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FOODPLANT, HABITAT, AND RANGE OF *CELASTRINA EBENINA* (*LYCAENIDAE*)

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ABSTRACT. The larval foodplant of the recently described *Celastrina ebenina* Clench is *Aruncus dioicus* (Walt.) Fernald (Rosaceae), the Goat's-beard. Over 150 adults were raised from eggs and young larvae. The range of the butterfly coincides nicely with that of the plant, from Pennsylvania to North Carolina and Missouri. The habitat for plant and butterfly is moist, rich forest. The closely related *C. pseudargiolus* Boisduval & LeConte is vastly more abundant and ubiquitous than *W. ebenina*, and has a wide variety of larval foodplants. Larvae of *C. ebenina* differ in several respects from those of *C. pseudargiolus*, including color pattern and stellate processes. Also described and discussed are the plant and butterfly associates of *C. ebenina*, flower visitations of the adults, experiments on foodplant specificity, feeding characteristics of the larvae, broods, botany of the foodplant, and geographical distributions, including a number of new locality records. A guide for discovering new colonies of this rare eastern American butterfly is provided.

Except for brief reports (Clench, 1972; Wagner & Showalter, 1976), little has been published on the biology of the poorly known Dusky Blue Butterfly, *Celastrina ebenina* Clench, of the eastern United States. This lycaenid is notable for several reasons. Interpreted for over a century as an aberration or form, it was not recognized as a distinct species until 1972. The colors of the upper surfaces of the males and females are peculiar for being the reverse of the usual situation among plebejine blues in that the males are dull, dark grayish-brown or blackish, while the females are mainly lustrous blue. The insect is regarded as especially rare and local, having been reported previously, usually as just one or a few individuals, from only 12 localities. Knowledge of its foodplant, behavior, habitat, and geographical distribution has been incomplete or lacking.

The present paper records the results of research in 1976. We now understand the ecology of *C. ebenina* far better than we did in the past, and we believe that we have an explanation for the geographical distribution and sporadic occurrence of the species. At the outset of this study, as botanists, we entertained the possibility that the peculiarities of occurrence of *C. ebenina* might be due to specialized larval foodplant preference.

Because of earlier reports of the species there, the area chosen for our field investigations was in the Daniel Boone National Forest, in and

around the Red River Gorge in Powell and Menifee cos., Kentucky, a few miles north of the town of Slade. We found that habitats suitable for *C. ebenina* occur extensively, though sporadically, throughout this area, and in some places the butterfly is common or abundant, though extremely localized, flying with the much more numerous and ubiquitous Common Blue or "Spring Azure," *C. pseudargiolus* Boisduval & LeConte. The topography in the Red River Gorge is made up of steep, abrupt hills and valleys, ranging from 700′ altitude in the river and stream beds to over 1300′ at the tops of the highest hills. Commanding cliffs of light tan or whitish sandstone crop out at the crests of some of the hills, but in the valleys where *C. ebenina* flies, the most conspicuous rock is a loose, broken, dark-gray shale. The general area is mainly traversed by narrow dirt roads, especially along the larger streams, and there are only occasional two-lane hardtop roads.

Our search for suitable habitats to study was initiated on 17 April 1976. We drove from place to place along the country roads, stopping wherever we encountered roadside puddles or wet streamside flats. In such spots accumulations of butterflies were the rule when it was bright and sunny, especially between the hours of 0900 and 1400. Among the guests at these "puddle parties" we encountered rare males of *C. ebenina*, practically always with at least several and usually many *C. pseudargiolus*, the latter being much more conspicuous in flight. In spite of our success in encountering specimens of *C. ebenina* here and there over an area of perhaps a dozen square miles, at no place were there more than a few individuals. Rare observations of females showed them almost always to be in flight, and following them gave no clue to where their eggs were laid.

Finally, at around 1030 hrs the following day, we came upon an excellent locality—a moist, steep, rocky, north-facing wooded slope, along a narrow dirt road along the Red River. In only 20 min, ca. three dozen *C. ebenina* of both sexes were observed, the females numbering about twice as many as the males. The latter were all more or less worn, dull in appearance, and flying along the edges of the road, occasionally alighting on wet muddy spots (Fig. 1, lower photo). Most of the females, however, were in fresh condition and were flitting around the vegetation on the slopes above and below the road. It was obvious that many of them were engaged in oviposition. They flew rapidly in an "exploratory" pattern, pausing often at a single species of plant, the Goat's-beard, *Aruncus dioicus* (Walt.) Fernald. Occasionally the females landed on the abundant and conspicuous Wild Hydrangea, *Hydrangea arborescens* L., but usually only momentarily.

