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MATING BEHAVIOR OF *ACRAEA ANDROMACHA ANDROMACHA* (FABRICIUS) (NYMPHALIDAE) IN NEW CALEDONIA

Additional key words: Acraeinae, sphragis, courtship.

Acraea andromacha andromacha (Fabricius) is reported from Australia (primarily N and E), the SW Pacific, and the Lesser Sunda Islands of Indonesia (Holloway, J. D. & J. V. Peters 1976, J. Nat. Hist. 10:273–318). It belongs to the mostly African subfamily Acraeinae (Nymphalidae) which feeds on Passifloraceae. The species is the only Australasian one of *Acraea,* and Passifloraceae occurs chiefly in the Neotropics and Africa (Heywood, V. H. 1978, Flowering plants of the world, Oxford Univ. Press, 335 pp.).

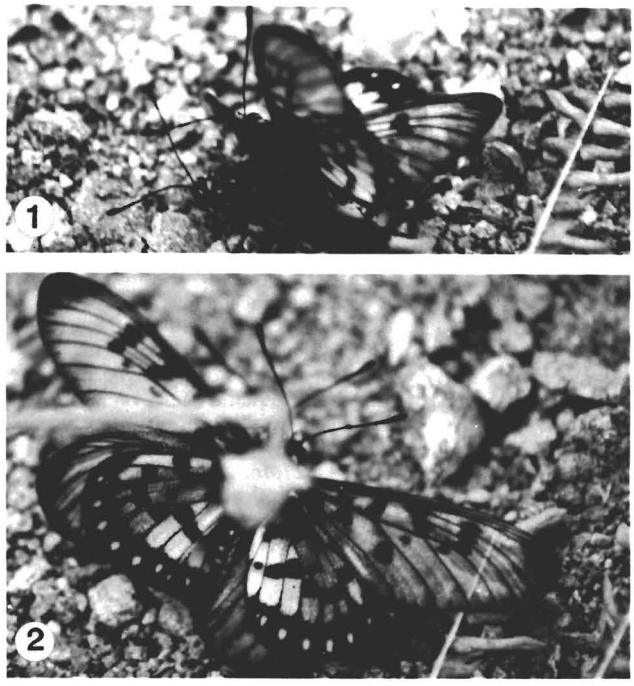
During copulation, male *Acraea* secrete a sphragis or plug and deposit it externally, thus preventing multiple female matings (Eltringham, H. 1912, Trans. Roy. Entomol. Soc. London, pp. 1–374). A large sphragis is believed to prevent mating by blocking the release of pheromone (Eltringham, above) and by the male detecting the sphragis physically (Scott, J. A. 1972, J. Res. Lepid. 11:99–127; for a review of the role of the sphragis, see Drummond, B. A. 1984, pp. 291–370 *in* Smith, R. L., Sperm competition and the evolution of animal mating systems, Academic Press). Common and Waterhouse (1972, Butterflies of Australia, Angus & Robertson, Sydney, 498 pp.) report the presence of the sphragis on Australian female *A. A. andromacha.* The sphragis is also known in other Acraeinae (*Planema* and *Actinote*), Papilionidae, and Danainae (Scott, above).

Along with the sphragis, African species of *Acraea* and *Planema* and *Parnassius* spp. lack courtship rituals (Eltringham, Scott, above). Strong female pheromones are postulated to replace courtship for intraspecific recognition (Eltringham, Scott, above). This mating strategy (assuming the pheromones exist) may have evolved where congeneric species of similar appearance and courtship occur sympatrically, as in African *Acraea.* Because *A. andromacha* is geographically isolated from congeners, it is not faced with interspecific mating.

This note confirms that *A. a. andromacha* has mating behavior typical of its congeners, presents evidence of multiple mating, and discusses possible gene flow effects resulting from single mating in an island environment.

In New Caledonia, *A. a. andromacha* occurs commonly in open, dry habitats with secondary vegetation and *Acacia* scrub (Holloway & Peters, above). Its external appearance and fluttery slow-wingbeat flight are reminiscent of *Parnassius* species (Papilionidae). I observed mating of *A. a. andromacha* on 28 January 1984 5 km N of Nepoui on the W coast of New Caledonia. The site was dominated by *Leucaena leucocephala* (Lam.) Dewit, an introduced legume-shrub found throughout the Pacific that occurs naturally in tropical America. The *Acraea* and other butterflies (*Junonia villida calybe* [Godart], *Anaphaeis java persithene* [Boisduval]), and an arctiid moth (*Utetheisa* sp.) were nectaring on *Tridax procumbens* L., a weedy roadside composite. At 1100 h, a male *A. a. andromacha* pounced on a female in flight, and seconds later, on the ground, climbed on her dorsum and copulated without a courtship dance (Figs. 1, 2). When disturbed, the pair flew, *in copula,* to a nearby *Tridax* flower. Although I did not observe which sex flew, the female presumably carried the male because she alighted on the flower. In some *Acraea* species, either sex flies, whereas in others the male or female flies (Scott, above).

