THE LEPIDOPTERISTS' NEWS

Volume 8 1954 Numbers 3-4

A GUIDE TO COLLECTING THE PLANT-BORING LARVÆ OF THE GENUS *PAPAIPEMA* (NOCTUIDÆ)

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The prime purpose of this paper is to offer selected data in simple and readily referable form in order to stimulate Society members to embark upon the study of the fascinating and beautiful North American noctuid genus, *Papaipema* Grote. There is very much remaining to be learned and reason to believe that undiscovered species still await careful and fortunate workers; this is probably especially true in the western states.

No attempt has been made to cover the widely scattered literature for all of the facts. The fine original papers of the pioneer workers in the field must be read to learn the intimate details of the respective species and to appreciate the thousands of hours of search, keen observation, and painstaking labor necessary for their discovery. Although the material in this presentation is assembled in part from these, it is more particularly compiled from direct notes contributed for use in this paper by HENRY BIRD, OTTO BUCHHOLZ, FRANK MORTON JONES, ROY LATHAM, JOSEPH MULLER, and ALEX K. WYATT. Their splendid and prompt co-operation is most gratefully acknowledged. Included among these contributors are the authors of most of the original papers referred to. The very extensive published material of HENRY BIRD stands at the head of the *Papaipema* literature.

It was not until this paper was near completion that an article strikingly similar in purpose and contents, published by Mr. WYATT (1916), nearly forty years ago, was brought to my attention. In view of the elapsed time and the comparative unavailability of the earlier publication it was nevertheless considered desirable to complete the project in its new form.

Species are not included in the table when little or nothing is known of the early stages. A complete taxonomic list, with authors' names, is available in McDunnough's "Check List" (1938). The known range of the species is also omitted because of the concentration of records at favorite collecting points of the relatively few workers, the difficulty of examining and compiling the fragmentary information, and the certainty of wide extension of known ranges as a result of new work. Dyar's *List* (1902) offers considerable information on distribution but much has been added since then. It also furnishes the source of the original descriptions of most of the species. In general, a species should be looked for anywhere in the range of its food

SPECIES	FOOD PLANT	EVIDENCE OF PRESENCE	POSITION OF		DATES OF	
			LARVA	PUPA	PUPATION	EMERGENCE
P. appassionata	PITCHER PLANTS (all *Sarracenia*)	Orange frass	Root; to new root in July	Root or soil near plant	Aug.1-10	Sept.15
P. araliæ	HERCULES' CLUB (*Aralia spinosa*)	Bored new growth; withered leaves; dead branch	Stem tip, new growth	Soil	Aug.10	Oct.1
P. arctivorens	THISTLE(*Cirsium* spp.), BURDOCK (*Arctium lappa*)	Thistle:branching below crown or crown black; frass	Stem	Soil	July 20-Aug.20	Aug.5-Oct.5
P. astuta (*verona* may be form)	HORSE-BALM, STONEROOT (*Collinsonia canadensis*)	Dry stem; white frass	Stem, later cell in root	Soil	Aug.1-10	Sept. 12-24
P. baptisiæ (*circumlucens* may be same)	WILD INDIGO (*Baptisia tinctoria,B.alba*), INDIAN PLANTAIN (*Cacalia tuberosus*), DOGBANE (*Apocynum*)	Discolored foliage; frass; holes in stem; sometimes fallen plant	High in stem to upper root	Burrow if plant large, soil if small	Aug.1-Sept.10	Aug.16 Oct.16
P. beeriana & f."lacinaria"	SNAKEROOT(*Liatris pycnostachya spicata*)	Wilted tip or brown and dry leaves	Lower stem, root crown	Burrow or near root	Aug.10-Sept.5	Sept.6-Oct.16
P. cataphracta & f."sulphurata"	Esp. BURDOCK (*Arctium*), THISTLES, LILIES, *et al.* (26 spp. on L.Is.-LATHAM)	Plants stunted, drooping, discolored; swelling; much frass	Stem, at maturity near ground	Stem (sometimes root)	Aug.10-Sept.25	Sept.8-Oct.15
P. cerina	TURK'S CAP (*Lilium superbum*), *et al.**	Small hole; drying or dry stem; little frass	Stem	Burrow	Aug.5-25	Aug.30-Oct.14
P. cerussata	IRONWEED (*Vernonia noveboracensis*)	Plant stunted, broken, or bent at larval entrance; top may be much branched from later boring below	Stem(early) to root	Soil, 2"-12" from root	Aug.10-	Sept.5-15