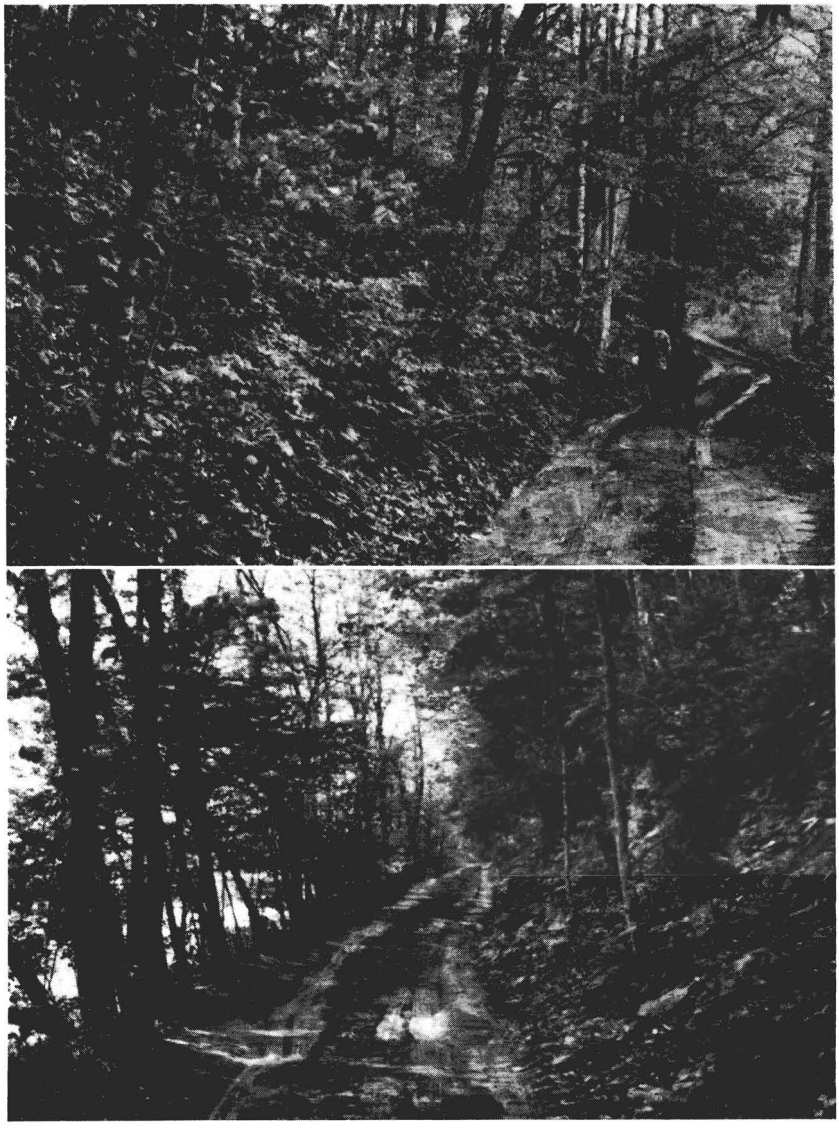
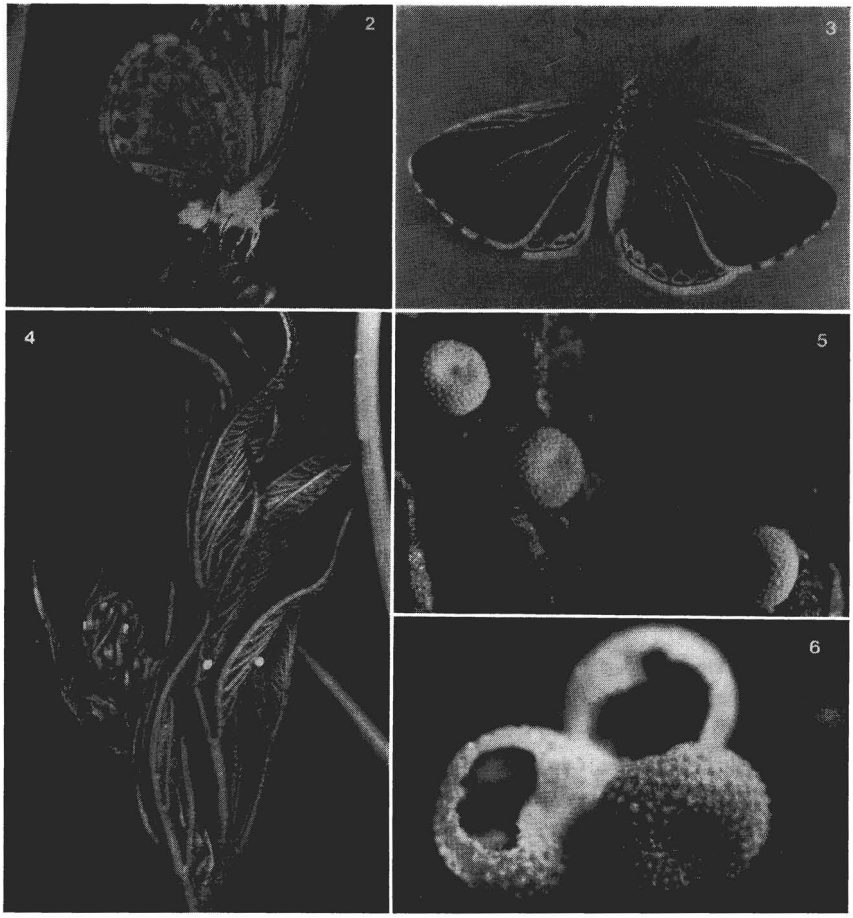


Fig. 1. *Celastrina ebenina* habitat along Red River, Powell Co., Ky. *Upper*: View upstream showing extensive understory growth on forest slope. Butterflies visit Geranium flowers here. *Lower*: View downstream showing damp ruts in road where males congregate. (Photo by J. M. Beitel.)



Figs. 2–6. *Celastrina ebenina* adults and eggs: 2, female laying eggs on young *Aruncus* shoots (R. P. Carr); 3, freshly emerged male, showing blue scaling (T. L. Mellichamp); 4, eggs on leaf and inflorescence primordia of *Aruncus* (cf. fig. 14) (T. L. Mellichamp); 5, unhatched eggs; 6, eggs (two of them hatched) showing wall pattern detail (R. P. Carr).

