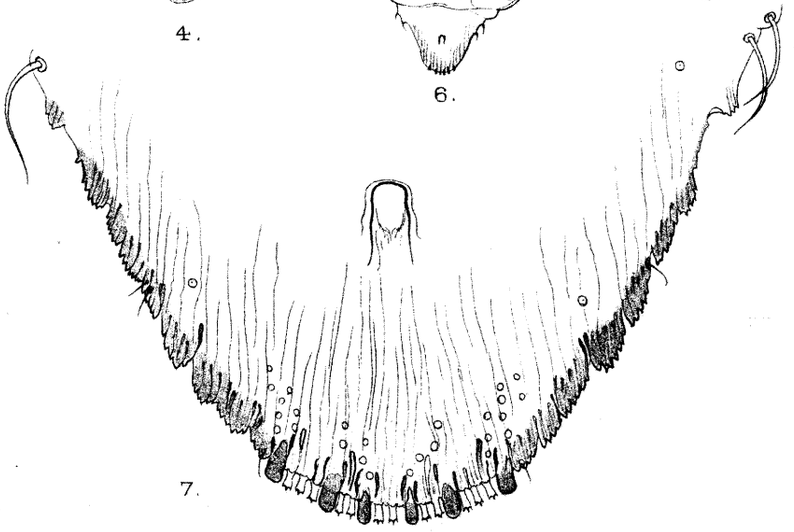
4.



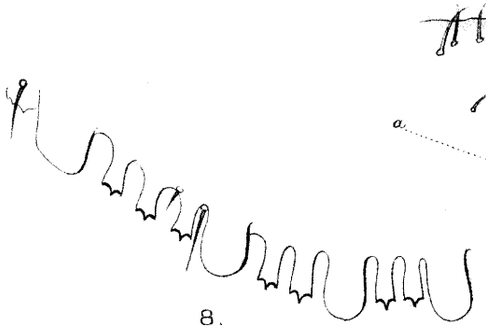
6.



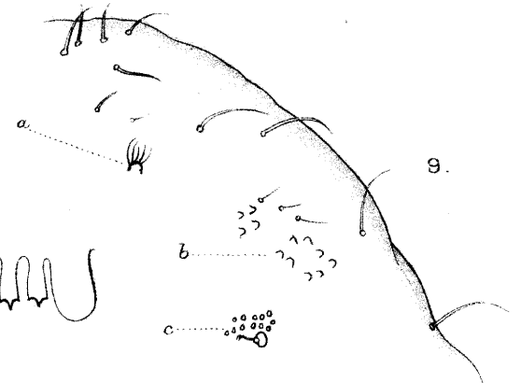
5.



7.

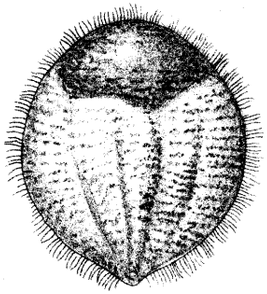


8.

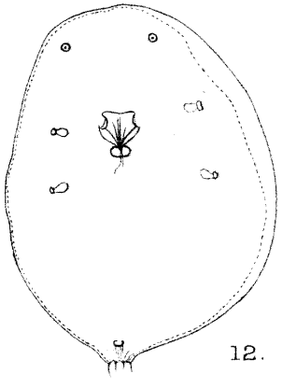


9.

10.



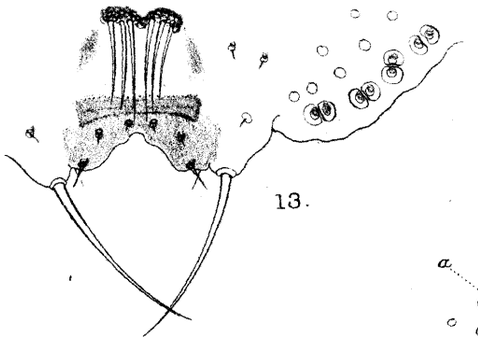
11.



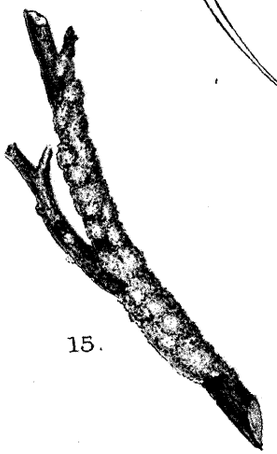
12.

NEW SPECIES OF COCCIDS.

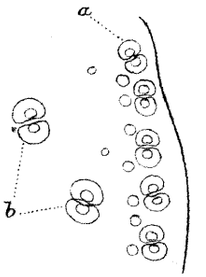
Journ. Econ. Biology, 1910, Vol. V, pt 1.



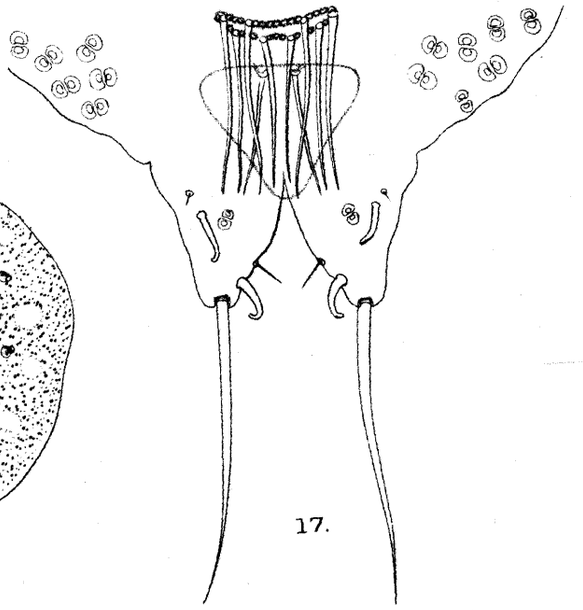
13.



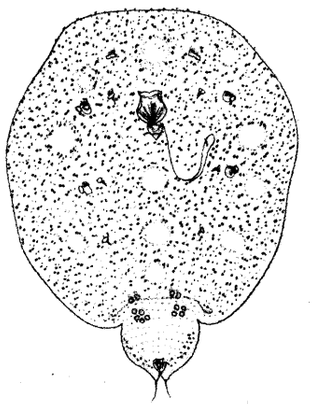
15.



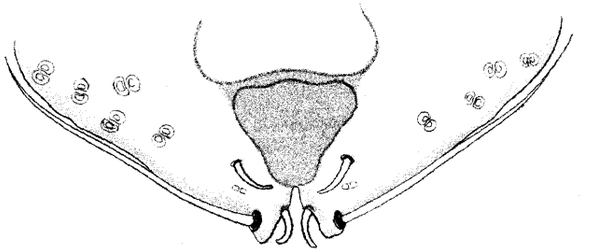
14.



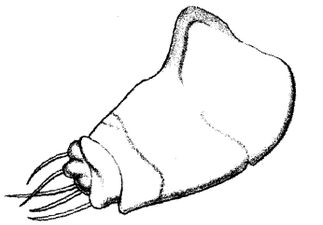
17.



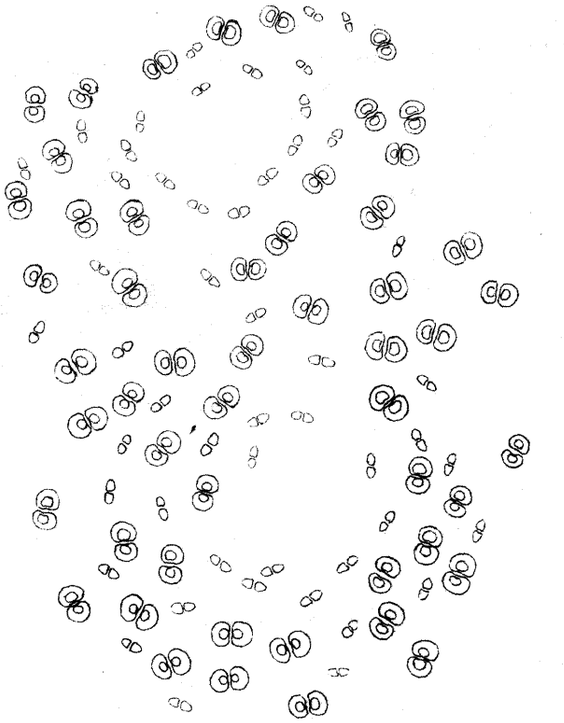
16.



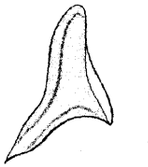
18.



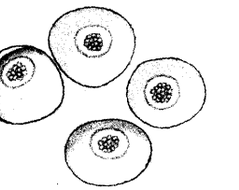
19.



21.



20.



22.

E.E. Green, del. ad nat.

NEW SPECIES OF COCCIDS.

Huth sc. et imp.

SOME OBSERVATIONS ON THE EGGS OF THE HORSE BOT FLY, *GASTROPHILUS EQUI* (FABR.)

By

WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S.

With 3 Figures.

Although there is a voluminous literature treating of the structure and life-history of the Horse Bot Fly, *Gastrophilus equi* (Fabr.), I have been unable to find a single correct figure of the egg of this insect.

Many authors do not figure it at all, whilst those that do, represent it in an incorrect manner.

The most recent description I know of is that by Froggatt,[1] who states: "The eggs are dull light-brown to dirty white in colour, elongate oval in form, somewhat pointed, and broadest at the apex." His figures (Figs. 3 and 4) show a somewhat spindle-shaped egg, with strong *longitudinal* striation and an operculum lying at a right angle to the long axis of the egg, and with the broad end uppermost.

Osborn[2] states: "They are about one-sixteenth of an inch in length, and taper a little towards each end, though the attached end is the smaller. The outer end is provided with a little cap (operculum), which is set quite obliquely to the axis of the egg, though some authors represent it as cutting the egg square off at the end."

Osborn's figures (Fig. 37 *a* and *b*) are both upside down.

Neumann's[3] account reads as follows: "The ova of the *Gastrophilus* of the Horse are yellowish-white in colour and conical in shape, being 1.25 mm. long; they are transversely striated, and provided at the larger extremity with an operculum which is obliquely truncated. They adhere to the hairs by their narrow end, in the same manner as the 'nits' of the Louse, by means of a viscid matter that is deposited with them; their wide end remains pendent."

The idea that the eggs were conical at one end and adhered to

[1] N.S.W. Dept. of Agric., Miscell. Pub., No. 432, March, 1908, p. 3.

[2] U.S. Dept. Agric., Div. of Entom., Bull. No. 5, new series, 1896, p. 79.

[3] A Treatise on the Parasitic Diseases of the Domesticated Animals. English Trans. 2nd ed. 1905, p. 293.

[Journ. Econ. Biol., March, 1910, vol. v, No. 1.]

the hairs of the horse by a sticky secretion seems to have been copied from Bracy Clark's account[1] by practically all succeeding writers.

No mention is made of the egg by Schroeder van der Kolk[2] in his classical account of the anatomy of this insect.

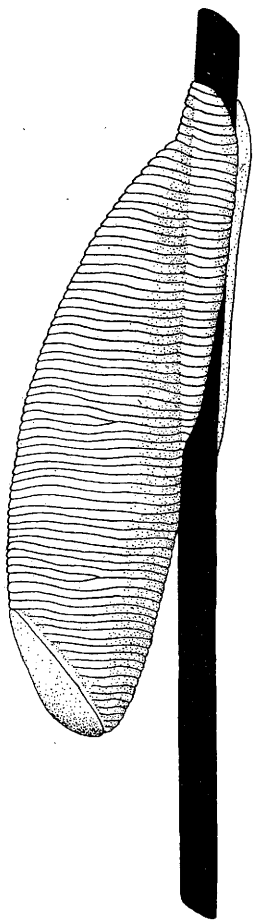


Fig. 1.

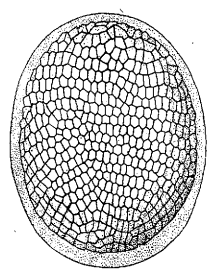


Fig. 3.

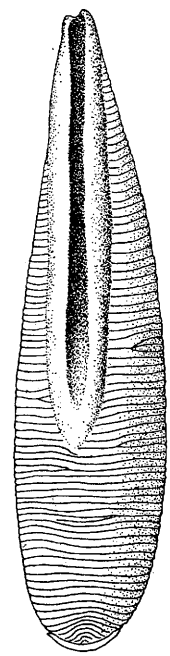


Fig. 2.

Fig. 1.—Egg of *Gastrophilus equi* (Fabr.), attached to hair by lip-like valves.
Fig. 2.—The same seen from under side showing attachment surface.
Fig. 3.—Operculum, seen from above.

A careful examination of the egg at once proves the incorrectness of the above accounts, and it seems strange that when the eggs of other species of *Oestridae* have been so carefully figured and

[1] Trans. Linn. Soc., 1797, vol. iii.

[2] Nieuwe Verhandl. K. Nederl. Inst., Amsterdam, 1845, T. 9, pp. 1-155, plts. i-xiii.

described, no one should have thought it worth while to carefully examine those of the species under consideration.

I therefore propose to here give a short description of the egg, together with figures made from recently deposited specimens.

When deposited the eggs are almost white in colour, afterwards turning to a light yellow or a dirty white. They show a well-marked series of transversely raised ridges situated at about equal distance apart, here and there having a wavy or sinuous character and occasionally merging into one another.

In length they average 1.25 mm. and taper to a blunt point at one end and are obliquely truncate at the other. This the anterior or pendent end is covered by a cap or operculum, which lies obliquely to the long axis of the egg and not at a right angle.

Like that of *Hypoderma* the egg may be said to consist of two parts, viz., the egg proper and a pair of lips or valves, which close round the hair and secure the attachment of the egg. The wavy striation is continuous over these lip-like bodies.

If the egg is detached from the hair the margins of these lips usually adhere to it and a very definite attachment surface can be made out on the egg. (Fig. 2).

The peripheral margin of the operculum extends slightly over the edge of the opening of the egg, and so when the slightest friction is brought to bear upon the ripe egg it is easily torn off.

When newly deposited, what I have termed the attachment surface and the inside of the two lateral extentions are covered with a sticky matter which soon dries, at the same time the lateral extentions close around the hair and almost meet together, thus very firmly securing the egg to the hair.

In spite of many statements to the contrary it is most unusual for the eggs to be detached by the action of the horse's tongue. What actually takes place is, the operculum is brushed off and the larva within is carried by the tongue to the horse's mouth.

The empty eggs may be found weeks after, firmly attached to the hairs on the shoulders, forelegs, mane, etc.

The operculum is convex above and marked with a honeycomb pattern (Fig. 3). I hope to give some further particulars in a later paper respecting this.

Experiments with the Eggs.

The various statements respecting the hatching of the eggs are very contradictory and in not a few cases inaccurate.

Very briefly I wish to set forth the accounts given by different observers.

Verrill[1] states that "the eggs contain more or less perfectly developed larvae when laid; and when they are mature or have been a few days attached to the hair, they burst open and allow the young to escape almost instantaneously, when moistened. Thus when the horse licks itself, or its companions, the moisture hatches the eggs, and the young larvae are transferred to the mouth by the tongue or lips.

Froggatt[2] states "These eggs are generally deposited on the jaw, shoulders, or flanks of the animal, from whence, through the animal licking itself, they are conveyed to the lips and mouth, the warmth dissolving the gluey secretion and hatching the enclosed maggot, thus enabling it to crawl out into the throat."

Neither of these statements are borne out by the observations here recorded.

Bracy Clark's account,[3] although given upwards of a hundred years earlier, is much more correct. He writes: "The eggs thus deposited I at first supposed were loosened from the hairs by the moisture of the tongue, aided by its roughness, and were conveyed to the stomach, where they were hatched; but on more minute search I do not find this to be the case, or at least only by accident; for when they have remained on the hairs for four or five days they become ripe, after which the slightest application of warmth and moisture is sufficient to bring forth in an instant the latent larva. At this time, if the tongue of the horse touches the egg, its operculum is thrown open, and a small active worm is produced, which readily adheres to the moist surface of the tongue, and is from thence conveyed with the food to the stomach. If the egg itself be taken up by accident, it may pass on to the intestinal canal before it hatches; in which case its existence to the full growth is more precarious, and certainly not so agreeable, as it is exposed to the bitterness of the bile.

I have often, with a pair of scissors, clipped off some hairs with the eggs on them from the horse, and on placing them in the hand, moistened with saliva, they have hatched in a few seconds. At other times, when not perfectly ripe, the larva would not appear, though held in the hand, under the same circumstances, for several hours; a sufficient proof that the eggs themselves are not conveyed to the stomach. . . . The eggs, in the first place, when ripe, often hatch themselves, and the larva, without a nidus, crawls about till

[1] The External and Internal Parasites of Man and Domestic Animals. Hartford, Conn., 1870.

[2] *Op. cit.*, p. 3.

[3] *Op. cit.*

it dies; others are washed off by water, or are hatched by the sun and moisture, thus applied together."

Other writers state that the eggs hatch after a time, and the horse, feeling the irritation of the larvae creeping over the skin, licks itself and thus conveys them to the mouth.

Finally, Osborn[1] has recorded a series of most interesting experiments. He writes: "Eggs collected from a horse while flies were depositing, and therefore probably not long laid, were opened at different times by rubbing them with a moistened finger, simulating as nearly as possible to the action of the tongue in licking the body. While the larvae appeared to be fully formed during the first three or four days after deposition, the eggs hatched with difficulty and the larvae seemed inactive, and all larvae that were freed in this manner up to the tenth day were hatched with difficulty, though the larvae at the end of this time were becoming fairly active.

Four weeks after hatching the eggs opened with the slightest touch of a wet finger, and the larvae adhering to the finger were very active, though in some cases they were inactive and apparently dead. About five weeks after collecting the eggs nearly all gave only inactive or dead larvae, though opened with ease on being touched by the finger, and in forty days after collecting no living larvae could be found in the remaining eggs, except one which had succeeded in pushing off the cap of the egg and partially emerging.

In view of these results, I concluded:—

(1) That the eggs of the horse bot fly do not hatch, except by the assistance of the horse's tongue.

(2) That hatching does not ordinarily occur within ten or twelve days and possibly longer, or if during this period, only on very continuous and active licking by the horse.

(3) That the hatching of the larvae takes place most readily during the third to fifth week after deposition.

(4) That the majority of the larvae lose their vitality after thirty-five to forty days.

(5) That the larvae may retain their vitality and show great activity upon hatching as late as thirty-nine days after the eggs were deposited.

(6) That it is possible, though not normal, for eggs to hatch without moisture or friction.

(7) That in view of these results, the scraping off of the eggs, or their removal or destruction by means of washes will be effective, even if not used oftener than once in two weeks during the period

[1] *Op. cit.*

of egg deposition, and, probably, that a single removal of the eggs after the period of egg deposition has passed, will prevent the great majority of bots from gaining access to the stomach, or at least so large a proportion that little injury is likely to occur.

Wishing to know still more definitely the period of most ready hatching, and the effect of different washes for treatment, I suggested to a veterinary student, Mr. Harry Shanks, a careful series of observations, which were carried through during the summer of 1894.

From this study, which was made under my direction, and so that I had frequent opportunity to note progress, a number of points were gained, which are worth adding to the above record. Three hundred eggs were collected from a horse which had been previously freed from eggs, so that the exact date of deposition was assured. The eggs were tested every day.

On the day of collection (first day) the eggs appeared immature. One day later eight eggs opened by picking the operculum off, showed three larvae with slight movement, and five immovable. On the third day a half-hour of friction failed to hatch eggs, but the larvae when freed by picking off the operculum showed two, slight movement; one, no movement, and one sufficient movement to get out of the opened shell.

On the fourth day the larvae in eleven eggs were all active, but had to be freed by picking off the operculum; the same was true up to the seventh day, the only difference being noted in greater maturity and size of larvae.

On the ninth day, or when the larvae were eight days from deposition, one larva was freed by seventeen minutes' rubbing with wet finger, another in twenty-two minutes; on the tenth day two others, one in fourteen and the other in eight minutes; and on the eleventh day several were hatched, the time varying from two to five minutes of subjection to the saliva and friction. On the twelfth day it required but one or two minutes, and on the thirteenth eggs would hatch in fifteen to thirty seconds. On the fourteenth day a number of eggs were tried, about one-third of which hatched almost immediately upon being touched with the moist finger, the others in from five to eight seconds. On the fifteenth day all eggs seemed fully mature, and probably nine-tenths would have hatched at once upon being touched by a horse's tongue in the ordinary motion of licking. From the sixteenth day to the twenty-second the eggs would open with a touch of the finger, but the larvae would not adhere except with moisture. On the twenty-third day the first dead larva was noted, and a day later four out of eleven eggs opened had dead

larvae. On the twenty-fourth day all of the eggs not previously opened were examined with a lens, and only one showed the cap removed, the larva being partly out but dead. The hatching of but one egg out of three hundred seems to me to establish pretty fully my former opinion, that the eggs require moisture or friction for the release of the young.

On the twenty-fifth day, out of ten eggs three contained dead larvae, five could move slightly, and two were quite active. On the twenty-sixth day caps were removed from thirty-five eggs, twenty-seven larvae being dead, seven were capable of slight movement, and one was active enough to escape from the shell.

On the twenty-seventh day out of forty-three eggs opened only one larva was alive, and on the twenty-eighth day only one out of sixty-five, and on the twenty-ninth day all the remaining eggs, one hundred and three, showed only dead larvae.

The results of this study it will be seen, confirm in the main the conclusion of the former observations, the principal difference lying in the fact that all the larvae were dead at a somewhat earlier period. Of course it could not be said that of the eggs opened in the earlier days none would have survived longer than four weeks, but considering the number used and that one-third of them were kept the full four weeks and two-thirds nearly that long before being opened, the presumption is strong that that is the full normal period of survival.

It is safe, I think, to sum up the matter by saying that the eggs normally require friction and moisture to permit of their hatching and transfer to the horse's mouth, that hatching occurs with difficulty before the tenth day, and most readily after the fourteenth day, and that they lose vitality at a period varying between the twenty-eighth and fortieth days, the bulk not surviving more than four weeks. This gives a solid foundation upon which to base recommendations as to the time when eggs must be destroyed."

Before describing my own experiments, I should like very briefly to deal with the views advanced by the above-mentioned writers.

Verrill's statement that larvae are present in the egg when laid I consider not entirely accurate. It is possible, indeed probable, if after the fertilization of the eggs dull weather follows and the ova are retained for some time within the parent, that this may be the case, as I have recorded for *Oestrus ovis,* Linn.,[1] and further, I have an egg taken from a torpid female, in which a fairly well-developed larva is present, still in the ordinary course of nature I think we are

[1] Journ. Econ. Biology, 1906, vol. 1, pp. 72, 73.

not warranted in stating that the eggs contain larvae when laid.

The further statement that "moisture hatches the eggs" is scarcely correct in the light of Osborn's experiments and those recorded here.

Froggatt's statements that the eggs are carried to the mouth and hatch there is certainly wrong, and that of Bracy Clark's that the "warmth and moisture is sufficient to bring forth in an instant the latent larva," I am unable to verify.

A view largely held by farmers and others that the larvae hatch and creep about the skin, is also without any supporting evidence.

So far as I can learn Osborn (*op. cit.*) was the first to definitely establish the fact that the eggs were not taken into the horse's mouth, and that in addition they required friction in addition to warmth and moisture. In his experiments, however, he does not seem to have taken into consideration the possibility of newly-laid eggs containing larvae.

The object, therefore, of the experiments here recorded is to verify or otherwise those made by Osborn.

A. The first batch of eggs were taken a few hours after being deposited.

1. A number of hairs with eggs attached were placed in a glass jar in which a damp sponge was suspended from the rim of the jar, but not in contact with any of the eggs. A temperature of 80° to 85° F. was maintained by means of a water bath. On the twenty-third day two eggs hatched and were removed, the following day one hatched and twenty-two remained unhatched on the fortieth day. When examined the larvae were all found to be dead.

2. The above experiment was also tried with eggs from batch A, leaving out the damp sponge. On the twenty-second day two eggs hatched, and the remainder were kept under observation for nearly five weeks, but no further hatchings took place.

3. A third experiment was made with some of the eggs of batch A as follows: a bundle of the hairs were tied together and tied to a piece of canvas tacked on to a piece of wood, which was allowed to hang outside exposed to the rain and sun. There were fifty-seven eggs, and at the end of twenty-one days only one egg was observed to have lost its operculum. They were examined daily to the end of the eighth week, when fifty-four eggs remained unhatched.

4. A fourth lot of eggs, similar to batch A, and may therefore be included here, were tested by first fixing the hairs to a piece of cloth and carefully wiped over with a piece of close, damp sponge. One half of the eggs were left untouched until the thirtieth day. On the twelfth day five eggs hatched, and the larvae adhered to the

sponge, on the fourteenth day fourteen hatched, on the sixteenth day twenty, on the eighteenth day nineteen, on the twentieth day twenty, on the twenty-fourth day four, and on the twenty-eighth day one, a total of 83. All the empty egg-shells were still adhering to the hairs and there remained eleven dead eggs on the thirty-sixth day.

On the twenty-fourth day the second half of the eggs were treated and three hatched, on the twenty-fifth day two, and on the twenty-seventh day one. The method of carefully wiping over with the sponge was continued until the thirty-sixth day, but no further hatchings took place.

Summary.

From the foregoing observations it is concluded that :—

1. The egg of *Gastrophilus equi* (Fabr.), is provided with a pair of lip-like valves, by means of which it is firmly attached to the hair.

2. After the larva has escaped the egg-shell adheres for some considerable time to the hair.

3. The eggs are not taken into the mouth as stated by Froggatt.

4. My experiments confirm and supplement those of Osborn, although the actual dates differ somewhat, thus the largest number of eggs hatched from the sixteenth to the twentieth day, and none hatched after the thirty-sixth day.

5. Without moisture or friction very few eggs hatch.

It is hoped to repeat these experiments and others during the coming summer, when further details will be given.

ON TWO NEW SPECIES OF AFRICAN COCCIDAE.

By

ROBERT NEWSTEAD, M.Sc., A.L.S., Etc.

With 2 Figures.

The two interesting Coccids herein described were collected by the Revd. Father P. Kohll. Missionhaus, Sittard. I have pleasure in expressing my indebtedness to him for giving me the opportunity of examining the material.

Hemilecanium recurvatum, n.sp.

Fig. A.

Female, adult. Piceous, with a large central yellowish-brown area, the extreme margins being also slightly paler than the darker

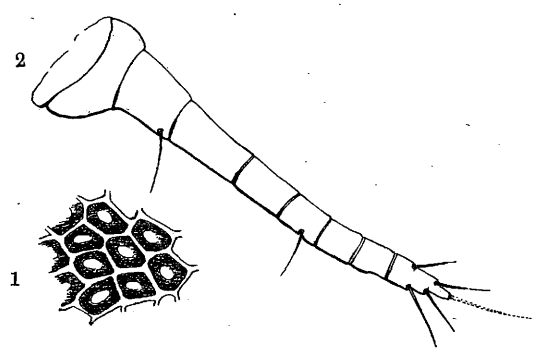


Fig. A.—*Hemilecanium recurvatum*, n.sp. 1.—Derm cells. 2.—Antenna.

portions of the chitine. Short ovate or sub-circular, thin and flat (transversely), but *strongly recurved at both extremities;* median area with a very large, deep, and more or less circular depression in the centre of which are placed the anal plates. This depression is rendered all the more conspicuous by its pale colour due to the thinness of the integument which in the dry specimens becomes almost transparent by transmitted light, the rest of the integument very dense. Derm cells (Fig. A, 1) rather large, irregularly polygonal, angles rounded, each with a clear central or sub-central area. Anal

lobes large; apex with many fine spinose hairs; a faint short line extends from these towards the anal margin, but the anal cleft is completely fused as in the type (*H. theobromae*, Newst.[1]). Antennae (Fig. A, 2) of 8 segments; the third being slightly longer than the second; formula 3, 2, 8, 4, 1 (5, 6, 7). Legs short or a very little longer than the antenna. Length, 1.50-2 mm.

Larva (extracted from the body of the parent) not differing apparently from typical *Lecanium;* but the specimens have not restored sufficiently well in the potash to enable one to trace all the anatomical details with any degree of accuracy. The anal lobes are, however, decidedly large with a distinct but finely reticulated surface. Antennae of six segments, of which the third is much the longest. The derm cells seen in *H. theobromae* are not traceable, and owing to the condition of the specimens it is impossible to say whether they exist or not.

Easily distinguishable by its small size, the large central depression and the recurved character of the body.

Habitat.—"Trouvés dans les branches creuses de Plectronia *Laurentii,* De Wild; Cultivés par les Cremastogaster. Romée près de Stanleyville, Haut Congo." Nos. 7 and 9 Coll. P. H. Kohll.

Stictococcus formicarius, n.sp.

Fig. B.

Female, adult. Pale castaneous; usually oval, but some examples are decidedly narrowed posteriorly; dorsum flat or slightly concave with deep gland pits and irregular transverse grooves becoming more pronounced at the bluntly but strongly crenulated margin; sides sub-vertical and deep; ventral margin distinctly carinated. The deep crenulations of the upper margin are interrupted in the centre of the frontal area, where there are two distinct and rather widely separated eye-like tubercles; these latter, together with the other sculpturings of the dorsal surface, give the insect a striking resemblance to a miniature trilobite.

Antennae (Fig. B, 1) short, equal in length to the tibio-tarsal segments together; third and fifth segments the longest; apical segment with several long and very stout setae. Legs short, stout; digitules of the claw unequal; one is broad and flat, apparently of equal width throughout, with the apex suddenly recurved and faintly dilated; the second is normal with a faint apical knob. Tarsal digitules normal. Marginal spines (Fig. B, 2) of three types: a broad obtuse form (*a*) arranged in more or less regular sequence

[1] Journ. Econ. Biol., 1908, vol. iii, 2, p. 39, fig.

all round the body; a series of slender straight spines (*b*) slightly inset; and at long and irregular intervals there are also a few large serrated ones (*c*), and at still greater intervals single long bristles. Epidermis of the dorsum with numerous large gland tracts; and each of the large, blunt, prominences forming the crenulations of the upper margin are furnished with a single large tubular organ having a broadly dilated and trumpet-shaped orifice (Fig. B, 3); between the large gland tracts are numerous spinnerets and minute spines.

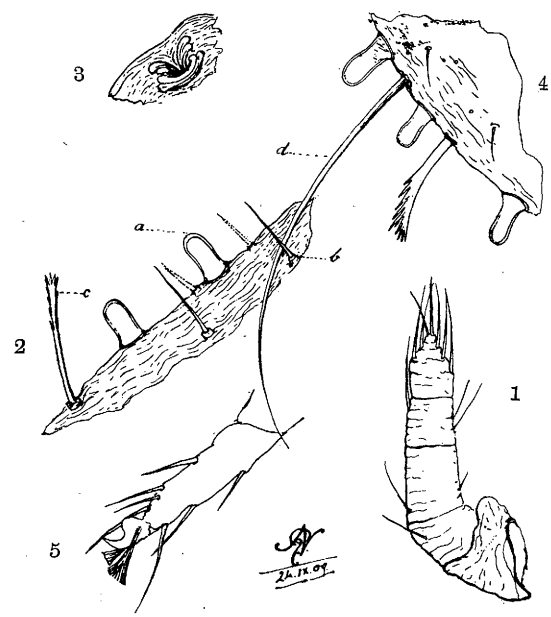


Fig. B.—*Stictococcus formicarius*, n.sp. 1.—Antenna. 2.—Marginal spines, *a*, broad obtuse form, *b*, slender straight form, *c*, serrated form. 3.—Orifice of gland. 4.—Marginal spines of larva, *d*, one of the long bilateral bristles. 5.—Tarsus.

Venter with few gland tracts, spinnerets and minute spines. Anal orifice normal. Length, 3 mm.

Larva (extracted from the body of the parent), short ovate; dorsum with four[1] longitudinal rows of strong spines, broadly dilated and irregularly serrated anteriorly. Margin (Fig. B, 4), with a series of spines similar to those in the adult female, but the long

[1] There may be more; but it is impossible to determine the exact number owing to the somewhat crumpled condition of the specimens.

bilateral bristles (*d*) are in length almost equal to the width of the body; and the median anal pair are of still greater length. *Antennae,* short and apparently composed of five segments, but the articulations are faint and not clearly defined. Legs short setose; tarsus (Fig. B, 5) nearly twice the length of the tibia; upper tarsal digitule bristle-like; lower digitules broadly dilated, with many fine radiating striae and a truncate extremity. Anal orifice, with six long setae; and the inner and upper half of the orifice with a fringe of fine hairs. Mentum doubtfully monomerous.

Habitat.—"Trouvés dans les branches creuses de *Barteria fistulosa,* Mast., cultivés par les fourmis *Sima spininoda,* Andre. Trouvés à Romée près de Stanleyville, Haut Congo." "No. 6" Coll. P. Hermann Kohll.

The habitat of this insect, apart from its association with the Cremastogaster, is very remarkable. It is very rarely that Coccids locate themselves in the hollow stems of their food-plants. Each female also forms a marked depression or pit which is distinctly traceable on the outer surface of the branch as a slightly raised and irregular prominence, more especially so on those branches in which the woody tissues are relatively thin.

In the female the superficial resemblance to *Stictococcus sjostedti,* Ckll., is very striking indeed, but it may at once be distinguished from this species by the marked character of the marginal spines, and the presence of the tubercles at the anterior margin of the body. In the larva there is also a still more marked difference: *S. sjostedti* having a fringe of very long hair-like bristles at the margin, which in *S. formicarius* are almost entirely replaced by the curiously shaped spines similar to those in the adult female. Three additional examples ("Nos. 5 and 8") of a *Stictococcus,* undoubtedly referable to *S. formicarius,* were also collected by Father P. Hermann Kohll. These, however, differ from the type lot by being piceous in colour, much more convex dorsally, and the crenulations at the margin are replaced by a series of minute and very widely separated angular projections. These examples are, I assume, much older individuals than those found in the hollow stems of the *Barteria;* though it is noteworthy that the co-types (No. 6) all contained fully developed larvae. The data accompanying these three specimens is as follows:—

"No. 5. Trouvés dans les branches creuses de *Cuviera angolensis,* Welw., cultivés par les fourmis *Cremastogaster africana* sub-sp; *laurentii,* For. Trouvés à Romée près de Stanleyville, Haut Congo."

"No. 8. Trouvés dans les branches creuses *Cuviera angolensis,* Welw., cultivés par des *Cremastogaster. Congo.*" Two females. One of the examples in this lot contained a minute Lepidopterous larva which has partly destroyed its host. *S. sjostedti* is also preyed upon by a similar larva, which, however, builds for itself a little silken cocoon into which it weaves fragments of the skin of its host's body, so cleverly wrought as to appear like little convex patches of glistening brown mosaic when examined under a low magnifying power.

School of Tropical Medicine,
The University.

31*st January,* 1910.

RESEARCHES ON FUNGI.[1]

IN order that the precise scope of the present work may be indicated it is necessary to append the qualifying title, which is as follows: "An account of the production, liberation, and dispersion of the spores of Hymenomycetes, treated botanically and physically, also some observations upon the discharge and dispersion of the spores of Ascomycetes and Pilobolus." The text, then, deals with the dissemination of basidiospores and sporangial spores of certain types. And at the outset it may be stated that the book gives evidence of much tireless and careful observation on the part of the author, and contains no inconsiderable amount of new information.

Chapters I.-V. deal largely with the coarser anatomical and physiological characters of the fructifications of Hymenomycetes from the point of view of arrangements for facilitating the dispersal of spores. It is pointed out that the freshly freed basidiospores are adhesive, so that provision must be made for them to fall freely and vertically from the more or less confined spaces in which they are produced.

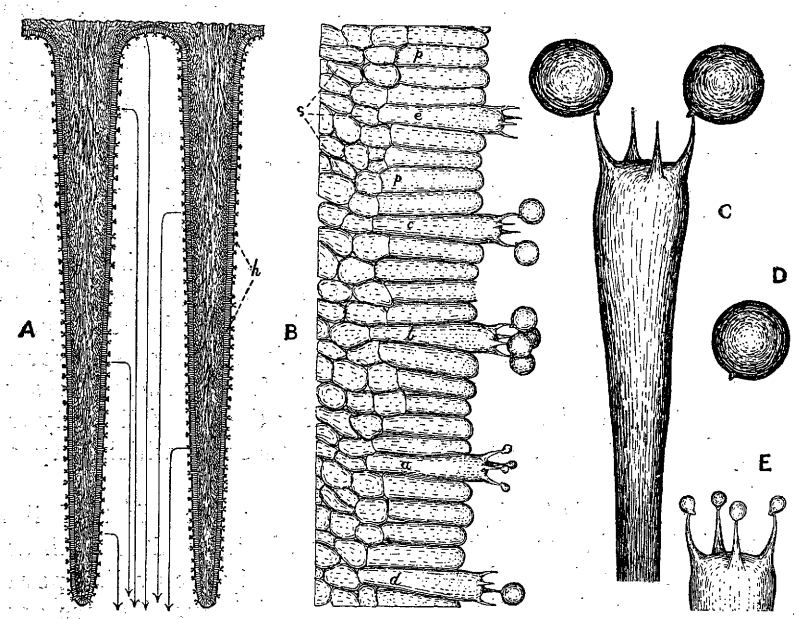
Among the varied subjects discussed are: the effect of light upon the vitality of spores; the production of gills and so forth as a means of increasing the surface and consequently the prolific power, with due economy of somatic material; the minimum distance apart of opposed hymenial surfaces permitting the violently projected spores to fall freely; structural and physiological devices for maintaining the hymenium-lined spaces in a vertical position under varying surroundings.

The remaining chapters, which include the larger part of the observations that are novel in essence, deal with the finer details of the liberation, fall, and dispersal of the basidiospores. The author describes his method of viewing falling spores by the aid of a beam of light. He gives records of the length of the period during which the fructification of various species sheds spores.

[1] Researches on Fungi, an account of the Production, Liberation, and Dispersion of the Spores of Hymenomycetes treated Botanically and Physically, also some Observations upon the Discharge and Dispersion of the Spores of Ascomycetes and of Pilobolus. Pp. xi + 286, plts. i-v, and 83 text figs. London: Longmans, Green & Co., 1909. Price 12s. 6d. net.

[JOURN. ECON. BIOL., March, 1910, vol. v, No. 1.]

Falk's conclusion that the setting free of the basidiospores in an active vital process is experimentally confirmed. The interesting information is given that the fructifications of certain Hymenomycetes may be dried up, with the result that the shedding of the spores is arrested and kept in a living but desiccated condition for years, so that when once more supplied with moisture they recommence to shed spores. Thus a class of "xerophytic" fungi is recognized.

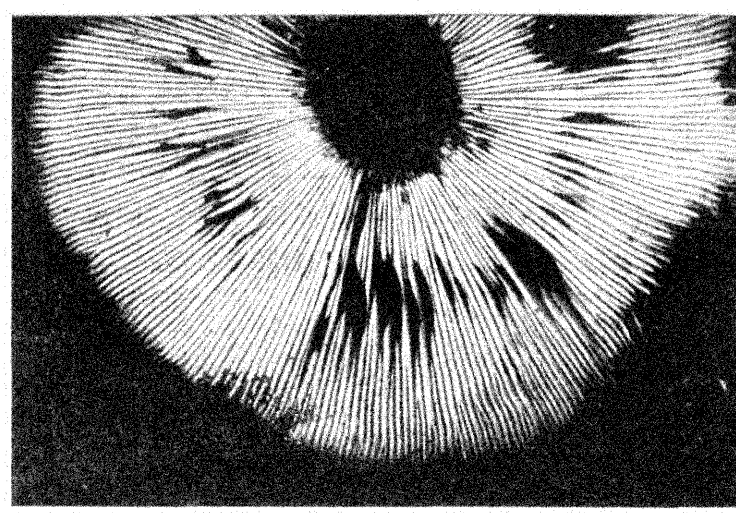


Amanitopsis vaginata.—Relations of the spores to the fruit-body. A, transverse section through two gills showing the hymenium, *h*, from which basidia are projecting. The arrows indicate the paths of spores which, after discharge from their basidia, have fallen in still air. Magnification, 15. B, vertical section through the hymenium and subhymenium. *p*. paraphyses: *a*—*e*, basidia; *a*, with rudimentary spores; *b*, with ripe spores; *c*, with two spores discharged; *d*, with three spores discharged; *e*, with all the spores discharged: *s*, the subhymenium. Magnification, 370. C, isolated basidium with two spores discharged showing mode of attachment of spores to their sterigmata. Magnification, 1110. D, discharged spore. Magnification, 1110. E, basidium with rudimentary spores. Magnification, 1110.

En passant it may be remarked that it would be well to restrict the term xerophytic to plants having permanent *anatomical* devices enabling them to resist desiccation: these fungi cannot be termed xerophytes until such devices have been demonstrated. But Professor Buller does describe one interesting case—that of *Schizophyllum commune*—in which there is a reversible change of

form of the sporophore under differing conditions of drought and moisture, of such a kind as to recall the temporary xeromorphy of grass-leaves that "roll up" when exposed to drought.

Professor Buller confirms Brefeld as to the fact that the spores are violently projected from the basidium, but he supplies a correction important to the comprehension of the mechanism, by pointing out that the four spores of the basidium are shot forth successively, not simultaneously. He concludes that the violent action is not due to the opening of the basidium and the consequent liberation of hydrostatic pressure with a "squirting discharge," but is more pro-



Spore-deposit produced in about twenty hours from a pileus of *Lepiota rachodes*. (The central parts of some of the gills were in contact with the paper: hence slight disturbances to the regularity of the deposit.) Natural size.

bably caused by a sudden splitting of the common wall beween the sterigma and the spore into two separate layers.

The author endeavoured to test the truth of Stokes' law relating to the velocity of fall of microscopic spheres, but his results exceeded the value calculated according to Stokes' formula by nearly fifty per cent. Professor Buller observed that each individual spore showed variation in velocity during its fall, and in particular exhibited a final decrease which was more marked in dry than in saturated air. According to Stokes' formula the final velocity varies distinctly as the density and the square of the radius of the spherule; and Professor Buller attributes the ultimate decrease in velocity to decreased size of the spore as it parts with water during

its descent. (In explaining this loss by evaporation Professor Buller makes the extraordinary statement: "One must remember that a spore has an enormous surface compared with its mass . . . ") The difficulty of testing Stokes' formula is evident when it is remembered that the spore should be spherical, and should be measured

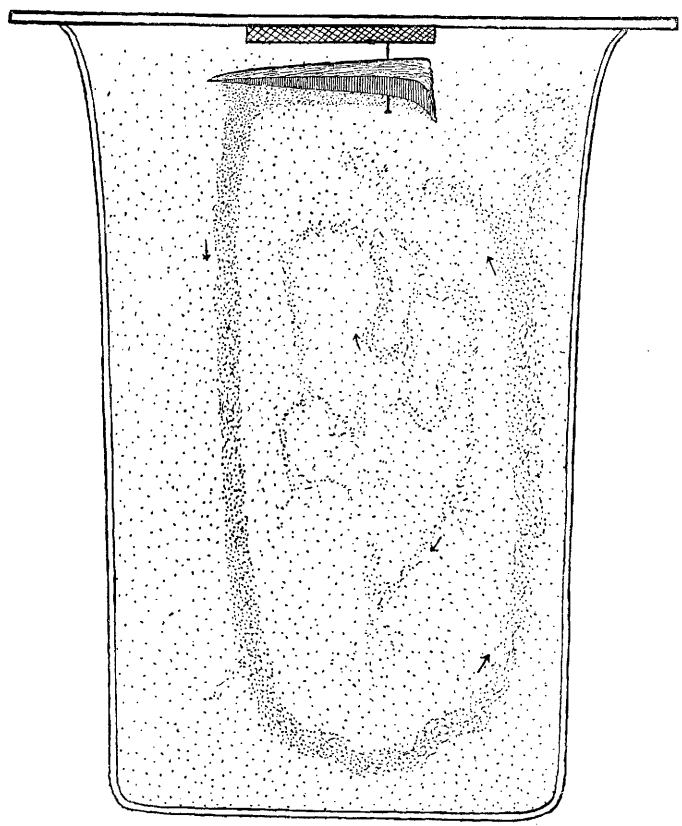


Diagram illustrating the discharge of spores from a fruit-body of *Polystictus versicolor* as seen by the beam-of-light method. The fruit-body is pinned in its natural position to a piece of cork attached to a circular glass cover placed upon a beaker. A stream of spores is carried round within the beaker very slowly by convection currents and gradually breaks up so that the spores become scattered fairly uniformly. Reduced to about 2/3.

when just ready to fall from the basidium (not in water) and exactly at the conclusion of its measured flight, and its surface should be smooth.

But falling basidiospores are also liable to undergo change of shape, and Professor Buller mentions that the descending and dry-

ing mushroom spores acquire a boat-shape. By the assumption that these buckle up during their descent, he explains that the mushroom is exceptional in showing a final acceleration after the retardation, in the rate of fall of the spores. This acquisition of a semi-concave form on the part of drying basidiospores is, I believe, a very widespread phenomenon (though it may escape notice because the observer's breath is sufficient to restore the convex form, at least in some cases), and I cannot help regarding it as more probable that

The liberation of spores of *Coprinus comatus*. The fruit-body was gathered in a field and then set in a vertical position under a bell-jar. As the pileus expanded below, spores began to fall. The black spore-deposit upon the paper around the base of the stipe was formed in the course of three hours. 1/3 natural size.

the concavity is calculated to retard the rate of fall by causing the descending spore to act as a parachute.

In the excellent and detailed account of the spore dispersal of *Coprinus*, Professor Buller demonstrates that the spores are scattered by the wind and that the inky fluid (produced by autodigestion) takes no share in the process.

As indicating the range of subjects discussed and of original information provided, mention may be made of the pages dealing

with the part played by animals in transporting basidiospores, the rôle of fungus-eating slugs, which, it is pointed out, are not kept at bay by acrid juices nor deadly poisons such as muscarin.

Some neat observations and suggestive remarks on the mechanism of the ascus, the scattering of spores by animals, and a most useful summary of the contents of the whole volume, chapter by chapter, conclude a volume which is not only a notable and truly interesting contribution to a branch of fungology that has received but little attention, but is also a work calculated to excite further research in the same field.

PERCY GROOM.

REVIEWS.

Kirkaldy, G. W.—Catalogue of the Hemiptera (Heteroptera) with biological and anatomical references, lists of food plants and parasites, etc. Vol. i. *Cimicidae*. Pp. xl + 392. Berlin: Felix L. Dames, 1909.

Mr. Kirkaldy's work aims at being something more than a mere catalogue of names. As the title of the work well expresses it gives biological and anatomical references, lists of food plants, parasites, etc.

Volume i treats of the *Cimicidae* and is admirable in all details but one. We cannot understand why the author has departed from the long recognized method of giving the references under the actual genera, sub-genera, etc. It is most confusing to find no reference on p. 118 to the sub-genus *Acrosternum*, and we have to turn back to p. 115 to the genus *Nezara* to find the reference there. This, to our mind, is a very serious drawback to the Catalogue, which in every other way has been carefully thought out and must, when complete, form an extremely valuable work, and one which no student of the Hemiptera can afford to be without.

