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Source: Proceedings of the Entomological Society of Washington, 119(1):18-23.
Published By: Entomological Society of Washington
DOI: http://dx.doi.org/10.4289/0013-8797.119.1.18
URL: http://www.bioone.org/doi/full/10.4289/0013-8797.119.1.18

PROC. ENTOMOL. SOC. WASH.
119(1), 2017, pp. 18–23

FIRST NORTH AMERICAN RECORDS OF *PORPHYROSELA MINUTA* CLARKE (LEPIDOPTERA: GRACILLARIIDAE), WITH NOTES ON ITS NATIVE CONGENER, *P. DESMODIELLA* (CLEMENS)

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Abstract.—The South American moth *Porphyrosela minuta* Clarke (Gracillariidae) is documented for the first time in the United States, where it is already widespread. The larvae are leafminers of white clover (*Trifolium repens* L., Fabaceae). Adults and larval habits are compared with those of the native Nearctic *P. desmodiella* (Clemens), which mines leaves of several other legumes. We summarize and add to the known distribution and parasitoid records for both species.

Key Words: leafmining, clover, *Trifolium repens*, Fabaceae, introduced species, Eulophidae, *Chrysocharis*, *Hemiptarsenus*, *Pediobius*, *Pnigalio*, *Sympiesis*, *Zagrammosoma*, Braconidae, *Pholetesor*

DOI: 10.4289/0013-8797.119.1.18

Porphyrosela desmodiella (Clemens) is the type species and the only described North American representative of *Porphyrosela* Braun. The larvae form underside tentiform mines, sometimes gregariously, in leaves of *Desmodium* Desv. and certain other legumes (Fabaceae) (Braun 1908). *Porphyrosela minuta* Clarke was described from adults reared from "trèfle" (clover) in Argentina (Bourquin 1951; Clarke 1953). Bentancourt and Scatoni (2007) gave a detailed account of the biology of *P. minuta* on white clover (*Trifolium repens* L.) in Uruguay. The larvae form upper surface blotch mines, and as with *P. desmodiella* there may be several larvae per mine. Ten additional *Porphyrosela* species have been described from Africa, Asia, and Australia, all with hosts in Fabaceae, but none of these is known to feed on *Trifolium* (De Prins and De Prins 2016).

Dodge (2012) reared an adult of *Porphyrosela* in Durham, North Carolina from a leaf mine on white clover exactly like those of *P. minuta* illustrated by Bourquin (1951) and Bentancourt and Scatoni (2007), but the specimen was not saved. Other BugGuide.net contributors photographed the mines in Baltimore, Maryland (Wilson 2012) and Roseville

(Placer Co.), California (Zungri 2015). In 2015, we reared and preserved *P. minuta* adults from leaf mines collected in North Carolina and Oklahoma. In this paper we summarize the known distribution, host plants, and parasitoids of both *P. minuta* and *P. desmodiella*.

Materials and Methods

Leaves containing *Porphyrosela* larvae or pupae were placed in sealed, 9- or 15-dram plastic vials, which were kept at room temperature and checked daily for emerging moths and parasitoids. Adult moths were pinned, and two voucher specimens of *P. minuta* were deposited in the Canadian National Collection of Insects, Arachnids and Nematodes, Ottawa, Ontario (CNC). Others remain in the private collection of the first author. Parasitoids were preserved in 95% ethanol; the braconid was deposited in the CNC, and eulophids were deposited in the Museum of Zoology, Lund, Sweden, with the exception of the *Zagrammosoma*, which was deposited in the Entomology Research Museum at the University of California, Riverside.

