NOTES ON THE LIFE CYCLE AND NATURAL HISTORY OF BUTTERFLIES OF EL SALVADOR. V. *ANAEA (MEMPHIS) MORVUS BOISDUVALI* (NYMPHALIDAE)

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This is the fifth article of a series relating what my sons and I have found with respect to the life cycle and natural history of the butterflies that occur in the neighborhood of San Salvador, capital of the Republic of El Salvador. As stated in one of our prior articles, we undertook the present task because of the exiguous literature on the early stages of many Neotropical species of butterflies. This is particularly true of the genus *Anaea*. We hope to fill as much of the existing gap as our limited capacity allows, thus facilitating the completion of the job by the experts. In addition to the series of articles, specimens of the early stages of the species described are being placed with museums so as to be available to students of the groups.

Anaea (Memphis) morvus boisduvali Comstock, is, if not scarce, so elusive as to seem scarce in this country. During eight years of collecting and observing local butterflies, we have seen only about twenty adult specimens of this species, half of them in local collections, including ours. Again my younger son accidentally found first instar larvae of "a new *Anaea*" during September 1972. (In November 1970 he discovered the foodplant of *Morpho polyphemus polyphemus* P. & H. and in December 1971, the foodplant of *Prepona omphale octavia* Frühstorfer.) Having located the foodplant, it was a matter of patience to see a female ovipositing. When this happened, we first thought the female was *Anaea (Memphis) pithyusa* R. Felder using the "new *Anaea*'s" foodplant as an alternate choice, as both species resemble each other. We still collected the eggs, but after some moults it was evident that it was the "new" species. On that day we collected eight eggs and 11 first and second instar larvae.

The material was kept in transparent plastic bags containing only fresh leaves of the foodplant. The leaves were kept fresh by sticking them into a wad of cotton covered by a smaller plastic bag containing water. It was noticed that the larvae that fed on slightly decaying leaves invariably died. Photographs were made of all stages of development, records were kept of developmental time and measurements of each instar were taken. Specimens of the early stages were preserved in

alcohol. The bags with the living material were kept at all times under ambient light and temperature conditions. Since then we have collected larvae of this species during October–January.

Life Cycle Stages

Egg. Transluscent white with greenish tinge, almost spherical with flattened base and shallow depression at micropyle. About 1 mm diameter. All hatched in 5 days.

First instar larva. Head roundish, dark brown with darker markings. Body dark brown with annulets between segments. Cephalic end of body thicker than caudal end. Grow from 2 mm to about 3.2 mm in 6 days.

Second instar larva. Head dark brown with small stubby horns at apex of epicrania. Body dark brown with a profusion of paler, tiny tubercles that form rings around segments. Grow to 0.5 or 0.6 cm in 5 days.

Third instar larva. Head thicker than body at first, brown, with many pale, small tubercles scattered mostly along sides. Stubby black horns at epicrania, with small tubercles bearing clear setae. Alternate black and light brown vertical bands in frontal area. Body grayish brown, with dark brown, almost black patch covering lateral area from prothorax to first proleg, slanting up from prothoracic spiraculum to subdorsal area in second abdominal segment, then abruptly down to subspiracular zone in third abdominal segment. A second dark area starts on fifth abdominal segment covering supraspiracular zone, diffusing caudad. Whole body crossed dorsally by rings of pale tubercles bearing minute setae. Larvae grow to about 1.1 cm in 5 days.