The volume before us is well printed and on thin paper, and contains a mass of wonderfully valuable details.

W. E. C.

Knuth, Paul.—Handbook of Flower Pollination. Translated by J. R. Ainsworth Davis. Vol. iii, pp. iv + 644, and 208 figs and 1 plt. Oxford: The Clarendon Press, 1909.

In the present volume the Angiospermae are completed as well as the Gymnospermae, and the systematic list of insect visitors is given. This latter, extending as it does over one hundred pages, will prove most useful.

The present volume is full of interest and presents a wealth of material for both the entomologist and botanist.

It has been no slight task to bring together the voluminous records here given, and the translator is to be congratulated on the able manner in which he has carried out his task.

Long, Harold C.—Common Weeds of the Farm and Garden. In collaboration with John Percival. Pp. xviii + 451, 106 figs. London: Smith, Elder and Co., 1910. Price 6s. net.

A small handbook treating of our common weeds and their relationship to agriculture has long been needed, and Mr. Long has admirably supplied that need in the form of the excellent work before us.

Writing upon this same subject some years ago we drew attention to the fact, that whilst almost every country regards the neglect of weeds as dangerous, England is about the only one in which there are no laws concerning the matter.

Mr. Long deals very thoroughly with the whole subject, first pointing out what weeds are, and how they affect our crops and live-stock, and in this connection he shows how many species harbour injurious insects and fungi.

The different agencies by which weeds are distributed is clearly set forth, as also the general preventive and remedial measures. A systematic account of the weeds of arable and grass land is next given. Parasitic and poisonous weeds, those of ponds, rivers, and ditches, and lawns and drives, are all carefully described.

There is a clear account of the principles of seed testing which should prove very useful, whilst a most useful list is given of weeds and poisonous plants, in which scientific and common names are given, the soil, situation, time of flowering, method of propagation, and other details.

Finally we have a concise account of the legislation enforcing the destruction of noxious weeds in the chief agricultural countries of the world, which shows, as usual, in nearly all matters concerning agriculture, our own country is behind her Colonies and other countries.

It is a book every agriculturist and horticulturist may read with considerable profit, and if it spurs them on, as we hope it will, to demand the same protection as is afforded in other countries, the author may feel justly proud of his labours.

W. E. C.

Swanton, E. W.—Fungi and How to Know Them. Pp. xi + 210 and 48 plts. London: Methuen and Co., 1909. Price 6s. net.

The object of the present work, the author informs us, is to supply an introduction to the more advanced treatises on systematic mycology, and he has more than succeeded in his work.

After a general explanation of the development of fungi the author describes the various groups and illustrates the same by an excellent series of plates. Miss Spittal is to be complimented on the faithful rendering she has given of the different species.

We much regret that the author has omitted the names of the authors of the different species, thereby considerably reducing the value of his work.

There are a few passages which are not quite clear especially to the beginner, for which the work is primarily intended, and the author himself is frequently in error in regarding the fructification as the fungus.

On the whole the book appears to steer clear of the pitfalls that invariably waylay the popular writer, and will serve a useful purpose.

W. E. C.

Thimm, C. A.—Bibliography of Trypanosomiasis. Embracing original Papers published prior to April, 1909, and References to Works and Papers on Tsetse-Flies, especially *Glossina palpalis,* Rob.-Desv. Pp. iv + 228. London: Sleeping Sickness Bureau. 1909. Price 4s. net.

That the publication of a bibliography of trypanosomiasis, such as the one before us, will prove of great service there can be no doubt, and Mr. Thimm's labours can scarcely fail to meet with the appreciation of investigators in all parts of the world.

Nearly two thousand references are given under authors and the journals in which they have appeared, each reference carrying an index number.

From Dr. Bagshaw's preface we learn that a subject index is in course of preparation, in which the numbers to be consulted for the various subjects will be indicated.

Both the compiler and the Sleeping Sickness Bureau are to be congratulated on the publication of a very useful and excellent piece of work.

CURRENT LITERATURE.

I.—General Subject.

Forbes, S. A.—The General Ecology of the Indian Corn Plant. Amer. Nat., 1909, vol. xliii, pp. 286-301.

Jack, R. J.—The "Nurseries Ordinance, 1909." Rhodesian Agric. Journ., 1909, vol. vii, pp. 806-816.

Middleton, T. H.—Annual Report of the Intelligence Division of the Board of Agriculture and Fisheries, for the year 1908, Pt. ii, 1909, pp. 1-55.

Wood, T. B.—Heredity in Farm Animals. Journ. Farmers' Club, 1909 (Dec.), pp. 905-919.

II.—Anatomy, Physiology, and Development.

Berlese, Antonio.—Monographia dei Myrientomata. Redia, 1909, vol. vi, pp. 1-182, T. i-xvii e 14 fig.

Cholodkovsky, N.—Zur Kenntnis des weiblichen Geschlechtsapparates der Musciden. Zeit. wiss. Insecktenbiol., 1909, Bd. v, pp. 333-337, 8 fig.

Del Guercio, G.—Contribuzione alla conoscenza dei Lacnidi italiani. Morfologia, sistematica, biologia generale e loro importanza economica. Redia, 1908, vol. v, pp. 173-359, T. ix.-xx, e 33 fig.

Shelford, R.—Two remarkable forms of Mantid oothecae. Trans. Entom. Soc. Lond., 1909, pp. 509-514, 3 figs.

III.—General and Systematic Biology, and Geographical Distribution.

Austen, E. E.—Note on the Suggested Possible Long Duration of the Life of *Glossina palpalis*. Bull. Sleeping Sickness Bur., 1909, No. 12, pp. 456, 457.

Bagnall, R. S.—On two new Genera of Thysanoptera from Venezuela. Journ. Linn. Soc. (Zool.), 1909, pp. 329-335, plt. 46.

The new genera and species are *Anactinothrips meinerti* and *Actinothrips longicornis*.

Börner, Carl.—Die Verwandlungen die Insekten. SB. Gessell. Naturf. Freunde, 1909, pp. 290-311, 10 figs.

Börner, Carl.—Über Chermesiden. vi. *Cholodkovskya, Aphrastasia* und *Gillettea*. Zool. Anz., 1909, Bd. xxxiv, pp. 498-511, 7 figs.

Börner, Carl.—Über Chermesiden. vii. *Cnaphalodes lapponicus* (Chol.). Zool. Anz., 1909, Bd. xxxiv, pp. 554-560, 1 fig.

Buffa, P.—I Tisanotteri esotici esistenti nel Museo Civico di Storia Naturale di Genova. Redia, 1908, vol. v, pp. 157-172, Tav. viii.

Cameron, P.—On some Diplopteryga from the South-west of North America. Pomona Journ. Entom., 1909, vol. i, pp. 78-85.

Cameron, P.—Some Odynerinae of the South-west United States. Pomona Journ. Entom., 1909, vol. i, pp. 122-134.

Many new species described, but without figures.

Crawford, D. L.—Some New Thysanoptera from Southern California, 1. Pomona Journ. Entom., 1909, vol. i, pp. 100-108, 31 figs.

The following are described as new *Ankothrips* (gen. nov.) *robustus, Aeolothrips longiceps, Euthrips minutus,* Moul., var. *setosus, Phyllothrips fasciculata,* and *P. fasciculata* var. *stenoceps.*

Crawford, D. L.—Some Thysanoptera of Mexico and the South, 1. Ibid., pp. 109-119, 29 figs.

The following are described as new *Aeolothrips vespiformis, Heterothrips decacornis, Chirothrips mexicana, Euthrips insularis,* Frank., var. *reticulata, Rhaptothrips* (gen. nov.) *peculiaris.*

Crawford, D. L.—Notes on Californian Thysanoptera. Ibid., pp. 120, 121.

Eichelbaum, F.—Käferlarven und Käferpuppen aus Deutsch-Ostrafrika. Zeit. f. wiss. Insektenbiol., 1910, Bd. vi, pp. 10-13, 6 fign.

Eltringham, H.—An Account of some Experiments on the Edibility of certain Lepidopterous Larvae. Trans. Entom. Soc. Lond., 1909, pp. 471-478.

Essig, E. O.—Combating the Citrus Bug. Pomona Journ. Entom., 1909, vol. i, pp. 89-91.

Essig, E. O.—Notes on Californian *Coccidae.* Ibid., pp. 92-97, 7 figs.

Essig, E. O.—*Aphididae* of Southern California, 111. Ibid., pp. 98, 99, 7 figs.

Fiske, W. F., and W. R. Thompson.—Notes on the Parasites of the *Saturniidae.* Journ. Econ. Entom., 1909, vol. ii, pp. 450-460.

Griffini, A.—Sulla "*Gryllacris rubinervosa,*" Serville con appunti sul genere *Dibelona,* Brunner e sulle "*Gryllacris americane.*" Redia, 1909, vol. vi, pp. 183-192.

Hayhurst, P.—Observations on Two Species of *Hyalopterus* (*Aphididae*). Journ. N.Y. Entom. Soc., 1909, vol. xvii, pp. 108-115, 1 plt.

Hayhurst, P.—Observations on a Gall Aphid (*Aphis atriplicis,* L.). Ann. Ent. Soc. Amer., 1909, vol. ii, pp. 88-99, 19 figs.

Hewitt, C. Gordon.—The Structure, Development and Bionomics of the House-fly, *Musca domestica,* Linn. Pt. III. Quart. Journ. Micros. Sci., 1909, vol. 54, pp. 347-414, plt. 22.

The author describes the bionomics of this pest, certain of its allies which may occur in houses, its parasites, and its relation to man, especially as the carrier of the bacilli of certain infectious diseases.

Houard, C.—Les collections cécidologiques du Laboratoire d' Entomologie du Museum d' Histoire naturelle de Paris. Marcellia, 1909, vol. viii, pp. 65-78, 23 fig.

Janet, Charles.—Sur l'ontogénèse de l'Insecte. Pp. 129, 4 figs. Limoges: Ducourtieux et Gout. 1909.

Kew, H. W.—Notes on the Irish False-Scorpions in the National Museum of Ireland. Irish Nat., 1909, vol. xviii, pp. 249, 250.

Linnaniemi, W. M. (Axelson).—Zur Kenntnis der Collembolenfauna der Halbinsel kanin und Benachbarter gebiete. Acta Soc. F. et F. Fennica, 1909, pp. 3-17, map.

Nalepa, A.—Der Heliotropismus der Gallmilben und seine biologische bedeutung. Marcellia, 1909, vol. viii, pp. 78-84.

Nüsslin, O.—Ueber *Aphrastasia pectinatae,* Chldk. Zeit. f. wiss. Insektenbiol., 1909, Bd. v, pp. 373-380, 6 fign.

Pierce, W. D.—Studies in North American Weevils. Proc. U.S. Nat. Mus., 1909, vol. 37, pp. 325-364.

Pierce, W. D.—A Monographic Revision of the Twisted Winged Insects comprising the Order Strepsiptera, Kirby. U.S. Nat. Mus., Bull. 66, 1909, pp. xii + 232, 15 plts, 3 text figs. and map.

In this very valuable revision the author emphasises the importance of a more intensive and extensive study of the Strepsiptera. He enters very fully into the history and systematic position, the biology, internal and external structure and classification, and gives a Check-list of the Order. There are a number of new genera and species described and a useful Host list given.

Sanders, J. G.—Catalogue of recently described Coccidae—II. U.S. Dept. Agric., Bur. of Entom., Tech. Ser. No. 16, pt. iii, 1909, pp. 33-60.

Sanders, J. G.—The Identity and Synonymy of some of our Soft Scale-Insects. Journ. Econ. Entom., 1909, vol. ii, pp. 428-448, plts. 19, 20.

Schmidt, H.—Beitrag zur Biologie der Steinobst-Blattwespe (*Lyda nemoralis,* L.). Zeit. f. wiss. Insektenbiol., 1910, Bd. vi, pp. 17-23, 18 fign.

Schumacher, F.—Beiträge zur Kenntnis der Verbreitung und Biologie der einheimischen Poeciloscytus-Arten (Fam. *Capsidae*). Zeit. f. wiss. Insektenbiol., 1909, Bd. v, pp. 380-390, 6 fign.

Silvestri, F.—Descrizione di un nuovo genere di Polydesmoidea (Diplopoda) del Mesico. Boll. Mus. Zool. Univ. Torino, 1909, vol. xxiv, pp. 1-4, 3 figs.

Holistophallus peregrinus, gen. et sp. nov.

Silvestri, F.—Descrizione di una nuova famiglia di Diplopoda Cambaloidea del Tonkino. Boll. Lab. Zool. R. Sc. Agric. Portici, 1909, vol. iv, pp. 66-70, 5 figs.

Fam. *Pericambalidae,* nov. *Pericambala orientalis,* gen. et. sp. nov.

Trägärdh, Ivar.—Zur Kenntnis von *Phytomyza xylostei,* Kltb., eine in *Lonicera symphoricarpus* minierende Fliege. Zeit. f. wiss. Insektenbiol., 1909, Bd. v, pp. 301-304, 11 fign.

Warren, Ernest.—Notes on the Life Histories of Natal Termites, based on the Observations of the late Mr. G. D. Haviland. Ann. Natal Gov. Mus., 1909, vol. ii, pp. 113-128.

Williamson, E. B.—The North American Dragonflies (Odonata) of the Genus *Macromia.* Proc U.S. Nat. Mus., 1909, vol. 37, pp. 369-398, plts. 35, 36.

IV.—Agriculture and Horticulture.

Back, A. E.—A New Enemy of the Florida Orange. Journ. Econ. Entom., 1909, vol. ii, pp. 448, 449.

The new pest is *Aleyrodes howardi,* Quaintance, hitherto only known from the West Indies.

Chittenden, F. H.—Some Insects Injurious to Truck Crops. U.S. Dept. Agric., Bur. of Entom., Bull. No. 82, Pt. ii, 1909, pp. 9-24, 6 figs.

The insects treated of are the parsnip leaf-miner (*Acidia fratria,* Loew.); the parsley stalk weevil (*Listronotus latinsculus,* Boh.); and the celery caterpillar (*Papilio polyxenes,* Fab.).

Chittenden, F. H.—Some Insects Injurious to Truck Crops. U.S. Dept. Agric., Bur. of Entom., Bull. No. 82, pt. iii, 1909, pp. 25-32, 1 fig.

Chittenden, F. H.—Control of the Mediterranean Flour Moth by Hydrocyanic Acid Gas Fumigation. U.S. Dept. Agric., Bur. of Entom., Circ. No. 112, 1909, pp. 1-22, 5 figs.

Chittenden, F. J.—A Disease of *Lavatera trimestris*. Journ. Roy. Hort. Soc. 1909, vol. xxxv, pp. 213-215, 1 fig.

Chittenden, F. J.—A Disease of *Antirrhinum*. Ibid., pp. 216, 217, 1 fig.

Darlington, H. R.—The Swift Moth Caterpillar and Daffodils. Journ. Roy. Hort. Soc., 1909, vol. xxxv, pp. 219-224.

French, Jun. C.—The Tomato Weevil. (*Desiantha novica*, Lea.). Journ. Vict. Dept. Agric., 1909, vol. vii, p. 642, 10 figs.

Forbes, S. A.—Twenty-fifth Report of the State Entomologist on the Noxious and Beneficial Insects of the State of Illinois. Pp. xxiii + 124, 35 figs. and 3 plts. Illinois, 1909.

An excellent report dealing with experiments with repellents against the Corn Root-aphis, the habits and behaviour of the Corn Field Ant, *Lasius niger americanus*, and the insect pests of Clover and Alfalfa.

Gillette, C. P.—Plant Louse Notes, Family *Aphididae*. Journ. Econ. Entom., 1909, vol. ii, pp. 385-388, 19 figs.

Gunn, David.—Some Insects Injurious to Stored Grain. Transv. Agric. Journ., 1909, vol. viii, p. 77, plts. 19, 20.

Gunn, David.—The Potato Tuber Moth. (*Gelechia operculella*, Zeller.). Ibid., pp. 80-82, plt. 21.

Gunn, David.—Two well-known Pests in the Transvaal. Ibid., pp. 82-85, plt. 22.

Güssow, H. T.—A Serious Potato Disease occurring in Newfoundland. Dept. Agric., Cent. Exp. Farm, Ottawa, Div. of Bot., Bull. No. 63, 1909, pp. 1-8, 2 plts.

Howard, L. O.—The Report of the Etnomologist for 1909. U.S. Dept. Agric., Ann. Rpt., 1909, pp. 1-45.

Hunter, S. J.—The Green Bug and its Enemies. A Study in Insect Parasitism. Bull. Univ. Kansas, 1909, vol. ix, No. 2, pp. ix + 221, plts. i-ix, figs. 1-65.

The subject of this exhaustive memoir is *Toxoptera graminum*, the Southern grain aphis which is parasitised by a small hymenopterous insect *Lysiphlebus tritici*, Ashm.

Professor Hunter has very thoroughly worked out the life-histories of both insects, and details a host of very valuable experimental work of great economic importance. Prof. P. A. Glenn adds an interesting paper on the influence of climate upon the pest and its parasite.

Jarvis, E. M.—Wireworm or Hairworm in the Melsetter District. Rhodesian Agric. Journ., 1909, vol. vii, pp. 771-778.

Lounsbury, Chas. P.—The Cotton Stainer Bug. Agric. Journ. C. of G.H., 1909, vol. xxxv, pp. 613-616.

Newell, W., and G. D. Smith.—Experiments with Powdered Arsenate of Lead as a Practical Boll Weevil Poison. State Crop Pest Comms. of Louisiana, Circ. No. 33, 1909, pp. 253-333, 3 figs.

Phillips, W. J.—The Slender Seed-Corn Ground-Beetle. U.S. Dept. Agric., Bur. of Entom., Bull. No. 85, Pt. ii, 1909, pp. 13-28, 6 figs.

Sanders, J. G.—The Euonymus Scale (*Chionaspis euonymi,* Comstock). U.S. Dept. Agric., Bur. of Entom., Circ. No. 114, 1909, pp. 1-5, 2 figs.

Sanderson, E. D.—A New Insectary. Journ. Econ. Entom., 1909, vol. ii, pp. 389-390, plt. 14.

Sanderson, E. D., and A. D. Jackson.—The Oblique-banded Leafroller (*Archips rosaceana,* Harris). Ibid., pp. 391-403, plts. 15-18.

Silvestri, F.—Parassiti introdotti m Italia nel 1909 per combattere la "*Diaspis pentagona,*" Targ. Boll. Soc. Agric. Italiani, 1909, An. xiv, pp. 1-10, figs. i-viii.

Thomsen, F.—Notes on Termites. Transv. Agric. Journ., 1909, vol. viii, pp. 86, 87.

Thomsen, F.—Some Insect Pests of Fruit Trees. Ibid., pp. 87-94, plt. 23.

Tucker, E. S.—Additional Notes upon the Breeding of the Coffee-bean Weevil (*Araecerus fasciculatus*, De Geer.). Journ. Econ. Entom., 1909, vol. ii, pp. 373-381.

Webster, F. M.—The Chinch Bug. (*Blissus leucopterus*, Say). U.S. Dept. Agric., Bur. of Entom., Circ. No. 113, 1909, pp. 1-27, 8 figs.

Webster, F. M.—The Lesser Clover-Leaf Weevil (*Phytonomus nigrirostris*, Fab.). U.S. Dept. Agric., Bur. of Entom., Bull. No. 85, Pt. i, 1909, pp. 1-12, 8 figs.

Webster, R. L.—Notes on Two Insects found in Corn. Journ. Econ. Entom., 1909, vol. ii, p. 463.

V.—Forestry.

Adkin, B. W.—The Butterflies and Larger Moths affecting Forestry in Britain. Quart. Journ. For., 1909, vol. iv, pp. 9-30.

We learn from a foot-note that this essay was awarded a silver medal in 1908, presumably by the Royal English Aboricultural Society. It is a poor compilation containing one or two very serious errors, which should have been corrected by someone before being printed.

Hopkins, A. D.—Contributions toward a Monograph of the Scolytid Beetles. 1. The Genus *Dendroctonus*. U.S. Dept. Agric., Bur. of Entom., Tech. Ser., No. 17, pt. i, 1909, pp. xiii + 164, 8 plts. and 95 figs.

Dr. Hopkins' contributions to forest entomology have a world-wide interest and fame, and the present monograph can only enhance the high reputation his work has so justly earned. The *raison d'etre* of the present piece of work is summarized in the author's own words as follows, "in order to give reliable information on applied entomology we must have at our command the knowledge gained by careful technical, or systematic. studies of the insects with which we have to deal."

The student of forest entomology has now such a work at his command in which no side has been overlooked. The author opens with a short historical summary, then the original description of the genus with translation, revisional notes and synonymy. This is followed by a detailed description of the imaginal and larval anatomy, illustrated by excellent figures.

The latter half of the work is occupied by a revision of the genus, together with systematic notes and descriptions of new species. It is a piece of work thoroughly investigated, carefully written, and beautifully illustrated. It will be studied by all students of insect morphology with considerable interest, and prove invaluable to the systematist also.

W. E. C.

Hopkins, A. D.—Bark Beetles of the Genus *Dendroctonus*. U.S. Dept. Agric., Bur. of Entom., Bull. No. 83, pt. i, 1909, pp. xv + 169, 2 plts., and 102 figs.

This second monograph may be described as the practical or applied side of the above-mentioned investigation.

Full details are given as to the habits and seasonal history, and other facts relating to various species. Climatic and other influences, natural and secondary enemies, and the general methods of control are all very fully dealt with. Following these we have a review of each species dealt with in detail, and an excellent bibliography, the whole forming a distinct acquisition to the literature on forest entomology, fully maintaining the high standard of the entomolgical publications of the United States Department of Agriculture, which have long been the envy and admiration of European workers.

W. E. C.

Hopkins, A. D.—Insect Depredations in North American Forests and practical methods of prevention and control. U.S. Dept. Agric., Bur. of Entom., Bull. No. 58, pt. v, 1909, pp. vi + 57-101.

Stebbing, E. P.—On some Undescribed *Scolytidae* of Economic Importance from the Indian Region 11. Ind. Forest Mem., 1909, vol. i, pt. ii, pp 1-20.

Troup, R. S.—Note on Burmese in Wood (*Dipterocarpus tuberculatus,* Roxb.). For. Ec. Ser. No. 6, 1909, pp. 1-24, 3 plts. and 1 map.

Webb, J. L.—The Southern Pine Sawyer. (*Monohammus titillator,* Fab.). U.S. Dept. Agric., Bur. of Entom., Bull. No. 58, pt. iv, 1909, pp. 41-56, figs. 13-24.

VI.—Fisheries.

VII.—Medicine.

VIII.—Animal Diseases, etc.

Balfour, Andrew.—Mosquitoes with Reference to Immigration and Horse Sickness, and Notes on the Destruction of their Larvae by Fish in the Sudan. Lancet, 1909 (Jan. 8th), pp. 100, 101.

Duerden, J. E.—Experiments with Ostriches—X. How the Bars in Ostrich Feathers are produced. Agric. Journ. C. of G.H., 1909, vol. xxxv, pp. 474-487, 7 figs.

Holmes, J. D. E.—Surra. Indian Civ. Vet. Dept. Mem. No. 1, 1909, pp. 1-36, 15 plts.

Holmes, J. D. E.—Immunisation against Haemorrhagic Septicaemia of Bovines. Ibid., pp. 48-68.

Holmes, J. D. E.—Rinderpest. Ibid., pp. 69-85.

Holmes, J. D. E.—A peculiar form of Steptotrichosis among Cattle. Ibid., pp. 86-93, 5 plts.

Holmes, J. D. E.—Flagellate form of *Piroplasma bovis*. Ibid, pp. 94-100, 1 plt.

Hooker, W. A.—The Geographical Distribution of American Ticks. Journ. Econ. Entom., 1909, vol. ii, pp. 403-428.

Jowett, W.—Biliary Fever or Malignant Jaundice of the Dog (Canine Piroplasmosis). Agric. Journ. C. of G.H., 1909, vol. xxxv, pp. 429-441.

Records the successful treatment of this disease by the injection of Trypan blau.

Jowett, W.—Biliary Fever or Malignant Jaundice of the Dog (Canine Piroplasmosis). Agric. Journ. C. of G.H., 1909, vol. xxxv, pp. 582-584.

Leishman, W. B.—The Mechanism of Infection in Tick Fever and on the Hereditary transmission of *Spirochaeta duttoni* in the Tick. Lancet, 1910 (Jan. 1st), pp. 11-14.

Newstead, R.—Reports of the Twenty-first Expedition of the Liverpool School of Tropical Medicine. Jamaica, 1908-1909: Section 1.—Medical and Economic Entomology. Part 1.—Ticks and other Blood-sucking Arthropoda. Ann. Trop. Med. and Paras., 1909, vol. iii, pp. 421-469, plts. xiii-xv.

Neumann, L. G.—Notes sur les Pédiculides. Arch. de Paras., 1909, T. xiii, pp. 497-537, 31 figs.

The new species are *Haematopinus latus, H.* (*Linognathus*) *praelongiceps, H.* (*Polyplax*) *quadridentatus, H.* (*P.*) *longulus H.* (*P.*) *bidentatus, H.* (*P.*) *echinatus, H.* (*P.*) *maniculatus.* Other species are also described and figured.

Neumann, L. G.—La Filaire de l'Autruche. Rev. Vétér., 1909, pp. 544-549, 4 figs.

Filaria spicularia, n. sp.

Neumann, L. G.—Le Pou d'*Orycteropus afer* et une nouvelle sous-espèce d'*Amblyomma.* Jahrb. Ver. Natur. Wiesbaden, 1909, pp. 1-6. Taf. i.

Stiles, C. W., and A. Hassall.—Index-Catalogue of Medical and Veterinary Zoology. U.S. Dept. Agric., Bur. An. Ind., Bull. No. 39, pts. 24, 25, 1909, pp. 1807-1893, 1895-1979, R. to Rz.

Theiler, Arnold.—Stock Diseases Carried by Flies. Transv. Agric. Journ. 1909, vol. viii, pp. 41-51.

THE

JOURNAL OF ECONOMIC BIOLOGY.

DISEASES OF BEES.

By

WALTER MALDEN, M.A., M.D., M.R.C.P.,

Pathological Laboratory, Cambridge University.

CONTENTS.

THERE has been a good deal of work done during the last few years on the bacteriology of bee diseases, which has added considerably to our knowledge. Professor Maassen and Professor Zander in Germany, Professor Burri in Switzerland, and Dr. Franklin White in America, have by their researches done much to elucidate problems which had previously been very obscure.

Diseases of the honey bee are most conveniently divided into two main groups: (1) Those affecting the larvae, and (2) those affecting the adult bee.

1.—DISEASES OF LARVAE.

By far the most important diseases in this group are those classed as "Foul Brood." Until a comparatively short time ago all cases of foul brood were believed to be due to the same cause. In 1886 Cheshire and Cheyne described a spore-bearing bacillus, named by them *B. alvei,* which they found constantly present in dead larvae in foul brood, and for many years this bacillus was regarded as the sole cause of the disease.

In 1902 White described a second variety of foul brood which was common in the United States; the cause of this appeared to be another spore-bearing bacillus, which he named *B. larvae,* and the disease caused by this organism is generally known in the United

States as American foul brood, while that in which *B. alvei* is present is known as European foul brood.

Shortly after this Maassen described an organism which he found present in a large number of cases of foul brood in Germany, which appeared to be not a bacillus but a spirochaete, a protozoal organism. White soon pointed out that what Maassen had taken for a spirochaete was nothing more than a mass of twisted flagella from the bacillus he had already studied and named *B. larvae*. Maassen subsequently acknowledged that this was the case and that he had been mistaken in thinking that these masses of flagella were spirochaetes. He afterwards found the bacillus from which these flagella came, and named it *B. brandenburgiensis,* though it is certainly the same organism as that which White had already named *B. larvae*. Quite recently Maassen and Burri have independently described another variety of foul brood which appears to be caused by a different organism, namely *Streptococcus apis*. This micrococcus is, however, frequently associated with *B. alvei,* and it is doubtful whether it is the primary cause of the disease or only an associated organism.

White considers that there is some reason to doubt whether *B. alvei* is really the cause of European foul brood. The original work done by Cheshire and Cheyne does not seem quite conclusive as to whether they actually produced infection in healthy brood by spraying with pure cultures of *B. alvei*. It is not denied that this organism is constantly present in cases of so-called European foul brood, but so far attempts to produce the disease in healthy brood by infection have failed.

There appears to be some reason for believing that a different organism may be the real cause of the disease. White finds that there is frequently to be seen in smears from dead larvae an organism which somewhat resembles *Streptococcus apis,* but it is not identical with it. Up to the present time it has been found impossible to cultivate this organism, so that judgment must be suspended until more work has been done on the subject as to the part it plays in the production of foul brood.

There can be no doubt as to the *B. larvae* being the pathogenic agent in American foul brood, as infection experiments have been uniformly successful in producing the disease in healthy brood. This bacillus, as has been said, is a spore-bearing organism which possesses numerous long flagella; these break off very easily and collect together in twisted masses, and can often be demonstrated in dead larvae when it is impossible to find either bacilli or spores. The organism is difficult to cultivate, and must be grown either on a

medium made from the juice of dead larvae, or on one which is prepared from animal brain extract, instead of the ordinary meat juice. Although the two principal varieties of foul brood have much in common yet there are some points which help to differentiate the two, apart from bacteriological examination.

In both forms there is a foul odour in the diseased combs when an affected hive is opened. German observers think they can distinguish between the two forms of the disease by the smell which they describe, but possibly the microscope would not confirm the nasal diagnosis.

Maassen is of opinion that the sealed brood is more often affected by *B. brandenburgiensis* (or *larvae*), while the disease in unsealed brood is more commonly due to *B. alvei*. In both forms there is considerable ropiness in the dead larvae; that is to say, if a splinter of wood be introduced into a cell containing a dead larva, the decomposing mass adheres to the wood and may be drawn out in a long glutinous thread. This ropiness is said to be due to the persistence of the chitinous tracheae after the softer tissues have broken down; and the condition is more marked in the case of American than in European foul brood.

Other organisms have been described as being the cause of foul brood, but the part they play in the production of disease is not sufficiently well known to warrant any conclusions being arrived at with regard to them at present.

In all forms of the disease propagation and infection are almost certainly due to bees from healthy hives entering diseased ones for the purpose of robbing, and conveying the disease in the stolen honey or pollen which they carry away. This is by far the most common and important means of spreading the disease, but it is possible that infection may also be conveyed to healthy hives by the bee-keepers hands or utensils which have not been properly disinfected after being employed on a diseased hive.

Treatment of Foul Brood.—In the opinion of most competent observers, there is only one safe method for treating an outbreak of foul brood. This consists in driving the bees from the affected into a clean hive or skep, and shutting them up for twenty-four or forty-eight hours. All the combs in the infected hive must be destroyed by burning them, as it is not worth while trying to preserve the wax or to attempt to disinfect them, in fact it is almost impossible to do the latter as the spores can resist the temperature of boiling water and are not destroyed by any of the ordinary disinfectants.

The infected hive must be thoroughly cleaned and the interior

burnt off with a painter's flare to destroy any spores which may remain on the woodwork. At the end of forty-eight hours the bees may be safely transferred to a fresh hive provided with clean combs or foundation wax, as by the end of that time they will have digested all the stores they took with them from their original hive, and inasmuch as adult bees are not affected by the disease they will have destroyed all the bacilli in their digestive tracts or passed the spores in their excrement. The hive which has been temporarily occupied must be carefully disinfected. This method of treatment, if thoroughly carried out, is found in nearly every case to stop the spread of the disease, and ought to be adopted by every bee-keeper as soon as he discovers that one of his stocks is affected. It is not advisable to feed with medicated syrups or to spray the combs with disinfectants, for although some cases of cure by these means have been reported, it is unsafe to rely upon them since they are useless in destroying the spores, and if these remain the disease will undoubtedly break out again.

Other Forms of Brood Disease.—Other forms of brood disease which lead to the death of the larvae are not generally supposed to be infectious. Among these may be mentioned Chilled brood, in which the larvae perish from cold or neglect; Pickle brood, which is supposed to be due to diminished fertility on the part of the queen and in consequence to the feeble vitality of the larvae. Black brood, which is probably only a variety of Chilled brood, in which the black appearance of the dead larvae is due to a particular kind of putrefactive organism. It is found in most cases in which the larvae perish without any infectious disease being present, that the dead grubs swell up and protrude from their cells if unsealed, or burst the caps if they do not die till after this process is completed. On the other hand in foul brood the larvae do not develop properly, are smaller than they ought to be, and after death shrink so that the cell caps appear sunken. This will often enable a bee-keeper to distinguish between larvae dead from disease and those who have perished from cold or some other cause.

Diseases of the Adult Bee.

Malignant Dysentery.—Professor Zander, of Erlangen, in 1909 described a form of dysentery which appears to be very prevalent in Bavaria, and is extremely virulent and infectious; he believes that many more stocks are destroyed by this disease than by foul brood. The complaint usually makes its appearance during the spring months, and rapidly kills all the bees in an infected hive. It may

appear to die down for a time, but generally lights up again, cases of complete recovery after an attack being very rare. Bees suffering from this complaint rapidly lose their power of flight, and are therefore unable to leave the hive in order to void their excrement, and in consequence foul the interior of the hive and alighting board. Many of the bees in their attempts to fly fall on the ground in front of the hive and there perish. Zander discovered that this disease was due to a protozoal parasite, and has named it *Nosema apis*. This parasite, when swallowed, makes its way into the epithelial cells, lining the chyle stomach and there rapidly multiplies. When it has exhausted its food supply it passes into a resting form or spore, and it is in this condition that it is usually found. These spores are oval, translucent, highly refractile bodies, considerably larger than bacterial spores, being about the size of yeast cells. Many thousands are passed in the excrement of an affected bee, and may remain alive for an indefinite time, as they are extremely resistant to heat, cold, or dessication. If the digestive tract of a bee dying from this complaint be examined the chyle stomach is sometimes found to have lost its natural pink colour and to be pearly white; this is due to the enormous numbers of *Nosema* spores which completely fill the secreting cells lining the chyle stomach. There does not appear to be any chance of saving a stock which has become infected with malignant dysentery, so that the only possible treatment is to destroy the bees and combs and thoroughly disinfect the hive and the ground in its neighbourhood which may have become contaminated by the dead bees or their excrement.

Simple Dysentery.—Non-malignant dysentery is a very different disease and appears to be caused either by spells of cold weather after warm days in the spring, or feeding the bees with too watery syrup or one made from inferior sugar. Bees affected by this complaint become weak and unwilling to fly, they void their excrement, which is usually thin and watery, on the combs and other parts of the hive. Some individuals die, but a stock usually recovers if proper steps are taken to put a stop to the trouble; these consist in keeping the bees warm and feeding with candy or good thick syrup.

May Sickness.—This complaint has not been described in this country, but it appears to be prevalent on the Continent of Europe about the month of May. The descriptions given by different writers of this disease are most conflicting, and various organisms have been described as being the cause of it. Professor Zander is inclined to believe that many cases of malignant dysentery have been put down to May sickness, if indeed it is not merely another name for that complaint.

Paralysis.—This does not appear to be a common affection in this country, but it is somewhat common in Ireland, and occurs in most other countries in which bee-keeping is practised. Bees affected by this complaint become unable to fly, and exhibit a curious tremulous motion of their bodies, which lose their healthy appearance and become black and shining. The cause of the disease has not at present been discovered, but it is not usually supposed to be infectious, and affected stocks generally recover after a shorter or longer period.

Isle of Wight Disease.—During the summer of 1904 an apparently new disease made its apperance in the Isle of Wight, and in the course of a few years practically exterminated the bees in the island. How the complaint originated it is impossible to say. When a hive is attacked it is noticed that the bees seem disinclined to work, and either fly aimlessly about or sit on the combs. They become lethargic and soon lose their power of flight, and in consequence large numbers of them fall on the ground near the hive, and as they are unable to regain it they quickly perish. The disease seems to be most prevalent and to spread most rapidly during the early summer months, but no time of year is exempt, many stocks perishing during the winter. Only the adult bees are effected; the larvae remain healthy, as do also the young bees, and it is only rarely that drones take the complaint. On more than one occasion a hive has been opened and found to contain a live queen, while all the other bees had perished. In nearly every instance in which accurate observations have been made it has been found that the disease was introduced into a healthy hive by foragers who had entered infected hives for the purpose of robbing; this clearly points to its infectious nature.

If a bee suffering from the disease be examined, it is usually found to be heavy, disinclined to move or use its sting, its wings are frequently dislocated and stick out in unnatural positions, the abdomen is swollen and inclined to droop posteriorly. On opening the abdomen the colon or hind gut is found to be greatly enlarged and full of a light yellow or light brown excrement which the bee appears to be unable to void; the contents of the gut consist largely of undigested pollen grains, small particles of wax and innumerable bacteria.

It has been suggested that the disease is nothing more than a stoppage of the bowel, but the accumulation may be accounted for by the fact that the bee normally voids its excrement during flight, so that when it loses its power of flight the contents of the bowel remain and accumulate. All the internal organs of a diseased bee

appear natural to the eye and also when examined microscopically, with the exception of the chyle stomach, which is frequently found to have lost its pinkish colour and to be greyish with dark contents; it is also much more fragile than normally, and frequently ruptures when the digestive organs are removed from the body. Under the microscope it is found that the chyle stomach in these cases have undergone degenerative changes, and that the lining membrane is either stripped off from the muscular coat or is only loosely attached to it. In the healthy bee the chyle stomach is generally free from bacteria, but in diseased specimens they may be present in large numbers. Among the bacteria in many of the bees that have been examined a short oval bacillus is found to be present, which stains deeply at both ends with any of the ordinary dyes with a band of unstained cyptoplasm in the centre. From its resemblance to the bacillus of plague this has been named the *Bacillus pestiformis apis*. This organism may frequently be found to have penetrated between the cells of the lining membrane of the chyle stomach and to be present in large numbers in the loosened tissue behind the secreting cells. It has been found present in about 60 per cent. of all the bees affected with this disease which have been examined.

The bacillus is not easily cultivated from the tissues of the bee as other organisms which are always present, particularly those of the *subtilis* family, grow more rapidly and prevent its development. It appears highly probable that this organism is the cause of the disease, but up to the present time no infection experiments have been successful in producing the complaint in healthy stocks, so that its relation to the disease cannot be said to be proved.

From the Isle of Wight the disease, during the last two years, has spread to the mainland, and has been noticed in Hants, Sussex, Surrey, Dorset, Berks., Bucks, Hertford, and Essex. It does not appear to be quite so virulent as it was in the Isle of Wight, where every old stock which existed before the outbreak has perished. Isle of Wight bee-keepers found that the first hives in an apiary which took the infection were those of the native bee, and although they ultimately became affected and perished, yet the Italian and hybrid stocks resisted longer than the native ones. In a few instances stocks badly affected in the Spring appeared to improve and get stronger during the Summer, but eventually perished in the Autumn, thus showing that the apparent improvement was only due to the hatching out of young and healthy bees which replaced for a time the older ones which had perished, and that when breeding ceased the remaining bees succumbed in their turn. So far no means have been found to check the spread of the disease, and the only treatment

is to destroy the stock as soon as it is proved to be infected. Fortunately the infection does not appear to remain long after the bees are dead: some cases have been recorded in which a swarm was allowed to take possession of a hive soon after the stock previously inhabiting it had died of the disease, and without any steps having been taken to disinfect or even remove the dead bees. In these cases it was found that the swarm remained healthy for a considerable time, thus showing that the infection disappears rapidly after the bees are dead. This may be due to the fact that the *B. pestiformis apis* is a non-spore bearing organism which cannot exist for any length of time except in the digestive tract of the living bee. It is interesting to note that the larvae apparently escape infection, as it would be natural to suppose that the food they receive would be contaminated by the bees which feed them. The explanation of this is probably that the nursing bees are those most recently hatched, and these do not seem to become infected till after they have finished their nursing duties. That the queen escapes infection is probably due to the fact that she receives different food from that which the workers eat; this also explains why the drones usually escape, as they help themselves from the stores which do not seem to harbour the infection.

Since this disease has already spread to the counties which are nearest to the Isle of Wight, there is little room to doubt that it will spread still further, and probably cause great damage to the bee-keeping industry all over the country. It behoves all those who keep bees to be on the look out for the first appearance of the disease in their apiaries, and to destroy any stock which shows signs of infection. By this means alone will it be possible to prevent the disease from spreading to all parts of the country.

As has been already said this complaint seems less virulent than when it originally appeared in the Isle of Wight, and it is to be hoped that this decrease in virulence will be maintained and at the same time that bees will gradually develop their powers of resistance which will enable them to throw off the disease even if they have become infected.

THE FEEDING HABITS OF THE ROOK, *CORVUS FRUGILEGUS*, LINN.[1]

By

WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S.,

Berkhamsted.

CONTENTS.

"*Economic Ornithology, or the study of the inter-relation of birds and agriculture, and an investigation of the foods, habits and plants, is an untrodden and promising field that lies open for investigation by the English agricultural scientist.*"

"*I question whether there exists in England a scientific ornithologist who has studied economic ornithology from an agricultural standpoint.*"

EARL CATHCART, *The Times*, May 16th, 1891.

I.—INTRODUCTION.

1.—*Scope of the Inquiry.*

In September, 1908, I was invited by the Council of the Land Agents' Society to undertake an inquiry upon the feeding habits of the Rook.

Farmers, on many estates, had long complained of serious depredations and consequent losses due to this bird, whilst, on the other hand, its value to the agriculturist was continually being put forward in the agricultural Press.

Not a few members felt that the matter was sufficiently important for the subject of a careful inquiry, for it seemed very

[1] Report to the Council of the Land Agents' Society upon the Feeding Habits of the Rook, by Walter E. Collinge, M.Sc., F.L.S., F.E.S., Honorary Consulting Zoologist of the Society. Presented to the Council, April 1st, 1910.

[JOURN. ECON. BIOL., June, 1910, vol. v, No. 2.]

desirable that some definite decision should be arrived at respecting the economic status of this bird,[1] and further that the conclusions should be based upon information obtained from all parts of England, and extending over a period of at least twelve months.

For some time previous to this invitation I had given considerable attention to the subject of the food of various British birds,[2] and had data for fifty-eight *post-mortem* examinations of the stomach contents of the rook.

Mr. Douglas T. Thring[3] had similar data I found for 141 specimens killed on one estate at intervals of a few days throughout one whole year—1908.

In the present inquiry I have examined 631 stomachs, making a total of 830, the largest number of *post-mortems* of the rook which have ever been put on record in this country.

The object, therefore, of the present report is:—

a.—To set forth in detail an account of the stomach contents of the rooks examined from January 11th, 1909, to January 21st, 1910, from the various counties of England and Wales, and

b.—After considering the evidence offered by these and other specimens mentioned above, to recommend what measures should be taken respecting this bird on the landed estates of this country, in order to safeguard the interests of agriculturists and others.

In carrying out this interesting inquiry I have placed myself under many obligations to a large number of members of the Land Agents' Society, to all of whom I offer my sincere thanks for the very valuable help they have so willingly rendered, and without whose hearty co-operation this inquiry would have been impossible; especially must I mention the name of Mr. Douglas T. Thring.

To the Society's late Secretary, Mr. Cyprian R. Knollys, I wish to express my great thanks for the admirable and speedy manner in which he appointed the forty-five correspondents, and for many other kindnesses rendered during this inquiry.

Finally I desire to express my thanks to my two assistants, Messrs. F. W. Crispe and J. W. Shoebotham, whose loyal co-operation has lightened an otherwise heavy task.

2.—*Area covered by the Inquiry.*

For the purposes of this inquiry, the North, East and West Ridings of Yorkshire, and North and South Wales have each been regarded as counties. The inquiry has therefore extended over

[1] *Vide* letter from Douglas T. Thring, Journ. L. A. Soc. 1908, vol. vii, p. 444.

[2] On the Preservation of Wild Birds. Rpt. Inj. Insects and other Animals for 1905, pp. 45-52.

[3] Journ. L. A. Soc., 1909, vol. viii, p. 351.

forty-one counties of England and Wales, the specimens having been forwarded by forty-five members as set forth below:—

The only counties not represented are those of Derbyshire and Middlesex.

County.	Agent.	Landowner.
Bedfordshire ..	H. G. Papillon ...	Sir Julius Wernher.
Berkshire	W. Crossland ...	Sir Alexander Henderson.
Buckinghamshire ...	C. H. G. Harrison ...	The Earl of Rosebery, K.G.
Cambridgeshire ..	H. J. Garrod ...	The Exors. of Col. McCalmont.
Cheshire	Hon. J. E. Cross ...	Lt.-Col. Hubert C. Leigh.
Cornwall	C. I. L. Allix ..	The Earl of St. Germans.
Cumberland ..	W. Little	
Devonshire... ...	C. Gerald Eve* ..	The Rev. W. Pollexfen Bastard.
Dorsetshire ..	G. Hastings Bostock	Lord Wolverton.
Durham	D. W. Meiklejohn ...	The Marquis of Londonderry, K.G.
Essex	E. A. Ruggles-Brise...	A. W. Ruggles-Brise, Esq.
Gloucestershire ...	G. F. C. Hamilton ...	Hugh Andrews, Esq.
Hampshire	J. E. Thorold ...	Sir George Cooper.
Herefordshire ...	F. W. Herbert ...	General E. H. Clive.
Hertfordshire ...	J. C. McCowan ...	The Marquis of Salisbury.
Huntingdonshire ..	J. Bell	The Duke of Manchester.
Kent	G. A. M. Levett ..	F. D. Brockman, Esq.
Lancashire ..	J. J. Hornby ...	The Earl of Derby, K.G.
Leicestershire ...	Hon. H. R. Scott ...	The Duke of Rutland.
Lincolnshire ..	H. G. Atkinson Clark	The Countess Dowager of Carnarvon.
Norfolk	J. M. Wood ...	The Earl of Leicester.
Northamptonshire ...	Douglas T. Thring ...	The Duke of Buccleuch, K.G.
Northumberland ...	Sir Francis E. Walker	The Duke of Northumberland, K.G.
Nottinghamshire ...	A. E. Elliott ..	The Duke of Newcastle.
Oxfordshire ...	C. A. Wykeham-Martin	W. A. Wykeham-Musgrave, Esq.
Rutlandshire ..	P. C. Chichester ...	The Earl of Gainsborough.
Shropshire	C. H. B. Cane ...	Lord Harlech.
,, ...	H. W. Fell ...	Capt. Heywood-Lonsdale.
Somersetshire ...	C. E. O. Wilkinson ...	George A. Gibbs, Esq.
Staffordshire ...	Walter Marchant ...	The Earl of Bradford.
Suffolk	Cecil S. Joy ...	Sir F. E. S. Adair, Bart.
Surrey	J. F. S. Mellor ...	The Duke of Northumberland, K.G.
Sussex	Lt.-Col. E. J. Mostyn	The Duke of Norfolk, E.M., K.G.

*E. T. Haslehurst, from November 1st.

