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Authors: Laurent, Ryan A. St, Wagner, David L., Reeves, Lawrence E., and Kawahara, Akito Y.

Source: The Journal of the Lepidopterists' Society, 71(3) : 177-181

Published By: The Lepidopterists' Society

URL: https://doi.org/10.18473/lepi.71i3.a9

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Journal of the Lepidopterists' Society
71(3), 2017, 177–181

NOTES ON THE LARVA AND NATURAL HISTORY OF *LACOSOMA ARIZONICUM* DYAR (MIMALLONOIDEA, MIMALLONIDAE) WITH NEW HOST AND PARASITOID RECORDS

RYAN A. ST LAURENT

McGuire Center for Lepidoptera and Biodiversity, Florida Museum of Natural History, University of Florida, 3215 Hull Road, Gainesville, FL 32611, USA, e-mail: rstlaurent@flmnh.ufl.edu

DAVID L. WAGNER

Ecology and Evolutionary Biology, University of Connecticut, Storrs, Connecticut, 06269, USA

LAWRENCE E. REEVES

Entomology and Nematology Department, University of Florida, 1881 Natural Area Drive, Gainesville, FL 32608, USA

AND

AKITO Y. KAWAHARA

McGuire Center for Lepidoptera and Biodiversity, Florida Museum of Natural History, University of Florida, 3215 Hull Road, Gainesville, FL 32611, USA

ABSTRACT. The larva of *Lacosoma arizonicum* Dyar is figured for the first time. This species was previously known to feed on oaks (*Quercus*), but no specific *Quercus* species has been reported. We studied the life history of *L. arizonicum* and confirm four larval host plants from field-collected larvae: *Quercus arizonica, Q. emoryi, Q. gambelii,* and *Q. hypoleucoides*. Larvae were successfully reared to pupation in captivity on *Q. virginiana* (in Florida). A tachinid fly in the genus *Lespesia*, was reared from a single *L. arizonicum* larva.

Additional key words: Frass net, larval case, *Lespesia*, *Quercus*, shelter

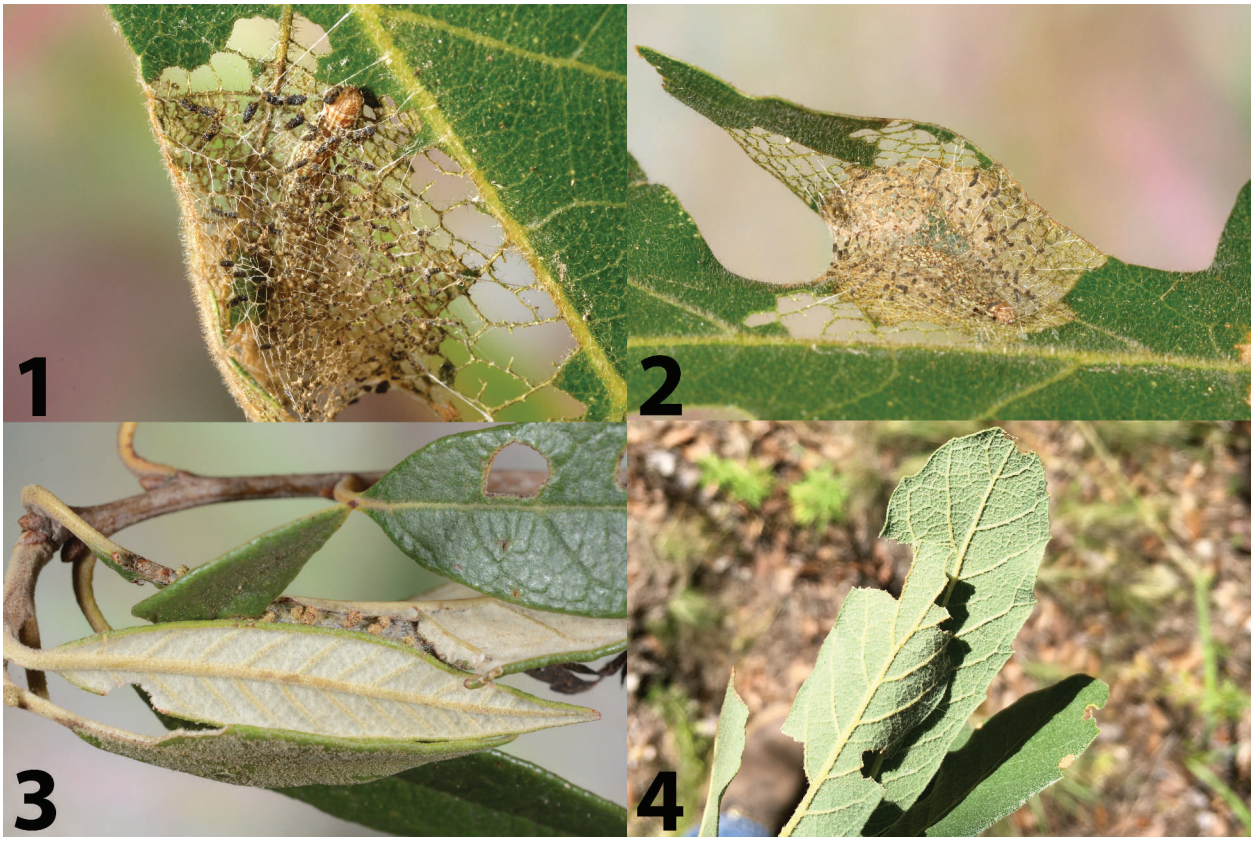
There are approximately 300 described species of Mimallonidae (RAS unpublished) of which only four occur in America north of Mexico (Franclemont 1973). Species diversity is highest in the tropics; for instance, in the lowland Atlantic tropical rainforests of northeastern Costa Rica, as many as 19 species of mimallonids have been taken at a single station (DLW unpublished). In the western United States (not including southern Texas), two species are reported: *Lacosoma arizonicum* Dyar, 1898 and *Cicinnus melsheimeri* (Harris, 1841) (Franclemont 1973, Powell & Opler 2009). Since the original description of *L. arizonicum* and the works of Franclemont (1973) and Powell and Opler (2009), little has been published on the natural history of *L. arizonicum*. These authors mention oak (*Quercus* L.) (oak species unspecified) as the larval host. Powell and Opler (2009) record the flight season for *L. arizonicum* as June through August, with a late night to early morning adult activity period, approximately 2000–0400 h.

