

Mating Behavior of Butterflies (Papilionoidea) and Skippers (Hesperioidae) in Indiana

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Introduction

From the spring of 1968 until the fall of 1978 the author researched the mating behavior of the butterflies (Papilionoidea) and the skippers (Hesperioidae) found *in copula* in Indiana. The remaining Lepidoptera have been excluded. In all, 719 pairs were collected *in copula*, representing 45 species. Slightly over 50 percent of the mating pairs comprise one species (*Pieris rapae*), the common European Cabbage White. Three pairs were crossbreeding.

The families included in this paper are the Danaidae, Satyridae, Nymphalidae, Lycaenidae, Pieridae, Papilionidae, and Hesperidae. Three families—Libytheidae, Riodinidae, and Liphyridae—have not been included because not one of the five Indiana species in these three families has been found *in copula* in Indiana.

The mating date, the time of mating, the temperature at the time of mating, the active sex partner (the sex which carries its partner in flight when *in copula*), nuptial and courtship behavior are noted. All recorded times for mating have been converted to Eastern Standard Time (E.S.T.). The nomenclature follows Howe (2).

Part One: Mating Behavior of Butterflies (Papilionoidea)

Danaidae

Danaus plexippus plexippus (Linnaeus). Forty-five mating pairs. The male was always the active flight partner; however, Pronin (4) reported the female as the active partner. His record is doubtful.

With the exception of two pairs mating in June (29. VI. 1977) the other 43 pairs mated in July and August. One pair mated 22. VIII. 1977, 9:45 A.M., at a cold 59° F, Silver Lake, Kosciusko Co. The male could not fly when released. Its wings were spread open toward the sun, a process of thermoregulation prior to morning flight. The other pairs were mating between 70° F and 92° F, the great majority mating in the mid-70s and mid-80s. Mating usually takes place from late morning to late evening (11:00 A.M.-6:45 P.M.), the greatest number mating between 2:00 P.M. and 4:30 P.M. A few pairs may remain *in copula* throughout the night and the author has seen mating pairs resting in the tree-tops at sunset.

Mating *plexippus* have been collected in Wabash, Kosciusko, Randolph, Delaware, Allen, and LaGrange counties. Three to four broods.

Satyridae

The author collected three species of this family *in copula*: *Lethe eurydice eurydice* (Johansson). Recently *L. eurydice* and *L. appalachia* have been separated as distinct species (no longer *Lethe eurydice appalachia* in Indiana) (5). Both species occur in Indiana. On 29. VII. 1972 pair of *L. e eurydice*, 12:30 P. M., 68° F, in a woodland bog, North Manchester, Wabash Co. Female was the active flight partner. One brood.

Eupychia cymela cymela (Cramer). Five pairs from June 6, 1969 to July 4, 1978. Mating times were from 11:50 A. M. to 3:10 P. M. The female was always the active flight partner. Temperatures, not always recorded, were generally in the 70s. Mating pairs from Wabash, Kosciusko, and LaGrange counties. One brood.

Cercyonis pegala (Fabricius). Thirty-four pairs *in copula*. In northeastern Indiana, mating of *pegala* and its many subspecies or integrating forms (*olympus*, *alope*, *nephele*, and others) begins in late July and has continued until August 25 (a late date), reaching its peak around mid-August. Pairs have been collected as early as 9:05 A. M. and as late as 5:20 P. M. Normally mating occurred between 11:00 A. M. and 3:00 P. M. Temperatures ranged from 65° F to 80° F, but the 70s and 80s dominated.

So far *C. pegala* has not been found in southern Indiana, mating or otherwise. When found *in copula* in Wabash and Kosciusko counties, the female was the active flight partner. One brood.

Nymphalidae

According to Miller and Clench (3), there is much variety in this family in the sex of the active flight partner; it may be the male of some species, the female of others, or the sex roles may alternate between the partners. However, the females clearly predominate. In the nine mating species of nymphalids collected in Indiana the author has found females to be the active partners.