County.	Agent.	Landowner.
Warwickshire ...	W. W. Hutton ...	Lord Willoughby de Broke.
Westmorland ...	G. Aitchison ...	S. H.-le Fleming, Esq.
Wiltshire	G. H. Aitken ...	The Marquis of Bath.
,, ...	E. A. Rawlence ..	E. F. B. Wingfield Digby, Esq.
Worcestershire ...	W. T. Meyrick ...	E. V. Wheeler, Esq.
Yorkshire, E. Riding	E. W. Thompson ...	Lord Wenlock.
,, N. Riding	F. W. Hall ...	The Marquis of Zetland.
,, W. Riding	L. C. Paget ...	The Earl of Harewood.
Wales, North ...	W. F. Addie ...	The Earl of Powis.
,, ,, ...	G. B. Bovill ...	Mrs. Wynne Finch.
,, South ..	G. Lipscomb ..	Miss Talbot.
,, ,, ...	P. Wilkinson ...	The Earl of Lisburne.

3.—*Specimens Received.*

It was desired that each correspondent should, as far as practicable, forward one bird every fortnight, together with a form of particulars (see Appendix B).

The number of birds actually received was six hundred and thirty-one, as follows:—

County.	Months.						
	Jan.	Feb.	Mar.	Apl.	May	June	July
Bedfordshire	1	1	2	—	3	1	—
Berkshire	—	1	2	2	1	1	2
Buckinghamshire ...	—	2	2	2	2	2	3
Cambridgeshire ...	—	2	2	2	3	—	—
Cheshire	1	—	3	1	2	—	1
Cornwall	—	2	2	2	2	1	2
Cumberland	—	1	2	3	2	2	2
Devonshire	1	2	—	—	—	—	1
Dorsetshire	—	2	2	—	—	—	—
Durham	2	2	2	1	2	2	—
Essex	—	—	2	2	2	2	1
Gloucestershire ..	—	2	2	2	2	—	—
Hampshire	—	2	1	1	1	1	—
Herefordshire	1	1	3	1	1	—	—
Hertfordshire	1	2	2	2	3	2	2
Huntingdonshire ...	—	—	2	2	2	2	—
Kent	—	—	2	—	—	—	—
Lancashire	—	2	2	3	2	—	1
Leicestershire	—	5	—	—	—	—	—
Lincolnshire	—	1	1	1	—	—	—
Norfolk	—	2	2	2	—	1	1
Northamptonshire ...	1	2	2	2	3	2	2
Northumberland ...	—	1	2	1	1	1	2
Nottinghamshire ...	—	2	3	2	2	2	—
Oxfordshire	1	1	3	1	1	—	1
Rutlandshire	1	1	2	1	2	—	1
Shropshire	—	1	4	4	2	3	1
Somersetshire	1	—	—	3	2	1	—
Staffordshire	1	2	2	2	2	—	—
Suffolk	1	2	1	3	2	2	2
Surrey...	2	2	2	2	3	1	1
Sussex	—	1	1	1	—	—	1
Warwickshire	1	1	3	2	2	2	2
Westmorland	—	2	2	2	1	1	2
Wiltshire	—	3	6	4	5	6	5
Worcestershire	—	1	2	3	—	—	—
Yorkshire, E. Riding ...	1	3	2	—	—	—	2
,, N. Riding ...	1	1	1	2	1	1	1
,, W. Riding ...	—	4	1	3	2	2	2
Wales, North	—	2	1	2	1	1	—
,, South	—	4	3	5	1	3	1
No. of Rooks received	18	68	81	74	63	45	42
No. of Counties represented	16	36	38	35	32	25	25

County.	Months.						
	Aug.	Sept.	Oct.	Nov.	Dec.	Jan., 1910.	Total.
Bedfordshire	—	—	—	—	—	—	8
Berkshire	1	1	2	—	2	1	16
Buckinghamshire ...	2	2	2	2	2	—	23
Cambridgeshire ..	—	—	—	1	2	—	12
Cheshire	2	1	2	—	—	—	13
Cornwall	—	1	3	2	3	1	21
Cumberland	2	2	3	2	2	1	24
Devonshire	2	—	1	1	—	—	8
Dorsetshire	—	1	1	—	—	—	6
Durham	3	2	2	3	1	1	23
Essex	1	—	—	—	—	—	10
Gloucestershire	—	—	—	—	—	—	8
Hampshire	—	—	—	—	—	—	6
Herefordshire	—	2	1	1	1	1	13
Hertfordshire	2	2	2	2	2	1	25
Huntingdonshire ...	1	1	1	2	—	—	13
Kent	—	—	—	—	—	—	2
Lancashire	2	2	1	2	1	—	18
Leicestershire	—	—	—	—	—	—	5
Lincolnshire	—	—	—	—	—	—	3
Norfolk	—	—	—	—	2	1	11
Northamptonshire ...	1	3	1	2	—	—	21
Northumberland ...	—	2	—	1	2	1	14
Nottinghamshire ...	1	—	1	1	—	—	14
Oxfordshire	—	3	1	—	—	1	13
Rutlandshire	3	2	1	2	1	—	17
Shropshire	1	2	1	1	1	—	21
Somersetshire	—	—	1	1	—	—	9
Staffordshire	1	1	2	—	—	—	13
Suffolk	2	2	2	1	2	—	22
Surrey	1	1	2	3	4	2	26
Sussex	2	—	1	—	—	—	7
Warwickshire	2	3	2	2	2	2	26
Westmorland	2	2	1	2	—	—	17
Wiltshire	5	2	4	3	3	3	49
Worcestershire	—	1	1	—	—	1	9
Yorkshire, E. Riding ...	2	2	2	2	—	1	17
,, N. Riding ..	1	1	1	1	1	—	13
,, W. Riding ...	1	1	1	1	1	—	19
Wales, North	—	—	—	—	—	—	7
,, South	2	2	2	2	2	2	29
					—		
No. of Rooks received	45	47	48	43	37	20	631
No. of Counties represented	25	27	30	25	20	15	

Of these, three hundred and two were male birds and three hundred and twenty-nine female. The heaviest specimen weighed 21 ounces, the lightest 12 ounces, the average being $15\frac{1}{2}$ ounces.

In eighty-one specimens the gizzards, when opened, were found to be empty, or contained a little grit only.

Without exception, all specimens were examined when fresh. The average time between being shot and dissected was thirty-two hours, in a few cases seventeen, and in two cases three days, due to the birds having fallen out of the boxes in the post, or the label having become detached. One specimen only has been lost in the post, and this occurred during the Christmas week.

As to the increase or otherwise in the different localities, eight members record an increase, eleven a slight decrease, two of which were due to the snowstorm of April 25th and 26th, 1908, when nearly all the young birds were destroyed; and twenty-four state that they have not observed any change in the numbers during the past few years.

The numbers at present in the various districts are commented upon by forty-three members; four of whom report the birds to be very abundant, thirty-four state abundant, and five not abundant.

Out of the forty-five replies only six state that the rooks are regularly shot each spring, but as this information was not definitely asked for, possibly the practice is carried out on other estates.

II.—The Rook in Relation to Agriculture.

1.—*Nature of its Food.*

It has generally been supposed that the food of the rook consists very largely of beetles, insect larvae, and earth-worms. A well-known ornithologist, the Rev. F. O. Morris, presented the following calculation before the "Wild Birds Protection Committee of the House of Commons of 1873": "A rook," he states, "requires at least one pound of food in a week, and of this nine-tenths is insects and worms. A rookery of 10,000 rooks will consume in one year 209 tons of worms, insects, and their larvae."

Saunders[1] states: "The food consists chiefly of insects and their larvae, but practically the rook will eat anything."

Other writers have made similar statements, but without any convincing evidence, so far as I am aware.

The rook, like many other birds, such as the thrush, starling, blackbird, etc., will destroy large numbers of beetles and insect larvae, but, as I have elsewhere pointed out,[2] "there are certain

[1] Illustrated Manual of British Birds, 2nd ed. 1899, p. 248.

[2] On the Preservation of Wild Birds. Rpt. Inj. Insects and other Animals for 1905, p. 45.

species of birds which are distinctly beneficial to the farmer, fruit grower, and gardener, if not allowed to become too numerous, but as soon as their numbers exceed a certain limit they become equally injurious, and cannot be regarded as other than enemies."

The nature of a bird's food must not be judged from a few specimens from one particular district, shot at one particular period of the year. Any conclusion based upon the information such investigations may reveal are sure to be misleading. The collection of this information must extend over a wide area and throughout all the months of the year. Further, great care is necessary in examining the stomach contents.

I need scarcely point out that where there is an unusual increase in a species over a series of years, there is usually a change in the food-habits, and this is nowhere more patent than in the case of the species here under consideration.

2.—*Life-History, Habits, etc.*

Few birds are better known than the rook, partly owing to the fact of its living in flocks, and also that it usually selects for its breeding places a situation close to human habitation.

In some localities it has undoubtedly rapidly increased during the last ten years; this is particularly so in Scotland, where it is said to destroy eggs on a large scale.

During the autumn months there is a large migration from the Continent on our east coast, and a return migration has been noted in the early spring.

The nest is usually built about the middle of March, but in some localities the birds have been observed building both earlier and later. Tall trees are usually selected, but sometimes firs, pollard-willows and even bushes have been chosen, and occasionally chimney-tops and church spires.

The nest consists of twigs and turf, lined with roots and straw. Here the three to five bluish-green eggs, blotched and streaked with olive-brown, are laid.

Breeding commences when the birds are nearly two years old.

III.—Nature of Food during 1908 and 1909.

In the following pages I have briefly summarised the nature of the food under different headings and the different months.

1.—*Vegetable Food.*

Grain.—The bulk of the food taken from the gizzards of the 631 rooks recorded in this report consisted of grain. Wheat and other grain was in the greatest abundance, it occurring in 320 cases.

Other Seeds.—Very few seeds were found amongst the stomach contents. In twelve there were a few seeds of charlock and dock, and in sixteen various species of knot grass, goose grass, etc.; whilst occasionally those of the broad bean occurred. In all, seeds were present in only 39 cases.

Fruits.—Remains of fruit were found in 84 cases; this consisted mainly of acorns, but in a few cases red currants and gooseberries were found.

Roots.—In 36 cases only were roots present, and in 80 per cent. these were grass roots, the remainder being potatoes.

Miscellaneous Vegetable Matter.—Sixty-two gizzards contained miscellaneous vegetable matter not identifiable.

2.—*Animal Food.*

Throughout the whole of this inquiry I have been astonished at the little animal food found in the gizzards, which averages *in the twelve months* only 15 per cent. of the total food contents of the gizzards.

Beetles (*Coleoptera*).—In 116 cases beetles or their larvae were present.

Flies (*Diptera*).—Dipterous larvae occurred in only 6 cases.

Butterflies and Moths (*Lepidoptera*).—In 15 gizzards larvae of Lepidoptera were present.

Aphids, Plant Bugs, etc. (*Hemiptera*).—In only a single case was this order of insects represented.

Other Insects.—Seven gizzards containing bees or wasps.

Millipedes.—These were found in 6 cases.

Other Animal Matter.—In addition to the animal matter found and mentioned above, the bodies of four long-tailed field mice, part of the small intestine of a rat (?), and a young rabbit, and eight young birds, five of which were undoubtedly blackbirds, were found.

In seven gizzards there were bits of egg shell, in five cases these were undoubtedly pheasant eggs, in one a blackbird's, and the remaining one was unidentifiable with certainty, but probably it was that of the pheasant.

Earthworms or their cocoons were present in twenty-seven cases.

Miscellaneous Food.—Pheasant food and household scraps, *e.g.*, bread, potato skins, bacon rind, etc., was present in 15 cases.

To summarise, of the 631 rooks, 70 per cent. of their food consisted of grain, 15 per cent. of seeds, fruits, roots, and miscellaneous vegetable matter; 4 per cent. of wireworms, 4 per cent. of other insects (mostly injurious), 1 per cent. millipedes, 2 per cent. earthworms, and 4 per cent. miscellaneous food. Adding these to the 141

rooks recorded by Mr. Douglas T. Thring, and the fifty-eight specimens previously dissected by myself, the results may be tabulated as follows:—

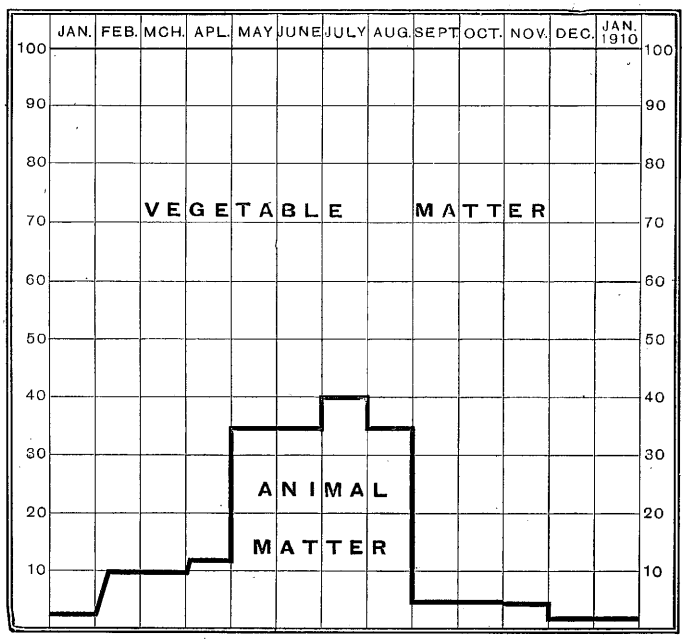
				Total.
No. of Rooks	631	58	141	830
Grain	70	65	53	71%
Seeds, fruits, roots, and miscellaneous vegetable matter ...	15	10		
Wireworms	4	6	30	15%
Other insects	4			
Millipedes	1	1		
Earthworms	2	12	17	10·5%
Miscellaneous Food (eggs, young game, field mice, etc.) ...	4	6		3·5%

3.—*Monthly Register.*

In setting forth the details of the food contents of the gizzard for each month, the variety of vegetable matter is placed in order of the greatest percentage. The percentages (see Table A) have been calculated as regards bulk.

TABLE A.

Month.	No. of Birds	Grain.	Other Seeds.	Fruits.	Roots.	Mcll. Veg. Matter.	INSECTA.					Millipedes.	Other Animal Matter.	Mcll. Food.	Percentage of Vegetable Matter.	Percentage of Animal Matter.	Remarks.
							Coleop.	Diptera.	Lepidop.	Hemiptera.	Other Insects.						
1909.																	
January	18	5	2	11	2	2	5	0	0	0	0	1	5	1	98	2	Very little food in gizzards.
February	68	24	4	21	2	6	7	0	0	0	0	1	7	1	90	10	17 empty. Very little food in gizzards, average about $\frac{1}{3}$rd.
March	81	30	2	15	5	16	1	0	1	0	0	0	6	0	90	10	17 empty. Gizzard average $\frac{1}{2}$ full.
April	74	38	4	5	3	12	7	0	3	0	0	2	9	3	88	12	7 empty. Gizzard generally full.
May	63	24	1	1	1	4	20	3	6	0	4	0	13	2	65	35	12 empty. Gizzard generally full.
June	45	12	6	2	3	3	13	2	2	0	1	1	7	2	65	35	7 empty. Gizzard generally full.
July	42	14	6	0	6	7	20	1	2	1	2	1	10	2	60	40	4 empty. Gizzard generally full.
August	45	27	3	0	3	1	16	0	0	0	0	0	3	4	65	35	7 empty. Gizzard generally full.
September	47	41	0	0	3	0	9	0	0	0	0	0	0	0	95	5	4 empty. Gizzard generally full.
October	48	39	10	0	3	5	10	0	0	0	0	0	3	0	95	5	1 empty. Gizzard generally full.
November	43	33	1	9	3	3	5	0	0	0	0	0	0	0	96	4	1 empty. Gizzard generally full.
December	37	23	0	12	1	3	1	0	1	0	0	0	2	0	99	1	2 empty. About $\frac{3}{4}$ full.
1910.																	
January	20	10	0	8	1	0	2	0	0	0	0	0	0	0	99	1	2 empty. About $\frac{3}{4}$ full.
	631	320	39	84	36	62	116	6	15	1	7	6	65	15	85	15	



January.—The first bird was received on January 16th, and seventeen more came in during the remainder of the month.

Generally speaking, but little food was contained in the gizzard. The contents were as follows:—

Acorns, oats, wheat, grass roots, bits of grass, 2 grains of maize, bits of bread and potatoes.

Part of the body of a bird (blackbird?), 8 wireworms, 2 click beetles, 5 green rose chafers (*Cetonia aurata*, Linn.), 8 black vine weevils (*Otiorhynchus sulcatus*, Fabr.), bits of 2 beetles, 5 earthworms, 7 cocoons of earthworms, bits of 2 centipedes.

Two of the gizzards, containing very little food, were highly inflamed.

February.—Number of birds received, 68. The gizzards of 17 were empty, and the remainder were about one-third full.

The contents were as follows:—

Bits of acorns, wheat, oats, maize, meal, broken seeds, cotton cake, grass roots, bits of potatoes, seeds of grass.

Body of long-tailed field mouse (*Mus sylvaticus*, Linn.).

Remains of 10 beetle larvae, 4 wireworms, 6 click beetles, remains of 8 beetles, 1 spider, 3 millipedes, 2 earthworms, 28 earthworm cocoons, and 1 shell of snail (*Helix hispida*).

March.—Number of birds received, 81. The gizzards of 17 were empty, and the remainder were about half full.

The contents were as follows:—

Acorns, wheats, oats, maize, grass roots, seeds of pheasant food, miscellaneous vegetable matter, bits of raw potato, bread.

One mouse and part of the small intestine of a rat (?)

Remains of 3 beetles, one larva of turnip dart moth (*Agrotis segetum,* Schiff.), 2 earthworms.

April.—Number of birds received, 74. The gizzards of 7 were empty, and the remainder were full.

The contents were as follows:—

Newly sown wheat, oats, grass roots, and miscellaneous vegetable matter.

Part of the small intestine of a young rabbit, bodies of 2 long-tailed field mice (*Mus sylvaticus,* Linn.), bodies of two young birds (blackbirds?), bits of yolk of egg, and egg shells of blackbird.

Remains of 4 beetles, 24 wireworms, 3 larvae of turnip dart moth (*Agrotis segetum,* Schiff.), 4 millipedes (*Polydesmus complanatus,* Linn.), 4 earthworms, and 22 earthworm cocoons.

May.—Number of birds received, 63. The gizzards of 12 were empty, and the remainder generally full.

The contents were as follows:—

Newly-sown wheat and oats.

Bodies of two young blackbirds (probably taken from eggs), parts of bodies of two other small birds. Bits of pheasant eggs found in three birds.

Remains of 20 beetles, 60 wireworms, 2 dor beetles, remains of 13 lepidopterous larvae, 74 larvae of winter moth (*Cheimatobia brumata,* Linn.), 5 larvae of turnip dart moth (*Agrotis segetum,* Schiff.), 1 earwig (*Forficula auricularia,* Linn.), 30 leather jacket grubs, 29 earthworms, remains of two millipedes, 1 bee.

June.—Number of birds received, 45. The gizzards of 7 were empty, and the remainder generally full.

The contents were as follows:—

Peas, potatoes, beans, maize, wheat, grass roots, gooseberries, oats.

13 wireworms, 20 click beetles (*Agriotes lineatus,* Linn.), 2 larvae of cockchafer (*Melolontha vulgaris,* Fabr.), 1 green rose chafer (*Cetonia aurata,* Linn.), 40 dung beetles (*Aphodius fimetarius,* Linn.), remains of 17 black ground beetles (*Pterostichus madidus,* Fabr.), 9 smaller June bugs (*Phyllopertha horticola,* Linn.), 7 June bugs (*Rhizotrogus solstitialis,* Linn.), 17 not identifiable, 139 lepidopterous larvae (mostly *Agrotis* sp.), puparia of 30 blow-flies

(*Calliphora vomitoria,* Linn.), and 4 larvae of same, 66 leather jacket grubs, 2 millipedes (*Julus pulchellus,* Koch), 13 earthworms, egg-shells in 3 birds.

July.—Number of birds received, 42. The gizzards of 4 were empty, and the remainder generally full.

The contents were as follows:—

Peas, potatoes, wheat, turnip plants, seeds, maize, oats, grass roots, miscellaneous vegetable matter.

Bodies of 5 young birds. Egg shells in two birds.

Two cockchafer larvae, 39 click beetles, 4 wireworms, 7 beetles (*Geotrupes* sp.), remains of 18 dung beetles (*Aphodius fimetarius,* Linn.), 12 black ground beetles (*Pterostichus madidus,* Fabr.), 16 not identifiable, 1 beetle larva, 4 lepidopterous larvae, one earwig, one plant bug (*Pentatoma* sp.), one spider, one millipede (*Polydesmus complanatus,* Linn.), 3 earthworms.

August.—Number of birds received, 45. The gizzards of 7 were empty, and the remainder generally full.

The contents were as follows:—

Oats, wheat, peas, miscellaneous vegetable matter.

Body of one young bird and 1 long-tailed field mouse.

Remains of about 200 beetles, probably many more were eaten. The number was arrived at by counting the legs and jaws; it was impossible to identify the species with any certainty. Some were undoubtedly the black ground beetle (*Pterostichus madidus,* Fabr.), but the greater proportion were smaller species and a few *Geotrupes stercorarius.*

September.—Number of birds received, 47. The gizzards of 4 were empty, and the remainder were generally full.

The contents were as follows:—

Wheat, oats, maize, miscellaneous vegetable matter, potatoes.

Beetle remains in 9 gizzards, 4 dung beetles (*Aphodius fimetarius,* Linn.), 14 dor beetles (*Geotrupes* sp.?), 2 black ground beetles (*Pterostichus madidus,* Fabr.), and 1 wireworm.

October.—Number of birds received, 48. The gizzard of 1 was empty, and the remainder were generally full.

The contents were as follows:—

75 per cent. wheat, maize, acorns, grass roots, and miscellaneous vegetable matter.

Remains of 8 beetles in 6 gizzards, 2 green rose chafers (*Cetonia aurata,* Linn.), 2 click beetles, 1 black ground beetle (*Pterostichus madidus,* Fabr.), and 5 earthworms.

November.—Number of birds received, 43. The gizzard of 1 was empty, and the remainder were generally full.

The contents were as follows:—

Wheat, barley, maize, few acorns, miscellaneous vegetable matter, and grass roots.

Remains of beetles in 5 gizzards, viz., 1 dor beetle and remains of 4 others.

December.—Number of birds received, 37. The gizzards of two were empty, and the remainder averaged three-quarters full.

The contents were as follows:—

Wheat, maize, barley, acorns, miscellaneous vegetable matter, and grass roots.

Two dung beetles (*Aphodius fimetarius*, Linn.), and 1 lepidopterous larva.

January, 1910.—Number of birds received, 20. The gizzards of two were empty, and the remainder averaged threequarters full.

The contents were mainly wheat, a few acorns, and grass roots. In two there were remains in each of a single beetle.

IV.—Parasites of the Rook.

In the six hundred and eighty-nine *post mortems* it is somewhat surprising that not a single entozoic parasite was found. Knowing how difficult it sometimes is to detect the presence of certain forms in freshly killed birds, special care was adopted.

The ectozoic parasites were not numerous as regards the number of species. Three species of lice (*Mallophaga*) and two species of mites (*Acarina*) were found.

The former were most plentiful during the months of March, April and May, and were present in lesser numbers throughout the year.

In no case was it noticed that the rooks suffered from these parasites, although in April and May scores of lice were to be found on a single bird.

In addition to the above true parasites, in single cases there were found an Aphid, a Psocid, and a bug (*Homoptera*).

V.—Summary and Conclusion.

The results of this investigation, embracing a consideration of the stomach contents of 830 rooks, shot throughout the years 1908-9, throughout England and Wales, show:—

1. That 67.5 per cent. of the food of the rook consists of grain; if to this we add that of roots and fruits, the percentage is raised to 71 per cent.

2. The animal food content was only 29 per cent., of which quite one-third must be reckoned against the rook.

3. There is ample evidence to show that with the present large number of rooks, a grain diet is preferred.

4. So far as the evidence of this inquiry shows, the rook is not a particularly beneficial bird to the agriculturist, although its usefulness might be considerably increased were it fewer in numbers.

Recommendations.

In writing of the birds that injure grain in the United States of America, Mr. F. E. L. Beal[1] states "If it be admitted that birds do not as a rule display an inordinate appetite for grain, the question naturally arises: What is the cause of the tremendous ravages they sometimes commit? Both stomach examination and field observation point to the same answer: Too many birds of the same or closely allied species are gathered together within a limited area."

No words could be more pertinent than these in respect to the inquiry in hand, in short *we have too many rooks*, indeed one might go further and state that we have *far too many of a number of species* which are distinctly destructive to cereal and root crops, game, etc.

The only recommendation I have to make is to suggest that Land Agents and others should at once proceed to systematically reduce this number and hold it in check.

[1] Year-book of the U.S. Dept. Agric., 1897, p 353.

VII.—APPENDICES.*

APPENDIX A.

THE LAND AGENTS' SOCIETY.

Inquiry *re* the Food of Rooks.

WALTER E. COLLINGE, M.Sc., F.L.S.,
HON. CONSULTING ZOOLOGIST,
BERKHAMSTED.

Senders' Name .....

Address .....

Is the district wooded ? .....

Are the fields bounded by hedges, dykes, or walls ? .....

.....

General character of neighbouring land .....

.....

.....

What crops are grown in the locality ? .....

.....

Is the species abundant in the locality ? .....

.....

Has there been any increase or decrease during the past few years ?

.....

.....

* Through an oversight, I omitted, in the original Report, to acknowledge the source of these Schedules. Permission was very kindly granted me by the Economic Ornithological Committee of the British Association, and I here tender them my grateful thanks.

APPENDIX B.

THE LAND AGENTS' SOCIETY.

Inquiry *re* The Food of Rooks.

WALTER E. COLLINGE, M.Sc., F.L.S.,
HON. CONSULTING ZOOLOGIST, BERKHAMSTED.

PARTICULARS OF SPECIMEN.

Sender's Name.....

Date on which Specimen was killed.....

Hour of the day when killed.....

Exact locality where Specimen was obtained.....

.....

Character of land upon or near which it was shot.....

.....

.....

Is the land well cultivated?.....

.....

.....

What was the bird doing when shot (feeding, flying, etc.).....

.....

Weather.....*Type of Weather prevailing*

Was the Specimen a member of a flock? if so, state the approximate size of the flock

.....

Date and hour of despatch.....

.....

General Remarks.....

Not to be filled up by Correspondent.

Specimen received—Date ..... *Hour* .....

Crop and Gizzard Removed—Date .....

Reference No. ..... *Weight of Bird* .....

By whom received .....

By whom dissected and food tabulated .....

Remarks :—

NOTE.

On the Feeding Habits of the Common Earwig, *Forficula auricularia*, Linn.

On page 2 of Dr. Malcolm Burr's recently published work on the Dermaptera of British India, it is stated that "earwigs are frequently accused of damaging flowers by devouring the petals; has this been proved?"

In the literature on economic entomology there are numerous references to the depredations of these insects, but some notes on recent personal observations may possibly not be without interest.

In the spring of 1908 I had planted against a wall a honeysuckle (*Lonicera periclymenum*), and about the middle of June I noticed that many of the flowers were being destroyed. Upon examination it was found that one or more earwigs were present in each damaged flower, and in order to prove whether or not these insects were the culprits, certain branches on one side of the tree (the right-hand) were coated with a mixture of glue and carbolic, whilst those on the left-hand side were left untouched. By the middle of July not a single undamaged blossom remained on the unprotected side, whilst those on the opposite side were untouched. Further the bark on the left-hand side had been torn away, and the tree thereby greatly damaged.

Specimens collected from the damaged blossoms were killed, and a microscopic examination was made of the stomach contents. No particle of animal matter was found, but amongst the vegetable contents there was distinct evidence that the food had largely consisted of the blossoms of the honeysuckle.

Examples taken from a large red Dahlia give similar results, but here the vegetable matter was distinctly tinged with red.

Specimens examined regularly from June to the end of September gave the following results: from June to the second week in September only vegetable matter was traceable. In the latter part of the month animal matter commenced to appear, whilst in a few unearthed from between rockery stones in October animal matter only was present.

I am fully aware that earwigs frequently hide in flowers without damaging them, but if an undamaged dahlia flower be placed in a closed box with a few earwigs overnight and examined next morning, the nature and extent of the damage these insects commit will be very quickly apparent.

WALTER E. COLLINGE.

REVIEWS.

Boyce, Rubert W.—Health Progress and Administration in the West Indies. Pp. xv + 328, 47 figs. and map. London: John Murray, 1910. Price 10s. 6d.

In the work before us, Prof. Boyce has given an extremely interesting account of the progress of sanitation and sanitary administration in the West Indies. The work, further, will serve, as the author remarks, as a small introduction to the history of yellow fever in the West Indies.

Prof. Boyce commences by giving a short account of the early history of yellow fever in the West Indies, tracing the subject through the eighteenth and nineteenth centuries, together with the old and modern views of the nature and mode of transmission of the disease. After pointing out some of the factors which have made the West Indies healthier, *e.g.*, pipe-borne water supplies and education, he briefly summarizes the more important factors in the war against insect pests, the anti-larval laws of the different islands, and the importance of exercising vigilance over trade routes and shipping.

Turning next to the outbreak of yellow fever in Barbadoes in 1907, the author states that had there been proper medical administration the disease would never have gained a footing. He characterizes the sanitary organization as out-of-date, "ancient and picturesque," "eminently respectable but shabby." The lack of registration of the causes of death, the need of district medical officers of health and the absence of regular sanitary reports, are, it is pointed out, all matters requiring attention, indeed the sanitary administration is tersely, but truly summed up by being described as "barbaric and primitive."

The situation when Prof. Boyce arrived in Barbadoes in March, 1909, is described as undoubtedly disclosing an extraordinary state of affairs—the total lack of a medical head for the colony. He spares neither the Legislative Council nor Government Officials, and if for no other reason his work will be welcomed as a fearless and outspoken condemnation of ignorance and laxity.

The book is well illustrated, and full of interest from cover to cover.

W. E. C.

Burr, Malcolm.—The Fauna of British India, including Ceylon and Burma. Edited by Dr. A. E. Shipley, F.R.S. Dermaptera (Earwigs). Pp. xviii + 217, x plts. and 17 text figs. London: Taylor and Francis, 1910.

Although a somewhat neglected Order, Dr. Burr in his introduction discusses a number of points in connection with the life-history and

structure of the Dermaptera, which cannot fail to arouse a renewed interest.

After reviewing the structure, he briefly discusses the determination of species, development, copulation, oviposition, ova, food, maternal care and geographical distribution. Brief as these scctions are, they are full of interest, and our only regret is that they are not more fully treated of. As the author points out we have yet much to learn respecting the bionomics of this order of insects, and it is to be hoped that the publication before us will incite new observations and contributions.

One hundred and thirty-five species are enumerated for British India, which are classified under 5 families, 14 sub-families and 51 genera; the descriptions are clear and full, and the classification distinctly helpful. As the recognized authority on this order, the author has given us a valuable and an interesting addition to the literature, which will be welcomed by entomologists generally.

W. E. C.

CURRENT LITERATURE.

I.—General Subject.

Ballou, H. A.—Legislation in the West Indies for the Control of Pests and Diseases of Imported Plants. W.I. Bull., 1910, vol. x, pp. 197-234.

Boyce, R., and F. C. Lewis.—The Effect of Mosquito Larvae upon Drinking Water. Ann. Trop. Med. and Paras., 1910, vol. iii, pp. 591-594.

Britton, W. E.—The Official Entomologist and the Farmer. Journ. Econ. Entom., 1910, vol. 3, pp. 12-20.

Colcord, Mabel.—List of Publications of the Bureau of Entomology. U.S. Dept. Agric., Bur. of Entom., Circ. No. 76 rev., 1910, pp. 1-32.

Cotton, E. C.—A Constant Low Temperature Apparatus for Biological Investigations. Journ. Econ. Entom., 1910, vol. 3, pp. 140-145, plts. 6-8, 1 fig.

Felt, E. P.—Control of Flies and other Household Insects. N.Y. State Mus., Bull. 136, 1910, pp. 5-53, 34 figs.

Fiske, W. F.—Superparasitism: An Important Factor in the Natural Control of Insects. Journ. Econ. Entom., 1910, vol. 3, pp. 88-97, 1 fig.

Hewitt, C. Gordon.—Importance of Entomology in the Development of Canada. Evidence of Dr. C. Gordon Hewitt. Ottawa, 1910, pp. 17-54.

Howard, A. and G. L. C.—Studies in Indian Tobaccos. No. 1. The Types of *Nicotiana rustica,* L., Yellow Flowered Tobacco. Mem. Dept. Agric. India, Bot. Ser., 1910, vol. iii, No. 1, pp. 1-58, plts. i-xxv.

Sanderson, E. D.—The Relation of Temperature to the Growth of Insects. Journ. Econ. Entom., 1910, vol. 3, pp. 113-140, 21 figs.

A very interesting and valuable paper.

II.—Anatomy, Physiology, and Development.

Baunacke, W.—Abdominale Sinnesorgane bei *Nepa cinerea.* Zool. Anz., 1910, Bd. xxxv, pp. 484-489, 4 fign.

Becker, E.—Zum Bau der Postantennalorgane der Collembolen. Zeit. f. wiss. Zool., 1910, pp. 327-399, T. xi, xii.

Hoppner, H.—Zur Biologie der Rubusbewohner. II. Die Konkurrenz um die Nistplätze. Zeit. wiss. Insecktenbiol., 1909, Bd. vi, pp. 93-97, 3 fign.

Meisenheimer, J.—Zur Ovarial transplantation bei Schmetterlingen. Zool. Anz., 1910, Bd. xxxv, pp. 446-450, 2 fign.

Regen, J.—Kastration und ihre Folgeerscheinungen bei *Gryllus campestris*, L. Zool. Anz., 1910, Bd. xxxv, pp. 427-432.

Rungius, H.—Über eine Besonderheit des Larvendarmes von *Dytiscus marginalis*. Zool. Anz., 1910, Bd. xxxv, pp. 341-347, 3 fign.

Schmidt, H.—Beitrag zur Biologie der Steinobst-Blattwespe (*Lyda nemoralis*, L.). Zeit. wiss. Insecktenbiol, 1910, Bd. vi, pp. 86-92, 3 fign.

Stevens, N. M.—Note on Reduction in the Maturation of male Eggs in *Aphis*. Biol. Bull., 1910, vol. xviii, pp. 72-75, 5 figs.

III.—General and Systematic Biology, and Geographical Distribution.

Annandale, N.—A minute Hymenopterous Insect from Calcutta. Rec. Ind. Mus., 1909, vol. iii, pp. 299, 300, plt. xxiii.

Berlese, Antonio.—Acari Nuovi. Man. v-vi. Redia, 1910, vol. vi, pp. 199-234, T. xviii-xxi.

Berlese, Antonio.—Lista di nuove specie e nuovi generi di Acari. Ibid., pp. 242-271.

Cameron, P.—Contribution to the Knowledge of the Parasitic Hymenoptera of Argentina. Trans. Amer. Entom. Soc., 1909, vol. xxxv, pp. 419-450, 4 plts.

Cockerell, T. D. A.—Some Bees of the Genus *Augochlora* from the West Indies. Proc. U.S. Nat. Mus., 1910, vol. xxxvii, pp. 489-494.

Cockerell, T. D. A.—New Dipterous Parasite of Bats. Canad. Entom., 1910, p. 59.

Cockerell, T. D. A.—A Link in the Evolution of the Bees. Nature, 1910 (May 12th), pp. 311, 312.

Crawford, D. L.—Thysanoptera of Southern California. II. Pomona Journ. Entom., 1910, vol. ii, pp. 149-152, 1 fig.

Anaphothrips longipennis is described as new.

Crawford, D. L.—Thysanoptera of Mexico and the South. II. Ibid., pp. 153-170, 8 figs.

The following new species are described: *Euthrips cephalicus*, *Dictyothrips reticulata*, *Thrips abdominalis*, *Phloeothrips raptor*, *Liothrips bakeri*, *L. mcconnelli*, *Anthothrips variabilis*, and *Idolothrips angusticeps*.

Graham, W. M.—On new Species of West African *Culicidae*. Ann. Mag. N.H., 1910, vol. v (s. 8), pp. 264-273.

Hitchings, E. F.—The Unprecedented appearance of the Saddled-prominent (*Heterocampa guttivitta*). Journ. Econ. Entom., 1910, vol. 3, pp. 146-148.

Howard, L. O.—The Parasites reared or supposed to have been reared from the eggs of the Gypsy Moth. U.S. Dept. Agric., Bur. of Entom., Tech. Ser., No. 19, pt. i, 1910, pp. 1-12, 7 figs.

Hitherto no native American egg-parasites have ever been reared from the eggs of the Gypsy Moth since its introduction into the United States in the late sixties. The parasites here described were reared from eggs received from Japan, they include *Schedius kuvanae,* gen. et sp. nov., *Tyndarichus navae,* gen. et sp. nov., *Anastatus bifasciatus* (Fonsc.), *Pachyneuron gifuensis,* Ashmead, and *Atoposomoidea ogimae*, gen. et sp. nov.

Kelly, E. O. G.—Studies on the development of *Eupelmus allynii*, French, and *Stictonotus isosomatus,* Riley. Journ. Econ. Entom., 1910, vol. 3, pp. 202-204.

Massalongo, C.—Galle e simili produzioni anormali. Marcellia, 1909, vol. viii, pp. 133-141, 6 figs.

Pantanelli, E.—Un Eriofiide nuovo sull' Olivo. Marcellia, 1909, vol. viii, pp. 142-146, 4 figs.

Silvestri, F.—Contribuzione alla conoscenza dei Miriapodi dell' Uganda. Ann. Mus. Civ. Stor. Nat. Genova, 1910, ser. 3, vol. iv, pp. 457-478, 9 figs.

Silvestri, F.—Descrizioni preliminari di novi generi di Diplopodi. Zool. Anz., 1910, Bd. xxxv, pp. 357-364, 10 figs.

Silvestri, F.—Materiali per una revisione dei Diplopoda Oniscomorpha. Boll. Lab. Zool. R. Sc. Agric. Portici, 1910, vol. iv, pp. 181-220, figs. i-xxii.

Silvestri, F.—Metamorfosi del *Cybocephalus rufifrons,* Reitter, e notizie sui suoi costumi. Ibid., pp. 221-227, figs. i-vi.

Silvestri, F.—Introduzione in Italia d'un Imenottero indiano per combattere la mosca delle arance. Boll. Lab. Zool. R. Sc. Agric. Portici, 1910, vol. iv, pp. 228-245, figs. i-viii.

Silvestri, F.—Contribuzioni alla conoscenza degli insetti dannosi e dei loro sunbionti. I. Galerucella dell'olmo. Ibid., pp. 246-289, figs. i-xxv.

IV.—Agriculture and Horticulture.

Adcock, G. H.—Erinose of the Vine. Journ. Dept. Agric., Victoria, 1910, vol. viii, pp. 203-205, 3 figs.

Ainslie, G. G.—The Larger Corn Stalk-borer (*Diatroea saccharalis*, Fab.). U.S. Dept. Agric., Bur. of Entom., Cir. No. 116, 1910, pp. 1-8, 4 figs.

Bancroft, C. K.—Fungi causing diseases of Cultivated Plants in the West Indies. W.I. Bull., 1910, vol. x, pp. 235-268, 1 plt.

Burgess, A. F.—Some Insecticide Methods used in Combating the Gypsy Moth. Journ. Econ. Entom., 1910, vol. 3, pp. 38-42.

Burgess, A. F.—Notes on *Calosoma frigidum*, Kirby, a native beneficial insect. Journ. Econ. Entom., 1910, vol. 3, pp. 217-222.

Butler, E. J.—The Wilt Disease of Pigeon Pea and the Parasitism of *Neocosmospora vasinfecta*, Smith. Mem. Dept. Agric. India, Bot. Ser., 1910, vol. ii, No. 9, pp. 1-64, plts. i-vi.

Collinge, Walter E.—Collembola as Injurious Insects. Journ. Econ. Entom., 1910, vol. 3, pp. 204, 205.

Cooley, R. A.—Notes on Spraying Experiments for the Oyster Shell Scale in Montana. Journ. Econ. Entom., 1910, vol. 3, pp. 57-64.

Davis, J. J.—Insect Notes from Illinois for 1909. Journ. Econ. Entom., 1910, vol. 3, pp. 180-186, plts. 9-11.

Dean, W. H.—Some notes upon the Life-History and Habits of the Sorghum Midge (*Contarinia* (*Diplosis*) *sorghicola*, Coq.). Journ. Econ. Entom., 1910, vol. 3, pp. 205-207.

Essig, E. O.—The Natural Enemies of the Citrus Mealy Bug. I. Pomona Journ. Entom., 1910, vol. ii, pp. 143-146, 3 figs.

Essig, E. O.—The Genus *Pseudococcus* in California. Ibid., pp. 147, 148, 2 figs.

Felt, E. P.—Observations on the House-Fly. Journ. Econ. Entom., 1910, vol. 3, pp. 24-26.

Felt, E. P.—Spraying for the Codling Moth. Journ. Econ. Entom., 1910, vol. 3, pp. 172-176.

French, Junr., C.—A new Fruit Pest (*Heliothis armigera*, Hubn.). Journ. Vict. Dept. Agric., 1910, vol. viii, pp. 50-52, 1 fig.

Gillette, C. P.—New Sprays for the Codling Moth. Journ. Econ. Entom., 1910, vol. 3, pp. 29-32.

Gillette, C. P.—Some Insecticide Tests for the Destruction of *Aphididae* and their Eggs. Journ. Econ. Entom., 1910, vol. 3, pp. 207-210.

Grossenbacher, J. G.—Crown-rot, Arsenical poisoning and Winter Injury. N.Y. Agric. Exp. Stat., Geneva, N.Y., Tech. Bull. No. 12, 1909, pp. 367-411, 8 plts.

Harding, H. A., and W. J. Morse.—The Bacterial Soft Rots of Certain Vegetables. Pt. I. The Mutual Relationships of the Casual Organisms. N.Y. Agric. Exp. Stat., Geneva, N.Y., Tech. Bull. No. 11, 1909, pp. 251-287.

Headden, W. P.—Arsenical Poisoning of Fruit Trees. Journ. Econ. Entom., 1910, vol. 3, pp. 32-35.

Headlee, T. J.—Notes on the Corn Ear-worm. Journ. Econ. Entom., 1910, vol. 3, pp. 149-157, 4 figs.

Hertzog, P. H.—Notes on "Cigarette Beetle." Journ. Econ. Entom., 1910, vol. 3, pp. 198-202.

Hinds, W. E., and W. F. Turner.—Carbon di-sulphide Fumigation for the Rice Weevil in Corn. Journ. Econ. Entom., 1910, vol. 3, pp. 47-56, plts. 4, 5.

Jack, R. W.—The Potato Tuber Moth. Rhodesian Agric. Journ., 1910, vol. vii, pp. 1110-1114, 1 plt.

Jones, L. R.—The Bacterial Soft Rots of Certain Vegetables. Pt. II. Pectinase, the cytolytic enzyme produced by *Bacillus carotovorus* and certain other Soft-rot Organisms. N.Y. Agric. Exp. Stat., Geneva, N.Y., Tech. Bull. No. 11, 1909, pp. 289-368, 10 figs.

Kirk, T. W., and A. H. Cockayne.—Scale Insects in New Zealand. 17th Ann. Rpt. N.Z. Dept. Agric., 1909, pp. 273-285, 6 figs.

Kirk, T. W., and A. H. Cockayne.—The Pests and Diseases of New Zealand. Phormium. Ibid., pp. 286-289, 9 plts.

Laidlaw, W.—The Onion Eel-worm. Journ. Dept. Agric. Victoria, 1910, vol. viii, pp. 163-171, 5 figs.

Lefroy, H. M., and G. Evans.—Experiments in the Storage of Seed-potatoes. Agric. Journ. Ind., 1910, vol. v, pp. 19-28, plt. i.

Lounsbury, Chas. P.—Miscible Oils for Spraying. Agric. Journ. C. of G.H., 1910, vol. xxxvi, pp. 110-114.

McAlpine, D.—Irish Blight on Tomatoes. Journ. Dept. Agric. Victoria, 1910, vol. viii, pp. 48, 49, 2 figs.

Marcinowski, K.—Parasitisch und semiparasitisch an Pflanzen lebende Nematoden. Arb. Biol. Anst. Land u. Forstwirtsch, 1909, Bd. vii, pp. 1-192, 1 tav, 76 fign.

Norton, J. B. S.—Some Obscure Diseases of Peach. Journ. Econ. Entom., 1910, vol 3, pp. 228-236.

O'Kane, W. C.—Work on the Apple Maggot (*Rhagoletis pomonella,* Walsh.). Journ. Econ. Entom., 1910, vol. 3, pp. 169-172.

Parrott, P. J.—The Cherry Ermine Moth (*Hyponomeuta padella,* L.). Journ. Econ. Entom., 1910, vol. 3, pp. 157-161.

Parrott, P. J.—Concentrated Lime-sulphur mixtures. N.Y. Agric. Exp. Stat., Geneva, N.Y., Bull. No. 320, 1909, pp. 419-438.

Pierce, W. M.—Fumigation Studies. I. Pomona Journ. Entom., vol ii, pp. 139-142, 4 figs.

Rane, F. W.—Present conditions of the Gypsy and Brown Tail Moth Work in the Massachusetts. Journ. Econ. Entom., 1910, vol. 3, pp. 36-38.

Sanderson, E. Dwight.—Controlling the Black Fly in the White Mountains. Journ. Econ. Entom., 1910, vol. 3, pp. 27-29, plts. 2, 3.

Sanderson, E. D.—Insect Notes from New Hampshire for 1909. Journ. Econ. Entom., 1910, vol. 3, pp. 210-212.

Saunders, W.—Report of the Division of Entomology and Botany for the Year ending March 31, 1909. Ann. Rpt. Exp. Farms, 1908-9, Ottawa, 1910, pp. 37-64, 1 plt.

Scott, W. M., and A. L. Quaintance.—Control of the Brown-Rot and Plum Curculio on Peaches. U.S. Dept. Agric., Bur. of Entom., Circ. No. 120, 1901, pp. 1-7.

Severin, H. H. P.—The San Jose Scale and its Relation to Climatic Districts or Life Zones in Wisconsin. Journ. Econ. Entom., 1910, vol. 3, pp. 101-103, 1 fig.

Smith, John B.—*Amara avida,* Say, as a Strawberry Pest. Journ. Econ. Entom., 1910, vol. 3, pp. 97-99, 8 figs.

Smith, John B.—Insects Injurious to Strawberries. Agric. Exp. Stat., New Jersey, Bull. 225, 1909, pp. 1-37, 11 figs.

Smith, Ralph E.—Report of the Plant Pathologist. Agric. Exp. Stat. Berkeley, Cal., Bull. No. 203, 1909, pp. 1-63, 23 figs.

Theobald, Fred. V.—Report on Economic Zoology, for Year ending April 1st, 1909. Pp. 110, 34 plts. Ashford: Headley Brothers, 1910. Price 2s. 6d.

