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NYMPHALIS CALIFORNICA (NYMPHALIDAE)

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Mass movements by California tortoise shell butterflies have been sporadically recorded during the past 115 years in widespread parts of the Pacific Coast states. The flights, which follow massive population increases in relatively localized areas, have been called migrations in the literature (e.g. Williams, 1930, 1938).

After about a decade of comparative stability, *N. californica* has again disrupted its equilibrium, and its swarms became conspicuous during 1971. According to an Associated Press release dated 11 August, which was published in various parts of the country, butterflies "by the millions" were flying in the vicinity of Mt. Shasta, Siskiyou County, California, "slickening the highways" in the towns of Mt. Shasta, Dunsmuir, and McCloud (see *Lepid. News*, 1971, No. 5).

Truck drivers were quoted as saying they could go only 25 miles per hour owing to the dense clouds of butterflies which crossed the highways. The report stated that the butterflies began appearing in hordes about five weeks previously [in early July]. Local naturalists reported that the flights consisted of six nymphalid and one lycaenid species (three of which do not occur in northern California), but the roster did not include *N. californica*. That swarms did consist of the latter species, however, is indicated by several lines of evidence: a) correspondence to the editor of *Lepidopterists' News* by five observers during the fall of 1971 agreed that this was the dominant species (*Lepid. News*, 1971 No. 6:1); b) R. Lyon (Pacific Southwest Forest and Range Experiment Station, Berkeley), who witnessed the flight on 6 August, reported (*in litt.*) that the butterflies appeared to be all one species and that it was identified as *Nymphalis californica* by R. Hill (formerly of the Pacific SW Forest and Range Expt. Sta., now retired). Hill made an on-site detection report to the Forest Service; c) J. Helfer (1971, *The Mendocino Beacon*, 20 Aug. 1971, p. 4) reported that the flights were observed by J. Myers who had just returned from Mt. Shasta, bringing a specimen which Helfer identified as *N. californica*.

From all reports the flight structure and timing are strikingly similar to those which I observed in 1958 when I lived at Mt. Shasta all summer. That season the butterflies appeared in large numbers on the mountain

slopes at 4,000–6,000 feet during 22–26 June, but were not seen to emigrate (snowline was then below 7,000 feet). Then during 3–7 August, a brood of fresh individuals appeared in tremendous numbers at 6,000 to 8,000 feet and moved outward to subtending areas. I observed them in aggregations at damp soil in the town of Mt. Shasta and as far as three miles northeast of Weed (6 SW and 6 NW airline miles from the colonies observed on the mountain). The three towns mentioned in the AP release above are approximately 6 SW, 11 SSW, and 8 SSE airline miles from timberline, respectively, so that it seems probable that dispersal occurs in all directions into the 2,000–3,000 ft. elevation valleys which surround the 14,000 ft. mountain.

How distant these flights extend is unknown, but in October 1971, mass flights were noted in two other parts of California where *N. californica* does not commonly occur in high numerical density, east of the Sierra Nevada in Mono County and in the San Francisco Bay area. These places are approximately 300 SE and 250 SW airline miles from Mt. Shasta. At Highway 395 near Mammoth Lakes, E. Kane (State Department of Agriculture, Sacramento) (*in litt.*) counted 173 *N. californica* flying easterly during a five minute period at about 1530 on 8 October. In the Berkeley Hills near San Francisco Bay the butterflies were flying southeastward, along the axis of the hill ridge, at rates of 1.5 to 11/minute on a 50-foot sighting line during midday on 5, 7, and 12 October and were absent on 14 and 28 October (Powell, 1972). Moreover, circumstances indicate that sightings reported by Arnaud (1972, in: Proc. Pacific Coast Entomol. Soc. 341st meeting, Pan-Pacific Entomol. 48: 72) at a height of 600 feet in downtown San Francisco on 4–5 October, also involved *N. californica*.

The last time that an outbreak occurred in the San Francisco Bay area was in 1959–1960, when moderate aggregations were followed in the second season by tremendous numbers of the adults in June in Marin County. Various personal communication and literature reports which I have accumulated in addition to those summarized by Williams (1930, 1938) show that the outbreaks are recurrent, especially at Mt. Shasta, where there are reports of the swarms for 1889, 1902, 1911, 1926, 1931, 1932, 1952, 1958, and 1971. Most likely the phenomenon occurred in other years as well but was not reported, such as during the 1918–1922 and 1941–1944 eras, judging from records at other localities. In any case, it appears that localized defoliation of *Ceanothus*, the preferred host plant, and mass movements of the butterflies occur at intervals of around 5–13 years but too irregularly to allow precise prediction of any cyclic periodicity.

Recorded outbreaks at secondary areas, such as Marin County in 1959-1960, apparently have resulted from preceding emigration from Mt. Shasta or other epidemic centers and have masked generalizations concerning possible periodic phenomena which may have obtained.

The records suggest that this species periodically develops an imbalance with factors in its population equilibrium at isolated sites, followed by mass emigration of adults in various directions, and sometimes subsequent colonization and population explosions in secondary districts in the first or second following year. The populations then return to low density numbers or may disappear altogether in outlying colonies. Thus, *Nymphalis californica* should not be considered a migratory species except in the broadest sense.

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