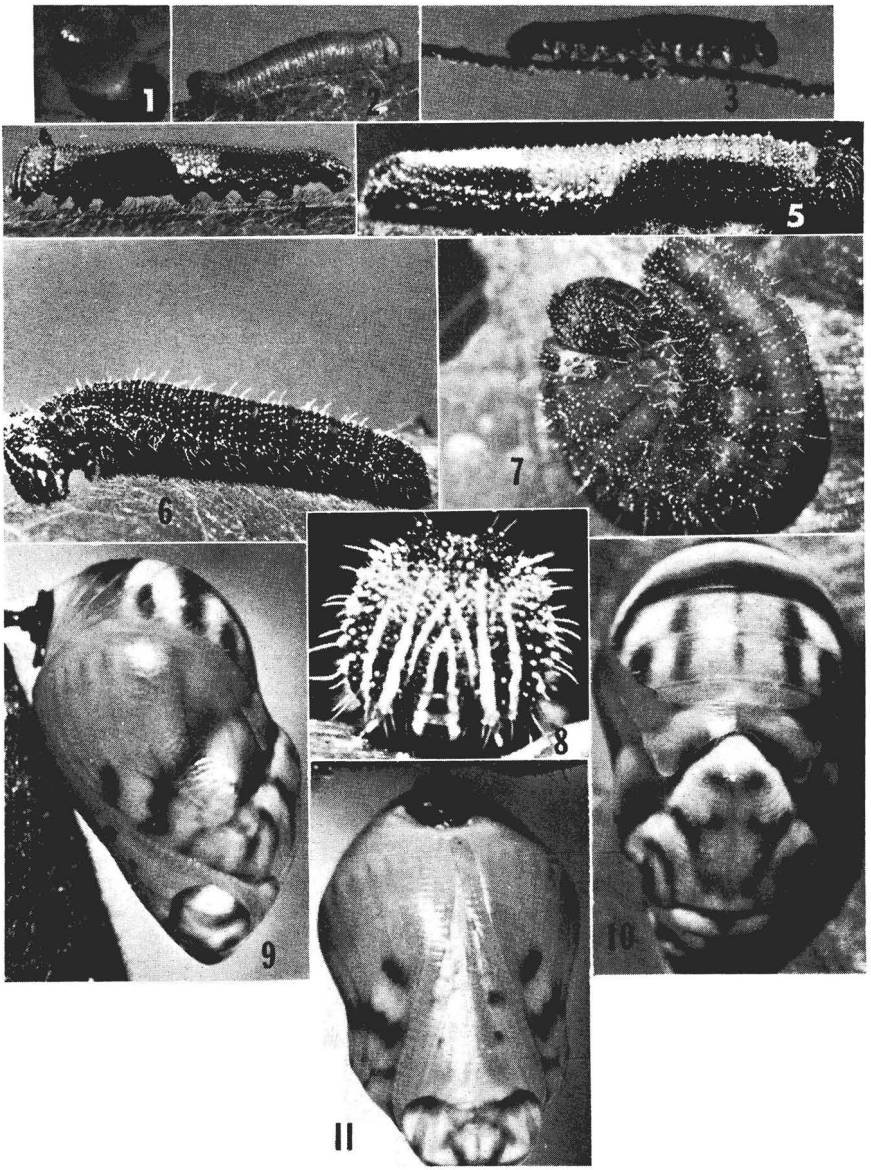
Fourth instar larva. Similar to third stadium. Head about as thick as body, with slightly bigger tubercles at sides. Tubercles, pale, each bearing a pale seta. Original pair of horns bigger, with noticeable tubercles; a second pair of horns anterior to first ones, small and thick. Light bands in front of head more contrasting. Body as in third stadium, but with olive tinge in certain individuals, reddish in others. The rings of pale tubercles and their setae more prominent. Grow to approximately 2.1 cm in 5–7 days.

Fifth instar larva. Head black with light bands: two from ocelli to epicranial horns, which are much reduced; two more bands converging, laterally bordering adfrontal sutures; two medially bordering adfrontal sutures, prolonging to labrum. Whole head covered with small, pale tubercles. Each tubercle bearing pale seta. Tubercles at sides of epicrania bigger, with longer setae. Body dark brown with olive or reddish tinge, with rings of small pale tubercles with pale setae contrasting against dark body. Spiraculum on first thoracic segment much bigger than the others, which are inconspicuous. Bases of prolegs bear tufts of light setae making the larvae appear hairy. Grow to 3.2–3.5 cm in 14–21 days.