On *Aruncus* the butterflies alighted on very young, unfolding leaflets, and then walked around slowly, laying eggs (Fig. 2). After an individual would fly away, we could easily find the eggs, mainly on the lower blade surfaces, on and between the main veins of the leaflets (Fig. 4). At this time of year the main axis of the plant is still embryonic, and the habit is very different from the mature habit with the inflorescence fully developed (cf. Fig. 13, full-grown plant, and Fig. 14, stage at time of oviposition). When freshly laid, the eggs showed a grayish blue color.

Sometimes several eggs are laid in the same spot, but usually they are laid separately (Figs. 4, 5, & 6). Egg-laying occurred over 1½ hours of observation, and there was no sign of abatement after 1200 hrs when we left the site.

For careful observations, a total of 18 young cuttings like those in Fig. 14 were randomly collected. The two oldest leaves overtop the main shoot at this stage. The main shoot, with its very young leaves and inflorescence primordium, is only about one-fourth the length of the oldest leaf (the large, bipinnate leaf on the right side of the figure) and one-half the length of the next oldest leaf. The softest, most embryonic tissues are those of the primordial main shoot. We found a total of 133 eggs altogether on the collected shoots—35 on the oldest leaves, 26 on the next oldest, and 66 on the young main shoots. Thus, our evidence suggests that the butterflies prefer to lay eggs on the youngest tissues. The number of eggs averaged seven per cutting, but one had 18.

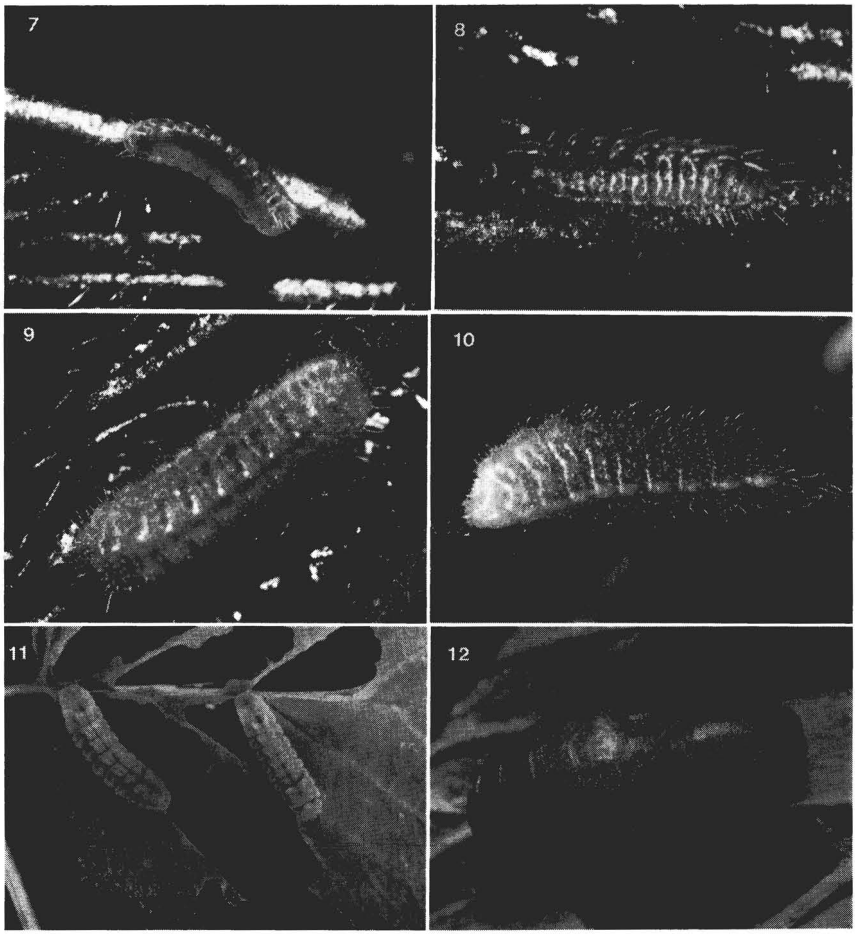
Naturally we wondered whether at least some of the eggs we found did not represent the closely related *C. pseudargiolus*, which flies in large numbers at this locality, a species noted for its polyphagy. Therefore, we decided a couple of weeks later to conduct an experiment designed to help us answer this question, as will be described below.

The plant community on this slope is a rich mixed-mesophytic forest. We recorded a total of 31 trees and shrubs and 56 herbs (including ferns and graminoids) in the area where *C. ebenina* was ovipositing. Most of these plants are typical associates of *Aruncus dioicus*, and some of the more prominent ones will be enumerated later in our discussion of this plant.[1]

The best place to find *C. ebenina* adults is in association with other mud-loving butterflies (*C. pseudargiolus*, *Callophrys henrici*, *Erynnis* spp., and *Papilio* spp.) in damp spots along dirt roads and gravelly, sandy, or muddy river flats. Practically all of the "mudding" individuals we observed were males, sometimes as much as a quarter of a mile from the foodplant, although usually much closer. On only two occasions did we find females landing on wet soil. We disturbed one of them several times, but each time it returned.

The only flower which seemed to attract *C. ebenina* at this locality was the Wild Geranium, *Geranium maculatum*. The showy rose-purple flower has a flat five-petalled corolla 3.0–3.5 cm across. Bearded nectaries occur between and at the bases of the petals. The butterflies walk over the top surfaces of the corolla and probe between the petal bases. Later

[1] A complete list of the associated plants at this locality will be sent upon request to readers.