This report is on the lines of those we have previously noticed. No new pests of special interest are reported. There is a short account of the Sheep Nasal Fly, details of a series of trials with nicotine sprayfluids, and experiments on greases and grease-banding.

Not the least valuable portion of the report is the account of a mosquito plague at Woking, and some notes on the British mosquitoes, This includes a list of the British *Culicidae,* a synonymic list, a synoptic table, and notes.

van Slyke, L. L., and others.—A Chemical Study of the Lime-sulphur Wash. N.Y. Agric. Exp. Stat., Geneva, N.Y., Bull. No. 319, 1909, pp. 383-418.

Washburn, F. L.—1. Further Observations on *Empoasca mali*. 2. Notes on *Papaipema nitela* and *P. cataphracta*. Journ. Econ. Entom., 1910, vol. 3, pp. 162-168.

Webster, F. M.—The Clover Root-borer (*Hylastinus obscurus*, Marsham). U.S. Dept. Agric., Bur. of Entom., Circ. No. 119, 1910, pp. 1-5, 4 figs.

Webster, F. M., and G. I. Reeves.—The Western Grass-stem Sawfly (*Cephus occidentalis*, Riley and Marlatt). U.S. Dept. Agric., Bur. of Entom., Circ. No. 117, 1910, pp. 1-6, 1 fig.

V.—Forestry.

Borthwick, A. W.—A New Disease of *Picea*. Notes R. Bot. Gard. Edin., No. xx, 1909, pp. 259-261, plt. l.

Dr. Borthwick describes under the name of *Curcurbitaria piceae*, n.sp., a fungus which was found attacking *Picea pungens* in Perthshire.

Borthwick, A. W.—Frost Canker of *Picea sitchensis* (Trantv. et Mey.) the Menzies Spruce. Ibid., pp. 263-265, plt. li.

Borthwick, A. W.—Abnormal Branch of *Prunus avium*. Ibid., pp. 267-269, plt. lii.

Thought to be due to some fungus; it evidently belongs to the same category of diseases as Witches' Brooms.

Forbes, A. C.—The Economic Importance of *Scolytidae* in Irish Forestry. Irish Nat., 1910, vol. xix, pp. 89-91, plt. 2.

Jones, W. S.—Pathological Secretory Cavities in Wood. Q. Journ. Fores., 1910, vol. iv, pp. 106-113, 9 figs.

Stebbing, E. P.—The Blue Pine "Polygraphus" Bark Borer (*Polygraphus major*, Steb.). For. Zool. Ser., Leaflet, No. 5, 1910, pp. 1-7, 6 figs.

Stebbing, E. P.—The Larger Deodar Bark Borer (*Scolytus major*, Steb.). For. Zool. Ser., Leaflet No. 4, 1909, pp. 1-12, 9 figs.

VI.—Fisheries.

VII.—Medicine and Human Parasites.

Webster, F. M.—A Predaceous Mite proves noxious to Man. (*Pediculoides ventricosus*, Newport.). U.S. Dept. Agric., Bur. of Entom., Circ. No. 118, 1910, pp. 1-24, 13 figs.

VIII.—Animal Diseases, etc.

Beuhne, R.—A Disease affecting European and Victorian Bees. Journ. Dept. Agric. Victoria, 1910, vol. viii, pp. 62-64.

Bevan, L. E. W.—Interim Report on the Animal Trypanosomiases of Southern Rhodesia. Rhodesian Agric. Journ., 1910, vol. vii, pp. 1029-1081, 2 plts.

Breinl, A., and E. Hindle.—Observations on the Life-history of *Trypanosoma lewisi* in the Rat Louse (*Haematopinus spinulosus*). Ann. Trop. Med. and Paras., 1910, vol. iii, pp. 553-564, plts. xix, xx.

Dixon, R. W.—East Coast Fever. Agric. Journ. C. of G.H., 1910, vol. xxxvi, pp. 19-26.

Gaiger, S. H.—A Preliminary Check List of the Parasites of Indian Domesticated Animals. Journ. Trop. Vet. Sci., 1910, vol. v, pp. 65-71.

Gilruth, J. A.—Diseases of Canaries. 17th Ann. Rpt. N.Z. Dept. Agric., 1909, pp. 298-300.

Holmes, J. D. E.—The Treatment of Surra in Horses by means of Arsenic and its Derivatives. Journ. Trop. Vet. Sci., 1910, vol. v, pp. 1-45, 30 figs.

Jowett, W.—Note on an Intestinal Parasite of the Ostrich. Agric. Journ. C. of G.H., 1910, vol. xxxvi, pp. 60-63, 6 figs.

Leese, A. S.—Summary of First Series of Experiments on treatment of Surra in Camels. Journ. Trop. Vet. Sci., 1910, vol. v, pp. 57-64.

Leese, A. S.—Filariae in Vitreous Chamber of the Eye of a Camel—Ophthalmia. Ibid., pp. 89-92, 2 figs.

Marlatt, C. L.—The Horn Fly (*Haematobia serrata,* Rob.-Desv.). U.S. Dept. Agric., Bur. of Entom., Circ. No. 115, 1910, pp. 1-13, 6 figs.

Price, C. A. E.—Examination of Bees for Bacterial Disease. Journ. Dept. Agric. Victoria, 1910, vol. viii, pp. 58-62, 2 figs.

Robertson, W.—Notes on Some Diseases of the Ostrich. Agric. Journ. C. of G.H., 1910, vol. xxxvi, pp. 34-41, 4 figs.

THE

JOURNAL OF ECONOMIC BIOLOGY.

ON THE PLACE OF ECONOMIC ZOOLOGY IN A MODERN UNIVERSITY.*

By

SYDNEY J. HICKSON, F.R.S.,

Professor of Zoology in the Victoria University of Manchester.

THE time has come when it is necessary for us to consider very carefully the position of Economic Biology, not only in relation to the State, but also in relation to the Universities. I think it may be said that some of our influential men, and some of our public bodies, are beginning to realise that the scientific study of Zoology and of Botany possesses something more than a purely academic interest, and that when applied to certain problems that affect the public health and some branches of our national industries, it has yielded practical economic results. The Universities, on the other hand, are beginning to realize that the investigation of problems which have some bearing upon industry and public health is of importance in the development of their Schools of Biology, and it is not inconsistent with the maintenance of high scientific ideals.

There is undoubtedly a growing demand for the services of men qualified to deal with the problems of Economic Biology, and it appears to me it is the duty of the Universities to provide a course of instruction and training specially adapted for that small class of students who are prepared to make the study of these problems their work in life. There may be many differences of opinion as to the best way to educate a young man who wishes to devote his life to Economic Zoology or Botany, and to gain his living professionally by the exercise of his skill and knowledge of these subjects; but there can be no manner of question that the economic biologist of to-day requires a wider and more profound training than was expected of him in the past.

* Read before the Association of Economic Biologists, Manchester Meeting, July 7th, 1910.

[JOURN. ECON. BIOL., Oct., 1910, vol. v, No. 3.]

Let us consider then, in the first place, the kind of training that might reasonably be expected of a man who is a candidate for a post as a teacher of Economic Zoology, or who is seeking to obtain a position as an adviser to a colony or to an agricultural company possessed of large estates in any part of the world, on the animal pests of the crops.

Not so very long ago, and to some extent to-day, the type of man who was considered to be best qualified for a post of this description was the man who is called "a good field entomologist," and it was thought that if he possessed a detailed acquaintance with the principal insect pests of agricultural crops, a general knowledge of theoretical and practical zoology was unnecessary. The student who had passed through the usual University course of studies and taken a degree with Honours in Zoology was regarded as a "Laboratory man," and of very little practical utility.

A good practical acquaintance with agricultural entomology is, and always must be, the important weapon in the hands of the Economic Zoologist, but he needs more than that if he wishes to deal successfully with the problems of his profession. He needs a general acquaintance with the principles of zoology, a practical knowledge of the methods used in a zoological laboratory, and the means of obtaining information about the progress of zoological research in the branches of the science that are of special interest to him.

It is not perhaps necessary for the student to have a very detailed knowledge of all the classes of the animal kingdom, and it is possible that the pressure of time would necessitate the omission of some groups of animals from the curriculum, but his knowledge of zoology should be sufficient to enable him to follow without difficulty lectures on Parasitism, Parthenogenesis, Heredity, and Embryology in which illustrative examples from any group of animals are used.

The special groups that a student should study are the Protozoa, the parasitic worms, the fresh water and terrestrial Mollusca, and particularly the tracheate Arthropoda, and I should regard it as of special importance that he should have a full course of practical work in the dissection of Arthropoda, and in the methods of microscopic investigation.

Such a course of study as I have sketched is one that could be given in the zoological departments of the principal Universities of our country without very much additional equipment, or a very material addition to the numbers of the teaching staff.

But in order that the student may have the opportunity of getting

some training in the recognition of insect pests in the field, the work of the laboratory should be supplemented by some systematic teaching in connection with an institution of the nature of an agricultural college, in which access to growing crops may be facilitated.

Whatever steps may be taken to provide for the training of economic zoologists by the Universities, it is quite clear that they cannot expect to be able to complete their education in a three years' course. If a given University is able to give them facilities for the study of agricultural pests, it will probably be unable to provide them with the pests of forests, and still more unlikely that it will be able to afford them much practical experience of the pests of tropical produce plants, such as the cotton plant, the sugar cane, the rubber trees, or the tea and coffee plants.

The education of an economic zoologist will not be finished until the end of his life-time. Wherever he may go, and whatever problem or set of problems he undertakes to investigate, he will find facts and conditions that are new to him, however thorough his preliminary education may have been. When he leaves his University or College, therefore, he must go on learning, and it is of the utmost importance that the training he receives before he goes out into the world should be of such a character as to render his post-graduate education as easy and rapid as possible. It is for this reason that I believe that the knowledge and training of the man who is known as a good field entomologist, valuable and indeed essential as they are, are not sufficient for the practical economic zoologist. He must have, in addition, a thorough scientific training similar to that of the University Honours student in one of the Biological subjects.

I do not suggest that the ordinary courses by which University students are trained for a degree in Science with Honours in Zoology, are, by any means the best that can be designed for the economic zoologists. It seems to me that the Universities have exhibited a tendency to underrate and depreciate the tastes and accomplishments of the young field naturalists, who enter upon their courses as students of zoology. Too frequently such students have had no opportunity in the final examinations of showing that kind of knowledge they have acquired before they came up to the University, and have widened and deepened, by their own private study, during the years they have spent in the University. The type of student that should be encouraged to pursue the study of economic zoology is the one that, whether by his observations of the life and habits of wild animals, or by his zeal as a collector of some group of insects,

has shown some ability as a field naturalist. Opportunities should be given to him to enlarge the scope of his favourite pursuits, and care should be taken that credit is given to him for his special knowledge in the final examination. I do not believe that a good field naturalist, like a good poet, must be born and cannot be made. I do not despair of making a good field naturalist of a clever boy, who has had no previous experience of field work, provided that he comes to me with a decided taste for scientific pursuits, some powers of observation and a determination to conquer difficulties. Nor on the other hand do I assume that a boy who has proved his abilities as a field naturalist is necessarily going to turn out a good economic zoologist. But, having got into the laboratory, students who for one reason or another show promise of good work, there are two features in their training which in my opinion are essential for the successful pursuit of economic work. One year should be almost entirely devoted to the special study of the structure and life-history of Insects. In the ordinary course of University studies, this will be the third or final year. Some opportunity should then be given to him to devote at least one year to the pursuit of some piece of post-graduate work of the nature of an original investigation under the guidance of his teachers, in order that he may learn the methods of research and the way to overcome technical difficulties.

It will probably be found that the greatest difficulty will arise in the provision for this last year of post-graduate study, for when a man has taken his degree he is himself naturally anxious to begin to earn his own living, or he finds, only too frequently, that the money that has been provided for his education is exhausted, and some paid appointment is a necessity. To help us out of this difficulty I think we might appeal to the public authorities for some substantial assistance.

There can be no doubt, I imagine, in the minds of any of those who have come into contact with the many questions of Economic Biology, that there is a great and increasing demand for the services of young men with special knowledge of these subjects, and that there is even a greater difficulty in finding properly qualified young men to fill the posts that are offered.

There are very few professions in which it can be said that the demand is greater than the supply, and yet it is true that in the profession of economic zoologists, there are not at the present time nearly enough qualified men to do the work that is required. It is true that the profession does not offer many very highly paid posts, and that for many years the young professional man will have to be

content with a very modest stipend, but I believe there are better times in store, and that when the public begin to appreciate better than they do at present, the immense commercial importance of the scientific treatment of household and agricultural pests both at home in the colonies, the remuneration of the more experienced and skilled men in the profession will be considerably improved. It is not without very careful consideration that I have ventured to express my opinion upon this point, for I feel that a very heavy responsibility rests upon those who are in a position to offer advice to young people at the age when their career must be determined, and I could not recommend to anyone (unless endowed with private means), a course of study and training which does not lead to a career of remunerated work.

At the present time there is admittedly a difficulty in all the Universities in getting students to devote their time to the study of Economic Zoology. We all know that the ignorance of the average Englishman of the facts and principles of zoology is profound, and it will be a long time before the general public is convinced that they can have any useful application. It is no wonder therefore that the parents hesitate before embarking their sons upon a career about which they know nothing and care less.

But nevertheless the public services demand the labour of men with a special training in Economic Zoology, and it is in the public interest that the supply of duly qualified men should be assured.

It is for this reason that I feel that an appeal for financial assistance for young men of ability who have embarked upon a recognized course of study, but are unable, without such assistance, to complete the fourth year of post-graduate work, is desirable. It is not my purpose to discuss in this paper the important questions of the opportune time and manner of making this appeal, I only wish to point out to you what appears to me the weak link in the chain of our educational system as regards the study of economic zoology, and to suggest that it should be strengthened.

It is of very little use for the public to spend money upon the scientific investigation of the pests of farm crops, of the insects that attack forest trees, and upon subjects of a similar kind unless the services of properly-trained persons can be secured. At the present day there is undoubtedly a shortage of such persons, and consequently the first step must be to endeavour to bring the supply up to the level of the demand, and for this there is a pressing need of financial help. It is possible that this financial help will be necessary only for a limited number of years. If it be proved, as I think

it will be, that there is a career for clever and industrious young men in Economic Zoology, students will be attracted to the University, who are in a position to take the full four years course without public assistance. It is also probable that in some of the Universities fellowships and scholarships may be endowed for the special purpose of the encouragement of agricultural research, and it may reasonably be expected that some of these may be available for the fourth year student in Economic Zoology. It is very unlikely that, at any time, the number of students in a single University will be a very large one, and it is certainly not desirable that the ranks should be overcrowded. The demand, therefore, for additional financial assistance need never be more than a very moderate one, but I am convinced that it must be made if the country is to be provided with the services of the minimum number of professional men that it obviously needs.

The relation of the modern University to the subject of Economic Zoology appears to me to be in the first place that of the Institution that provides the professional training of professional men. It may not be able to provide the whole of the training in this subject any more than a University can provide the whole of the training that is necessary for a medical man. There must be the same kind of association or co-operation between the University and some agricultural college in the neighbourhood as there is between the University and the hospital. But it is to the University that we must look for the systematic organisation of the courses of study, for the conduct of the examinations, and for the award of diplomas and degrees.

But the question arises whether this should be the only relation between the University and the subject. Should the staff of the University, in addition to their functions as the teachers of students, undertake the duties of consultants and advisers on questions of economic zoology that may arise in connection with the industries of the surrounding country. At the present time the members of the staff of the Manchester University and of the Manchester Museum are frequently consulted about the animal pests that appear in the farms, gardens, warehouses, and factories of the surrounding district, and, so far as possible, the pests are identified and suggestions are made as to the best means of combating the trouble.

In the initial stages of a School of Economic Biology there is an obvious advantage in the conduct of this branch of work. It enables the University and its Museum to complete their collections of the more frequent pests of the district, and it gives the University staff information as to the localities in which certain pests may be

most successfully searched for if they are wanted at any time for original investigation.

But I do not regard the "general practice" of Economic Biology, if I may use an expression borrowed from the medical profession, as strictly the function of a University. Such practice should be in the hands of specially qualified individuals appointed by the public authorities or of a department of the public institutions, which are specially concerned with agriculture and the public health.

The position of the University should be that of the consultant rather than that of the practitioner. In the economic laboratories or in the museum associated with the University, there should be a collection, as complete as possible, of specimens of economic importance both British and foreign. This collection should be consulted by the local practitioners when anything rare or unusual makes its appearance. The University should also be the seat of a library of Economic Biology as complete as possible in standard works and periodicals, and this library should be open to consultation by those engaged in economic work. But lastly, the University should have a small staff of teachers and a number of post-graduate scholars actively engaged in special investigations, and from them information should be procurable as to the latest and most efficient methods of investigation and treatment.

It will probably be some years before the Manchester University will be free from the self-imposed duty of making free identifications and giving free advice to all comers, but the burden of this duty is increasing year by year, and threatens in the near future to interfere to a material extent with what we may regard as the more legitimate functions of the University, the teaching of students, and the prosecution of original investigation.

In the preceding remarks I have referred to the subject of Economic Zoology as one that deals mainly with the animal pests of the farm, of the cattle yard, of the forests, and of human habitations, but there is another branch of the subject which I believe to be a very important one, and one that demands some words of reference in this paper. The great municipal corporations of this country are now engaged in two great enterprises: The provision of a good water supply and the disposal of sewage. Both of these enterprises involve problems of Economic Biology.

The main source of the water supply is usually some great lake or a series of artificial reservoirs in a distant mountainous country, and the water is conducted by closed pipes, many miles in length, to local reservoirs that feed the supply pipes. Chemical and

bacteriological analyses of the water are made, and, speaking generally, the supply is efficient and satisfactory. But from time to time various troubles arise which may give rise to what are called water-scares, such as the unpleasant smell in the water at Burnley in 1895, caused by *Limnaea peregra,* and the water-scare at Edinburgh in 1906. These troubles are in nearly all cases caused by different forms of animal life, sponges, polyzoa, molluscs, and crustacea. But so far as my information goes there has not yet been made any systematic biological analysis on a great scale of the sources of the water supply. There have, it is true, been some short papers published on the fauna and flora of the lakes, but a systematic and intensive study of the nature and periodicities of the plankton is still wanting, and until this is done we are not in a position to deal very satisfactorily with the biological difficulties which confront the water engineers. We meet with similar, but different problems, in connection with the disposal of sewage. In the outflow waters various species of animals are found—fresh-water mussels, leeches, worms, crustacea and protozoa. Some of these, such as the so-called sewage fungus—a species of *Epistylis*—are of considerable importance, and require careful investigation by competent and properly-trained biologists. But at the present time these problems are left in the hands of the chemists and bacteriologists, and very little progress is made towards their solution.

I should like to see the problems of animal and vegetable life in the sewage outflow of large towns the subject of an elaborate investigation, because there is every reason to believe that the result would be of great economic importance.

The investigation of these problems should be submitted to men who have had suitable training in Biology, and such men deserve as well as any other the designation of Economic Biologists. But for such men the training required should be on somewhat different lines to that provided for the Economic Biologists who deal with agricultural and public health problems. They need a special training in the methods of plankton research and a more detailed knowledge of such groups of animals as the fresh-water Protozoa and Algae, the Mollusca and Entomostraca. Such a training can only be given in the Universities working in conjunction with such an institution as the Sutton Broad laboratory, at present the only fresh-water biological station in the country.

A great many years may elapse before this branch of Economic Zoology will be duly recognized, and it would not be fair to encourage a student to take up this particular study with any hope

of obtaining permanent employment as an expert. But I believe the time will come when the services of such men will be required, and it might be well if the University teachers would bear this line of economic work in mind when they make their recommendations for special study or research to their students. Having sketched out in this paper a scheme for the teaching of Economic Zoology in the Universities, a word may now be said about the teaching of Economic Botany. The problem appears to me to be a very similar one in the two subjects. The subjects studied in the first year should be the same for the botanists as for the zoologists. In the second year, in addition to a full course in Botany, it is desirable that at least a short course on systematic zoology should be taken. As regards the details of the course in the third year I do not pretend to speak with authority, but I presume that special classes in vegetable Physiology and in the morphology of the Fungi will be necessary. The same need for some financial assistance to enable students to spend at least one post-graduate year in research will be felt in the botanical as in the zoological departments.

I hope it will not be long before courses of study for Economic Biologists, such as I have drawn up, are offered by several of the English Universities, and that they will meet with some small but encouraging success. When this is done we may trust that the sciences included in the term Economic Biology will make rapid progress in this country, and that a more scientific and better organized system for dealing with animal and vegetable pests will be found.

PRELIMINARY STUDIES ON THE BIOLOGY OF THE BEDBUG, *CIMEX LECTULARIUS*, LINN.

I. The Effect of Quantitatively Controlled Food-supply on Development.

By

A. ARSÈNE GIRAULT,

University of Illinois.

Introduction.

Quantitative studies on an insect of this kind made by an individual must necessarily be limited because of the time and care required to carry them on. The following studies, the first of which are included in the present paper, are designed to be carried on over a series of successive years, in order to make known as much as possible the actual biological facts in its life-history, and further to serve as an aid to those investigators who may desire to study the insect purely from the standpoint of its pathogenic relations. The bedbug is an exceedingly easy insect to rear; artificial laboratory conditions are more or less similar to its natural habitat, and its adaptability, hardiness, and longevity make it very pliable to the will of the experimenter.

As these studies are made at odd hours, subject to interruption, no excuse is needed for any shortcomings which they may have.

Purpose.

The purpose of the studies included in the present paper is to show how an approximately quantitatively controlled food-supply affects the rate of development. Two distinct generations were reared to maturity on human blood, each being divided into an experiment lot and a control lot. Both lots were fed at the same time, with this difference, the individuals of the control lot to repletion, but those of the experiment lot allowed to take approximately but one-half the blood for engorgement (satisfaction), always being interrupted at this point and not allowed food again until the next meal. The experiment consisted, therefore, primarily of disturbance before engorgement or repletion; in other words, the individuals of the experiment were not allowed to glut themselves as they naturally do, and as those in the control lot did, and hence it is to be inferred that the needs of the animals for food was not satisfied. This inference is borne out by the results.

[Journ. Econ. Biol., Oct., 1910, vol. v, No. 3.]

Laboratory Methods.

(*a*) *Method of Feeding; Conditions of the Experiment.*

As experience has shown that the individuals of this species vary considerably in regard to their capacity for food and in regard to the time taken for engorgement, it was found impracticable to control the quantity of food by using mechanical standards, so that engorgement, or satisfaction, was taken as the index of the optimum supply, and the food given to the individuals of the experiment was regulated accordingly. The individuals of the experiment were allowed to feed until swollen with blood, but in every instance were interrupted before engorgement or before the bug left the food of its own free will; and usually at approximately the half-way point. Normally, in all stages, the bedbug at any single meal feeds to repletion; during the meal, however, it has seemingly reached its capacity in about half the time actually required for satisfaction or repletion; that is, if the individual requires six minutes for repletion, the body is much more swollen and seemingly unable to hold more after about three minutes; but the bug continues to suck in more food and to expand until the longer period is completed. It was my aim at each meal, in the case of the individuals of the experiment, to prohibit feeding after this period of apparent capacity had been reached.

(*b*) *Apparatus Used; Procedure.*

All of the individuals used in this experiment, immediately after birth, were confined separately in small glass vials (37 mm. long, 9 mm. wide) stopped with cotton, and each containing a narrow strip of paper containing the number of the insect, and as well affording a support for it. The vials were placed within a tight, screw-capped tin cylinder (8.7 cm. long, 3.5 cm. wide), where they were constantly kept, excepting during the short periods of feeding. All of the animals were therefore in a similar environment, subjected to the same degrees of temperature, the same intensity of light, the same moisture content, and so on. This being true, all factors save those of the experiment, may be ignored.

In feeding the bugs, the vials were taken from the cylinder, and laid side by side on a table; the individuals of the control lot were then fed successively, followed similarly by those of the experiment; the vials were then returned to the cylinder. Each bug was fed singly by giving it access to a portion of the skin along the lower fore arm, usually accomplished by removing the cotton plug and placing the mouth of the vial against the skin, at the same time

inverting it; in this way, the narrow strip of paper in the vial afforded a support to the bug, which after response to the stimulus, simply ran down the inclined plane and inserted the setae into the skin.

It was the aim to feed the nymphs of the single generations at different periods of time, usually following ecdysis, but this was not regularly adhered to, from necessity.

Results of the Experiment.

The following table (Table I.) shows the differential of development in a generation of ten individuals, the progeny of a partly fed female bug captured in a state-room of a river steamboat, *en route* from Cincinnati, Ohio, to Louisville, Kentucky. The female was captured at 11.30 p.m., August 7th, 1907, and was immediately confined in an ordinary physician's pill-box and left there unfed. She died on August 26th after depositing the ten eggs which gave rise to this generation. The nymphs were confined, as previously stated, and kept at usual house temperatures for the season of the year. This generation was at first kept in the field laboratory of the Bureau of Entomology at New Richmond, Ohio, were later removed to a room in a hotel at that place, and on November 18th, 1907, they were transferred to Washington, D.C.; on December 27th to Chicago, Illinois, and on January 1st, 1908, to Urbana, Illinois. During these trips, and a few shorter ones, they were for brief intervals exposed to natural temperatures, being carried in a suit case. The tight tin tube in which the confining vials were kept, made this method of transportation without danger of infesting one's personal effects, pullman cars, hotels, and so on.

In this generation Lot I. was the control lot, Lot II. that of the experiment.

In Table II. the differential development of a generation of two (2) individuals of *lectularius* is shown. This generation, consisting of the control lot of four individuals, originated from an adult of a second bred generation from the original female parent of the generation recorded in Table I. Hence, it represents a third inbred generation which hatched from the four eggs at the average time of 8.15 p.m., April 21st, 1908. The recently born nymphs were immediately confined, as were the previous ones, and given their first meal just about twenty-four hours later. In this generation the actual time for each meal is recorded in addition to the other factors involved.

TABLE I.

Effect of Quantitatively controlled food-supply on the rate of development in a generation of 5 individuals of Cimex lectularius, Linn.
Lot I. = Control. Lot II. = Experiment. Ten (10) individuals, hatching August 27th, 1907, noon.

Lot. 1. Control; food-supply optimum and normal.

Stadium No.	No. 1. ♀ f.				No. 2. ♀				No. 3. ♂				No. 4. ♀				No. 5. – –				Ecdysis No.
	Moults	Meals	Days	Hours	Moults	Meals	Days	Hours	Moults	Meals	Days	Hours	Moults	Meals	Days	Hours	Moults	Meals	Days	Hours	
First.	7 a.m. Sep. 2	4 p m. Aug. 28 a.*	5	19	10 p.m. Sep 8	4 p.m. Aug. 28 3 p.m. Sep. 1 3 p.m. Sep. 3	12	10	8 p.m. Sep. 4	4 p.m. Aug. 28 a. a.	8	8	6 a.m. Sep. 2	4 p.m. Aug. 28 a.	5	18		4 p.m. Aug. 28 b.			1
Second.	Noon, Sep. 10	3 p.m. Sep. 3 a.	8	5	4 p.m. Sep. 17	8 p.m. Sep. 12	8	18	4 p.m. Sep 10	10 a m. Sep. 5 8 p.m. Sep. 6	5	20	8 p.m. Sep.10	3 p.m. Sep. 3 8 p.m. Sep. 6	8	14					2
Third.	4 p.m. Sep. 20	8 p.m. Sep. 12 9 p.m. Sep. 17	10	4	3 p.m. Sep. 22	9 p.m. Sep. 17 a.	4	23	6 p.m. Sep. 21	8 p.m. Sep. 12 9 p.m. Sep. 17	11	2	5 p.m. Sep. 17	8 p.m. Sep. 12	6	21					3
Fourth.	2 p.m. Oct. 1	8 p.m. Sep. 21 3 p.m. Sep. 23 a.	10	22	6 a.m. Oct. 4	3 p.m. Sep. 23 3 p.m. Sep. 26 a.	11	15	4 p.m. Oct. 3	a. 3 p.m. Sep. 23 3 p.m Sep. 26 a.	11	22	7 a.m. Sep 23	9 p.m Sep. 17 a.	5	14					4
Fifth.	Noon, Oct. 30	3 p.m. Oct. 2 3 p.m. Oct. 4 a. a. a. a.	28	22	5 p.m. Nov. 19	a. 8 p.m. Oct. 8 a. a. 8 p.m. Oct. 23 10 p.m Nov. 1	46	11	4 p.m. Nov. 9	3 p.m Oct. 4 8 p.m. Oct 8 a. 4 p.m. Oct. 17 8 p.m. Oct. 23 a.	37	0	6 p.m. Oct. 23	a.(5 p.m. Sep. 24) a. 3 p.m. Oct. 2 a. a. a. a.	30	11					5
Adult.		Length – 4.5 mm.				Length – 5.0 mm.				Length – 4.5.				Len'h – 4.35 mm.							6
Sums:	5	8	64	—	5	10	84	5	5	11	74	4	5	6	57	6					

Avg. Duration Cycles:	69.9 days
,, No. Meals:	8.75 ,,
,, No. Ecdyses:	5.

* See foot notes.

Lot II. Experiment; food-supply below optimum and abnormal.

Stadium No.	No. 1 – ♂. Moults	Meals	Days	Hours	No. 2. – – Moults	Meals	Days	Hours	No. 3 – ♀ Moults	Meals	Days	Hours	No. 4 – ♀ Moults	Meals	Days	Hours	No 5. – ♂ Moults	Meals	Days	Hours	Ecdysis No.
First.	11 p.m. Sep. 8	4-30 p.m. Aug. 28 3 p.m. Sep. 1 4 p.m. Sep. 3 a.	12	11	11 p.m. Sep. 7	4-30 p.m. Aug. 28 3 p.m. Sep. 1 3 p.m. Sep. 3 a.	11	11	10 p.m. Sep. 7	4-30 p.m. Aug. 28 3 p.m. Sep. 1 3 p.m. Sep. 3 a.	11	10	10 p.m. Sep. 7	4-30 p.m. Aug. 28 3 p.m. Sep. 1 3 p.m. Sep. 3 a.	11	10	7 a.m. Sep. 2	4-30 p.m. Aug. 28 a.	5	19	1
Second.	9 p.m. Sep. 30	8 p.m. Sep. 12 9 p.m. Sep. 17 8 p.m. Sep. 21 3 p.m. Sep. 23 a.	21	22	7 a.m. Sep. 22	8 p.m. Sep 12 9 p.m. Sep. 17 a.	14	8	4 p.m. Sep. 30	8 p.m. Sep. 12 9 p.m. Sep. 17 8 p.m Sep. 21 3 p.m. Sep. 23 a.	22	18	7 a.m. Oct. 1	8 p m. Sep. 12 9 p.m. Sep. 17 8 p.m. Sep. 21 3 p.m. Sep. 23 a.	23	9	5 a.m Sep. 18	3 p.m. Sep. 3 8 p.m. Sep. 6 8 p.m. Sep. 12 a.	15	22	2
Third.	9 p.m. Nov. 1	3 p.m. Oct. 2 3 p.m. Oct. 4 8 p.m. Oct. 8 3 p.m. Oct. 10 4 p.m. Oct. 17 a.	32	0		3 p.m. Sep. 23 3 p.m. Sep. 26 3 p.m. Oct. 2 3 p.m. Oct. 4 8 p.m. Oct. 8 3 p.m. Oct. 10 a. 8 p.m. Oct. 23 a 11 a.m. Nov. 24 c a. a. d.			11 a.m. Nov. 15	3 p.m. Oct. 2 3 p.m. Oct. 4 8 p m. Oct. 8 3 p.m. Oct. 10 4 p.m. Oct. 17 8 p.m. Oct. 23 10 p.m. Nov. 1	45	19	2 p.m. Nov. 4.	3 p.m. Oct. 2 a. 8 p.m. Oct. 8 3 p.m. Oct. 10 4 p.m. Oct. 17 8 p.m. Oct. 23 10 p.m. Nov. 1	34	7	Noon, Oct. 3	9 a.m. Sep. 18 3 p.m. Sep. 23 3 p.m. Sep. 26 a.	15	7	3
Fourth.	7 p.m. Dec. 18	a (10 p.m. Nov. 1) 11 a.m. Nov. 12 11 a.m. Nov. 24 Noon, Dec. 1 4 p.m. Dec. 8 a.	46	22					Noon, Dec. 26	11 a.m. Nov. 24 Noon, Dec 1 a. 4 p.m. Dec. 15 ad.	41	1	7 p.m. Dec. 10	11 a.m. Nov. 24 Noon, Dec. 1 a.	36	5	3 p.m. Dec. 4	8 p.m. Oct. 8 3 p.m. Oct. 10 4 p.m. Oct. 17 8 p.m. Oct. 23 10 p.m. Nov. 1 11 a.m. Nov 24 a.	62	3	4
Fifth.	9 p.m. Jan. 9 (1908).	11 p.m. Dec 22 3 p m. Dec. 29 a.	22	2					6 p.m. Jan. 17 (1908).	3 p.m. Dec. 29 8 a m. Jan 9, 1908 10 a.m. Jan. 12	22	6	11 a.m. Jan. 7	4 p.m. Dec. 15 11 p.m Dec. 22 3 p.m. Dec. 29	27	16	7 p m Jan. 9 (1908).	4 p.m. Dec. 8 4 p.m. Dec. 15 11 p.m. Dec. 22 3 p.m. Dec. 29 a.	36	4	5
Adult.		Length – 3.7 mm.								Length – 4.0 mm.			11 p.m. Jan. 16	8 a.m. Jan 9, 1908 10 a.m. Jan. 12 e. Len'h – 4.20 mm.	9	12		Length – 4.0 mm.			6
Sums:	5	18	135	9					5	20	143	6	6	20	142	11	5	17	135	7	

Avg. Duration Cycles:	139.09 days
,, No. Meals:	18.75
,, No. Ecdyses:	5.25

a. Refused food at the time designated for the meal.
b. Died August 30, 1907.
c. Very pale before this meal.
d. Refused to feed; accidentally killed. Very small, pale and thin; in warm room. (Dec. 15, 1907).
ad. Refused: timid.
e. An additional stadium.
f. The sex determinations were made by direct observation when possible, confirmed by the secondary characters in the female, noticeable in the figures of some authors, but particularly noticed and discussed by Ribaga (1897).

TABLE II.

Effect of Quantitatively controlled food-supply on the rate of development in a generation of 2 individuals of Cimex lectularius, Linn. Four (4) individuals hatching at the average time of 8 p.m., April 21st, 1908.

Stadium No.	Lot No. I.—Optimum. No. 1 – ♂ Moults	Days	Hours	Meals: Time of b.	Meals: Duration, minutes.	No. 2 – ♂ Moults	Days	Hours	Meals: Time of b.	Meals: Duration, minutes.	Lot No. II.—Half-supply or below Optimum. No. 1 – ♂ Moults	Days	Hours	Meals: Time of b.	Meals: Duration, minutes.	No. 2 – ♂ Moults	Days	Hours	Meals: Time of b.	Meals: Duration, minutes.	Ecdysis No.
First.	1 p.m. Apr. 26	4	17	8:33 p m Apr 22 a.	4	4 p.m. Apr. 26	4	20	8:33 p.m. Apr. 22 a (9.30 p.m. Ap. 25)	5	8 a.m. Apr. 27	5	12	8:33 p m. Apr. 22 a	1½	11 p.m. Apr. 26	5	3	8:33 p.m. Apr. 22 a.	1½	1
Second.	7 a.m. May 3	6	18	8:55 p.m. Apr. 27	4¾	10 p.m. May 3	7	6	9:05 p.m. Apr. 27	3½	May 10. e	13	0	9:15 p.m. Apr. 27 9:10 p.m May 4	2 3¾	May 10 e	14	0	9:10 p.m. Apr. 27 9:05 p.m. May 4	1½ 2½	2
Third.	May 10, e	7	0	8:45 p.m. May 4	9½	May 10, e	7	0	8:50 p.m. May 4	6½	9 a.m. June 28	49	1	10 p m. May 27 11:05 p m June 22 f.	3½ 4	Noon June 2	22	13	10:10 p.m. May 27	4	3
Fourth.	11 a.m. June 4	25	4	9:40 p.m. May 27	8½	7 p.m. June 3	23	21	10:20 p.m May 27	40 c	10 p.m. July 19	21	13	10:22 p.m July 4 10:06 p m. July 15	3½ 3	11 30 a.m. June 30	27	23½	10:45 p.m. June 22 g.	4½	4
Fifth.	8 p.m. June 30	26	9	11 p.m. June 22	9¾	2.40 p.m. June 30	26	19¾	10:30 p.m. June 22	20 d	Aug. 15	27	0	10:03 p.m July 22 9:43 p.m. Aug. 9	3¼ 6½	1 p.m. July 21	21	1½	10:22 p.m. July 4 9:57 p.m. July 15	3½ 3	5
Sixth.																Aug. 17	27	0	9:55 p.m. July 22 9:50 p.m. Aug. 9	3 3	6
Adult.																					
Sums:	5	70		5	36.5	5	69	18.75	5	75	5	116	2	9	31	6	117	17	9	26.5	
Averages		14		1	7.3		13.95		1	15		23.2		1.8	3.4		19.6		1.5	2.9	

Average No. of Ecdyses:		5	5.5.
,,	Duration of Cycles:	69.87 days	116.9 days
,,	No. number of meals per lot:	5.	9.
,,	Length, mm.:	4.4	3.87
,,	Total time of actual feeding, minutes:	38.75	28 75

a. Refused food at the time designated for the meal.
b. Average time for combined lots.
c. Twenty-six minutes for various insertions before and during the meal; 14 minutes of actual feeding. Weak, having difficulty in taking food.
d. Ei[illegible]t (8) minutes for various insertions of the setae.
e. N[illegible]bserved; average time.
f. Le[illegible]th, June 30th—2 mm.
g. Le[illegible]th, June 30th—2.1 mm.

INTERPRETATION OF THE RESULTS.

Primarily, it is obvious from the tables that the individuals of the experiment did not obtain enough nourishment, from the amount of food allowed them, to develop at a normal rate; in other words, for normal development, the insect requires to feed to repletion. Furthermore, it is shown that if glutted or fed to repletion once in each stadium, normal development occurs, though the insect will take additional meals in any one stadium after an interval of several days. After the individuals of the experiment came to maturity, some of them were fed to repletion and mated, and reproduction occurred normally with them. The reduced quantity of food, therefore, did not affect reproduction or sex, but lengthened the cycle indefinitely, reduced their size, and increased the average number of ecdyses. The most noticeable effect produced was the lengthening of the cycle. It is well to record here the fact that adult males feed as do the females, but are not as strongly stimulated when exposed to a host, and are more cautious in approaching it after response to the stimulus.

LITERATURE REFERRED TO.

Ribaga, Constantino.—Sopra un organo particolare delle Cimici dei letti (*Cimex lectularius*, L.) Revista di Patologia Vegetale, Portici, 1897, v, pp. 343-352, pl. xvi, figs. 1-3, text-figs 1-4. Separate, Portici, May, 1897.

SOME REMARKS ON THE PARASITES OF THE LARGE LARCH SAWFLY, *NEMATUS ERICHSONII.**

By

JOSEPH MANGAN, M.A., F.R.C.Sc.I.,

Department of Economic Zoology, the University, Manchester.

THE serious nature of the attacks of *Nematus erichsonii* in the Lake District are now well known, and although it is not practicable to efficiently control the pest outside the plantations of young larches, yet, owing to the work of Dr. Hewitt, it is known that its natural enemies render great services; the small field vole destroying quantities in the cocoons during winter, and various species of birds devouring the larvae on the trees in summer. The efforts to attract these useful birds to the district which are being carried out on the Thirlmere estate by the Manchester Corporation, are meeting with increasing success, half the boxes being occupied during the last summer. Some 280 nest-boxes are now suspended in these woods.

It is evident that a more or less complete destruction of the larches such as has taken place in certain extensive plantations will become general throughout the affected areas if the parasitic enemies of the Sawfly fail to increase to such an extent as to be able to cope with the attack. By far the most important parasite of *Nematus erichsonii* as yet recorded in this country is the ichneumon *Mesoleius aulicus,* Grav. In 1908 this species was present in hardly 6 per cent. of the Sawfly cocoons collected from various plantations in the Lake district, but in 1909 this proportion had increased to 15 per cent. During the present summer the number of these ichneumons had increased beyond all anticipations, some 62 per cent. of the cocoons from the same areas being parasitized. This ichneumon has been previously recorded as parasitising *Nematus croceus,* a Sawfly feeding upon the willow. It is impossible to at all accurately determine the number of larvae parasitized by a single ichneumon, but in the ovaries of individuals kept in captivity there were usually some thirty, and in cases as many as forty, mature eggs. About .3 per cent. of the cocoons furnished specimens of the ichneumon *Microcryptus labralis* this year. It was thought that this species was a hyper-parasite of *Mesoleius aulicus,* but, as it was present to the extent of some 16 for every 1,000 of the

* Read before the Association of Economic Biologists, Manchester Meeting, July 7th, 1910.

[JOURN. ECON. BIOL., Oct., 1910, vol. v, No. 3.]

latter during 1909, and only to the extent of 5 for every 1,000 during the present summer, this is unlikely. Another species of ichneumon was discovered this year emerging from two per cent. of the cocoons. It is possible that this is a hyper-parasite, though from the fact that *Mesoleius aulicus* transforms within the stout cocoon of *Nematus erichsonii,* and underneath the turf, it is not so liable to suffer from such. This species can be readily distinguished from *Mesoleius aulicus* by the white colour of the first and second coxae, and the dark tint of the third. With a lens it is seen that the face in the female is marked with white, and that in the male the white marking present in both species is broader than in *M. aulicus*. The base of the antennae in both sexes is tinged with white in front. The eggs evidently take some time to ripen, but some hundred eggs seemed capable of reaching maturity in the ovaries of this species. A specimen of still another species of ichneumon, with white bands in the middle of the antennae, was observed to emerge from the cocoons.

Complete investigations of the behaviour of the parasites of insect pests during periods of abnormal multiplication of their hosts are wanting, and the relative value of the several factors concerned in the checking of the undue extension of harmful species is usually a matter of conjecture. Notwithstanding this, such facts as are available allow of some conclusions being drawn from the observations made upon the parasites of the Larch Sawfly. The observations of Dr. L. O. Howard upon the white marked Tussock Moth, furnish an instance of the extreme thoroughness with which the parasites of a tree feeding caterpillar may be capable of doing their work. By the end of August, 1895, the caterpillars of this Tussock Moth had defoliated almost every poplar, soft maple, box elder, elm, alder, birch, and willow in the City of Washington, but the ichneumon and chalcid parasites had by this time so increased that they had parasitized 90 per cent. of the larvae. The eggs of the surviving moths hibernated, and the caterpillars of the first brood were parasitized to the extent of 98 per cent. In June it was a very difficult matter to get living individuals for rearing experiments. Hyper-parasites exerted an appreciable effect upon the parasites of the late brood, the larvae of the moth being in consequence a little less difficult to obtain than in June.

It was not to be expected that the parasites of the Larch Sawfly would increase in such rapid fashion and to the extent that was observed in the case of this Tussock Moth; nevertheless, it is reassuring to find that such an effective parasite as *Mesoleius aulicus* exists, and from the large percentage of cocoons parasitized it is extremely

likely that a perceptible lessening in the severity of the attack will be experienced this summer in the Thirlmere plantations. Moreover, owing to the fact that this ichneumon pupates beneath the turf within the cocoon of the Large Larch Sawfly, it is not so exposed to the attacks of hyper-parasites as in the case of the parasites of the white-marked Tussock Moth, and hence its effectiveness is not likely to be diminished by such agency.

That the small field vole, the birds, the fungus parasite, and the other insect parasites seriously check the multiplication of *Mesoleius aulicus,* wherever the proportion of larvae parasitized by the latter is considerable, is quite possible, but the results of such interference must be clearly distinguished from the effects of hyper-parasitism. The activity of the hyper-parasite leads to a direct reduction in numbers of its parasitic host. Primary parasites and the various natural enemies may, by constantly involving one another in mutual destruction, lower the efficiency of each separate factor concerned in checking the pest, but their combined activities will always produce a higher mortality than could result from the unhampered efforts of any single species, so that as a general rule it is advisable to encourage as far as practicable all the primary parasites and natural enemies. Although it is too much to look forward to more than a partial and perhaps inconsiderable alleviation of the severity of the Larch Sawfly attack during the present summer, yet it can be anticipated with much confidence that during next season the larches in the vicinity of Thirlmere will present a very much more favourable aspect than during the past few years.[1]

A Tachinid which was observed to emerge from the cocoons this season proved to be *Exorista dubia.* The fungus *Cordyceps,* sp., seemed to be slightly more prevalent, this year accounting perhaps for some 10 to 15 per cent. of the larvae.

The parthenogenetic origin of the vast majority of the Sawfly larvae was again evident as hardly more than .2 per cent. of the Sawflies emerged were males.

[1] A thorough inspection of the larch plantations at Thirlmere, during August of the present year, revealed a most marked improvement in the condition of the trees. The brown aspect of the older woods, such a conspicuous feature in previous years, was not at all in evidence, and even in young and unsprayed plantations it was very exceptional to meet with completely defoliated trees. That the greatly diminished numbers of the Larch Sawfly are not to be attributed to meteorological conditions is perhaps demonstrated by the fact that at Grasmere, only some five miles to the South, the larches, conspicuously attacked for the first time last year, are this summer as brown as possible. There can be little doubt but that *Mesoleius aulicus* is the chief, if perhaps not the only factor, in this diminution, and it now remains to be seen to what extent it will exert its controlling power in subsequent seasons.—[J. M.].

THE APTERYGOTA OF HERTFORDSHIRE.

By

WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S.,

AND

JOHN W. SHOEBOTHAM, N.D.A.

With Figures 1-15.

Introduction.

The number of papers dealing with the distribution of the Apterygota of the British Isles are very few, indeed, apart from a comprehensive account of the Collembola and Thysanura of the Edinburgh district by Carpenter and Evans (20), and a preliminary list of those of the Midland Plateau by one of us (25), no one has dealt with our British species in any detail since the publication of Lubbock's Monograph thirty-seven years ago.

Our object in issuing the present communication is to place in the hands of entomologists a record of our work on the Apterygota of Hertfordshire, a county rich in these interesting insects, and to give short descriptions of the chief specific characters as an aid to identification, together with figures of the leading structural characters of some of the species.

Carpenter and Evans (20) enumerate 4 species of Thysanura and 59 species of Collembola; in the present paper 4 species of Thysanura and 69 species of Collembola are recorded.

Previous Records of Apterygota from Hertfordshire.

So far as we are aware, there were no records of Apterygota from the county of Hertfordshire till we commenced our work on them.

We give a list of the species we have recorded up till now (left hand column), together with the names under which they are recorded in this paper (right hand column).

Curiously enough the first two papers were both published on the same day (April 23rd, 1909).

[Journ. Econ. Biol., Oct., 1910, vol. v, No. 3.]

Collinge and Shoebotham (26).