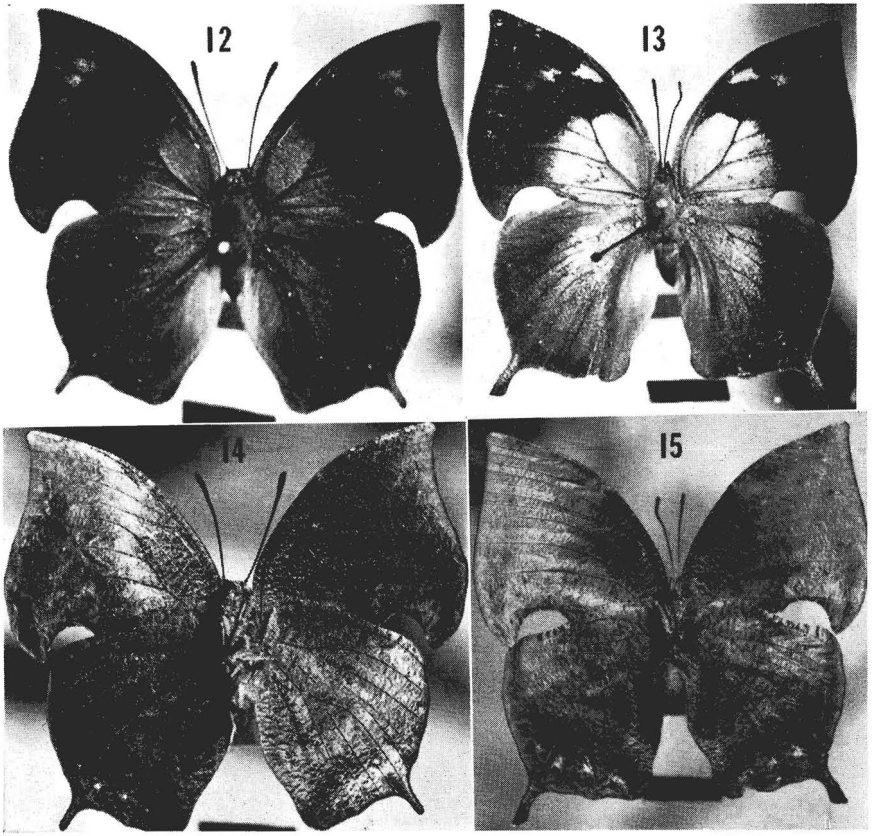
Prepupa. Body shortens considerably and becomes lighter brown. Stays incurvated laterally for one day.

Pupa. Very pale brown with dark brown markings mostly dorsally, giving it a marbled appearance. Black, elaborated cremaster directed at right angle to plane of body. Abdomen rounded and incurvated ventrally, with wing cases reaching close to cremaster. Thorax slightly keeled dorsally. Whole pupa formed by smooth curves without ridges or sharp angles. Spiracula inconspicuous light brown. Measures 1.5 cm long, 0.9 cm dorsoventrally at widest point, and 0.9 cm laterally at widest point. Duration 10–11 days.

Adults. Apex of forewing more-or-less acute, outer margin more-or-less sinuate, inner margin with emargination near tornus. Hindwing rounded with tail thin in males, spatulated in females. Anal angle rounded.



Figs. 1–11. *Anaea* (*Memphis*) *morvus boisduvali* Comstock. 1, Egg, width about 1 mm; 2, first instar larva, length about 2.5 mm; 3, second instar larva (on prolonged vein), 6 mm long; 4, third instar larva, 11 mm long; 5, fourth instar larva, about 21 mm long; 6, fifth instar larva, about 34 mm long; 7, prepupa showing characteristic lateral incurvation; 8, detail of head; 9, lateral view of pupa, about 15 mm long and 9 mm dorso-ventrally; 10, dorsal view of pupa, about 9 mm wide; 11, ventral view of pupa.



Figs. 12–15. *Anaea* (*Memphis*) *morvus boisduvali* Comstock adults. 12, Dorsal view of male, about 4.1 cm span between tips of spread front wings; 13, dorsal view of female, about 4.6 cm span between tips of spread front wings; 14, male, ventral view; 15, female, ventral view.

Males dorsally dull black on both fore- and hindwings, with dark blue reflection basally from midcostal area of forewing to tail on M3 vein of hindwing. Variable number of dark blue spots present subapically on forewing, forming a rough semicircle from costal margin to outer margin. Hindwing has discolored fold alongside inner margin.

Females dorsally dull black with light blue on both wings basally, reaching discal area. On hindwing light blue continued by darker blue reflection to tail on M3 vein and to anal angle. Subapically in forewing, light blue spots present starting at costal margin. As in males, discolored fold present alongside inner margin on hind wing.

Ventrally both sexes dark brown (darker in males), with grayish reflection, with some pale spots alongside outer margin, between tails and anal angle.

