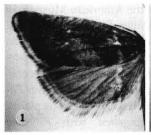
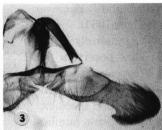
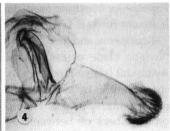
Volume 57, Number 2 153









FICS. 1–4. Dichrorampha acuminatana. 1, Wings of male from Steuben, ME. 2, Wings of male from Apetlon, Austria. 3, Genitalia of male from Steuben, ME. 4, Genitalia of male from Apetlon, Austria. Further details are in the Specimens examined section of the text.

The species is widely distributed in western and central Europe (Razowski 1996). Two Palaearctic congeners, *D. vancouverana* McDunnough (=D. gueneeana Obraztsov) and *D. petiverella* (L.), were previously reported in Maine (Roberts 1991), and subsequent collecting there has revealed well established populations of these species along the immediate coastline wherever undisturbed stands of their native or naturalized foodplant *Achillea millefolium* L. (Asteraceae) occur. With captures of *D. vancouverana* in the Pacific Northwest (Miller 1999), coastal distribution patterns of the two holarctic congeners continue to suggest they are immigrants, although the possibility cannot be ruled out that they represent spotty relicts of circumpolar distributions.

Specimens examined. &, Steuben, ME (Fig. 1), M. A. Roberts, 15/06/2001, genit. slide prep. MAR2027M (Fig. 3), forewing length 7.0 mm, in M. A. Roberts collection, Steuben, ME; &, Wangeroog, Ostfries. Inseln [Germany], 07/09/1949, E. Jäckh, genit. prep. on pin, forewing length 6.0 mm; &, Kelheim, Obfrk. [Germany], 03/08/1952, Jäckh, genit. prep. on pin, forewing length 6.0 mm; &, Hannover, Misb Moor [Germany], 29/05/1931, genit. slide prep. WEM 612011, forewing length 6.5 mm; &, Apetlon, Burgenland [Austria] (Fig. 2), 11/09/1971, E. Jäckh,

genit. slide prep. WEM612012 (Fig. 4), forewing length 5.5 mm. The four Palaearctic specimens are in the U.S. National Museum of Natural History (USNM), Washington, D.C.; we thank J. W. Brown for loaning them.

## LITERATURE CITED

Bentinck, G. A. & A. Diakonoff. 1968. De Nederlandse bladrollers (Tortricidae). Monogr. Nederlands. Entomol. Ver. No. 3, 201 pp.

KUZNETSOV, V. I. 1987. Family Tortricidae (tortricid moths), pp. 279–956. In Medvedev, G. S. (ed.), Keys to the insects of the European part of the USSR. U.S. Dept. of Agr. & Natl. Science Found. 991 pp. [translation]
MILLER, W. E. 1999. A new synonymy in Dichrorampha that re-

MILLER, W. E. 1999. A new synonymy in *Dichrorampha* that reveals an overlooked immigrant record for North America (Tortricidae). J. Lepid. Soc. 53:74–75.

RAZOWSKI, J. 1996. Tortricidae, pp. 130–157. In Karsholt, O. & J. Razowski (eds.), The Lepidoptera of Europe: a distributional checklist. Apollo Books, Stenstrup. 380 pp.

ROBERTS, M. A. 1991. Two Palearctic species of *Dichrorampha* discovered in Maine (Tortricidae). J. Lepid. Soc. 45:169–171.

MICHAEL A. ROBERTS, 367 Village Road, Steuben, Maine 04680, USA. Email: maroberts@acadia.net and William E. Miller, Department of Entomology, University of Minnesota, St. Paul, Minnesota 55108, USA. Email: mille014@umn.edu

Received for publication 8 April 2002; revised and accepted 11 November 2002.

Journal of the Lepidopterists' Society 57(2), 2003, 153–156

## HOST PLANT ASSOCIATIONS OF WESTERN SPECIES OF *PAPAIPEMA* (NOCTUIDAE) WITH PARTICULAR REFERENCE TO THE APIACEOUS PLANTS

Additional key words: host plants, Apiaceae, Asteraceae, polyphagy.

The genus *Papaipema* Smith (Noctuidae) is the largest noctuid genus endemic to North America has long been a favorite among students of lepidopteran life history (e.g., Kwiat 1916, Hessel 1954). With 46 described species and at least 5 undescribed species of which we are, *Papaipema* is the fifth most speciose noctuid genus on this continent (Hodges 1983), super-

seded only by the Holarctic genera *Acronicta* Ochs. (n = 81 Nearctic species), *Catocala* Schrank (n = 110), *Lacinipolia* McDunnough (n = 57), and *Schinia* Hübner (n = 123 species in North America) (Hodges 1983). *Papaipema* currently includes 46 valid described species, at least five undescribed species (Quinter, in MS), and two valid subspecific entities,

Papaipema baptisiae baptisiae (Bird) and Papaipema b. limata Bird (E.L. Quinter, in Hodges 1983).