Below we report new observations pertaining to the life history of *L. arizonicum*. We figure the larva for the first time, document four *Quercus* species as hosts in nature, and provide the first record of a parasitoid reared from a wild-collected larva. We also provide new observations and discussion on the larval feeding behavior, pupation, and diapause in *L. arizonicum*.

MATERIALS AND METHODS

Middle instar larvae of *L. arizonicum* were collected by RAS, LER, and AYK at two localities in southern Arizona, USA: Pima Co.: Santa Rita Mts., Coronado Nat. Forest, Box Canyon, 31.80075°, -110.76904°, 1490 m, 16.IX.2016, on *Quercus* arizonica Sarg. [one larva]; and Cochise Co.: Huachuca Mts., Coronado Nat. Forest, Sunnyside Canyon, 31.46495°, -110.38608° [coordinates approximate], ~1985 m, 18.IX.2016, on *Q. arizonica* [one larva] and *Q. emoryi* Torr., *Q. hypoleucoides* Camus [six larvae total from latter two *Quercus* species]. The habitat at both sites where collections were made was Madrean evergreen woodland, dominated by evergreen *Quercus* species. DLW collected young larvae at two localities in southeastern Arizona: Pima Co.: Catalina Hwy, below Incinerator Ridge, 32.40956°, -110.70470°, 2360 m, 1.VIII.2012, on *Q. gambelii* Nutt. [one larva]; Cochise Co.: Carr Canyon Road, 31.42480°, -110.29922°, 2255 m, 24.VIII, 2016, on *Q. hypoleucoides* [three larvae].

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FIGS. 1–4. *Lacosoma arizonicum* larval shelters, all from USA, Arizona. **1, 2.** Early instar frass-netting shelter. Pima Co., Catalina Hwy, below Incinerator Ridge, 2360 m, on *Q. gambelii*. **3.** Middle instar shelter, Cochise Co., Carr Canyon Road, 2255 m, on *Q. hypoleucoides*. **4.** Middle to late instar larval shelter being built, Cochise Co., Huachuca Mts., Coronado Nat. Forest, Sunnyside Canyon, ~1985 m.

RAS fed larvae on various *Quercus* sp. native to Florida, with only *Q. virginiana* being consumed for the duration of larval development. DLW reared his collections on natal hosts.

DLW's larval and photographic vouchers have been deposited in the Biological Collections facility at the University of Connecticut, Connecticut, USA. RAS's larval and adult vouchers are temporarily deposited in the research collection of Ryan St Laurent, Gainesville, FL, USA (CRAS), but will be donated to the collection of the McGuire Center for Lepidoptera and Biodiversity, Gainesville, FL, USA.