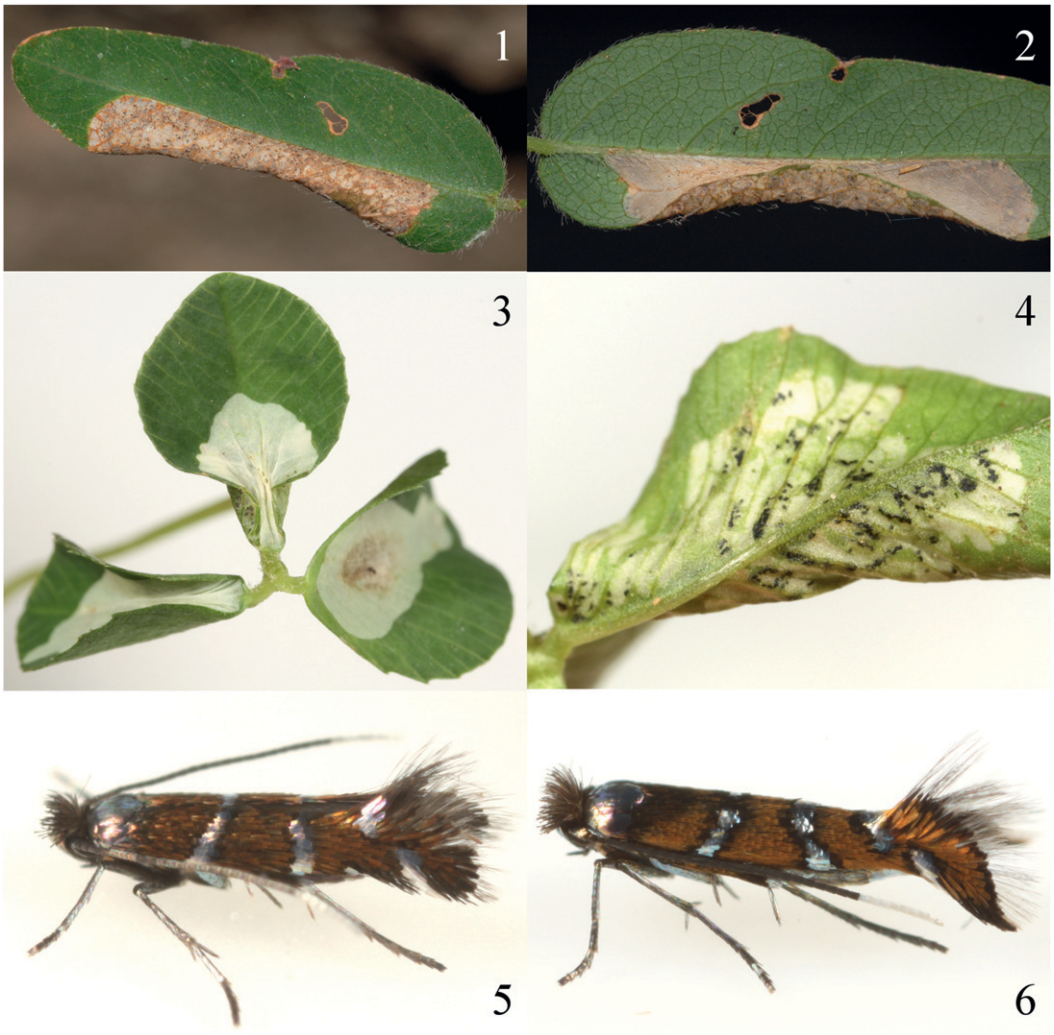
Results and Discussion

We reared and preserved 37 adults of *Porphyrosela minuta* from leaf mines collected in North Carolina and Oklahoma. This species is readily distinguished from *P. desmodiella* by the larval biology. Whereas the known hosts of *P. desmodiella* (see below) are all in the closely related tribes Desmodieae and Phaseoleae, *P. minuta* has been reared only from *Trifolium*, in the rather distantly related tribe Trifolieae (Wojciechowski 2003). The mine of *P. desmodiella* begins as a blotch on the lower leaf surface, and when complete the lower epidermis is wrinkled and the leaflet bends downward (Figs. 1–2). The mine of *P. minuta* begins as a conspicuous white blotch on the upper leaf surface; later the upper epidermis becomes wrinkled and the leaflet bends upward (Figs. 3–4).

Adults of the two species, on the other hand, can easily be confused. Clarke (1953) stated that the similarity "is extremely close but *minuta* can be distinguished from *desmodiella* by the hooked aedeagus and blunt cucullus and the sclerotized posterior portion of the ductus bursae. The two are further distinguished by the absence of the black terminal line of the forewing of *desmodiella*." We have noted another difference in forewing pattern that is apparent when the two species are viewed side by side. In *P. desmodiella* (Fig. 5), the second fascia is approximately perpendicular with the wing margins, bending somewhat so that it parallels the first fascia toward the costal margin. The space between the fasciae along the costal margin is approximately 20–30% larger than on the dorsal margin. In *P. minuta* (Fig. 6), the first and second fasciae are angled equally but in opposite directions, such that the space between them on the costal margin is about twice that on the dorsal margin.

