

NOTES ON THE BIOLOGY OF *PTERONYMIA NOTILLA*
(ITHOMIIDAE) IN A COSTA RICAN MOUNTAIN FOREST

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This report is one of a series of descriptive papers on the biology of species of ithomiid butterflies sympatric in one mountainous region of Costa Rica. It deals with the biology of *Pteronymia notilla* Butler & Druce. While a substantial amount of information is available on the taxonomy and phylogeny of the Central American Ithomiidae (Fox, 1968), my reports (Young, 1972a,b) emphasize: (1) description of immature stages, (2) larval foodplant records, and (3) selected behavior patterns of larvae and adults. The eventual goal of these seemingly unrelated studies of different genera and species in the Ithomiidae is to describe the ecological and behavioral mechanisms that account for the observed local species diversity and structure of the ithomiid community at the single locality selected for study. While we are a long way from this synthesis, the present paper includes the kinds of information on life history that will provide the foundation for interpretation of community structure. Inherent in this approach to the community ecology of tropical butterflies is the conviction that local community structure in these organisms is determined to a large extent by generic and species differences in adult reproductive behavior and larval foodplant selectivity.

METHODS

The selected locality is known as "Cuesta Angel" and is located on the Caribbean side of the Central Cordillera that runs through Costa Rica. The locality is about 8 km from Cariblanco (Heredia Province) and the specific area under study is one slope of a 300-meter deep forest-covered ravine (Fig. 1) whose bottom is the Rio Sarapiquí. The ridge-top elevation of the ravine is about 1000 m above sea level with persistent cloud cover (Fig. 1) and the general region is montane tropical forest or cloud forest. The ithomiine fauna is rich in both the forest understory and second-growth patches that are most abundant along a roadcut (the road to Puerto Viejo), which runs about 10 m from the ridge-top of the slope selected for study. Several genera of ithomiines, including *Dircenna*, *Godyris*, *Oleria*, *Hymenitis*, and *Pseudoscada* (in addition to *Pteronymia*) can be found both in river-bottom forest as well as ridge-top forest and second-growth. The river-bottom forest

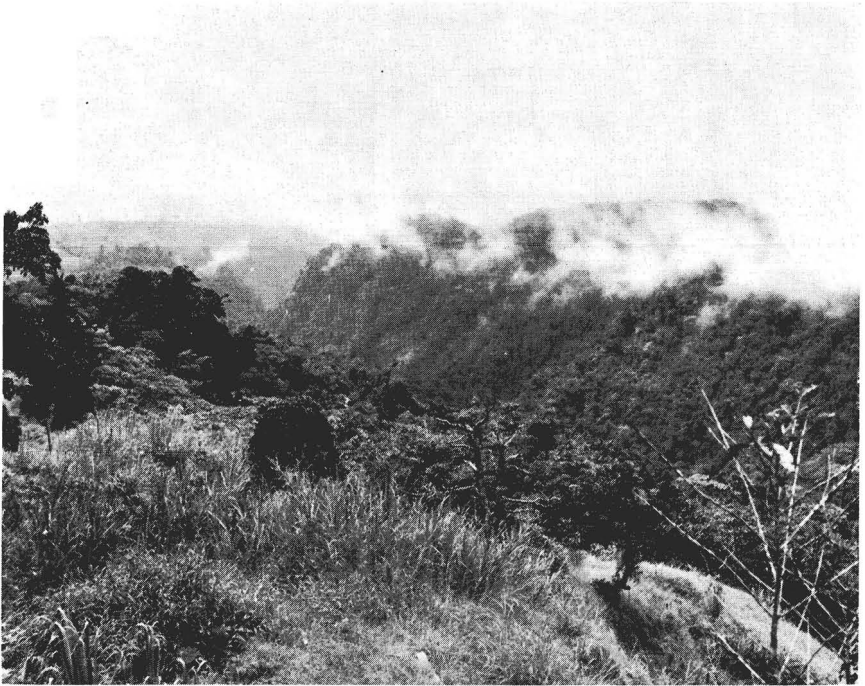


Fig. 1. The ravine at Cuesta Angel along the Central Cordillera in Costa Rica, where field studies of *Pteronymia notilla* were conducted. The butterfly is abundant in the understory of the forest down the sides of the ravine, and also along the edges of cleared second-growth (foreground and opposite ridge-top) associated with a roadcut.

is easily accessible via a small rock road that winds down the slope from the roadcut, and eventually goes up the opposite side of the ravine to the second ridge-top, where a small farming colony is located (see the cleared area on top of the opposite side of the ravine in Fig. 1). Other areas along the slope of the ravine are accessible with the use of rope and harness to work down the mountain side between roadcuts.