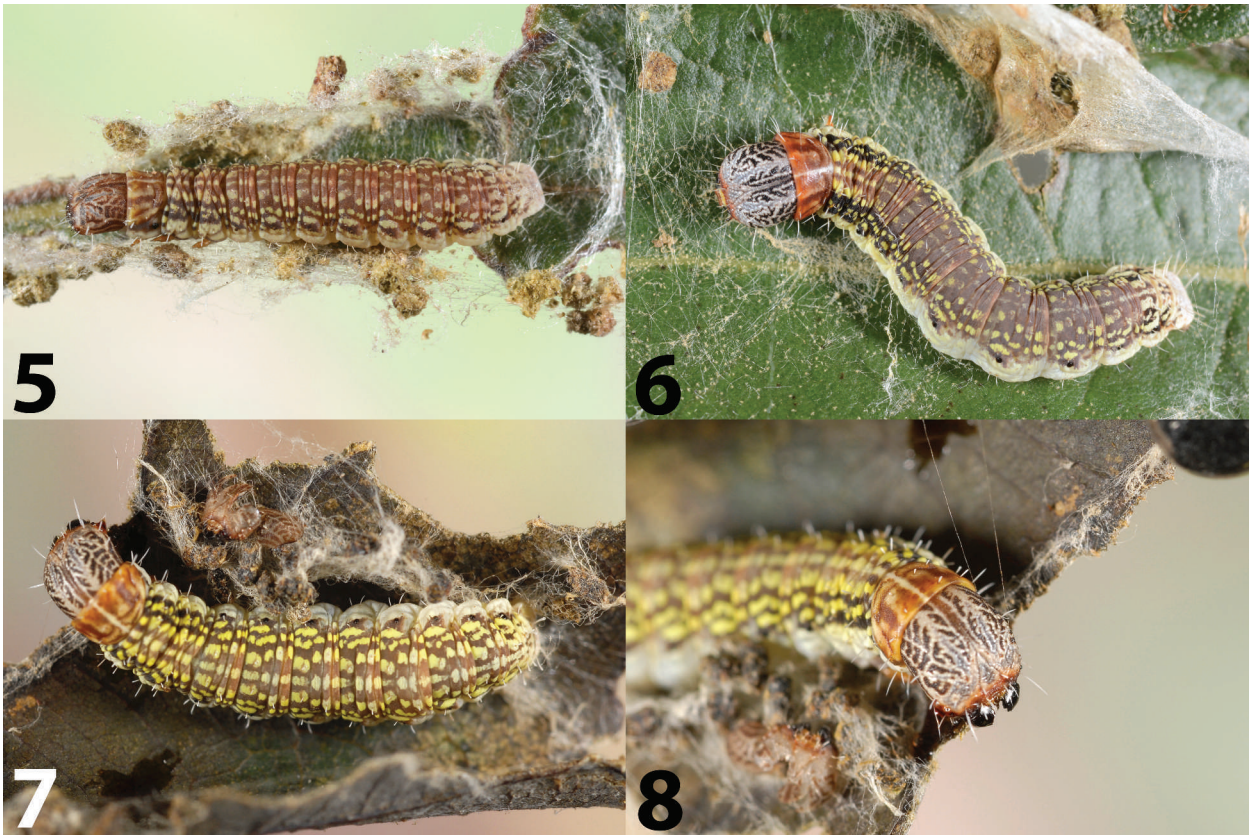
RESULTS

Natural host plants: We collected larvae on four oak species, *Quercus arizonica, Q. emoryi, Q. gambelii*, and *Q. hypoleucoides* in southern Arizona. Although our sample size is small, *Q. hypoleucoides* appears to be the favored oak species by ovipositing females.

Rearing: From eight larvae collected and reared by RAS on *Q. virginiana*, two individuals pupated. One of the two larvae sealed the anterior opening of the larval shelter prior to pupation in late X.2016, which eclosed as an adult male on 17.XI.2016 without diapause. This exceptional behavior, i.e., a November eclosion, may be a result of this individual being reared indoors with longer than normal photoperiods due to extended indoor lighting, and warm temperatures throughout the night (in Gainesville, Florida). In its natural habitat in mountainous southern Arizona, this species, being a late-season feeder, is exposed to shorter photoperiods and colder nighttime temperatures.

