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1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

A REVIEW OF CARRYING PAIR BEHAVIOR AND MATING TIMES IN BUTTERFLIES

OAKLEY SHIELDS
Department of Entomology, University of California, Davis, California
and
JOHN F. EMMEL
Children's Hospital, San Francisco, California

INTRODUCTION

ALTHOUGH THE KNOWLEDGE OF THE CARRYING HABIT of mating pairs in butterflies has periodically been augmented by data accumulation or a short note, there appears to be a kind of prejudice—unspoken—that says this subject is scientifically unimportant. For whatever reason (possibly the misconception that *in copulo* pairs always take flight only in stress situations and that either sex will fly under such circumstances), data in this field has been slow in coming. In 1920 Warren remarked "how fragmentary our knowledge of these flying-habits is, and how much further records are to be desired." As long ago as 1836, Donzel correctly realized that carrying pair records can be of broad taxonomic importance. In a recent review (1968), Miller & Clench drew attention once again to the inflexibility of the habit (i.e. either male carries female, or female carries male, or both) in the various butterfly families. In view of the scattered and fragmentary nature of such informaton and the need for an up-to-date treatment, we have attempted a synopsis. We are also aware that data on carrying pairs is rather difficult to accumulate and have included our records on the subject. We have made a modest attempt at summarizing the pertinent literature while realizing that the immensity of it prohibits a really comprehensive treatment.

Whether it is a male or female which is the carrying partner is significant in phyletic considerations if (1) there is a family or generic stability, (2) many records are consistant for one

sex, and (3) both adults of the *in copulo* pair are capable of flight (i.e. the passive partner is not newly emerged). For example, in hilltopping species such as *Erynnis tristis* where female carries male consistently, the partners could not have emerged at the mating site. Since the male invariably initiates the courtship (although we have seen a reference to one *Ornithoptera* exception), all female carrying male records must be for both adults with well-developed wings. Only male carrying female records need be suspect in phyletic considerations since this condition could either be due to a legitimate behavioral trait or merely due to the female having "wet" wings and not yet capable of flight. E.g., in *Danaus gilippus berenice* the male carried the female consistently in 78 pairs at the mating site, where both adults went through the courtship flight (Brower, Brower, & Cranston, 1965), while in pierids where the male nearly always carries the female, the female sometimes is newly emerged. However, if both partners take part in initial courtship as one of us (O.S.) has observed consistently in *Anthocaris cethura*, the carrying pair observation is phyletically valid when the male is the active partner.

CARRYING PAIR SUMMARY

Table 1 lists the carrying pair records we are aware of for butterflies. Warren (1938) and Miller & Clench (1968) have presented what they consider the general trends within butterfly families. We disagree with the latter authors in generalizing that the female is usually the active partner in Lycaenidae (see below). The data presented here indicate that the male carries the female in Pierinae (except *Aporia crataegi*), Coliadinae, and Danainae. The female carries the male in Papilioninae, Parnassiinae, Satyrinae (most reports), Riodininae (only one species reported), Theclini (5 species; also female walked male forward in *M. loki* [69], but either walked in *I. iroides* [68]), Hesperiinae, and Pyrginae. Either male carries female or female carries male in Acraeinae, Nymphalinae (in favor of female carrying male), and Lycaeninae (in favor of male carrying female, excluding Theclini). It may be worth noting that the only species of hesperiid where male carried female (one pair out of eight, in *Erynnis tristis*) did so when the male was harassed by another *tristis* male that investigated the pair in his territorial area. Occasional alternation of the carrying sex develops when the pair is continually disturbed (see Table 1). Additional records are badly needed; there are a number of

subfamilies as yet unreported. Past impassioned appeals for more records (e.g. Bandermann, 1921) have been largely unheeded. Authors such as Warren (1920) and Miller & Clench (1968) point out that determining which sex is carrying is not always an easy matter and not to be hastily attempted.