Most of the field observations on adults and immatures of *P. notilla* were made at the river-bottom; here, studies were confined to a strip of very dense forest understory bordering the bank of the Rio Sarapiquí. The same area of river-bottom forest has been the study site for similar studies on the biology of *Itaballia caesia* (Pieridae) (Young, 1972c), the ithomiine *Hymenitis nero* (Young, 1972a), and the nymphalid *Victorina epaphus* (Young, 1972e). This area was visited a total of 10

days during July and August of 1971 for the sole purpose of studying *P. notilla*. Usually no more than 3 to 4 hours during the morning were spent here each day.

During July 1972, we found a thin strip of clearing that ran up the slope of the ravine at a point further west of this river-bottom site, and very close to a second wooden bridge (the one not having a waterfall near it) at a hairpin turn in the road to Puerto Viejo. The clearing was made by the I. C. E. (Instituto Costarricense de Electricidad) during the installation of a telegraph line across the Rio Sarapiquí; the vegetation under the line is cut down at least twice annually. Here we searched a total of five days for eggs, larvae, and foodplants of *P. notilla*, within the dense understory immediately to either side of this strip, and within the thinned-out vegetation of the strip itself. We worked a distance of about 100 m, from river-bottom to the road on top, spending about three hours each day doing only this work. Although the butterfly was seen frequently in the second-growth along the roadcut near the ridge-top, we did not make any attempts to study it there.

Field studies of *P. notilla* included observations of habitat selection by flying adults, observations on oviposition behavior, determinations of larval foodplants, and note-taking on larval behavior. All of these studies were conducted each day we visited the river-bottom at Cuesta Angel.

Laboratory studies consisted of describing life stages and estimating mean developmental time from egg to adult. The "laboratory" was a converted tool shed on the premises of the Costa Rican program of the Associated Colleges of the Midwest in San Jose, Costa Rica. Eggs were collected in the field at Cuesta Angel and transported by jeep to San Jose within one or two days. The eggs were confined to clear plastic bags (each one 8 × 20 cm) containing fresh cuttings of the foodplant. We inspected immatures every one to three days, measuring body length of larvae, collecting head capsules, and examining color patterns. A total of 25 eggs were collected for these studies, all within a three day period, and divided into five laboratory cultures each containing five eggs. The 25 eggs represent a total of seven oviposition sequences in the river-bottom study area. Probably several different females were involved in the egg-laying, so that genetic differences may be a source of variability in estimating developmental time.

Laboratory conditions were 21–23° C and 40–60% humidity for the 35-day rearing period in San Jose. The cultures were kept on a table in a shaded part of the shed. Foodplant was replenished every 3–4 days and bags were wiped clean of excess moisture and feces. The same techniques have proven successful for rearing immature stages of several

different groups of tropical butterflies with minimal mortality (Young, 1972a, b, c, d, e, f; Young & Muyschondt, 1972, 1973).

RESULTS

Habitat and larval foodplant. The butterfly (Fig. 2,A) is found throughout the slopes of the ravine, but adults are more abundant in shaded forest understory, especially where it borders thinned-out areas of second-growth. The uniform abundance of the butterfly at various points on the side of the ravine indicates that the species is not responding to any gradients in micro-environmental factors. But a difference in larval foodplants exists between the river-bottom and higher places within forest understory on the side of the ravine: the single larval foodplant found at the river-bottom is *Cestrum megalophyllum* Dum. in the Solanaceae. Here, the plant occurs as a small woody understory tree that grows to about 3 m in height. The tree can often be found growing in small groups of 2-5 individuals, although these groups are patchily-distributed in the understory. The uppersides of the very large conspicuous leaves of this species are often covered with moss and other forms of epiphytic growth.

Further up the side of the ravine, another larval foodplant is an unidentified species of *Capsicum*, also a member of the Solanaceae. This species represents another small woody member of the understory. But along the cleared strip of vegetation made by the I.C.E., there are extensive growths of suckers from the cut-down trunks of the original trees. The leaves of these suckers are generally larger than those of the original trees and often much lighter green in color. Only these two solanaceous species at Cuesta Angel provide oviposition sites and larval food for *P. notilla*.

Life cycle and developmental time. The oblong-shaped egg is 1.2 mm high by 1.0 mm wide at the middle. It is marked by several vertical grooves, and the top is rounded (Fig. 2,B); the egg is uniformly white until the hatching of the first instar larva.