Limenitis astyanax (Fabricius). Two pairs: 21. VIII. 1969, 3:45 P. M., Silver Lake, Kosciusko Co. and 7. VI. 1970, 2:25 P. M., Brown County State Park. When the last pair was disturbed, it flew into a tree at the edge of the meadow. The female carried the limp male. Three broods.

Limenitis archippus archippus (Cramer). Seven pairs found breeding in July, August, and September. The lowest mating temperature was 70° F and highest 90° F. Mating occurred in the afternoons from 1:00 P. M. to 4:00 P. M. Copulating pairs were collected in Wabash, Kosciusko, and Carroll counties. The female was always the active flight partner. Two broods.

On 7. IX. 1971, 1:30 P. M. the author witnessed a *L. archippus* x *L. astyanax* *in copula*, North Manchester, Wabash Co., but was unable to catch this wild mating pair because of a dangerous bull protecting his turf. These two species have been known to hybridize.

Precis coenia (Hübner). Two pairs: 30. VII. 1970, 3:05 P. M., in a cow pasture, Delphi, Carroll Co.; and 31. VIII. 1970, 9:50 A. M., 60° North Manchester, Wabash Co. When disturbed both pairs settled again in the deep grass. The females were the active flight partners. One or two broods.

Phyciodes tharos tharos (Drury). Fifty-eight mating pairs. Found in copula every month from May 17 until October 7 (a late date for any species). Mating sometimes occurs in the early morning hours (9:00-10:00); however, the great majority mated between 11:00 A.M. and 3:30 P.M. Only a few mated between 3:30 and 5:45 P.M.

In one pair, courtship lasted only five minutes prior to copulation. Twice the female flew to a new location only to be pursued by the male. When the pair perched on a blade of grass, there were moments of wings rubbing and antennae touching. Then their caudal portions were joined achieving copulation. When disturbed the female, as is always the case in this species, flew a few feet carrying the male which had its wings completely closed. The author watched one pair courting for one and one half hours but no mating occurred.

Temperatures for mating ranged from 66° F to 90° F; however, the mid-70s to mid-80s accounted for the majority. Mating occurs in a variety of habitats—near margins of lake, rivers, and streams, occasionally in an open lawn or field. Mating pairs were collected in Wabash, Kosciusko, Carroll, and LaGrange counties. Four, possibly five broods.

Chlosyne nycteis nycteis (Doubleday). Three pairs: 17. VI. 1971, 3:05 P.M., 85° F, Milford, Kosciusko Co.; and 28. VI. 1978, 3:30 P.M., 88° F, Silver Lake, Kosciusko Co. The first pair mated in a raspberry patch surrounded by trees, the last pair rested on a dogbane shrub. The female was the active flight partner. One brood.

Euphydryas phaeton (Drury). One pair: 15. VI. 1977, 12:20 P.M., 72° F, North Manchester, Wabash Co. The pair was copulating on a shrub in a woodland marsh. After photographing them, the pair was captured in the author's net. The female, carrying the male, flew up and down in the white bag, a good technique for determining the active sex partner. One brood.

Vanessa (Cynthia) virginianensis (Drury). One pair: 10. VII. 1977, 3:20 P.M., 80° F, in alfalfa/red clover field, Silver Lake, Kosciusko Co. The female was the active flight partner. Two broods.

Speyeria cybele cybele (Fabricius). Ten mating pairs. With the exception of one copulating pair (9. VII. 1969), the other pairs mated in late June. Six pairs were mating 22. VI. 1977, 70° F, between 2:15 P.M. and 3:25 P.M., Silver Lake, Kosciusko Co. They were all mating near the border of a forest and grass field. Two other pairs mated when the temperature was 84° F.

