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NOTES ON THE LIFE CYCLE AND NATURAL HISTORY OF *VANESSA ANNABELLA* (NYMPHALIDAE)

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ABSTRACT. Observations on the life history of *Vanessa annabella* (Field) show the early stages to be quite variable: the eggs in rib structure, and the later larval stages in color pattern and behavior. Immature and adult behavioral characteristics are similar to those of other *Vanessa*. *V. annabella* is usually present throughout the year in coastal southern California.

Vanessa annabella (Field), the West Coast Lady, is a common and familiar butterfly in western North America. Because it can usually be found throughout the year in coastal southern California, opportunities to study its life history are almost always present. However, there are few published records available and none has included photographs of the complete life cycle. Of published reports, Dyar (1889) gave one of the more complete written accounts; Huguenin (1921) made some general observations on the life cycle and natural history; and Coolidge (1925) described the egg in detail and listed the larval foodplants. More recently Emmel & Emmel (1973) illustrated paintings of a light form of the last instar larva and the pupa and gave brief descriptive notes.

Specimens used for the present descriptions of the life cycle stages were collected as freshly laid ova by following an ovipositing female at the type locality in Ventura, California (Dimock, 1972). The leaves on which these eggs were laid were placed in plastic containers 11 cm square by 4 cm deep. Humidity was maintained by dampened tissue paper placed on the container bottom. The containers were kept indoors in a room temperature which varied from 17 to 25°C. Photographs and measurements were made of each stage. Other specimens were reared upon cut stalks of nettle placed in water so that leaf shelter construction and other activities could be observed. Afternoon sunshine provided direct and ambient light.

Full descriptions of the adults are given by Field (1971); thus, the following adult descriptions are limited to those characteristics which help distinguish *V. annabella* from related North American species.

Life Cycle Stages

Egg (Fig. 1). Barrel-shaped, light green, with 10 to 14 transparent vertical ribs. Measurements (Coolidge, 1925): 0.72 mm tall, 0.52 mm wide, tapering to 0.30 mm at base and 0.26 mm at top. Duration 4 days.

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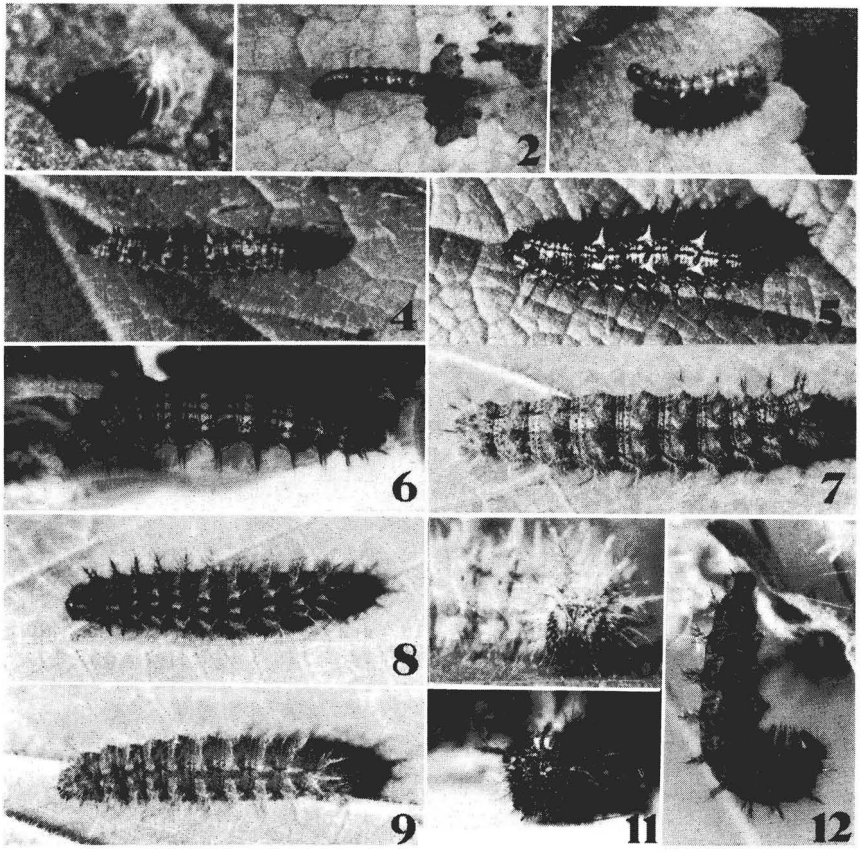