The first instar larva is generally dark green in color, once it begins to feed on plant tissue. By the time of the first molt, it is about 3.5 mm long. The first, second, and third instars are virtually identical in appearance (Fig. 2C,D,E). Each larva is dark green dorsally. On each side dorsolaterally, a thick light green line runs from the first thoracic segment to the anal plate (Fig. 2,E). Beneath this pair of lines the body continues to be dark green for an additional fraction of a mm; then this color gives away to light translucent green. The head in

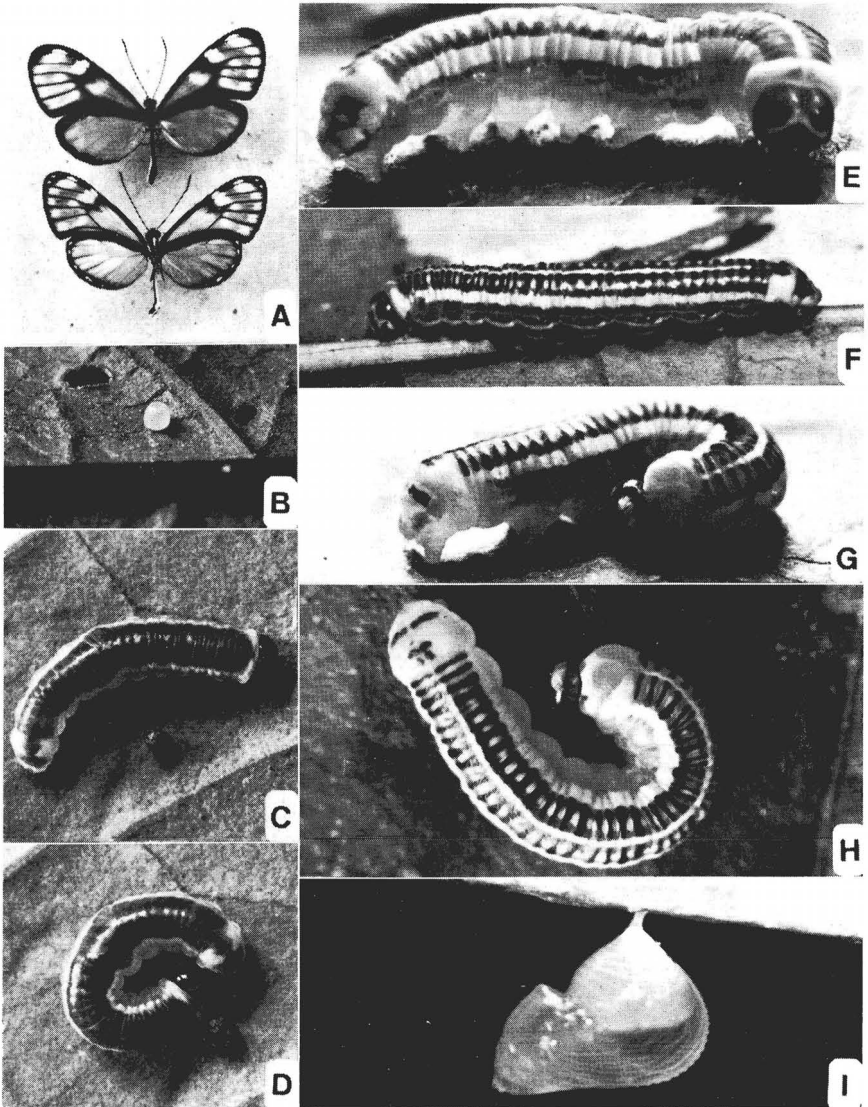


Fig. 2. Life stages of *Pteronymia notilla*: (A) adult (dorsal and ventral aspects); (B) egg; (C) second instar, dorsal aspect; (D) second instar in curled-up position (presumably defensive); (E) third instar, lateral aspect; (F) fourth instar, lateral aspect; (G) fifth instar in curled-up position (presumably defensive); (H) fifth instar, dorsal aspect; and (I) pupa, lateral aspect. Dimensions of life stages are given in the text.

all three of these instars is shiny black, but has a mask-like appearance, resulting from a three-pronged, forked light green line, that superficially divides the head into three regions (Fig. 2,E). The anterior edge of the first thoracic segment behind the head is enlarged and orange-yellow. The anal plate is dark green and bordered with thick patches of yellow. The true legs are dark green and the false feet are light green. The second instar attains a length of 6.5 mm by the second molt, and the third instar is about 12.0 mm long by the third molt.