On 12. VII. 1978 the author observed a male *cybele* pursue a female. The female seemed to reject the pursuer by positioning herself on the underside of a blade of grass with the male directly above on the upper surface. She remained motionless with her wings closed, as the helpless male fluttered his wings and moved his antennae up and down. He soon left her and pursued another female, again being rejected in the same manner. The females were the active flight partners. One brood.

Boloria bellona (Fabricius). One pair: 30. IX. 1975, 3:45 P.M., 72° F, North Manchester, Wabash Co. The pair settled in a grassy field. For hours the author has watched this abundant species engage in its courtship activities, but have not

yet figured out the rejection method used by the females. The female was the active flight partner. Two broods.

Lycaenidae

The author supports writers Miller and Clench that "all the reliable records indicate that the female is the active partner in this family" (3). To date the author has collected only six lycaenid species of this large family *in copula*.

Satyrium caryaevorus (McDunnough). One pair on dogbane, edge of a forest, 26. VI. 1977, 3:50 P.M., 83° F, North Manchester, Wabash Co. One brood.

Satyrium acadica acadica (W. H. Edwards). One pair: 10. VI. 1977, 10:45 A.M., 60° F, settled in a patch of sedge grass east of Lake Waubee, Milford, Kosciusko Co. Dogbane nearby is one of its favorite host plants. One brood.

Lycaena (Tharsalea) hyllus (Cramer). Three pairs: 10. IX. 1969, 12:15 P.M., 62° F; 9. VII. 1970, 2:15 P.M., 80° F; and 10. VI. 1973, 5:35 P.M., 85° F—all in North Manchester, Wabash Co. and all breeding among *Iris versicolor* in marshy fields. Two broods.

Lycaena phlaeas americana (Harris). Four pairs: 21. IX. 1968, 8:45 A.M., 50° F, an extremely low temperature for mating, North Manchester, Wabash Co., indicating that the pairs had copulated through the night; 30. VIII. 1969, 10:30 A.M. and 7. IC. 1969, 11:40 A.M., both in North Manchester. The fourth pair matched 29. V. 1972, 9:05 A.M., Mongo, LaGrange Co. It is curious that no pairs of this species were found mating in the afternoons. Two broods.

Celastrina argiolus pseudargiolus (Boisduval & LeConte). One pair: 23. VI. 1969, 2:30 P.M., North Manchester, Wabash Co. Although this species with its spring and summer forms flies from mid-April until mid-September, its courtship and breeding habits seem to defy observation. Three broods.

Everes comyntas comyntas (Godart). Twelve pairs, the mating period extending from June 24 until October 7 (rarely). Mating usually occurs from 1:45 P.M. to 6:20 P.M., however, one pair was mating (2 IX. 1970) at 10:35 A.M., 70° F, Silver Lake, Kosciusko Co., on a *Polygonum* leaf. Mating temperatures were primarily in the 70s and 80s. Look for them in or near wooded areas. One brood.

Pieridae

In this family the author has found the male of each species observed *in copula* to be the active flight partner.

Pieris protodice protodice (Boisduval & LeConte). One pair: 24. VIII. 1971, 11:15 A.M., 65° F, Mongo, LaGrange Co. When the female wants to reject the approaches of the male, she does so by raising her abdomen to an almost perpendicular angle with her own thorax and vibrates her abdomen. Or, she may simply fly high into the air with the male frequently bumping her with his wings until they finally fly apart, "falling" to the ground well apart from each other.

Pieris napi oleracea (Harris). Four pairs, all *in copula* near watercress *Nasturtium officinale*, one of its larval foodplants, in the largest tamarak bog of

Indiana, Pigeon River Fish and Wildlife Area, Mongo, LaGrange Co. The first pair (23. VII. 1975) was mating at 12:35 P.M., 90° F (6). On 29. IV. 1978, 11:00 A.M., 70° F, the heavily veined spring form was *in copula* on the leaf of a Marsh Marigold amidst the usual watercress. Two pairs, 11. VII. 1978, were found at 2:25 P.M and 2:40 P.M., the temperature reading 73° F for both pairs. Three broods.

