GENERAL NOTES

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NOTES ON THE NATURAL HISTORY OF *QUADRUS* (*PYTHONIDES*) *CONTUBERNALIS* (HESPERIIDAE) IN COSTA RICA

Additional key words: skipper butterflies, larval behavior, pupae, parasitism, Piperaceae.

Skipper butterflies of the genus *Quadrus* (Hesperiidae) exploit various species of *Piper* (Piperaceae) in the Amazon Basin (Moss, A. M. 1949, Acta Zool. Lilloana 7:27–79). *Quadrus contubernalis* Mabille is widely distributed from Mexico to Colombia and Brazil (Draudt, M. 1922, pp. 886–887 [text] *in* Seitz, A. (ed.), Macro-Lepidoptera of the world. Vol. 5. Div. 2. The American Rhopalocera. Stuttgart: A. Kernan Verlag). Adults of this small skipper are chocolate brown with two transverse light-blue stripes on the uppersides of the hindwings. Nothing has been reported previously on the life cycle and other aspects of its natural history. Here I report for the first time the caterpillar food plant, the unusual larval shelter, notes on the abundance of caterpillars and pupae, and other aspects of the natural history of this species at one locality in Costa Rica.

The study site consisted of a border strip of abandoned cacao (1400 m^2) mixed with lowland tropical wet forest (Holdridge, L. R. 1964, Life zone ecology [rev. ed.]. San Jose, Costa Rica: Tropical Science Center) at "Finca Experimental La Lola," near Siquirres (10°06'N, 83°30'W; 50 m elev.), Limon Province, Costa Rica. This forest was composed of densely-shaped Matina cacao (*Theobroma cacao* L.) trees with an overstory chiefly of *Hura crepitans* L. (Euphorbiaceae) and many woody-to-herbaceous understory species (Young, A. M. 1986, J. Trop. Ecol. 2:163–168), including a dense patch of the larval food plant of *Q. contubernalis* (Fig. 1). Observations at this site were made on five dates between 1986 and 1990 (see Table 1).

Following initial discovery of an unidentified hesperiid caterpillar enclosed in a perforated leaf shelter (Fig. 2) during March 1986 at the study site, I subsequently collected, reared, and examined caterpillars of this species. Periodic censuses were taken of caterpillars, pupae (which I also discovered to be inside the folded-leaf structure), and shelters in this stand of food plant that encompassed an area of approximately 40 × 30 m. For time to time, partly-grown caterpillars (n = 8) collected in the wild were confined, with food plant cuttings or transplants, in jars or plastic bags for rearing. I did not count eggs, but only checked plants that had one or more of the distinctive and conspicuous larval shelters. I scored these tent shelters for the presence of a caterpillar, pupa or pupal shell, or as being unoccupied (empty). Voucher specimens of the food plant were taken for identification and deposited in the National Museum of Costa Rica, and adult butterfly specimens reared were deposited in the Milwaukee Public Museum. Parasitic flies obtained from rearings (Diptera: Tachinidae) were saved for identification (U.S. National Museum).

Larval food plant and shelter. The caterpillar food plant at La Lola is *Piper pseudolindenii* C. DC., identified from non-flowering material. In the study plot this semi-woody, shrub-like forest understory plant (Fig. 1) ranged in height from about 0.5 to 1.5 m. Individual plants occurred closely together, forming large patches. They were easy to distinguish from other plants in the area by their leaves and growth profile (Fig. 1). Folded leaf shelters of various sizes and shapes (Fig. 2) were easy to spot, because the caterpillar partially excises a portion of tissue from the edge of the leaf and folds it back over the top of the leaf, securing it with silk. In this manner the pale underside of the leaf becomes exposed against the dark green upper surface, and the unusual holes made by the caterpillar in the shelter top made the shelters easy to locate in the shaded understory (Fig. 2). Smaller shelters, made by folding over a piece of leaf near its edge, were occupied by smaller caterpillars (up to 14 mm long). Larger shelters, involving a whole leaf being folded over and perforated (Fig. 2), were made by larger caterpillars (20–35 mm long).

FIG. 1. Top: Abandoned cacao habitat at La Lola. Below, left: *Piper pseudo-lindenii* at study site (8 stems showing plant life-form or profile); below, right: *P. pseudo-lindenii*, close-up of leaves.