Porphyrosela desmodiella (Clemens)

Leaf mines collected.—ARIZONA: Santa Cruz Co., Madera Canyon, 6. xi.2012, C. S. Eiseman, *Desmodium*. MASSACHUSETTS: Nantucket Co., Nantucket, Tawpeshaw, C. S. Eiseman, 25.vii.2014, *Lespedeza*. NORTH CAROLINA: Scotland Co., Laurinburg, St. Andrews University, 30. ix.2015, T. S. Feldman, *Centrosema virginianum*. VERMONT: Chittenden Co., Colchester, Lakeshore Drive, 9. viii.2015, C. S. Eiseman, *Hylodesmum nudiflorum*.



Figs. 1–6. Leaf mines and adults of *Porphyrosela* spp. 1–2. Leaf mine of *P. desmodiella* on *Desmodium*. 1, Upper surface. 2, Lower surface. 3–4. Leaf mines of *P. minuta* on *Trifolium repens*. 3, Upper surface (flat, incomplete mine at right). 4, Lower surface. 5, Adult *P. desmodiella* reared from *Desmodium* sp. 6, Adult *P. minuta* reared from *Trifolium repens*.

Distribution.—Records of this species listed by De Prins and De Prins (2016) are Canada: ON; United States: ME to FL, west to MO and TX; Cuba; Virgin Islands: Saint Thomas. This range is extended westward by an adult reared from *Lespedeza capitata* Michx. at Puccoon Prairie, Polk Co., Iowa (Hatfield 2011); mines on *L. capitata* observed at Konza Prairie Biological Station, Riley Co., Kansas (C. Eiseman, personal observation); and adults reared from *Desmodium* mines in Arizona listed above (a voucher specimen is now in the collection of D. L. Wagner, University of Connecticut, Storrs).

Host plants.—Fabaceae: *Centrosema virginianum* (L.) Benth., *Desmodium tortuosum* (Sw.) DC., *D. viridiflorum* (L.) DC., *Lespedeza bicolor* Turcz., *L.*

capitata, *L. thunbergii* (DC.) Nakai, *Strophostyles leiosperma* (Torr. & A. Gray) Piper (Walsingham 1897; Braun 1908; Kimball 1965). We failed to rear any adults from *Hylodesmum nudiflorum* (L.) H. Ohashi & R.R. Mill, but we consider it probable that the underside tentiform mines we found on this host were caused by *P. desmodiella*, because no other North American moth is known to make similar mines on plants in the tribe Desmodieae (another gracillariid, *Caloptilia violacella* (Clemens), makes a small underside tentiform mine on *Desmodium*, but then exits to feed in a leaf roll). However, it is not inconceivable that the miner was actually *Macrosaccus morrisella* (Fitch) (Gracillariidae), because this species is known to share another host (*Strophostyles leiosperma*) with *P. desmodiella* (Davis and De Prins 2011). We also did not rear adults from the *Centrosema virginianum* mines, but this host has been recorded previously for *P. desmodiella* in the Virgin Islands (Walsingham 1897).

Parasitoids.—Two eulophid wasps were reported previously from *P. desmodiella*: *Achrysocharoides guizoti* Girault and *Elasmus nigripes* Howard (Noyes 2015). To these we add *Chrysocharis walleyi* Yoshimoto (AZ) and *Zagrammosoma multilineatum* (Ashmead) (MA). The Massachusetts collection also yielded four females of an *Achrysocharoides* similar to *A. bisulcus* Yoshimoto, but the identity of these is uncertain. From the *Hylodesmum nudiflorum* mines (VT) tentatively attributed to *P. desmodiella*, we reared two more eulophids, *Sympiesis sericeicornis* (Nees) and a probable new species of *Pediobius* Walker, as well as *Pholetesor ornigis* (Weed) (Braconidae).

Porphyrosela minuta Clarke

Leaf mines collected.—NORTH CAROLINA: Durham Co., Durham, Parkwood Lake, 17.viii.2015, T. S. Feldman, *Trifolium repens*; Durham, Duke University, lawn of French Family Science Center, 22.ix.2015, E. F. LoPresti, *Trifolium repens*; Scotland Co., Laurinburg, St. Andrews University, 25. viii.2015, 10.ix.2015, 15.ix.2015, and 28.x.2015, T. S. Feldman, *Trifolium repens*. OKLAHOMA: Payne Co., Stillwater, Oklahoma State University, Center for International Trade and Development, 31.viii.2015 and 15.ix.2015, M. W. Palmer, *Trifolium repens*.