I found sphraga on 14 of 15 female specimens, 1 per specimen, collected by M. G. Pogue and me in New Caledonia; and on 10 of 12 in the U.S. National Museum from Australia (8), New Caledonia (2), and the New Hebrides (2 without sphraga). Spermatophore counts were made on three New Caledonian specimens with sphraga and one without. Two of the three with sphraga showed evidence of multiple matings, with two partially dissolved spermatophores, while the remaining specimen with a sphragis had a single fully formed spermatophore. The specimen without a sphragis had no spermatophores, indicating, along with the excellent condition of her wings, that she was virgin.



FIGS. 1, 2. Mating behavior and copulation in *Acraea a. andromacha*. **1,** Male climbs on dorsum of female and without courtship begins copulation. Wings of male nearly closed, pointing toward viewer, right wings more visible than left. Female's right hind wing positioned in front of her right forewing. **2,** Male's wings, now open, cover all but female's forewings, which are positioned beneath male's hindwings.

Multiple female matings, indicated by more than one spermatophore, have been reported in several other *Acraea* species (Owen, D. F. et al. 1973, Entomol. Scand. 4:155–160). They may be explained by loss of the sphragis due in part to its solubility in water, or by a second mating while the sphragis is still soft (Drummond, above).

Number of matings between individuals can affect gene flow between Lepidoptera populations. A female that mates only once, before migration, increases gene flow by transporting both her and her mate's genes to a new environment (Scott, above). In contrast, a female that mates again after migration lessens gene flow because the latter male fathers her subsequent offspring (sperm precedence, Labine, P. A. 1966, Evolution 20:580–586).

Sphragal-induced monogamy is more common in mainland areas, and one would assume that it has less adaptive value on islands. Nonetheless, such monogamy may serve to replace genes removed by natural selection from isolated island populations. Mated female *Acraea a. andromacha* with persistent sphraga (preventing further matings) and vagility equal to unmated females would influence gene flow among populations on Pacific islands more than unmated females. However, occurrence of multiple spermatophores in *Acraea* reported above and in the literature does not support this hypothesis.

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A MIGRATORY FLIGHT OF THE CALIFORNIA TORTOISE-SHELL BUTTERFLY

Additional key words: *Nymphalis californica*, Nymphalidae.

While migrations, swarms, and dense clusterings of butterflies are well documented, we believe any significant mass movement of a lepidopteran should be reported. Ultimately, published reports will form the basis for a clearer understanding of the conditions causing migrations. With such an objective, we here present field observations and data by one of us (RMK) of a unidirectional mass movement of *Nymphalis californica* (Boisduval) (Nymphalidae), the California tortoise-shell butterfly. This insect is known as a "loner" or "singleton" (Ferris, C. D. & F. M. Brown 1980, Butterflies of the Rocky Mountain States, University of Oklahoma Press, Norman, 442 pp.), but also has been recorded in enormous numbers and as migrating (Ferris & Brown, above; Howe, W. H. 1975, The butterflies of North America, Doubleday and Co., Garden City, New York, 633 pp.; Williams, C. B. 1930, The migration of butterflies, Biol. Monogr. & Manuals No. IX., Edinburgh, Oliver & Boyd, London, 473 pp.). The observations were made in California in July 1986. Specimens were identified by one of us (ENL).

On 25 July 1986 while driving E on US Interstate Hwy. 80 (I-80) at Pla-Vada, which is on the boundary between Placer and Nevada counties, a dense flight of *N. californica* was noted moving to the SW. This locality is 12 km E of the junction of I-80 and California State Hwy. 20 at an elevation of 1860 m. For a road distance of 400 m, butterflies swarmed over the highway in such numbers that they hit the automobile faster than they could be counted. So many insects both living and dead were in the air turbulence of automobiles that they constituted a distraction to motorists. The density of this moving population gradually decreased eastwardly for 1.5 km at which point no further butterflies were seen. The time was 1145 h (PDT), temperature was 19°C, and relative humidity 35% under clear skies. Wind was estimated to be at 10–12 kmh out of the N.

About 15 minutes later, more eastwardly on I-80, at the Donner Summit Rest Area, Nevada Co., located 12 km W of the junction of California State Hwy. 89 (S) and 24 km E of Pla-Vada, at an elevation of 2203 m, another flight of the species was observed. This migration was as dense as that noted above, and presumably was a part of the same population surge. The most dense section of this portion of the swarm stretched about 800 m along I-80. After the dense swarm was passed, lesser numbers were observed for 8 km E of Donner Pass to the Donner Lake Interchange (elevation ca. 2000 m). This second encounter with what we assume to be the same flying population observed earlier in the day was flying SW under weather conditions similar to those noted above.

At the Donner Summit Rest Area, 8 butterflies (2 ♂, 6 ♀) were collected from the dead in a windrow along the road. Dead butterflies numbered 20–50/m² of roadside area, and extended along I-80 for at least 3 km. No species other than *N. californica* were noted among the dead. While this estimate gives some idea of the large numbers killed, visual