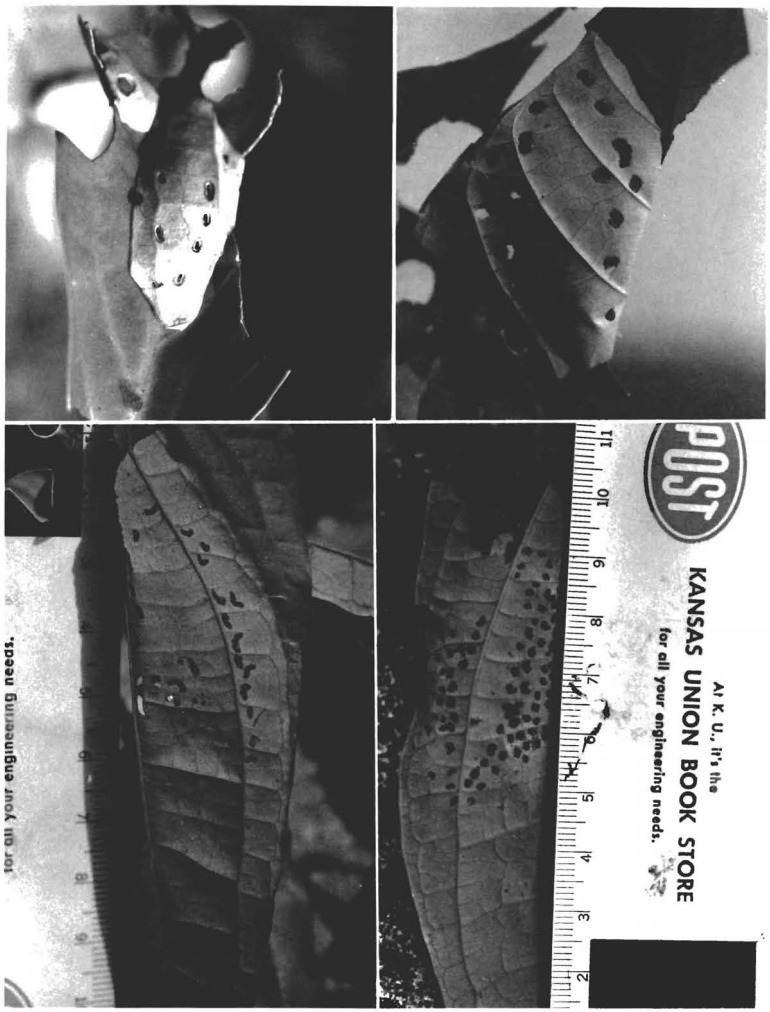

FIG. 2. Folded leaf shelter construction by *Quadrus contubernalis* larvae. Clockwise, from upper left: shelters made by progressively larger caterpillars. Note the unusual perforations in the folded-over portion of the partly-excised (top photos) or entirely-folded over (bottom photos) leaves. Scale in mm.

No preference for young meristem leaves, as opposed to older leaves, was observed for either feeding or constructing shelters. Caterpillar feeding, which occurred at either end of the shelter and distally on portions of the leaf not part of the shelter, is presumably nocturnal, since none was observed during the day.

Holes in the larval shelter were made by a larva chewing all the way through the leaf (although this behavior was not examined for very small larvae). The holes were covered with a thin webbing of silk. Larger shelters had more holes than smaller ones, although