Sminthurus biflavopunctatus	...	Sminthurinus fenestratus.
Sminthurus aureus ...	...	Sminthurinus aureus.

Shoebotham (67).

Collembola.

Anura muscorum ...	...	Neanura muscorum.
Entomobrya albocincta ...	...	Entomobrya albocincta.
Isotoma palustris ...	...	Isotomurus palustris.
Isotoma viridis	...	Isotoma viridis.
Lepidocyrtus cyaneus ...	...	Lepidocyrtus cyaneus.
Orchesella cincta ...	...	Orchesella cincta.
Orchesella villosa ...	...	Orchesella villosa.
Tomocerus vulgaris ...	...	Tomocerus vulgaris.
Sminthurus aquaticus ...	...	Sminthurides aquaticus.

Thysanura.

Campodea staphylinus ...	...	Campodea staphylinus.
Lepisma saccharina ...	...	Lepisma saccharina.

Collinge and Shoebotham (27).

Amerus normani	...	Megalothorax minimus.
Neelus murinus	...	Neelus murinus.

Collinge and Shoebotham (28).

Pseudachorutes subcrassus	...	Pseudachorutes subcrassus.
Achorutes neglectus ...	...	Achorutes manubrialis var. neglecta.
Isotoma binoculata ...	...	Folsomia quadrioculata var. diplophthalma.
Isotoma minor	...	Isotoma minor.
Neelus murinus	...	Neelus murinus.
Sinella höfti	...	Sinella höfti.
Sinella curviseta	...	Sinella curviseta.
Lepidocyrtus sexoculatus ...	...	Lepidocyrtus sexoculatus.
Pseudosinella alba ...	...	Lepidocyrtus albus.

Economic Importance.

Although this paper is entirely of a systematic nature, it must not be forgotten that certain of the Collembola are injurious to farm and garden crops. The economic aspect has recently been treated of by Carpenter (19), and Collinge (22, 24). Professor Carpenter (19, p. 15), says :—

"No worker at applied science should be discouraged from the study of any branch of knowledge because it seems to have no direct bearing on economic work. The systematic study of Collembola would have been regarded as waste of time by the severely practical man a few years ago. But he cannot afford to neglect it any longer."

Our thanks are due to Professor F. Silvestri and Dr. Carl Börner for assistance and kind criticism.

To the Council of the Birmingham Natural History and Philosophical Society we are indebted for the loan of figures 6, 7, 9, 10, and to Miss O. B. Bagnall and Mr. E. Popple for specimens of Apterygota. Miss Bagnall has collected Collembola and Thysanura from Kimpton, near Welwyn, and all specimens recorded from that locality were taken by her. Mr. Popple has collected three of the species of Thysanura.

Except for the above, all the specimens here recorded have been collected by us, chiefly in Berkhamsted or close to the town.

Sub-Class APTERYGOTA, Oudemans.
Order THYSANURA, Latr, Lubb.

Family CAMPODEADAE, Lubb.
Genus **Campodea,** Westwood.

In examining our specimens of the genus *Campodea,* we noticed two types, differing in the length and hairing of the cercopods, and thought that possibly they represented separate species. Prof. Silvestri, to whom we submitted specimens, thought there were probably two species, but could not say for certain owing to the small number and broken condition of the specimens.

1.—**Campodea staphylinus,** Westw.

Hab.—Berkhamsted, in greenhouse (E. Popple); in garden soil.

2.—**Campodea,** sp.

Hab.—Berkhamsted, in greenhouse; under stones.

Family LEPISMIDAE, Grassi.
Genus **Lepisma,** Linn.

3.—**Lepisma saccharina,** Linn.

Hab.—Berkhamsted, in pantry (1); in greenhouse (1) (E. Popple); in kitchen cupboard (common); Kimpton, Welwyn, in kitchen (2).

Family MACHILIDAE, Grassi.

Genus **Praemachilis**, Grassi.

4.—**Praemachilis italica** (Cor.), Silv.

? = *Praemachilis hibernica*, Carpenter.

Prof. Silvestri, who identified this species, is of opinion that it is identical with Carpenter's *P. hibernica*.

Hab.—Great Gaddesden, under a stone (1) (E. Popple); Berkhamsted, under a dry piece of wood (1).

Order COLLEMBOLA, Lubb.

Collembola, Lubbock, Notes on the Thys., pt. IV, 1870, p. 295.
Collembola, Lubbock, Monograph, 1873, p. 36.

Sub-order **Arthropleona**, Börn.

Arthropleona, Börner, Vorläuf. Mitth, über ein. neue Aphor., 1901, p. 5.
Arthropleona, Börner, Apterygoten-Fauna von Bremen, 1901, p. 12.

Family ACHORUTIDAE, Börn.

Achorutidæ, Börner, Vorläuf. Mitth. über einige neue Aphor. u. zur Syst. d. Coll., 1901, p. 12.

Sub-family **Podurinae**, Börn.

Podurinae, Börner, Das Syst. d. Coll., 1906, p. 160.

Genus **Podura**, Linn., Tullb.

Podura, Linné, Syst. Nat., Ed. II, 1740, p. 62.*
Podura, Tullberg, Fört. öfver Sv. Pod., 1871, p. 153.

1.—**Podura aquatica**, L., Nic.

Podura aquatica, Linné, Syst. Nat., Ed. X, 1758, p. 609.*
Podura aquatica, Nicolet, Rech. p. serv. à l'hist. d. Pod., 1842, p. 55.

Eyes, 8 on each side of the head. Upper claw long and slender, with 1 small inner tooth, without lateral teeth. Lower claw absent or rudimentary. Anal horns absent. Furcula long, reaching past the ventral tube. Dentes bow-shaped. Colour, back blackish, legs, antennae, and underside with a reddish tinge.

Hab.—Berkhamsted, on watercress beds (few); Waterend, on water of mill-pool (fairly common).

Sub-family **Achorutinae**, Börn.

Achorutini, Börner, Apterygoten-Fauna v. Bremen, 1901, p. 26.
Hypogastrurinae, Börner, Das Syst. d. Coll., 1906, p. 160.

* The * denotes that the reference has not been seen, but taken from other authors.

Genus **Achorutes**, Templ., Lubb.

Achorutes, Templeton, Thys. Hib., 1834, p. 96.
Achorutes, Lubbock, Notes on the Thys. pt. II, 1862, p. 591.

2.—**Achorutes viaticus** (Linn.), Tullb.

Podura viatica, Linné, Fauna Suecica, Ed. I, 1746, p. 343.*
? *Achorutes dubius*, Templeton, Thys. Hib., 1834, p. 96.
Achorutes murorum, Tullberg, Skand. Pod. underf. Lipur., 1869, p. 7.
Achorutes viaticus, Tullberg, Sver. Pod., 1872, p. 50.
? *Achorutes dubius*, Lubbock, Monograph, 1873, p. 178.
Achorutes murorum, Lubbock, Monograph, 1873, p. 182.

Eyes, 8 on each side of the head. Upper claw with an inner tooth a little beyond the middle (as in *purpurescens*), with a lateral tooth on each side near the distal end. Lower claw bristlelike, reaching to the tooth on the upper claw, with an inner lamella about half its length. All the legs with 3 clavate hairs. Anal horns more slender than in *purpurescens*, lightly curved, longer than the papillae on which they stand. Papillae separated at the base. Mucro with a broad, toothed lamella. Colour deep blue-black.

Hab.—Berkhamsted, about a rubbish heap where decaying Mangels had been thrown, amongst crevices in soil, and on water that had drained away (extremely common, being present in thousands); on garden footpath (common).

3.—**Achorutes purpurescens**, Lubb.

Achorutes purpurescens, Lubbock, Notes on the Thys., part III, 1868, p. 302.*
Achorutes purpurescens, Lubbock, Monograph, 1873, p. 181.

Eyes, 8 on each side of the head. Upper claw with strong inner tooth a little past the middle, with a lateral tooth on each side near the base. Lower claw bristlelike, reaching to the tooth on the upper claw, with broad inner lamella half its length. Front tibio-tarsus

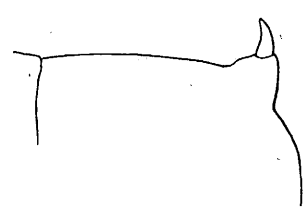


FIG. 1.—*Achorutes purpurescens*, Lubb. Abd. vi, from the side, showing anal horn.

with two, middle and hind with three clavate hairs. Anal horns thick, lightly curved, shorter than the papillae on which they stand. Papillae touching at the base.

Mucro with very narrow inner lamella, and a little broader outer lamella, two-thirds the length of the mucro. Colour dark purple, pigment mottled.

Hab.—Berkhamsted, common in greenhouse on flower-pots, underside of a fungus, under bricks and wood in a garden, and on water in a tank.

4.—**Achorutes armatus** (Nic.).

Podura armata, Nicolet, Rech. p.s. à l'hist. d. Pod., 1842, p. 57.

Eyes, 8 on each side of the head. Upper claw with 1 inner tooth about the middle and 1 lateral tooth on each side near the base. Lower claw bristlelike with fairly broad inner lamella. Tibio-tarsus with 1 clavate hair, the end of which is only very slightly thickened. Dentes tapering. Mucro with large, toothed outer lamella. Anal horns long, slightly curved. Anal papillae touching at their bases.

Hab.—Berkhamsted, under sticks in a wood (common); under flower-pots in greenhouse (few); underside of a fungus (common); under bricks in a garden (few).

5.—**Achorutes rufescens** (Nic.).

Podura rufescens, Nicolet, Rech. p.s. à l'hist. d. Pod., 1842, p. 57.

Eyes, 8 on each side of the head. Upper claw with a weak inner tooth. Lower claw bristlelike, one-third as long as the upper claw, with an inner lamella in the basal half. Tibio-tarsus with 1 clavate hair. Dens broader at the distal than the proximal end. Anal horns 2, short, almost straight. Colour reddish.

Hab.—Berkhamsted, on water in a cart rut (few).

6.—**Achorutes manubrialis,** Tullb.

Achorutes manubrialis, Tullberg, Skand. Pod. underf. Lip., 1869, p. 9.
Achorutes schötti, Reuter, Apt. Fenn., 1895, p. 31.
Achorutes manubrialis, Schött, Étud. s.l. Coll. d. Nord. 1902, p. 9.
Achorutes manubrialis, Ågren, Zur. Kennt. d. Apt. Sud-Schwed., 1903, p. 122.

Eyes, 8 on each side of the head. Upper claw with 1 inner tooth a little beyond the middle. Lower claw bristlelike, without lamella, reaching to the tooth on the upper claw. Tibio-tarsus with 1 clavate hair. Manubrium equal in length to the dens and mucro together. Dens twice as long as the mucro. Anal horns, 2, short, straight. Anal papillae separated. Colour reddish or dark blue.

Hab.—Berkhamsted, on water in a cart rut (4).

var. **neglecta,** Börn.

Anal horns and papillae absent.

Hab.—Berkhamsted, amongst short grass and on water in a cart rut (few).

Genus **Xenylla**, Tullb.

Xenylla, Tullberg, Skand. Pod. underf. Lip., 1869, p. 11.

7.—**Xenylla grisea**, Axels.

Xenylla grisea, Axelson, Vorläuf. Mitth. über ein. neue Coll. aus Finnland, 1900, p. 4.

Body slender. Eyes, 5 on each side of the head. Upper claw without inner teeth. Tibio-tarsus with 2 clavate hairs. Dens and mucro fused together. Mucrodens a little shorter than the manubrium but longer than the foot claw, with hooked end. Anal horns 2, fairly long, curved, standing on large papillae, which are separated at their bases. Colour, pale blue grey.

Hab.—Berkhamsted, under bark of rotting oak stick (fairly common); under bark of fence post (common).

This is the first record for this country.

Sub-family **Onychiurinae**, Börn.

Onychiurinae, Börner, Neue Coll. u. z. Nomen. d. Coll., 1901, p. 698.
Onychiurinae, Börner, Das Syst. d. Coll., 1906, p. 159.

Genus **Onychiurus**, Gerv., Börn.

Lipura, Burmeister, Hand. der Ent., 1838, p. 447.*
Onychiurus, Gervais, Écho du Monde savant, 1841.*
Onychiurus, Börner, Neue Coll. u. z. Nomen. d. Coll., 1901, p. 698.

8.—**Onychiurus fimetarius** (Linn., Lubb.).

Podura fimetaria, Linné, Syst. Nat., Ed. XII, 1766.*
Lipura inermis, Tullberg, Skand. Pod. underf. Lip., 1869, p. 18.
Lipura fimetaria, Lubbock, Monograph, 1873, p. 191.
Lipura wrightii, Carpenter, Coll. of Mitch. Cave, 1897, p. 230.

Eyes absent. Pseudocelli of the *armata* type. (Börner, 6, p. 20). Antennal base with 2 pseudocelli and 1 just outside the Ant. base. Hind edge of the head with 2 on each side. Postantennal organ with 14-16 circular granular tubercles. Upper claw without inner or lateral teeth. Lower claw bristlelike reaching to, or past, the end of the upper claw. Anal horns and papillae absent. End of Abd. VI. rounded.

Hab.—Berkhamsted, in cellar under flower-pots (few); on water in cistern (few); under board and flower-pots in greenhouse (fairly common); in loose soil (few).

9.—**Onychiurus ambulans** (Linn., Tullb.).

Podura ambulans, Linné, Syst. Nat., Ed. X, 1758, p. 609.*
Lipura ambulans, Tullberg, Skand. Pod. underf. Lipur., 1869, p. 17.
Lipura ambulans, Lubbock, Monograph, 1873, p. 189.

Eyes absent. Pseudocelli of the *armata* type (see Börner, 6, p. 20), 2 on each antennal base and 1 just outside the antennal base, hind edge of the head with 2 on each side. Postantennal organ of 12-14 circular granular tubercles. Upper claw without inner or lateral teeth. Lower claw bristlelike, reaching to the end of the upper. Colour white.

Hab.—Berkhamsted, under flower-pots in a cellar (few); amongst decaying leaves (few); under flower-pots in greenhouses (common); Kimpton, Welwyn, in greenhouse (common).

10.—**Onychiurus armatus** (Tullb.).

Lipura armata, Tullberg, Skand. Pod. underf. Lipur , 1869, p. 18.

Eyes absent. Antennal base with 3 pseudocelli, hind edge of the head with 3-4 on each side. Postantennal organ with smooth oval tubercles, generally 22-32, but some have more than this.

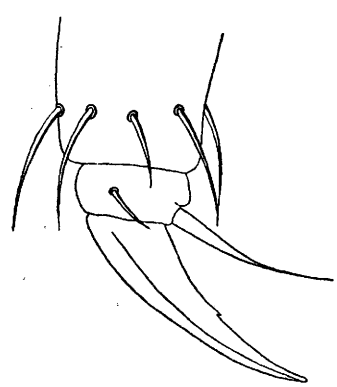


FIG. 2.—*Onychiurus armatus* (Tullb.). Foot, from the side.

Upper claw without lateral teeth, sometimes with one inner tooth. Lower claw bristlelike, reaching to the end of the upper. Anal horns, 2. Colour white.

Hab.—Berkhamsted, under board and flower-pots in a greenhouse (fairly common); under a board in a garden (few); under stones (few); Waterend, under a log of wood (1).

11.—**Onychiurus burmeisteri,** (Lubb.).

Lipura burmeisteri, Lubbock, Monograph, 1873, p. 190.

Eyes absent. Pseudocelli of the *tuberculata* type (see Börner, 6, p. 20), antennal base with 2, hind edge of the head with 0. Postantennal organ of 24-26 smooth, oval tubercles. Anal horns, 2, stout, curved. Skin granules much larger than other British species of *Onychiurus*. Colour creamy white.

Hab.—Berkhamsted, under logs of wood, boards and stones in gardens (very common); under flower-pots in greenhouses (fairly common); Kimpton, Welwyn, under a piece of wood (few).

This species is very distinct from *O. armata*. It seems to be confined to the southern and midland parts of England.

Genus **Tullbergia,** Lubb., Börn.

Tullbergia, Lubbock, New Gen. and Spec. of Coll. fr. Kerg. Isl., 1876.*
Tullbergia, Börner, Jap. Coll., 1909, p. 102.

12.—**Tullbergia krausbaueri** (Börn.).

Mesaphorura krausbaueri, Börner, Vorläuf. Mitth. über einige neue Aphor. u. zur Syst. d. Coll., 1901, p. 2.
Stenaphorura krausbaueri, Börner, Apterygoten-Fauna von Bremen, 1901, p. 24.

Body very slender. Eyes absent. Pseudocelli distributed as follows:—In front of postantennal organ 1, hind edge of the head 1 on each side, and 1 on each side of Th. II, III, and Abd. IV. The pseudocelli are of a peculiar type, each being composed of 6-7 tubercles arranged in a ring similar to some postantennal organs. Postantennal organ of 40-50 oval tubercles. Upper claw without inner or lateral teeth. Lower claw only present as a small bristle. Anal horns 2, short, slightly curved. Furcula and tenaculum totally absent. Colour white. Length 1 mm.

Hab.—Berkhamsted, under bark of rotting wood (few); under a brick lying on the ground in a small wood (few).

Sub-family **Neanurinae,** Börn.

Neanurinae, Börner, Über. ein neues Achorut. Willemia, 1901, p. 431.

Genus **Anurida,** Laboulb.

Anurida, Laboulbène, Rech. sur l'*Anurida maritima*, 1864.*

13.—**Anurida granaria** (Nic.).

Anoura granaria, Nicolet, Essai sur une classif. d. Ins. Apt. de l'ordre des Thys., 1847, p. 387.*
Anurida granaria, Tullberg, Skand. Podur. af underf. Lip., 1869, p. 20.
Anoura granaria, Lubbock, Monograph, 1873, p. 198.

Eyes absent. Pseudocelli absent. Postantennal organ of 14-16 oval tubercles arranged in a ring. Lower claw absent. Tibio-tarsus without clavate hairs. Skin granules large. Colour creamy white.

Hab.—Kimpton, Welwyn, in greenhouse under flower-pots (few); Berkhamsted, under sticks and stones lying in soft earth (fairly common); amongst soil in a greenhouse (few).

Genus **Friesea**, D.T.

Triaena, Tullberg, Fört. öfv. Sv. Pod., 1871, p. 155.
Friesea, Dalla Torre.

Tullberg's name was pre-occupied and the genus was renamed by Dalla Torre.

14.—**Friesea claviseta**, Axels.

Friesea claviseta, Axelson, Vorläuf. Mitth. über ein. Neue Coll. aus Finnland, 1900, p. 8.

Eyes, 8 on each side of the head. Postantennal organ absent. Upper claw without inner teeth. Lower claw absent. Tibio-tarsus with 4-5 clavate hairs. Furcula short, mucrodens shorter than the manubrium. Abd. V and VI, with several long, clavate hairs. Abd. VI with 3 anal horns. Colour light grey-blue.

Hab.—Berkhamsted, under bark of oak stump (few); in greenhouse, under flower-pots (few).

This is the first British record of this species.

Genus **Pseudachorutes**, Tullb.

Pseudachorutes, Tullberg, Fört. öfver Sv. Pod., 1871, p. 155.

In a previous paper (28) we recorded the species *P. subcrassus* from this county and mentioned that we had also a second species. This we have identified with the *P. asigillatus* of Börner.

15.—**Pseudachorutes subcrassus**, Tullb.

Pseudachorutes subcrassus, Tullberg, Fört. öfver Sv. Pod., 1871, p. 155.

Eyes, 8 on each side of the head. Postantennal organ of 8-11 tubercles arranged in a ring. Upper claw with distinct inner tooth about the middle and 1 lateral tooth on each side slightly nearer the proximal end. Tibio-tarsus without clavate hairs. Anal horns absent. Colour pale blue-grey, underside lighter. Length, 1.8 mm.

Hab.—Berkhamsted, under bark of rotting wood (fairly common).

16.—**Pseudachorutes asigillatus**, Börn.

Pseudachorutes asigillatus, Börner, Apterygoten-Fauna von Bremen, 1901, p. 36.

Eyes, 8 on each side of the head. Postantennal organ absent. Upper claw with distinct inner tooth about the middle, 1 small lateral

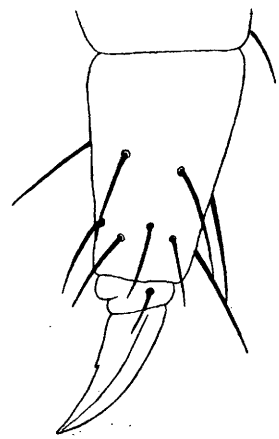


FIG. 3.—*Pseudachorutes asigillatus*, Börn. 1st, tibio-tarsus and claw, from the side.

tooth on each side near the base. Tibio-tarsus without clavate hairs. Anal horns absent. Colour blue-grey, underside lighter.

Hab.—Berkhamsted, under moist bark (fairly common); Kimpton, Welwyn, under piece of oak (few).

This species has not been previously recorded from this country.

Genus **Neanura**, MacG.

Neanura, MacGillivray.

17.—**Neanura muscorum** (Templ.).

Achorutes muscorum, Templeton, Thys. Hib., 1834, p. 97.
Achorutes tuberculatus, Nicolet, Rech. p. s. à l'hist. d. Pod., 1842, p. 51.
Anoura muscorum, Lubbock, Monograph, 1873, p. 197.

Eyes, 3 on each side of the head, the 2 anterior near together, the posterior one some distance away. Postantennal organ absent. Mouth-parts suctorial, produced cone-like in front of the head. Upper claw without teeth. Lower claw absent. Clavate hairs absent. Abd. VI terminating in 2 tubercles. Segmental tubercles present. Colour, dark grey-blue or purple.

Hab.—Berkhamsted, under logs and sticks on the ground (very common); Ashridge, Berkhamsted, under sticks and amongst leaves (common); Kimpton, Welwyn, under sticks (few); Waterend, under a stick (3); Little Gaddesden, under moist bark (2).

Family ENTOMOBRYIDAE, D.T.

Entomobryidae, Dalla Torre.
Entomobryidae, Börner, Vorläuf. Mitth. über ein. neue Aphor., 1901, p. 14.

Sub-family **Isotominae**, Schäff., Börn.

Isotominae, Schäffer, Coll. d. Umgeb. v. Hamb., 1896, p. 177.
Isotomini, Börner, Vorläuf. Mitth. über ein. neue Aphor, 1901, p. 14.

Genus **Isotoma**, Bourl., Börn.

Isotoma, Bourlet, Mém. s. l. Podures, 1839. p. 23.*
Isotoma, Börner, Das Syst. d. Coll., 1906, p. 171.

18.—**Isotoma viridis**, Bourl., Schött.

Isotoma viridis, Bourlet, Mém. s. l. Podures, 1839.*
Isotoma anglicana, Lubbock, Monograph, 1873, p. 171.
Isotoma viridis, Schött, Zur Syst. u. Verb. Pal. Coll., 1893, p. 59.

Eyes, 8 on each side of the head. Upper claw with 2 inner teeth and 1 strong lateral tooth on each side. Lower claw about half as long as the upper with a small tooth on the inner side. Tibio-tarsus without clavate hairs. Mucro with 3 teeth, the 2 proximal ones opposite each other.

Hab.—Berkhamsted, under sticks, fence rail on ground, over-turned sheep trough, etc. (very common); Kimpton, Welwyn, under a piece of wood (common); Waterend, under a log (common).

19.—**Isotoma grisea**, Lubb.

Isotoma grisea, Lubbock, Notes on the Thys., Pt. IV, 1870, p. 278.
Isotoma grisea, Lubbock, Monograph, 1873, p. 172.
Isotoma grisescens, Schäffer, Coll. d. Umgeb. v. Hamb., 1896, p. 188.

Eyes, 8 on each side of the head. Postantennal organ long and narrow. Ant. II longer than Ant. III. Upper claw with 1 inner tooth about the middle and 1 lateral tooth on each side near the base.

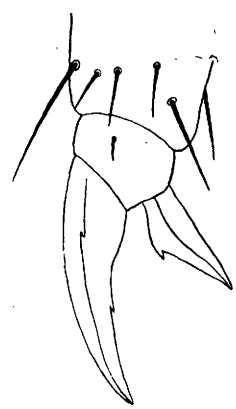


FIG. 4.—*Isotoma grisea*, Lubb. 3rd foot, from the side.

Lower claw half as long as the upper with 1 tooth on the inner side. Tibio-tarsus without clavate hairs. Mucro with four teeth, 3 in the middle line, and 1 on the outer side. The 2 distal teeth are much larger than the proximal teeth. Colour bluish grey.

Hab.—Berkhamsted, under sticks in a garden (common); amongst loose soil (few); under over-turned sheep trough (few); Waterend, under sticks (few).

Carpenter and Evans (20, p. 248) record this species from from several localities in Scotland under the name of *Isotoma grisescens,* thinking it probably identical with Lubbock's *I. grisea.* We are of the opinion that the two are synonymous.

20.—**Isotoma minor,** Schäff.

Isotoma minor, Schäffer, Coll. d. Umgeb. v. Hamb., 1896, p. 182.

Eyes absent. Postantennal organ absent. Near the end of Ant. IV. are 6-7 blunt sensory hairs. Upper claw without inner or lateral teeth. Lower claw broad at base, pointed, about half as long as

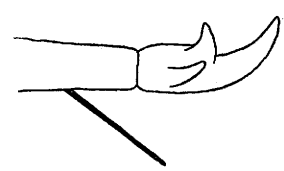


FIG. 5.—*Isotoma minor*, Schäff. Mucro, from the side.

the upper. Tibio-tarsus without clavate hairs. Body segments with some large feathery hairs. Colour very light grey or white. Length 1 mm.

Hab.—Berkhamsted, under sticks in a wood (few); under flower-pots in a greenhouse (few); under a stone (1).

21.—**Isotoma notabilis,** Schäff.

Isotoma notabilis, Schäffer, Coll. d. Umgeb. v. Hamb., 1896, p. 187.

Eyes, 4 on each side of the head. Postantennal organ very large, broad elliptical, nearly as large as the eye-patch. Upper claw without inner or lateral teeth. Lower claw without teeth, half as long as the upper. Tibio-tarsus without clavate hairs. Dentes very slender. Mucro with 3 teeth, 2 in the middle line, and 1 on the outer side. Colour, light grey.

Hab.—Berkhamsted, under flower-pots in greenhouses (common); under sticks (few); under bark of rotting oak (few); under an over-turned sheep-trough (fairly common); Kimpton, Welwyn, in greenhouse (few).

This species has not previously been recorded from the British Isles.

22.—**Isotoma arborea** (Linn.), Ågr.

Podura arborea, Linné, Syst. Nat., Ed. X., 1758.*
Isotoma arborea, Lubbock, Monograph, 1873, p. 167.
Isotoma denticulata, Schäffer, Coll. d. Umgeb. v. Hamb., 1896, p. 189.
Isotoma arborea, Ågren, Zur Kenn. d. Apt. Sud.-Schw., 1903, p. 140.

Eyes, 8 on each side of the head. Posterior eyes smaller than the others. Postantennal organ oval, $1\frac{1}{2}$ times as long as the diameter of 1 anterior eye. Upper claw with 1 inner tooth one-third from the distal end and 1 lateral tooth on each side one-third from the proximal end. Lower claw broad at the base with 1 small inner tooth. Front pair of legs with 2, middle and hind with 3 clavate hairs. Dens twice as long as the manubrium. Mucro with 4 teeth, 3 in the middle line and 1 at the outer side. Colour reddish violet to black, legs and furcula colourless.

Hab.—Berkhamsted, under bark of posts and rails (common); amongst decaying leaves (few); Kimpton, Welwyn, under log of wood (few).

Carpenter and Evans in 1899 (20, p. 223 and 250) claimed the first British record of this species, but Lubbock recorded it in 1873 from Great Britain (52, p. 168).

23.—**Isotoma cinerea** (Nic.).

Desoria cinerea, Nicolet, Rech. p.s. à l'hist. d. Pod., 1842, p. 60.

Eyes, 8 on each side of the head, all about the same size. Upper claw with 1 inner tooth and 1 small lateral tooth on each side. Tibio-

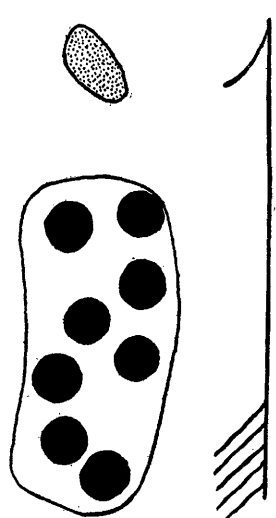


FIG. 6.

FIG. 7.

FIG. 6.—*Isotoma cinerea* (Nic.). Left eye-spot and postantennal organ.
FIG. 7.—*Isotoma cinerea* (Nic.). Mucro, from the side. (*After Collinge*).

tarsus with 2-3 clavate hairs. Mucro with 4 teeth, 3 in the middle line and 1 on the outer side. Colour grey, mottled with some violet pigment.

Hab.—Berkhamsted, under the bark of a dead Beech tree (few); under bark of rotting oak sticks (common); Kimpton, Welwyn, under sticks (few).

Genus **Proisotoma,** Börn.

Proisotoma, Börner, Das Syst. d. Coll., 1906, p. 172.

24.—**Proisotoma schötti** (D.T.).

Isotoma litoralis, Schött, Zur Syst. u. Verb. Pal. Coll., 1893, p. 75.
Isotoma schötti, Dalla Torre, Die Gatt. u. Art. d. Apt., 1895.*

Eyes, 8 on each side of the head. Upper claw without inner or lateral teeth. Lower claw broad at the base, tapering to a point.

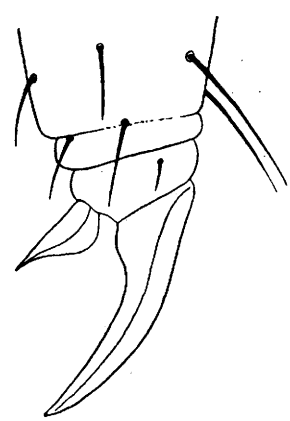


FIG. 8.—*Proisotoma schötti* (D.T.). 3rd foot from the side.

Tibio-tarsus without clavate hairs. Dentes not tapering. Mucro with 2 teeth. Colour violet.

Hab.—Berkhamsted, on water in a cart rut (3).

Schött's name *litoralis* being pre-occupied, Dalla Torre renamed the species in 1895.

Genus **Folsomia,** Willem.

Folsomia, Willem, Note prélim. s.l. Coll. d. grottes d. Han et d. Roch., 1902, p. 280.

25.—**Folsomia fimetaria** (L., Tullb.).

Podura fimetaria, Linné, Syst. Nat., Ed. X, 1758, p. 609.*
Isotoma alba, Tullberg, Fört. öfv. Sv. Pod., 1871, p. 152.
Isotoma fimetaria, Tullberg, Sver. Pod., 1872, p. 48.

Eyes absent. Postantennal organ elongate-oval. Upper claw without inner or lateral teeth. Tibio-tarus without clavate hairs. Dens about twice as long as the manubrium. Mucro with 2 teeth. Colour white.

Hab.—Berkhamsted, in a cellar under flower-pots (few); under bark of decaying log (common); in ant's nest (few); Waterend, under a log (3).

26.—**Folsomia quadrioculata** (Tullb.).

Isotoma quadrioculata, Tullberg, Fört. öfv. Sv. Pod., 1871, p. 152.

Eyes, 2 on each side of the head. Postantennal organ elongate-oval. Upper claw without inner or lateral teeth. Tibio-tarsus without clavate hairs. Furcula shorter than in *fimetaria*. Dens equal to or a little longer than the manubrium. Mucro with 2 teeth. Colour grey, pigment mottled.

Hab.—Berkhamsted, under sticks lying on the ground (few); amongst decaying leaves (few); under flower-pots in a greenhouse (few); Ashridge, Berkhamsted, under sticks (few); Kimpton, Welwyn, under sticks (few); Waterend, under a log (2).

var. **diplophthalma** (Axels.).

Isotoma binoculata, Collinge and Shoebotham, Notes on some Coll. new to Gt. Britain, 1909, p. 88.

Eyes, 1 on each side of the head. Colour white with a little greyish pigment.

Hab.—Berkhamsted, under a flower-pot in a greenhouse (1).

Axelson (3) described the above variety as a separate species in 1902, but in his Apterygoten-fauna Finlands, 1907, he regards it as a variety of *quadrioculata,* Tullberg. We were mistaken in identifying our specimen (28) with the *Isotoma binoculata* of Wahlgren (73).

Genus **Anurophorus,** Nic., Tullb.

Anurophorus, Nicolet, Rech. p. serv. à l'hist. d. Pod., 1842, p. 52.
Anurophorus, Tullberg, Skand Podur. af underfam. Lip., 1869, p. 12.

27.—**Anurophorus laricis,** Nic.

Anurophorus laricis, Nicolet, Rech. p. serv. à l'hist. d. Pod., 1842, p. 53.
Lipura corticina, Lubbock, Monograph, 1873, p. 191.

Eyes, 8 on each side of the head. Postantennal organ in a groove, ringlike as in *Isotoma*. Upper claw without inner or lateral teeth. Lower claw absent. Tibio-tarsus with 4 clavate hairs.

Furcula and tenaculum totally absent. Anal horns absent. Colour dark blue to black.

Hab.—Berkhamsted, on puddle of water in a road (few); under bark of dead tree (few); under bark of fence post (few); under board in a garden (fairly common).

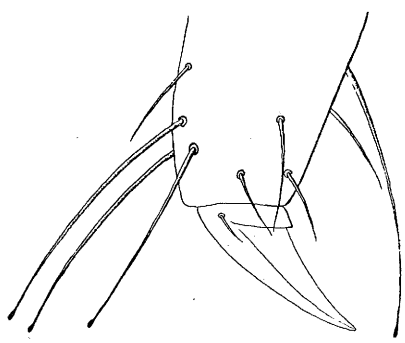


FIG. 9.

FIG. 10.

FIG. 9.—*Anurophorus laricis* (Nic.). 3rd foot from the side.
FIG. 10.—*Anurophorus laricis* (Nic.). 3rd antennal joint from the side, showing the antennal-organ III. (*After Collinge.*)

Sub-family **Tomocerinae**, Schäff.

Tomocerinae, Schäffer, Coll. d. Umgeb. v. Hamb., 1896, p. 177.

Genus **Tomocerus**, Nic.

Tomocerus, Nicolet, Rech. p. serv. à l'hist. d. Pod., 1842, p. 67.

28.—**Tomocerus vulgaris** (Tullb.).

Macrotoma vulgaris, Tullberg, Fört. öfv. Sv. Pod., 1871, p. 149.

Antennae shorter than the body. Upper claw with 5-6 inner teeth and 1 large lateral tooth (pseudonychium) on each side. Lower claw lanceolate, without teeth. Spines on the dentes, simple.

Hab.—Berkhamsted, under fence rail on the ground (common); under boards and logs of wood (few); in a cellar on fire-wood (2); in greenhouses (fairly common); Kimpton, Welwyn, under a piece of wood (few).

29.—**Tomocerus minor** (Lubb.).

Macrotoma minor, Lubbock, Notes on the Thys., pt. II, 1862, p. 598.
Macrotoma tridentifera, Tullberg. Sver. Pod., 1872, p. 37.
Tomocerus plumbeus, Lubbock, Monograph, 1873, p. 138.

Antennae shorter than the body. Upper claw with 5-6 inner teeth and 1 large lateral tooth (pseudonychium) on each side. Lower claw with 1 tooth on the inner side. Spines on the dentes, tridentate.

Hab.—Berkhamsted, under logs, stones, boards, and decaying leaves (very common); Kimpton, Welwyn, under oak log (fairly common); Waterend, under logs (common).

30.—**Tomocerus longicornis** (Müll.).

Podura longicornis, Müller, Zool. Dan. Prod., 1776.*
Tomocerus plumbeus, Nicolet, Rech. p. serv. à l'hist. d. Pod., 1842, p. 68.
Macrotoma plumbea, Lubbock, Notes on the Thys., Pt. II, 1862, p. 598.
Macrotoma plumbea, Tullberg, Sver. Pod., 1872, p. 37.
Tomocerus longicornis, Lubbock, Monograph, 1873, p. 137.

Antennae longer than the body. Upper claw with 2-3 inner teeth. Lower claw with apical appendage reaching almost to the end of the upper. Spines on the dentes, simple.

Hab.—Berkhamsted, under sticks and decaying leaves (fairly common).

Sub-family **Entomobryinae**, Schäff., Börn.

Entomobryinae, Schäffer, Coll. d. Umgeb. v. Hamb., 1896, p. 177.
Entomobryini, Börner, Vorläuf. Mitth. über ein. neue Aphor., 1901, p. 15.

Genus **Isotomurus**, Börn.

Isotomurus, Börner, Neue Altwelt. Coll., 1903.*

31.—**Isotomurus palustris** (Müll.).

Podura palustris, Müller, Zool. Dan. Prod., 1776.*
Podura aquatilis, Müller, Zool. Dan. Prod., 1776.*
Isotoma palustris, Lubbock, Monograph, 1873, p. 169.
Isotoma aquatilis, Lubbock, Monograph, 1873, p. 170.

Hab.—Berkhamsted, on the water of grassy ponds (very common); under decaying pieces of wood (common); Waterend, on water of mill-pool (common).

var. **fucicola** (Reut.).

Hab.—Berkhamsted, on the water of grassy ponds (common).

var. **prasina** (Reut.).

Hab.—Berkhamsted, under decaying pieces of wood lying in a grass field (common).

32.—**Isotomurus maculatus** (Schäff., Börn.).

Isotoma palustris var. *maculata*, Schäffer, Coll. d. Umgeb. v. Hamb., 1896, p. 186.
Isotoma maculata, Börner, Apterygoten-Fauna von Bremen, 1901, p. 51.

Hab.—Berkhamsted, about flower-pots in greenhouses (very common); on a brick in a garden (fairly common).

Genus **Entomobrya**, Rond.

Entomobrya, Rondani, Dipterol. Ital. Prodr., Vol. IV.*
Degeeria, Nicolet, Rech. p. s. à l'hist. d. Pod., 1842, p. 70.
Entomobrya, Brook, A Revis. of the Gen. Entom., 1883, p. 272.

33.—**Entomobrya nivalis** (Linn.).

Podura nivalis, Linné, Syst. Nat., Ed. X, 1758, p. 609.*
Degeeria annulata, Lubbock, Monograph, 1873, p. 159.

Hab.—Kimpton, Welwyn, in greenhouse (few); Berkhamsted, amongst moss in a hedge (few); under bark of fence posts (common); on Gorse bush (few); on hawthorn bush (very common).

34.—**Entomobrya albocincta** (Templ.).

Podura albocincta, Templeton, Thys. Hib., 1834, p. 95.
Degeeria cincta, Lubbock, Monograph, 1873, p. 162.
Degeeria albocincta, Lubbock, Monograph, 1873, p. 160.

Hab.—Berkhamsted, under bark of posts and rails, etc. (very common); under wood lying on the ground (few); in a greenhouse (few); Kimpton, Welwyn, under sticks (few).

35.—**Entomobrya nicoleti** (Lubb.).

Degeeria nicoletii, Lubbock, Notes on the Thys., Pt. III, 1868.
Degeeria nicoletii, Lubbock, Monograph, 1873, p. 161.

Hab.—Berkhamsted, under pieces of wood (common); under bark of rails and posts (common); Waterend, under bark of fence-post (5).

36.—**Entomobrya multifasciata** (Tullb.).

Degeeria multifasciata, Tullberg, Fört. öfv. Sv. Pod., 1871, p. 148.
Degeeria nivalis, Lubbock, Monograph, 1873, p. 158.

Hab.—Berkhamsted, under logs of wood and sticks lying on the ground (common); beaten from grass (few).

Genus **Sinella**, Brook.

Sinella, Brook, On a new Gen. of Coll. allied to *Degeeria*, 1882, p. 543.

37.—**Sinella curviseta,** Brook.

Sinella curviseta, Brook, On a new Gen. of Coll. allied to *Degeeria*, 1882, p. 544.

Eyes, 2 on each side of the head. Upper claw with 3 inner teeth, the 2 proximal opposite each other. Lower claw without teeth. Mucro with 2 teeth and basal spine. Colour yellow with mottling of reddish pigment.

Hab.—Berkhamsted, in flower-pots in greenhouse (few).

38.—**Sinella höfti,** Schäff.

Sinella höfti, Schäffer, Coll. d. Umgeb. v. Hamb., 1896, p. 192.

Eyes absent. Upper claw with 3 inner teeth, 2 large proximal ones opposite each other and 1 smaller distal tooth about the middle. Lower claw with toothed outer lamella as in *Cyphoderus albinus*.

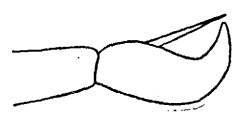


FIG. 11.—*Sinella höfti*, Schäff. Mucro, from the side.

Tibio-tarsal spur-hair pointed. Mucro with 1 tooth and basal spine. Colour white.

Hab.—Berkhamsted, in flower-pots in a greenhouse (common); under stones (few).

Genus **Seira,** Lubb.

Seira, Lubbock, Notes on the Thys., pt. IV, 1870, p. 279.
Seira, Lubbock, Monograph, 1873, p. 143.

39.—**Seira nigromaculata,** Lubb.

Seira nigromaculata, Lubbock, Monograph, 1873, p. 146.

Eyes, 8 on each side of the head. Upper claw with 3 inner teeth and 1 lateral tooth on each side. Lower claw lanceolate. Tibio-tarsus with 1 clavate hair. Dentes ventrally without scales. Mucro with 2 teeth and basal spine. Colour in life, greyish, in spirit, yellow with some darker markings.

Hab.—Berkhamsted, on window-sills, walls, gate posts, etc., about a cattle yard (common).

40.—**Seira buskii,** Lubb.

Seira buskii, Lubbock, Notes on the Thys., Pt. IV, 1870, p. 280.
Seira buskii, Lubbock, Monograph, 1873, p. 145.

Eyes, 8 on each side of the head. Upper claw with 3 inner teeth and 1 lateral tooth on each side. Lower claw lanceolate. Tibio-tarsus with 1 clavate hair. Dentes ventrally without scales. Mucro with 2 teeth and basal spine. Colour of body, dark violet; head, legs, and base of the antennae yellow.

Hab.—Berkhamsted, about flower-pots in a greenhouse (few).

Genus **Pseudosira**, Schött, Börn.

Pseudosira, Schött.
Pseudosira, Börner, Das Syst. d. Coll., 1906, p. 174.

41.—**Pseudosira domestica** (Nic.).

Degeeria domestica, Nicolet, Rech. p. s. à l'hist. d. Pod., 1842, p. 76.
Seira domestica, Lubbock, Monograph, 1873, p. 144.

Eyes, 8 on each side of the head. Upper claw with 3 inner teeth and 1 lateral tooth on each side. Lower claw lanceolate. Tibio-

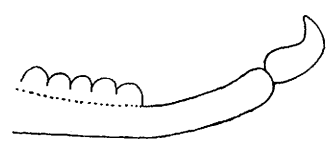


FIG. 12.—*Pseudosira domestica* (Nic.). End of dens and mucro, from the side.

tarsus with 1 clavate hair. Dentes ventrally with scales. Mucro with 1 tooth, without basal spine. Colour brown.

Hab.—Berkhamsted, on and under flower-pots in a greenhouse (few).

Genus **Lepidocyrtus**, Bourl.

Lepidocyrtus, Bourlet, Mém. s. l. Podures, 1839.*
Lepidocyrtus, Börner, Das Syst. d. Coll., 1906, p. 174.

42.—**Lepidocyrtus curvicollis**, Bourl.

Lepidocyrtus curvicollis, Bourlet, Mém. s. l. Podures, 1839.*
Lepidocyrtus curvicollis, Lubbock, Monograph, 1873, p. 150.

Eyes, 8 on each side of the head. Head almost concealed under the projecting mesothorax. Upper claw with 2 inner teeth and 1 large lateral tooth on each side. Lower claw lanceolate, reaching to the second tooth on the upper claw. Tibio-tarsus with 1 clavate hair.

Hab.—Berkhamsted, on firewood in a cellar (common); on flower-pots in greenhouses (common); Kimpton, Welwyn, in greenhouse (fairly common).

This is the largest of the British species of *Lepidocyrtus*.

43.—**Lepidocyrtus lanuginosus** (Gmel.), Tullb.

Podura lanuginosa, Gmelin, Linn. Syst. Nat., T.I., 1788, p. 2911.
Lepidocyrtus lanuginosus, Tullberg, Sver. Pod., 1872, p. 38.

Eyes, 8 on each side of the head. Mesothorax projecting over the head more than in *cyaneus*. Upper claw with 2 inner teeth and 1 large lateral tooth on each side. Lower claw lanceolate. Tibio-tarsus with 1 clavate hair. Dentes slightly longer than the manubrium. Colour, silvery blue, in spirit pale yellow.

Hab.—Berkhamsted, under sticks and stones (common); amongst decaying leaves (fairly common).

44.—**Lepidocyrtus ruber,** Schött.

Lepidocyrtus lanuginosus, Börner, Apterygoten-Fauna von Bremen, 1901, p. 74.
Lepidocyrtus ruber, Schött, Étud. s.l. Coll. d. Nord, 1902, p. 31.

Eyes, 8 on each side of the head. Upper claw with 1 inner tooth about the middle, and 1 small lateral tooth on each side. Lower claw

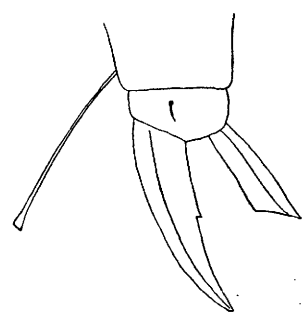


FIG. 13.—*Lepidocyrtus ruber*, Schött. 3rd foot, from the side.

with almost parallel sides for three-quarters of its length, then the inner lamella is suddenly cut away. Tibio-tarsus with 1 clavate hair.

Hab.—Berkhamsted, on aquatic plants and on water in a pond (few).

This is the first record of this species for this country.

45.—**Lepidocyrtus cyaneus,** Tullb.

Lepidocyrtus cyaneus, Tullberg, Fört. öfv. Sv. Pod., 1871, p. 150.
Lepidocyrtus purpureus, Lubbock, Monograph, 1873, p. 155.

Eyes, 8 on each side of the head. Mesothorax projecting very little over the head. Upper claw with 2 inner teeth and 1 small lateral tooth on each side. Lower claw lanceolate. Tibio-tarsus with 1 clavate hair. Dentes a little shorter than the manubrium.

Colour of body, dark blue, in spirit dark blue. Head, base of antennae and legs, yellow.

Hab.—Berkhamsted, under sticks and boards (few); amongst newly-mown grass (fairly common); under stones in an arable field (few).

46.—**Lepidocyrtus sexoculatus** (Schött).

Pseudosinella sexoculata, Schött, Étud. s. l. Coll. d. Nord, 1902, p. 34.
Lepidocyrtus sexoculatus, Guthrie, Coll. of Minn., 1903, p. 86.

Eyes, 3 on each side of the head, placed on 2 distinct eye-spots, the anterior one having 2 and the posterior one 1.

Hab.—Berkhamsted, under stick lying on the ground (1); in greenhouse (1).