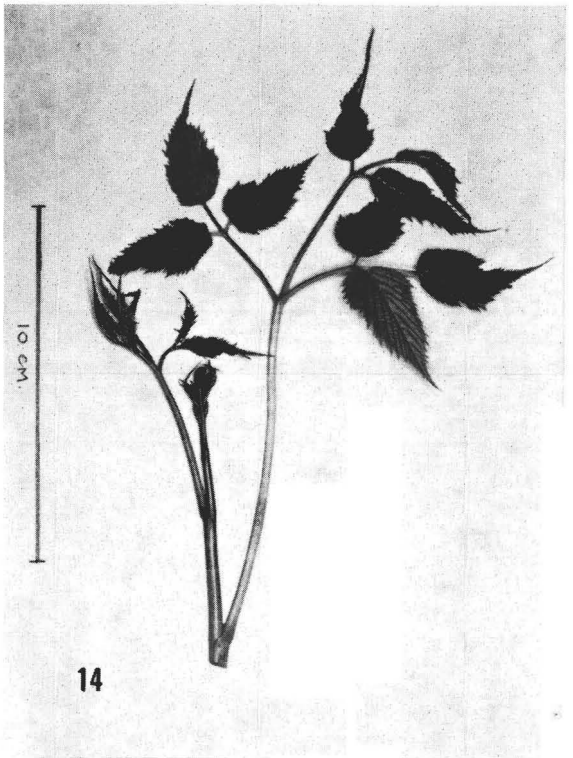


Figs. 7–12. *Celastrina ebenina* immature stages: 7 & 8, instar 1 caterpillars (J. G. Bruce III); 9 & 10, instar 2 caterpillars (J. G. Bruce III); 11, mature caterpillars, showing pale, poorly contrasting pattern and characteristic leaf damage; 12, pupa attached to *Aruncus* leaf (R. P. Carr).

we discovered that the bulk of individuals obtain their nectar from underneath the flower! Both sexes flit from flower to flower, landing on the peduncle or on the underside of the perianth, then walking toward the sepal bases where they insert their proboscises. So positioned on the flowers, the butterflies are invisible from above.[2]

We recorded all of the species of butterflies we found in association

[2] Curious to see whether other butterflies behaved in the same manner, we discovered (in Michigan in the middle of May) that *Erynnis juvenalis* displayed the same routine on Geranium flowers.



Figs. 13–14. *Celastrina ebenina* foodplant: 13, habit drawing of fully grown *Aruncus dioicus* showing inflorescence (apex) and form of compound leaves in mid-June (Del. J. G. Lacy); 14, young shoot of *Aruncus* at time of oviposition by *C. ebenina* (see text) (T. L. Mellichamp).