P. duovata (usually lays 2 eggs)	SEASIDE & LATE GOLDENROD (*Solidago sempervirens, S. gigantea leiophilla*)	Several openings in stem; often whitish frass on sand	Stem (early) to root	Burrow	Aug.15-	Sept.15-Oct.20
P. duplicata	HORSE-BALM, STONE-ROOT (*Collinsonia canadensis*)	Wilted leaves or dry stem; sometimes white frass	Stem (early) to root	Root	Aug.15-	Sept.30-Oct.28
P. eryngii	BUTTON SNAKEROOT (*Eryngium aquaticum, E. yuccifolium*)	Little or none; yellow or dead leaf; bored	Leaf or stem (early) to root	Burrow in root	Aug.15-30	Sept.10-Oct.15
P. eupatorii	JOE-PYE-WEED (*Eupatorium purpureum*)	Leaning stem usually still living; sometimes frass	Stem to root	Burrow at base	Aug.5-Sept.5	Sept.12-Oct.5
P. frigida	JACOB'S LADDER (*Smilax herbacea*), MEADOW RUE (*Thalictrum revoltum*)	Slightly dwarfed plant; stem yellowed or bending; hollow stem always blackened	Tip of stem (early) to root	Soil, 1"-15" from plant, ½"-3" deep	Aug.10-Sept.15	Sept.1-Oct.10
P. furcata	RED, WHITE, & BLACK ASH (*Fraxinus pennsylvanicus, F. americana, F. nigra*)	Dry branch or blackened tip of shoot; clean hole to later burrow in older growth	First in new growth, later in near wood	Soil	July 30-Aug.25	Aug.24-Sept.20
P harrisi	COW PARSNIP (*Heracleum maximum*), ANGELICA (*Angelica atropurpurea, A. lanatum*)	Yellow or wilted leaf in *Heracleum;* drooping stem in *A. lanatum*	Leaf stem to root crown	Soil	July 15-22	Aug.8-Sept.25
P. impecuniosa	ASTER (*Aster punicius, A. umbellata*), SNEEZE-WEED (*Helenium autumnale*)	Large opening for moth	Lower stem to root	Base of stem or root	Aug.15-Sept.10	Sept.10-Oct.15
P. inquæsita & f. "wyatti"	SENSITIVE FERN (*Onoclea sensibilis*)	Yellow, brown to dry stem, hole at entry; orange frass	Stem (early) to root	Root	July 20-Aug.15	Sept.1-Oct.1

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			LARVA	PUPA	PUPATION	EMERGENCE
P. limpida (=*ærata*)	BURDOCK (*Arctium*)	Wilted branch	Lower stem		July 15	Aug.24-Sept.6
P. lysimachiæ	LOOSESTRIFE (*Lysimachia quadrifolia*, rarely *L. terrestris*)	Yellow, brown or dry stem	Stem (early) to root	Soil, 2"-15" from plant, ½"-3" deep	Early Aug.-Sept.15	Sept.1-Oct.1
P. marginidens (=*birdi*)	WATER HEMLOCK (*Cicuta maculata*), WATER PARSNIP (*Sium suave*), other umbellates	Bending or fallen top, or branch at point of entrance	3' from ground to root	Soil, 4"-20" from plant, 1"-2" deep	Late July-Sept.5	Early Aug.-Oct.16
P. maritima	GIANT SUNFLOWERS (*Helianthus giganteus, H. lætiflorus*)	Frass and gall-like swelling; stem may be broken at top of burrow; pupa near hole	Base of stalk	Base of stalk (in gall)	Aug.15-Sept.2	Sept.5-Oct.20
P. merrickata	MAY APPLE, MANDRAKE (*Podophyllum peltatum*)	Yellow leaf and much frass	Root	Soil	Aug.10-Sept.5	Sept.7-Oct.5
P. nebris & f."nitela"	General feeder, esp. RAGWEED (*Ambrosia artemisiifolia*), BURDOCK (*Arctium*)	Swellings or galls; holes in stem	Lower stem	Burrow or soil	Aug.10-mid-Sept.	Sept.5-Nov.10
P. necopina (=*imperturbata*)	SUNFLOWER (*Helianthus divaricatus*), INDIAN PLANTAIN (*Cacalia tuberosus*)	Elongate enlargement or gall at base	Stem to root	Root burrow or soil	Aug.5-30	Sept.9-20
P. nelita	TALL CONEFLOWER (*Rudbeckia laciniata*)	Gall	Base or root	Soil	July 20	Sept.1-15
P. nepheleptena (=*moeseri*)	TURTLEHEAD (*Chelone glabra*)	White frass	Stem	Soil	Aug.10-15	Oct.1