BEHAVIOR

Copulation begins after the pair has alighted on a substrate (Ford, 1957:100). Miller & Clench (1968) note that *in copulo* pairs tend to remain motionless unless disturbed. Although the courtship is usually rather conspicuous in some groups, *in copulo* pairs remain camouflaged on bark of sticks (*E. tristis*, Shields, 1967), tree trunks (*N. antiopa*, Pronin, 1964), on top of trees (*A. iris*, Heslop, 1960), in tree foliage, in bushes on leaves (*H. crysalus*, Chambers, 1962; *I. iroides*, Powell, 1968), on the extremities of stems, and on rocks, often the sites of initial copulation. We have noted *in copulo* pairs of *C. tullia californica* and *D. plexippus* flying into trees when disturbed, also reported for *A. hyperantus*, *A. crataegi* (Sermin, 1954), and *A. paphia* (Weitbrecht, 1920). *In copulo* pairs on their larval foodplants, namely *C. viridis*, *C. dumetorum*, *L. argyrognomon anna*, and *Philotes* reported here, usually perched on the extremities of the bush. A disturbed pair of *P. sennae* repeatedly lit in the underbrush. However, two *P. shasta* pairs were fully exposed on the ground. Sermin (1954) noted one *in copulo* pair of *G. rhamni* hanging on a tree stump. Females of *E. editha* (Labine, 1966: 91) and *M. arion* (Sermin, 1954) sometimes carry the pair deep into the grasses. Occasionally mating pair females are found feeding on flowers (e.g. *Speyeria idalia*, Clark, 1932: 107; *Phyciodes mylitta*, present paper).

During the Dictionary Hill hilltopping study, O.S. noted that *P. zelicaon*, of those recorded, coupled at or adjacent to the summit in 10 pairs and flew downslope (more than 50′) to mate in 5 pairs. The breakdown of mating sites in *zelicaon* was as follows:

no. pairs	Site	Height above ground
3	Artemisia	1-1½′
5	Rhus	2-3′
2	Eriogonum	2-3′
1	Baccharis	2′
1	Brassica	6″
1	on ground in brush	0
2	unspecified plants	2-3′

In copulo pairs of *E. tristis* in that study perched on *Rhus* 2-3′ high in 5 pairs and on *Baccharis* 1-3′ high in 15 pairs, with one pair on a rock, one pair on a dead weed, and one pair on a bush composite, all on the summit. In *A. cethura,* one pair was on wild oats 1′ high, one pair on *Baccharis* 3′ high, and one pair on vegetation 15″ high, on the summit. All these pairs were rather inconspicuous, to the human observer, when perched on vegetation, and presumably would likewise be so to a vertebrate predator.

In the *in copulo* pairs we have observed that are hanging on vegetation, the male carries the female when the male is up and the female facing down and the female carries the male if the female faces up. Also, the carrying partner is the uppermost when the pair again alights (e.g., *M. jurtina, P. brassicae* in Dixey, 1915; *A. crataegi* in Sermin, 1954; and our observations). If copulation is initiated vertically on a subtrate, the male or female walks around to face down after initial copulation depending on the species, so that the uppermost partner is the carrying partner. It may be that the *in copulo* pair is perched up at a vantage point where the carrying partner is alert to disturbances, to take flight when a predator approaches at this vulnerable time. We have noticed that *in copulo* pairs are frequently quite wary when approached, often repeatedly flying and alighting or flying a fair distance before alighting. One pair of *Aphantopus hyperanthus* flew off over a stagnant pond (Sermin, 1954). A "post-nuptial flight" by the *in copulo* pair away from the area of initial copulation, without provocation, has been observed in *Danaus* (Urquhart, 1960: 153; Brower, Brower, and Cranston, 1965: 16). Table 2 summarizes the distances travelled by some *in copulo* pairs.

Some reports indicate that the active partner continues to carry the passive partner even when it is in a worn, decrepit wing condition. Colthrup (1917), in reference to a *Fabriciana niobe* pair, says, "I have seen a male of this species, so worn and broken as to be incapable of flying more than a yard or two at a time, paired with a large, heavy, newly emerged female, making strenuous efforts to escape capture." He also says in *Melanargia galathea* the male carries female even when the male is "worn to rags." Of *Argynnis paphia,* Tutt (1901) says, "It is remarkable that, however worn and battered, and apparently incapable the male may be physically to accomplish such a flight, the female never attempts, in my experience, to fly."

