

BIOLOGY AND IMMATURE STAGES OF *SCHINIA MASONI* (NOCTUIDAE)

BRUCE A. BYERS

Natural Science Program, Campus Box 331,
University of Colorado, Boulder, Colorado 80309-0331

ABSTRACT. *Schinia masoni* (Smith) was studied using field observations, laboratory rearing, and data from museum collections. Its larval host plant, not previously reported, is *Gaillardia aristata*. Adults also take nectar from this plant and are well camouflaged on its blossoms. The flight period of *S. masoni* is synchronized with the blooming of *Gaillardia aristata*, both peaking in late June. Eggs are deposited between disk-flowers of the host, there are five larval stages, and pupation occurs in the soil. Museum records suggest that this species occurs only in Colorado. *Schinia masoni* and forms with coloration almost identical to closely-related *S. volupia* occur sympatrically on *Gaillardia aristata* in east-central Colorado, and individuals with intermediate coloration are common in this area, raising a question about the systematic relationship of these two species.

Additional key words: *Schinia volupia*, *Gaillardia aristata*, Heliothinae.

Schinia masoni (Smith 1896), a heliothidine flower moth, feeds in the larval stage on flowers and developing seeds of blanketflower, *Gaillardia aristata* Pursh (Asteraceae). The burgundy wings and yellow head and thorax of adults make them extremely well camouflaged when feeding or resting on *G. aristata* blossoms (Cockerell 1910, Ferner & Rosenthal 1981, Owen 1980). Cockerell (1927) wrote that this species "was discovered by Mr. J. Mason, formerly of Denver, through the picking of a *Gaillardia* flower on which a moth happened to be resting." In his description of the species, Smith (1896) stated that it was collected on flowers of *Rudbeckia*. Several facts suggest that this may be an error: the flowers of *Gaillardia* and *Rudbeckia* are somewhat similar and are commonly confused by non-botanists; the colors of *Schinia masoni* do not match those of *Rudbeckia*; and it was never observed on *Rudbeckia* ($n \cong 400$ blossoms) during this study even when these were interspersed with *Gaillardia aristata* on which *S. masoni* was observed. Cockerell (1910) observed it only on *Gaillardia aristata*.

Three photographs of *Schinia masoni* resting on *Gaillardia aristata* have been published (Brower & Brower 1956, Ferner 1980, Owen 1980), as well as one paper and two notes on how its behavior relates to camouflage (Brower & Brower 1956, Cockerell 1910, Ferner & Rosenthal 1981). The species was illustrated in Holland (1903) as *Rhododipsa masoni*; this generic name was later synonymized with *Schinia* (Hardwick 1958).

A combination of field observation, laboratory rearing, and data from museum collections was used in this study, which reports for the first time the larval host plant and immature stages of *Schinia masoni*, and

considers the systematic relationship between *Schinia masoni* and closely-related *S. volupia*.

Biology

All but 6 of 90 specimens in several museums (American Museum of Natural History, Canadian National Collection, Denver Museum of Natural History, Los Angeles County Museum of Natural History, University of Colorado Museum, and the U.S. National Museum) come from Colorado, specifically the foothills of the Rocky Mountains between Denver and Ft. Collins. Six specimens from the U.S. National Museum are labelled from "Utah" or "U.T." These specimens have no dates of collection, and their locality data are incomplete and uncertain (R. W. Poole pers. comm.). *Schinia masoni* has been collected from only a very small part of the range of *Gaillardia aristata*, which occurs northward from Colorado into Canada and westward to Washington, Oregon, and British Columbia (Biddulph 1944).

Dates of collection of the 90 museum specimens of *Schinia masoni* range from 10 June–15 July, with a peak during the last week of June. Adults were observed in Boulder Co., Colorado, from 14 June–6 July, 1988, at elevations from 1820 to 2730 m. Adults appeared at the lowest elevations first.

During the day adults were usually observed resting on the disk of a flower ($n = 7$) or under the ray-flowers ($n = 2$). *Gaillardia aristata* has brick-red disk-flowers and yellow ray-flowers. Moths resting on the tops of flowers were often oriented with their yellow heads and thoraces outward over the bases of the yellow ray-flowers and their burgundy wings over the brick-red disk, the most advantageous position for camouflage, as noted by Cockerell (1910), Brower and Brower (1956), and Ferner and Rosenthal (1981). Adults were observed actively flying and seeking nectar at dusk ($n = 5$).

Captive adults ($n = 4$) were kept in the laboratory in 4-l glass jars with four or five blossoms of *G. aristata* in a small container of water. Blossoms were replaced daily; no other water or food was added. The laboratory room was open to free circulation of outdoor air, and temperatures were essentially the same as outdoors, ranging from 21° to 29°C. Captive moths were most active during the late afternoon and early evening, and rested on blossoms during the day. Captive adults lived up to 6 days.