The fourth and fifth instars are identical to one another in coloration, but very different from the previous three instars (Fig. 2F,G,H). The dorsal color pattern consists of a thin medial light blue line running from the first thoracic segment to the anal plate, and bordered to either side by an alternating series of short light blue and dark green bands, running perpendicular to the central blue line (Fig. 2,H). These series of bands do not extend to the head and anal plate: anteriorly, there is a swollen region just behind the head, and posteriorly, there is another one just before the anal plate. The anterior swollen region forms a light green collar ringed with orange; the posterior swollen region is uniformly bright orange, but does not cover the entire dorsal region (Fig. 2,H). The light green thick dorso-lateral line of the previous instars is now yellow, and the body beneath it is light green. The thin, central blue line continues through both swollen areas. Just behind the swollen anal region, there is one segment bearing the typical body color pattern.

The head of the fourth and fifth instars now appears to be much smaller due to the swollen aspect of the anterior trunk segments. It is shiny black with the inverted "Y" portion of the light green line pattern being thicker than in the previous instars (Fig. 2,G). Finally, there is a thin yellow lateral line running the length of the body, located just where the ventrum joins the lateral aspects of the body. The fourth and fifth instars are much more brightly colored than the previous instars. The larva is about 16 mm long by the end of the fourth instar, and about 22 mm long by the end of the fifth instar.

Immediately prior to pupation, the fifth instar larva contracts in length and becomes a uniform green color. This prepupa produces a pupa (Fig. 2,I) which is uniformly light green and slightly reflective. The pupa is remarkably translucent with only abdominal regions being clouded over with a yellowish coloration just beneath the cuticle. The cremaster is light red. The pupa is about 17 mm long by 7 mm wide (dorsoventrally) through the thoracic region. The coloration of the pupa does not change appreciably prior to the eclosion of the adult.

There is very little sexual dimorphism in coloration of the wings in

TABLE 1. The developmental time (days) of *Pteronymia notilla* on *Cestrum megalophyllum* (Solanaceae) in the laboratory.*

	EGG	INSTARS					PUPA	TOTAL EGG- ADULT
		1	2	3	4	5		
MEAN	5	2	2	3	5	6	7	30
± S.E.	± 0.3	± 0.2	± 0.1	± 0.1	± 0.6	± 0.7	± 1.1	
No. Individuals Measured (N)	24	24	21	21	21	21	20	

* All measurements were made in one laboratory in San Jose, Costa Rica. During this time, laboratory conditions were 21–23° C and 40–60% relative humidity. See text for further details.

the adult (Fig. 2,A); good descriptions are given by R. Haensch in Seitz (1924) and by Fox (1968). For a total of 20 individuals reared in the laboratory, the mean length of the forewing is 25 ± 0.7 mm, which is very similar to forewing length of wild caught individuals.

The egg through adult developmental time in the laboratory required 30 days (Table 1). Developmental time is undoubtedly quite variable in the field.

Larval behavior. The larvae of *P. notilla* generally occur singly on leaves of the foodplant; there is no evidence of gregarious behavior when more than one larva is present on an individual plant. Both resting and feeding are confined to the undersurfaces of leaves, and the larvae of all instars are most frequently found in the field on older leaves. Pupa- tion often occurs on the foodplant and both living pupae and hatched pupal cases have been found on the undersurfaces of leaves attached along a major rib. The earlier instars (1–3) are very cryptic in appearance, and are very difficult to find on foodplants in the wild. Despite the increased conspicuousness of the later instars (4–5), there are no noticeable changes in larval habits and behavior. Individuals of all instars exhibit a pronounced curling up behavior upon tactile contact with forceps (Fig. 2D,H); this behavior may be defensive.

Individual larvae build silken trails over leaves and stems, but there is no nest construction as seen in the solitary larvae of *Hymenitis nero* (Young, 1972a). Furthermore, there is no “dropping off” behavior, where individual larvae suspend themselves from long silken threads as a means of escaping predatory attack. Such behavior has been noted for various ithomiine larvae, and it has recently been seen in *Dircenna relata* where the larvae are semi-gregarious (Young, 1972b).

Adult behavior. Adults are often seen flying about 1–2 m from the ground in forest understory. Presumably adults spend a substantial

amount of time cruising for courtship encounters and searching for oviposition sites. Courtship has not been observed in *P. notilla*. The reproductive strategy of *P. notilla* involves carefully laying each egg singly on the ventral surface of older leaves of *Cestrum megalophyllum* and *Capsicum* sp. Eggs are also laid on the large leaves coming from suckers of cut-down trees.