Carpenter (1935) has pointed out that which sex carries is not merely a matter of size since in some, either sex may carry. Carpenter (1918a) noted that in Pierinae, the male always carries even when smaller than the female, e.g. in an *Eurema brigitta* pair. He also mentions that in some *Acraea,* the larger female was carrying the smaller male in two species, and in one species the larger male was carrying the smaller female. The smaller female carried the larger male in some pairs of *Aphantopus hyperantus* and *Maniola jurtina;* in both cases the female could only make a short flight with its burden (Sermin, 1954). The larger female carried a smaller male in an *Issoria lathonia* pair (Sermin, 1954), and a larger male carried a smaller female in *Syntarucus telicanus* (Carpenter, 1918a). One might suppose that there would be selection for females carrying males in species with heavy-bodied females, as in, e.g., *Papilio, Euphydryas,* and hesperiids, with a selection for male carrying female in species with lighter-bodied females, as in, e.g., Pieridae, *Danaus,* and many lycaenids. In one case, there would be more chance of escape from predation if the heavier individual flew, and in the other case where little or no weight difference exists, the more vulnerable active partner should be the male, for in the event of an attack, the female may escape for propogation purposes. In this regard, we should mention here that *in copulo* pairs separated upon capture in *Limenitis camilla* (Wheeler, 1917) and *Lasiommata megera* (Sermin, 1954), and we have noted separation of an *in copulo* pair with *Pieris protodice* (when missed with a net swing) and *Erynnis tristis* (when net clamped over pair). However, we have noted that many pairs did not separate upon capture or harassment.

Sermin (1954) performed a simple experiment. With an *Aphantopus hyperantus in copulo* pair, where female carries the male, he held the female by the wings; the male did not fly off and remained passive. Bryk (1921) noted that in *Pieris napi* the male carries the female, but when he killed the male in a tandem pair by pinching its thorax, the female flew with the dead male, repeatedly. Clark (1932: 159) noted with *Colias philodice,* where male carries female: "I once caught a white female that was carrying a yellow male. But on examination the male proved to be dead, probably having been killed by a phymatid bug or a crab spider." We have seen no mention of both members of a pair flying simultaneously; one of the pair is always passive in flight. When the flying partner alternates, the previous active partner becomes passive. This passive state

might be analogous to "death feigning" that butterflies such as *Nymphalis* and *Euphydryas* assume when directly threatened (i.e., wings appressed, legs folded against thorax).

We know of females with wet wings (unexpanded or recently expanded) or "newly emerged" females *in copulo* in *Colias eurytheme* (Stern & Smith, 1960: 419), *Pieris protodice* (Ferris, 1969), *Pieris napi* and *P. bryoniae* (Petersen, 1952), *Eurema nicippe* (present paper), *Brintesia circe* (Verity, 1919), and *Fabriciana niobe* (Tutt, 1901; Colthrup, 1917). Sometimes these were being carried in the carrying flight. Females of these pairs are almost assuredly incapable of flight. *In copula* pairs with one sex unable to fly are certainly the exception. Stern & Smith (1960) note that *Colias eurytheme* generally mates after the female's wings have thoroughly hardened.

DURATION OF COPULATION

Records for duration of copulation in butterflies are not common but indicate that the length of time is considerable. An undisturbed *Papilio zelicaon* pair on Dictionary Hill summit, XII-22-67, took 36 minutes from inception to break-up. An *Aporia crataegi* pair noted from inception was still *in copulo* after one hour, when the pair was induced to make carrying flights (Sermin, 1954). *Pieris rapae crucivora* remained 80 minutes *in copulo* (Obara, 1967). A *Danaus plexippus* pair was *in copulo* for 1½ hours but it was not stated if start and finish were noted (Urquhart, 1960: 52). *Danaus gilippus berenice* duration is reported to be ca. 1-2 hours by Brower, Brower, and Cranston (1965: 16) and 4½ hours or longer by Pliske and Eisner (1969). For 25 pairs of *Incisalia iroides*, Powell (1968) noted, "In one instance a pair separated before sunset, after not more than two hours, 40 minutes of mating, but in most other cases copulation lasted four to six hours and occasionally as long as seven or eight hours." In 13 laboratory crosses in *Poanes hobomok*, the duration ranged from 27½-56 minutes with a mean of 38¼ minutes (Burns, 1970). In one undisturbed pair of *Erynnis tristis*, hook-up to break-up lasted 61 minutes (Shields 1967: 141).

