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POPULAR AND ECONOMIC ENTOMOLOGY.

Some of the Benefits from Spraying with Arsenates in the Apple Orchards of Nova Scotia.*

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During the seasons of 1912 and 1913 an experiment was conducted by the local laboratory of the Entomological Branch to determine the extent of benefit from each of the four sprays then applied to the orchards of the Annapolis Valley in controlling the three most important groups of biting insects, namely, the Bud-moths, the Fruit Worms and the Codling Moth.

The orchard under experiment was six to seven years old, standard trees forty feet apart, with Wagner fillers eight feet two inches apart, and when taken was moderately infested with Bud-moths, heavily infested with Fruit Worms and moderately infested with Codling Moth. The results throughout were taken on Wagners. Ten acres of orchard were used, divided into plots of 10-12 acres each.

The composition of the spray used was commercial lime and sulphur, one to thirty-five, and Swift's acid paste lead arsenate, five pounds to one hundred gallons; it was applied with a hand pump. The first application was made when the buds were bursting, as soon as the first Bud-moth started eating its way into the bud, to be referred to as spray 1. The second was applied from two to three days before the blossoms opened, to be referred to as spray 2. The third was applied immediately after the blossoms fell, to be referred to as spray 3, and the fourth was applied two weeks later, to be referred to as spray 4.

The infestation of Bud-moths in the buds in the unsprayed checks at the end of the experiment was 59.56 per 100 buds, while

*Contributions from the Entomological Branch, Department of Agriculture, Ottawa.

in the plots receiving spray 2 and 3 together they averaged 22.1 per 100 buds, or the number of Bud-moths was reduced by 60.75 per cent.

The infestation of Fruit Worms at the end of the first season in the checks (unsprayed) was 12.44 injured apples per 100 picked, while in the plots receiving spray 2 and 3 together there were 4.33 injured apples per 100 picked, or the injury by Fruit Worms was reduced by 65.19 per cent. The second season, with a much lighter infestation throughout the orchard, the benefit was 63.56 per cent. reduction in Fruit Worm injury.

The Codling Moth infested 4.54 per cent. of the apples in the checks in 1913. It was found that spray 2 gave 71.3 per cent. reduction in injury. Spray 3 gave 89.2 per cent. reduction, and spray 4 gave 65.6 per cent reduction. From the fact that the Codling Moth is, as a rule, an insect of minor importance in Nova Scotia, and that it is largely controlled by sprays other than the regular Codling Moth spray, the Nova Scotia apple growers are free to advance or retard by two or three days the first spray after the blossoms, as may be advantageous to them in controlling any other pest, with practically no reduction in benefit to Codling Moth.

The injury done by the three insects under observation was divided into two classes; the first, reduction in the set of fruit, and the second, injury to the picked fruit.

Effect of Bud-moth in Reducing Set

In the Experimental orchard 59.56 per cent. of the blossom buds in the checks contained Bud-moth. Counts of 1000 blossom clusters infested with Bud-moth showed 305 apples set, while 1000 blossom clusters free from Bud-moth on the same trees set 1205 apples. In other words, the reduction in set in the blossoms infested is 75 per cent., or in the checks where the infestation was 59.56 per cent. the reduction in set was approximately 45 per cent. By the use of spray 2 and 3 we reduced the number of Bud-moths by 60.75 per cent., so instead of growing 55 apples where 100 would have set if no Bud-moth had been present, we increased the set to 82, or an increase in set of 49.09 per cent.

Effect of Fruit Worm in Reducing Set.

In the check plots we found 12.44 per cent. of the picked fruit showing Fruit Worm injury. Observations during June showed that 72.48 per cent. of the young fruits injured by Fruit Worms drop to the ground before maturity. So the number of apples which fell in the checks was 32.75 per cent. of the total set on 67.28 apples were grown where 100 would have grown if no Fruit Worms had been present. Spray 2 and 3 reduced this injury by 65.19 per cent. and so increased the set from 67.28 apples to 88.61 apples or an increase in set of 31.7 per cent.

TABLE SHOWING INCREASE IN SET DUE TO BUD-MOTH AND FRUIT WORM CONTROL.

Due to	Per cent. drop due to insect injury.	Per cent. set in unsprayed plots	Per cent. benefit by spraying in controlling insects.	Per cent. set when sprayed.	Per cent. increase in set due to insect control.
Fruit Worm...	32.72	67.28	65.19	88.61	31.7
Bud-moth......	45.	55.	60.75	82.	49.09
			Total increase in set..........		80.79%

Or where in the treated plots we grew 100 apples in the untreated plots we grew 55 apples.

Bud-moth Injury to the Picked Fruit

In estimating Bud-moth injury to the picked fruit, the counts in the various plots varied greatly, depending on the crop, size of the leaves, etc., so that no accurate idea of control beyond the general benefit in reducing Bud-moth could be gathered. The whole twelve plots averaged 44.7 per cent. Bud-moth infestation in the buds, while 9.5 per cent of the total crop of apples had leaves tied up to them, the surface showing injury by the young larvæ. A total injury of about one apple to every five buds injured in the spring. All apples injured by Bud-moths under the present interpretation of the Fruit Marks Act are packed as No. 3's or "culls," the injury being properly classed as "causing material waste."

Fruit Worm Injury to the Picked Fruit

In the check plots the total Fruit Worm injury was 12.44 per cent. of the picked fruit. Of these 39.5 per cent., or 4.97 per cent. of the total, were so damaged as to be fit only for No. 3's or culls.

In many cases the injury is much greater than this, a larger proportion of those injured being classed as No. 3's and culls.

Codling Moth Injury to the Picked Fruit.

In the check plots the Codling Moth injury was 4.54 per cent., while in the plots receiving spray 3 the injury averaged 5 per cent. Both calyx and side injury were present, and the injury predominating.

TABLE SHOWING INJURY TO THE PICKED FRUIT.

Due to	Per cent. total injury to picked fruit.	Per cent. injury serious enough to throw apples into No. 3's and culls.	Per cent. serious injury in sprayed plots.	Per cent. reduction in injury by spraying before and after the blossoms.	Per cent. increase in marketable apples due to spraying
Bud-moth.....	9.5	9.5	3.8	60.75	5.7
Fruit Worm...	12.44	4.97	1.74	65.19	3.23
Codling Moth.	4.54	4.54	.5	89.2	4.04
		Total increase in marketable apples.........			12.97%

Economic Results.

Apples are seldom worth less than $1.00 per barrel on the trees in Nova Scotia. For every 100 barrels grown by proper spraying in orchards similarly situated to the one in which we experimented, 45 barrels of the picked fruit in every 100 and 12.97 per cent. more Nos. 1 and 2; among those grown may be attributed directly to the control of Fruit Worms, Bud-moths and Codling Moth by spraying. The results obtained were practically from two sprayings, one from one to three days before the blossoms, and one directly after the blossoms. Spray 4 gives some results when applied alone in the control of Fruit Worms, Bud-moths and Codling Moth; but when spray 2 and 3 are applied, the additional benefit of the later spray becomes so small as to be scarcely noticeable.

Cost of Spraying

The cost in Nova Scotia varies, but, on the average, five cents per barrel per application more than covers the cost; reckoning the dilute mixture of lime and sulphur and lead arsenate at one cent per gallon and the cost of the application at one and one-half cents per gallon and two gallons per barrel per application. For two applications of spray mixture costing ten dollars per 100 barrels we had in return 45 barrels more of apples and 12.97 barrels more Nos. 1 and 2 to the hundred due to insect control alone. We did not reckon any benefit from black spot control, which is even a more important problem, leaving that to the plant pathologists. We conducted the experiment to show that when the weather is fine and black spot not present that spray is not wasted on trees, but that a man pays for his entire four or five applications of spray which the plant pathologists recommend to keep black spot off the various varieties in Nova Scotia from two to three times over by controlling three groups of insects: the Fruit worms, the Bud-moths and the Codling Moth, which are present in every orchard and in every year in the Annapolis Valley, often in greater quantities than in our experimental orchard.

