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LIFE HISTORY AND IMMATURE STAGES OF *CATOCALA ATOCALA* (NOCTUIDAE)

LAWRENCE F. GALL

Entomology Division, Peabody Museum of Natural History, Yale University, New Haven, Connecticut 06520, USA

JOHN W. PEACOCK

185 Benzler Lust Road, Marion, Ohio 43302, USA

AND

JEFFREY R. SLOTTEN

5421 N.W. 69th Lane, Gainesville, Florida 32653, USA

ABSTRACT. The immature stages of *Catocala atocala* are described and illustrated for the first time. Notes on the biology of the adults and larval foodplants are provided.

Additional key words: underwing moths, Louisiana, Mississippi, nutmeg hickory, *Carya* (Section *Apocarya*) *myristicaeformis*.

Catocala atocala Brou (1985) was recognized only recently as a separate species, having been treated in the literature as a variant of *C. agrippina* Strecker ever since Strecker (1874) provided the first illustration. Such late recognition of a new Nearctic underwing species is unusual given the longstanding interest in the genus, and the existence of several dozen 19th and early 20th century specimens of both sexes of *C. atocala* in institutional collections in North America and Europe (Brou 1985:889 mistakenly believed he had collected the first known females in the 1970's). Ironically, more than 50 years ago the Palearctic lepidopterist E. A. Dadd understood that *C. atocala* was a separate species, as he prominently labeled a male and female in a series of five *C. atocala* ex Boll collection at the Museum für Naturkunde (Berlin) as the types of "*Catabapta torfrida* Dadd." However, to our knowledge, the name was never published.

We are not aware of any previously published information on the life history of *Catocala atocala* other than Gall's (1991) speculation that, based on the external morphology and wing pattern of the adults, the foodplant would likely prove to be "pecan hickories" (*Carya* Nutt. Section *Apocarya* DC.) rather than "hickories" sensu strictu (*Carya* Section *Eucarya* DC.)

(Juglandaceae). Here we report on the successful rearing of *C. atocala* from ova deposited by wild-caught females, present field observations of adults in Louisiana and Mississippi, and suggest a probable natural larval foodplant for this species.

DISTRIBUTIONAL AND BIOLOGICAL NOTES

In June 1999, LFG and JWP traveled to Louisiana and Mississippi to search for *C. atocala* and elucidate its biology. At the time, the only lepidopterist with significant firsthand knowledge of the species was its describer, Vernon Brou. His type series of 35 specimens was collected between 1975 and 1983. Among those specimens, 32 were taken at Edgard, St. John the Baptist Parish, Louisiana, two were from Weyanoke, West Feliciana Parish, Louisiana, and one was from Mississippi State, Oktibbeha County, Mississippi. Brou (in litt., June 1999) described the type locality as follows: "The Edgard . . . location I lived on and collected for about 14 years is not easily accessible. I . . . haven't been back there for about 15 years, and I'm sure it is nearly impossible [now] to get to the pecan tree area . . . this area is primarily agriculture (sugar cane), private property, or mostly impenetrable swamp requiring a pirogue (boat)." The few specimens of *C. atocala* cap-

tured in Tennessee, Arkansas, Illinois, and Oklahoma since the 1985 description all came from habitats apparently comparable to the type locality—low-lying regions within approximately 30 km of either the Mississippi River or a major river that drains into it (Brou's Weyanoke locality was nominally in upland woodlands, but nevertheless, quite close to the Mississippi River).

Based on this information, we opted to begin searching in the broad vicinity of Weyanoke, Louisiana, making transects using local roads that ran largely perpendicular to the Mississippi River, on the assumption that the moth's primary habitat was not upland woodlands per se. On the first transect run on 28 June 1999, JWP found a number of adult *C. atocala* just east of the Mississippi River near Saint Francisville, Louisiana. Our further exploration of the Saint Francisville area on 29–30 June 1999 revealed that adult *C. atocala* appeared to occur only in shaded woodlands in and around the floodplains immediately adjacent to the Mississippi River. We successfully applied this search protocol on 1–2 July 1999 as we drove north along the western border of Mississippi, ultimately finding adult *C. atocala* in the following six parishes and counties: off State Route 10, 1 km S of Saint Francisville, West Feliciana Parish, Louisiana; off Carthage Point Road, 4 km W of Carthage, Adams County, Mississippi; 4 km NW of Magna Vista, Issaquena County, Mississippi; 5.5 km W of Deeson, Bolivar County, Mississippi; 8 km WSW of Friar's Point, Coahoma County, Mississippi; west of Sam's Town Casino, 12.5 km W of Robinsonville, Tunica County, Mississippi. Despite an extended search on 2 July 1999, we failed to locate adult *C. atocala* W of Walls in DeSoto County, Mississippi (in that area, on the outskirts of Memphis, Tennessee, the appropriate habitat appeared significantly more fragmented and less dense than in all counties to the south; but note the prior capture of *C. atocala* by M. Furr in Meeman Shelby State Forest, Shelby County, Tennessee). On 3–5 July 1999, JRS visited the Saint Francisville locality and made further observations on *C. atocala* adults.