In a total of 13 oviposition sequences observed on five different dates, there were six in which the female laid more than one egg on a single leaf. In these instances, there were no more than three eggs laid on the leaf. Furthermore, the eggs were never close to one another, but were widely scattered on the under surface of the leaf. On a visit to a single foodplant tree, an ovipositing female would lay anywhere from one to seven eggs in the tree; there were never more than three eggs on a leaf when multiple ovipositions were seen.

Egg laying involved the female landing on the ventral surface. The female walked toward the interior of the leaf and laid the egg. If more than one egg was to be laid, there were brief periods of walking before laying the next egg. Eggs were never laid near the edges of the leaves. Oviposition has been observed at various times throughout the morning, but seldom during the afternoon hours. There appears to be no correlation between time of oviposition and the amount of sunshine filtering down through the forest canopy. Females often rest for several minutes between oviposition sequences.

DISCUSSION

P. notilla differs from other ithomiids in a number of ways: first, egg color and external morphology when compared with that of two other recently studied species in Costa Rica, namely, *Hymenitis nero* and *Dircenna relata* (Young, 1972a,b). The egg of *H. nero* is white and less oblong than the egg of *P. notilla*, but it has the same distribution of vertical grooves as in the latter. The egg of *D. relata* is deep yellow and has the general shape of the egg of *H. nero*; but unlike both this species and *P. notilla*, there is a complex series of short horizontal grooves evenly-spaced between adjacent vertical grooves on the external surface.

The larval stages of these three species are very different in appearance and of these three, only the fourth and fifth instars of *P. notilla* show a dramatic change in coloration from the previous instars (Fig. 2); similar changes in color are not seen in the other two species. The larvae of both *H. nero* and *D. relata* retain a generally mottled green cryptic appearance throughout all instars (Young, 1972a,b). Furthermore, the

pupa of *D. relata* is extensively covered with gold coloration, especially on wing pads and dorsal aspects of the thoracic and abdominal regions.

The pupa of *H. nero* is heavily adorned with a bright silver coloration on the wing pads and thorax. Such highly reflective silver or gold pigmentation is entirely absent from the pupa of *P. notilla*, in which protective coloration is limited to light green translucence with relatively minor reflectance properties. Finally, the developmental time for these three ithomiid butterflies is between 25 and 30 days in the laboratory.

These three species also illustrate ecological divergence in the Ithomiidae with respect to larval foodplants. While it is known that most Ithomiidae feed on various Solanaceae (e.g. Brower & Brower, 1964; Ehrlich & Raven, 1965), little is known about patterns of divergence in foodplant exploitation at the generic and species levels among these butterflies. Such information is clearly of great importance in studying the community structure of the butterflies.

In the present situation, at least two sympatric ithomiids, *P. notilla* and *H. nero*, exploit different species of *Cestrum* in the forest understory of Cuesta Angel. *D. relata* is found in *S. hispidum* at one locality (Bajo la Hondura) on the Pacific slopes of the Central Cordillera (Young, 1972b); the butterfly also occurs at Cuesta Angel, but the larval foodplant has not yet been determined. However it is likely that this species feeds on different foodplants than both *P. notilla* and *H. nero* at Cuesta Angel. While *H. nero* is a blue clear-winged species of ithomiid, *P. notilla* is one of the more conspicuous orange-winged species. The showy coloration of the late instars of the latter species may be indicative of noxious or unpalatable properties of older larvae, pupae, and adults. Clear-winged species such as *H. nero* are presumably more palatable, since their immature stages employ a more pronounced strategy of crypsis than is seen in *P. notilla*: the larvae are cryptically-colored throughout all instars; the pupae are more effective in resembling large drops of rain water hanging from leaves (e.g., Brower, 1971); and the larvae construct nests of partially closed leaves where they rest when not feeding (Young, 1972a).

Furthermore, the transparent qualities of the wings make the adults rather inconspicuous in shaded forest understory. This apparent divergence in adaptive strategy is interesting since both species feed on related species of *Cestrum*. Such a divergence in larval feeding habits is illustrative of very subtle environmental factors (i.e., species differences in secondary compounds among congeneric sympatric plants), which influence the evolution of morphological and behavioral traits among

herbivorous larvae toward either crypsis or warning coloration, two very different adaptive strategies.