JUNE COLLECTING IN MAINE.—(COLEOPTERA).

BY C. A. FROST, FRAMINGHAM, MASS.

June 17th, 1912, found me in the pleasant little village of South Paris, Maine, which is situated on the Little Androscoggin River in the County of Oxford, formerly famous for its bears. The general elevation of the village is about 350 feet above sea level, and the highest point near there is Streaked Mountain about 1700 feet.

This was the second season I had been able to collect in this place, and as I had confined my investigations to the higher land and the hills in 1910, this year I collected along the river and devoted considerable time to the numerous lumber yards in the village. The most remarkable collecting I have ever experienced was enjoyed in the yard of the Mason Manufacturing Company, which contained huge piles of white pine boards and rapidly diminishing tiers of short logs, mostly white and red (Norway) pine. There were also long piles of slabs, the composition of which showed that spruce, fir, hemlock, and several species of hard woods were used in the establishment.

Between the river and the yard on the east is a thick stand of young white pines, which extends also a short distance on the north side and forms an enclosed angle into which the afternoon sun beats with tropical fury. In this corner the logs, the tree trunks, along the edge of the woods, a pile of empty packing cases, and the sides of several small buildings, provided resting places for hundreds of wood-boring Coleoptera. *Chalcophora virginiensis* and

Monohammus scutellatus buzzed from one resting place to another, and the sweating workmen addressed them in unique, if somewhat lurid, phrases when the huge insects struck them in the face or scratched an erratic course across the back of their neck. In this yard I bottled 160 of the former and 265 of the latter species, most of them being taken on two of the warmest afternoons of the week. *Chalcophora fortis* was taken once on a board pile and *liberta* several times in company with *virginiensis.*

All the specimens of *Dicerca chrysea* seemed to have congregated on the trunk of a sickly white pine at the edge of the woods, where I secured eleven of them. Many of them were so high up that I was forced to stand on a pile of logs and dislodge them with a long pine branch. Those that missed the net in their fall were found clinging to projecting sticks or to the base of the tree, which they must have reached by spreading their wings just before striking the ground. I have noticed this neat bit of parachute work by *Dicerca divaricata* after vainly searching for them on the ground. This species and *punctulata* were taken on the trunk of a maple tree at the south end of the yard. The single specimen of the latter species is my only record for Maine.

Chrysobothris scabripennis was common on the pine logs and *dentipes* became a nuisance as its quick flight distracted the attention from more desirable species. *C. harrisi* was seen four times and, remarkable enough to record, not a specimen escaped.

One *Buprestis impedita* was taken from a pine trunk so close to the ground that it nearly escaped observation. The remains of *B. consularis* were discovered under a board and by careful patching a presentable specimen was secured; then by running melted paraffine into the body cavity it was made strong enough to pin. Many rare specimens might be saved if care is taken in transporting damaged insects from the field and a little ingenuity exercised in repairing them. It is also a good plan to pick up any dead, even though imperfect, specimens and reserve for future examination unless they are well-known forms. I have not forgotten the lesson I once received, for the result brought me an almost perfect specimen of one of my rarest New England Cerambycidæ. I was tramping through a thick forest growth of hardwood, interspersed with huge hemlocks, that clothed the ruggedness of a Maine hillside in the town of Wales, when I caught a gleam of emerald in a small patch of freshly washed out earth on which a wandering sumbeam for a moment rested. I picked up the specimen and carelessly threw it in to the alcohol bottle, thinking it a new record for *Gaurotes cyanipennis*, for I had never seen it in Maine. Some weeks later, when I came to examine it, I found it was *Anthophilax malachiticus*.

The most conspicuous—that is, after they were once seen–of the *Elateridæ* were *Alaus oculatus* and *myops*, which were taken on the board piles with *Agriotes stabilis* (also taken on raspberry flowers) and *Elater semicinctus*. *Corymbites cruciatus* was taken only once flying in the yard.

When the shadows began to lengthen, the air was filled with minute flying forms—*Scolytidæ*, *Staphylinidæ*, *Lathridiidæ* and many others whose family names have not yet been noted.

On the second day after my arrival, a small sand-bar at the edge of the river attracted my attention, and before I was aware of it, an hour had passed. Here I secured a single *Elaphrus riparius*, my first record for New England, although I have seen several from the Lake of the Clouds, Mt. Washington, N. H. By scooping up water and throwing it over the mud and sand, numbers of *Bembidium*, *Staphylinidæ*, and a few *Omophron americanum*, and *Heterocerus tristis*, were taken.

On another day, when the sun had become obscured and a cold wind had driven all the lumber-loving species to cover, I spent two or three hours throwing water with an abandoned basin upon the stony beach that marks the fording place of an old Indian trail. Here several species of *Bembidium*, *Tachys scitulus*, *Hypnoideus exiguus* a larger species of *Hypnoideus*, *Apristus subsulcatus*, *Omophron tessellatum*, and many species of *Staphylinidæ* were driven out of their hiding places and captured as they scurried about. When the basin failed me and more water came through the bottom than out the top, I turned my attention again to the slab piles and stray bits of lumber. Here I found *Dinoderus substriatus* (?) boring into the strips of bark that clung to small bits of pine slabs. A fine specimen of *Ditylus cæruleus* encouraged me to handle over a cord or so of pitchy pine and silvery hemlock, without further success, except a few well-known *Histeridæ* and *Cucujidæ*.

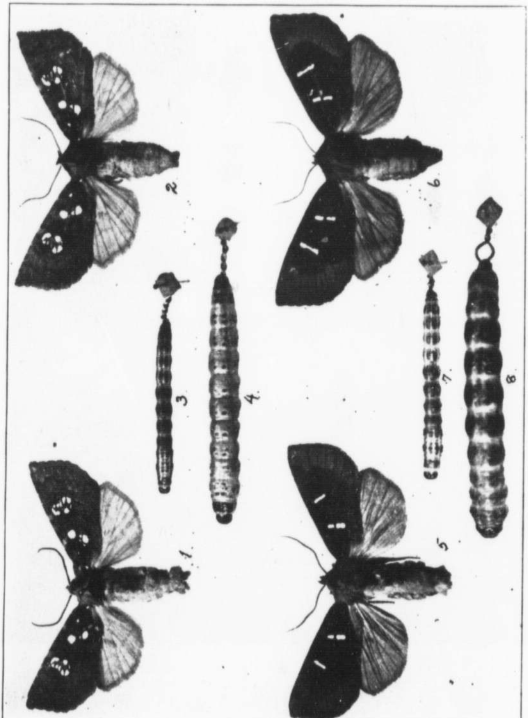
It was here that I secured my second New England record (first one at Wales, Me.) of *Geotrupes semiopacus*, which was boring in the earth beneath excrement. A sluggish *Chalcophora fortis* that was waiting on the end of a log for the sun to appear again, fell over backwards to escape my menacing fingers and landed in the waiting net.

Near here, on a sunny day, I swept two *Agrilus crinicornis* from the leaves of the red raspberry. This genus does not seem to be abundant in Main , where I have collected. I have once found *A. bilineatus* in numbers on red oak leaves and logs, and at another time captured a good series of *pensus* on the leaves of Ostrya This species was also taken in small number by beating *Alnus incana* after sunset. A single specimen of the rare *lateralis* was taken at the same time at Wales, Me. A very few specimens of *obsoletoguttatus* have been taken on oak and scattering individuals of *politus* are occasionally seen.

Among the other species taken in this locality were the folowing: *Schizogenius amphibius*, *Amara erraticus*, *Rhizophagus approximatus* (?) *Lathridius liratus*, *Tyrus humeralis*, *Connophron fossiger*, *Xantholinus cephalus*, *Conosoma littoreum* and *knoxii*, *Gronevus* (*Corylophus*) *truncatus*, *Ernobius luteipennis*, *Annobium notatum*, *Ptilinus ruficornis*, *Cœnocara scymnoides*, and *Anthicus ephippium*.