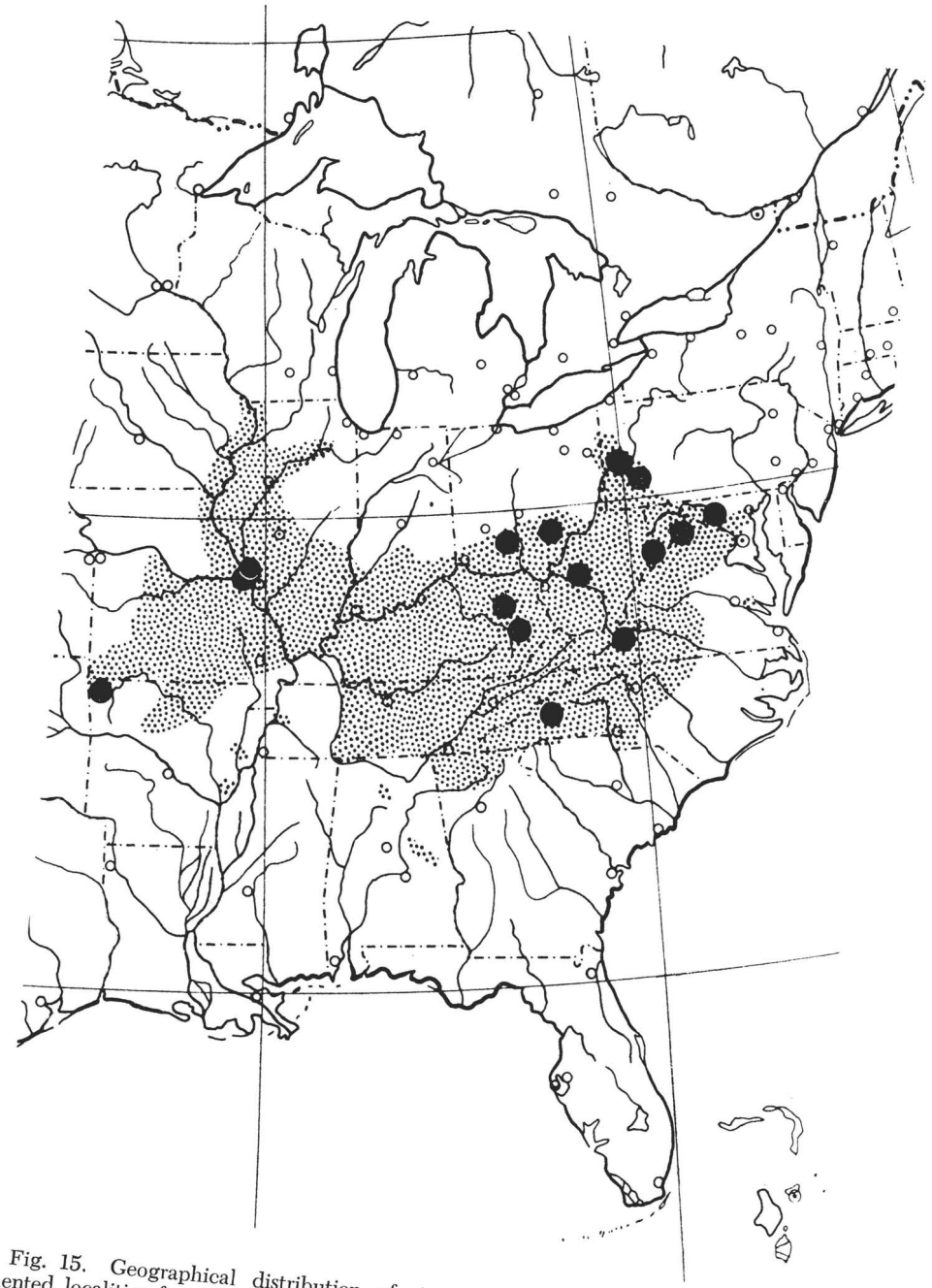


Fig. 15. Geographical distribution of *Aruncus dioicus* (stippling) and documented localities for *Celastrina ebenina* (dots) (T. L. Mellichamp).

with *C. ebenina* on 18 April. The following list is a compilation, since no one locality had all of the species (those marked with an asterisk occurred with *C. ebenina* on wet soil): *Papilio glaucus,* P. troilus,* Battus philenor, Pieris virginiensis,* Colias eurytheme, C. philodice, Polygonia comma, P. interrogationis, Boloria bellona, Phyciodes tharos,* Callophrys henrici,* Celastrina pseudargiolus,* Erynnis brizo,* E. juvenalis,* Amblyscirtes samoset, A. aesculapius,* and *Epargyreus clarus.* On several later visits to the study area by Loran D. Gibson, Amos H. Showalter, and ourselves, the following additional species were observed, most of them, however, well beyond the normal flight period of *C. ebenina*, which ended the first week of May: *Limenitis astyanax, Speyeria cybele, Asterocampa celtis, Euptychia hermes, E. cymela, Lethe creola, L. anthedon, Autochton cellus, Thorybes pylades,* and *Poanes hobomok.*

Experiment on Foodplant Specificity

The question we addressed ourselves to was whether *C. pseudargiolus* also shared the foodplant of *C. ebenina.* The former is abundant in the Red River Gorge area and is in constant association everywhere with *C. ebenina.* Although we did not observe *C. pseudargiolus* ovipositing upon *Aruncus*, this would not preclude the possibility that it occurs. The number of *Celastrina* eggs we observed was so great that it seemed reasonable to assume, because of their morphological similarity, that perhaps some of them belonged to the abundant species, especially since *C. pseudargiolus* is noted for its varied bill of fare. Literature records show that no less than 10 families of flowering plants contain larval foodplants for this species, and we have discovered early stages of it on such different families as Caprifoliaceae and Cornaceae. It would not have surprised us, therefore, to find *C. pseudargiolus* utilizing *Aruncus*, especially since its larvae have been reported on *Spiraea*, another closely related genus in the same subfamily of Rosaceae.

On 2 May, accordingly, we revisited the Red River Gorge area and collected from seven to nine shoots with attached eggs and minute larvae from each of five colonies of the foodplant, all of them a mile or so separate from one another. These shoots were brought back to The University of Michigan in Ann Arbor, and the eggs and young larvae were raised to adulthood. Extra foodplant shoots were kept in plastic bags and refrigerated to preserve them until they were needed, and additional foodplants were grown for further supplies. The cut bases of the shoots of *Aruncus* bearing eggs and larvae were inserted in jars of water in $1 \times 1 \times 2$ ft glass aquaria covered with a plastic material to keep the

larvae from escaping. Some of the caterpillars drowned when they walked down the main stems into the water, others escaped and were lost, and some died as a result of cannibalism. Nevertheless, a total of 153 butterflies were raised to maturity by the end of the second week in June, 76 males and 77 females. Another eight butterflies came from larvae which escaped from their containers. The first caterpillars pupated on 16 May, 14 days after the field collection, and the first adults to emerge appeared on 23 May. This second brood apparently does not occur in nature (see below).

The results of this experiment were striking. Not only were none of the "checkery" caterpillars of *C. pseudargiolus* noticed among the paler, less contrasty larvae of *C. ebenina* (Figs. 7–9), but not a single one of the adults was *C. pseudargiolus*; all were *C. ebenina*. Furthermore, the 14 additional butterflies from our 18 April eggs were all *C. ebenina*. Also, the four individuals that emerged from dormant chrysalids the following winter were all *C. ebenina*. With *C. pseudargiolus* as abundant as it is in the localities where our collections were made, one would expect at least some evidence of its occurrence on *Aruncus* if it fed on that plant at all.

It is interesting to note that ca. one-third of the males display blue scales (Fig. 3), at least at the time of emergence. Although the original description by Clench (1972, p. 37) records the male upperside as "uniform blackish brown when fresh," blue scales are conspicuous in these individuals, especially on veins R_1 to R_5 and the discal portions of M_3, Cu_1, and Cu_2 on the fore wings, and scattered in the discal area of the hind wings. The occurrence of blue scaling on the males may constitute a regional difference. The ground color above of the males varies from blackish gray to pale slate gray. The females vary greatly in ground color (whitish blue to fairly intense blue) and the amount of dark marking. There is no confusing any of these specimens, however, with any of the forms of *C. pseudargiolus* known to us.