Pieris napi in the lab at 6.5°C remained 5 days *in copulo* and separated within ½ hour when placed in 20°C, but another pair lasted only a day at 7.2°C (Petersen & Tenow, 1954: 189). Burns (1970) noted that cloudiness and lower temperatures

prolong duration of copulation; "presumably it cannot be prolonged indefinitely because of the logistics of spermatophore production." Two females collected on Dictionary Hill, after being *in copulo* for 6½ minutes in *Anthocaris cethura* and 9 minutes for *Callophrys dumetorum*, had already received a new spermatophore (Shields, 1967). If this proves to be the rule in butterflies, that the spermatophore is passed early in the *in copulo* period, why do butterflies remain *in copulo* for such a long period? One might otherwise suppose that the prolonged copulation is necessary for the complete transfer of the spermatophore.

GENITALIA

References to the morphology of the genitalia in Lepidoptera would nearly fill a library but references to actual function are scarce (Lorkovic, 1953). Papers dealing with the morphology of the valvae in butterflies include White (1878), Gosse (1883), and Sibatani et al (1954). Forbes (1939) gives a discussion of valvae muscles in butterflies. Apparently many authors are impressed by the large "claspers" or valvae and their vice- or jaw-like grip of the female's abdomen during copulation as the method of holding the pair securely together during the "carrying" flight (e.g. Wallace, 1865:35; Gosse, 1883:271; Klots 1951:40; Ford, 1957:100; Urquhart, 1962:52). However, Lorkovic (1953) has demonstrated by excision experiments in many European butterflies that instead it is the uncus (plus gnathos where present) which curves into a hook into a pocket under the ovipore, that is mainly responsible for the secure grip, the valves having a negligible effect.

When coupling, the male clasps the end of the female's abdomen with his valvae, uncus, gnathos, and falces before inserting the aedeagus into the bursa copulatrix (Klots, 195-). The manner of the initial attachment of the male abdomen to the female's in some species is described by Richards (1927:339) and Brower, Brower and Cranston (1965). In *Colias eurytheme* this grasp is on "the chitinous plate surrounding the ovipositor and ostium bursae" (Stern & Smith, 1960:420). The uncus first attaches, then the valves compress the end of the the female's abdomen laterally (Lorkovic, 1953; Hannemann, 1954; Stekol'nikov, 1965). The aedeagus insertion into the bursa copulatrix of the female further aids in anchorage (Hannemann, 1954). Rather detailed accounts of genitalia extrusion during copulation are given for Plebeiidi (Chapman, 1916) and *Argynnis paphia*

(Hannemann, 1954). Hardwick (1965) describes the mechanics of copulation in the noctuid moth *Helicoverpa,* and Stekol'nikov (1965) discusses muscle actions associated with the copulation sequence in moths.

In *Argynnis paphia* the male genitalia is extruded by means of contraction of the pleural muscle fibers which unite the lateral sections with either the tergite or the sternite in the abdomen; retraction of these muscles restores the genitalia to its normal internal condition (Hannemann, 1954).

Lorkovic (1953) notes that although the uncus is rather uniform in most genera, there is a diversity of valve forms. The aedeagus and ductus may change form between two closely related species in Plebeiidi (Chapman, 1916). Lorkovic says the marked variation in butterfly genitalia results from the genitalia's complete uselessness to that individual's existence, allowing it to vary far greater evolutionarily than, e.g., feet. He reasons that since rather large differences in genitalia do not prevent interspecific hybridizations in the lab (where they were mechanically paired), in nature these pairings are prevented by sexual odor differences. (We believe that courtship behavior differences also probably aid in preventing interspecific pairings.)