A week is a most deplorably short space of time for an entomologist to explore the possibilities of a new region, and yet, with all the fields and forests before me, I return again and again to the sun-baked piles of logs and slabs, fascinated with the thought that just ahead there is another rarity. The noon hour passes into oblivion, and the faintly stirring memory of an early breakfast vanishes with the capture of a handsome Buprestis. The rays of the afternoon sun come slanting down between the pines and I say to myself, "Just once more around the piles," but the six o'clock mill whistles find me amid the flying bark-beetles and the falling dusk sends me reluctant toward the supper table.

To the entomologist there comes anticipation—and the mind conjures up a beautiful country swarming with unknown forms; realization—and the nature student is delighted with the never-failing unexpected; retrospection—and time has softened the harshness, effaced the petty annoyances, and magnified all that



PAPAIPEMA FURCATA (1-4) AND
PAPAIPEMA SPECIOSISSIMA (5-8)

(See Page 145)

was joyous and beautiful. And as I sit with open box before me and listen to the sleet driven from out the winter darkness against the window panes, I dream of June vacation days—the scent of spruce and fir arises and I gaze across the logs through shimmering heat waves to the cool shadows of the clustering pines.

NEW LIFE HISTORIES IN PAPAIPEMA SM. (LEPIDOPTERA.)

BY HENRY BIRD, RYE, N. Y.

(Continued from p. 115).

Papaipema speciosissima G & R.

A thirteen-year search for the larva of this species, one of the few eastern ones remaining unknown, culminated successfully in 1913. By reason of its fine coloration and large size the species was well known as a moth, even though but few examples ever found a way into collection. At the time of the description in 1868 (Trans. Am. Ent. Soc., Vol. I, 342), Grote and Robinson relate receiving their type from Seekonk, a suburb of Providence, R. I., and an accompanying figure made its individuality clear. Thirty years later Prof. J. B. Smith found "perhaps a dozen female examples" in the aggregate of the principal American collections which he perused when writing monographically of the genus. While known to be generally scattered over the north-eastern United States, most of the examples coming to light of late years bore the label of northern New Jersey. As the establishment of the preferred food-plant through a painstaking search has brought out a bearing of primitive conditions on the result, it may be helpful to relate details.

It was conceded the larva would have a boring habit, its large size would indicate the occupation of some stocky stem or root, so this problem of isolating the food-plant was the first question, and one beset by certain ecological features. So long ago as 1900 the writer visited the type locality in hopes of meeting some plant peculiar to that section which might furnish a clue to the desideratum. Obviously, one way of getting an idea of a likely plant for investigation would be to visit a number of places where the moth had occurred, compare the floral conditions, and note the suitable plant forms common to such stations. Working on these lines many stations from Montreal, Can., to Wilmington, Del., were visited, but the results led nowhere. What did appear was that the great semi-tidal marsh westward of Jersey City and Hoboken, N. J., yearly gave up a few of the moths, and made it apparent an established colony must be flourishing in these fastnesses. The flora of this region is of the usual luxuriance of an ancient marsh, though modified by a considerable salinity in its lower reaches. Very conspicuous are a number of giant grasses, *Phragmites phragmites, Spartina cynosuroides, Zizania aquatica,* and others, which are capable and fit to serve as food-plants. For many years we laboured under the impression that some of these grasses must be the answer to the riddle. A number of large herbaceous species also occur and the field for investigation was a large one. From a contemplative viewpoint this habitat offers much to be desired. Many of the floral conditions here have seen little change in the last piling up of centuries, certain sections remaining doubtless in their pre-Columbian verdancy, and we should, theoretically at least, find our larva easily. But the proximity to so great a population has produced much artificiality and the region is interspersed by numerous railroads that are responsible for frequent burnings. The principal hinderance to a thorough search, however, is the fact that the territory is wet to submergence except during very droughty times.

Our meeting with the larva of *P. inquæsita* in a Cryptogam, in 1898, made us early mindful of the ferns, though the food-plants of the genus centre principally among the Composites. Light dawned in 1912 when *P. stenocelis* proves a fern feeder, for *inquæsita, stenocelis* and *speciosissima* are a trio aloof from the allies, and it becomes clear we must now also look for the latter in a fern. But what fern was peculiar to the Jersey Meadows? Early in 1913 we found a young borer at work in *Aspidium*, at Rye, but the instance did not reflect a normal operation for our desideratum. Latterly, Mr. Otto Buchholz, of Elizabeth, N. J., had rendered assistance in the Jersey Meadow hunt, being close by the field, and keen, through a wide experience and with a skill rarely equalled, for detective work of this nature. Upon being advised the search had narrowed down to the ferns, with usual acumen, he soon located the great colony of the Meadows. It developed the common Osmundas are the ones chosen, both *O. regalis* and *O. cinnamomea* being infested. Whether *O. claytoniana* is also bored did not develope, since that species did not occur here, being a denizen of dryer places. While it is a surprise this common fern proves the food-plant so long sought, *Osmunda regalis* being the favourite, and that negative results had followed its examination in hundreds of cases previously, the prominent feature is the localized colony encountered, with the evidence of its probable antiquity. From twenty years' observation on the growth of *Osmunda* under our windows, we do not hesitate to state that most of these individual plants represent fifty years development at least. The gnarled, ruminating root-stocks are elevated 50 to 60 cm. above the level of the quaking morass, in the effort to get above the water and from the nature of the yearly accumulations, and show the borings of preceding generations.

The presence of the larva in *O. regalis* is not easily noted. There is no wilting or drying of a conspicuous frond as happens with the other fern borers. The newly emerged larva enters a miniature stipe whose uncoiled, tender tip has sprung up but three or four centimeters, and in a few days has tunnelled down into the root-stock. This dies, it is true, and is some evidence, but a peculiarity with this fern in this locality seems to be that many more fronds start than eventually mature, what appears to be a fungous blight nipping some in their tender incipiency. Further, a dipterous larva bores these young stipes and causes them to die, so that we find two other similar results produced at the same time in the plant, as is occasioned by the working of *speciosissima*. As the larval period lengthens, the frass thrown out is the only indication, and this is not in the usual well-formed pellets, but a rusty-brown, mud-like deposit. Even this sign is hard to detect for the fruiting fronds send down their brown inflorescence, which, with the chaff-like scales from the stipes sprinkle the root-stock and help to smother the meagre clues. So the apprehension of this larva is not as easy as with most others, and the surprise greater, when, at maturity, one of these old roots is cleft open, disclosing a pair often of great pink larvæ which have their whereabouts hidden to such a remarkable degree.

The last week of May can be assigned as the date of general emergence from the over-wintering egg, and maturity is reached about Aug. 1. It did not develope that there was the usual amount of parasitism from the smaller hymenoptera that work so assiduously against most of the allies about the fourth instar, and only *Ceromasia myoidæa* seemed to assail the last stages, but this Tachinid was a prevalent check.

The following brief tabulation, except for the first instar, may sufficiently place the larva:

Stage II.—Generically typical, of the group with dark purplish-brown girdle which is not crossed by the white lines; head shows side line; tubercles well developed but not large, blackish, IVa absent on joint ten. Head and cephalic shield concolorous, dorsal and subdorsal lines whitish and broken at girdle.

Stage III.—Colour unchanged, tubercles not prominent, except on joint eleven III and 111a are fused into a large plate greater than the spiracle and the latter somewhat larger than the anterior ones, and on twelve I and II are of the usual prominence.

Stage IV.—Head has lost dark line at ocelli, is chestnut brown; the cephalic shield is as wide as head, yellow, margined laterally with a black border; lines white and conspicuous, the girdle becomes a shade paler; tubercles the same.

Stage V.—Colour changes to a pinker tone, otherwise similar; the fused III and IIIa on eleven remain the largest of the lateral plates, which on the whole are small.