Papaipema and its relatives form a putatively monophyletic clade of endophagous plant borers in the Apameini (sensu Hodges 1983). Whereas most of the species in this tribe are associated with monocotyledonous plants, species of Papaipema feed and specialize on members of between 22 and 25 plant families (Goldstein 1999). Though well studied, a number of questions remain concerning host plant associations in this group, especially among the relatively few western species (Papaipema attains its highest regional diversity in the eastern United States). In this paper, we present life history data based on recent collecting and rearing efforts for species belonging to the Papaipema birdi (Dyar 1908) and Papaipema harrisi Grote species complexes, and summarize the known host associations for the remaining western Papaipema species and those associated with Apiaceae regardless of geography. Our observations bear on the evolution of umbellifer-feeding in Lepidoptera, and Papaipema in particular and possibly the role of coumarin compounds in mediating the evolution of host association (e.g., Berenbaum 1981, 1983). We also discuss collecting and rearing efforts on eastern umbel-feeding Papaipema species. All larvae encountered were reared on artificial diet, and adult specimens deposited at AMNH and FMNH.

Apiaceous host plant records for Papaipema species. A few species of Papaipema are known to feed on apiaceous plants, and although at least three of these (P. birdi, P. harrisii and P. eryngii Bird) appear to be specialists on Apiaceae, the others exhibit a broader range of apiaceous and non-apiaceous host use. The P. birdi complex includes an eastern species (P. birdi) and two western species (P. pertincta Dyar and P. insulidens [Bird]), all of which are associated with the Apiaceae (=Umbelliferae). Papaipema birdi has been considered oligophagous specialist on apiaceous plants, its primary host being the water hemlock Cicuta maculata L. Prior to the present study, other host records included Sium suave Walt. (Apiaceae), and "other umbellates" (Hessel 1954:60; treating P. birdi as a synonym of P. marginidens, of which there are no known host records), as well as several asteraceous plants (Kwiat 1916). The two other species in the P. birdi complex, P. pertincta and P. insulidens, each of which have been recorded from both apiaceous and non-apiaceous plants, are western species apparently separated by the Cascade Mountains, with P. pertincta to the west and P. insulidens to the east. A host of P. insulidens was described by Bird (1921, 1931) as a species of Senecio (Asteraceae). In the field

notes of his son (archived at the American Museum of Natural History), the late Junius Bird, the host plant was described as a "large, Dill-like weed," suggesting an apiaceous plant. The published association of *P. pertincta* with *Lupinus polyphyllus* Lindley (Fabaceae) (see Bird 1926) is curious because only two other *Papaipema* species are associated with fabaceous plants: the western *Papaipema angelica* with *Psoralea macrostachya* DC., and the eastern *Papaipema baptisiae* with *Baptisia tinctoria* (L.).

Outside the Papaipema birdi complex, umbelliferfeeding occurs in Papaipema eryngii, a threatened species restricted to prairie wetlands where it specializes on Eryngium yuccifolium, and in the P. harrisi group, comprising P. harrisi and P. verona Smith). Host records for *P. harrisi*, whose distribution suggest an association with Heracleum lanatum Michx. (Apiaceae) along the Atlantic Coast and an association with Angelica atropurpurea L. (Apiaceae) westward following the Great Lakes (Kwiat 1916, Hessel 1954, Jones & Kimball 1943, Quinter unpublished data). Both of these host species are apiaceous plants. In the Northeast, it is thought that P. birdi and P. harrisi segregate themselves according to host plant, with P. birdi confining itself to Cicuta maculata and P. harrisi to Angelica atropurpurea (see Kwiat 1916, Hessel 1954). Papaipema verona, for which we do not report novel host records, is a western species recorded primarily from species of the umbel genus Heracleum.

Recent field collections. During 1995, we examined several eastern USA sites for larvae of both P. birdi and P. harrisi. Visits to wetlands in western Connecticut and Massachusetts with dense populations of Angelica atropurpurea yielded only two Papaipema larvae (Papaipema harrisi has become decidedly rare in New England and is considered extirpated from Massachusetts). However, visits to a calcareous sedgemeadow complex in Otsego County, New York yielded more than two dozen Papaipema larvae from both Angelica atropurpurea and Cicuta maculata. All larvae collected from C. maculata and A. atropurpurea at the upstate New York site proved to be P. birdi. Although reports of "other umbellates" than Cicuta maculata and Sium suave occur in the literature (e.g., Kwiat 1916), our collections appear to be the first documentation of Angelica atropurpurea as a host for P. birdi. Although Kwiat (1916) reported non-apiaceous hosts for P. birdi, it is conceivable that the taxonomic confusion that typically surrounds *Papaipema* has resulted in erroneous reporting of hosts subsequent to that publication.