To make preliminary comparisons of the caterpillars of *C. ebenina* and *C. pseudargiolus*, we obtained eggs and first instar larvae of the latter in two localities near Ann Arbor in Washtenaw Co., Michigan. They were readily found on the young inflorescences of Grey Dogwood, *Cornus racemosa* and Red Osier, *C. stolonifera* (Cornaceae), and Nannyberry, *Viburnum lentago* (Caprifoliaceae); the dates of collection were 8 and 22 May. We maintained the larvae under the same conditions as those of *C. ebenina* but kept them in a separate room to avoid any opportunity of possible escapees getting mixed up.

We did not make detailed comparisons of the larval morphology, but

certain differences were obvious. The final instar caterpillars of *C. ebenina* (Fig. 11) are considerably more uniform in color than those of *C. pseudargiolus*. They are pale whitish blue–green, with three slightly contrasting longitudinal stripes of yellowish white, two lateral and one dorsal. Between the dorsal and each lateral stripe is a line of yellow–white dots, and similar dots and dashes are scattered over the body. The caterpillars of *C. pseudargiolus*, as is well known, are more variable in ground color, ranging from pinkish or pale bronze to yellowish green; the pattern is much more conspicuously blotched as a rule. Earlier larval stages of the two species (young instars of *C. ebenina* shown in Figs. 7–10) are very similar in their uniform pale green color.

In both species the mature larvae are velvety because of elaborate stellate processes, each with a narrow and pointed filament arising from the center. In *C. ebenina* the filaments are only slightly curved and stand nearly erect. In *C. pseudargiolus* the filaments are more strongly curved and tend to be arched over such that they are distally nearly parallel to the body surface. This difference applies mainly to the more abundant, smaller filaments; larger ones in both species are more alike, only slightly curved and nearly erect.

Another difference between the larvae of the Dusky and Common Blues involves the use of their respective foodplants. Although larvae of *C. ebenina* occasionally feed upon the tiny embryonic floral primordia of *Aruncus*, the bulk of their feeding is upon the blade tissue between the major lateral veins of the leaflets. Their feeding produces characteristic elongated perforations in the blades; these persist when the leaflets have achieved their full size, and give valuable clues during late spring and summer for localities of the butterfly. Fig. 11 shows the characteristic perforations. The younger caterpillars were observed on the tops of the leaves more often than the older ones. Feeding between a pair of lateral veins usually begins near the midrib of the leaflet and progresses outward, but only rarely all the way to the margin and including it. Very large caterpillars in the last instar may eat major lateral veins.

In our experience the larvae of *C. pseudargiolus* feed primarily upon floral primordia. Their eggs and larvae are found in inflorescenses. We tried moving larvae to leaves, but always, after eating a small amount, they would return to their floral clusters where they continued feeding. Larvae of *C. pseudargiolus* bite into the sides of the closed flower bud or the inferior ovary and eat the entire contents or leave certain parts (e.g., petals). The body of the caterpillar sits motionless on the floral pedicel or the side of the bud, and the extensible head is projected into

the cavity in the young flower to feed. From certain angles the larva appears headless.

Broods

Previous field experience of our own and others suggested either that *C. ebenina* is univoltine (in the Red River Gorge, flying from the second week of April to the first week of May), or else, if it has more than one brood, that adults of any later broods are so similar to those of *C. pseudargiolus* that they have not been recognized as distinct. The second laboratory brood is like the first brood. As it turned out, the vast majority of our pupae (Fig. 12) emerged within a week or two of pupation. Of those that failed to emerge and were kept until the following winter, only a few produced butterflies.

The first adult from our 18 April field collections of *C. ebenina* eggs emerged on 11 May. The first from our 2 May collections of eggs and young larvae emerged on 23 May. Emergence continued until 29 May, when it was stopped by placing the cultures in a coldroom from this date until 4 June to keep more butterflies from appearing while we were out of town. After we returned them to normal temperatures, emergence resumed on 5 June and continued to 12 June. A grand total of 175 butterflies in our laboratory cultures seemed to demonstrate that there is a second brood in the wild that follows closely upon the first, the second brood flying from the second week in May to the first or second week in June.

We therefore returned to the Red River Gorge to determine whether a second brood occurred in nature. The results of our survey were most unexpected. Loran D. Gibson visited there on 26 May and saw not a single *C. ebenina*, although many other butterfly species were seen (*in litt.*, 2 June 1976). We then reconnoitered the area on 4 June, when the butterflies should have been at their peak abundance, if there is a second brood in nature. We saw no *C. ebenina* despite the fact that *C. pseudargiolus* was common as well as 16 other species of butterflies. On 9 June, Amos H. Showalter searched the area and reported that "*C. pseudargiolus* was common, but no *ebenina*" (*in litt.*, 28 June).

After 13 June, the 28 pupae that remained in our cultures apparently went into dormancy, and no more butterflies emerged. At the end of June, therefore, we placed them in a coldroom at a temperature of 2°C and left them there until 22 December. We hope that by keeping them thus, in a set-up that we have used for "winterizing" fruits and seeds, we might avoid the destructive effects other workers have had with *C. pseudargiolus*, which involve either drying out or molding of the chrys-

alids. On 1 January 1977, two females emerged, one of which failed to expand its wings. Another female emerged on 4 January, and still another female failed to escape from the pupal skin. All the remaining pupae appeared to have died, eight of them having moldy surfaces and the rest having an unnatural brown color.