Penultimate Stage.—Colour is pronounced pink, the translucence at the sutures giving a ringed appearance, the white lines are nearly lost except the dorsal on the thoracic joints; tubercles and spiracles black, the former reduced; III and IIIa have separated on joint eleven.

Maturity.—A robust larva with prominent brown head, cephalic and anal plates, the tubercles except I and II on joint twelve inconspicuous; IVa has never developed on joint ten, and on eleven III and IIIa still more separated, the former the largest lateral plate; IV never gains its usual prominence as occurs with most other congeners. The colour is a pale pinkish hue, and with the large size is productive of an individuality pronounced with this species. Length, when full grown, 50 mm.; breadth, 7 mm.

The gallery is abandoned for pupation, dates Aug. 1 to 15; emergence of forty specimens range Sept. 1 to 28. The pupa is correspondingly robust, the anal extremity armed with two curved hooks. Length 28, breadth 8 mm.

The larval characters further accentuate the relationship with *inquæsita* and *stenocelis*. Like these species, the slightly enlarged posterior spiracle indicates these larvae have had a super-abundance of moisture to contend against, and is a modification that is yet needed.

Papaipema furcata Sm.

The larva of this species seems to have been first encountered by Mr. Jacob Doll in the vicinity of New York City, but the general habitat is that of the central Mississippi valley. It bores the terminal twigs of Ash, and an instance of economic record against the species is cited by Prof. Washburn in his State Report as entomologist of Minnesota for 1907-08. The mature larva is there described, and a case of damage to nursery stock noted, with suggested remedy for such chance occurrences. My own searchings for this borer from Pittsburg, Pa., eastward have born negative results. Recently the species has been found as a larva in some numbers, by the Chicago collectors, particularly Messrs. A. Kwiat and E. Beer, and I am indebted to the former for these further details of the life history as well as a fine series of larval and perfect specimens.

The larval period extends from May 15 to July 30, considering early emergencies and tardy maturities. The soft, newly grown tip is entered at the base of one of the terminal leaves and the larva works in this portion for a short time. They then leave their burrow here and go back and enter the harder, last season's growth, usually a short distance below the point of the wintering bud. Why they do not continue their first gallery down into the old wood is not clear, for a considerable pith exists in both. However, the move to a new burrow in harder wood seems very general.

Three species of Ash were found infested, *Fraxinus nigra, F. americana,* and *F. pennsylvanica.* At maturity the burrow is vacated and pupation occurs in the ground. The larva probably falls to the ground, for such borers at maturity are clumsy and cannot cling well to vertical surfaces. An indication of its early presence exists in the withered leaf at point of entry, with an exudation of frass at the orifice; later when in the harder wood, it is less easily noticed. The larva belongs to that group in the table wherein the lines are broken centrally, but the species considered in its entirety is very distinct.

Stage I.—Markings indistinct, the three anterior and last segments of lighter colour, middle brownish; lines not indicated, tubercles show slightly, blackish; cervical and anal plates prominent; duration of stage assumed to be five days.

Stage II.—Generic characters in evidence, dorsal and subdorsal lines prominent and pure white, they are broken at and unindicated on the first four abdominal segments in general terms, though the break is not exactly at the sutures, these middle segments appear as a girdle in deep purple brown; on joint ten there is indication of tubercle IVa, but the chitinization is not heavy and is concolorous; anal plate of much prominence, shining black. cervical shield much lighter, tubercles black.

Stages III, IV, V.—Appearance similar, the head shining chestnut brown, but lacks the usual black, oblique line at the ocelli; on joint ten IVa is a well emphasized plate.

Stage VI.—The colour fades, the brown tone remaining to the middle girdle, all tubercles and plates retain their prominence, blackly marked, excepting the cervical shield, which is the tone of the head, a yellowish brown, and edged at the side with a black border.

Maturity.—We have now a rather stout larva averaging 40 mm. in length and 6 mm. in breadth; the head is yellowish brown, width 2.8 mm., the colour a whitish translucence throughout, the longitudinal lines lost; the black tubercles and spiracles stand out strongly, of the former special reference should point to joint two, where an elongate plate occurs anterior to Ia and Ib, the fused Xa and Xb apparently; Ia, Ib, IIa show as mere dots, IIb, III and IV larger, the two latter being greater than a spiracle; on joint ten IVa is as large as IV, and I and II are more quadrately placed than occurs anteriorly; on twelve these are especially large and almost confluent; anal and its preceding plates black, and form a heavy armature to the posterior extremity.

This instance of a black anal plate becomes a specific feature paralleled only with *cerussata*. The larval period seems about sixty days.

The pupa is of the stout, active form normal to the group, with a period of about thirty days. The dates for emergence in a series of fifty-five specimens are Aug. 26 to Sept. 5.

The male genitalic modifications, noted already by Smith, might be suggestive of departures with the female structures to meet some special requirement in placing the egg, but other than a slightly longer ovipositor, there seems no change from the prevalent type. This modification exists in the peculiar two pronged clasper, which is unique absolutely. The eggs which are placed in September hibernate and are likely deposited near the extremity of the branches so the emerging larva may be near the food supply. Parasitism has not been observed so far. The sap beetle, *Ips quadriguttatus*, occurred numerously in the deserted galleries.

Explanation of Plate IV.

Fig. 1—*Papaipema furcata*, male.

Fig. 2—*Papaipema furcata*, female.

Fig. 3—*Papaipema furcata*, larva, stage IV.

Fig. 4—*Papaipema furcata*, larva, mature.

Fig. 5—*Papaipema speciosissima*, male.

Fig. 6—*Papaipema speciosissima*, female.

Fig. 7—*Papaipema speciosissima*, larva, stage IV.

Fig. 8—*Papaipema speciosissima*, larva, mature.

NOTES ON SOME TROPIC REACTIONS OF MACRODACTYLUS SUBSPINOSUS FAB.

BY HARRY B. WEISS, NEW BRUNSWICK, N. J.

During the summer of 1914, while investigating a "rose chafer" complaint in southern New Jersey, a long wait for a train, an abundance of beetles and favourable surroundings tempted me to test the action of this insect in the field under different conditions of light and temperature.

A comparatively cool, shady woods, where the temperature was 75 degrees F., a tree in the open under the shade of which the temperature was 84 degrees F. and a dead leafless tree in the bright sunlight where the temperature was 89 degrees F., constituted all the apparatus at my disposal. Forty-five beetles were collected while feeding and copulating and three batches of fifteen each were liberated one at a time at the base of a tree in each of the surroundings described above. The following table gives the distances (vertical) covered by each beetle.

Shade, Temp. 75 F.		Shade, Temp. 84 F.		Sunlight, Temp. 89 F.	
Beetle	Distance covered	Beetle	Distance covered	Beetle	Distance covered
1	0 ft. 2 in.	1	0 ft. 2 in.	1	1 ft. 0 in.
2	6 " 0 "	2	0 " 4 "	2	0 " 11 "
3	3 " 0 "	3	0 " 6 "	3	0 " 3 "
4	1 " 6 "	4	0 " 1 "	4	0 " 10 "
5	5 " 0 "	5	0 " 2 "	5	1 " 0 "
6	1 " 0 "	6	0 " 5 "	6	0 " 2 "
7	0 " 8 "	7	0 " 2 "	7	0 " 6 "
8	2 " 0 "	8	0 " 3 "	8	0 " 4 "
9	1 " 0 "	9	0 " 4 "	9	0 " 6 "
10	0 " 6 "	10	4 " 0 "	10	0 " 2 "
11	1 " 0 "	11	0 " 3 "	11	0 " 8 "
12	0 " 6 "	12	0 " 4 "	12	0 " 2 "
13	0 " 4 "	13	0 " 3 "	13	0 " 3 "
14	0 " 6 "	14	0 " 1 "	14	0 " 2 "
15	2 " 0 "	15	0 " 6 "	15	0 " 4 "
Totals	22 ft. 38 in.	Totals	4 ft. 46 in.	Totals	2 ft. 63 in.
Averages	20.1 "	Averages	6.2 "	Averages	5.8 "

At a shade temperature of 75 degrees F., the average distance covered was 20.1 inches. At a shade temperature of 84 degrees F., the average distance was 6.2 inches, and in the sunlight, with the temperature five degrees higher, the average distance was 5.8 inches. It thus appears that thermotropism and phototropism either together or alone were responsible for the quicker escape of the insects into the air and the lessened distances covered.