Body in both sexes has same shade as base of wings, from above and underneath. Eyes and proboscis light brown, antennae black. Females usually larger than males: 4.6 cm and 4.0 cm between tips of spread wings respectively.

Total developmental time varied from 51–61 days, females usually taking longer than males.

Natural History

We have found the eggs and larvae of *A. morvus boisduvali* consistently on one species of Lauraceae, identified by Lic. Jose Salvador Flores, Universidad Nacional, as *Nectandra sinuata* Mez. This plant, which grows to small tree size, is seen in shady ravines of the San Salvador volcano. The oblong coriaceous leaves, 10–25 cm long, give a strong scent when rubbed.

About Lauraceae in general and *Nectandra* in particular, we have found the following: *"Toutes les Lauracées contiennen des cellules a huile essentielle."* (Beille, 1909). *"Les Lauracées sont essentiellement des plantes aromatiques . . . . Leur feuilles . . . sont souvent parsemées de réservoirs pellucides et punctiformes, gorgées d'huile essentielle, odorante et volatile."* (Baillon, 1870). According to Standley (1922) a close relative of this species, *Nectandra rodiaei* Hook, contains several alkaloids: beeberine, sipirine and nectandrine, in addition to the essential oils.

Upon emerging, the tiny larvae completely eat the egg shell and remain under the leaf without feeding for a time, moving later to the edge of the leaf where they nibble around a vein, baring it. This vein is used from then on as a resting place and is covered with frass and silk. The larvae usually keep their head pointing outwards, and all through the first, second and third stadia they abandon this vein only to feed very early in the morning or in the evening. During the fourth stadium the larvae start wandering about, moving slowly, until they select a leaf where each builds a hiding place by folding an edge of the leaf forming a narrow funnel about 3.5 cm long, with the interior lined with silk. Again the larvae only leave this refuge for feeding purposes at dawn and at dusk. The wide end of the funnel is effectively blocked by the massive head of a larva and the narrow end is used to eject the excreta. As all Charaxinae we have reared, the larvae of *A. morvus boisduvali* are very slow moving and passive during all their development. When prodded with a stiff brush, they sometimes react by making pushing motions with their tubercled head. We could not detect in this species any scent nor the extrusion of the gland cephalad the prothoracic legs as in other *Anaea.*

When ready to pupate the larvae abandon for good their funnel, and locate a suitable pupation site. There they form a button of silk in a place vertical to the ground and fasten their anal prolegs thereon. Their body shows a general discoloration and a noticeable shortening. During

this short period the larvae do not hang as most Nymphalidae do, but stay incurvated laterally, as do all other *Anaea* spp. in this area.

The pupae, due to the angle formed by the cremaster in relation to the body, remain vertical to the ground, even if affixed to a vertical twig or drooping leaf. They are rather stiff and seldom react. When handled they occasionally make lateral movements.

Adults emerge from the pupa shell very rapidly and are ready to fly in less than 20 minutes. They expel an amount of reddish meconium.

As for the behavior of the adults of *A. morvus boisduvali* very little can be said with certitude. On the wing they look very much like the locally more abundant relative *A. pithyusa*, and therefore, the observations might be confusing. It is only when the adults are feeding that they can be closely approached, making it possible to accurately identify them. We do know that both sexes are strong flyers and favor woody areas and shady ravines where their foodplant is found, usually keeping near treetops. The adults also visit the ground to feed on fermenting fruits (avocados, mangoes, guayavas, etc.) and on vertebrate excrements. They feed avidly for long periods of time, and this is the only time they loose their usual alertness. They are very responsive to baits, and while at the bait they can be netted rather easily. The adults mimic dried leaves while at rest.

Discussion

According to Comstock (1961) nothing has previously been published on the life cycle of *A. morvus boisduvali.* Information about the life history of a close relative, *A. morvus stheno* Prittwitz, was published by Müller (1886).

The eggs of *A. morvus boisduvali* have the same size, shape and color as the eggs of other *Anaea* spp. found in El Salvador, with the exception of *A.* (*Zaretis*) *itys* Cramer and *A.* (*Siderone*) *marthesia* Cramer. The eggs of these species have a yellowish tinge instead of greenish. *A. marthesia* also has eggs that are bigger and more flattened at the micropyle than *A. morvus boisduvali.* The eggs are very hard to find because the female deposits them singly on the shadowy underside of mature leaves. The early stages of the larva also very much resemble the other *Anaea*, with the exception of the two mentioned species. But from the fourth stadium on, there is marked difference in appearance from all the others. This is true also for the pupa.