47.—**Lepidocyrtus albus,** Pack.

Lepidocyrtus albus, Packard, Syn. Thys. Essex Co. Mass., 1873.*
Tullbergia ocellata, Lie-Pettersen, Norges Coll., 1896, p. 16.
Pettersenia ocellata, Lie-Pettersen, Apt. Sogn. u. Nordfj., 1898, p. 10.
Pseudosinella alba, Schäffer, Würrt. Coll., 1900, p. 269.

Eyes, 2 on each side of the head, on a black patch. Upper claw with 3 inner teeth, the 2 proximal large and opposite, the distal one

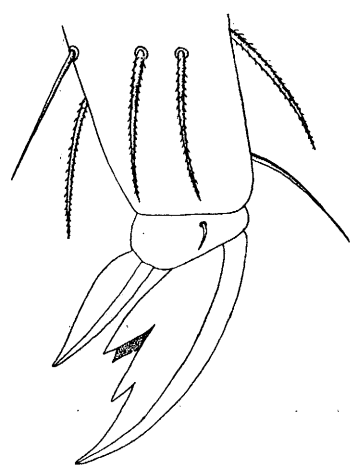


FIG. 14.—*Lepidocyrtus albus*, Pack. 1st foot, from the side.

smaller. Lower claw lanceolate. Tibio-tarsal spur-hair pointed. Colour silvery white.

Hab.—Berkhamsted, under sticks and boards lying on the ground (fairly common); amongst decaying leaves (few); in loose soil (common).

48.—**Lepidocyrtus cavernarum** (Mon.).

Seira cavernarum, Moniez, Esp. nouv. d. Thys. trouv. dans. l. Grotte de Darg, 1893.*
Cyphoderus martelii, Carpenter, Coll. of Mitch. Cave, 1897, p. 228.
Tullbergia immaculata, Lie-Pettersen, Norges Coll., 1896, p. 16.
Cyphoderus albinos, Guthrie, Coll. of Minn., 1903.

Eyes absent. Upper claw with 3 inner teeth, the 2 proximal lamella-like, opposite each other. The distal tooth is small. Tibio-tarsal spur-hair pointed. Colour white.

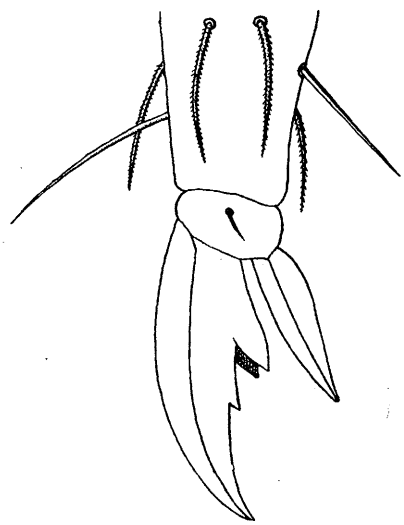


FIG. 15.—*Lepidocyrtus cavernarum* (Mon.). 3rd foot, from the side.

Hab.—Berkhamsted, under stones and sticks lying in loose soil (few).

Genus **Orchesella**, Templ.

Orchesella, Templeton, Thys. Hib., 1834, p. 92.

49.—**Orchesella cincta** (Linn.), Lubb.

Podura cincta, Linné, Syst. Nat., Ed. X, 1758, p. 609.*
Orchesella cincta, Lubbock, Monograph, 1873, p. 129.

Eyes, 8 on each side of the head. Upper claw with 3 inner teeth. Tooth on the outer side of the lower claw, in the distal half. Abd. III with a distinct black band.

Hab.—Berkhamsted, under bark of posts and rails (few); under boards (common); amongst decaying leaves (common); under sticks and logs of wood (very common); Kimpton, Welwyn, in greenhouse (few); under sticks (common).

var. **vaga** (Linn.).

Hab.—Berkhamsted, under a fence rail lying on the ground (common).

50.—**Orchesella villosa** (Geoff.), Lubb.

Podura villosa, Geoffroy, Hist. abr. d. Insect. qui s. trouv. aux Env. d. Paris, 1762.*
Orchesella villosa, Lubbock, Monograph, 1873, p. 131.

Eyes, 8 on each side of the head. Upper claw with 2 inner teeth. Tooth on the outer side of the lower claw, in the proximal half. Body without any distinct transverse bands.

Hab.—Berkhamsted, on decaying potato (3); under a board in a garden (common); under sticks, bark, stones, etc., lying on the ground (common); amongst decaying leaves (common).

Genus **Heteromurus**, Wankel.

Heteromurus, Wankel, Beit. z. mähr. Grottenf, 1861.*
Templetonia, Lubbock, Notes on the Thys., Pt. II., 1862, p. 595.

51.—**Heteromurus nitidus** (Templ.).

Podura nitida, Templeton, Thys. Hib., 1834, p. 94.
Templetonia crystallina, Lubbock, Monograph, 1873, p. 143.

Terminal segment of the antenna ringed. Eyes, 1 on each side of the head. Upper claw with 2 inner teeth placed opposite each other near the base, and 1 lateral tooth on each side near the base. Lower claw with a small tooth on the outer side. Mucro with 2 teeth, without basal spine. Scales present. Colour silvery white, with a little reddish pigment.

Hab.—Berkhamsted, common under flower-pots in greenhouses; under stones in loose soil; and under sticks and boards.

Genus **Cyphoderus**, Nic., Tullb.

Cyphodeirus, Nicolet, Rech. p. s. à l'hist. d. Pod., 1842, p. 63.
Cyphoderus, Tullberg, Fört. öfv. Sv. Pod., 1871, p. 150.

52.—**Cyphoderus albinus**, Nic.

Cyphodeirus albinos, Nicolet, Rech. p. s. à l'hist. d. Pod., 1842, p. 67.
Beckia albinos, Lubbock, Monograph, 1873, p. 149.

Ant. II longer than Ant. III. Eyes absent. Upper claw with 1 large inner tooth. Lower claw with broad, toothed outer lamella. Tibio-tarsus with 1 clavate hair. Dens twice as long as the mucro. Mucro elongate, with 2 distal teeth. Colour white.

Hab.—Berkhamsted, in ant's nests in the ground (few); in an ant's nest in a flower-pot (3); Frithesden, near Berkhamsted, in ant's nests (few).

Sub-order **Symphypleona,** Börn.

Symphypleona, Börner, Vorläuf. Mitth. über ein. neue Aphor., 1901, p. 5.
Symphypleona, Börner, Apterygoten-Fauna von Bremen, 1901, p. 78.

Family NEELIDAE, Fols.

Neelidae, Folsom, *Neelus m.* repr. a new Thys. Fam., 1896, p. 391.
Neelidae, Börner, Coll. Symph., Fam. Neel., 1906, p. 2.

Genus **Neelus,** Fols.

Neelus, Folsom, *Neelus m.* repre. a new Thys. Fam., 1896, p. 391.
Neelus, Börner, Coll. Symph., Fam. Neel., 1906, p. 3.

53.—**Neelus murinus,** Fols.

Neelus murinus, Folsom, *Neelus m.* repr. a new Thys. Fam., 1896, p. 391.

Hab.—Berkhamsted, under flower-pots in a greenhouse and under sticks in a wood (few).

Genus **Megalothorax,** Willem.

Megalothorax, Willem, Un type nouv. de sminth. *Megaloth.*, 1900, p. 7-10.
Megalothorax, Börner, Coll. Symph. Fam. Neel., 1906, p. 3.

54.—**Megalothorax minimus,** Willem.

Megalothorax minimus, Willem, Un type nouv. de sminth. *Megaloth.*, 1900, p. 7-10.
Megalothorax minimus, Börner, Apterygoten-Fauna von Bremen, 1901, p. 82.
Amerus normani, Collinge & Shoebotham, Desc. of a New Gen. of Coll. of the Fam. Neel., 1909, p. 47.

Hab.—Berkhamsted, under flower-pots in a greenhouse and under decaying wood embedded in loose soil (few); Little Gaddesden, under moist bark (1).

Family SMINTHURIDAE, Lubb.

Smynthuridae, Lubbock, Notes on the Thys., pt. I, p. 430.
Sminthuridae, Börner, Apterygoten-Fauna von Bremen, 1901, p. 85.

Sub-family **Sminthuridinae,** Börn.

Sminthuridinae, Börner, Das Syst. d. Coll., 1906, p. 163.

Genus **Sminthurides,** Börn.

Sminthurides, Börner, Apterygoten-Fauna von Bremen, 1901, p. 91.

55.—**Sminthurides aquaticus** (Bourl.).

Smynthurus aquaticus, Bourlet, Mém. s.l. Podurelles, 1843.

Eyes, 8 on each side of the head. Upper claw of first and second pairs of legs with 1 inner tooth, third pair without. Sub-

apical bristle of the under claw of the first pair of legs not quite reaching to the end of the upper claw. Dens three times as long as the mucro. Mucro with broad lamella. Colour green.

Hab.—Berkhamsted, on herbage around, and on the surface of water of ponds (common).

56.—**Sminthurides malmgreni** (Tullb.),

var. **elegantula** (Reut.).

Sminthurus malmgrenii, Tullberg, Coll. Bor., 1876, p. 30.
Sminthurus elegantulus, Reuter, Étud. s.l. Coll., 1880, p. 20.*
Sminthurus malmgrenii, var. *elegantulus*, Schött, Zur Syst. u. Verb. Pal. Coll., 1893, p. 35.

Eyes, 8 on each side of the head. Upper claw of first and second pairs of legs with 1 inner tooth, third pair without. Sub-apical bristle of the under claw of the first pair of legs reaching past the end of the upper claw. Dens two-and-half to three times as long as the mucro. Mucro with broad lamella. Colour, yellow with three broad longitudinal brown bands.

Hab.—Berkhamsted, about grassy ponds, on the herbage and on the surface of the water (fairly common).

57.—**Sminthurides violaceus** (Reut.).

Sminthurus violaceus, Reuter, För Finl. nya Coll., 1878, p. 203.*

Eyes, 8 on each side of the head. Upper claw with 1 inner tooth. Dens about twice as long as the mucro. Mucro, elongate, without broad lamella. Colour violet.

Hab.—Berkhamsted, few on water lying in cart ruts, and on garden footpath.

Genus **Sminthurinus,** Börn.

Sminthurinus, Börner, Apterygoten-Fauna von Bremen, 1901, p. 99.

58.—**Sminthurinus niger** (Lubb.).

Smynthurus niger, Lubbock, Notes on the Thys., Pt. III, 1868.*
Smynthurus niger, Lubbock, Monograph, 1873, p. 111.

Hab.—Berkhamsted, under and about flower-pots in green-houses (fairly common); under a flower-pot in a garden (few).

59.—**Sminthurinus fenestratus,** Börn.

Sminthurinus fenestratus, Börner, Jap. Coll., 1909, p. 124.
Sminthurus biflavopunctatus, Collinge & Shoebotham, Descr. of two new sp. of Coll., 1909, p. 9.

Hab.—Berkhamsted, under and about flower-pots in greenhouses (common).

In April, 1909, we described the above species from specimens taken in Berkhamsted, but Dr. Börner afterwards pointed out that it was synonymous with his *Sminthurinus fenestratus,* from Japan, the description of which was published two months previously.

60.—**Sminthurinus aureus** (Lubb.).

Smynthurus aureus, Lubbock, Notes on the Thys., Pt. II, 1862, p. 589.
Smynthurus aureus, Lubbock, Monograph, 1873, p. 112.

Eyes, 8 on each side of the head. Upper claw without inner teeth. Tibio-tarsus with 4-5 clavate hairs. Mucro with fine dorsal teeth. Colour, golden yellow.

Hab.—Berkhamsted, under sticks and decaying leaves on the ground (common).

var. **ochropus** (Reut.).

Hab.—Berkhamsted, under sticks on the ground in a grass field (few).

Genus **Arrhopalites,** Börn.

Arrhopalites, Börner, Das Syst. d. Coll., 1906, p. 182.

61.—**Arrhopalites caecus** (Tullb.).

Sminthurus caecus, Tullberg, Fört. öfv. Sv. Pod., 1871, p. 146.

Eyes absent. Upper claw with 1 inner tooth about the middle. Tibio-tarsus without clavate hairs. Mucro ending in a knob. Colour white, with a little reddish pigment.

Hab.—Kimpton, Welwyn, in a greenhouse (few); Berkhamsted, under flower-pots in a greenhouse (few).

Sub-family **Sminthurinae,** Börn.

Sminthurinae, Börner, Das Syst. d. Coll., 1906, p. 163.

Genus **Bourletiella,** Banks, Börn.

Bourletiella, Banks.
Bourletiella, Börner, Das Syst. d. Coll., 1906, p. 182.

62.—**Bourletiella hortensis** (Fitch).

Smynthurus hortensis, Fitch, 8th Report on the Nox. and other Ins. of the State of New York, 1862, p. 186.*

May be distinguished from *B. lutea* (Lubb.), by the inner tooth of the upper claw of the third foot being nearer the distal end. The

sub-segments in Ant. IV of *lutea* are more distinct than in *hortensis*.

Hab.—Berkhamsted, on water in a cart rut (fairly common); on garden footpath (few).

63.—**Bourletiella lutea** (Lubb.).

Smynthurus luteus, Lubbock, Notes on the Thys., Pt. III, 1868, p. 296.*
Smynthurus luteus, Lubbock, Monograph, 1873, p. 108.

Eyes, 8 on each side of the head. All three pairs of feet alike. Upper claw with 1 inner tooth about the middle, and 1 lateral tooth on each side a little nearer the proximal end. Lower claw rather more than half as long as the upper, with narrow outer and broader inner lamella, with a short sub-apical bristle not reaching to the end of the upper claw. Tibio-tarsus with 2-3 clavate hairs. Colour yellow.

Hab.—Berkhamsted, amongst newly-mown grass (few); on a puddle of water (few).

64.—**Bourletiella bilineata** (Bourl.).

Smynthurus bilineatus, Bourlet, Mém. s. l. Pod., 1843, p. 58.*

Lower claw of first pair of legs with apical bristle reaching past the end of the upper claw; of second, and third pairs of legs, with broad inner and narrow outer lamella, shorter than the upper claw.

Hab.—Berkhamsted, amongst grass (few).

65.—**Bourletiella sulphurea** (Koch), Börn.

Sminthurus sulphureus, Koch, Poduridae, 1840.*
Bourletiella sulphurea, Börner, Coll. aus Südafrika, 1908, p. 54.

Lower claw, on all feet with only indistinct lamella, about half as long as the upper claw.

Hab.—Berkhamsted, on Red Currant leaves (few).

var. **pallipes** (Bourl.).

Hab.—Berkhamsted, on Red Currant leaves along with the yellow form.

Genus **Sminthurus,** Latr., Börn.

Smynthurus, Latreille, Hist. Nat. Crust. et Ins., 1804.*
Sminthurus, Börner, Das Syst. d. Coll., 1906, p. 183.

66.—**Sminthurus viridis** (Linn.).

Podura viridis, Linné, Syst. Nat., Ed. X, 1758, p. 608.*
Smynthurus viridis, Lubbock, Monograph, 1873, p. 100.

Hab.—Berkhamsted, on puddles of water in a pasture field (few); under rails on the ground (few); amongst newly-mown grass (fairly common); amongst heather (few).

Genus **Allacma**, Börn.

Allacma, Börner, Das Syst. d. Coll., 1906, p. 183.

67.—**Allacma fusca** (Linn.).

Podura fusca, Linné, Syst. Nat., Ed. X, 1758, p. 608.*
Smynthurus fuscus, Lubbock, Monograph, 1873, p. 101.

Eyes, 8 on each side of the head. Upper claw with tunica and pseudonychium. Tibio-tarsus without clavate hairs. Dens with 2-3 clavate hairs. Mucro with toothed inner margin. Colour dark brown.

Hab.—Berkhamsted, under chips of wood and sticks (common).

Sub-Family **Dicyrtominae**, Börn.

Dicyrtominae, Börner, Neue Coll. u. z. Nomen. d. Coll. Lubb., 1901, p. 711.

Genus **Dicyrtoma**, Bourl., Börn.

Dicyrtoma, Bourlet, Mém. s. l. Podurelles, 1843.*
Dicyrtoma, Börner, Das Syst. d. Coll., 1906, p. 184.

68.—**Dicyrtoma fusca** (Luc., Lubb.).

Smynthurus fuscus, Lucas, Thys. d. l'Alg., 1849.*
Papirius cursor, Lubbock, Notes on the Thys., Pt. I, 1862, p. 436.
Papirius fuscus, Lubbock, Monograph, 1873, p. 120.

Upper claw without tunic, with 2 inner teeth and 2 lateral teeth on each side. Lower claw with long sub-apical appendage reaching past the end of the upper claw. Dens with setae serratae. Colour dark brown, head with a yellowish tinge.

Hab.—Berkhamsted, under a stick (1 specimen).

Genus **Dicyrtomina**, Börn.

Dicyrtomina, Börner, Das Syst. d. Coll., 1906, p. 183.

69.—**Dicyrtomina minuta** (O. Fabr., Tullb.).

Podura minuta, O. Fabricius, Besk. ov. nog. lid. bekj. Pod., og en besond. Loppe, 1783, p. 307.*
Papirius minutus, Tullberg, Sver. Pod., 1872, p. 35.
Papirius nigromaculatus, Lubbock, Monograph, 1873, p. 127.

Eyes, 8 on each side of the head. Upper claw with tunic. Dentes without setae serratae. Colour yellow, with squarish black anal patch.

Hab.—Berkhamsted, under sticks on the ground in a grass field (common); on water in a cart rut (fairly common); beaten from a Gorse bush (few).

var. **ornata** (Lubb.).

Hab.—Berkhamsted, under sticks, bark and rails on the ground (common); amongst decaying leaves (common).

INDEX TO GENERA AND SPECIES.

INDEX TO GENERA AND SPECIES.

BIBLIOGRAPHY.

1. **Ågren, H.**—Zur Kenntniss der Apterygoten-Fauna Süd-Schwedens. Stett. Entomol. Zeit., 1903, pp. 113-176, pl. II.
2. **Axelson, W. M.**—Vorläufige Mittheilung über einige neue Collembolen-Formen aus Finnland. Meddel. Soc. pro Fauna et Flora Fenn., 1900, H. 26.
3. **Axelson, W. M.**—Diagnosen neuer Collembolen aus Finland und angrenzenden Teilen des nordwestlichen Russlands. Meddel. Soc. pro Fauna et Flora Fennica, 1902, Heft 28, No. 19, pp. 101-111.
4. **Bagnall, R. S.**—The Bristle-tails (Thysanura) of the Derwent Valley. Transactions of the Vale of Derwent Nat. Field Club (n.s.), 1908, vol. i, part i, pp. 26-30.
5. **Börner, C.**—Vorläufige Mittheilung über einige neue Aphorurinen und zur Systematik der Collembola. Zool. Anz., 1901, Bd. xxiv, No. 633, pp. 1-15.
6. **Börner, C.**—Zur Kenntnis der Apterygoten-Fauna von Bremen und der Nachbardistrikte. Beitrag zu einer Apterygoten-Fauna Mitteleuropas. Abh. Nat. Ver. Brem., 1901, Bd. xvii, Heft 1, pp. 1-141, pls. i, ii, text figs. 1-63.
7. **Börner, C.**—Über ein neues Achorutidengenus Willemia, sowie 4 weitere neue Collembolenformen derselben Familie. Zool. Anz. 1901, Bd. xxiv, No. 648, pp. 422-433, figs. 1-9.
8. **Börner, C.**—Neue altweltliche Collembolen, nebst Bemerkungen zur Systematik der Isotominen und Entomobryinen. Sitzungs-Ber. der Gesellsch. naturf. Freunde zu Berlin, 1903, No. 3, pp. 129-182, 1 pl.
9. **Börner, C.**—Das System der Collembolen nebst Beschreibung neuer Collembolen des Hamburger Naturhistorischen Museums. Mitt. aus dem Naturhist. Museum, Hamburg, 1906, vol. xxiii, pp. 147-188, with 4 text figs.
10. **Börner, C.**—Collembola Symphypleona, Fam. *Neelidae*. Genera Insectorum, 1906, Fasc. 45, pp. 1-5, with 1 pl.
11. **Börner, C.**—Collembolen aus Südafrika, nebst einer Studie über die I Maxille de Collembolen. L. Schultze, Forschungsreise im westl. u. zentral. Südafrika, 1903-1905. (Denkschriften der mediz.-naturw. Gesellsch., Bd. 13) IV Insecta, 1908, pp. 53-68, Taf. 6, 7, u. Text figs. 1-15.
12. **Börner, C.**—Japans Collembolenfauna. SB. Gesell. naturf. Freunde z. Berlin, 1909, No. 2, pp. 99-135 (Published Feb. 9, 1909).

13. **Bourlet, M. l'abbé.**—Mémoire sur les Podures. Mém. Soc. des Scienc. de l'Agricult. de Lille, T. i, 1839, pp. 377-417, 1 Taf.

14. **Bourlet, M. l'abbé.**—Mémoire sur les Podurelles. Mém. Soc. Roy. et Centr. d'Agricult., Scienc. et Arts du Depart. du Nord, séant à Douai, 1841-1842. Douai, 1843, pp. 1-78, 1 pl.

15. **Brook, G.**—On a new Genus of Collembola (*Sinella*) allied to *Degeeria,* Nicolet. Journ. Linn. Soc. Zool., 1882, vol. xvi, pp. 541-545, figs. 1-3.

16. **Brook, G.**—A Revision of the Genus *Entomobrya,* Rond. (*Degeeria,* Nic.). Journ. Linn. Soc. Zool., 1883, vol. xvii, pp. 270-283, pls. x, xi.

17. **Burmeister, H.**—Handbuch der Entomologie. Bd. ii, Berlin, 1838.

18. **Carpenter, G. H.**—The Collembola of Mitchelstown Cave. Irish Naturalist, 1897, vol. vi, No. 9, pp. 225-233, pl. 2.

19. **Carpenter, G. H.**—Springtails as Injurious Insects. Proc. Assoc. Econ. Biol., 1905, vol. i, pt. i, pp. 14, 15.

20. **Carpenter, G. H., and W. Evans.**—The Collembola and Thysanura of the Edinburgh District. Proc. Roy. Phys. Soc., Edin., 1899, vol. xiv, pp. 221-266, pls. v-viii.

21. **Carpenter, G. H., and W. Evans.**—Some Springtails new to the British Fauna, with Description of a New Species. Proc. Roy. Phys. Soc., Edin., 1904, vol. xv, pt. 2, pp. 215-220, pl. iv.

22. **Collinge, W. E.**—The Rôle of Collembola in Economic Entomology. Journ. Econ. Biol., 1909, vol. iv, pt. 3, pp. 83-86, fig. 1. (Published Sept. 30th. 1909).

23. **Collinge, W. E.**—Note on *Amerus normani.* Journ. Econ. Biol., 1909, vol. iv, pt. 4, p. 124. (Published Dec. 16th, 1909).

24. **Collinge, W. E.**—Collembola as Injurious Insects. Journ. Econ. Entom., 1910, vol. iii, pp. 204, 205.

25. **Collinge, W. E.**—A Preliminary List of the Thysanura and Collembola of the Midland Plateau. The Fauna of the Midland Plateau, Birmingham, 1910, pp. 1-14, figs. 1-6.

26. **Collinge, W. E., and J. W. Shoebotham.**—Descriptions of two new species of Collembola. Journ. Econ. Biol., 1909, vol. iv, pt. 1, pp. 9-13, pl. iii. (Published April 23rd, 1909).

27. **Collinge, W. E., and J. W. Shoebotham.**—Description of a New Genus of Collembola of the Family *Neelidae,* Folsom. Journ. Econ. Biol., 1909, vol. iv, pt. 2, pp. 45-50, pl. vi. (Published July 7th, 1909).

28. **Collinge, W. E., and J. W. Shoebotham.**—Notes on some Collembola new to Great Britain. Journ. Econ. Biol., 1909, vol. iv, pt. 3, pp. 87-90. (Published Sept. 30th, 1909).

29. **Dalla Torre, K. W. v.**—Die Gattungen und Arten der Apterygogenea (Brauer). 46 Programm des K.K. Staats-Gymnasiums in Innsbruck, 1895.

30. **Fabricius, O.**—Beskrivelse over nogle lidet bekjendte Podurer, og en besonderlig Loppe. Kong. Danske Vidensk. Selsk. Skr., D. ii, 1783.

31. **Fitch, A.**—Eighth Report on the noxious and other insects of the State of New York. 1862.

32. **Folsom, J. W.**—*Neelus murinus,* representing a new Thysanuran Family. Psyche, 1896, vol. vii, No. 242, pp. 391, 392, plt. 8.

33. **Geoffroy, E. L.**—Histoire abrégée des insectes qui se trouvent aux environs de Paris. T. ii, Paris, 1762.

34. **Gmelin, J. F.**—Linnaei Systema Naturae, Ed. xiii, aucta, reformata. T. i, P. 6, 1788-93.

35. **Guthrie, J. E.**—The Collembola of Minnesota. Geol. and Nat. Hist. Surv. of Minnesota, Zool. Series, iv, 1903, pp. 1-110, pls. 1-16.

36. **Imms, A. D.**—Anurida. L.M.B.C. Memoirs, xiii, 1906, pp. 1-99, pls. 1-7.

37. **Koch, K. L.**—Poduridae. A. C. Fürnrohr, Naturhistorische Topographie von Regensburg, Bd. iii, Fauna Ratisbonensis, 1840, pp. 352-359.

38. **Laboulbène, A.**—Recherches sur l'Anurida maritima, insecte Thysanoure de la famille des Podurides. Ann. Soc. Ent. de France, 1864, Sér 4, Tome iv, pp. 705-720.

39. **Latreille, P. A.**—Histoire Naturelle générale et particulière des Crustacés et des Insectes. T. viii, Paris, 1804.

40. **Lie-Pettersen, O. J.**—Norges Collembola. Fortegnelse over de i Norge hidtil observerede arter. Bergens Museums Aarbog, 1896, No. viii, pp. 1-24, pls. i, ii.

41. **Lie-Pettersen, O. J.**—Apterygogenea in Sogn und Nordfjord 1897 u. 98 eingesammelt. Bergens Museums Aarbog, 1898, No. vi, pp. 1-17, 1 pl.

42. **Linnaniemi, W. M. (Axelson).**—Die Apterygotenfauna Finlands, I Allgemeiner Teil. Akademische Abhandlung, 1907, Helsingfors, pp. 1-134 and i-xii, with map.

43. **Linné, C.**—Systema Naturae. Ed. ii, Holmiae, 1740.

44. **Linné, C.**—Fauna Suecica. Ed. i, Stockholmiae, 1746.

45. **Linné, C.**—Systema Naturae. Ed. x, Holmiae, 1758.

46. **Linné, C.**—Fauna Suecica. Ed. ii, Stockholmiae, 1761.

47. **Linné, C.**—Systema Naturae, Ed. xii. T. i, Holmiae, 1766.

48. **Lubbock, J.**—Notes on the Thysanura, part i, *Smynthuridae*. Trans. of the Linn. Soc., 1862, vol. xxiii, pp. 429-448, pls. 45; 46.

49. **Lubbock, J.**—Notes on the Thysanura, part ii. Trans. of the Linn. Soc., 1862, vol. xxiii, pp. 589-601, pl. 59.

50. **Lubbock, J.**—Notes on the Thysanura, part iii. Trans. of the Linn. Soc., 1868, vol. xxvi.

51. **Lubbock, J.**—Notes on the Thysanura, part iv. Trans. Linn. Soc., 1870, vol. xxvii, pp. 277-297, pls. 45, 46.

52. **Lubbock, J.**—Monograph of the Collembola and Thysanura. London, Ray Society, 1873, pp. 1-276, pls. 1-78.

53. **Lubbock, J.**—On a new Genus and Species of Collembola from Kerguelen Island. Ann. and Mag. of Nat. Hist., 1876, vol. xviii.

54. **Lucas, H.**—Thysanoures de l' Algerie. Exploration scientifique de l' Algerie pendant les années 1840-1842, Zoologie, i. Histoire Naturelle des Animaux articules, par H. Lucas, vol. i, Paris, 1849.

55. **Moniez, R.**—Espèces nouvelles des Thysanoures trouvées dans la Grotte de Dargilan. Rev. Biol. Nord France, 1893, vol. vi, pp. 81-86.

56. **Müller, O. F.**—Zoologiae Danicae Prodromus. Hafniae, 1776.

57. **Nicolet, H.**—Recherches pour servir à l'histoire des Podurelles. Mém. de la Soc. Helv. des Sc. Nat., 1842, Tome vi, pp. 1-88, pls. 1-9.

58. **Nicolet, H.**—Essai sur une classification des Insectes Apteres de l'ordre des Thysanoures. Ann. de la Soc. Entom. de France, 1847, Sér. ii, Tome v, pp. 335-395.

59. **Packard, A. S.**—Synopsis of the Thysanura of Essex County, Mass., with Descriptions of a few extralimital forms. Fifth Ann. Rpt. Peabody Ac. Sci., 1873, pp. 23-51.

60. **Reuter, O. M.**—För Finland nya Collembola. Medd. Soc. Faun. Flor. Fenn., 1878, vol. vi, pp. 203, 204.

61. **Reuter, O. M.**—Études sur les Collemboles. I-III. Act. Soc. Scient. Fenn. 1880, xiii, 20 pp., 1 pl.

62. **Reuter, O. M.**—Apterygogenea Fennica. Finlands Collembola och Thysanura. Acta Soc. pro Fauna et Flora Fennica, 1895, vol. xi, No. 4, pp. 1-35, pls. i, ii.

63. **Schäffer, C.**—Die Collembola der Umgebung von Hamburg und benachbarter Gebiete. Mitth. aus dem Naturhist. Museum, 1896, vol. xiii, pp. 149-216, pls. i-iv.

64. **Schäffer, C.**—Ueber Württembergische Collembola. Jahresh. d. Ver. f. Vaterl. Naturk. in Württemberg, 1900, Bd. 56, pp. 245-280, pl. vi.

65. **Schött, H.**—Zur Systematik und Verbreitung palaearctischer Collembola. Kongl. Svenska Vet.-Akad. Handl., 1893, vol. xxv, No. 11, pp. 1-100, pls. i-vii.

66. **Schött, H.**—Études sur les Collemboles du Nord. Bihang till K. Svenska Vet.-Akad. Handl., 1902, Band 28, Afd. iv, No. 2, pp. 1-48, pls. i-vi.

67. **Shoebotham, J. W.**—List of Injurious and Beneficial Insects and other animals received during 1908. Journ. Cooper Research Lab., Berkhamsted, 1909, No. i, pp. 57-67. (Collembola and Thysanura, p. 58). (Published April 23rd, 1909).

68. **Templeton, R.**—Thysanurae Hibernicae. Trans. Ent. Soc., 1834, vol. i, pp. 89-98, pls. xi, xii.

69. **Tullberg, T.**—Om Skandinaviska Podurider af underfamiljen Lipurinae. Akademisk Afhandling, Upsala, 1869, pp. 1-21.

70. **Tullberg, T.**—Förteckning öfver Svenska Podurider. Öfvers. Kongl. Vet.-Akad. Forhandl., 1871, Årg. 28, No. i, pp. 143-155.

71. **Tullberg, T.**—Sveriges Podurider. Kongl. Svenska Vetens.-Akad. Handl., 1872, vol. x, No. 10, pp. 1-70, pls. i-xii.

72. **Tullberg, T.**—Collembola borealia—Nordiska Collembola. Öfvers. Kongl. Vet.-Akad. Forhandl., 1876, Årg. 33, No. 5, pp. 23-42, pls. viii-xi.

73. **Wahlgren, E.**—Ueber die von der schwedischen Polarexpedition, 1898, gesammelten Collembolen. Öfv. Kongl. Vet.-Akad. Förhandl., 1899, No. 4, pp. 335-340, figs. 1-8.

74. **Wankel, H.**—Beiträge zur mährischen Grottenfauna. Sitzungsb. der kais. Acad. der wissensch. in Wien, Bd. xliii, 1861, p. 251.

75. **Willem, V.**—Un type nouveau de sminthuride : *Megalothorax*. Ann. Soc. Ent. Belg., 1900, T. 44, pp. 7-10, 1 pl.

76. **Willem, V.**—Note préliminaire sur les Collemboles des grottes de Han et de Rochefort. Ann. Soc. Entom. Belg., 1902, T. xlvi, pp. 275-283.

77. **Börner, C.**—Neue Collembolenformen und zur Nomenclatur der Collembola Lubb. Zool. Anz., 1901, Bd. xxiv, No. 657/658, pp. 696-712, figs. 1-10.

REVIEWS.

Daniels, C. W., and E. Wilkinson.—Tropical Medicine and Hygiene. Pt. i. Diseases due to Protozoa. Pp. v + 264, 2 cold. plts. and 69 figs. London: John Bale, Sons, Danielsson, Ltd. 1909. Price: 7s. 6d. net.

This work is to be completed in three parts. The first, under review, treats of those diseases known to be due to Protozoa; in the second part those diseases due to the higher forms of animal life will be considered; whilst part three will be devoted to bacterial diseases, to the effects of certain animal and vegetable poisons and to certain diseases, the causation of which is unknown or but imperfectly understood.

The authors open with a capital introductory chapter treating of the classification and life-history of the Protozoa; the various diseases are next very clearly described, then clinical features, methods of examination, and the preventive measures.

There are a series of very useful appendices, dealing with notable dates, important measurements, classification of Diptera, ticks, etc.

The work forms a most valuable addition to the literature on tropical medicine, and students of the same will look forward to the early completion of the remaining parts of what promises to be a standard treatise.

W. E. C.

Ellis, David.—Outlines of Bacteriology (Technical and Agricultural). Pp. xii + 262, 134 figs. London: Longmans, Green and Co., 1909. Price 7s. 6d. net.

Bacteriology plays so important a part in up-to-date agriculture that we are somewhat surprised that no one has ere now thought it worth while to incorporate within a readable volume the recent developments that are of fundamental importance.

Dr. Ellis' work is just the one that we have hitherto looked for (in vain), and we heartily commend it to all who take an interest in the subject.

The author has steered clear of controversial questions and those requiring a technical knowledge of a special nature, his aim being the demonstration of the fundamental principles which underlie that application, rather than the discussion of the details.

His own experience as a teacher of the subject has served him well, and we heartily commend this work as one of more than usual merit.

W. E. C.

Green, E. Ernest.—The Coccidae of Ceylon. Part iv, pp. 251-344, plts. xciv-cxxxii. London: Dulau and Co., 1909.

When about to issue the first part of this valuable monograph the author estimated that it would probably extend to four parts, each containing thirty plates. On completing the fourth part, however, he finds, in spite of the addition of the 15 extra plates, it will be necessary to bring out a fifth part of double size, containing from fifty to sixty plates.

The part before us deals with the remaining species of the sub-family *Lecaniinae,* treating of nine genera and nineteen species, of which ten are new, and commences the new sub-family *Asterolecaniinae,* treating of six genera, twenty-four species and two varieties, of which seventeen are new.

The work evidences an enormous amount of personal observation and investigation, whilst the labour bestowed upon the illustrations makes it one of the most important that has been issued upon this particularly interesting family of insects, and at the same time places students of the *Coccidae* and entomologists generally under a further debt of gratitude to the author.

We look forward with much interest to a further part and supplemental parts.

W. E. C.

Henderson, R.—The Estate Manager. Pp. xv + 548, 133 figs. Edinburgh: William Green and Sons, 1910. Price 15s.

The author has succeeded in presenting within the compass of a single volume a very complete résumé of the technical knowledge required by estate managers, and at the same time a useful work of reference. In the main he deals with the general principles, as a lead to beginners on one hand, and as matter that may be suggestine to many men in practice on the other.

The work contains much sound advice, and whilst in some cases we differ from the opinions expressed, it will be found most useful, and in many cases be distinctively suggestine of better methods.

Beginners will find much to absorb and profit by, and to such we recommend a careful perusal.

L. G.

Hewitt, C. Gordon.—The House Fly, *Musca domestica,* Linnaens. Pp. xiii + 195, 10 plts. Manchester: The University Press. 1910. Price 20s. net.

We welcome the publication of Dr. Hewitt's papers on the House Fly in a single volume. The author has taken the opportunity of adding an

introduction, various appendices, and an index, all of which greatly add to the value of an excellent piece of work.

It seems strange that no one had previously thought it worth while to treat of this common insect in detail; it is another instance of the enormous amount of work that awaits the economic zoologist.

Dr. Hewitt's work is already known to zoologists throughout the world; it is therefore unnecessary to comment upon it beyond stating that it is thorough without being verbose, ably conceived, and beautifully illustrated.

We understand that only 200 copies are being offered for sale; those therefore desiring one should order at once.

W. E. C.

Massee, George.—Diseases of Cultivated Plants and Trees. Pp. xii + 652, 171 figs. London: Duckworth and Co., 1910. Price 7s. 6d. net.

It would be useless to deny the fact that from various sources there is a demand for a work on diseases of plants due to fungi. Hitherto we have had to content ourselves with the works by Hartig and Somerville, Dr. M. C. Cooke, Tubeuf and Smith, etc., but none of these exactly meet our requirements. True it is, there are one or two excellent but somewhat costly German works, but a work in English has been much desired; we are therefore somewhat surprised that the author of this excellent handbook has not attempted a much more ambitious production.

Mr. Massee's work deals with a number of causes of disease besides fungi, and his pertinent remarks on primary and secondary causes, epidemics, how plants are infected by fungus spores, how fungus diseases are disseminated, facts not generally known, wounds, drought, injuries due to frost and hail, chlorosis, injury by smoke, acid fumes, gas, etc., intumescens or warts, fasciation, bacteriology of the soil, economic aspects of plant diseases, fungicides, spraying, and injury caused by non-parasitic or undetermined organisms, though brief, will be read with interest.

In addition to the parasitic fungi-causing diseases, there are sections devoted to lichenes, bacteria, myxogastres, injuries caused by animals and birds, mites and eelworms.

Mr. Massee deprecates, as all right-thinking economic biologists must, the stump-orator "whose energies are expended in denouncing the powers that be for not promptly suppressing all traces of (the) disease from the British Empire." Such self-advertising methods we have no patience with, and they appear dreadfully purile and foolish by the side of the retiring and patient labours of the author of this manual.

T

In the words of Colonel Prain, who contributes a short intoduction, the work is " the outcome of long-continued, personal investigation of the morphological and biological peculiarities of many types of the organisms that cause or are associated with cases of disease in plants, by a writer who is not only capable of representing accurately the views of others, but is competent to give reasons for the faith which he himself professes."

The book is well printed, in a handy form, and illustrated by numerous figures.

We have by no means exhausted the good features of this book, but the exigencies of space forbid us to go further.

There are a few omissions at which we are, in a sense, surprised; thus we find no mention of Professor Gilchrist's work on " Finger and Toe " disease, Professor Buller's on *Polyporus squamosus,* Miss Bayliss' on *Polystictus versicolor,* Mr. C. E. C. Fischer's on *Pestalozzia hartgii,* and Sir Charles Whitehead's on Potato Disease, all original contributions to the subject; whilst there is a large mass of literature which the author does not seem to have made use of, time and space, no doubt, being the causes.

We sincerely hope that the reception of the present volume will induce the author to undertake a much more ambitious work dealing with the various diseases in greater detail and with more illustrations.

W. E. C.

Theobald, Fred. V.—A Monograph of the *Culicidae* or Mosquitoes. Mainly compiled from Collections received at the British Museum. Vol. v, pp. xv + 646, plts. i-vi, 261 figs. London, 1910. Published by the Trustees of the British Museum. Price £1 5s. od.

The economic importance of the *Culicidae* have been responsible for a voluminous literature during the past few years, and the new genera and species seem legion.

In a preface to Mr. Theobald's fifth volume Dr. Harmer points out that the first two volumes have for some time been out of print, and it has been decided to include in the present volume some mention at least of all the species described in any of its predecessors.

The fifth volume contains descriptions of 21 genera and 392 species. We are glad to see that the author enters a protest against the wholly inadequate diagnoses of certain American writers, and against genera and species founded in larval characters. It is becoming more and more common amongst the entomologists of the United States to describe new genera and species in this manner, whilst in many cases illustrations are regarded as entirely superfluous.

Mr. Theobald has worked out synoptic tables of the genera and

species in each genus of the *Anophelinae, Megarhininae, Culicinae, Heptaphlebomyinae, Uranotaeninae,* but lack of time has not yet permitted him to do the same for all the *Aedinae,* not the unbanded-legged species of the genus *Culex*. These will undoubtedly prove most useful.

The author adheres to the system of classification by scale-structure, and to our surprise, it apparently works out well in practice. Taxonomic conclusions, founded upon the larval characters, are unsatisfactory and dangerous, and those on palpal structure, whilst being important, do not lend themselves to the method of simple grouping as do scale-structure ones.

There are numerous excellent illustrations, many of which are original. The absence of reference figures to these, however, in the text, is regrettable.

Mr. Theobald has our heartiest congratulations upon the completion of a most laborious piece of work.

W. E. C.

Wheeler, W. M.—Ants, their Structure, Development and Behaviour. Pp. xxv + 663, 1 plt. and 286 figs. New York: The Columbia University Press; London: Macmillan and Co., Ltd., 1910. Price, 21s. net.

This is a truly fascinating work, and at a time when the teaching of zoology consists almost wholly of an elementary knowledge of the structure of a few animal types (excellent as a means to an end), it will be welcomed by all who take an interest in the study of the life-history and habits of animals.

As the author points out, he has endeavoured to appeal to several classes of readers, viz., the general reader, the zoologist, the entomologist, and the comparative psychologist.

The work covers a wide field, and it is only possible here to very briefly outline the ground covered. He commences by reviewing ants as dominant insects, and instances a number of factors in proof; the probable cause of this dominance, their economic importance, and the maze of fascinating problems they present to the biologist are also dealt with.

Chapters 2-4 treat of the external and internal structure, chapter 5 with their development, chapters 6 and 7 with their polymorphism, whilst the remaining chapters deal with the history of myrmecology, the classification and distribution of ants, their habits, ant-nests, the relation of ants to vascular plants, the symbiotic relation between the fungus-growing ants and their fungi, the relations of ants to various insects, ant guests, ecto- and entoparasites, the compound nests, and parasitism, etc.

The three concluding chapters deal with the psychological and

metaphysical aspects, and there are also a series of appendices, including an extensive bibliography.

It is impossible in a review of a work of this extent to do more than point out the important topics dealt with, and to express our highest praise for such an able and valuable treatise, which should find a place in the library of every biologist and entomologist, and of every natural history society in the country.

W. E. C.

CURRENT LITERATURE.

I.—General Subject.

Annual Report of the Board of Scientific Advice for India for the year 1908-09. Pp. viii + 245 + iii. Calcutta: 1910. Price 1s. 6d.

Beal, W. J.—Seeds of Michigan Weeds. Mich. Agric. Exp. Stat., Bull. 260, 1910, pp. 103-182, 214 figs.

A very useful publication.

Nelson, J.—Report of the Biologist. 13th Ann. Rpt. N.J. Agr. Exp. Stat., 1910, pp. 223-266, plts. i-v.

II.—Anatomy, Physiology, and Development.

Becker, R.—Zur Kenntnis dei Mundteile und des Kopfes der Dipteren-Larven. Zool. Jahrb. (Abt. Anat.), 1910, Bd. xxix, pp. 281-314, Taf. 17-19, u. 4 fig.

Bordas, L.—Considérations générales sur les tubes de Malpigi des larves de Lépidoptères. Compt. Rendus, 1910, pp. 737-739.

Grove, A. J.—The Anatomy of *Siphonophora rosarum,* Walk., the "Greenfly" pest of the Rose. Parasitology, 1910, vol. iii, pp. 1-16, plts. i, ii.

Kershaw, J. C. W., and G. W. Kirkaldy.—A Memoir on the Anatomy and Life-history of the Homopterous Insect *Pyrops candelaria* or Candle Fly. Zool. Jahrb. (Abt. System.), 1910, Bd. xxix, pp. 105-124, Taf. 8-10.

Pérez, Ch.—Recherches histologiques sur la métamorphose des Muscides (*Calliophora erythrocephala,* Mg.). Arch. Zool. exp. et gen., 1910, Bd. xliv, pp. 1-274, plts. 2-16 et 162 figs.

Portchinsky, J.—Sur les larves de Gastrophilus. Zool. Anz., 1910, Bd. xxxv, pp. 669, 670.

Railliet, A. et A. Henry.—Etude Zoologique de l' Oesophagostome de Thomas. Ann. Trop. Med. and Paras., 1910, vol. iv, pp. 89-94, plt. vi.

Tobey, E. N.—The Cytology and Life-history of Trypanosomes. Journ. Med. Research, 1910, vol. xxii, pp. 379-387.

III.—General and Systematic Biology, and Geographical Distribution.

Bagnall, R. S.—A Contribution towards a Knowledge of the Neotropical Thysanoptera. Journ. Linn. Soc. (Zool.), 1910, vol. xxx, pp. 369-387, plts. 51-53.

Baker, C. F.—Californian *Emesidae* (Hemiptera). Pomona Coll. Journ. Entom., 1910, vol. ii, pp. 225-227, 1 fig.

Banks, Nathan.—The Scorpions of California. Pomona Coll. Journ. Entom., 1910, vol. ii, pp. 185-190, 2 figs.

Banks, Nathan.—Catalogue of Nearctic Spiders. U.S. Nat. Mus., Bull. 72, 1910, pp. 1-80.

Bayer, Émile.—Les Zoocécidies de la Bohême. Marcellia, 1910, vol. ix, pp. 63-72.

Brunetti, E.—Notes on Ceylon Diptera. Spolia Zeylanica, 1910, vol. vi, pp. 170-172.

Cockerell, T. D. A.—The Northern American Bees of the Genus *Nomia*. Proc. U.S. Nat. Mus., 1910, vol. xxxviii, pp. 289-298.

Cook, M. T.—Cecidology in America. Bot. Gaz., 1910, pp. 219-222.

Crawford, D. L.—American *Psyllidae*, I. *Triozinae*. Pomona Coll. Journ. Entom., 1910, vol. ii, pp. 228-237, 2 figs.

Crawford, J. C.—Three new Genera and Species of Parasitic Hymenoptera. Proc. U.S. Nat. Mus., 1910, vol. xxxviii, pp. 87-90, 5 figs.

The new genera and species are *Erixestus winnemana, Psylledontus insidiosus, Plagiomerus diaspidis*.

Crawford, J. C.—New Hymenoptera from the Philippine Islands. Proc. U.S. Nat. Mus., 1910, vol. xxxviii, pp. 119-133.

Describes a number of new genera and species, but none are figured.

Crawford, J. C.—Descriptions of Certain Chalcidoid Parasites. U.S. Dept. Agric., Bur. of Entom., Tech. Ser. No. 19, Pt. ii, 1910, pp. 13-24, figs. 8-22.

The following species are new:—*Chalcis fiskei, C. paraplesia, Perilampus inimicus, Hypopteromalus apantelophagus, H. poecilopus, Pleurotropis orientalis, P. howardi,* and *Dimmockia secundus,* all from Japan.