A NEW GENUS OF TACHINIDÆ FROM THE CANADIAN NORTHWEST.*

BY HARRISON E. SMITH,
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Saskatchewania, new genus.

Proboscis long, slender, about two times as long as the dorso-ventral diameter of the head. Labella not well developed. Palpi small, well developed. Head slightly broader than the thorax. Facial plate with broad, highly raised, distinct median carina. Facial ridges bare. Eyes bare. Antennæ inserted near a line drawn through the middle of the eye, descending but slightly below the middle of the face. Parafrontals bare outside of the frontal row. Frontal bristles not descending below base of antennæ. Ocellar bristles weak, proclinate. Orbital bristles absent in each sex. Diameter of head at the vibrissæ as long as at the base of antennæ. Abdomen not bearing the usual macrochætæ. Tip of apical cell ending at the extreme wing tip. Apical cell closed, long petiolate, the petiole as long or slightly longer than the posterior cross-vein. Posterior end of the hind cross-vein nearer to the small cross-vein, than to the margin of the wing. Fourth longitudinal vein, beyond the bend, with a short distinct stump.

Type of the Genus—*Saskatchewania canadensis*, new species.

Saskatchewania canadensis, new species.

Black, densely brassy-gray pollinose. Length 5-6 mm. Frontal vitta bright opaque, brownish black, slightly concave. At narrowest part somewhat wider than the parafrontals at the same point. Front at narrowest part not more than two times as wide as the distance between the posterior ocelli. Ocellar triangle and sides of front grayish pollinose. Head as viewed from the side projects but little in front of the eye. Parafacials grayish pollinose with a strong brassy tinge; about one-fifth as wide as the median depression. Cheeks covered with black bristly hairs, gradually simulating macrochætæ on the anterior margins. About one-fifth to one-fourth as wide as the eye height. Transverse impression of face well defined, concave, piceous. Antennæ black, the first joint scarcely discernible, brownish black. Second and third joints opaque black, the third joint not over two times as

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long as the second. Arista thickened on less than the basal half, the penultimate joint as broad or broader than long. Antennal fovea deeply concave. Median facial carina on its upper surface convex, as broad as the third antennal joint at its greatest width. Vibrissæ cruciate, situated on a level with the front edge of the oval margin, one or two weak bristly hairs above each. Proboscis shining black, once geniculate. Palpi black, slightly thickened at the tip. Occiput, except the epicephalon, covered with numerous short bristly black hairs.

Thorax black, brassy-gray pollinose with four distinct sub-shining brownish black vittæ, the outer vittæ considerably wider than the two median. Bearing three dorso-central bristles (the anterior two, sometimes very weak), and two distinct sterno-pleural bristles. Scutellum rather small, broader at the base, gradually narrowing to a rounded point apically. Bearing a pair of long basal and a single pair of long apical, marginal scutellar bristles. Median discal scutellar bristles weak.

Abdomen black, brassy-gray pollinose with a distinct median brownish black vitta. Clothed with numerous long sub-erect bristly hairs, which are somewhat stouter in the male. Hypopygium in the male black, pollinose, bearing black bristly hairs, protruding forward beneath the venter. In the female shining black, distended outward, a narrow deep median hollow groove on the dorsum. The outer margin thickly beset with rather long, flattened, pointed spines, directed upwardly.

Legs black, faintly pollinose. Knees reddish. Middle tibiæ each bearing a single short bristle on the outerside below the middle. Hind tibiæ with a few short bristles on the outer margin. Last joint of front tarsi slightly longer than the tarsal claws. Pulvilli whitish.

Wings hyaline with a yellowish tinge at the base. First and third longitudinal veins not bristly. Posterior cross-vein straight. Bend of fourth longitudinal vein right angular, beyond bend approaching the third longitudinal vein in a straight line. Last section of the fifth longitudinal vein much shorter than the preceding section. Calypteres whitish, with a yellowish tinge along the borders.

Habitat—Saskatchewan, Canada.

Described from two males and four females collected June, August, and September, 1907, at Farwell Creek, South Saskatchewan, Canada. This genus is named in honour of the Saskatchewan region, a very rich collecting ground in the Canadian northwest.

Holotype—One male, Cat. No. 19213, U. S. N. M.

Allotype—One female, Cat. No. 19213, U. S. N. M.

Paratypes—One female in collection of the Boston Society of Natural History; one female in collection of the Massachusetts Agricultural College and a specimen of each sex in author's collection.

GEOMETRID NOTES—NEW SPECIES AND VARIETIES.

BY L. W. SWETT, BOSTON, MASS.

Stamnodes blackmorei, n. sp.

Expanse 21-27 mm. Palpi very short, head dark brown, antennæ mottled brown and white. Thorax and abdomen fuscous, of about the same colour as in *Diastictis inceptaria*. Wings full and rounded, the general colour fawn brown, as in *inceptaria*. The insect at first sight looks like *gibbicostata* Walk., to which it is closely allied. Fore-wings form base to outer two-thirds clear fuscous, except at costa, where they are heavily shaded with brown. About one-fourth out from body the costa is intersected by a white dash and about the middle there is another white dash, followed by a large brownish patch, which extends to the median vein. Beyond this is a broad white band running from costa, at a slight angle, to median vein; then curving inward toward the body and almost disappearing as it nears the inner margin. Bordering this white line at costa is a very dark brown and black patch, sometimes square, sometimes elongated. It is very distinct on all specimens, and is edged outwardly with yellow, followed by two white spots on edge of costa, then a black dot at almost apex of wing. Fringe light brown, with black checks at ends of veins, heavily shaded with dark fuscous from outer to inner margin. Discal dots absent, or, if present, to small too be apparent. Hind wings of same colour as fore wings. Viewed from beneath, the difference between this species and *gibbicostata* is most apparent. Fore-wings beneath darker than above with a rosy hue, the brown markings on the costa above being replaced by reddish beneath. There are the same white spots to the extra-discal band, and the black spot shows beneath as small and linear. The extra-discal line is quite angled beneath and has a pointed instead of a rounded projection, but the line fades out as it approaches the inner margin. Beyond the extra-discal white line is a large square reddish-brown patch, followed by a whitish ashen patch, which extends to tip of wing, and is marked with two minute points on costa. Beneath this ashen patch the wing is rosy along outer border to inner margin. Hind-wing, from base to white discal dash, clear, with a rosy flush. In *gibbicostata* the same space is heavily striated. In one specimen there is a white extra-discal band curving across the wing; in the others it shows only on inner and outer margins. On the inner margin the white extra-discal line is shaded with a large rosy-brown patch. There is another patch at junction of veins 6 and 7, below outer margin. The outer border is rose-shaded, this colour sometimes running into the checkered fringe.

This geometer can be distinguished from allied species by the conspicuous costal patch above, shaded with red beneath, and the rosy shading of the entire fore-wing. On the hind-wings the two widely-separated rosy-brown patches, white discal dash and extra-discal line separate it from *albiapicata* Grossb. The most distinctive feature is the clear central space extending to the discal dot, which has only a rosy line and lacks striations. I think this species, when once seen, can hardly be confused with any other.

Mr. Blackmore tells me this species is very rare, and even the older collectors, like Mr. Hanham, have seen only one or two individuals. I take pleasure in naming this pretty species after my friend Mr. Blackmore, who has done such valuable collecting in the vicinity of Victoria.

Type—1 ♂, Victoria, B. C., July 3, 1914, from E. H. Blackmore, in my collection.