The other larva, however, sealed both openings of the larval shelter and underwent diapause. It is worth noting that this individual was reared under the same conditions as the nondiapausing larva, suggesting variability in the indoor rearing setup or perhaps natural variation in diapausing behavior. Upon opening the overwintering

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FIGS. 5–8. *Lacosoma arizonicum* larvae, all from USA, Arizona. **5.** Middle instar, Cochise Co., Carr Canyon Road, 2255 m, on *Q. hypoleucoides*. **6.** Final instar, a more obscurely marked individual, locality as for Fig. 5. **7.** Late instar, a more contrastingly marked individual, Pima Co., Catalina Hwy, below Incinerator Ridge, 2360 m, on *Q. gambelii*. **8.** Late instar head detail, defense posture displaying opened, jetblack mandibles, locality as for Fig. 7.

larval shelter during February/March 2017, a larva was observed, not a pupa, confirming that *L. arizonicum* overwinters as a larva as in other North American Mimallonidae (Dyar 1900, Wagner 2005). The diapausing individual was kept outdoors in a small cylindrical mesh cage, roughly 30 cm tall by 15 cm in diameter.

Larval feeding behavior: Like all Mimallonidae for which the life history is known, *L. arizonicum* builds larval shelters which differ in structure depending on the age of the larva. Early instar larvae feed below a meshwork of silk and frass-netting that spans over the midrib of a leaf, or may be built along the edge of a leaf, curling the edge slightly (Figs 1, 2). Older larvae affix two or more leaves together with silk (Figs 3, 4), forming a shelter, which becomes more rigid and tubular in structure as the larvae develop and feed on the material surrounding the sealed compartment, often killing the incorporated leaves. The final shelter (case) is compact in structure, and has openings on either end, from which the larva extends outwards to feed, retracting inwards at the slightest disturbance. The entire inside surface of the larval shelter is generously lined with silk.

Larval description: Our observations of *L. arizonicum* larvae are based on 12 middle (Fig. 5) and late instar larvae (Figs 6–9, 11), as well as on photographs of the same individuals. We note morphological characters typical of the concealed-feeding Mimallonidae, specifically an enlarged, heavily sclerotized, rugose, anteroventrad projecting head and elongate prothorax; a thick abdomen with the widest segments being A4–A7; and a distinctly flattened, and heavily armored anal plate. There are two L group setae on T1. The crochet arrangement on the anal prolegs is unique: they form a transverse oval with the anterior crochets enlarged and distinctly biordinal (Stehr 1987).

The thick, pitted and verrucose head and flattened anal plate are apomorphic for mimallonoid larvae (Stehr 1987) and are clearly specialized (armored) for blocking the two openings of the larval shelter (Forbes 1923).

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FIG. 9. Final instar *Lacosoma arizonicum* feeding on *Quercus virginiana* in captivity, displaying fully extended body, reared ex. wild-collected southern Arizona, USA.



FIG. 10. Prepupal *Lacosoma arizonicum* larva, USA, AZ, Cochise County, Huachuca Mountains, Miller Canyon, 5.X.2012, 4 cm in length. (Photo courtesy of Charles W. Melton, used with permission).

Coloration of the final instar is diagnostic, but with slight variation in the expression of yellow, as well as the degree of development of the broken longitudinal stripes (compare Figs 6 and 7). The thin middorsal stripe is usually continuous (especially anteriorad); there are three splotchy stripes, one subdorsal, and two supraspiracular. The yellow markings contrast with the dirty- to red-brown ground color. The thorax and abdomen are pale and mostly unmarked below the spiracles. The middorsal stripe divides the light red-brown prothoracic shield. The rugose head (Fig. 8) is handsomely patterned with silver-gray protuberances, giving way to black bars and lines above the level of the frons. The primary setae are white, peg-like, and somewhat widened apically. Middle and penultimate instars (Fig. 5) are similar to the final instar, but browner overall, with more subdued markings. Mature larvae are approximately 3–4 cm in length, but may stretch themselves to almost twice in length when extended from their shelters during feeding (Fig. 9).

We have not observed prepupal larvae directly because the larvae that survived to this stage remained within their larval shelters up until and during the pupal stage. However, Charles W. Melton provided photos (one shown in Fig. 10) of what we deduce to be a prepupal larva. This inference is based on the darker than usual coloration, wandering behavior as evident by the observed behavior of this individual being found crawling on the ground in an oak woodland, and the late season record: 5.X.2012 (C. Melton pers. comm.). The photo shows a larva similar to the one that we figure in Fig. 6, but more purple in coloration and fully fed. The purple hue is most obvious on the abdominal segments except A8–A10. Considering that this apparently prepupal larva was found in the absence of its larval shelter, we recognize the possibility that *L. arizonicum* may occasionally pupate outside of a shelter, but have not formally documented this behavior. Our specimen, however, did overwinter within the larval shelter.