Eggs oviposited by captive females were always laid between disk-flowers ($n = 27$), although in the field a few eggs were found on the surfaces of buds in which the disk-flowers were still very tightly packed. Three captive females oviposited in the laboratory. Oviposition was observed five times between 1200 and 2115 h, but most often (3/5

cases) at dusk. Captive females commonly laid more than one egg in each blossom; one laid seven eggs in one blossom. In the field it was not uncommon to find two or three eggs or small larvae in a flower. Unhatched eggs were found in the field on blossoms from the bud stage to those that were almost finished blooming (1½ weeks past the bud stage).

Newly-hatched larvae tunneled into an adjacent disk-flower. Blossoms containing small larvae showed patches of brown and shrunk disk-flowers; larger larvae pushed up patches or ridges of disk-flowers in feeding on the developing seeds underneath.

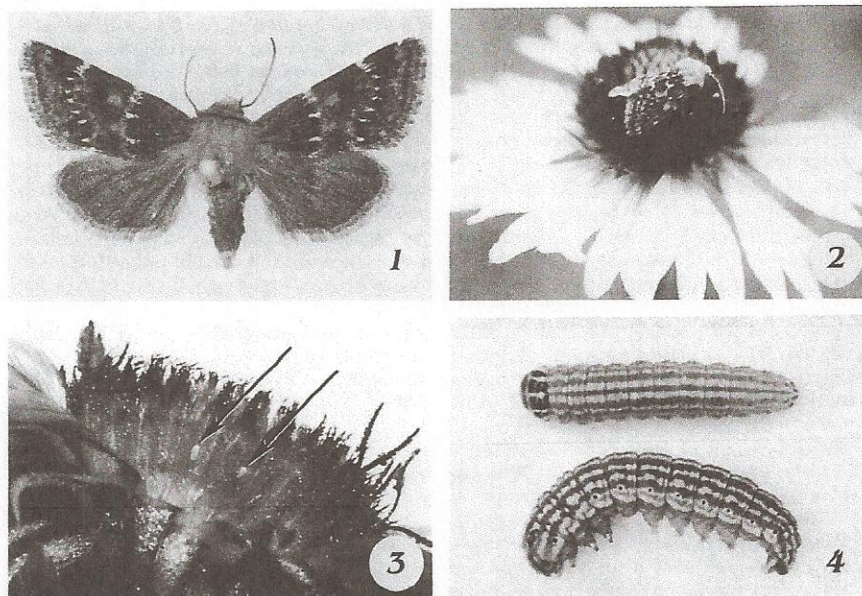
Larvae burrowed into the soil to pupate. Pupae removed from sandy soil in the laboratory had bound soil particles together with silk to a distance of approximately 5 mm in all directions to form a weak pupation chamber ($n = 16$). This species appears to be univoltine.

Description of Stages

Descriptions of immature stages are based on both field-collected and laboratory-reared larvae. Head widths and body lengths were measured on larvae collected in the field. Larvae were reared in the laboratory using techniques described by Hardwick (1958). They were examined every second day, and changes in body length, color pattern, and evidence of molting were noted. Duration of each larval stage was estimated from dated evidence of molts and body length measurements of laboratory-reared larvae, supplemented with head-width and body-length measurements from field-collected larvae. Unless otherwise noted, numerical data are means and standard deviations.

Adult. (Figs. 1, 2) ($n = 19$) Smith's (1896) original description seems generally accurate although the following differences or additions should be noted: **Abdomen:** dark grayish brown, rather than "blackish" as stated by Smith, often with row of yellow scales at posterior margin of each segment; some dark purplish pink scales ventrally and laterally. **Forewing:** burgundy or crimson due to mixture of dark purplish red and dark grayish brown scales (not "black" as stated by Smith). Lines and spots of very pale yellow; distinctness of lines variable. Antemedial (am) line with even outcurve and often with white teeth pointing basally. Postmedial (pm) line bisinuate, narrowing median space toward inner margin. Orbicular and claviform spots very pale yellow; claviform spot often appearing to connect am and pm lines. Subterminal line very pale yellow, often indistinct. Fringe grayish pink to pinkish fawn. Underside of forewing dark grayish brown (not "black" as stated by Smith) with carmine or burgundy around costal and outer margins. Fringe grayish pink to pinkish fawn. **Hindwing:** medium to dark grayish brown (not "black" as stated by Smith); outer margin and anal angle sometimes with burgundy tinge. Fringe grayish pink to pinkish fawn. Underside of hindwing mostly carmine or burgundy, often with dark grayish brown around inner margin and humeral and anal angles. Fringe pale pinkish yellow to pinkish fawn. Sexes same coloration. **Forewing length:** 10.8 ± 0.7 mm ($n = 11$).