The preferred habitat of *C. atocala* in Louisiana and Mississippi appears to be shaded, moist woodlands in lowland floodplains adjacent to the Mississippi River with concentrations of box elder (*Acer negundo* L.) (Aceraceae), sycamore (*Platanus occidentalis* L.) (Platanaceae), sassafras (*Sassafras albidum* (Nutt.) Nees) (Lauraceae), nutmeg hickory (*Carya* Section *Apo-carya myristicaeformis* (Michx. f. Nutt.) (Juglandaceae), water locust (*Gleditsia aquatica* Marsh.) (Fabaceae), and various oaks (*Quercus* sp.) (Fagaceae). All our adult *C. atocala* were taken by flushing them from resting sites on tree trunks during day-

light hours—none were attracted to our bait traps at night (deployed only one night), and we did not employ MV or UV light traps. Adult *C. atocala* were common at the West Feliciana Parish, Adams County, and Issaquena County sites, with up to 10–20 moths per hour observed at each. Adults were seen resting head down from 0.5 to 2.0 m above the ground on the trunks of various trees, most often box elder and nutmeg hickory, and usually adjacent to or under vines ca. 1–4 cm in diameter. When startled, adult *C. atocala* proved to be among the wariest of any *Catocala* species we have encountered, and displayed a penchant for alighting repeatedly on the often inaccessible vines; pursuits of 10–20 minutes per moth were not uncommon. Adult *C. atocala* were flushed from trees as early as 0715 h at the Saint Francisville locality. Daytime high temperatures throughout the period 28 June to 2 July 1999 ranged from 31–35°C.

The only other *Catocala* species occurring in significant numbers with *C. atocala* in these wooded floodplains was *C. agrippina*. In the Adams County and (especially) Issaquena County localities, adult *C. atocala* outnumbered adult *C. agrippina*. The *Catocala* species encountered at each locality were as follows: Louisiana, West Feliciana Parish: *C. amatrix* Hübner, *C. agrippina*, *C. amica* Hübner, *C. atocala*, *C. carissima* Hulst, *C. ilia* Cramer, *C. insolabilis* Guenée, *C. maestosa* Hulst, *C. piatrix* Grote, *C. vidua* J. E. Smith; Mississippi, Adams County: *C. agrippina*, *C. atocala*, *C. amatrix*, *C. carissima*, *C. innubens* Guenée; Mississippi, Bolivar County: *C. atocala*, *C. agrippina*, *C. innubens*; Mississippi, Coahoma County: *C. agrippina*, *C. atocala*, *C. carissima*, *C. innubens*; Mississippi, Tunica County: *C. agrippina*, *C. atocala*, *C. innubens*; Mississippi, DeSoto County: *C. maestosa*.

REARING OBSERVATIONS

Ova were secured from two of six moderately worn female *C. atocala* collected during the day from Saint Francisville, Louisiana, between 30 June and 4 July 1999. The females were confined in paper grocery bags (8 × 13.5 × 27 cm) at near ambient temperature (15–30°C), and were offered a weak sucrose solution daily on small pieces of sponge; a new sponge piece with solution was provided approximately every other day. Although females lived from three to eight days, only two oviposited, and each of these deposited only three ova. One set of ova was overwintered at ambient outside temperatures in Gainesville, Alachua County, Florida by JRS (coldest periods of circa 5 to 10°C), and another in a protected garage in Westport, Fairfield County, Connecticut by LFG (coldest periods of circa –2 to 5°C). Overwintering ova were kept in empty



FIG. 1. Immature stages and distribution of *Catocala atocala*. **a**, lateral view of 6th (last) instar larva. **b**, closeup of head capsule of 6th instar larva. **c**, dorsal view of egg as revealed by scanning electron microscopy (60 \times). **d**, distribution of *Catocala atocala* in North America; open circles, pre-1950 records; filled circles, post-1950 records; each circle represents a county in which the species has been recorded; shading represents distribution of *Carya (Section Apocarya) myristicaeformis* (after Little 1977, 1980).

plastic film containers and misted lightly once every few weeks.