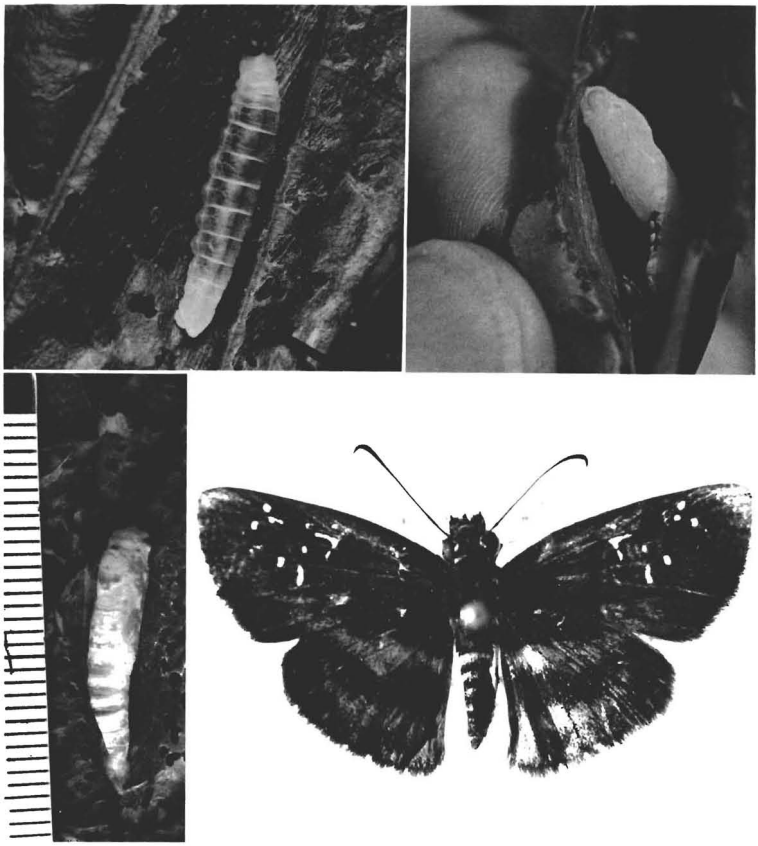

FIG. 3. Life stages of *Q. contubernalis*. Clockwise from upper left: final instar larva; lateral aspect of pupa; adult male (forewing length 14 mm); dorsal aspect of pupa. Scale in mm.

a correlation between shelter size and the number of holes was not investigated. Shelters with pupae did not necessarily have more holes than those with larvae. Mandibles of larvae were not examined to determine if they were modified in any way for cutting holes.

Life stages (Fig. 3). Material examined in the field and laboratory provided descriptions of some early stages and behavior as follows:

Small larva (10 mm long) (n = 6): Head capsule 1.00 mm (range 0.90–1.10), black. Body ground color translucent greenish-yellow; lateral thin white line running lengthwise beginning on first abdominal segment. This line more yellowish on last 3 segments; overall less pronounced in larger larvae. Prolegs blackish. Prothoracic shield not pronounced but edged in yellow or white. Anal plate yellow or white.

Large larva (20–35 mm long) (n = 7): Head capsule 3.00 mm (range 2.90–3.00), now more heart-shaped and reddish brown with small patch of darker brown on lower lateral area. Body ground color greenish-blue, owing to gut contents; lateral markings as before but less pronounced. Prolegs black. Prothoracic shield prominently ridged in white or

TABLE 1. Distribution and abundance of larvae and pupae of *Quadrus contubernalis* Mabille in a stand of its larval food plant, *Pipe pseudo-lindenii* C.DC., in a cacao forest, near Siquirres, Limon Province, Costa Rica.*

Census dates	No. of food plants searched	Total no. of larvae	Total no. of pupae	No. of immatures per plant	No. of pupal exuviae	No. of empty shelters	Total no. of immatures, exuviae, and shelters per plant
30-VI-86	201	8	1	0.045	5	12	0.13
28-II-87	198	4	1	0.025	2	25	0.16
15-II-88	208	5**	3	0.038	11	34	0.25
20-II-89	270	0	1	0.004	2	30	0.12
2-III-90	235	0	0	0.000	2	24	0.11

* Censuses taken within a rectangular plot of understory vegetation approximately 40 × 30 m.
** Two individuals of *Siphosturmia* sp. near *rafaeli* (Townsend) (Tachinidae) were obtained from one of these larvae.

yellow. Anal plate yellow or white. Intersegmental rings pronounced and yellow or white (Fig. 3). A 10 mm long larva required about 3 weeks to reach pupation (n = 4).

Pupa (n = 7): 18.00 mm long (range 17.50–18.25), slender, white (Fig. 3), with cluster of small black dots ventrally near distal end of abdomen; cremaster (2.0–3.0 mm long) black and attached to shelter with yellow silk. Within a few days after formation, pupae developed a yellowish-white waxy bloom; day before eclosion, pupa darkens. Duration of pupa (n = 3): 12–13 days. Both larvae and pupae wriggled vigorously when the shelter was opened. Eclosion occurred quickly, with adult (Fig. 3) ready for flight within 30 min. Adults very wary and difficult to capture in the wild.

Parasites. Three dipteran parasitoids (Tachinidae), all *Siphosturmia* sp. near *rafaeli* (Townsend), were obtained from wild-collected caterpillars. Two of these emerged as full grown maggots from one caterpillar (February 1988). A second caterpillar was successfully transferred from *P. pseudo-lindenii* at La Lola to *Piper nigrum* L. (black pepper) from another locality and produced a tachinid pupa (on 18 Feb. 1988) and an adult fly two weeks later.

Abundance. The number of immatures per plant at the La Lola study site for the five census dates ranged from 0 to 0.045 (Table 1) and showed little variation between drier (February–March) and wetter times of the year. Adult *Q. contubernalis* were either absent or very scarce at the study site; usually only one individual was encountered per visit.