Paratypes—8 ♂, Victoria, July 2-27, 1913, and 1914, E. H. Blackmore; six in his collection, two in mine (No. 264 and No. 305).

Petrophora defensaria var. **mephistaria** nov.

Expanse 20 mm. Head and body light grey. Fore-wings flesh-coloured and almost immaculate, except for the solid black median band. There are traces of a faint, slightly angled, basal band below the costa, followed by a clear whitish, ashen or flesh-coloured space, extending to the wide, black, median band. Inner margin of central black band curving slightly outward below costa, then running almost straight to inner margin. Outer margin of band running almost straight to median vein, where there is a deep sinus, then running suddenly outward in a sharp projection, curving back and running straight to inner margin. Beyond this the wing is almost clear, except for a few faint double dots on the veins. Just below apex of wing is a dark dash and a large black spot and on the costa, near the apex, are two black dashes. Fringe ashen with black dots at ends of veins. Hind wings light ashen, with a small, black discal spot, beyond which are five faint wavy brown lines curving across the wing, two being very near together beyond the discal dot. These lines are most apparent on the inner margin. Fore-wings beneath darker than above with the black median band showing through. There is a slight reddish cast near apex of wing and a slight clouding. Black discal spot distinct. Hind-wings crossed by five irregular extra-discal lines, the first three very close together and appearing as dots on the veins. There are traces of two faint lines near the outer margin.

This is a distinct variety and is very striking. The intense, solid, black band crossing the wing will separate it from any others, but the general appearance, except for the band, is much like normal *defensaria*.

Type—♂, Victoria, B. C., Jan. 9. 1909, from Mr. A. J. Croker. Paratype ♂, Ladysmith, B. C., Feb. 3, 1906, from Mr. C. Livingston. Also 1 ♂ from Victoria in Mr. Blackmore's collection. The specimen from Mr. Livingston was received by me through the kindness of Mr. Wolley Dod.

Hydriomena grandis Hulst. var. **saawichata** nov.

Expanse 23-25 mm. Palpi short and slender. Head black, thorax and abdomen dark ashen grey. Fore-wings light rusty brown with a large black basal patch, the exterior line running out from costa to mesial vein. Just below this it forms a projecting almost rectangular point, then running obliquely to inner margin. Beyond this basal patch to the broad central band the wing is rust brown, almost devoid of markings, except two faint parallel rusty streaks in the centre of the space. The intradiscal line runs irregularly across the wing as in *grandis*. The central band is jet black with no inside lines, but the black discal streak is very noticeable. The extra-discal line is bordered externally with white, like the intra-discal line, but the extra-discal band runs exactly as in typical *grandis*. Beyond the extra-discal line the wing is light rust-red to the outer margin, except for the row of white spots, shaded exteriorly with black, which run from costa to inner margin. At veins 5 and 6 there are two, sometimes three, elongated black streaks and below there is a large silvery-white patch. The fringe is light brown with basal line and intervenular black dots arranged in pairs. Hind-wings light ashen with spots on the veins forming an indistinct extra-discal line. There are traces of two fine reddish hair-lines running parallel across the wings. Fringe light brown with double spots at margin. Fore-wings beneath smoky brown, the black central band showing through faintly, and a dark brownish band near outer margin. Hind-wings darker than above with black discal dot more conspicuous. There is an irregular black extra-discal band with dots on the veins. Beyond this, towards outer margin, are two irregular, parallel, red lines crossing the wings.

This variety is very striking and does not resemble typical *grandis* closely, the latter having the central band fawn brown, as is also the outer border of the fore-wings, and the central band is composed of double extra and intra-discal wavy lines.

I am not sure that this is not a distinct species, but, realizing the great variability of the Hydriomenas, I prefer to treat it as a variety of *grandis*. I have placed this species and the variety temporarily in the genus Hydriomena, which seems to be a resting place for mixed genera, until these can be separated more satisfactorily by a study of their habits and genitalia. Such species of Hydriomena as *autumnalis*, *fuscata* and allied forms, constitute a natural group, distinct in markings and in life histories, but no satisfactory separation of the species has yet been made upon a structural basis.

The present variety was discovered by my friend Mr. E. H. Blackmore, who called my attention to its distinctness from typical *grandis*, and suggested the name *saawichata*. I have never seen it in any other collection, and he assures me it is rare.

Type ♂, Victoria, B. C., May 28, 1914; E. H. Blackmore.

Type ♀, Victoria, B. C., May 5, 1914; E. H. Blackmore.

Paratypes 1 ♂, *4* ♀, Victoria, B. C., May 28 to June 20, 1914; all in Mr. Blackmore's collection.

A FOSSIL FUNGUS-GNAT.

BY T. D. A. COCKERELL, BOULDER, COLORADO.

Some time ago Miss Olive M. Braden collected a number of fossils in the Miocene shales of Florissant, Colorado, and through the kindness of Mr. A. E. Holch, of the Cripple Creek High School, I was enabled to examine the series and identify the species. Miss Braden very kindly gave to the University of Colorado Museum several species new to our collection, the most interesting being a fungus-gnat, described below. It is remarkable to find such fragile insects excellently preserved, and to note that they are entirely of the same type, in many instances, as their modern representatives. In a million years or so, some of the Mycetophilidæ appear to have remained without evolutionary progress, except to the extent of slightly modifying or shifting minor specific characters.

Mycetophila bradenæ, n. sp.

Length about 6 mm.; general appearance and structure exactly as in the living *M. punctata* Meigen, but anterior tibial spurs longer. Antennæ cylindrical about 1.5 mm. long, joints about as broad as long; wings brownish, not spotted, venation quite normal for the genus; abdomen with alternating light and dark bands; hind tibiæ with two rows of long dark spines, as in *M. punctata*, about 320 microns long; anterior tibiæ about 990 microns long, with spur 660. The following wing measurements are in microns: End of subcosta (on radius) to origin of radial sector, 660; length of radio-medial cross-vein, 225; branching of cubitus basad of level of lower end of radio-medial cross-vein, 160; branching of media from lower end of radio-medial cross-vein, 145.

This is the first genuine *Mycetophila* found fossil in America. Scudder's *M. occultata*, from White River, Colorado, is said to have the legs unarmed, and not very long, and the venation cannot be clearly made out. It is evidently not a true *Mycetophila*. In Europe *Mycetophila* is known by a number of species from Baltic Amber, of Oligocene age.

PODISMA FRIGIDA BOH. IN ALASKA.

BY A. N. CAUDELL, BUREAU OF ENTOMOLOGY,
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Among a number of miscellaneous insects recently received by the United States National Museum from the International Boundary Survey were two species of Acridididæ collected by J. M. Jessup in the extreme northeastern part of Alaska. The labels on these specimens read as follows: "International Boundary, Alaska, J. M. Jessup. Lat. 69° 20 N., Long. 141° W. 8-VIII-12." Of the two species of Orthoptera received there were fifteen specimens, one male and three female specimens of *Gomphocerus clavatus* Thom. and five male and six female specimens of a short winged grasshopper, which is determined as *Podisma frigida* Boh. While this record of *P. frigida* from Alaska is of interest, being the first reported occurrence of this European species in the New World, it is in no way remarkable, being but an eastward extension of the known distribution.

Podisma frigida was described from Norway, and has been reported from various points in northern Europe and Asia and from the mountains of Switzerland. Material of both sexes from Norway and Switzerland is in the National Museum collection, having been received from Saussure, who was quite surely responsible for the determination. Noticeable variation exists in this material from these two regions, but direct comparison of the Alaskan material with the specimens from Norway shows scarcely any taxonomic divergence. As the Alaskan specimens exhibit no tangible structural differences from material from Norway, the typical region of *frigida*, it has seemed wise to determine them as that species.