Figs. 1–12. *Vanessa annabella* (Field): (1) egg, ca. 0.5 mm wide; (2) first instar larva, 3 mm; (3) second instar larva, ca. 4 mm: (4) third instar larva, ca. 9 mm; (5) fourth instar larva, ca. 13 mm; fifth instar larvae, all ca. 30 mm: (6) dark morph, black and yellow, (7) intermediate morph, orange and gray, (8) rusty orange morph, (9) light morph, gray; (10) head, fifth instar, light tan morph; (11) head, fifth instar, dark morph; (12) prepupa.

First instar larva (Fig. 2). Head shiny black, setae and thoracic legs black. Ground color grayish brown after feeding for 2 days. When mature, body with vague brownish mottling. Segments A-2, A-4, and A-6 with a pair of light yellow spots between subdorsal and supralateral setae. Grows to 3 mm in 5 days.

Second instar larva (Fig. 3). Head shiny black. Ground color mottled dark brown. Short branched spines black except for middorsal spines on A-4 and A-6 and subdorsal spines on A-2, A-4, and A-6, which are yellow. A narrow pair of vague yellow lines divided by a narrow middorsal line of dark ground color running from about T-1 to A-8. Grows to 4.5 mm in ca. 3 days.

Third instar larva (Fig. 4). Head shiny black with black setae arising from black chalazae. Ground color usually black, but may begin to lighten as in lighter morphs. Spines black except for subdorsal spines on A-2, A-4, A-6, and usually

Fig. 13. *Vanessa annabella* (Field): fifth instar larval nest on *Urtica holosericea* Nutt.

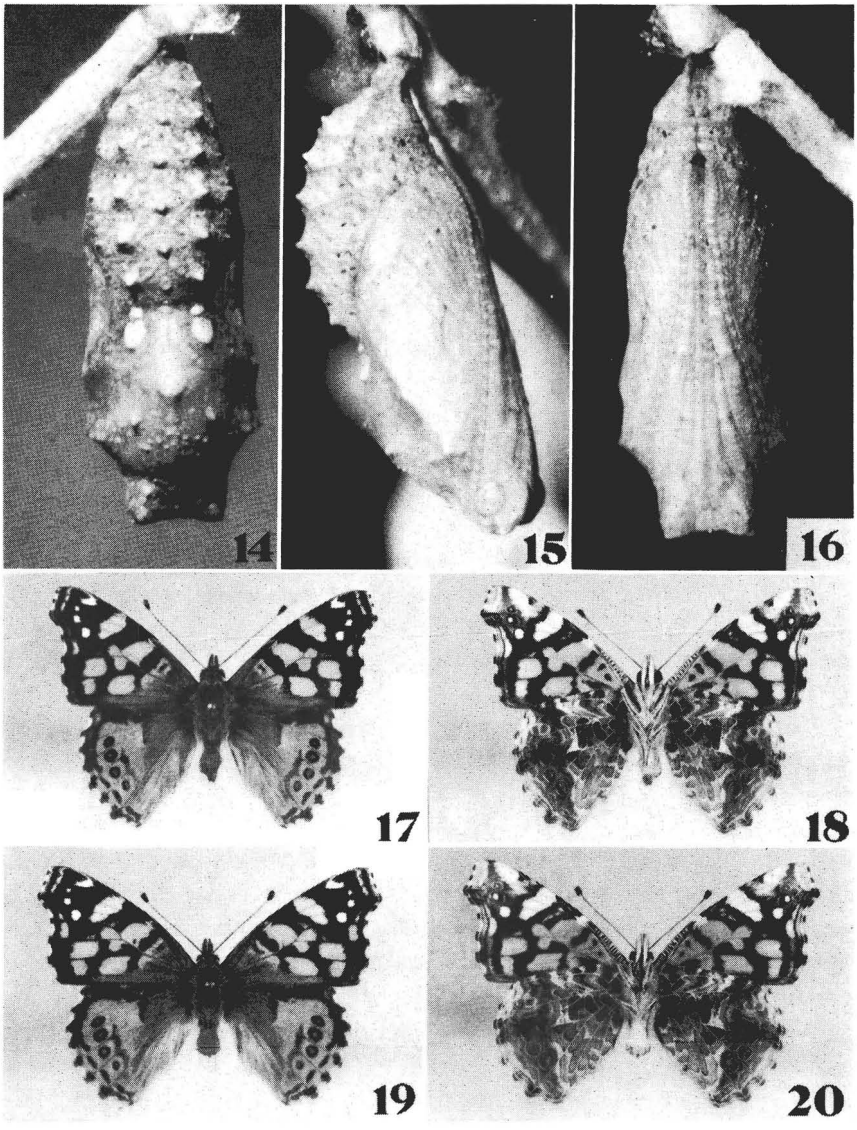
middorsal spines on A-4 and A-6, which are yellow with black tips and yellow bases confluent with dorsal double yellow lines. These paired lines, variable in expression, separated by a middorsal line of ground color, are interrupted by ground color at bases of non-yellow spines. Grows to ca. 9 mm in ca. 3 days.