The unusual shelter construction by larvae in the genus *Quadrus* (also documented by Moss *op. cit.*; Kendall, R. O. & W. W. McGuire. 1975, Bull. Allyn Mus. Entomol. No. 27), may function as a line of defense against parasites and other natural enemies. Heavy parasitism of *Quadrus* by tachinids and hymenopterans has been observed in Mexico (R. O. Kendall pers. comm.). Perforated shelters, such as those described here, may enhance air circulation inside the shelter, preventing buildup of pathogenic bacteria and fungi which thrive in the wet, shaded forest understory of the larval food plant. The vigorous body-flicking movements of the caterpillar and pupa also may be a defense against parasites, as noted in other lepidopterans (e.g., Young, A. M. 1985, J. Lepid. Soc. 39:225–227).

All food plants reported *Quadrus* are in the genus *Piper* (also R. O. Kendall pers. comm.). Moss (*op. cit.*) reported the caterpillar food plants of *Quadrus cerealis* Stoll and *Quadrus deyrollei* Mabille as *Piper* sp. Unpublished records of Roy O. Kendall (pers. comm.) from Mexico indicate *Piper* food plants for *Q. cerealis Stoll* and *Q. lugubris Felder.*

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OBSERVATIONS OF *AMORPHA*-FEEDING *CATOCALA* (NOCTUIDAE) IN WISCONSIN

Additional key words: Catocalinae, *abbreviatella, whitneyi, amestris,* Fabaceae, prairie.

Although recent efforts to preserve and restore Wisconsin prairies have focused attention on prairie *Catocala* whose larvae feed on lead plant (Fabaceae: *Amorpha*), little has been published recently on the early stages of these moths (see Dodge, E. A. 1925. Entomol. News 36:267–268 for larval notes). Here we report our observations in Wisconsin on three of the largely sympatric *Amorpha*-feeding *Catocala*: *C. abbreviatella* Grt., which occurs from Manitoba to Texas and east to central Wisconsin and Illinois; *C. whitneyi* Dodge, which ranges slightly farther southeastward to northern Kentucky; and *C. amestris* Stkr. which ranges further to Florida.

We first encountered *C. whitneyi* on 16 July 1978 when RJB flushed an adult out of the grass while observing *Hesperia ottoe* Edw. (Hesperiidae) on Muralt Bluff Prairie (Green Co., Wisconsin), a 62-acre dry prairie on a curved ridgetop of sandstone thinly capped with limestone. Over 100 species of prairie plants have been identified on this ridge, where managed fires have halted the invasion of encroaching woody plants (Department of Natural Resources, Wisconsin Scientific Areas. 1977. 52 pp.). Xeric conditions have fostered abundant growth of *Amorpha canescens* Pursh.

Subsequently, having obtained the necessary permits from the Wisconsin Department of Natural Resources, we attempted to attract adult *Catocala* at Muralt Bluff with artificial bait, fluorescent blacklights, and a 175-watt mercury vapor lamp. Although the open prairie was not conducive to baiting, short baitlines at the edges of the prairies attracted one *C. whitneyi* and three *C. abbreviatella* adults. Initially, *C. whitneyi* was thought to be uncommon; at least we seldom collected this species during the period between 2130 and 0030 h. Although never as common as *C. abbreviatella* during fifteen nights of observations over a six-year period (1986–91), *C. whitneyi* was, however, later found to be more common at its peak flight time between 0130 and 0300 h (*C. abbreviatella* numbers peaked between 2300 and 0200 h). Our earliest Wisconsin collection dates for *C. abbreviatella* and *C. whitneyi* were 27 June and 2 July, respectively.

We began our search for larvae on Muralt Bluff and neighboring prairies on 18 May 1990 between 1900 and 0100 h as larvae were thought to be crepuscular or nocturnal. Leaf buds of *Amorpha* were barely opening and no larvae were found on 18 May. The sites were revisited on 26 May, 1 June, and 19 June 1990. By 26 May the leaves had begun to unfurl and we found 36 *Catocala* larvae ranging in length from 13–47 mm ($\bar{x}$ = 30, SD = 8 mm). Most larvae rested at the uppermost tips of old growth, with no more than one or two individuals per plant. The striped larvae appeared cryptic against the *Amorpha* stems and were capable of jumping when disturbed. On 1 June another search yielded 46 more *Catocala* larvae ranging in length from 15–53 mm ($\bar{x}$ = 42 ± 9 mm).