Of the known North American species of *Podisma*, the *nubicola* of Scudder is the most nearly allied to *frigida*, Here, however, as usual throughout the Melanopli, the genital structures of the male furnish excellent diagnostic characters. Thus in *frigida* the subgenital plate of the male is apically conical and noticeably elevated above the lateral margins and the cerci are about three times as long as the median width, while in *nubicola* the subgenital plate is more truncate apically and barely elevated above the lateral margins and the cerci are not, or barely, more than twice as long as the median width.

NOTES ON THE CAUSE OF THE BLUE COLORATION OF THE BLUE LYCÆNIDS.

BY H. M. SIMMS, MONTREAL.

The question has recently been raised by certain entomologists whether the blue tint of the blue species of the genus Lycæna and its allied genera is actually due to blue pigment or dye in the scales of the upper surface of the wings, or whether it is due to a kind of "construction" similar perhaps to the apparent construction of a green tint on the under surface of the wings of certain species of the genus Euchloe. The latter, as is well known, on examination by a microscope, is found to be caused not by a field of green scales, but by one of black and yellowish scales intimately mixed in approximately equal quantities. I do not think that it has ever been suggested that the blue colour of the Lycænids is produced by an exactly similar *mixing* of scales of two distinct colours, but it has been suggested that the blue tint is due to the superposition of a layer of white, practically transparent scales over a layer of dark-brown or blackish scales, and that the blue effect is in reality either an illusion as in the case of the Euchloid green tints, or else a phenomenon of interference of light, analogous, perhaps, to the production of the rainbow tints between two reflecting surfaces very close together and separated by a transparent medium, these being known as "Newton's Rings." They are familiar to all in the bright colours visible on the surface of soap bubbles as well as the bright tints seen on the surface of stagnant water, or on the fine film of oil covering the surface of oily water and at times in puddles of automobile oil on roads. Now it can, I think, be clearly shown that this latter suggestion is not the correct explanation of the present case. The colours of "Newton's Rings" depend upon the angle from which they are viewed, as well as upon the distance between the surfaces. If one looks at stagnant water from different angles, it will be seen that the colour at any one point varies according to the angle, and if the blue colour were due to any such cause as those which produce "Newton's Rings," the colour should pass right through the spectrum from red to violet or vice versa, as the angle of sight was shifted. But not only is this not the case, but if the wing of a blue butterfly is placed between two strips of glass and subjected to pressure, thus changing the distance between the two surfaces of any one scale and also between the two layers of scales, it will be found that there is no corresponding change of colour, thus showing that the colour is not due to interference of the light reflected from the surfaces in question.

On the other hand, an examination by means of the microscope reveals the fact that the light and dark scales are not mixed, as are the yellow and black scales of the Euchloids, and hence the blue colour is not due to the *mixing* of two other tints. The scales are arranged in two layers, the top one consisting of the whitish transparent scales, and the lower one of dark opaque scales of a dark-brown or black. In male specimens there are also a vast number of small sexual scales known as "androconiæ" or "plumules," but these do not contribute towards the coloration, and need not be considered here. There are left for consideration three possible explanations of the blue effect produced by this arrangement of the scales.

1.—By diffraction of light from the finely striated upper surface of the top layer of scales in the same way that colours are produced when white light is reflected from the finely ruled mirrors of a diffraction spectroscope. This theory is untenable, however, since the colour would have to range from red to violet, according to the angle of view, and at any one point would only give rise to such colours in a line at right angles to the striations and not in one parallel to them. The effect of diffraction is, however, seen in those species of Lepidoptera which display "sheen." This not only varies according to the angle, but at any one point becomes totally invisible when looked at from a point in line with the striations. This sheen, however, is an additional source of colour, and is quite independent of the general tint of the insect.

2.—As an optical illusion due to seeing the dark layer of scales through a whitish transparent upper layer. This explanation will be considered together with the 3rd and last, namely, that it is due to internal colouring matter in the upper scales. It has been held that this latter explanation cannot be correct, because when loosely scattered scales from the blue surface are examined by means of a microscope with transmitted light, the blue effect totally disappears and we see only an equal number of dark brown or blackish scales and yellowish transparent ones, which are sometimes nearly colourless. This, however, is not a valid objection, since many colouring matters appear of a totally different colour by transmitted light. Gold leaf appears yellow by reflected light, and green by transmitted light. A solution of chlorophyll in alcohol appears a beautiful green colour by transmitted light, but blood-red by strong reflected light. Aniline dyes show this property also, and hence it is quite possible that if there is colouring matter in the scales, that it may also show complimentary colours when viewed by reflected and transmitted light. Now, the light scales always appear more or less distinctly yellow by transmitted light, and yellow is complimentary to blue. If now such an assemblage of loose and scattered scales be viewed by a microscope with reflected illumination and against a dark or quite black background, it will be at once seen, provided the illuminating light is white or nearly so, that the light scales are strongly tinted with blue and often are *very* blue. The dark ones on the contrary remain dark and show practically no colour except occasional metallic flashes tinted either blue, green or red. Hence we see here that the light transparent scales have undoubtedly the power to appear blue quite independently of whether they are superimposed on the dark ones. If they are now examined against a white background, such as a piece of white paper, they still appear bluish, but are much paler in colour owing to their transparency. If they are further observed against backgrounds of different colours, red, green, yellow, orange, violet or blue, they always appear distinctly blue, although the background may be seen through them, thus complicating the apparent colour. Against a neutral background or a dark-brown one such as dark-brown paper they appear as blue as when viewed in their natural positions on the wing. Furthermore, when two of these blue scales overlap the density of the blue is very much increased, and in the natural positions they occupy on the wing there is a great deal of such overlapping. Again, it will be noticed that the blue scales taken from the wings of very pale or silvery blue butterflies, such as *Lycæna argiolus*, or *pseudargiolus*, appear very pale blue when isolated and examined by reflected light, and are practically invisible against a background of white paper. With transmitted light they appear very pale yellow. Similar scales taken from butterflies of a more intense blue, such as *Lycæna bellargus*, appear darker blue by reflected light, and much darker yellow by transmitted light, which is easily and obviously explainable on the hypothesis that the colour is due to pigment or dye, but is not explainable if the colour were due to the superposition of white transparent scales on a background of black or dark-brown ones. Finally, further light may perhaps be thrown on the subject by actually analysing the colours as they are emitted from the wing, by means of the spectroscope. To do this I improvised a small spectroscope attachment to an old and low-power microscope in my possession. When I examined the wings of white butterflies or moths, the whole spectrum was clearly visible. When I examined the red portions of such butterflies as *Vanessa atalanta*, *Parnassius apollo*, the under wing of a Catocala or the red spots on a Zygænid, the red portion of the band remained brilliant, but the yellow and green was greatly weakened and the rest was practically invisible. Orange and reddish-brown butterflies, such as the Argynnids or *Chrysophanus hypophlœas*, gave strong red and orange bands, weaker yellow and the rest of the spectrum was very much weakened, but nevertheless contributed something to the total effect. When I examined the wings of *L. pseudargiolus*, I found the green, blue and violet strong, as I expected, but there was some red and yellow present also, but weak. The intensely blue wing of *L. bellargus*, however, gave brilliant green and blue bands, rather weaker violet and very weak red-yellow and orange. When it is considered that these experiments were made with the light of an incandescent gas burner, the results are not surprising. Such light is known to be deficient in the blue and violet rays, but are strong in the yellow and red rays, although ,of course, the entire spectrum is clearly visible. Again, the presence of red in every case is, I think, partly due to total reflection from the metallic surfaces of the scales at angular points and from the glass itself which covers the wing in those cases where a slide was made for the purpose of examination. Also it is notoriously difficult to produce artificially a green or blue colour free from red, though it is easy to produce red free from blue and green, and this difficulty may also be felt by nature in preparing the natural tints of insects. In any case the strongly-marked blue end of the spectrum and the much-weakened red end show clearly that the scales themselves are inherently blue, in that the total colour emitted by the wing *is* actually blue and is not a mixture of rays from a brown or black surface seen through a white transparent layer, which from some unknown reason produces a blue sensation in the eye.