Dyar, H. G.—Descriptions of some new Species and Genera of Lepidoptera from Mexico. Proc. U.S. Nat. Mus., 1910, vol. xxxviii, pp. 229-273.

Unfortunately there are no figures.

Essig, E. O.—Notes on Californian *Coccidae.* V. Pomona Coll. Journ. Entom., 1910, vol. ii, pp. 209-222, 14 figs.

Essig, E. O.—*Aphididae* of Southern California. IV. Ibid., pp. 223, 224, 1 fig.

Fletcher, T. B.—The Plume Moths of Ceylon. Pt. ii. The *Orneodidae.* Spolia Zeylanica, 1910, vol. vi, pp. 150-169, plts. G and H, and 8 figs.

In this interesting paper the plate figures are largely spoilt by being reproduced upon a brown-tinted paper instead of a snowy-white.

Girault, A. A., and G. E. Sanders.—The Chalcidoid Parasites of the Common House or Typhoid Fly (*Musca domestica,* L.) and its allies. Psyche, 1910, vol. xvii, pp. 9-28.

Hancock, G. L.—Notes on Ceylonese *Tetriginae* (Orthoptera), with Descriptions of some new Species. Spolia Zeylanica, 1910, vol. vi, pp. 140-149.

Höppner, H.—Zur Biologie der Rubusbewohner. Zeit. f. wiss. Insektenbiol., 1910, Bd. vi, pp. 161-167, 6 figs.

Howard, L. O.—On the Habit with certain Chalcidoidea of feeding at puncture holes made by the ovipositor. Journ. Econ. Entom., 1910, vol. 3, pp. 257-260.

Hine, J. S.—Comparative Study of Four Genera of Horse Flies. Ohio Nat., 1910, vol. x, pp. 149-151, 5 figs.

Jensen-Haarup, A. C.—*Anobium pertinax* and barometrical minima. Zeit. f. wiss. Insektenbiol., 1910, Bd. vi, pp. 167-169.

Johannsen, O. A.—The *Mycetophilidae* of North America. Pt. 1. Maine Agric. Exp. Stat., Bull. No. 172, 1909, 1910, pp. 209-276, 3 plts.

Lefroy, H. Maxwell.—Life-histories of Indian Insects. Coleoptera, 1. Mem. Dept. Agric. India, Entom. Ser., 1910, vol. ii, pp, 139-163, plts. xiii-xix.

Leigh, H. S.—A Biological Inquiry into the Nature of Melanism in *Amphidasys betularia,* Linn. Entom. Rec., 1910, vol. xx, 1 pp., plt. v.

Metz, C. W.—Bees of the Genus *Colletes* from Mexico. Pomona Coll. Journ. Entom., 1910, vol. ii, pp. 191-208, 8 figs.

Mitterberger, F.—Beitrag zur Biologie von *Scardia boletella,* F. Zeit. f. wiss. Insektenbiol., 1910, Bd. vi, 171-173.

Nalepa, A.—Die Besiedlung neuer Wirtspflanzen durch die Gallmilben. Marcellia, 1910, vol. ix, pp. 105-109.

Neumann, L. G.—Un nouveau Nématode parasite du Boeuf (*Onchocerca gutturosa,* n.sp.). Rev. Vétér., 1910, pp. 270-278, 5 figs.

Neumann, L. G.—Description de deux nouvelles espèces d' Ixodinae. Tijdsch. v. Entom., 1910, D. liii, pp. 11-17, Pl. i.

Newstead, R., and H. W. Thomas.—The Mosquitoes of the Amazon Region. Ann. Trop. Med. and Paras., 1910, vol. iv, pp. 141-150, plt. xi.

Mansonia longipalpis and *Neomelaniconion chrysothorax* are described and figured as new.

Pierre, L'Abbé.—La cécidie d'hiver de *Chlorops lineata,* Fabri. = *Taeniopus,* Meig. Marcellia, 1910, vol. ix, pp. 61, 62.

Rübsaamen, Ew. H.—Beiträge zur Kenntnis Aussereuropäischer Zooceciden. iv. Afrikanische Gallen. Marcellia, 1910, vol. ix, pp. 1-36, 31 figs.

Rohiver, S. A.—On a Collection of Teuthredinoidea from Eastern Canada. Proc. U.S. Nat. Mus., 1910, vol. xxxviii, pp. 197-209.

Smith, J. B.—The *Noctuidae* of California. I. Pomona Coll. Journ. Entom., 1910, vol. ii, pp. 179-184, 10 figs.

Thompson, W. R.—Notes on the Pupation and Hibernation of Tachinid Parasites. Journ. Econ. Entom., 1910, vol. 3, pp. 283-295.

Trotter, A.—Sulla possibilita di una omologia caulinare nelle galle prosoplatische. Marcellia, 1910, vol. ix, pp. 109-113.

Watson, M.—A new Anopheline from the Federated Malay States. Ann. Trop. Med. Paras., 1910, vol. iv, pp. 251-253, 1 fig.

IV.—Agriculture and Horticulture.

Back, E. A.—The Woolly White-fly: A new enemy of the Orange. (*Aleyrodes howardi,* Quaintance). U.S. Dept. Agric., Bur. of Entom., Bull. No. 64, pt. viii, 1910, pp. 65-71, plt. iv, figs. 19-22.

Ballou, F. H.—Protection of Fruit Trees from Rodents. Ohio Agric. Exp. Stat., Bull. 208, 1909, pp. 53-70, figs. 1-20.

Ballou, H. A.—Disinfection of Imported Plants. W.I. Bull., 1910, vol. x, pp. 349-372.

Britton, W. E.—Ninth Report of the State Entomologist for the Year 1909. Rpt. Conn. Agr. Exp. Stat., New Haven, Conn., 1910, pp. 323-374 + vi, plts. i-xvi and 9 figs.

Gives an excellent account of the Rosy Apple Aphis and Bud Moth, in addition to much other useful information on various insects. The illustrations are excellent.

Brooks, Charles.—Some Apple Diseases. New Hampshire Agric. Exp. Stat., Bull. 144, 1909, pp. 109-138, 29 figs.

Carruthers, J. B.—Cacao Canker. Bull Dept. Agric. Trinidad, 1910, vol. ix, no. 64, pp. 30, 31.

Coleman, L. C.—The Ring Disease of Potatoes (A Preliminary Report). Dept. Agric. Mysore State, Bull. No. 1, Mycolog. Ser., 1909, pp. 1-15, 14 plts.

Dr. Coleman, in the present report, gives a very useful account of this disease for those interested in potato cultivation, it being intended to deal with the subject at greater length in a later and more technical paper.

The disease is due to bacteria which infest the underground stalk, and later the tubers. Both tomatoes and brinjals are also liable to the disease.

Various experiments are in progress, and we look forward to particulars of these and their results.

Collinge, Walter E.—The Feeding Habits of the Rook (*Corvus frugilegus,* Linn.). Journ. Land Agents' Soc., 1910, vol. ix, pp. 183-201.

Collinge, Walter E.—Fourth Annual Report of the Honorary Consulting Zoologist. Journ. Land Agents' Soc., 1910, vol. ix, pp. 237-265, 15 figs.

Cordley, A. B., and C. C. Cate.—Spraying for Peach Fruit Spot. Oregon Agr. Exp. Stat., Bull. No. 106, 1909, pp. 1-15, 8 figs.

Cordley, A. B.—Insecticides and Fungicides. Ibid., Bull. No. 108, 1910, pp. 1-20.

Dean, W. H.—The Sorghum Midge. (*Contarinia* (*Diplosis*) *sorghicola,* Coq.). U.S. Dept. Agric., Bur. of Entom., Bull. No. 85, pt. iv, 1910, pp. 39-58, plts. i, ii, figs. 20-31.

Doidge, Ethel M.—Leaf Blight of the Pear and Quince (*Entomosporium maculatum,* Lév.). Transv. Agric. Journ., 1910, vol. viii, pp. 465, 466, plt. 85.

Evans, I. B. P.—Corky Scab of the Potato. Transv. Agric. Journ., 1910, vol. viii, pp. 462, 463, plt. 86.

Evans, I. B. P.—A New Disease of Citrus Fruits. The Natal " Black Rot " of the Lemon (*Diplodia natalensis,* P.E.). Ibid., pp. 463-465, 1 plt.

Houghton, C. O.—Two Important Leaf-Miners. Delaware Agric. Exp. Stat., Bull. No. 87, 1910, pp. 3-15, 3 figs.

The two species treated of are the Apple Leaf-miner (*Tischeria malifoliella,* Clem.), and the Blackberry Leaf-miner (*Scolioneura capitalis,* Norton).

Howard, C. W.—Locust Destruction in South Africa. Journ. Econ. Entom., 1910, vol. 3, pp. 260-272, plt. 19 and 2 maps.

Johannsen, O. A.—Insect Notes for 1909. Maine Agric. Exp. Stat., Bull. No. 177, 1910, pp. 21-44, figs. 10-57.

Johnston, J. R.—The Serious Coconut Palm Diseases in Trinidad. Bull. Dept. Agric. Trinidad, 1910, vol. ix, No. 64, pp. 25-29.

Kellerman, K. F.—The Functions and Value of Soil Bacteria. Yearbook U.S. Dept. Agric., 1909. Washington, 1910, pp. 219-226, 3 figs.

Lefroy, H. Maxwell.—A New Insecticide. Agric. Journ. India, 1910, vol. v, pp. 138-143.

McAlpine, D.—The Smut of Maize and its treatment. Journ. Dept. Agric. Victoria, 1910, vol. viii, pp. 290-298, 11 figs.

McAtee, W. L.—Plants Useful to Attract Birds and Protect Fruit. Yearbook U.S. Dept. Agric., 1909. Washington, 1910, pp. 185-196.

McRae, W.—The Outbreak of Blister-Blight on Tea in the Darjeeling district in 1908-1909. Agric. Journ. India, 1910, vol. v, pp. 126-137, plts. x-xiii, 1 fig.

Manns, Thos. F.—The Blade Blight of Oats—A Bacterial Disease. Agr. Exp. Stat. Ohio, Bull. 210, 1909, pp. 91-167, 2 plts. and 35 figs.

A disease caused by a symbiotic relation of two species of bacteria, the disease being greatly influenced by weather conditions and to some extent disseminated by insects.

Morgan, A. C.—Methods of Controlling Insects. U.S. Dept. Agric., Bur. of Entom., Circ. No. 123, 1910, pp. 1-17, 11 figs.

Nice, Margaret M.—Food of the Bobwhite. Journ. Econ. Entom., 1910, vol. 3, pp. 295-313.

Orton, W. A., and Ethel C. Field.—Wart Disease of the Potato. U.S. Dept. Agric., Bur. Plant Indus., Circ. No. 52, 1910, pp. 1-11.

Parker, W. B.—The Life-History and Control of the Hop Flea-beetle (*Psylliodes punctulata*, Melsh.). U.S. Dept. Agric., Bur. of Entom., Bull. No. 82, pt. iv, 1910, pp. 33-58, plts. iii, iv, figs. 8-17.

The author gives an excellent account of the life-history of this insect, its habits, seasonal history, and methods of control.

Patel, C. U.—Competition of Cultivators for checking the Stem-borer of Sesamum. Agric. Journ. India, 1910, vol. v, pp. 153-159, 1 fig.

Percival, J.—Potato Wart Disease. The life-history and cytology of *Synchytrium endobioticum* (Schilb.), Percl. Centralb. f. Bakter., 1909, Bd. xxv, pp. 440-447, 3 tav.

Pettit, R. H.—Insects of Field Crops. Michigan Agric. Exp. Stat., Bull. 258, 1910, pp. 35-84, 51 figs.

Pierce, W. M.—Fumigation Studies. II. Does ordinary contract fumigation pay? Pomona Coll. Journ. Entom., 1910, vol. ii, pp. 175-178.

Quaintance, A. L., and E. R. Sasscer.—The Oyster-shell Scale and the Scurfy Scale. U.S. Dept. Agric., Bur. of Entom., Cir. No. 121, 1910, pp. 1-15, 7 figs.

Rorer, J. B.—Preliminary Report on Cacao Spraying Experiments. Bull. Dept. Agric. Trinidad, 1910, vol. ix, No. 64, pp. 10-14.

Rorer, J. B.—The Bud-rot of the Coconut Palm. Ibid., pp. 22-24.

Rorer, J. B.—The Witch Broom Disease of Cacao in Surinam. Bull. Dept. Agric. Trinidad, 1910, vol. ix, No. 64, pp. 32-37.

Sanderson, E. Dwight.—The Codling Moth and How to Control it by Spraying. New Hampshire Agric. Exp. Stat., Bull. 143, 1909, pp. 61-106, 23 figs.

Scott, W. M.—The Substitution of Lime-Sulphur Preparations for Bordeaux Mixture in the Treatment of Apple Diseases. U.S. Dept. Agric. Bur. Plant Indus., Circ. No. 54, 1910, pp. 1-15.

Seymour, G.—Experiments with Potato Diseases, 1909-10. Journ. Dept. Agric. Vict., 1910, vol. viii, pp. 360-364, 7 figs.

Smith, J. B.—Report of the Entomologist. 13th Ann. Rpt. N.J. Agr. Exp. Stat., 1910, pp. 351-417, 12 figs.

Tempany, H. A.—The Root Disease of Sugar-Cane in Antigua. W.I. Bull., 1910, vol. x, pp. 343-347.

Urich, F. W.—Froghoppers in Sugar Cane. (*Tomaspis postica,* Walk.). Bull. Dept. Agric. Trinidad, 1910, vol ix, No. 64, pp. 15-21.

Vickery, R. A.—Contributions to a knowledge of the Corn Root-Aphis. (*Aphis maidi-radicis,* Forbes). U.S. Dept. Agric., Bur. of Entom., Bull. No. 85, pt. vi, 1910, pp. 97-118, figs. 54-59.

Wallace, E., and H. H. Whetzel.—Peach Leaf Curl. Cornell. Univ. Agric. Exp. Stat., Bull. 276, 1910, pp. 157-178, figs. 79-86.

Lime and sulphur have been used " with almost perfect results."

Webster, R. L.—The Apple Leaf-hopper, *Empoasca mali,* LeB. Exp. Stat. Ames, Iowa, Bull. 111, 1910, pp. 1-32, 14 figs.

Weldon, G. P.—Two Common Orchard Mites. Colorado Agric. Exp. Stat., Bull. 152, 1909, pp. 3-12, 7 figs.

Whetzel, H. H., and V. B. Stewart.—Fire Blight of Pears, Apples, Quinces, etc. Cornell. Univ. Agric. Exp. Stat., Bull. 272, 1909, pp. 31-51, figs. 5-23.

Whetzel, H. H.—Summer Use of Concentrated Lime-sulphur. N.Y. State Fr. Growers' Assoc., pp. 31-44.

Yothers, W. W.—The Effects of Fumigation with Hydrocyanic Gas on the Human System. Journ. Econ. Entom., 1910, vol. 3, pp. 317-319.

V.—Forestry.

Annand, J. F.—Observations on the Large Sawfly (*Nematus erichsoni,* Hart.), with suggestions for remedial and preventive treatment in infested Larch Woods. Quar. Journ. Fores., 1910, vol. iv, pp. 203-221, 1 plt., 3 figs.

Burke, H. E.—Injuries to Forest Trees by Flat-headed Borers. Yearbook U.S. Dept. Agric., 1909. Washington, 1910, pp. 399-415, figs. 25-36.

Fisher, W. R.—Recent Progress in Indian Forest Technology. Nature, 1910 (June 9th), pp. 428, 429.

Groom, Percy.—Remarks on the Oecology of *Coniferae*. Ann. Botany, 1910, vol. xxiv, pp. 242-269.

Jones, W. S.—A Disease of the Alder. Quar. Journ. Fores., 1910, vol. iv, pp. 221-224, 4 figs.

Lantz, D. E.—Pocket Gophers as Enemies of Trees. Yearbook U.S. Dept. Agric., 1909. Washington, 1910, pp. 209-218, plts. viii-x, 1 fig.

Lounsbury, Chas. P.—Giant Twig Gall, of Willow, Poplar, Peach, Apple, and other Trees. Agric. Journ. C. of G. H., 1910, vol. xxxvi, pp. 408-411, 2 figs.

Patch, Edith M.—Chermes of Maine Conifers. Maine Agric. Exp. Stat., Bull. No. 173, 1909, pp. 277-308, figs. 108-146.

VI.—Fisheries.

Lebour, Marie V.—*Acanthopsolus lageniformis,* n. sp., a Trematode in the Catfish. Rpt. Northumberland Sea Fish. Comm., 1910, pp. 29-35, plt. i.

Meek, A.—Report of the Scientific Investigations for the Year 1909, and to June 15th, 1910. Ibid., pp. 1-27.

VII.—Medicine and Human Parasites.

Smith, J. B.—Report on the Mosquito Work for 1909. 13th Ann. Rpt. N.J. Agr. Exp. Stat., 1910, pp. 419-459, 3 figs.

VIII.—Animal Diseases, Etc.

Davison, A. G.—The Ked, or Sheep Louse. Agric. Journ. C. of G. H., 1910, vol. xxxvi, pp. 398-403, 5 figs.

Hall, M. C.—Some important facts in the Life-history of the Gid parasite and their bearing on the Prevention of the Disease. U.S. Dept. Agric., Bur. An. Indus., Circ. 159, 1910, pp. 1-7.

Mohler, J. R., and H. J. Washburn.—Tuberculosis of Hogs and How to Control it. Yearbook U.S. Dept. Agric., 1909. Washington, 1910, pp. 227-238, plts. xi-xiii.

Ransom, B. H.—The Prevention of Losses among Sheep from Stomach Worms (*Haemonchus contortus*). U.S. Dept. Agric., Bur. An. Idus., Circ. 157, 1910, pp. 1-10.

Shipley, A. E.—Grouse Disease. Pp. 1-15. London : J. P. Bland. 1910.

This is a reprint from *The Times* of April 19th and 25th, and presents a useful summary of the existing knowledge of the diseases of the grouse not hitherto specificially defined.

Stiles, C. W., and A. Hassall.—Index Catalogue of Medical and Veterinary Zoology. Pt. 26. U.S. Dept. Agric., Bur An. Indus., Bull. No. 39, 1910, pp. 1981-2076.

Theiler, A.—A Contribution to our Knowledge of Gall-sickness (Anaplasmosis of Cattle). Transv. Agric. Journ., 1910, vol. viii, pp. 423-435.

IX.—Commercial.

Wood, J. T.—The Bacteriology of the Leather Industry. Journ. Soc. Chem. Indus., 1910, vol. xxix, pp. 666-672.

THE

JOURNAL OF ECONOMIC BIOLOGY.

NOTES ON THE WARBLE-FLY OF THE REINDEER, *OEDEMAGENA TARANDI* (LINN.).[1]

By

GEORGE H. CARPENTER, B.Sc., Lond., M.R.I.A.,

Professor of Zoology in the Royal College of Science, Dublin, and President of the Association of Economic Biologists.

With Plate III, and 12 Figures.

In April of the present year, a gelding Reindeer was received at the Dublin Zoological Gardens. The animal was in very poor condition, and the bad state of its health was due, at least in part, to the large number of warble-maggots with which it was infested. During the months of May and June as many as 104 of these parasites were squeezed from the animal's back. As naturalists not resident in high northern latitudes have but scant opportunity of studying this interesting insect, a few observations on its various stages may be worthy of record.

Thirty-seven of the larvae came into my hands, seventeen of which had been obtained on May 7th and twenty on May 28th. Having repeatedly tried, without success, to rear flies from squeezed-out maggots of the common Ox Warble (*Hypoderma*), I was agreeably surprised to notice that one of the earlier batch of larvae formed an apparently normal puparium in the course of a few days. From this emerged on June 22nd a female fly in perfect condition, the pupal period having thus lasted about six weeks, the period which I have found usual for the development of imagos of *Hypoderma* in this country.

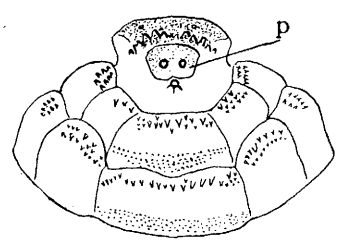
The Larva.

The maggot of *Oedemagena* was described half a century ago by Brauer ('58, p. 406, '63, pp. 133-4), from specimens in the final

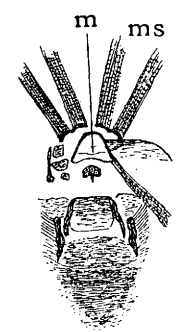
[1] Read before the Association of Economic Biologists, Manchester Meeting, July 7th, 1910.

larval instar varying in length from 22 to 30 mm., none of them, according to Brauer's opinion, being quite "ripe." The examples which I have had the opportunity of examining this year are mostly from 23 to 28 mm. in length—the dimension varies according to the distension of the cuticle—but three specimens are distinctly smaller, having attained a length of 15-18 mm. only.

As regards the main external features of the larva, there is little to be added to the description of Brauer, who remarks that the maggot of *Oe. tarandi* differs from those of allied species in the similarity of the spiny armature on the dorsal and ventral surfaces. In the larvae of *Hypoderma bovis* and *H. lineata,* for example, the rows of spines towards the front edges of the body segments are very poorly developed on the dorsal aspect. But on the dorsal surface of the *Oe. tarandi* larva there are strong, blackish spines, arranged in two, three or four irregular rows towards the front border of each body-segment from the second to the eighth inclusive, while on the ventral surface similar rows of spines are present on the ninth and tenth segments, in addition to those anterior. The arrangement of these spines is clearly shown in the appended photographs (Pl. iii, figs. A, B, and C), showing the larva from the dorsal, lateral, and ventral aspects respectively. If these series of spines be studied in detail, it is found that they are irregular and unsymmetrical. The drawings of the dorsal (Fig. 4) and ventral (Fig. 1) aspects of the



1



2

3

Fig. 1.—Head and two anterior body-segments of larva, ventral view. Magnified 5 times. *p*. pre-oral sclerite, behind which is seen the small mouth.

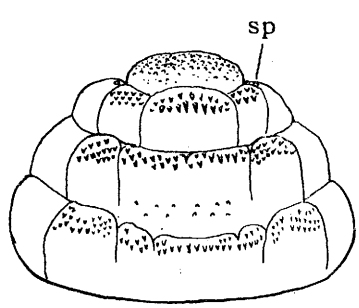
Fig. 2.—Mouth, mouth-hooks, and supporting sclerites, as seen after removal of the dorsal pharyngeal wall. Magnified 50 times. *m*. mouth. *ms*. muscles attached to the mouth-hooks. On the left are shown the small intermediate sclerites; on the right the chitinized area around the mouth.

Fig. 3.—Median chitinized region of ventral pharyngeal wall with supporting sclerites, Lateral view, Magnified 50 times,

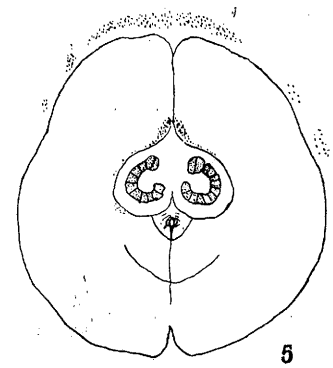
front end of the larva, represent fairly the differences that may be observed between the right and the left side.

In his figure of the head region of this larva, Brauer ('63, p. viii, fig. 4) shows a large number of minute spines in front of the mouth-plate. In the specimens which I have examined, I find on either side a row of from four to six strong spines, very sharp and prominent, and in some cases bifid (Fig. 1).

The mouth-hooks of this larva, like those of *Hypoderma,* are very small. The ventral pharyngeal wall is strongly chitinized, with transverse ridges, forming a firm dark median region (Fig. 2), which passes on either side into a distinct longitudinal sclerite. To these are attached other paired sclerites associated with an anterior, transverse chitinized area. In dorsal view these sclerites appear narrow (Fig. 2), seen laterally they are deep and arched anteriorly and ventral-wards (Fig. 3). In front of the chitinized area is a median dentate sclerite, which lies just behind the mouth (Fig. 2, *m.*), dorsal to which may be seen, when in the retracted state, the small mouth-hooks, each shaped like a double bow and worked by two strap-shaped muscles (Fig. 2, *ms*). Between the mouth hook of either side and the basal ventral sclerite, lie a slender longitudinal and three small plate-like sclerites.



4



5

Fig. 4.—Anterior dorsal region of larva which forms "lid" of puparium. Magnified 5 times. *sp.* anterior spiracles. The posterior line of suture is in front of the hind series of spines on the third body-segment.

Fig. 5.—Hinder end of larva showing spiracular area, horse-shoe shaped spiracular plates and small anus. Magnified 8 times.

In the *Hypoderma* larva, the suture surrounding the anterior dorsal region, which will form the "lid" of the puparium, is very distinct. In the maggot of *Oedemagena* it is, perhaps, even plainer (Pl. iii, figs. A and B). The outline of this region, as bounded by

the suture, can be seen in the drawing (fig. 4), which shows the arrangement of its spiny armature. The anterior spiracles are situated laterally (Fig. 4, *sp.*) close to this suture and to the dorsal head sclerite.

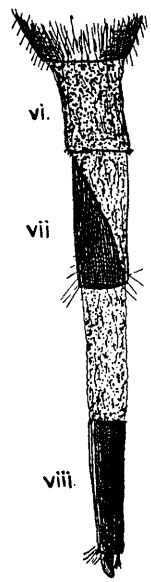
The hinder spiracular area is heart-shaped, with the small anal opening situated just ventral to it. Each spiracular plate is of the horse-shoe form usual in the group, and under fair magnification can be seen to consist of eight or more quadrangular or V-shaped plates (Fig. 5).

The Puparium.

The puparium of *Oedemagena* closely resembles that of *Hypoderma* in its general form and its firm, black cuticle. The spiny armature and posterior spiracles of the larva are easily recognisable in the hardened puparium, from which the dorsal part of the head region and of the first, second, and most of the third trunk-segments split off so as to allow the imago to escape (Pl. iii, figs. D, E and F).

The Imago.

Many former writers from Linné onwards have described the fly, of whose structure there is little new to record, especially as I succeeded in rearing only a single female specimen. This individual, however, had the terminal abdominal segments which form the ovipositor fully extended (Pl. iii, fig. G). The fifth abdominal segment is sub-conical in form, and, like the two preceding segments, is densely clothed with reddish hairs. The short cylindrical sixth segment has a cuticle which, though black and rough, is entirely membraneous, and bears a few black hairs at its extremity (fig. 6, vi). The elongate seventh segment is strengthened by a sclerite which, beginning in front as a narrow, dorsal strip, broadens towards the hinder end, where it reaches to the ventral aspect, its posterior edge being bordered with a few reddish hairs (Figs. 6 and 7, vii). This is succeeded by a stretch of intersegmental membrane, as long as either the seventh or the eighth segment. The latter (Figs. 6 and 7, viii) has a narrow median membranous dorsal region, but the sides and the ventral aspect are protected by a continuous, firm, shining black sclerite, bearing scattered red hairs at its extremity. Behind this segment are visible the dorsal median process—the tergite of the ninth segment according to Hewitt ('07, p. 432)—which is smooth and rounded, and the somewhat shorter and narrower lateral processes or cercopods (Fig. 8, *c*). Each of these bears a group of five stout spines directed outward and backwards. When the apparatus is retracted the eighth segment is

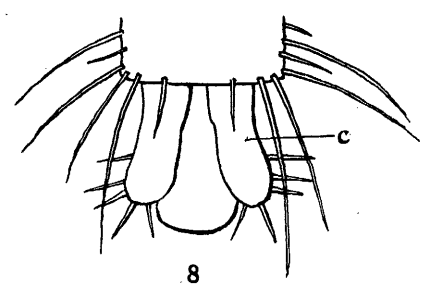


6

7

Fig. 6.—Terminal abdominal segments (ovipositor) of female fly, fully extended. Lateral view. Magnified 8 times. vi, vii, viii, mark the dorsal aspects of the sixth, seventh and eighth abdominal segments.

Fig. 7.—The same, partly extended. Dorsal view. The sixth segment is withdrawn within the fifth, and the eighth is largely hidden by the inturned intersegmental membrane.



8

Fig. 8.—Tip of ovipositor. Ventral view. Magnified 50 times. *c*. cercopod. Between the two cercopods the dorsal sclerite is visible.

drawn back into the tubular intersegmental membrane, which is itself inverted and telescoped into the seventh segment. This latter is in its turn drawn back into the sixth, which is inverted within the fifth segment. When these segments are fully extended they form a telescopic ovipositor as long as the rest of the abdomen. The organ is relatively longer than in *Hypoderma,* and in the details of its structure it differs from the ovipositor of *Musca* recently described by Hewitt ('07), in which the tubular sixth, seventh and eighth abdominal segments are strengthened only by narrow chitinous rods.

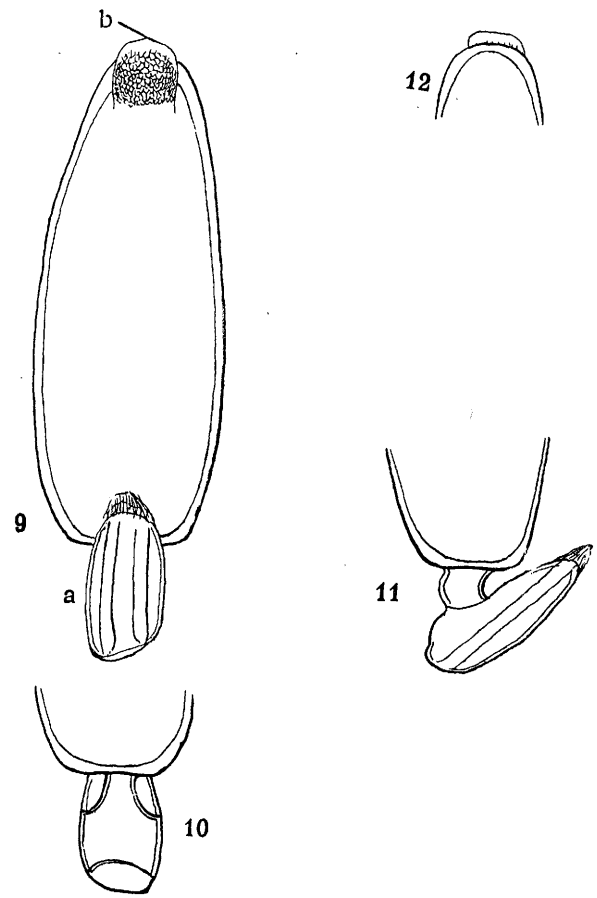


Fig. 9.—Egg seen from attachment aspect. *a.* grooved flange for attachment. *b.* reticulated "lid" area.

Fig. 10.—Base of Egg showing flange from opposite face.

Fig. 11.—Base of Egg, side view, showing flange and stalk.

Fig. 12.—Top of Egg, opposite aspect from fig. 9.

Figs. 9—12 are magnified 80 times.

The Egg.

From the body of the single female at my disposal I extracted a number of eggs for comparison with the eggs of *Hypoderma.* In most respects the resemblance is very close. In *Oedemagena,* as in *Hypoderma,* the egg is elongate oval, rounded at both extremities; in the case of *Oedemagena,* however, the outline towards the attachment-process tends to be slightly sub-quadrate (Figs. 9 and 11). The attachment-process, with its flange and longitudinal grove (Figs. 9, 10 and 11) adapted for fitting over a hair of the host-animal, is closely like that of the Ox Warble flies' eggs. One small, but possibly important distinctive feature is the presence at the free end of the egg of *Oedemagena* of a thin flap, marked with fine reticulations (figs. 9*b* and 12), along whose edge the egg-case splits open very readily. Its position and appearance recalls those of the "lid" of the egg of the Horse Bot fly (*Gastrophilus*) and suggest the probability of the young maggots of *Oedemagena* being licked and swallowed by the Reindeer immediately on hatching, subsequently making their way through the gullet-wall and reaching the skin of the back from beneath, as is now believed to be the case with regard to the maggots of *Hypoderma.*

In the egg of *Hypoderma,* however, no such "lid" can be distinguished, the whole distal region of the egg-case having a firm and even surface. This fact lends support to the suggestion—recently made by Jost ('07)—that the host of *Hypoderma* swallows, not the young maggot, but the egg, which is presumably hatched within the digestive tract. Such a difference between the early life-history of *Hypoderma* and that of *Oedemagena* would be interesting. Further observation may perhaps show if belief in its existence be warranted.

REFERENCES.

'58. **Brauer, F.**—Die Oestriden des Hochwildes, u.s.w. Verhandl. K. K. zool. bot. Gesellschaft. in Wien, 1858, viii.

'63. ————————Monographie der Oestriden. Wien, 1863.

'07. **Hewitt, C. G.**—The Structure, Development and Bionomics of the House-fly. Pt. 1, Quart. Journ. Micr. Sci. 1907, vol. li.

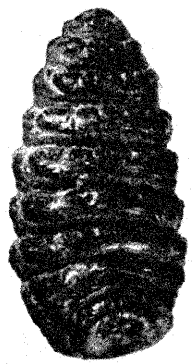
'07. **Jost, H.**—Beiträge zur Kenntnis des Entwicklungsganges der Larve von *Hypoderma bovis.* Zeitsch. f. wiss. Zool., 1907, vol. lxxxvi.

EXPLANATION OF PLATE III.

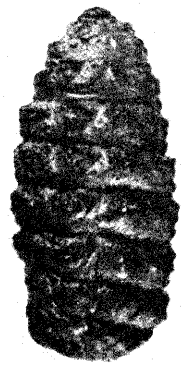
Illustrating Professor George H. Carpenter's paper "On the Warble Fly of the Reindeer."

Fig. A.—*Oedemagena tarandi* (Linn.). Fully grown larva, dorsal view.
Fig. B.— ,, ,, lateral view.
Fig. C.— ,, ,, ventral view.
Fig. D.— ,, Puparium, dorsal view.
Fig. E.— ,, "Lid" of puparium.
Fig. F.— ,, Puparium, ventral view.
Figures A—F., twice natural size.
Fig. G.— ,, Female imago with extended ovipositor, $1\frac{3}{4}$ times natural size.

From photographs by T. Price.

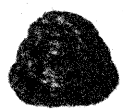


A

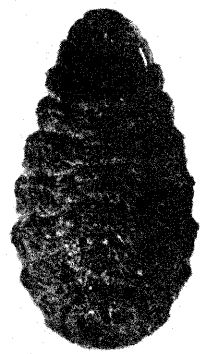


B

C

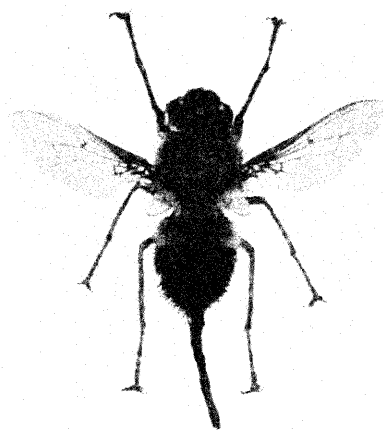


E



D

F



G

OEDEMAGENA TARANDI *(Linn.)*.

THE EFFECT OF CERTAIN REAGENTS ON HIDES.

By

W. F. COOPER, B.A. (Cantab.), and W. H. NUTTALL, F.I.C.

The question of finding some reliable deterrent against insect infestation of our domestic animals, is of the greatest economic importance. In this country, as in others, a large number of hides are rendered unfit for use by the tanner, owing to their penetration by "Warble." The Tick is responsible for a much greater loss, not only in hides, but in the animals themselves, this being specially so in warmer countries. Further, we have the Blow-fly in Australia, which is spreading rapidly, and is seriously impeding sheep raising in that country.

Up to the present, no satisfactory reagent is known, which will prevent the infestation of animals by these pests. Dipping or Spraying with arsenical preparations is one of the most successful means of controlling Ticks; but it fails, inasmuch as it has very little deterrent effect. Against Warbles, no remedy is known, and recourse is had to squeezing out the immature pupae.[1] Similarly also, we have no means of dealing with the Blow fly.

Any substance which might be adapted to this end, should have the following properties. Firstly, it should be cheap enough to be used on a large scale; secondly, it must remain on the hair, wool, or skin for a considerable time, and resist inclement weather; thirdly, it must have a persistent taste or odour, objectionable to the pest.

There are a large number of chemicals having these properties; such as Picric Acid, Pyridine, Commercial Methylene Blue, Mercury Salts, Lead Salts. Many, however, appeared to be open to two serious objections; either the greater number of substances which would combine with the skin, are dyes and cause discolouration; or else they are such as have some chemical action on the constituents of the skin. In either of these cases, the tanning properties of the hides might be seriously interfered with; so much so, as to render them as unfit for the tanner as though they were punctured by the Warble.

[1] See Journ. Board of Agric., vol. 17, p. 659.

In order to test the effect of such chemicals upon the tanning properties of the skin, the authors carried out some experiments with a few of them; though, as experimental tanning is expensive, the size and number of the skins had to be limited.

The substances selected were Picric Acid, Pyridine Picrate, and Mercury Bichloride. The first is a persistent dye, and has a very bitter taste. The second was tried as being a dye, and also because it gradually decomposes and evolves odours which were expected to be disagreeable to the pests. The third was tried on account of its power of combining with gelatine and of precipitating Tannin, which property, it was considered, might interfere with tanning.

A whole skin of an adult ox was taken and cut into four quarters. Three of these were treated with the three substances; the fourth was kept as control, untreated.

The skin was stretched on the ground, hair side up, then a 1 per cent. solution of the substance in water was poured upon it and worked in with a brush. A large amount was applied so that thorough penetration might take place. After leaving to soak, and then hanging up to drain, they were allowed to dry in the sun, packed up, and sent off to be tanned. The fourth piece was merely salted, as is generally done abroad in the ordinary course of drying skins.

The skins were sent to Dr. Gordon Parker to be tanned, and he reported "That the treatment had not interfered with the tanning in any way." The four pieces were absolutely similar in colour, texture, etc.; also, two local authorities were unable to pick out the piece which had not been treated: so that it is evident that the application of the materials had not interfered with the tanning; and therefore, as far as any objection to tanning is concerned, there is no reason why a large number of other dyes and chemicals should not be tried as a means of controlling and preventing other infestations by many pests.

For instance, *Hypoderma bovis* lays its eggs on the lower portions of the oxen's legs; from here, they are transferred to the stomach by the animal in licking itself. Some of the dyes, such as Picric Acid, or Commercial Methylene Blue (which contains Zinc Chloride) have a very bitter taste, and, if applied to the animal's legs, they might prevent the licking of those parts. It would be interesting, at least, to try driving some cattle through a trough containing a solution of Picric Acid, or some other similar compound and comparing them with animals not so treated.

In the case of the Blow-fly in Australia, Copper Sulphate is employed, though it cannot be said to be satisfactory.

One of us made a preliminary experiment to try the effect of

spraying Picric Acid, Isopurpuric Acid or Grenat Soluble (a compound of Picric Acid and Prussic Acid), and Methylene Blue, on to clean beasts and exposing them to Tick infection in South Africa; the results were not altogether promising, and, unfortunately, the work could not be repeated or continued. We consider that there is a large and untried field in the application of dyes and certain metallic salts to these purposes. From these experiments, at all events, it would appear that there need be no apprehension of any interference in the process of tanning, or of loss in colour of the tanned pelt.

REVIEWS.

Adams, Isabel H.—Wild Flowers of the British Isles. Revised by J. E. Ragnall. Vol. ii, pp. xi + 199, 62 cold. plts. London: William Heinemann, 1910. Price 30s. net.

The second volume of Mrs. Adams's work on British wild flowers fully maintains the high standard set in the previous volume. The two volumes complete the subject with the exception of aquatic plants and trees, and we sincerely hope that the authoress will at least add a third volume treating of the former, and so complete a work most ably executed, beautifully illustrated, and excellently produced. Amongst the very numerous volumes treating of our British wild flowers, we know of none that supply so much accurate information in so concise a manner, and there are certainly none more profusely or better illustrated. The able assistants, whose names are recorded, are mostly well-known botanists, and their contributions have undoubtedly added to the completeness of this most desirable volume.

W. E. C.

Bancroft, Keith.—A Handbook of the Fungus Diseases of West Indian Plants. Pp. 70, 6 plts. London: Geo. Pulman & Sons, Ltd., 1910.

The author of this little handbook gives, in a small compass, a useful account of the fungus diseases of West Indian Plants.

After a short introduction, in which Mr. Bancroft indicates the chief problems in connection with West Indian plant pathology, the different diseases are described in systematic order. A technical diagnosis of the fungus and references to the more important literature, together with a description of field symptoms, and the treatment to be followed, is given in the case of all the more important fungi.

The book should prove of material service to all concerned in the raising of crops in the West Indies.

W. E. C.

Doncaster, L.—Heredity in the Light of Recent Research. Pp. x + 140, 12 figs. Cambridge University Press, 1910. Price 1s.

There is undoubtedly a growing interest in, and keen appreciation of the recent advances made in the wide and complex subject of Heredity. With the recent and excellent works of Bateson, Lock, Thomson, and Punnett, we should have thought there was hardly room for another, even though it were a small one, unless it were a distinct advance upon these;

we must therefore confess some disappointment at Mr. Doncaster's little book. It is distinctly feeble, and does not add anything to what we already know. It may serve a useful purpose possibly, to those who do not wish to possess more than a conversational knowledge of the subject.

W. E. C.

Duggar, B. M.—Fungous Diseases of Plants. Pp. xii + 508, 240 figs. Boston: Ginn and Company, 1910.

Professor Duggar's book will be equally welcome to British students of mycology as to those in America, for it treats of numerous diseases due to fungi common to both countries.

The plan of the work is excellent. After a careful and eminently practical account of culture methods and technique, and physiological relations, we have the general account of the different diseases in systematic order. Each disease is given under its popular name, followed by the scientific name of the fungus, and references to a few of the leading papers on the subject, indeed, wherever one looks, full acknowledgment is given to the work of other investigators. In the discussion of each disease three important considerations have been kept in view, viz. :— (1) a description of the pathological effects and other relations of host and parasite; (2) a clear, yet concise, account of the life-history of the fungus; and (3) a brief account of the approved or suggested methods of the prevention or control. The illustrations, which are numerous, are all very good, and greatly add to the value of the text. In conclusion we have a host index of the fungous diseases described or cited.

We have nothing but the highest praise for this admirable handbook, which is deserving of a wide recognition both in the laboratory and field.

W. E. C.

Eltringham, H.—African Mimetic Butterflies. Pp. 136, 10 cold. plts. and a map. Oxford: The Clarendon Press, 1910. Price £2 12s. 6d.

The author of this interesting work states that he has endeavoured to compile into one volume the information contained in many publications together with drawings of specimens from several collections, and it is hoped that others may find in the result, materials of some interest and a basis for further research.

There is a valuable introduction, in which the author gives a general account of animal coloration and mimicry, and discusses the views of other workers; this is followed by descriptions of mimetic associations in African Rhopalacera; a chapter is devoted to objections which have been raised to the theories of mimicry, and the evidence on which such theories are based; another to the consideration of the evidence that some butterflies are more palatable than others; and a final one to the evidence that butterflies are preyed upon by birds. The work concludes with a brief review of general conclusions, bibliography, and a good index.

The ten coloured plates are on the whole good, but it is a thousand pities that they were not printed on white paper. Plate 3 is perhaps the worst, spoilt purely by the background.

W. E. C.

Lafar, Franz.—Technical Mycology: the Utilization of Micro-organisms in the Arts and Manufacturs. Translated by Charles T. C. Salter. Vol. ii, pt. ii, pp. lx + 192-748, 50 figs. London: Charles Griffin and Co., Ltd., 1910. Price 18s. net.

The previous parts of Mr. Salter's translation of Dr. Lafar's well known work have been before the public for some time, and we welcome the second part of volume ii, thus concluding the work.

The present part is especially interesting, treating as it does of Yeast Nutrition and Yeast Culture at considerable length.

Dr. Klöcker describes the life-history and variability of the Saccharomycetes, and the classification of the family and Schizosaccharomycetaceae. The morphology and classification of certain technically important higher Ascomycetes and allied forms, and the chemical activity of the Aspergillaceae are treated of by Dr. Carl Wehmer. The general morphology, physiology, and classification of technically important budding fungi of the group "Fungi Imperfecti," are dealt with by Dr. H. Will, Dr. R. Meissner, Dr. H. Müller-Thurgau, and Dr. H. Wichmann; whilst the enzymes and enzyme actions of yeast are ably described by Dr. R. Rapp, Dr. Bau, Dr. Hahn, and the author.

There is an excellent Bibliography and index.

To brewers, distillers, analyists, pharmacists, and technical and agricultural chemists, there is a wealth of information of the greatest practical value, and it is such that will welcome and appreciate a standard modern text-book on this all-important subject.

McAlpine, D.—The Smuts of Australia: their Structure, Life-history, Treatment, and Classification. Pp. vii + 285, 57 plts. and 6 figs. Melbourne: Department of Agriculture, Victoria, 1910.

This is a companion volume to the author's work on the *Rusts of Australia,* the two volumes forming a notable contribution to mycological literature.

The mode of treatment is similar to that previously followed: the first part treats of the general subject of smuts, the second and third with the life-histories and treatment of those attacking cereals and grasses, these are followed by an account of the field experiments carried out during 1909, the fifth and final part dealing with the classification and technical descriptions. A useful bibliography, host index, and general index complete a most satisfactory volume.

The thoroughness with which the author has dealt with his subject, in

so clear and comprehensive a manner, and the accuracy and fulness of detail, with a wealth of illustration, make this volume a most valuable contribution to the subject, which cannot fail to meet with the same flattering reception extended to its companion.

W. E. C.

Pycraft, W. P.—A History of Birds. With an Introduction by Sir Ray Lankester. Pp. xxxi + 458, 37 plts. and 50 figs. London: Methuen and Co., 1910. Price 10s. 6d. net.

During the past few years we have had numerous works purporting to treat of bird-life, in most of which we have been surprised at the little information they contained and the total absence of first-hand knowledge. The work before us is of a very different nature. As Sir Ray Lankester states in his introduction, it does "not start with a scheme of classification and then take up the groups one by one," but generally discusses the numerous phenomena which make the study of bird-life so fascinating. Thus we have first a general introduction pointing out the general characters of structure, followed by two chapters on the phylogeny, and others on geographical distribution, the relations of birds to the seasons, migration, the relations of birds to plants and animals, peculiar interrelations, and the relation of the sexes. The subject of nests, eggs, care of offspring and nestlings are dealt with at considerable length. Variation, acquired characters, natural and artificial selection, adaptions and convergence of form are all very fully discussed.

Information on such points as the origin of nests, food-storing, parasitic birds, causes of migration, interbreeding, weapons, isolation and its significance, influence of food on colour, and a host of other facts, make Mr. Pycraft's work a most valuable and a complete epitomé of bird-life. The illustrations are excellent. In short, it is by far the best work on birds we have, and one we have stood in need of for some time past.

W. E. C.

CURRENT LITERATURE.

I.—General Subject.

Ballou, H. A.—Nomenclature of Scale Insects. W. I. Bull., 1910, vol. xi, pp. 35-38.

