

below the partial failure of an act of ecdysis—a developmental malfunction which did not prevent transformation, but one that was eventually fatal to the butterfly involved. Such malfunctions are not uncommon in laboratory cultures; however, this observation is of interest because it involved a wild-caught adult.

On 17 July 1977 at 1100 hours CDT, I was handed an adult female *Asterocampa celtis antonia* (Edwards) which had been hand-collected in a residential backyard in Austin, Travis County, Texas. Lack of worn spots on the fully expanded wings, occasional release of untransformed fluids and an egg-packed abdomen indicated recent emergence, probably that same morning. I soon discovered that the head was covered with partial exuviae which had not been properly shed. Practically the entire chrysalid head capsule was still present covering the greater part of the imaginal head. Additionally, the left side of the larval head capsule was still attached to the outside of the chrysalid head capsule.

Upon metamorphosis of the prepupa to pupa, the left half of the final-instar larval head capsule failed to separate from the newly formed pupal epidermis. When imaginal emergence occurred, both sides of the pupal "head" failed to separate as a result of mechanical restriction caused by the still-present larval head capsule section.

Although the adult was able to emerge and properly expand and dry its wings, damage to selected parts of the head effectively negated any chance that this individual would reproduce. Both eyes appeared completely normal and allowed reaction to approaching objects. The left antenna was not visible, having been transformed into an unrecognizable mass associated with the remnant exuviae. The right antenna was free and fully developed; however, it was flexed laterally and horizontally (about 75° from perpendicular) about 2 mm from its base. This antenna could be moved at its base, but such movements occurred only when the antenna was touched; no spontaneous movements were observed. The most significant damage affecting the fitness of this individual involved its proboscis. The proboscis was entirely nonfunctional because of failure of the two maxillae to properly fuse. The two halves adhered to each other in a haphazard manner and to the remaining exuviae; removal of the exuviae was accompanied by removal of the proboscis halves.

Lack of a functional proboscis caused early death of this individual, because the butterfly was unable to feed or obtain moisture. This damaged individual grew progressively weaker until it died approximately 75 hours following capture (in a cage at an ambient diurnal temperature range of about 25–35°C). I thank Patrick K. Neck for supplying the specimen.

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AGGREGATIVE BEHAVIOR OF *ANARTIA FATIMA* (NYMPHALIDAE) IN GUANACASTE PROVINCE, COSTA RICA DURING THE DRY SEASON

The neotropical butterfly *Anartia fatima* Fabricius (Nymphalidae: Nymphalinae) is widespread throughout the coastal wet and dry regions of Central America and northern South America (Godman & Salvin 1879, *Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera*, vol. 1, 487 p.). Several larval foodplants, in the Acanthaceae, are shared with other nymphalines such as *Siproeta* (Young & Muyschondt 1974, *Stud. Neotrop. Fauna* 9: 155–176), but during the severe dry season of dry regions these plants exhibit leaf drop and become unsuitable for oviposition (Young & Stein 1975, *Contr. Biol. & Geol.*, Milwaukee Pub. Museum, No. 8, 29 p.). Several years of observing *A. fatima* populations in the lowland tropical dry forest region (Tosi 1969, Mapa

ecologico de Costa Rica, Trop. Sci. Centr., San José, Costa Rica), Guanacaste Province, indicate that adults are abundant and active throughout the dry season, especially in fields with fully leaved shrubs and trees. This note discusses aggregative behavior of adult *A. fatima* in Guanacaste.

During the afternoon (1530 h) of 26 January 1977, 12 individuals of *A. fatima* were seen fluttering about a low shrub in a field near Playas del Coco. The general area is about 4 km from the Pacific coast and highly exposed to strong gusty winds characteristic during the dry season. Most of these butterflies were worn. Eventually they settled inside the bush for the rest of the day and night. They were scattered in the leeward side of the bush. Most rested, with wings folded, by hanging from shaded branches. This behavior was observed again on 20 February 1977 at Playa Naranjo; six butterflies settled into a shrub at 1615 h remaining there until the following morning. This bush was 400 m from the beach (Gulf of Nicoya) and exposed to strong gusty winds. During the following day, adults fluttered inside the bush, with occasional settling for short periods (1–6 min). At no time were more than one or two butterflies resting at once. Both days were sunny, with air temperature near these bushes being 40–42°C. The air temperature inside them at the same time of day was 32–34°C. *Anartia fatima* was active, along with *Phoebis* (Pieridae), in the surrounding habitat, visiting various flowers. These observations took place during the severe, 4–6 month dry season of this region. The bushes used by *A. fatima* were low and dense with branches and leaves. Strong winds coming from the nearby coast were blocked, as indicated by holding a handkerchief on the lee side of the bushes.