Our findings in the northwestern United States extended the known host ranges of *P. pertincta* and *P. in-*

Volume 57, Number 2 155

TABLE 1. Collecting information and host associations of western Papainema species	discovered during this stud	lv.
--	-----------------------------	-----

Species	Locality	Life stage	Host plant	Dates
	Oregon: Tillamook Co.: Rt. 101, 1 mi S. of Wheeler	4 larvae	Heracleum maximum	8 July 1995
	Oregon: Clatsop Co.: Rt. 101, 8 mi. S. of Astoria (at jct. Rts. 101 & 30)	9 larvae, 1 pupa	Cicuta douglasii	8 July 1995
	Oregon Tillamook Co.: Rt. 101,	8 larvae	Senecio vulgaris	9–10 July 1995
	1–2 mi. N. of Manzanita	8 larvae	Heracleum maximum	, ,
		4 larvae	Ligusticum apifolium	
		1 larva	Daucus sp.	
		8 larvae	Cirsium sp.	
		3 larvae	Erechtites minima	
	Oregon: Lincoln Co:, E. Devil's Lake Rd., 0.7 mi E. of Jct. Rt. 101	1 larva	Cicuta douglasii	11 July 1995
	Oregon: Tillamook Co.: Rt. 101, 12 S. of Jet. Rt. 22	6 larvae, 1 pupa	Heracleum maximum	11 July 1995
	Oregon: Lincoln Co: Three Rocks Rd., 1.5 mi W. Rt. 101	1 larva	Heracleum maximum	13 July 1995
P. sauzalitae	Oregon: Lincoln Co: Three Rocks Rd., 1.5 mi W. Rt. 101	1 larva	Cirsium sp.	13 July 1995
P. insulidens	Washington: Whitman Co: Steptoe Butte, el. 2500'–3000'	13 larvae	Heracleum maximum	15 July 1995

sulidens. These represent the least well-known Papaipema species for which published host records exist; their close resemblance to P. birdi as well as the informal description by Junius Bird of a "large, dill-like" host for P. insulidens suggested that apiaceous plants might fall within the host spectra of one or both of these two western species in the birdi complex. An additional southwestern species, Papaipema angelica Smith, 1899 has remained uncollected in recent decades despite our knowledge of its life history and host affiliation (Bird 1931). Although several dozen specimens of P. pertincta exist in the Oregon State University insect collection (which now includes the private collection of the late Elmer Griepentrog), we have been unable to verify the association of P. pertincta with any species of Lupinus. We thoroughly examined the botanical holdings at OSU to identify sites likely to support strong populations of various western lupines, but we found no Papaipema at any of these, and apparently no western collectors have observed or reared P. pertincta from Lupinus since Bird's (1926) second-hand account of the association. However, several dozen P. pertincta were reared from a variety of plants, mostly apiaceous, at six sites in Tillamook, Clatsop, and Lincoln counties (Table 1). Like its eastern relative P. birdi, P. pertincta appears to feed primarily in apiaceous plants; but unlike its eastern associate, P. pertincta also feeds in non-apiaceous plants.

In three weeks of field work in eastern Washington and Idaho, we failed to collect *P. insulidens* from its recorded host, *Senecio hydrophilus* Nutt. We examined sites suggested by the literature, museum labels, and the hand-written field notes and sketches of Ju-

nius Bird indicating large apiaceous host plants in Whitman County, Washington. Near localities visited by Junius Bird, several stands of *Conium maculatum* L. (Apiaceae), which matched his description and sketch, were checked without success. Thirteen larvae of *P. insulidens* were discovered and reared from *Heracleum maximum* Bartr. (Apiaceae) at Steptoe Butte at an elevation of 2500–3000′. Although we could not verify many published host associations of the two western members of the *Papaipema birdi* complex, we did take them on other hosts, apiaceous and otherwise. One possibility is that the dill-like host plant of *P. insulidens* referred to by Junius Bird was not apiaceous at all, but the introduced tansy ragwort *Senecio vulgaris*, one of the host plants from which we reared *P. pertincta*.