Fourth instar larva (Fig. 5). Head black with bronze hightlights. Head capsule width 1.5 mm. Ground color and markings nearly as variable as in fifth instar (see following description). Grows to ca. 14 mm in ca. 3 days.

Fifth instar larva (Figs. 6–9). Head blackish or brownish black (Fig. 11) with bronze highlights, or less often with vertical whitish tan stripes in light morphs (Fig. 10). Capsule width 2 mm. Extremely variable in ground color and markings. Ground color varies from black to greenish white or grayish white, including various browns and tans. Light markings present in fourth instar here vary from dark rusty reds and oranges to yellow or various browns and tans. Extent of markings and lateral line varies independently of color; these tend to disappear altogether in morphs of whitish ground color. Lateral line may be absent in any morph. Rusty orange spots may appear between subdorsal and supralateral spine bases, varying in extent from absence to confluence with other pattern elements. Spines branched, variable from black in dark morphs to whitish in light morphs, or dark anteriorly and light posteriorly in intermediate morphs. Arrangement of spines: middorsal row on segments A-1 to A-8, subdorsal rows on T-2 to A-8, supralateral rows on T-2 to A-10, and lateral rows on A-1 to A-8. Body shape thickest at midabdominal segments. Grows to ca. 25–30 mm in ca. 5 days.

Prepupa (Fig. 12). Light markings darken somewhat. Larva becomes slightly shorter and thicker. Duration 1 day.

Pupa (Figs. 14–16). Head without projections. Mesothorax with a raised middorsal point and a pair of subdorsal points. Metathorax with two large sub-



Figs. 14–20. *Vanessa annabella* (Field): (14) pupa, dorsal view, 19 mm; (15) pupa, lateral view; (16) pupa, ventral view; (17) adult male, dorsal view, 47–mm expanse; (18) adult male, ventral view; (19) adult female, dorsal view, 49–mm expanse; (20) adult female, ventral view.

dorsal white spots, raised anteriorly. Abdomen with two small subdorsal white spots on A-1 bordering those on metathorax. A-2 to A-7 each with one very small middorsal point and a pair of more prominent subdorsal points. Color variable from overall tan to mottled dark browns, sometimes with a greenish golden cast.

A spiracular line, darker brown than ground color, is variable in expression. Measurements (average of five specimens): length 19 mm; width 7 mm; depths: thorax 6.25 mm, saddle 5.25 mm, abdomen 7.25 mm. Duration 8–11 days.

Adults (Figs. 17–20). Sexual dimorphism subtle, females having a more rounded hindwing than males, especially at M_3, Cu_1, and Cu_2. Color pattern same in both sexes: tawny orange with black markings, white subapical forewing spots, and blue pupilled hindwing ocelli. On upperside, forewing cell crossed completely by a black bar. Forewing costal bar, between cell end and apex, orange. Forewing apex pointed, not rounded, at M_1, with marginal tawny spot in interspace Rs. Hindwing with four blue pupilled submarginal ocelli in interspaces M_1, M_2, M_3, and Cu_1, and often a small solid black ocellus in interspace Rs. Hindwing undersides mottled principally in various buffs, tans, browns, and grays, with a whitish triangle in interspace M_2 at cell end. Expanse averages between 40 and 48 mm, females often larger than males.

Total developmental time for this species is ca. 30 to 36 days.