Carrying pairs, or phoretic copulation, is also known in three Hymenoptera families (Bethylidae, Tiphiidae, and Mutillidae), with winged males and wingless females (Evans, 1969). Here, major specializations in both male and female genitalia produce an extremely firm interlocking of their genitalia in flight. Certain Mutillidae even have modifications of the male's mandible, apparently to capture the female prior to copulation (Sheldon, 1970). Reasons surmised for this prolonged copulation with flight in certain Hymenoptera include: (1) adaptation to rival male interference, (2) an escape mechanism from predators, or (3) both (Lin, 1966; Evans, 1969).

A peculiar *in copula* posture is assumed by some species of *Incisalia* and *Erynnis.* Cook (1907) describes this pose for *I. henrici*: 'The posture of the butterflies during *coitus* merits attention, as it doubtless explains or is explained by the peculiar modification of the genitalia found in the Theclini. . . . these butterflies held their abdomens high so that they formed an angle of about ninety degrees. . . . The wings were closely appressed, the secondaries lifted away from the body, and the primaries dropped forward between them so that, except for the projecting apices, they were completely hidden. Whenever

the female moved forward even a little the male would immediately back up until the position described was regained, acting as though any other postion was painful, or at least uncomfortable." The same posture pertains to *I. iroides* in cop. (Powell, 1968).

During the Dictionary Hill study, O. S. observed some *Erynnis tristis in copulo* pairs resting in a position about 30 degrees from the horizontal (Shields, 1967, fig. 14). Burns (1964) says that the asymmetry in *Erynnis* genitalia is exceptional in skippers; "an aedeagus directed toward a male's right requires an ostium bursae situated on the female's left" (p 5).

In other species that we have noticed, the pose is linear.

INTERSPECIFIC HYBRIDS AND COURTSHIPS

Known wild-caught hybrids have been reported within the genera *Papilio, Parnassius* (Heydemann, 1943), *Anthocaris, Colias, Limenitis, Lycaena, Agathymus, Carterocephalus* (Alberti, 1943), etc. Hybridization within a genus might be expected but there is no evidence as yet that higher crosses (e.g. inter-generic, inter-family, butterfly X moth) are ever successful. Downey (1962) maintains that cross-matings are rarely attempted; "some of the reasons for this may be involved in size, behavioral characteristics, time of flight, time of maximum activity, seasonal cycles, and micro-ecological niches." Peterson (1952) and Peterson & Tenow (1954) have had no trouble producing crosses between *Pieris napi* and *P. bryoniae* for several generations but note that in nature the isolating factors of elevation, emergence time, and food plant differences prevent them from crossing. Wright (1906) gives a rough estimate that about one in 70 (*not* one in 140 as originally reported: see Downey, 1962) are mismatings, in his experience. Table 3 lists the copulation instances of mismatings that we are aware of. In the few instances of two males taken "*in copulo*", perhaps the proper behavioral cues were elicited for courtship and subsequent mating; the two instances that are reported were between two different species. (In addition, some 12 unusual pairings between moths are given by Graves, 1894; Perkins, 1914; de Fleury, 1934; and Downey, 1962.)

Courtships between two different species are occasionally encountered and could result in a "mismating." Toliver (1968) reported a male *Megathymus yuccae coloradensis* Riley court-

ing a female *M. streckeri* (Skinner); the male attempted to copulate but the female flew up, at which point both were netted. He notes that it was an unusual year in that the two were sympatric, usually being temporally isolated by two or three weeks. O'Byrne (1948) noted a much-worn male *Phyciodes nycteis* (Dbl. & Hew.) courting over a *P. gorgone* (Hbn.) female for more than half an hour. The female "responded as to a male of her own species." The event was ended by a thunderstorm.