What can we conclude regarding the broods of *C. ebenina*? In the field we found no evidence for a second brood. If there is one, it must be in extremely low numbers, i.e., a small "partial" brood. Somehow the conditions of our laboratory cultures must have caused an abnormal eclosion without the customary prolonged dormancy period. Some diapause stimulus that effects *C. ebenina* must have been weak or missing under the conditions of our experiment, and thus only a small percentage of the chrysalids went into long–term dormancy.

Botany of the Foodplant

The colloquial name of the foodplant, *Aruncus dioicus*, may cause some confusion, since its name "Goat's-beard" is applied also to the unrelated *Tragopogon pratensis* L. in the Asteraceae, a naturalized weed from Europe. The generic name *Aruncus* comes from the Greek and means literally "goat's beard." It is a member of the Rosaceae and is a native eastern American plant of rich, mature forests. It is famous among United States' botanists as an illustration of convergent evolution, because superficially *A. dioicus* resembles closely the "False Goat's-beard," *Astilbe biternata*, of the Saxifragaceae. So closely do these plants resemble each other that they are regularly confused, even in herbaria. Ecologically the two look-alikes occupy almost identical niches, and they are both unusual among members of the mesophytic forest association in being dioecious (male and female flowers being borne upon separate plants). They are pollinated not by wind, which is the usual situation in dioecious plants, but rather by insects, mainly small Hymenoptera. The geographical range of *Aruncus dioicus* is shown in Fig. 10. The range of *Astilbe biternata* is much narrower, mainly in the mountains of North Carolina and adjacent parts of Virginia, W. Virginia, Kentucky, Tennessee, South Carolina, and Georgia. *Aruncus* overlaps it completely, so that students of *C. ebenina* must be warned of the danger of confusing the "True" with the "False" Goat's-beards in the area of their sympatry. Accordingly, we have prepared a comparison of the two in Table 1, the most obvious characters marked with asterisks. A line drawing of a mature specimen of *Aruncus* nearly 1½ m tall is reproduced in Fig. 1. The stage of growth when the plant serves as larval food for *C. ebenina* is shown in Fig. 2, corresponding to only the two bottom leaves and the lower

TABLE 1. Comparison of "True" and "False" Goat's-beards.

		Aruncus dioicus	*Astilbe biternatum*
*1.	Stipules	Absent	Present
2.	Terminal leaflet	Unlobed	3-lobed
3.	Leaf base	Attenuate	Cordate (heart-shaped)
*4.	Veins per leaflet	8–18 pairs	8 or less pairs
*5.	Leaf and stem hairs	Absent	Abundant (glandular)
6.	Marginal teeth	Convex	Acuminate
7.	Sepals per flower	5	5
8.	Petals per flower	5	0–5
9.	Stamens per flower	15–20	8–10
*10.	Carpels per flower	3–4	2

sixth of the drawing. The tissues upon which the caterpillars feed are soft, and the earliest instars feed upon the most embryonic parts. The plants grow rapidly and come into flower 5–7 weeks after the butterflies lays their eggs.

Both *Aruncus* and *Astilbe* have rather massive underground stems that produce large roots or root masses which hold the plants firmly in place on steep slopes (Fig. 3). Many buds are present at the ground level, and some of these may develop into shoots at the crown, producing clumps of as many as eight flowering shoots. Their spreading compound leaves fill in the space where they grow, presumably allowing little growth of other plants beneath them.

The Goat's-beards are most typical of rich, mesic woods, partly shaded roadsides, and sloping sides of streams and rivers. The ancient habitat was probably on steep eroding slopes and stream banks in dark forested areas, but man has stimulated its spread by creating new habitats where roads have been cut through the mesic forest. In a uniformly shaded forest stand only 10% of the plants may flower, but when released from the effects of low light levels, as on road cuts at the forest edge or steep, eroding stream banks, the populations may display up to 100% flowering. The plants require, however, relatively cool, moist conditions, and they exist almost exclusively upon north-facing slopes. *Aruncus* is known to occur as high as 5500′ altitude in the mountains (Buncombe Co., N.C.), although the average occurrence throughout its range is considerably less than 2500′.

Would-be collectors of *C. ebenina* should seek the foregoing site conditions, with the following array of associated species (based upon studies of a number of *Aruncus* localities by Mellichamp 1976): woody plants—*Acer rubrum, A. saccharum, Aesculus octandra, Betula lenta, Carpinus caroliniana, Cornus florida, Fagus grandifolia, Lindera benzoin,*

Liriodendron tulipifera, and *Tilia americana*; herbs—*Adiantum pedatum*, *Athyrium filix-femina*, *Botrychium virginianum*, *Carex plantaginea*, *Cimicifuga racemosa*, *Geranium maculatum*, *Impatiens capensis*, *Laportea canadensis*, *Tiarella cordifolia*, and *Trillium* spp. The presence of a majority of these species, together with Wild Hydrangea, *Hydrangea arborescens*, given the topographical conditions cited, especially a north-facing slope, should lead to colonies of *Aruncus* and therefore *C. ebenina*.