Natural History

Vanessa annabella uses a variety of foodplants in the families Urticaceae and Malvaceae. Native foodplants most frequently used in southern California are *Urtica holosericea* Nutt. (Urticaceae), *Sida* species, *Sidalcea malvaeflora* (DC.) Gray, and *Sphaeralcea ambigua* Gray (Malvaceae). Introduced plants include *Malva* species, especially *M. parviflora* L., and *Althaea rosea* (L.) Cav. (Malvaceae). John F. Emmel, M.D. (pers. comm.) also reports the use of *Urtica urens* L. (Urticaceae).

The eggs are laid singly, usually on the uppersides of the leaves. On nettles (*Urtica*) the eggs are often attached to the sides of the stinging spines.

The hatching larva eats away the top and adjacent walls of the egg and crawls to a suitable place on the leaf uppersurface to construct a shelter. This consists of fine silk webbing tied across a leaf midrib, petiole, or small wrinkle on the leaf margin. The young larva lives under this webbing as it feeds on the leaf and places its frass into the webbing, creating a protective camouflage. In the second instar the larva may enlarge the old nest or construct a new one nearby. When the larva is at the growing tip of a nettle stalk, the nest may incorporate two or more of the tiny new leaves. By the third instar the larva is capable of folding a larger area of the leaf or constructing a deeper nest at the petiole. In the fourth instar the entire leaf may be folded together (on *Urtica*) or closed about the top edges (on *Malva*). Frass is allowed to fall out of the nest but often accumulates in piles in the nest bottom. The fifth instar larval nest is usually larger and may incorporate neighboring leaves and stems (Fig. 13). Sometimes leaves of nearby plants which are not foodplants are also tied into the nest even though they are

not eaten. On plants with small leaves, such as young *Malva*, the larva may tie together many leaves before a nest enclosure is completed. On *Urtica holosericea*, when a single leaf is used, larvae of *V. annabella* usually construct nests on the uppersides of the leaves, either by folding over one edge and securing it to the leaf surface or by tying both edges together to form an enclosure. The petiole or nearby midribs may or may not be partially cut to cause the leaf to hang vertically. Less frequently, the larvae will fold the leaf edges underneath so that the undersurface forms the nest interior.

Pupation sites are on either the foodplant or nearby objects. When the foodplant is used, a leaf chamber is constructed with firm webbing and the larva suspends itself from the chamber ceiling. Larvae in other locations may secure together any nearby objects to approximate an enclosure or may simply pupate in exposed places, such as from twigs or branches. Pupae often react to disturbances by wiggling laterally.

Emerging adults hang from the pupal shell or adjacent perch to expand their wings. A reddish brown meconium is ejected and the adult is ready for flight in an hour.

Adults of *V. annabella* may be encoutered in any life zone from sea level to alpine areas where open sunny places are preferred. Both sexes visit flowers. In the afternoon males tend to congregate on hilltops or other exposed places such as forest openings, glades, meadows, and streamside slopes, especially when patches of dry, bare earth are available for sunning. Many man-made situations are particularly favorable: windbreaks of trees, orchard rows, trails, firebreaks, garden paths, and paved sidewalks and driveways. At these locations, when not occupied in sunning, males will chase after each other and the other vanessid butterflies *Vanessa atalanta rubria* (Fruhstorfer), *V. cardui* (L.), and *V. virginiensis* (Drury), along with unrelated butterflies which congregate in the same places. They often bravely chase larger insects and birds and in general will investigate anything that flies through their established area, including falling leaves and objects thrown overhead. These activities ultimately bring the males into contact and subsequent courtship and mating with females, but between these encounters the males spend a great deal of time and energy simply chasing each other. From observations made on hilltops in the vicinity of Ventura, California, during November 1976 when all four *Vanessa* were present, it was noted that any one species will chase the same or any other species, and two or more individuals may join in the chase. The butterflies may chase each other to a height of ca. 20 m or more before breaking chase and quickly gliding down to land once again on the ground with backs to the

sun and wings spread. The butterflies' wings frequently come into contact during these encounters, but without damaging effects, and the resulting noise can be heard nearby.

Females, although not congregating in the manner of the males, are likely to be found anywhere, feeding, seeking foodplants, or ovipositing, including hilltop localities when the foodplants or nectar sources occur there also.