During the Dictionary Hill hilltopping work, O.S. observed two inter-generic courtships. On March 19, 1967, a worn male *Papilio zelicaon* courted a MALE *Euphydryas chalcedona* between 11:38-11:39 a.m. PST, 66°F, 70% R.H. The *zelicaon* many times performed a bobbing flight behind and in front of the *chalcedona*, as male *zelicaon* do while courting females. When the *chalcedona* alighted, the *zelicaon* landed on top of him with his legs, causing the pair to fly up (repeated three times). The *zelicaon* followed the *chalcedona* in flight closely the whole time. The other courtship was between a male *Vanessa atalanta* and a fresh female *Papilio zelicaon* on January 8, 1967, 12:47 p.m. PST, 60°F, 35% R.H. The *zelicaon* was first noticed in low circling flights over the summit, as performed by virgin female *zelicaon*. When the *atalanta* investigated the female, the *zelicaon* broke into a fluttering, hovering flight and descended slowly toward the ground. The pair eluded capture, and the female flew rapidly downhill.

We know of two moth-butterfly courtships. Heitzman (1964) found a male *Thorybes pylades* Scudder courting a male *Euclidina cuspidea* Hubner, a noctuid moth. The *pylades* dipped lower and lower until the moth took flight, eleven times, before the moth crawled deeply into the grass. Two other "courtships" between these two species occurred that day, and both times the *pylades* quit while the *cuspidea* was still resting in the open. *Polites sabuleti* near *comstocki* Gunder were extremely abundant in an alkali grass field on August 30, 1964, at Waford Spring, 6500′, on Hwy. 31, 10½ air mi. NE of Lee Vining, Mono Co., Calif., leg. O.S. The numerous males often "boiled" around each other and pursued two species of unidentified whitish moths that superficially resembled the pale female *comstocki* in color. In the instances above and in Table 3, it may be noteworthy that the moths attended by male butterflies have been approximately the same color as that butterfly species' female, although their size may be larger or smaller than the female butterfly, with somewhat different flight habits.

MATING TIME

From Table 4, a few tentative generalizations can be made about when species mate, for the most part in agreement with the views of Miller & Clench (1968). The evidence is against the belief that butterflies mate at any time during the day. Those groups that mate mostly from mid-morning to early afternoon include *Papilio zelicaon* (primarily between 11:00-12:30 PST), *Argynnis, Speyeria, Phyciodes, Euphydryas, Chlosyne, Callophrys,* and *Celastrina.* Those that mate from mid-morning to mid-afternoon are *Philotes, Plebejus,* and *Erynnis tristis* (primarily between 11:30-1:00 PST). Those from mid-morning to late afternoon include Satyrinae, Coliadinae, and *Pieris. Danaus* pairs are mostly found in the late afternoon and possibly remain *in copulo* overnight in some cases. Late afternoon to early evening mating occurs in *Vanessa, Hypaurotis, Satyrium,* and *Incisalia iroides. Libytheana bachmannii* has been taken *in copulo* at U-V light in the evening. Many more observations are needed before definitive conclusions can be drawn.

Figs. 1 and 2 give the hourly spread of captured hilltopping females on Dictionary Hill summit for *Papilio zelicaon* and *Erynnis tristis,* although there is a collecting bias. That is, most collecting tends to be done in mid-day since the weather is best at that time. The total number of times a given ½ hour interval was checked on the days that that species' females were collected are as follows (somewhat approximate):

	10-10:30	10:30-11	11-11:30	11:30-12	12-12:30
P. zelicaon	9	15	18	21	33
E. tristis	—	11	13	14	11
	12:30-1	1-1:30	1:30-2	2-2:30	2:30-3
P. zelicaon	29	23	13	10	6
E. tristis	10	6	5	2	—

In addition, 16 virgin female *P. zelicaon* from the release experiment arrived at the summit between 11:20-12:45 PST during a 3-day period.

Stern and Smith (1960) make the following observations about the mating time in *Colias eurytheme*: "In the San Joaquin Valley on very hot days, mating as well as general activity is more pronounced during the morning and late afternoon, while during midday, activity nearly ceases. On mild days, mating and other activity occur throughout the day. On cold days, there is very little activity."