Only one first instar larva emerged on 14 April 2000 from the three ova overwintered in Florida, and only

one emerged on 12 May 2000 from the three ova overwintered in Connecticut. The Florida larva was offered only water hickory (*Carya Section Apocarya aquatica* (Michx. f.) Nutt.), which it accepted. The

Connecticut larva was offered an array of potential juglandaceous foodplants in an arena food choice test (see Gall 1991); it accepted black walnut (*Juglans nigra* L.) and butternut (*J. cinerea* L.), but refused to feed on shagbark hickory (*C. Section Eucarya ovata* (Mill.) K. Koch), pignut hickory (*C. Section Eucarya glabra* (Mill.) Sweet), and bitternut hickory (*C. Section Apocarya cordiformis* (Wang.) K. Koch). This larva subsequently was reared on *J. nigra*. Both larvae were reared indoors at 20–24°C, and each appeared to eat their respective foods equally well, as development times per larval instar differed by one day or less. Both larvae were preserved in alcohol as fully grown last instars. The average duration for each stage was as follows (based on $n = 2$ larvae): 1st instar, 4 days; 2nd instar, 4 days; 3rd instar, 3.5 days; 4th instar, 4.5 days; 5th instar, 5.5 days; 6th instar >5 days (larvae were preserved before entering pre-pupal stage). A description of the mature larva is as follows:

6th (final) instar larva (Figs. 1a, b). Length 6 cm; head capsule width 3–4 mm; body color light mousy grey tinged with pink; dorsal tubercles reddish orange; spiracles black; finely dispersed black to brown specks forming interrupted but nearly complete dorsal and lateral lines along length of body, most apparent in the vicinity of the dorsal tubercles; 5th abdominal segment with slightly elevated, 2 mm wide transverse protuberance, slightly lighter than body color, with a large dark brown lateral "saddle patch" contrasting strongly with the body color, all lines formed by specks being darker and more prominent on this segment; 8th abdominal segment with a pair of ventrally projecting, 1 mm long tubercles; lateral filaments present along entire length of body, whitish pink, dense, 1–2 mm in length, simple (not bifurcate or multifurcate); ventral surface of body segments dirty whitish pink, with black spots on each abdominal segment, edged and overlaid with orange on 4th through 7th abdominal segments; capitad surface of head capsule flattened but not strongly produced addorsally, lacking lateral stripes from antennae to dorsal margins; antennae and true legs pinkish; setae on head capsule and body pinkish, sparse; head capsule color same as body color, but with slightly darker striations; based on limited sample sizes, the larva of *C. atocala* appears to have a more prominent "saddle patch" than the larva of *C. agrippina*, and the first few dorsal tubercles behind the head capsule in *C. agrippina* are usually yellowish, as opposed to reddish orange in *C. atocala*.

It is unlikely that *Carya aquatica* or *Juglans nigra* are the wild larval foodplants of *C. atocala* at the Louisiana or Mississippi localities visited during 1999. No *Carya aquatica* were seen at these localities, and *J. nigra*, *Carya Section Eucarya ovata*, and *Carya Section Apocarya illinoensis* (Wang.) K. Koch (pecan) occurred only sporadically, and then not in close proximity to the adult moths. However, *Carya myristicaeformis*, the only other juglandaceous tree species at any of the *C. atocala*

collecting sites, was present and often common where the moths were found, and was one of the tree species on which the adults frequently rested during the daytime. In addition, the overall geographic range of *Carya myristicaeformis* approximates the known range of *C. atocala* (Fig. 1d). We thus believe *Carya myristicaeformis* is the wild foodplant for *C. atocala* along the Mississippi River in Louisiana and Mississippi. Because another global stronghold for *Carya myristicaeformis* appears to be along the Red River and its tributaries on the border of Oklahoma and Texas, we predict that *C. atocala* occurs there in greater numbers than the few recent Oklahoma captures (Cleveland, Murray and Tulsa Counties; G. Gier & C. Harp, pers. com.) suggest. In addition, disjunct populations of *Carya myristicaeformis* that could harbor *C. atocala* exist in coastal South Carolina. We encourage lepidopterists to look for *C. atocala* and *Carya myristicaeformis* in these other drainage systems, as well as at greater distances from rivers per se, as our sampling efforts during 1999 were at best inconsistent the farther we were from the Mississippi River.

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