Egg. (Fig. 3) ($n = 10$) White, sometimes with very pale yellow tint, iridescent. Elongate, 0.8–0.9 mm long and 0.3–0.4 mm wide, blunter and more rounded at micropylar end. Often deformed by compression between tightly-packed disk-flowers. Remains same color



FIGS. 1-4. *Schinia masoni* (Smith); adults and immature stages. 1, Paralectotype *S. masoni*, male, Denver Museum of Natural History; 2, adult feeding on its food plant *Gaillardia aristata* (not in head-out resting position most advantageous for camouflage); 3, two eggs deposited between disk-flowers of *G. aristata*; 4, fifth instar larvae, dorsal and lateral views.

until black head and thoracic shield become visible through chorion shortly before hatching. **Incubation period:** 3-4 days ($n = 10$).

First instar. ($n = 16$) Head, prothoracic, and suranal shields black. Body white. Spiracles with dark rims. **Head width:** 0.26 mm ($n = 1$). **Duration:** 4.5 days ($n = 7$).

Second instar. ($n = 10$) Head very dark brown. Prothoracic and suranal shields dark brown to black; sometimes solid color, sometimes with three longitudinal lines of cream or very pale yellow, lines usually less distinct than in later instars. Mid-dorsal line varying from medium brown, pale reddish brown and pale tan, to pale pink or yellowish pink. Subdorsal area cream or very pale yellow, usually with two subdorsal lines of same color as, or slightly paler than, mid-dorsal line. Supraspiracular line same color as mid-dorsal and subdorsal lines. Subdorsal and supraspiracular lines sometimes not well developed, pigmented only in middle of segments. Spiracular line and suprapodal area cream or very pale yellow. Spiracles with black rims. Thoracic legs varying from cream or very pale yellow to caramel. **Head width:** 0.56 ± 0.06 mm ($n = 5$). **Duration:** 4 days ($n = 10$).

Third instar. ($n = 9$) Head light to dark caramel, sometimes mottled with darker brown or black. Prothoracic and suranal shields black or very dark brown with three longitudinal stripes of ivory or very pale yellow. Mid-dorsal line varying from dark brown or dark purplish brown, through reddish brown and brick red, to pale pink or yellowish pink. Subdorsal area cream or very pale yellow with two subdorsal lines of same color as, or slightly paler than, mid-dorsal line. Supraspiracular line same color as mid-dorsal and two subdorsal lines. Spiracular line cream or very pale yellow. Spiracles with black rims. Suprapodal area usually cream or very pale yellow, sometimes with pale rose or brown color. Thoracic legs varying from cream or very pale yellow to caramel. **Head width:** 0.92 ± 0.06 mm ($n = 19$). **Duration:** 2.5 days ($n = 9$).

Fourth instar. (n = 9) Generally same as third instar. Pigmentation of suprapodal area often darkening; concolorous with, but paler than, mid-dorsal, subdorsal and supraspiracular lines. **Head width:** 1.45 ± 0.10 mm (n = 15). **Duration:** 3–3.5 days (n = 9).

Fifth instar. (Fig. 4) (n = 9) Head light to dark caramel, sometimes mottled with darker brown or black. Prothoracic and suranal shields black or very dark brown, divided into four bars by three longitudinal stripes of ivory or very pale yellow. Mid-dorsal line varying from dark brown or dark purplish brown, through reddish brown and brick red, to pale pink or yellowish pink. Subdorsal area ivory or very pale yellow with two subdorsal lines of same color as, or slightly paler than, mid-dorsal line. Supraspiracular line same color as mid-dorsal and two subdorsal lines. Spiracular line ivory or very pale yellow. Spiracles with black rims. Suprapodal area concolorous with, but usually paler than, mid-dorsal, subdorsal and supraspiracular lines, with a broken longitudinal line of ivory or very pale yellow. Thoracic legs varying from ivory or very pale yellow to caramel. Setal arrangement same as that of members of the elliptoid-eyed group of the genus (Hardwick 1958, fig. 87). On the first eight abdominal segments (A1 to A8), SD2 is minute and variably absent; on the first and second thoracic segments (T1 and T2), SD1 and SD2 are sometimes absent (Stehr 1987). **Head width:** 2.36 ± 0.06 mm (n = 11). **Duration:** 5.5–6 days (n = 9).

