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Pupal polymorphism of the Bog Copper butterfly *Lycaena (Epidemia) epixanthe* (Bsd. & Le C. [1835]) (Lycaenidae: Lycaeninae) in New Jersey.

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ABSTRACT. The immature stages of the Bog Copper butterfly, *Lycaena epixanthe*, were described in detail by the author nearly forty years ago. Two different pupal colors were interpreted to represent distinct separate morphs with genetically-fixed incidences. Reassessment of the data discloses a pattern of progressive color change of each individual pupa throughout the pupal period. This transforming strategy is adaptive and may reduce predator recognition.

Key words: Bog Copper, cranberry bogs, pupal polymorphism

INTRODUCTION

The lycaenid Bog Copper butterfly, *Lycaena (Epidemia) epixanthe* (Boisduval & Le Conte [1835]) is restricted to acid bogs in northeastern North America, extending from the Canadian Maritime Provinces westward to Minnesota and Manitoba, and south to the Appalachian Mountains in West Virginia and the Coastal Plain of New Jersey. The butterfly in all stages is closely associated with its cranberry larval hosts (*Vaccinium macrocarpon* Ait. and *V. oxycoccos* L.). The morphology of the immature stages was previously described by the author (Wright, 1983). In that study the author stated the great majority of pupae were green with a few being blackish purple. These morphs were interpreted to represent two distinct varieties with fixed incidences. By comparison, Newcomb (1911) characterized the pupal colors of the Dorcas Copper, *Lycaena (Epidemia) dorcas* (W. Kirby, 1837), as “hardly any two are alike”. This notion prompted a reassessment of the pupal polymorphism of *L. epixanthe*.

MATERIALS & METHOD

The colony of *Lycaena epixanthe* in Forge Pond bog (Fig. 1) has been under investigation since 1976. A butterfly rearing study initiated in June, 1981, yielded 56 live larvae from overwintering ova. First instar emergences *ex ovum* commenced on April 16th in 1982. After four molts, pupation began on May 27th. The pupal period averaged 13 days and ranged from 11 to 15 days. Adult eclosions occurred from June 7th to 26th. The color patterns of twenty pupae are documented in the author’s notebook and photo files. Images were scanned into digital format for inclusion here.



Fig. 1. Forge Pond cranberry bog, Atlantic County, New Jersey. Large Cranberry in bloom in the foreground.
Fig. 2. Pupal color patterns of Bog Copper butterfly. **2a.** Green speckled. **2b.** Transitional. **2c.** Blackish purple.

RESULTS

Lycaena epixanthe pupae as a group display a substantial diversity of color. Yet, significantly, the colors of each individual pupa change as the pupal period progresses. Pupae are pale green at the start and finish as solid black before eclosion. Some usual progressive changes include black speckling after two days (Fig. 2a), partitioning of wing cases (cream or tan) and thorax (gray or black) after 5-6 days (Fig. 2b), and generalized darkening (black or blackish purple) after 11-13 days (Fig. 2c). Variation in the intensity of black maculations and streaking of veins on the wing cases are commonly observed. Occasionally, the blackish purple phase may appear earlier in the pupal period (e.g., day 3-6). Rarely, a pupa is devoid of all black speckling and streaking. The observed pupal patterns are cryptic within their natural habitat. When hidden among the cranberry leaves and sphagnum moss, these pupae are virtually inconspicuous to the human eye.

DISCUSSION

Pupal color plasticity generally occurs in species whose larvae have preferences for pupation sites which vary in color (West & Hazel, 1996). The adaptive significance of this plasticity is crypsis (Hazel *et al.*, 1998). The sharing of traits among closely-related species may shed light on when they evolved within the Lycaeninae (Coppers). To date, pupal plasticity is found chiefly in species of the subgenus *Epidemia*, which customarily overwinter in the egg stage with larvae emerging in spring. Pupal periods are short. Pupal polymorphism is reported in *L. helloides* by Coolidge (1911) and Scott (2008); in *L. dorcas* by Newcomb (1911) and Scott (1986, 2008); in *L. florus* by Scott (2014); in *L. nivalis* by Newcomer (1911, 1963); and in *L. epixanthe* by Wright (1983). No data is available for *L. mariposa*. The most pronounced assortment of color patterns occurs in wetland species like *L. dorcas* and *L. epixanthe*, which are confined to alkaline fens and acid bogs. In these species, pupation and adult emergence take place concurrently with the bloom period of their larval host plants (*Potentilla fruticosa* and *Vaccinium macrocarpon*). This crucial period attracts numerous insects into the open habitat seeking nectar and prey. A broad variety of pupal colors would reduce the likelihood that a predator would build a successful search pattern. The bogs of the New Jersey Pine Barrens came into existence at the end of the Pleistocene around 10,000 to 11,000 years ago (Buell, 1970). Genomic studies reveal the *Epidemia* clade experienced a burst of radiation around 5 Mya during the Pliocene (Zhang *et al.*, 2019). Rapid diversification regularly correlates with the sharing of beneficial genes among radiating species. Progressive pupal polymorphism is likely is one of these shared qualities.

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