Pieris rapae (Linnaeus). Space will not permit a detailed record of the 363 pairs found *in copula*. Only a summary of the most relevant data will be presented. Mating takes place from early morning until late in the evening, some mating as early as 9:30 A.M. and others as late as 6:30 P.M., a few probably remaining *in copula* throughout the night. More observations of this phenomenon are needed.

Pierids, like most other butterflies, generally mate on warm, humid days, periods free from strong winds but not necessarily free from gentle rain followed by periods of sunshine. In the main, mating occurs from 11:00 A.M. until 4:00 P.M. Temperatures vary from a low 64° F (rare) to a high 91° F; however, the mid-70s to mid-80s account for the vast majority. The Cabbage White may be found copulating almost anywhere, even while crossing a major highway. Alfalfa fields, clover fields, and gardens where cabbages and other Cruciferae (larval foodplants) grow, supply the greatest number of breeding pairs.

Numerous observations show that the female, unprepared for copulation, will raise its abdomen nearly upright above its opened wings and vibrate its abdomen and antennae, a proven rejection method. After a full minute or two the male will fly away to pursue the first female scented. A mating pair may be bombarded by five or more males, but the author has never seen the copulating pair separated by the additional male activity.

Although entomologist report only three broods, may data show that in 1969 there were five broods in northeastern Indiana: (1) April 23 to May 6, (2) June 16 to July 1, (3) July 12 to August 4, (4) August 19 to September 5, and (5) September 14 to 22. This fact should not go unnoticed for this serious European pest and it is found breeding in Wabash, Kosciusko, Allen, Stuben, LaGrange, Elkhart, Noble, Delaware, Randolph, and Brown counties. Three to five broods.

Colias eurytheme and the next species (*Colias philodice*) occasionally hybridize. But, from 1964 until 1978 only two pairs have been found crossbreeding, even though both species fly together in the same hayfields, *philodice* doing best on clovers (*Trifolium*) and *eurytheme* being more successful on alfalfa (*Medicago sativa*). On 5. IX. 1969, a female *C. eurytheme* was found mating with a male *C. philodice*, 1:05 P.M., Silver Lake, Kosciusko Co. The other pair was collected 24. VIII. 1977, 1:25 P.M., 64° F, Silver Lake, with the male being a *philodice*. Although some hybridization takes place between these two species, it is best for the present to treat them as two separate species.

Only one male of *C. eurytheme* was found breeding a white or "alba" form female. Quite a contrast to the next species (*C. philodice*), where 40 percent of the females were "alba" forms. The rejection method of this species is the same as

used by the other pierids. Mating pairs have been collected in Wabash and Kosciusko counties.

Colias philodice philodice (Godart). Ninety-seven pairs. As in *P. rapae*, the information is overwhelming and difficult to analyze. Only a few pairs were matching before 11:00 A.M., the vast majority mating between noon and 4:00 P.M. A few, however, have mated as late as 6:35 P.M. The coldest mating temperature was 60°F, but most occurred in the higher 70s and 80s. A lot of courtship activity begins when the temperature reaches 68°F. During August and September mating activity reaches its peak, but it may occur any month from mid-June until early October.

It is hard to explain genetically why 40 percent of the females found *in copula* were "alba." The percentage seems too high. This matter needs more research.

Mating pairs have been found in Allen, Wabash, Kosciusko, Huntington, Elkhart, Carroll, and LaGrange counties. Two broods.