To sum up briefly, it appears to me that there is very little evidence in favour of any theory except the old and hitherto unquestioned one, that the blue colour of these butterflies is due to internal colouring matter, probably a dye of some sort, since, as far as I know, pigments, properly so called, do not show complimentary colours when seen by transmitted and reflected lights. The presence of the dark background is probably for the purpose of cutting out all transmitted light which might give a yellow tinge to the blue, and to hide the variegated pattern of the underside, which otherwise, owing to the transparency of the blue scales, would be visible through them and finally to give a greater depth to what would otherwise be an extremely pale tint.

(Read before Montreal Branch Ent. Soc. of Ont., Feb. 20,1915.)

FIELD NOTES AND QUESTIONS.

New Jersey Nursery Insects For 1914.

The following is a list of the commoner species found in New Jersey nurseries. Most of them are confined to ornamental stock, inasmuch as this class of plants occupies 2400 acres out of an acreage of 2600 for all the nurseries, the remaining 200 being planted to fruit stock, bush berries and strawberries.

Aspidiotus perniciosus Comst. Light infestations on left over fruit stock, mountain ash, hawthorn, currants, gooseberries, *Cornus sanguinea*, *Aronia arbutifolia*, Chinese privet, standard privet, *Spirea sorbifolia*, snowberry.

Lepidosaphes ulmi Linn. Increasing in importance and numbers. Does far more damage than the San José Scale. Found principally on lilacs, poplars and willows.

Gossyparia spuria Mod. on elm. *Chionaspis euonymi* Comst. on euonymus. *Aspidiotus forbesi* Johns. on cherry. *Pissodes strobi* Peck. more abundant than usual in white pine.

Scolytus rugulosus Ratz. common in left-over and neglected peach and cherry stock. *Cryptorhynchus lapathi* L. in poplars and willows. *Agrilus viridis* Linn. var. *fagi* Ratz. fairly abundant in *Rosa rugosa*. *Agrilus sinuatus* Oliv. in pear, scarce.

Galerucella luteola Mull. on elms. *Cyllene robiniæ* Forst. in locust. *Melasoma scripta* Linn. present in small numbers on poplars and willows. *Podosesia syringæ* Harr. in lilacs. *Macro-*

noctua onusta Grt. very abundant, doing considerable damage to iris in many parts of the state. *Zeuzera pyrina* Linn. noted in lilacs, shade trees, pear and apple stock in northern New Jersey nurseries. *Hyphantria cunea* Dru. fairly common on all kinds of trees and shrubs. *Certomia catalpa* Bois. on catalpa. *Vanessa antiopa* L. on Lombardy poplars and elms. *Thyridopteryx ephemeræformis* Steph. on spruce, arbor vitæ, lilac, maple and deciduous cypress. *Pteronus ribesi* Scop. on currants and gooseberries. *Vespa crabro* L. and allied species stripping bark from various plants, especially lilacs. *Leptobyrsa explanata* Heid. on rhododendrons. *Trioza tripunctata* Fitch. on blackberries in southern New Jersey nurseries. *Eriophyes pyri* Pgst. on pear. *Eriophyes quadripedes* Shimer. common on silver maple. *Aphis forbesi* Weed on strawberry roots in southern New Jersey nurseries, scarce. *Chermes abietis* Linn. scarce, on spruce in northern New Jersey. *Aphis mali* Fabr. very abundant the past season; did considerable injury to apple stock. *Schizoneura lanigera* Hausm. on apple.

Tetranychus bimaculatus Harv. on evergreens, shade trees.

HARRY B. WEISS, New Brunswick, N.J

BOOK REVIEWS.

MEDICAL ENTOMOLOGY.

"Handbook of Medical Entomology." By W. A. Riley, Ph.D., and O. A. Johannsen, Ph.D., IX, 348 pp., 172 figs. Comstock Publishing Co., Ithaca, N. Y. Price, $2.00.

This volume is the outgrowth, we are told, "of a course of lectures along the lines of insect transmission and dissemination of diseases of man given by the senior author in the Department of Entomology of Cornell University during the past six years." It is intended "to afford a general survey of the field and primarily to put the student of medicine and entomology in touch with the discoveries and theories which underlie some of the most important work in preventive medicine. At the same time the older phases of the subject—the consideration of poisonous and parasitic forms —have not been ignored."

The authors do not expect that the book will meet the needs of the specialist, that is not its purpose, which is to serve as a book of reference to physicians, sanitarians, working entomologists and teachers. The admitted purpose of the book prevents us from making certain criticisms that we might otherwise feel disposed to offer regarding the treatment of the subject. As a work of reference for the entomologist and sanitarian who is not a specialist on the subject, the book will prove to be very useful, as it contains the kind of information not hitherto collected in so convenient a form by previous treatises on the subject. The contents are made easily accessible by a full index.

In treating the various groups of insects and diseases, the authors summarise the historical facts and experimental work, and describe the diseases, the methods of transmission and eradicative measures, thus presenting in a convenient form the essentials of the subject. A fairly extensive bibliography enables the student, if he has access to the literature, to pursue the subject further, should he wish to do so, although the memoirs of the authors quoted are not always given in the bibliography, which is only intended as an avenue to the more specialized fields.

The authors are inclined, we think, to assume from time to time too great a knowledge of medical terminology on the part of the non-medical student or reader; a difficulty that might be obviated by means of a glossary.

While the book deals with species from all countries and will therefore be of use to a wider constituency than that of North America, in the selection of typical forms the choice has naturally been made from those occurring on this continent. The synoptic tables given at the end of the book, together with the figures, will prove of great assistance to students, as also the notes given from time to time in regard to securing material. The illustrations also greatly add to the value of the book as they are representative in character.

The omission on page 216 of the name of Bruce in connection with the origin of the idea that the Sleeping Sickness trypanosome is carried by *Glossina palpalis* should be corrected, for to him belongs the chief credit of this discovery. On page 215 "Bugosa" should be Busoga. The authors are to be congratulated on having a publisher who not only produces a well-printed book, but enables them to include in the text an abstract of a paper published in the month previous to the publication of their book! It is a book that is sure to appeal to a large circle of readers; it is reasonable in price, and will, we hope, assist in swelling the increasing body of investigators now devoting their attention to a branch of entomology that was so long neglected. C. G. H.

MONOGRAPH OF THE BOMBYCINE MOTHS OF NORTH AMERICA—Including their transformations and origin of the larval markings and armature. Part III, Families Ceratocampidæ, Saturniidæ, Hemileucidæ and Brahmæidæ. By the late Alpheus Spring Packard. Edited by Theodore D. A. Cockerell. Vol. XII, First Memoir, National Academy of Sciences, Washington, D. C., 516 pages, 4to., 113 plates, 34 of which, depicting larvæ, are coloured.

This sumptuous volume contains the remainder of Dr. Packard's work on the Bombycine Moths, two other parts having been published some years ago. At the time of his death in 1905, the author left a large amount of material which he had prepared with a view to the completion of his monograph; though necessarily incomplete, the great value of this material rendered it highly desirable that it should be made available, and thus the present publication was brought about. It is in great measure due to Prof. Cockerell that the undertaking has been so satisfactorily accomplished. The species described are by no means confined to North American forms, but have been drawn from various parts of the globe, as the author evidently had in view the preparation of a complete monograph of the Saturnioid Moths of the world.

THE AUSTRALIAN ZOOLOGIST.—The Royal Zoological Society of New South Wales has begun the publication of a magazine, of which the first part has been received. It is edited by Mr. Allan R. McCulloch, and printed at Sydney. The number contains 36 pages, large octavo and four plates. The contents include papers on Australian birds and bird sanctuaries, fish, the photograph and description of a live chimpanzee, and the following papers on entomological subjects: The Mallophaga as a possible clue to Bird Phylogeny; A Monograph of the genus Tisiphone (butterflies), and A New Victorian Araneiad.

Mailed May 8th, 1915