Ranges of Plant and Butterfly

There is a remarkable correlation between the known localities where the butterfly has been found and the geographical distribution of *Aruncus dioicus*. Clench (1972) has already discussed doubtful records for *C. ebenina*, including New York City and southern Colorado. We should like to add to the list of doubtful records that of Blatchley in Wabash Co., Indiana (Clench, 1972, p. 41), unless an actual specimen is discovered. The "black male" he referred to could have been a melanistic male of *C. pseudargiolus*, a wind-blown stray of *C. ebenina*, or a mislabeled specimen. Clench mentions that Edwards had vaguely attributed the species to Tennessee and Georgia, although Clench himself had seen no specimens in these areas. It now seems very likely, as Clench (1972) suggested, that *C. ebenina* may turn up in both of those states.

Aruncus grows far to the west of the localities cited in earlier studies of *C. ebenina* (Clench, 1972; Wagner & Showalter, 1976), the westernmost documented records for which were all east of Cincinnati, Ohio, and Lexington, Kentucky. We can now report records in Illinois, Missouri, and Arkansas. Charles L. Remington took a fresh male south of Elsah, Jersey Co., Illinois, on 15 April 1942 (*in litt.*, 21 Jan. 1977). He found additional males in St. Louis Co., Missouri, in the late 1930's. Also, J. Richard Heitzman (*in litt.*, 14 July 1976) has informed us that he obtained by exchange "a male and a female taken 4 May 1924 at Creve Coeur Lake near St. Louis, St. Louis Co. There is no collector's name, but it should have been one of the active collectors of the day, probably Ernst Schwarz, E. P. Meiners, or H. I. O'Burne. All were active at the time and collected often at Creve Coeur." The dot shown in Fig. 10 for Arkansas is based upon a single male taken in Hickory Flat Hollow, Washington Co., on 2 April 1973 by Edward Gage. Gage writes (*in litt.*, Dec. 1976): "This male particularly stood out as it was flying about a mud puddle with several *C. argiolus* and *Everes comyntas*. . . . I immediately assumed that it was a melanic form and quickly collected it. The site was in close proximity to a draw or shallow canyon. About 50% of the immediate surrounding area is deciduous hardwood. . . . Can-

yons and woodland extend all around Beaver Lake from the collecting site."

CONCLUSIONS

Celastrina ebenina may have larval foodplants other than *Aruncus dioicus*. However, it should be noted that none of the unquestioned localities of this butterfly lies outside the known range of *Aruncus*. Furthermore, we now have good reason to believe that the abundant Common Blue, *C. pseudargiolus*, does not share the foodplant of the Dusky Blue, *C. ebenina*. Our experimental raising of eggs and young larvae on *Aruncus* from areas in which *C. pseudargiolus* is abundant revealed not a single specimen of that species. All were *C. ebenina*.

One reason for apparent rarity of *C. ebenina* in comparison with its near relative is that its geographical range is much more limited. Another is that it is probably monophagous rather than polyphagous. Its foodplant is confined to one habitat—north-facing, richly wooded, shaded slopes, so that the butterfly tends to be highly localized and colonial. The multiple foodplants of *C. pseudargiolus* occupy many habitats, and the butterfly is therefore practically ubiquitous.

Celastrina ebenina is probably often overlooked. The dull males in flight may suggest badly worn individuals of *C. pseudargiolus*. *Celastrina ebenina* tends to fly closer to the forest floor (a concomitant of its understory foodplant?), whereas *C. pseudargiolus* has a slow, up-and-down flight reaching the shrub and lower tree layer. The bright reflecting blue of *C. pseudargiolus* males plus their tremulous flight pattern through the woods at heights of roughly 2–10′ make them especially visible. The females of *C. ebenina* resemble dull females of *C. pseudargiolus*, but they are even more localized than the males, rarely even visiting mud puddles, occurring rather in the herb layer of the forest in more or less checkered sunlight. We wonder how many collectors (including ourselves!) in the spring have overlooked *C. ebenina* while they focused instead on such critical genera as *Erynnis* and *Callophrys* as well as such widely advertised rarities as *Pieris virginiensis* and *Erora laeta*, both of which are now known to fly in association with *C. ebenina*.

If the conclusions of this research are correct, we predict that *C. ebenina* will be found not only in many new localities in the states from which it is already known, but, in addition, southern Indiana, eastern Tennessee, northern Georgia, western South Carolina, and western Marylan. To help achieve this, we propose the following formula:

1. Locate areas of rich mesophytic forest in rolling or mountainous country.

2. Follow roads or streams and find north-facing, cool, shaded forest slopes with some erosion or disturbance.

3. Look for plant associations including such trees and shrubs as *Hydrangea*, *Acer*, *Aesculus*, *Betula*, *Carpinus*, *Cornus*, *Fagus*, *Lindera*, *Liriodendron*, *Rhododendron*, and *Tilia* plus the majority of herbs given above.

4. Explore for large colonies of "Goat's-beard," *Aruncus dioicus*, the larval foodplant, especially on north-facing roadsides and streamside slopes.

5. Visit the area in April and early May in search of *C. ebenina*—males on muddy spots, females around the foodplant, and both sexes on Geranium flowers (careful!—they may be underneath the petals).

6. Or, if the weather is cloudy or rainy, search the young shoots of *Aruncus* for greenish blue, rough-surfaced eggs, and (or) pale green caterpillars, the latter evidenced by narrow perforations in the soft leaf tissue between the veins of young leaflets.

To sum up, our evidence thus far indicates that *Celastrina ebenina* is a "specialist," not a "generalist." When compared with *C. pseudargiolus*, it has a narrow range (not broad), one foodplant (not many), a single brood (not several), and an essentially uniform morphology (not many varieties and forms).

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