Papilionidae

Very little is known with certainty about the mating of swallowtails in any part of the world. Pronin (4) reported *Papilio machaon* Linnaeus in Europe (1:00-2:00 P.M. with the female as the active flight partner) and *Papilio multicaudatus* Kirby (California, 2:00-3:00 P.M.) without designating the active flight partner. Clench found the male *Battus montezuma* to be the active partner (personal correspondence). It is odd that species in this family are so difficult to find *in copula*. The author tried releasing several black female *Papilio glaucus glaucus* (Linnaeus) where many yellow males were flying in the tree-tops. Whenever a male detected the female, he would pursue her but no mating took place under these circumstances. Four Indiana species have been collected *in copula*, but my data are inconclusive.

Papilio philenor philenor (Linnaeus). One pair: 23. IV. 1976, 2:50 P.M., 70°F, Silver Lake, Kosciusko Co.; settled on a branch of a Hawthorne tree. The female was the active flight partner. Two broods.

Papilio polyxenes asterius (Stoll). One pair was reported to the author by the author's daughter (biology minor in college): 5. VII. 1978, 3:30 P.M., Daleville, Delaware Co. Unfortunately the active sex partner was not noted. Two or more broods.

Papilio troilus troilus (Linnaeus). One pair: 17. VII. 1971, 1:15 P.M., 76°F, Silver Lake, Kosciusko Co., mating in a woodland raspberry patch. After chasing the disturbed pair for nearly 100 yards through the woods and its heavy underbrush, the pair settled on a low bush. After netting them, the author determined that the female was the active flight partner; however, sex identification in these crowded quarters was difficult. Two broods.

Graphium marcellus (Cramer). Two pairs: 16. VI. 1968, 9:00 P.M. and 19. V. 1978, 1:45 P.M., 82°F—both in a woods, Silver Lake, Kosciusko Co. The flight partner of the first pair could not be determined because the pair took refuge in a raspberry patch. Two broods, possibly three.

When wanting to mate the males of two species—*Graphium marcellus* and *Papilio glaucus*—try to force the females to the ground, fluttering over them until rejection has been accepted.

Part Two: Mating Behavior of Skippers (Hesperioidae)

Hesperiidae

Seventeen species of this large family *in copula*, but the data is usually limited to a single pair or to a few pairs of each species. In every case the female was the active flight partner.

Euphyes conspicus conspicus (Edwards). One pair: 3. VII. 1970, 1:35 P.M., North Manchester, Wabash Co., mating among the sedges of a woodland marsh. One brood.

Euphyes bimaculata (Grote & Robinson). One pair: 20. VI. 1969, 1:00 P.M., North Manchester, Wabash Co., in a marshy meadow. One brood.

Euphyes vestris metacomet (Harris). One pair: 20. VI. 1969, 2:00 P.M., Silver Lake, Kosciusko Co., in woods copulating on a raspberry twig. One brood.

Atrytone delaware delaware (Edwards). One pair: 29. VI. 1970, 3:30 P.M., 89° F, in a grassy field, Silver Lake, Kosciusko Co. One brood.

Atalopedes campestris (Boisduval). One pair: 6. VIII. 1971, 3:15 P.M., 78° F, resting on *Helianthus strumesus*, a sunflower in a marshy field, North Manchester, Wabash Co. One brood.

Wallengrenia otho egeremet (Scudder). One pair: 9. VIII. 1971, 12:15 P.M., 79° F with high humidity, North Manchester, Wabash Co., on dogbane flowers. Two broods.

Polites coras (Cramer). Four pairs: 6. VI. 1970, 10:55 A.M., Tippecanoe Co.; 10. VII. 1971, 9:15 A.M., 76° F, North Manchester, Wabash Co.; 18. VIII. 1971, 3:30 P.M., 90° F, North Manchester; and 24. V. 1977, 12:55 P.M., 84° F, North Manchester. This last pair copulated on a blade of cattail in a marshy field. Two broods.

Polites themistocles (Latreille). Three pairs: 20. VI. 1969, 1:25 P.M., Silver Lake, Kosciusko Co.; 20. VI. 1971, 1:45 P.M., 85° F, North Manchester, and 24. VI. 1971, 2:00 P.M., 85° F, North Manchester, Wabash Co. One brood.