But orange-winged species of ithomiids, like *P. notilla*, may not be as unpalatable as other orange-winged genera such as *Dircenna* and *Mechanitis*. This is suggested by several factors: (1) oviposition in *D. relata* is semi-clustered, while it is single in *P. notilla* (Young, 1972b); (2) oviposition is clustered in *M. isthmia*; (3) larvae are semi-gregarious in *D. relata* (Young, 1972b) and gregarious in *M. isthmia*, but solitary in *P. notilla*; (4) the dorsal wing surfaces of *D. relata* are brighter than those of *P. notilla*, whereas those of *M. isthmia* are strongly mimetic, since they have familiar tiger-striped pattern of various heliconiids and the danaid *Lycorea*.

The observed differences in life cycles, larval foodplant utilization, and dorsal wing surface coloration among different genera of the Ithomiidae suggest that differences in adaptive strategy with respect to escape from predators have evolved. One lesson to be learned from such preliminary assays of ithomiine natural history is that experimental feeding studies utilizing a wide range of vertebrate and invertebrate predators must be performed to demonstrate differences in the relative palatability of adults and larvae among different genera. Such studies must be accompanied by field studies elucidating various behavioral patterns (e.g., communal roosting, alarm positions, etc.) which may be correlated with increasing unpalatability in heliconiid butterflies (Benson, 1971).

SUMMARY

(1) The life cycle and developmental time of the ithomiid *Pteronymia notilla* Butler & Druce are given for individuals reared from eggs collected at one montane tropical forest locality in central Costa Rica. The developmental time in the laboratory is about 30 days and fourth and fifth instar are brightly colored relative to earlier instars.

(2) The major larval foodplant at the bottom of the ravine where the species was studied is *Cestrum megalophyllum* (Solanaceae). Further up the side of the ravine, another foodplant is *Capsicum* sp. (Solanaceae). Both species occur as small woody understory trees.

(3) Both eggs and larvae generally occur singly on the foodplants, and there is no evidence of cluster oviposition and larval gregariousness, as noted in other ithomiids.

(4) Oviposition is precise in this species and involves the female walking to a suitable spot on the ventral leaf surface before an egg is

laid. Females seem to show some selectivity, preferring to oviposit on older leaves.

(5) The noticeable change in larval appearance at the third molt is suggestive of increased unpalatability, which may be carried over to the adult stage. Orange-winged ithomiids such as *P. notilla* appear to the human observer more conspicuous than clear-winged species of comparable wingspan. The unpalatability of dull orange species like *P. notilla*, however, may be weak, since some of the more bright-orange genera (*Dircenna* and *Mechanitis*) have life cycles in which oviposition is clustered and larvae are gregarious. These forms are presumably more unpalatable than similar appearing ithomiids with solitary oviposition habits and non-gregarious larvae. Such correlations, however, are very tentative, in the absence of experimental data on the relative palatability of adults and immatures for representatives of different genera.

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CELASTRINA EBENINA (LYCAENIDAE) IN NORTH CAROLINA

Recently Clench (1972, *Ann. Carnegie Mus.* 44: 33–44) described a new species of Lycaenidae, *Celastrina ebenina*. This butterfly was formerly known as a "black form" of the common *C. argiolus pseudargiolus*: form ♂ *nig* and form ♀ *intermedia* as listed by dos Passos (1964, *Lepid. Soc., Mem.* 1: 69, 481). Clench asked me to be on the lookout for this species and on 29 April 1972, I took two males in Buncombe County, North Carolina, and sent them to him. My find extended the confirmed range into North Carolina.

On 21 April 1973 I took another male and on 4 May 1973 I found a single female. All of the *ebenina* I have taken were found in Buncombe County, North Carolina, along the dirt road which is an extension of Buncombe County road number 2178 south of its junction with county road 2173 at Dillingham, a small community near Barnardsville. The two taken in 1973 were found about 2.1 miles south of the junction near the parking place on the left side of the road (elevation about 2880'). A mountain stream parallels the road on the right at this point. The two taken in 1972 were found about 3 miles south of the junction (elevation about 3260'). This road runs from Dillingham to the Blue Ridge Parkway, and the locations described can therefore be reached by driving north (down the mountain) from the Parkway.

I am publishing this note to encourage other collectors to look for this butterfly in the southeastern mountains of the United States. According to Clench it should be sought in cool, moist, forested ravines and is almost always found near areas where *Trillium grandiflorum* is in bloom. The habitat in which I took *ebenina* matches perfectly with this description which Clench gave of the other areas in which it has been taken. I would be pleased to hear from others who find it.

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