The reported host associations of the western P. sauzalitae (Grote) are atypically diverse for Papaipema, and include members of the asteraceous plant genera Arctium, Cirsium, and Cynara as well as Castilleja (Scrophulariaceae), and Rumex (Polygonaceae) (Crumb 1956). Peter McEvoy (pers. com.) of Oregon State University reports an association of P. sauzalitae with Senecio (Asteraceae) as well. Our collecting efforts yielded but a single specimen, from the exotic Cirsium vulgaris. However, California material at the Essig Museum includes specimens from Inverness Park (Marin Co.) where larvae were observed in Heracleum maximum, Artemisia douglasiana Bess. in Hook. (Asteraceae), and Ribes sp. (Grossulariaceae). suggesting that P. sauzalitae may be polyphagous (J. Powell pers. com.). If this is the case, the member species of each of the primary umbellifer-feeding Papaipema species groups (the harrisi-verona-sauzalitae

complex and the *birdi-pertincta-insulidens* complex), have broadened their host usage to include both composites and umbels on the west coast.

The association of *P. pertincta* with apiaceous and non-apiaceous plants is noteworthy for two reasons. First, this species parallels *P. insulidens* in having a wider range of non-apiaceous recorded hosts than expected, given the apparently tighter associations of their eastern relatives (*P. birdi* and *P. sauzalitae*, respectively) with umbels. Second, based on available DNA sequence data, *P. pertincta* is nearly indistinguishable from *P. birdi* (Goldstein 1999). We can not, therefore, rule out the possibility of *P. pertincta*'s feeding facultatively on *Lupinus*, though we were unable to recover larvae from any fabaceous plants and it is clear that the species is not thus restricted.

Although both facultative and obligate association with asteraceous plants is common among *Papaipema* species, umbel-feeding is less common. The parallel variation in host breadth among umbel-feeding *Papaipema* species is thus noteworthy, and suggests a profitable line of inquiry for further work on host use specialization in this group.

We thank P. McEvoy, E. Griepentrog, and J. Lattin for access to specimen material and assistance in locating collecting sites. J. Powell loaned material from the Essig Museum and shared his observations based on collecting and rearing efforts. We thank Kenneth and Elaine Bernard for lodging and permission to collect in their farm in Otsego Co., NY. This work was supported by an NSF doctoral dissertation improvement grant, an EPA graduate fellowship, and an AMNH Theodore Roosevelt Memorial Fund travel grant to PZG.

## LITERATURE CITED

Berenbaum, M. 1981. Patterns of furanocoumarin distribution and insect herbivory in the Umbelliferae: plant chemistry and community structure. Ecology 62:1254–1266.

- ——. 1983. Coumarins and caterpillars: a case for coevolution. Evolution 37:163–179.
- BIRD, H. 1921. New species and life histories in *Papaipema Sm.* (Lepidoptera). No. 20 Can. Entomol. 53:79–81.
- ——. 1926. New life histories and notes in *Papaipema* (Lepidoptera). No. 24. Can. Entomol. 58:249–284.
- . 1931. The *Papaipema* species of the Pacific Coast (Lepidoptera). Can. Entomol. 63:183–187.
- CRUMB, S. E. 1956. The larvae of the Phalaenidae. U.S. Dept. Agric. Tech. Bull., no. 1135. U.S. Government Printing Office, Washington, D.C. 356 pp.
- GOLDSTEIN, P. Z. 1999. Molecular systematics and the macroevolution of host plant use in the endophagous moth genus *Papaipema* Smith 1899. Ph.D. Dissertation, University of Connecticut.
- HESSEL, S. A. 1954. A guide to collecting the plant-boring larvae of the genus *Papaipema* (Noctuidae). Lepid. News 8:57–63.
- HODGES, R. W. et al. (eds.). 1983. Check list of the Lepidoptera of America north of Mexico. London, E. W. Classey Limited and The Wedge Entomological Research Foundation. 284 pp.
- JONES, F. M. & C. P. KIMBALL. 1943. The Lepidoptera of Nantucket and Martha's Vineyard Islands, Massachusetts. Publications of the Nantucket Maria Mitchell Association IV. Nantucket. 217 pp.
   KWIAT, A. [=A. K. WYATT]. 1916. Collecting Papaipemae (Lep.).
- KWIAT, A. [=A. K. WYATT]. 1916. Collecting Papaipemae (Lep.) Entomol. News 27:228–234.
- QUINTER, E. L. 1983. *Papaipema*, pp. 138–139 (in part). *In* Hodges, R. W. et al. (eds.), Check list of the Lepidoptera of America north of Mexico. London, E. W. Classey Limited and The Wedge Entomological Research Foundation.

Paul Z. Goldstein, Division of Insects, Field Museum of Natural History, 1400 S. Lake Shore Drive, Chicago, Illinois 60605, USA and Committee on Evolutionary Biology, University of Chicago, Culver 401, 1025 East 57th Street, Chicago, Illinois 60637, USA and Eric L. Quinter, Division of Invertebrate Zoology, American Museum of Natural History, Central Park West @ 79th, New York, New York 10024, USA

Received for publication 25 August 2002; revised and accepted 20 December 2002.