Polites origines origines (Fabricius). Three pairs: 10. VII. 1969, 3:30 P.M., Silver Lake, Kosciusko Co.; 11. VII. 1969, 3:10 P.M., Silver Lake, Kosciusko Co.; and 6. VI. 1970, 10:55 A.M., Tippecanoe Co. One brood.

Polites mystic (Edwards). One pair: 30. V. 1977, 4:55 P.M., 80° F, North Manchester, Wabash Co., mating on a blade of marsh grass in an open field. One brood, possibly two.

Thymelicus lineola (Ochsenheimer). Four pairs: 20. VI. 1969, 2:25 P.M., Silver Lake, Kosciusko Co.; 27. VI. 1970, 11:45 A.M., Mongo, LaGrange Co.; 26. VI. 1971, 1:00 P.M., 84° F, Silver Lake, Kosciusko Co.; and 3. VI. 1977, 11:00 A.M., 70° F, Silver Lake, on alfalfa. One brood.

Ancyloxipha numitor (Fabricius). Three pairs: 22. IX. 1969, 1:25 P.M.,

71° F, Silver Lake, Kosciusko Co., in grass by the border of a pond; 7. X. 1970, 2:15 P.M., 90° F, Carroll Co., in a grassy field; and 24. V. 1977, 9:20 A.M., 80° F, North Manchester, Wabash Co., resting on a blade of grassy in a marshy field. Two broods.

Pholisora catullus (Fabricius). Three pairs: 25. VII. 1969, 2:30 P.M., Silver Lake; 4. X. 1970, 12:40 P.M., 78° F, Silver Lake; and 16. VII. 1971, 12:45 P.M., 80° F, Silver Lake, Kosciusko Co.—all in an alfalfa field. Two broods.

Erynnis horatius (Scudder & Burgess). One pair: 30. IV. 1977, 1:45 P.M., 65° F, Silver Lake, Kosciusko Co., mating near the top of a dead raspberry twig where the mimicry was nearly perfect. Two broods.

Erynnis juvenalis juvenalis (Fabricius). Two pairs: 30. IV. 1976, 2:00 P.M., 65° F, Silver Lake, Kosciusko Co.; and 25. V. 1978, 11:40 A.M., 78° F, Mongo, LaGrange Co. The courtship of this last pair took less than one minute. The pair settled on a twig of a bush, turned their caudal portion toward each other and joined in copulation. One to two broods.

Thorybes pylades (Scudder). Five pairs: 11. VII. 1969, 3:10 P.M., Silver Lake; two pairs 1:20 P.M. and 2:25 P.M., Silver Lake, both pairs mating on a small path in a woodland raspberry patch; 23. VI. 1970, 2:35 P.M. and 25. VI. 1970, two more pairs mating on the ground in the above area, Silver Lake, Kosciusko Co. One to two broods.

Epygyreus clarus clarus (Cramer). One pair: 15. VIII. 1970, 10:40 A.M., 72° F, North Manchester, Wabash Co. One brood.

Tentative Conclusions and Research Questions

In the Danaidae and Pieridae families, the male of each species collected *in copula* was the active flight partner. In the Satyridae, Lycaenidae, and Hesperidae families, it was always the female which carried the male in flight. In the Nymphalidae and Papilionidae families, there was a variety of flight patterns, sometimes the male but more often the female being the active flight partner. Indiana records of copulation are needed for the Libytheidae, Riodinidae, and Liphyridae families.

More observations of the female's rejection techniques would be interesting for the remaining species. Only the pierids, and possibly that of one nymphalid (*Speyeria cybele*), are partially understood.

Many questions remain to be researched: How long do the various species remain *in copula*? How often will the same female or male mate? Why do so many common species escape observation when they are copulating? What is the purpose of nuptial flights high into the sky? Which species hybridize? More data are needed to answer these and other intriguing questions.

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