Total duration of larval life, laboratory rearing at 21–29°C: 19.9 ± 1.3 d (n = 9). At elevations between 2560 m and 2730 m collections of larvae made 18 days apart suggest that larval development may require up to twice as long as above, undoubtedly because of colder temperatures.

Pupa. (n = 16) Orange-brown. Spiracles on segments 2 and 3 borne on weak projections of cuticle; on segment 4 on a level with general surface of cuticle; on segments 5–7 in shallow depressions. Anterior margins of segments 5–7 with band of conspicuous pits. Proboscis terminating at apices of wings. Cremaster usually consisting of four setae borne on prolongation of 10th abdominal segment. Apical abdominal segments similar to those of *S. pallicinta* (Hardwick 1972a) or *S. jaegeri* (Hardwick 1972b) except for number of setae. Setae often slightly curved ventrally; inner pair (approx. 0.3–0.4 mm long) slightly longer than outer pair (approx. 0.2 mm long), which is directly lateral to inner pair. One or both outer setae occasionally much reduced or absent. **Length** from anterior end of pupa to posterior margin of fourth abdominal segment: 7.9 ± 0.5 mm (n = 16).

Larval Diagnosis

In the elliptoid-eyed members of the genus *Schinia*, Hardwick (1958) found that "chaetotaxy . . . has no significance on the specific level There is rather wide latitude in the setal arrangement of individual larvae but no interspecific variation is evident." In fact, throughout the genus *Schinia* setal patterns are of very little diagnostic use, whereas larval color patterns are very often diagnostic (D. F. Hardwick pers. comm.).

The color pattern of the fifth instar distinguishes *Schinia masoni* from other described species of *Schinia*. The four black or very dark brown bars on the prothoracic shield distinguish it from all but *S. pallicinta* (Hardwick 1972a), which was formerly placed in the genus *Rhododipsa* along with *S. masoni*. The prothoracic shield of *S. jaegeri* is similar, but the dark bars are not as well defined (Hardwick 1972b). The presence of a mid-dorsal band, two subdorsal bands, and a supraspiracular band, and the reddish pigmentation of these bands, dis-

tinguishes *S. masoni* from both *S. pallicinta* and *S. jaegeri*. These diagnostic pigmentation patterns may be seen in Fig. 4.

Larval Feeding Ecology

To compare the larval development of *S. masoni* with the rate of development of *Gaillardia aristata* blossoms, 10 blossoms were marked at the bud stage and photographed twice a week for three weeks. This record showed that it took 2½ weeks for a flower to go from the bud stage (ray-flowers absent or just emerging) to the early seed-head stage (ray-flowers dried and shriveled, or dropped; seeds beginning to dry and harden).

Nearly three weeks were required for *S. masoni* to complete its development from egg to pupa in the laboratory. In the field, it appeared that some larvae had completed development on a single blossom. However, captive fifth instar larvae ate the developing seeds of an entire blossom approximately every two days for about the last four days before pupation. Such a feeding rate makes it seem unlikely that a larva could complete development in the flower on which its egg was laid. Movement of larvae from flower to flower was observed in the field: several late third or early fourth instar larvae were seen crawling on uneaten blossoms near ones that had been eaten but that contained no larvae. On the other hand, many larvae were found on isolated blossoms many meters from any other, making it seem unlikely that they could locate and move to another blossom to complete their development. Clarification of this aspect of the larval feeding ecology of *S. masoni* will require further research.

Systematic Status

The original description of *Schinia masoni* (Smith 1896) recognized its close resemblance to *Schinia volupia* (Fitch), and these species are still considered to be closely related (D. F. Hardwick pers. comm.). The larval and adult food plant of *S. volupia* has not previously been reported; during this study it was found to be *Gaillardia pulchella* Fougereux, at least in eastern Colorado. Specimens of *S. volupia* in the museums listed above were collected in Colorado, Kansas, Oklahoma, Texas, New Mexico, and Louisiana; this area overlaps most of the range of *Gaillardia pulchella* (Biddulph 1944).

During this study an area was found on the Palmer (Platte-Arkansas) Divide between Denver and Colorado Springs where typical *S. masoni* and individuals with coloration almost identical to *S. volupia* occur together on *Gaillardia aristata*. *Schinia volupia* has light pink to carmine-pink forewings and hindwings, and none of the specimens from

eastern Colorado or New Mexico I examined ($n = 12$) had any grayish brown scales on either forewings or hindwings. The pale *volupia*-like forms from the Palmer Divide all had some grayish brown scales on the upper hindwings, giving them a visible brownish tinge not seen in typical *volupia*. Individuals with intermediate coloration were common in this area. If these intermediate forms are hybrids, it is possible that *S. masoni* and *S. volupia* are subspecies rather than full species.

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