While it is generally well documented that unpalatable butterflies exhibit highly structured communal nocturnal roosting (e.g., Crane 1957, *Zoologica* 42: 135–146; Brower & Brower 1964, *Zoologica* 49: 137–159; Urquart 1960, *The Monarch Butterfly*, Univ. Toronto Press, 361 p.; Owen & Chanter 1969, *J. Zool. (London)* 157: 345–374; Young & Thomason 1975, *J. Lep. Soc.* 29: 243–255), less is known about the nocturnal behaviors of supposedly palatable species. Other nymphalines, such as *Marpesia berania* (Hewitson), *Hypolimnas bolina* Linnaeus, and *Smyrna karwinski* (Geyer), exhibit highly structured nocturnal communal roosting (Barrett & Burns 1951, *Butterflies of Australia and New Guinea*, Seward, Melbourne, 187 p.; Benson & Emmel 1973, *Ecology* 54: 326–335; Muysshondt & Muysshondt 1974, *J. Lep. Soc.* 28: 224–229) although the adaptive role of this behavior has not been determined. The unstructured condition of *A. fatima* aggregates and their low numbers suggests that such behavior is a sheltering and thermoregulatory response to a dry, windy environment. Prevailing high temperatures throughout the day, low air humidity, and strong evening winds induce flocking behavior in *A. fatima*, causing adults to aggregate in some bushes. Low, thick bushes offer protection from the sun and evening gusty winds. On the Pacific slopes of the Cordillera Central in Costa Rica, evening aggregates of another nymphaline, *Siproeta stelenes* Fabricius, are found in coffee bushes during the dry season (pers. ob.); these localities are also exposed to strong, gusty winds and dry conditions.

The presence of worn adults suggests that sites of aggregation are not necessarily located near eclosion sites; both *A. fatima* and *S. stelenes* oviposit singly, and eggs are distributed over large areas, resulting in low densities of adults eclosing at one spot (Young & Stein 1975, op. cit., Young & Muysshondt 1974, op. cit.). On Grand Cayman Island, British West Indies, adults of *Anartia jatrophae* Linnaeus cling to the leeward sides of low clumps of the creeping vine *Clitoria* sp. (Leguminosae) on sunny afternoons in February (pers. obs.).

The aggregative behavior of nymphaline butterflies in exposed secondary habitats near the wind-blown coasts of Caribbean islands and mainland Central America during the dry season could be related to thermoregulation and physical protection from strong winds. The dark brown wing and body color of *A. fatima* and other species such as *S. stelenes* undoubtedly result in considerable heat gain during afternoon

hours; the thermoregulatory problems of *A. fatima* have been discussed (Emmel 1972, Evolution 26: 96-107). Gradual heat gain on sunny days leads to shade-seeking behavior by late afternoon and shady perches also provide nocturnal shelter from winds. It is known that for some insects living in hot climates, such as desert cicadas, gains in body heat result in definite periods of movement into shade and subsequent quiet periods (e.g., Heat & Wilkin 1970, Physiol. Zool. 43: 145-154). Dark butterflies in lowland tropical dry climates may have similar temperature-response problems.

The above observations and comments suggest that aggregative behavior of *A. fatima* is an adaptive response to highly localized climatic or abiotic factors, having little or nothing to do with biotic factors such as vertebrate predators. A biotic result of such behavior, however, may be the maintenance of a cohesive adult population that survives until the following rainy season to oviposit on foodplants as they leaf out. This idea has been discussed with respect to *S. karwinski* (Muyshondt & Muyshondt 1974, op. cit.) and it may be generally true for other secondary habitat or pasture-dwelling tropical nymphalines which pass the dry season in the adult stage.

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BISTON BETULARIA, OBLIGATE F. INSULARIA INDISTINGUISHABLE FROM F. CARBONARIA (GEOMETRIDAE)

It is well known that there is sometimes difficulty in phenotypically recognizing and scoring *f. insularia* of *Biston betularia*. On the one hand it may be confused with *carbonaria* (Kettlewell 1973, The Evolution of Melanism, Oxford, London) and on the other with "typical," particularly in the Isle of Man (Bailey *et al.* 1973, Entomologist 106: 210-214). To help clarify the matter, various scoring methods have been devised for *insularia*, e.g., that of Lees and Creed (1977, Heredity 39: 66-73, and used by us), where I^1 is the lightest and I^3 the darkest. Nevertheless, difficulties remain, and Lees and Creed (1977) report a brood, B/574, in which a mating between two *insularia* I^3 /"typical" heterozygotes produced 66 "typical," 149 I^3 *insularia* and 77 *carbonaria* which were thought to be I^3/I^3 homozygotes. They also quote Bowater (1914, J. Genet. 3: 299-315) who crossed a wild *carbonaria* male with a "typical" female, and all the resulting progeny were dark *insularia*, which is consistent with the I^3/I^3 hypothesis.

The present note shows that this cannot always be the explanation since the brood to be described could not have produced I^3/I^3 homozygotes. On 13 June 1976 a female "typical" (Fig. 1a) was caught in a mercury vapor trap on Hilbre Island near West Kirby, Wirral, England. She was placed in a tin for the following five nights and laid a few eggs, but these were infertile. On the night of 19 June 1976, she was put in a hanging cage with a male *insularia* (Fig. 1b) (score I^1 , confirmed by Lees and Creed, pers. comm.), which had been caught in the mercury vapor trap at Caldy, Wirral. Mating took place the same evening and the female then laid freely (brood 14672). After she died on 28 June 1976 her body was found to contain a single spermatophore only.