P. nephrasyntheta	BUTTON SNAKEROOT (*Eryngium yuccifolium*)	Yellow leaf; brown frass	Root	Burrow	Aug.15	
P. ochroptena (=*humuli*)	HOP(*Humulus lupulus*)	Cigar-shaped gall	Stem	Soil	(retrieve larva July 20)	Aug.15 Sept.2-23
P. polymniæ	LEAFCUP (*Polymnia uvedalia*)	Irregular swelling	Mid-stem to base	Soil	Aug.5-10	
P pterisii (=*triorthia*)	COMMON BRAKE (*Pteridium aquilinum*)	Yellow or brown frond; orange frass	Stem to upper root	Soil near root	July 25-Aug.15	Aug.7-30
P. purpurifascia (=*luteipicta*)	COLUMBINE(*Aquilegia canadensis* and other *A.* spp.	Wilted plant; frass	Root(often needs two)	Soil	July 15-Aug. 15	Sept.1-19
P. rigida	GOLDEN ALEXANDERS (*Zizia aurea*), OX-EYE (*Heliopsis helianthoides*), SUNFLOWER (*Helianthus strumosus*)	Holes in stem near base; slight swelling; frass	Stem(early) to root	Soil	July 25-Aug.20	Aug.30-Oct.11
P. sciata	SPEEDWELL (*Veronicastrum virginicum*)	Dry, black, dead stem, sometimes broken; frass	Long roots	Soil	Aug.10-Sept. 10	Sept.10-Oct.10
P. silphii	PRAIRIE DOCK, ROSIN-WEED, CUP-PLANT (*Silphium* spp.)	Brown leaf or two; frass	Root	Soil	Aug.1-30	Sept.16-Oct.20
P. speciosissima	CINNAMON, ROYAL, INTERRUPTED FERN (*Osmunda cinnamomea, O. regalis, O. claytoniana*)	Yellow(June) to dry (Aug.); frond bends as larva matures; frass	Stem through root stock	Burrow or fibres of root	Aug.10-	Aug.25-early Oct.
P. stenoscelis	CHAIN-FERN(*Woodwardia virginica*), N.Y. FERN(*Dryopteris noveboracensis*)	Brownish to dry frond; orange frass	Stem(near tip of frond) to root	Soil	Aug.15-Sept.15	Sept.10-Oct.10

*Small larvæ have been found in STARRY CAMPION (*Silene stellata*), MAY APPLE (*Podophyllum peltatum*) feeding upward, and quite commonly in BOTTLE-BRUSH GRASS (*Hystrix patula*); will mature in iris but require several stems; will not enter root. —WYATT

plant. Such information is easily obtainable from the popular botanical handbooks. Latin plant names follow *Gray's Manual of Botany,* 8th Edition, 1950, by Fernald. Common names are from the same source if available, otherwise from Britton & Brown, *Illustrated Flora of Northern U. S. and Canada.* The best colored plates of *Papaipema* imagoes are to be found in the works by Seitz (1930) and Hampson (1910), especially the former.

As the field work forming the basis of the data was accomplished primarily in the states of the East and Middle West, the material is, of course, representative primarily of that area. Its usefulness need not be so restricted, however, as the patterns indicated with respect to the various types of plants may be projected to similar species in the search of any flora for the tell-tale signs of *Papaipema* presence. If not the same species, at least most of the genera of host plants mentioned are represented across the country as well as in many other parts of the world and are worthy of particular attention in starting the search for *Papaipema.* The dates, compiled as they are, from data of different years, originating over a wide and diverse area and including observations under other than undisturbed natural conditions presumably show a considerably wider range than would likely be experienced in any given locality in a single or even many years.

Collecting equipment may be very simple; almost essential, however, are a narrow trowel, preferably sharpened on the edges, and a stout pocket knife. Glass or tin containers and carrying apparatus are necessary. The collector will vary these according to taste and experience and whether or not transportation is readily at hand for heavier loads. Plants must be kept fresh. Often they may be potted (paper pots are handy) and loaded in a car almost on the spot. If material, especially large roots, must be carried along on foot a vasculum is helpful. Sphagnum moss, sometimes at hand in the field, or brought along, is very useful in maintaining a moist condition.

In general, *Papaipema* larvæ may be recognized when young by their dark ground color with dorsal and sub-dorsal white lines; later they become translucent with the markings very faint or absent. Because of the difficulty in keeping many species of food plants fresh it may be desirable to permit the larvæ to develop in their natural habitat as long as possible. Plants may be marked in the field and collected at a later date. It often happens in the course of examining a plant and finding a larva that it is disturbed and leaves its burrow. WYATT (1916) points out that an attempt to induce it to return is a waste of time. From my much more limited experience I can confirm this. He offers the ingenious solution of placing the individual larva in a narrow tube which may be placed over the end of a new plant, obliging the larva to cease its exhausting wandering and to enter and feed at a proper position. For those species pupating in burrows care must be taken that drying and shrinking plant tissues do not pinch or crush the pupa. The latter may be removed for safety and placed on a moist sphagnum bed or, if the plant is maintained in fresh condition, they may, of course, be left undisturbed.

Failure to locate larvæ in a good development of food plant may often be explained by the burning over of the area sometimes as long ago as

fifteen or twenty years. ROY LATHAM points out with respect to *P. frigida* that mice at times almost annihilate a colony, especially if it had been a particularly heavy infestation. This may also apply to other species. Parasites, too, take their toll, but these should be considered prizes reared out carefully, and passed along to competent authorities.

Late July is the best season to begin your search. Be alert to anything queer about the condition of a plant, look for further clues, close in on the culprit, and sentence him to life imprisonment; and don't forget that notebook! Besides a contribution to lepidopterology it is likely that you will find the work the most fascinating form of "whodunit" you have yet experienced.

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