Distribution.—This species is apparently native to South America and a recent arrival in the United States. Based on the differences in forewing pattern discussed above, we believe that all photos of non-reared adult *Porphyrosela* posted to www.BugGuide.net as of this writing represent *P. minuta* and not *P. desmodiella*. The first documented evidence of *P. minuta* in North America is therefore an adult photographed in Florien, Sabine Parish, Louisiana on 10 June 2008 (Melder 2008), followed by one in Sand Springs, Osage County, Oklahoma on 16 November 2008 (Houston 2008). The first photographs of leaf mines in North Carolina (Dodge 2012) were preceded by an adult photographed at a black light in Watauga County on 23 September 2011 (Lynch 2011). One of us (TSF) recalls seeing the mines and an emerging adult sometime between 2000 and 2002 in the lawn at Duke University where EFL collected mines in 2015, but was unaware of the significance of this observation and did not document it.

The northernmost observation of leaf mines is that of Wilson (2012), who reported that the mines were "incredibly common" in his backyard in Baltimore, Maryland. He had been intensively photo-documenting flora and fauna in

this area for 6–7 years and had not previously encountered the mines. In 2013 the mines were scarce, and in 2014 and 2015 none were found (T. Wilson in litt.).

Based on the above data and the records cited in the introduction, the known distribution of *P. minuta* includes the United States (CA, LA, MD, NC, OK), Argentina, and Uruguay. The observations of T. Wilson in Maryland suggest that cold winters may prevent the range of this species from expanding further north in the near future.

Host plants.—Fabaceae: *Trifolium repens* L. Although this is the only known host, there is presumably a native plant (at least in South America) that also serves as a host. White clover is native to Europe, where no *Porphyrosela* is known to occur.

Parasitoids.—Bourquin (1953) reported a 70–80% parasitism rate in Argentina. He reared a braconid and two different entedonine eulophids and stated that E. E. Blanchard was studying them, but if they were ever identified, this information does not seem to have been published. The only associate listed for *P. minuta* by Yu (2012) and Noyes (2015) is the generalist egg parasitoid *Trichogramma minutum* Riley (Trichogrammatidae). We reared 15 individuals representing three species of eulophine eulophids. Our North Carolina collections yielded 13 males of a *Hemiptarsenus* species and one male of *Sympiesis sericeicornis*. A single female of *Pnigalio coloni* (Girault) emerged from one of the Oklahoma collections.

Other notes.—In Uruguay, *P. minuta* is multivoltine with 7–9 generations occurring from mid-November to early April; the larvae overwinter (Bentancourt and Scatoni 2007). Leaf mines have been found in August in California, Maryland, North Carolina, and Oklahoma, with larvae active into mid-November in Oklahoma. Adults emerged from our 28 October North Carolina collection between 7 and 9 November. Photographs of adults in the field indicate that they appear in Louisiana and North Carolina in mid-June (Melder 2008; Kittelberger 2015). In the spring of 2016, we monitored our 2015 collection sites for the first appearance of larval mines, which we observed on 30 March in a sheltered courtyard at St. Andrews University, North Carolina; 1 May in Durham, North Carolina; and 7 June at Oklahoma State University.

The mature mines of *P. minuta* are easily distinguished from those of other North American clover-mining insects by the wrinkled upper epidermis. We have found superficially similar mines of an unidentified ornixoline gracillariid, probably *Micrurapteryx occulta* (Braun), on red clover (*Trifolium pratense* L.) in Colorado. However, these remain flat, and all frass is expelled through a hole in the lower epidermis rather than deposited on the floor of the mine as in *P. minuta* (C. Eiseman, personal observation). The other clover miners are agromyzid flies, whose mines are generally at least partially linear, whereas *P. minuta* mines are blotches even when very small. With the exception of some individuals of *Liriomyza trifoliearum* Spencer, these agromyzids (like *Micrurapteryx*) exit their mines to pupate. In *P. minuta*, as with virtually all lithocolletine gracillariids, pupation is within the mine and the pupal exuviae protrude from the mine upon adult emergence.

Acknowledgments

We thank Julia A. Blyth, Northfield, Massachusetts, for mounting the moth

specimens; Christer Hansson, Department of Zoology, Lund University, Lund, Sweden, and Ryan Perry, Department of Entomology, University of California, Riverside, for identifying the eulophids; and José L. Fernández-Triana, Canadian National Collection of Insects, Ottawa, Ontario, for identifying the braconid.

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