The flight of *V. annabella* is composed of glides with the wings held horizontally, interrupted frequently by several fluttering beats. Chasing is mostly vigorous fluttering, and the return dives are composed of gliding and braking.

Diapause was not investigated, but if it does occur in this species it is almost certainly during the adult stage, as it is in the other vanessid-nymphalinid butterflies. If adults of *V. annabella* are unable to survive prolonged or severe frosts, the species probably reinvades the greater part of its northern and eastern range from the milder southwestern areas where breeding is continuous throughout the year.

Vanessa annabella is easily attracted to suburban gardens by planting *Althaea rosea* (Hollyhock) or encouraging *Malva parviflora* (Cheeseweed) to become established. It is an easy butterfly to raise in captivity, even under poor conditions. Larvae collected in the wild on one foodplant (for example, *Urtica holosericea*) can be switched to other foodplants (*Malva*, *Althaea*) when the former is less easily obtained. The larvae are very often parasitized by tachinid flies, which emerge from the mature butterfly larvae or pupae as mature maggots.

DISCUSSION

Coolidge (1925) noted that the egg ribs of *V. annabella* varied in number from 11 to 13, with 11 the most common number. My observations confirm this, but eggs with 10 and 14 ribs were found during the present study. This is in partial disagreement with Field (1971), who stated that the genus *Cynthia* (in which *annabella* was placed) had from 14 to 19 egg ribs, and Clench (in Howe, 1975), who gave 14 or 15 as the number of egg ribs in the subgenus *Cynthia*.

The larvae of *V. annabella* are extremely variable, as are the larvae of *V. atalanta rubria* and *V. cardui*, and this variability not only makes a written description difficult but compounds the task of providing reliable characteristics with which the three species can be separated. In general, the descriptions given for the larvae in this article can be compared with those for *V. a. rubria* and *V. cardui* in subsequent articles. However, fifth instar larvae of *V. annabella* can always be distinguished

by their smaller head capsule width of 2 mm; in *V. a. rubria* and *V. cardui* the fifth instar larval head capsule is nearly 3 mm. Once *V. annabella* is identified, *V. a. rubria* is distinguished by the numerous white cephalic chalazae, which in *V. cardui* are black.

From observations made on *V. annabella* larvae collected in various locations and larvae reared under controlled conditions, it was noted that the variations in ground color were at least partly due to environmental conditions. The light, grayish–white morphs were more frequently encountered on plants exposed to full sunshine, whereas the darker morphs were found mostly on plants in secluded, shaded areas. Darker morphs also resulted when larvae were reared under crowded conditions.

Because *Malva* species are especially successful in disturbed areas and are abundantly available throughout the year as foodplants, *V. annabella* has probably become much more common since the introduction of these weeds from Europe. This is the situation in the coastal southern California lowlands, where a favorable climate prevails and *V. annabella* can be found in every month of the year.

In his revision of the *Vanessa* butterflies, Field (1971) resurrected the genus *Cynthia* for the *carye*, *cardui*, and *virginiensis* species groups. Clench (in Howe, 1975) reunites all the species in *Vanessa*, treating *Cynthia* as a subgenus. Emmel & Emmel (1973) used the cases of hybridization between *V. a. rubria* and *Cynthia annabella* to demonstrate the "close genetic relationship and probable generic identity" of the two species. With no disrespect to the fine work of Field, I favor a treatment similar to that of Clench, with reservations on the precise placement of *annabella*. There are 10 known cases of hybridization between *V. a. rubria* and *V. annabella*: one specimen reported by Edwards (1877), one by Grinnell (1918), one by Gunder (1930), three by Dimock (1973), one by Emmel & Emmel (1973), one specimen collected by Kirby in the collection of the Natural History Museum of Los Angeles County, and two specimens raised by Henne and Ingham in the Peabody Muscum collection. Mr. William D. Field (pers. comm.) discovered upon dissection the partially crippled specimen designated as "Hybrid #3" in Dimock (1973) to be a female, not a male as erroneously reported. In my opinion these occurrences support, at least, the arrangement of Clench and the generic identity suggested by Emmel & Emmel. Biologically, the examples of hybridization may also demonstrate the presence of an as yet incomplete reproductive isolatory mechanism caused by a recent invasion of *V. annabella* from South America or a recent invasion of *V. a. rubria* from Eurasia, or invasions by both species.

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