Larvae of *L. arizonicum* are similar to those of *L. chiridota* Grote, 1864 (Dyar 1900, Wagner 2005) (Fig. 12), but markings of *L. chiridota* are less distinct due to reduced contrast between yellow dorsal markings and an overall yellowish tan coloration of the larval dorsum. We include images of both species for comparison (Figs 11, 12).

Parasitoid: Of the eight *L. arizonicum* larvae originally collected by RAS, five perished, two resulted in either an eclosed adult or a (presently, at time of writing) diapausing larva, and one penultimate instar produced a single tachinid parasitoid that pupated after



FIGS. 11, 12. Comparison of North American *Lacosoma* species. **11.** *L. arizonicum*, freshly molted final instar, captive reared ex. wild collected southern Arizona, USA. **12.** *L. chiridota*, mature final instar, captive reared ex. female Austin Cary Forest, Alachua County, Florida, USA. Not to scale.

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FIG. 13. Adult male *Lacosoma arizonicum*, USA, Arizona, Cochise Co., Ramsey Canyon, Nature Conservancy Preserve. 3.VIII.2012. (Photo courtesy of Margarthe Brummermann, used with permission).

the first week of October 2016. After the adult fly emerged from its puparium, it was killed and deposited in the Canadian National Collection of Insects, Arachnids and Nematodes, Ottawa, Ontario, Canada (CNC). James O'Hara (CNC) identified the tachinid specimen as a *Lespesia* species, possibly undescribed. This represents the first record of a parasitoid from *L. arizonicum*. The Janzen Costa Rican parasitoid database has records of *Lespesia* parasitizing Mimallonidae in the genera *Druentica* Strand, 1932 and *Trogoptera* Herrich-Schäffer, [1856] (Janzen and Hallwachs 2017).

DISCUSSION

So far as is known, *L. arizonicum* is restricted to *Quercus* hosts, although it seems to be unspecialized with regard to oak species. Its eastern relative, *L. chiridota*, is also an oak specialist (Robinson et al. 2002, Wagner 2005). In the tropics, several woody families are used by *Lacosoma*, such as: Fabaceae, Lauraceae, Melastomataceae, Myrtaceae, Proteaceae, Rosaceae, Sapotaceae, Styracaceae, and Vochysiaceae (Robinson et al. 2010, Janzen & Hallwachs 2017). While it appears that many *Lacosoma* may be dietary specialists (Janzen & Hallwachs 2017, this paper), the alpha taxonomy of the genus is too nascent and knowledge of wild hostplant associations in the Neotropics are too incompletely known to assess to what degree diets might be more generalized.

Very little information is available regarding North American mimallonid parasitoids. Arnaud (1978) lists *Chrysotachina alcedo* (Loew) as a parasitoid of *Cicinnus melsheimeri*, which is interestingly a parasitoid of another concealed shelter former, the hesperiid *Urbanus proteus* (Linneaus). RAS has reared another inconclusively identified tachinid from *C. melsheimeri* sleeve-reared in Tompkins Co., New York, USA. Considering the paucity of parasitoid records for Mimallonidae, this is an area warranting further study. For example, it would be interesting to know if there are tachinid parasitoids specialized on unrelated concealed feeders such as Mimallonidae and Hesperiidae.

ACKNOWLEDGEMENTS

We thank Ana P. S. Carvalho, Charles Covell (University of Florida), and an anonymous reviewer for offering valuable corrections and suggestions. Richard Peigler (University of the Incarnate Word) provided RAS with the Arnaud reference, and pointed out the interesting similarity in host behavior of *Chrysotachina alcedo*. We offer a special thanks to James O'Hara (CNC) for his expertise in the identification of the parasitoid reared from *Lacosoma arizonicum*. Margarthe Brummermann gave us permission to use her photo of an adult *L. arizonicum* and Charles W. Melton provided excellent photos of a prepupal *L. arizonicum* larva, one of which is figured in this article. This study was funded in part by NSFDEB-NERC grant number 1557007 to AYK and by USFS Co-op Agreement 14-CA-11420004-138 and an award from the Richard P. Garmany Fund (Hartford Foundation) to DLW.

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Submitted for publication 23 February 2017; revised and accepted 9 March 2017.

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