Bernstein, J.—Summary of Literature relating to the Bionomics of the Parasitic Fungus of Flies; *Empusa muscae* (Cohn), with special reference to the Economic Aspect. Rpts. Loc. Gov. Bd. (n.s. no. 40), 1910, pp. 41-44.

Collins, C. W.—Some results from feeding eggs of *Porthetria dispar* to Birds. Journ. Econ. Entom., 1910, vol. iii, pp. 343-346.

Reiff, W.—Some Experiments on the Resistance of Gypsy Moth Eggs to the Digestive Fluids of Birds. Psyche, 1910, pp. 161-164.

Urich, F. W.—Annual Report of the Entomologist. Bd. of Agric., Trinidad, 1910, pp. 1-6.

II.—Anatomy, Physiology, and Development.

Backhoff, P.—Die Entwicklung des Copulationsapparates von *Agrion*. Zeit. f. wiss. Zool., 1910, Bd. 95, pp. 647-706, Taf. xxi, 29 fign.

Bauer, A.—Die Muskulatur von *Dytiscus marginalis*. Zeit. f. wiss. Zool., 1910, Bd. 95, pp. 594-646, 19 fign.

Hasper, M.—Zur Entwicklung der Geschlechtsorgane von *Chironomus*. Zool. Anz., 1910, Bd. xxxv, pp. 737-743, 5 fign.

Nüsslin, O.—Zur Anatomie und Biologie der Borkenkäfergattung *Cryphalus*. Naturw. Zeits. Forst. u. Land., 1910, pp. 289-298, 5 fign.

Snodgrass, R. E.—The Anatomy of the Honey Bee. U.S. Dept. Agric., Bur. of Entom., Tech. Ser. No. 18, 1910, pp. 1-162, 57 figs.

An excellent and most useful piece of work.

Solowiow, P.—Ban der Stigmen bei den Larven *Cimbex*. Zeit. f. wiss. Insektenbiol., 1910, Bd. vi, pp. 271-275, 9 fign.

Vogel, R.—Uber die Innervierung und die Sinnesorgane des Schmetterlingsflügels. Zool. Anz., 1910, Bd. 36, pp. 193-204, 5 fign.

III.—General and Systematic Biology, and Geographical Distribution.

Burr, Malcolm.—The Dermaptera (Earwigs) of the United States National Museum. Proc. U.S. Nat. Mus., 1910, vol. 38, pp. 443-467, figs. 1-8.

Carpenter, Geo. H.—On some Subantarctic Collembola. Subantarctic Islands of New Zealand. Wellington, 1909, pp. 377-382, plt. xviii.

Records *Achorutes viaticus*, Tullb., and *Triacanthella alba*, n. sp.

Coquillett, C. W.—The Type-species of the North American Genera of Diptera. Proc. U.S. Nat. Mus., 1910, vol. xxxvii, pp. 499-647.

Davidson, W. M.—Further notes on the *Aphididae* collected in the vicinity of Stanford University. Journ. Econ. Entom., 1910, vol. iii, pp. 372-381, 2 figs.

Essig, E. O.—Some Variations in the Wings and Antennae of *Trifidaphis radicicola*, Essig. Pomona Coll. Journ. Entom., 1910, vol. ii, pp. 283-285, 13 figs.

Girault, A. A., and G. E. Sanders.—The Chalcidoid Parasites of *Musca domestica*, Linn., and its Allies. Psyche, 1910, pp. 108-117, 145-160, 5 figs.

Glaue, H.—Beitrage zu einer Monographie der Nematodenspecies *Ascaris felis* und *Ascaris canis*. Zeit. f. wiss. Zool., 1910, Bd. 95, pp. 551-593, 26 fign.

Gravely, F. H.—Pedipalpi of Ceylon. Spolia Zeylanica, 1910, vol. vii, pp. 43-47, 3 figs.

Grossbeck, J. A.—Studies of the North American Geometrid Moths of the Genus *Pero*. Proc. U.S. Nat. Mus., 1910, vol. 38, pp. 359-377, plts. 13-16.

Hall, H. V. M.—A Phytoptid Gall on *Artemisia californica*. Pomona Coll. Journ. Entom., 1910, vol. ii, pp. 280-281, 2 figs.

Harding, H. A.—The Constancy of Certain Physiological Characters in the Classification of Bacteria. N.Y. Agric. Exp. Stat., Geneva, 1910, Tech. Bull. No. 13, pp. 3-41, 3 charts.

Imms, A. D.—The Habits and Distribution of *Scutigera* in India. Nature, 1910 (Oct. 6th), p. 429.

Johannsen, O. A.—The *Mycetophilidae* of North America. Agric. Exp. Stat., Orono, Maine, Bull. No. 180, Pt. II, 1910, pp. 125-192, 4 plts.

Kieffer, J. J.—Description de nouveaux Hyménoptères. Boll. Lab. Zool. R.Sc. Agric., Portici, 1910, vol. iv, pp. 105-117.

Kieffer, J. J.—Cecidomyies parasites de *Diaspis* sur le Mûrier. Ibid., 1910, vol. iv, pp. 128-133, 3 figs.

Kieffer, J. J.—Description de quelques Diptères exotiques. Ibid., pp. 327-328, 1 fig.

Kieffer, J. J.—Nouveaux Cynipides exotiques. Ibid., pp. 329-342.

Kieffer, J. J.—Description de nouveaux Scelionides d'Angleterre. Ibid., 343-345.

No figures are given.

Kleine, R.—Biologioche Beobachtungen an *Dendrosoter protuberans,* Nees. Zeit. f. wiss. Insektenbiol., 1910, Bd. vi, pp. 289-292, 1 fig.

Leonardi, G.—Die nuove specie di *Aleurodicus,* Douglas. Boll. Lab. Zool. R.Sc. Agric., Portici, 1910, vol. iv, pp. 316-322, 4 figs.

Martelli, G.—Altre notizci dietologiche della mosca delle olive. Boll. Lab. Zool. R.Sc. Agric., Portici, 1910, vol. iv, pp. 73-104, 9 figs.

Martelli, G.—Notizie sulla *Drosophila ampelophila,* Liv. Ibid., 1910, vol. iv, pp. 163-174, 6 figs.

Martelli, G.—Sulla micofagia dell Coccinellide *Thea vigintiduo-punctata,* L. Ibid, 1910, vol. iv, pp. 292-294, 1 fig.

Martelli, G.—Per la conoscenza delle convittime del *Dibrachys boucheanus* (Ratz.). Ibid., pp. 323-324.

Masi, L.—Contribuzione alla conoscenza dei Calcididi italiani. Boll. Lab. Zool. R.Sc. Agric., Portici, 1910, vol. iv, pp. 3-37, 28 figs.

Patch, Edith M.—Four rare Aphid Genera from Maine. Agric. Exp. Stat., Orono, Maine, Bull. No. 182, 1910, pp. 241-248, 6 plts.

Paoli, G.—Sulla *Sarcophaga lineata,* Fallen, parassita dello *Stauronottus maroccanus* (Thunb.) in Sardegna. Boll. Lab. Zool. R.Sc. Agric., Portici, 1910, vol. iv, pp. 347-352.

Pierce, W. D.—Some New Species of Weevils of Economic Importance. Journ. Econ. Entom., 1910, vol. iii, pp. 356-366.

Rohiver, S. A.—Some New Hymenopterous Insects from the Philippine Islands. Proc. U.S. Nat. Mus., 1910, vol. xxxvii, pp. 657-660.

Brief description of 1 new genus and 5 new species, none of which are figured.

Sicard, A.—Description d'une espece nouvelle de Coccinellide de l'Afrique du Sud. Boll. Lab. Zool. R.Sc. Agric., Portici, 1910, vol. iv, pp. 118-119.

Silvestri, F.—Metamorfosi del *Cybocephalus rufifrons,* Reitter. Boll. Lab. Zool. R.Sc. Agric., Portici, 1910, vol. iv, pp. 221-227, 6 figs.

Silvestri, F.—Contribuzioni alla conoscenza dei Chilopodi. III, IV. Boll. Lab. Zool. R.Sc. Agric., Portici, 1910, vol. iv, pp. 38-65, 16 figs.

Smith, J. D.—The *Noctuidae* of California. II. Pomona Coll. Journ. Entom., 1910, vol. ii, pp. 275-279.

Trotter, A.—Le cognizioni cecidologiche e terratologische di Ulisse Aldrovandi e della sua Scuola. Marcellia, 1910, vol. ix, pp. 114-120.

Viereck, H. L.—Descriptions of New Species of Ichneumon-Flies. Proc. U.S. Nat. Mus., 1910, vol. xxxviii, pp. 379-384, 3 figs.

Wheeler, W. M.—The Effects of parasitic and other kinds of Castration in Insects. Journ. Exp. Zool., 1910, vol. 8, pp. 377-438, 8 figs.

Wolcott, A. B.—Notes on some *Cleridae* of Middle and North America, with descriptions of new species. Field Mus. N.H., Zool. Ser., 1910, vol. vii, no. 10, pp. 339-401, plts. v, vi.

IV.—Agriculture and Horticulture.

Ainslie, Geo. G.—The Cowpea Curculis (*Chalcodermus aeneus*, Boh.). U.S. Dept. Agric., Bur. of Entom., Bull. No. 85, pt. viii, 1910, pp. 129-142, figs. 67-69.

Bancroft, C. K.—A New West Indian Cacao Pod Disease. W.I. Bull., 1910, vol. xi, pp. 34, 35, 1 plt.

Carpenter, Geo. H.—Injurious Insects and other Animals observed in Ireland during the year 1909. Ec. Proc. Roy. Dub. Soc., 1910, vol. ii, pp. 8-30, plt. ii, 10 figs.

Coleman, L. C.—Diseases of the Areca Palm. I. Koleroga. Dept. Agric. Mysore State, Bull. No. 2, Mycolog. Ser., 1910, pp. vii + 92, plts. i-xviii, 6 figs.

The disease known as Koleroga or Rot-disease of the Areca Palm is one of the most serious plant diseases in Southern India, and entails an annual loss of at least 3 to 4 lakhs of rupees. Dr. Coleman's report of his recent investigations will therefore be welcomed as giving a very thorough account of the disease, the conditions influencing the growth and spread of the fungus, combative measures, and the experiments that have been carried out. He further describes the disease and the species of Phytophthora causing it, and other points of interest, the whole of which are excellently illustrated.

Essig, E. O.—Spraying for the Citrus Mealy Bug. Pomona Coll. Journ. Entom., 1910, vol. ii, pp. 246-259.

Essig, E. O.—The Natural Enemies of the Citrus Mealy Bug. II. Ibid., pp. 260-274, 3 figs.

Felt, E. P.—Recent observations upon European Insects in America. Journ. Econ. Entom., 1910, vol. iii, pp. 340-343.

Felt, E. P.—Gall Midges of *Aster, Carya, Quercus* and *Salix*. Journ. Econ. Entom., 1910, vol. iii, pp. 347-356.

Felt, E. P.—25th Report of the State Entomologist on Injurious and other Insects of the State of New York, 1909. N.Y. State Mus., Bull. 141, 1910, pp. 3-178, 22 plts., 1 fig.

As usual, Dr. Felt's report is full of interesting and valuable matter. Chief amongst the injurious species are accounts of the typhoid or house fly, brown tail moth, codling moth, hickory leaf stem borer, and rhododendron lace bug.

A useful list of the insect types in the New York State Museum is given, and Mr. D. B. Young contributes an additional list of Adirondack insects. The usual notes for the year, publications and additions to collections complete this 25th report.

Foster, S. W.—On the Nut-feeding Habits of the Codling Moth. U.S. Dept. Agric., Bur. of Entom., Bull. No. 80, pt. v, 1910, pp. 67-70, plts. vii, viii.

Gillette, C. P.—Plant Louse Notes, Family *Aphididae*. Journ. Econ. Entom., 1910, vol. iii, pp. 367-371, 24 figs.

Hardenberg, C. B.—The Codling Moth in the Transvaal. Transv. Agric. Journ., 1910, vol. viii, pp. 635-640, 2 plts.

Holmes, E. S.—"Scab" and Eelworm in Potatoes. Journ. Dept. Agric. Victoria, 1910, vol. viii, pp. 570-582.

Laidlaw, W.—The Potato Eel-Worm. Journ. Dept. Agric., Vict., 1910, vol. viii, pp. 508-511, 1 fig.

Lounsbury, Chas. P.—Fourth Annual Report of the Committee of the South African Central Locust Bureau. Pp. 59, 2 plts., 15 maps. Cape Town: Cape Times Ltd., 1910.

McAlpine, D.—The Genuine Locust Fungus (*Empusa grylli*, Fres.). Journ. Dept. Agric. Vict., 1910, vol. viii, pp. 434-436, 20 figs.

McRae, W.—Report on the Outbreak of Blister Blight on Tea in the Darjeeling District in 1908-1909. Agric. Research Inst. Pusa, Bull. No. 18, 1910, pp. 1-19, plts. i-vi.

Martelli, G.—Sulla presenza del maschis dell' *Icerya Purkasi*, Mask. in Italia. Boll. Lab. Zool. R.Sc. Agric., Portici, 1910, vol. iv, pp. 290-291, 1 fig.

Martelli, G.—Alcune note intorno ai costuni ed ai danni della mosca delle arance (*Ceratatis capitata,* Wied.). Ibid., 1910, vol. iv, pp. 120-127, 1 fig.

Martelli, G.—Notizie sui costumi del *Cerapterocerus corniger* (Walk.). Ibid., pp. 325-326.

Patch, Edith M., and O. A. Johannsen.—Apple Tree Insects of Maine. Agric. Exp. Stat., Orono, Maine, 1910, pp. 1-68, 4 plts.

Phillips, E. F.—Bees. U.S. Dept. Agric., Farmers' Bull. 397, 1910, pp. 1-44, 21 figs.

Pierce, W. M.—Fumigation Studies. III. Pomona Coll. Journ. Entom., 1910, vol. ii, pp. 241-245, 6 figs.

Quaintance, A. L.—The San Jose Scale and its Control. U.S. Dept. Agric., Bur. of Entom., Circ. No. 124, 1910, pp. 1-18, 10 figs.

Quelch, J. J.—Report on the Giant Moth-Borer. With Notes on the Small Moth-Borer and the Beetle-Borer. Pp. 32, 1 plt., Georgetown. Demerara: "The Argosy" Company, Ltd., 1910.

Deals very fully with *Castnia licus,* with notes on *Diatraea saccharalis,* and *Sphenophorus sericeus.*

Rorer, J. B.—The Froghopper Fungus. Bd. of Agric., Trinidad, 1910, pp. 9, 10.

Sackett, W. G.—Stem Blight, a New Bacterial Disease of Alfalfa. Colorado Agric. Exp. Stat., Bull. 159, 1910, pp. 3-15, 1 plt.

The cause of the blight is *Pseudomonas medicaginis,* n.sp., which, presumably, lives in the soil, and enters the plants with soil through stems that are cracked and split by late frosts.

Silvestri, F.—Introduzione in italia d'un Imenottero indiano per combattere la mosca delle arance. Boll. Lab. Zool. R.Sc. Agric., Portici, 1910, vol. iv, pp. 228-245, 8 figs.

Silvestri, F.—Contribuzioni alla conoscenza degli insetti dannosi e dei lors simbionti. Ibid., pp. 246-289, 25 figs.

South, F. W.—The Control of Scale Insects in the British West Indies by means of Fungoid Parasites. W.I. Bull., 1910, vol. xi, pp. 1-30, 10 figs.

Urich, F. W.—Interim Report on Froghoppers. Bd. of Agric., Trinidad, 1910, pp. 3-8.

Wildermuth, V. L.—The Clover-root Curculio (*Sitones hispidulus,* Fab.). U.S. Dept. Agric., Bur. of Entom., Bull. No. 85, pt. iii, 1910, pp. 29-38, 5 figs.

V.—Forestry.

Butler, E. J.—The Bud-Rot of Palms in India. Mem. Dept. Agric. India., Bot. Ser., 1910, vol. iii, no. 5, pp. 221-280, plts. i-v.

Hewitt, C. G.—Insects destructive to Canadian Forests. First Ann. Rpt. Comms. Conservation, 1910, pp. 1-12.

Patch, Edith M.—Gall Aphids from the Elm. Agric. Exp. Stat., Orono, Maine, Bull. No. 181, 1910, pp. 193-240, 13 plts.

Stebbing, E. P.—A Note on the Preservation of Bamboos from the Attacks of the Bamboo Beetle or "Shot-borer." Forest Zool. Ser. No. 2, Pamph. No. 15, 1910, pp. 1-18, plts. i, ii.

VI.—Fisheries.

VII.—Medicine and Human Parasites.

Copeman, S. M.—Note as to work on hand, but not yet published; and as to proposed further work in reference to Flies as Carriers of Infection. Rpts. Loc. Gov. Bd. (n.s. no. 40), 1910, pp. 45-48, 1 fig.

Graham-Smith, G. S.—Observations on the ways in which Artificially-infected Flies (*Musca domestica*) carry and distribute Pathogenic and other Bacteria. Rpts. Loc. Gov. Bd. (n.s. no. 40), 1910, pp. 1-41, plts. i-vii, 25 Tables.

Hewitt, C. G.—House-flies and the Public Health. Ottawa Nat., 1910, vol. xxiv, pp. 31-35.

Ross, R.—A Summary of Facts regarding Malaria suitable for Public Instruction. Pp. 15. London: John Murray, 1910. Price 2d.

Malarial fever is perhaps at the present time the most important of human diseases. In India alone it has been officially estimated to kill every year on the average 1,130,000 persons. The subject has been long and patiently studied, and at last it may be said that final success has been assured. Major Ronald Ross, of the Liverpool School of Tropical Medicine, whose recent work, "The Prevention of Malaria," is probably the most exhaustive and authoritative treatise on the subject, has issued a pamphlet which should prove of the greatest possible value in making known to the general public the best practical, every-day means for preventing the spread of the disease. With a view to widespread distribution, it is published at the nominal price of 2d. (postage 1d. for 3 copies), by Mr. John Murray, Albemarle Street, London, W.

Todd, J. L.—A Review of the Recent Advances in our Knowledge of Tropical Diseases. John Hopkins Hosp. Bull., 1910, vol. xxi, pp. 1-18.

VIII.—Animal Diseases, etc.

Carpenter, Geo. H., and T. H. Corson.—The Warble Flies. Third Report on Experiments as to Life-History and Treatment. Journ. Dept. Agric. and Tech. Instr. Ireland, 1910, vol. x, pp. 1-10, i plt.

THE JOURNAL OF ECONOMIC BIOLOGY.

Volume V, pt. 3, October 20th, 1910.

Page 134, line 12, and 8 from bottom, for "suggestine" *read* "suggestive."

Page 136, line 5 from bottom, for "in larval characters" *read* "on larval characters."

Page 137, line 3 from top, for "not the unbanded" *read* "nor the unbanded."

PROCEEDINGS

OF THE

ASSOCIATION OF ECONOMIC BIOLOGISTS.

ANNUAL MEETING, July 6-8, 1910.

WEDNESDAY, JULY 6TH, 1910.

The Ninth Annual Meeting was held in the Beyer Buildings of the University of Manchester.

Professor S. J. Hickson, F.R.S., occupied the chair, and on behalf of the University of Manchester offered a welcome to the Association.

The minutes of the previous meeting were read, confirmed, and signed.

The following gentlemen were elected members of the Association: S. J. Hickson, F.R.S., T. G. B. Osborn, B.Sc., Theodore Rettie, D.Sc., and C. B. Saunders, B.Sc.

Mr. Collinge read the following Annual Report.

FIFTH ANNUAL REPORT.

In presenting their Fifth Annual Report (covering the period from July, 1909, to July, 1910), your Council are pleased to report a continued steady growth in the numerical strength of the Association.

The total number of members of all classes on June 30th, 1910, was 118, namely:—

Honorary	...	...	...	...	8
Ordinary	...	...	...	...	98
Associate	...	...	...	...	12
					118

There are also four candidates awaiting election.

A successful meeting was held at the University of Oxford on July 13th, 14th, and 15th, 1909.

The total receipts up to June 30th, 1910, amounted to £169 8s. 5d., whilst the total expenditure for the same period amounted to £55 8s. 6d., leaving a balance in the hands of the Hon. Treasurer of £113 19s. 11d.

There is also a balance of £47 2s. 3d. due for outstanding subscriptions.

In accordance with Law 12, the Council nominated the following as Officers of the Association for the year 1910 to 1911. No further nominations having been received these were put to the meeting and declared elected.

President:

PROFESSOR GEO. H. CARPENTER, B.Sc., M.R.I.A., F.E.S.

Vice-Presidents:

PROFESSOR J. B. FARMER, M.A., D.Sc. (Oxon), F.R.S.
SIR PATRICK MANSON, K.C.M.G., LL.D., M.D., F.R.S.
PROFESSOR G. H. F. NUTTALL, M.A., M.D., Sc.D., F.R.S.
PROFESSOR E. B. POULTON, M.A., D.Sc., F.R.S.
PROFESSOR RONALD ROSS, C.B., F.R.C.S., F.R.S.

Council:

PROFESSOR PERCY GROOM, M.A., D.Sc., F.L.S.
R. STEWART MACDOUGALL, M.A., D.Sc., F.R.S.E.
FRANCIS H. A. MARSHALL, M.A., D.Sc., F.R.S.E.
ROBERT NEWSTEAD, M.Sc., A.L.S., F.E.S.
A. E. SHIPLEY, M.A., Hon. D.Sc., F.R.S.
HERBERT STONE, F.L.S.
FRASER STORY, F.R.S.E.
CECIL WARBURTON, M.A.

Hon. Treasurer:

R. T. LEIPER, M.B., Ch.B., F.Z.S.

Hon. Secretaries:

WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S.
W. G. FREEMAN, B.Sc., A.R.C.S., F.L.S.

Professor Geo. H. Carpenter took the chair on his election as President.

The following alterations in the Laws were then read.

In accordance with Law 18, the Council propose the following alterations in the Laws:—

Law 10. "Three shall form a quorum at all meetings" (instead of five, as at present).

Law 12. In place of "three Vice-Presidents," *read* "three or more Vice-Presidents."

Law 18. Par. (1) The omission of the words "and be read and lie on the table at a General Meeting to enable Notice of Amendments to be given."

No amendments having been received the proposition was put to the meeting and declared carried.

The President delivered his Presidential Address entitled "Biology—Pure and Applied."

BIOLOGY—PURE AND APPLIED.

By

Professor GEORGE H. CARPENTER, B.Sc., M.R.I.A.

In assuming the Presidency of this Association, I wish in the first place to express my hearty thanks to my colleagues for the unexpected and undeserved honour which they have done me in calling me to the office. The diffidence that I felt when I received the invitation of the Council returns now that I find myself face to face with this ninth Meeting of the Association, and step into the place vacated by our friend Dr. A. E. Shipley, who for the past four years has filled with such ability, distinction, and enthusiasm, the presidential chair. My colleagues will testify that I use no words of flattery when I say that Dr. Shipley has so discharged his duties as to set before his successor a high standard of achievement. The excellence of the outgoing is the difficulty of the incoming president. Yet all the more on the account of my difficulties do I rely on the sympathetic help and support of my colleagues, whom I can promise that at least I will do my best.

Some friends at home to whom I have confided the news of the honour to be conferred on me here at Manchester enquired with some interest as to the nature of those special biologists who describe themselves as "economic." Did the name, they asked, imply that these votaries of the science of life abjure first-class travel and expensive hotels? I replied that biologists generally follow a pursuit which, however fascinating, does not bring to their pockets such extensive material gains as justify lavish expenditure, and that any

biologist does well to practise economy, especially if he support a family. Then I proceeded to a linguistic discussion on the difference between the words "economical" and "economic," which, I trust, left my friends in possession of a clear idea of the aims of our Association.

This discussion led me to think over the relation between the economic and the more general aspects of biology, and I have become so bold as to offer to my colleagues a few remarks on this wide and possibly well-worn subject rather than to review any special line of enquiry in our science. The very existence of our Association, and the success that it has achieved, bear witness to the advantage of organization among those biologists whose work deals largely with economic problems. At the same time the names of our supporters, the standard of the papers read at our meetings, or published in our Journal, remind us that the advancement of science is our aim, as it is the aim of those biologists who are not specially interested in economic questions. I rejoice in the work of our Association because it brings home to us the inspiring thought that there is no hard-drawn frontier line between what is called "applied" or "economic," and what is called "pure" science. Are we not all students of the one great fascinating and mysterious science of life?

Our Association does well to uphold this principle, because there still lingers much of that sectarian spirit which has often marred the work and the mutual relations of different sets of scientific men. This spirit, on the one hand, is embodied in the well-known though possibly apocryphal toast: "Here's to the latest scientific discovery, and may it never do a pennyworth of good to anybody," or in the saying of one of the great men of my city that a University is essentially a place for the cultivation of useless knowledge. Under such sayings lurks the assumption that useless knowledge must be "purer" than knowledge which can benefit mankind, and must confer on its followers a certain distinction and dignity which is altogether wanting in those whose work leads to results of definite utility. But the workers in economic science show, on their side, the same intolerant spirit when they refuse to undertake themselves and discourage others from undertaking, research that will not lead obviously to some material gain. It will be our part to cultivate that truly catholic spirit which recognizes the whole field of science "pure" and "applied" as one. It is convenient to have a society of economic biologists. It is convenient also to have societies of mycologists or entomologists, but the naturalist with a comprehensive general outlook will make the best special student of moulds or midges. And that economic biologist is the best equipped who

realizes most clearly that his researches, even if "useful," tend to advance knowledge, and that any path of enquiry apparently the most "useless" may lead to results of high economic value. He refuses to call his pursuits "common and unclean," because they have a practical bearing on the work of the physician or the farmer. But he recognizes that gain for himself or others gives poor inspiration for research; pressing steadily on in pursuit of truth, he trusts that in due time the material benefit will be added, and his faith is not disappointed.

It may serve as a corrective to the sectarian spirit, and as an encouraging introduction to our meeting, if we recall a few instances, among many that might be cited, of the mutual indebtedness between "pure" and "economic" biology. How often has the academic worker opened up some line of research that has afterwards proved most fruitful to the leaders of industry. How often, too, have investigations, primarily undertaken with an economic object, led to results of surpassing interest and importance to the students of pure science.

In the history of human thought we cannot doubt that biology appealed to man first of all as an applied science. Primitive, barbarous, and often civilized men approach zoology from the standpoint of the hunter or the fisher, study comparative anatomy as an aid to surgery, and become gardeners or herbalists long before they become botanists. Then the living creatures appeal to their human exploiters, as worthy of study in themselves, and from such studies men learn facts that enable them to make an increasingly profitable use of the animals and plants flourishing around them.

In no branch of biology has our knowledge been more remarkably increased in recent years than among those Protozoa that are parasitic in the blood-corpuscles and plasma of vertebrates—the Sporozoan Haemosporidia and the Haemoflagellata—and no better example could perhaps be afforded, than by the study of this group, of the marvellous results—fruitful equally in the advance of human science, the relief of human suffering, and the saving of human life—that have been brought about by researches carried on, some with, and others without special reference to considerations of definite utility. Let us review in briefest outline the story of these researches. Mayer and Gruby had described before 1850 the Trypanosoma of the frog; Lankester in 1871 discovered the first-known Haemosporidian, Drepanidium, in the blood of the same animal. What discoveries could be imagined promising less practical benefit to mankind than the determination of such minute and obscure Protozoa in the cold-blooded martyr of the zoological laboratory? Yet the

next stage in the history of sporozoan research was the recognition (in 1882) by Laveran of the malarial parasite in the human blood, though he erroneously believed it to be a plant, and it was left to Metchnikoff to elucidate its true sporozoan affinities. Meanwhile, Danilewsky had, by his researches on the blood of birds, demonstrated that warm-blooded vertebrates might be hosts of Trypanosomes. Then the interest of research into these parasitic Protozoa became mainly medical. The hypothesis that the malarial parasites were conveyed from one vertebrate host to another by means of a blood-sucking arthropod such as a gnat or tick, was before the end of the last century established beyond dispute by the brilliant labours of Ross and his followers. The wonderful life-history of the typical Haemosporidia, the asexual fission in the blood of the vertebrate alternating with sexual reproduction and subsequent sporulation, in the body of the gnat, was made known to an admiring world, and in the elucidation of this life-history the comparative study of human and bird-haunting parasites played an important and indispensable part. Reverting to the flagellate parasites, we remember how Bruce in 1897 showed that the dreaded African horse and cattle disease is due to a Trypanosome, of which the Tsetse fly (Glossinia) acts as a host alternately with the affected mammal, and how subsequently a number of eager workers have described haemoflagellates in many species of all the great vertebrate classes. Of supreme interest among these, is the Trypanosome whose passage from the human blood-stream into the cerebrospinal cavities causes the terrible sleeping-sickness of Tropical Africa.

These facts are so familiar that it may seem needless to call attention to them again before this Association. But I wish to dwell upon the thought that these later researches, carried out largely by physicians and surgeons with the direct object of combating disease, have led to results of surpassing interest to the philosophical naturalist. The existence of various complex adaptations for parasitism in two hosts, with a correspondingly complex life-cycle among minute unicellular organisms, has opened up far-reaching problems in classification and phylogeny. In these life-cycles we find typical sexual reproduction, previously unknown among the Protozoa, but now throwing a suggestive light on the probable origin of the germ-cells among the higher animals. And according to the observations of Schaudinn on the blood-parasites of owls, biologists are confronted with the possibility of a close relationship of the Flagellata with the Sporozoa on the one hand, and with Spirochaet-like organisms on the other. All these fascinating problems,

with the activities of that increasing and ardent band of "protozoologists" who strive to solve them, have been made possible by the work of a group of investigators whose primary object was to alleviate the diseases of man and his domestic animals, but who brought the strictest scientific methods to their task, and who were not afraid of pursuing any path of research which promised to lead them to new facts.

The development of Protozoology, then, has been immense during the last fifteen years. And along with it has advanced another branch of zoology to which I may now direct your attention with the feeling that I am passing to ground to myself more appropriate and more familiar. Some of the glamour that surrounds Trypanosoma and Halteridium has passed to the Tsetse and the gnat that harbour them, and the formerly unsuspected pathological importance of the blood-sucking Diptera and Acarina has led to increased interest in entomology among physicians and that large section of intelligent persons who are eager for hygienic progress. Here, again, the economic importance of the organisms has had a stimulating and beneficial effect on their scientific study. Our members are not likely to forget the admirable monograph on the Culicidae of the world which students owe to our first president—F. V. Theobald. It is doubtful if that great work would have been undertaken, but for the pathological importance shown by the work of Ross and his colleagues, to attach to the mosquitoes. In such cases, where certain genera and species of a family act as alternative hosts of deadly micro-organisms while others are harmless, it is obvious that the worker must have at his disposal as complete a systematic knowledge of that family as possible; unless every student be encouraged to widen our knowledge of any species of the family, entirely without reference to its recognized pathological importance, some fact of the greatest pathological importance unseen to us at present, will be lost to us in the future. We rejoice to think that the Entomological Research Committee recently appointed by the Colonial Office, largely, as we know, through the influence of our late president, shows, by its method of work and the nature of its newly published bulletin, that its members recognize no hard and fast barrier between pure and applied biology.

But we twentieth-century workers do well to remember that the same ideals of work inspired our predecessors. Among the pioneers of modern entomology in this country during the early part of the last century, we have notable examples of the combined study of the "pure" and the "applied" science. John Curtis is remembered

not only for his magnificent series of "Illustrations in British Entomology," but also for his classical work on "Farm Insects," in which he set forth many original observations on life-histories. John Obadiah Westwood, that great master in systematic entomology, was keenly interested in the economic aspects of the science, and rejoiced to publish the results of much valuable work in the pages of the *Gardeners' Chronicle*. Interest in the life-histories of insects other than Lepidoptera, has been largely stimulated by the fact that economically harmful insects are commonly injurious in the larval stage; and it often happens that the worker who from the economic standpoint is inclined to curse some destructive grub, remains to admire the details of its structure and to marvel at the beauty of its adaptations.

Perhaps, I may be allowed to give a few instances of the mutual independence of pure and applied entomology that have come within my own experience. For several years past I have made a special study of the lowly wingless springtails or Collembola. To many persons of the straitly utilitarian type of mind such study might well seem useless in the extreme. Yet every year that passes, as our secretary has lately shown us, brings more clearly to light the part often played by springtails as destroyers of plant-roots. The most rigidly economic entomologist simply cannot afford to neglect them, and the enthusiastic admirer of springtails for their own sake may lose much if he despise economic work. Everyone knows that attempts have been made to grow tobacco in Ireland during recent years, and naturally various Hibernian plant-eating insects try their mandibles on the strange new crop. The larvae of Agriotes flourish on the roots of tobacco seedlings in spring, while the caterpillars of *Mamestra brassicae* and *M. oleracea* delight to eat the leaves in autumn. Two years ago there were sent to me from one of the experimental plots seedlings of tobacco, the leaves covered with specimens of a tiny grey springtail—an Isotoma. That insect is a north European species *Isotoma tenella,* Reuter, previously unknown in the British Isles, which might have remained long enough unknown, had not its few and obscure representatives been enticed from their lurking-places by a new and (presumably) pleasant kind of food, provided in large quantity, on which they increased and multiplied so greatly as to alarm the cultivator. In such cases the interest does not lie merely in the record of a species new to the country. To the thoughtful naturalist they are experiments on a large scale from which something can be learnt about the response of organisms to their surroundings. And the introduction of tobacco into Ireland with the showers of tobacco-eating insects which have in consequence

fallen to my lot, convinces me that over a wide area, during successive years, individuals of the same species respond in the same way to a similar stimulus. I believe that the widespread appearance of some insect or other creature " new " as an economic pest is always an illustration of this general principle. What unique opportunities then has the economic worker for studying change of habit under changed condition.

One reason among many why the Collembola and their allies the Thysanura are of such great interest to the zoologist is the presence among them of a pair of jaws—the maxillulae of Hansen —intermediate in position between mandibles and maxillae. These maxillulae are known to be present in a reduced condition in insects of several primitive exopterygote orders—Dermaptera, Orthoptera, Corrodentia—but their existence has not been recognized among the higher orders of insects whose members pass through what is called a complete transformation. In the summer of 1908 I received for identification from an Irish farmer a number of root-eating beetle-grubs unknown to me. They were like lamellicorn larvae in build, but with the whole cuticle well chitinised, and they are ultimately proved to belong to the silky oblong-shaped beetle *Dascillus cervinus*. An examination of the jaws—which the abundance of material rendered possible—showed the presence of maxillulae, distinct and well-developed in this larva. The immense variety in type exhibited by beetle grubs makes the transformation of the Coleoptera of high import to the student of insectan phyogeny. Here we see a most suggestive morphological fact brought to light as the bye-product of a simple agricultural enquiry.

Such experiences as these bring home to us that the whole field of biology—pure and applied—is one, and that the earnest worker receives the due reward of his toil now in new knowledge and now in material benefit for his fellows. The facts of phylogenetic import to which I have just referred remind us that the echoes of the Darwin Centenary have not yet died away, and that the great English naturalist whose memory the whole scientific world honoured last year exhibited in his life-work that union of economic and theoretic interest in biology for which I plead. Need examples be given of this commanding view-point occupied by Darwin? All students of applied biology are taught the surpassing economic importance of earthworms, and the benefit derived from cross-pollination in plants —results at which Darwin arrived through enquiries carried on in the purest spirit of scientific research. And what reader of those books whose evolutionary ideas have dominated modern biology can fail to recognize the debt which Darwin's theoretic work owed to

practical facts due to the labours of the gardener and the breeder?

And, in conclusion, do we not find the most striking illustration of our principle in the work of those naturalists who are to-day carrying on the Darwinian tradition—in Darwin's own University and elsewhere—by their investigations of the phenomena of inheritance and variation inspired by the long forgotten researches of Mendel—themselves researches in which the economic and theoretic aspects of biology are finely joined? It may indeed be doubted if all or even most of the facts of heredity will ever be explained on Mendelian principles, but no student can doubt that by the application of these principles an increasing flood of light is being thrown on many of those facts. And how wonderfully does Mendelian theory applied to agricultural industry help the practical work of the cultivator and the breeder. The farmer has it now within his power to grow corn immune to fungoid disease, and to produce at will domestic animals showing within well-defined approximation, desired features of coat-colour, build, or horn. Who can put limits to the possible development of these principles in the future, and their practical application in the improvement of our domestic animals and plants? It is a suggestive fact that the leader of the English school of Mendelians should have resigned a Cambridge chair to take up the headship of a horticultural station, for we believe that in the midst of economic work, Prof. Bateson will find occasion for research, more illuminating than before, into the problems of heredity. Here surely we have a meeting place for economy and theory. The breeder knows now that "blue" Andalusian fowls can never breed true, and that white cattle will always breed true. The biologist—economic or otherwise—looks, with the eye of a scientific imagination enlightened by thoughtful cytological study, and sees in the germ-cells whence those animals spring the meeting and the sorting of those hidden determinants to which their outward appearance is due. And, while in the light of this vision, many facts of hybridization and reversion become explicable to him, he realizes that "many things are hidden greater than these." Yet he rejoices that in his "common task," which brings help to the workers who toil for the world's daily bread, he is privileged, so far as mortal man yet may be, to penetrate at least within the confines of that temple which enshrines the mysteries of Creative Power.

Professor F. E. Weiss contributed the results of observations on the garden *Tropaeolum,* some plants of which bore flowers of different colour at different seasons of the year. These and other cases of differing flower decoration, *e.g.,* in *Anagallis arvensis,* are

under investigation to ascertain to what degree they are hereditary characters, and to which factors the changes are to be attributed.

On behalf of Dr. Walter Malden, Mr. Collinge read his paper on Diseases of Bees.

Dr. R. Stewart MacDougall, in a most interesting paper, emphasised the importance in dealing with coleopterous enemies of trees—of taking account of the length of life passed in the various stages.

Mr. Walter E. Collinge described the structure of the egg of the Horse Bot Fly, *Gastrophilus equi* (Fabr.), and gave an account of his experiments on their method of hatching.

THURSDAY, JULY 7TH, 1910.

Professor S. J. Hickson read a paper "On the place of Economic Zoology in a Modern University," in which he pointed out how at present the demand for trained men capable of dealing with agricultural and other pests is in excess of the supply, especially in the colonies. He outlined a scheme for securing to students an efficient grounding in general science combined, by co-operation with experiment stations, with proper practical experience. Stress was laid on the importance of the fourth year's work, and the advisability of securing, if possible, training at a central agricultural college or experiment station, *e.g.*, in India or Ceylon, for those destined for a tropical career.

Professor Carpenter gave an account of the life-history of the Warble-fly of the Reindeer, *Oedemagena tarandi* (Linn).

On behalf of Mr. G. O. Sherrard, the President communicated a paper "On a species of *Rhabditis* injurious to Cress."

Another well discussed and important topic was the problem of wild bird protection, introduced by Walter E. Collinge, who pointed out that under the restrictions imposed by the Wild Birds' Protection Acts some birds had apparently multiplied to an excessive degree. He advocated securing definite knowledge as to which birds were harmful, and taking steps to secure their diminution, *e.g.*, by placing in schools specimens of the eggs of such birds, and offering rewards for their collection. The discussion brought out prominently the difficulty of determining exactly whether certain birds, *e.g.*, the rook, were beneficial or harmful in all districts and at all seasons; and practical suggestions, some of which are already being utilised, for acquiring this necessary knowledge were made.

Mr. W. G. Freeman gave a very full account of "The Economic Importance of the Cambium in Plants."

Dr. R. Stewart MacDougall discussed various problems suggested by the life-history of the Sheep Maggot Fly (*Lucilia sericata*), to which Mr. Collinge added a number of observations.

Mr. Joseph Mangan described the parasites of the large larch sawfly (*Nematus erichsonii*) and the progress of the work being carried out at Thirlmere.

It was announced that on the invitation of Mr. Collinge the Association would hold its next meeting at Birmingham.

Votes of thanks were passed to Profs. Hickson and Weiss for their hospitality, and to Mr. Joseph Mangan for his services as local secretary.

On the invitation of the Council of the Manchester University, the members attended the opening of the Biological Experiment Laboratories at Fallowfield by Sir Thomas Elliot, of the Board of Agriculture and Fisheries, which was followed by a garden party.

INDEX TO VOLUME V.

Vol. 5. March 31st, 1910. No. 1.

THE JOURNAL OF ECONOMIC BIOLOGY.

Edited by

WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S.,

Foreign Member of the American Association of Economic Entomologists; Joint Honorary Secretary of the Association of Economic Biologists; Honorary Consulting Zoologist to the Land Agents' Society, and the Midland Reafforesting Association; late Special Lecturer on Economic Zoology in the University of Birmingham.

With the co-operation of

Professor A. H. REGINALD BULLER, D.Sc., Ph.D.,
The University of Manitoba, Winnipeg.

Professor GEO. H. CARPENTER, B.Sc., M.R.I.A.,
The Royal College of Science, Dublin.

Prof. PERCY GROOM, M.A. (Cantab. et Oxon.), D.Sc., F.L.S.,
Imperial College of Science and Technology, London.

ROBERT NEWSTEAD, M.Sc., A.L.S., F.E.S.,
Liverpool School of Tropical Medicine.

AND

A. E. SHIPLEY, M.A., Hon. D.Sc. (Princeton), F.R.S.,
Christ's College, Cambridge.

The Journal will be issued at a prepaid annual subscription of 16/-, four parts to constitute a volume.

All business and literary communications should be addressed to the Editor.

All Subscriptions should be forwarded to the Publishers.

LONDON:

DULAU & Co., Ltd.,

37, Soho Square, W.

Berlin: R. FRIEDLÄNDER & SOHN, Carlstrasse, 11.

Vol. 5. June 24th, 1910. No. 2.

THE JOURNAL OF ECONOMIC BIOLOGY.

Edited by

WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S.,

Foreign Member of the American Association of Economic Entomologists;
Joint Honorary Secretary of the Association of Economic Biologists;
Honorary Consulting Zoologist to the Land Agents' Society, and
the Midland Reafforesting Association; late Special
Lecturer on Economic Zoology in the University
of Birmingham.

With the co-operation of

Professor A. H. REGINALD BULLER, D.Sc., Ph.D.,
The University of Manitoba, Winnipeg.

Professor GEO. H. CARPENTER, B.Sc., M.R.I.A.,
The Royal College of Science, Dublin.

Prof. PERCY GROOM, M.A. (Cantab. et Oxon.), D.Sc., F.L.S.,
Imperial College of Science and Technology, London.

ROBERT NEWSTEAD, M.Sc., A.L.S., F.E.S.,
Liverpool School of Tropical Medicine.

AND

A. E. SHIPLEY, M.A., Hon. D.Sc. (Princeton), F.R.S.,
Christ's College, Cambridge.

The Journal will be issued at a prepaid annual subscription of 16/-, four parts to constitute a volume.

All business and literary communications should be addressed to the Editor.

All Subscriptions should be forwarded to the Publishers.

LONDON:

DULAU & Co., Ltd.,

37, Soho Square, W.

Berlin: R. FRIEDLÄNDER & SOHN, Carlstrasse 11

Vol. 5. October 20th, 1910. No. 3.

THE JOURNAL OF ECONOMIC BIOLOGY.

Edited by

WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S.,

Foreign Member of the American Association of Economic Entomologists; Joint Honorary Secretary of the Association of Economic Biologists; Honorary Consulting Biologist to the Land Agents' Society, and the Midland Reafforesting Association; late Special Lecturer on Economic Zoology in the University of Birmingham.

With the co-operation of

Professor A. H. REGINALD BULLER, D.Sc., Ph.D.,
The University of Manitoba, Winnipeg.

Professor GEO. H. CARPENTER, B.Sc., M.R.I.A.,
The Royal College of Science, Dublin.

Prof. PERCY GROOM, M.A. (Cantab. et Oxon.), D.Sc., F.L.S.,
Imperial College of Science and Technology, London.

ROBERT NEWSTEAD, M.Sc., A.L.S., F.E.S.,
Liverpool School of Tropical Medicine.

AND

A. E. SHIPLEY, M.A., Hon. D.Sc. (Princeton), F.R.S.,
Christ's College, Cambridge.

The Journal will be issued at a prepaid annual subscription of 16/-, four parts to constitute a volume.

All business and literary communications should be addressed to the Editor.

All Subscriptions should be forwarded to the Publishers.

LONDON:

DULAU & Co., Ltd.,

37, Soho Square, W.

Berlin: R. FRIEDLÄNDER & SOHN, Carlstrasse

Printed by Messrs. Curtis & Beamish, Ltd., Coventry.

Vol. 5. December 16th, 1910. No. 4.

THE JOURNAL OF ECONOMIC BIOLOGY.

Edited by

WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S.,

Foreign Member of the American Association of Economic Entomologists; Joint Honorary Secretary of the Association of Economic Biologists; Honorary Consulting Biologist to the Land Agents' Society, and the Midland Reafforesting Association; late Special Lecturer on Economic Zoology in the University of Birmingham.

With the co-operation of

Professor A. H. REGINALD BULLER, D.Sc., Ph.D.,
The University of Manitoba, Winnipeg.

Professor GEO. H. CARPENTER, B.Sc., M.R.I.A.,
The Royal College of Science, Dublin.

Prof. PERCY GROOM, M.A. (Cantab. et Oxon.), D.Sc., F.L.S.,
Imperial College of Science and Technology, London.

ROBERT NEWSTEAD, M.Sc., A.L.S., F.E.S.,
Liverpool School of Tropical Medicine.

AND

A. E. SHIPLEY, M.A., Hon. D.Sc. (Princeton), F.R.S.,
Christ's College, Cambridge.

The Journal will be issued at a prepaid annual subscription of 16/-, four parts to constitute a volume.

All business and literary communications should be addressed to the Editor.

All Subscriptions should be forwarded to the Publishers.

LONDON:

DULAU & Co., Ltd.,

37, Soho Square, W.

Berlin: R. FRIEDLÄNDER & SOHN, Carlstrasse

The Journal of Economic Biology.

Vol. 5. DECEMBER 16th, 1910. No. 4.

Contents.

**

THE JOURNAL OF ECONOMIC BIOLOGY.

Edited by

WALTER E. COLLINGE, 59, Newhall Street, Birmingham.

TO CONTRIBUTORS.

All papers submitted for publication *must be type-written*; and the illustrative figures should be planned so as to fill a 4to. or 8vo. plate. The maximum space available for figures in a 4to. plate is $7\frac{1}{4} \times 10\frac{1}{2}$ inches, in an 8vo. plate $7\frac{1}{4} \times 4\frac{5}{8}$.

Contributors desiring separate copies of their papers will be furnished with the same on payment of the printer's charges, if ordered on returning proofs.

TO SUBSCRIBERS.

The subscription price of each Volume is 16s. payable in advance: the Parts, four in number, are supplied as they appear post free. Single parts are not supplied. *All Subscriptions should be forwarded to* MESSRS. DULAU & Co., 37, SOHO SQUARE, LONDON, W.

LANTERN SLIDES of many of the Plates and other Illustrations may be obtained from MESSRS. FLATTERS & GARNETT, LTD., Dover Street, Manchester.

Printed by Messrs. Curtis & Beamish, Ltd., Coventry.