The defense strategy is based on crypsis, the same as the majority of the local species, *A.* (*Consul*) *fabius* Cramer, *A.* (*C.*) *electra* Westwood,

A. (*Memphis*) *eurypyle confusa* Hall and *A.* (*M.*) *pithyusa*, i.e., the bared vein during the initial instars and the funnel-shaped refuge during the latter.

The pupae of *A. morvus boisduvali* have a coloration mimicking, remarkably well, a common snail which is found on the leaves of shrubs and trees. The swift flying adults exploit the flash and hide effect caused by their dorsal blue reflection and their dead leaf ventral coloration.

It is possible that *A. morvus boisduvali* also derives protection from its larval foodplant, *Nectandra sinuata*, which is engorged with essential oils and, perhaps, alkaloids in addition to its complex cryptic behavior. This would be similar to the situation of the *Aristolochia* feeding Troidini. The species may also be part of a Müllerian mimicry complex with the closely related *Anaea pithysusa.* The latter also feeds on very aromatic and bitter plants, *Croton reflexifolius* H. B. K. and *C. niveus* Jacquin (Euphorbiaceae). Experiments to investigate these possibilities are needed.

The eggs of this species are parasitized by a tiny Chalcidoidea wasp that also parasites other *Anaea* spp. We have not found cases of parasitism during the larval stage, as so often happens with the other species, by a Tachinidae fly identified as *Crysotachina* sp. by Dr. C. W. Sabrosky, U. S. National Museum. One observed cause of mortality during the first and second instars is a fungus that mummifies the larvae while on their bared vein.

Heavy predation by spiders is strongly suspected, because we frequently found spiders on leaves bearing an empty bared vein. This would seem to eliminate the possibility of this species being totally unpalatable. We have observed spiders preying on larvae of other species of families considered distasteful to predators based on experimentation (Brower, et al., 1963; Brower & Brower, 1964; Benson, 1971). Included in our records are *Heliconius charitonius* L., *Dryas iulia iulia* (Fabricius) and *Agraulis vanillae incarnata* Riley, all Heliconiidae. We also have seen massive predation by lizards on larvae of *Dione iuno huascama* Reakirt (Muyshondt, Young & Muyshondt, ms. in prep.).

The most common cause of mortality in this species in our insectary has been caused by feeding the larvae slightly decaying leaves of the foodplant, which apparently become toxic to them.

The scarcity of the species in El Salvador suggests either low fertility or a high rate of mortality during the early stages due to causes other than parasitism, or a combination of the two factors.

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LITERATURE CITED

BAILLON, H. 1870. Histoire des plantes. Hachette et Cie, Paris. 460 p.

BEILLE, L. 1909. Précis de botanique pharmaceutique. A. Malone, Paris. 330 p.

BENSON, W. W. 1971. Evidence for the evolution of unpalatability through kin selection in the Heliconiinae (Lepidoptera). Amer. Natural. 105: 213–226.

BROWER, L. P. & J. VAN ZANDT BROWER. 1964. Birds, butterflies and plant poisons: a study in ecological chemistry. Zoologica 49: 137–159.

BROWER, L. P., J. VAN ZANDT BROWER & C. T. COLLINS. 1963. Experimental studies of mimicry. 7. Relative palatability and Müllerian mimicry among neotropical butterflies of the subfamily Heliconiinae. Zoologica 48: 65–84.

COMSTOCK, W. P. 1961. Butterflies of the American Tropics. The genus *Anaea*, Lepidoptera, Nymphalidae. American Museum of Natural History, N. Y. 214 p.

MÜLLER, W. 1886. Südamerikanische Nymphalidenraupen. Zeitschr. Syst. Geogr. Biol. Thiere 1: 417–678, Taf. 12–15.

STANDLEY, P. C. 1922. Trees and shrubs of Mexico (Fagaceae-Fabaceae). Contrib. U. S. Natl. Herb. 23, Part 2. 296 p.