Our records are given in Tables 5-8. Accompanying weather data is given for *P. zelicaon, A. cethura,* and *E. tristis;* Powell (1968) records weather information for 30 mating pairs of *Incisalia iroides.*

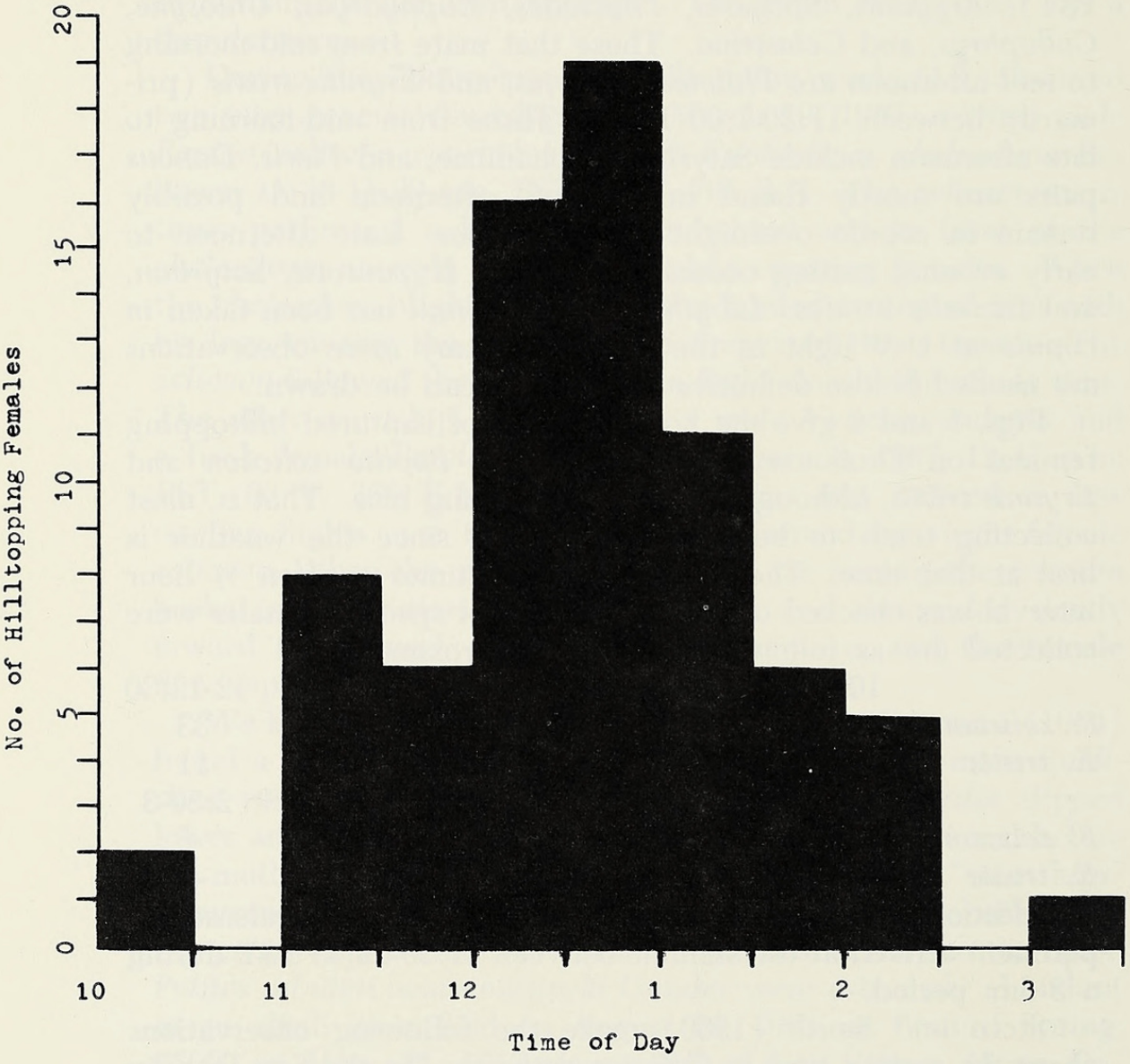

Fig. 1.—Numbers of *Papilio zelicaon* females that were present on the summit of Dictionary Hill during the day (see also Table 6).

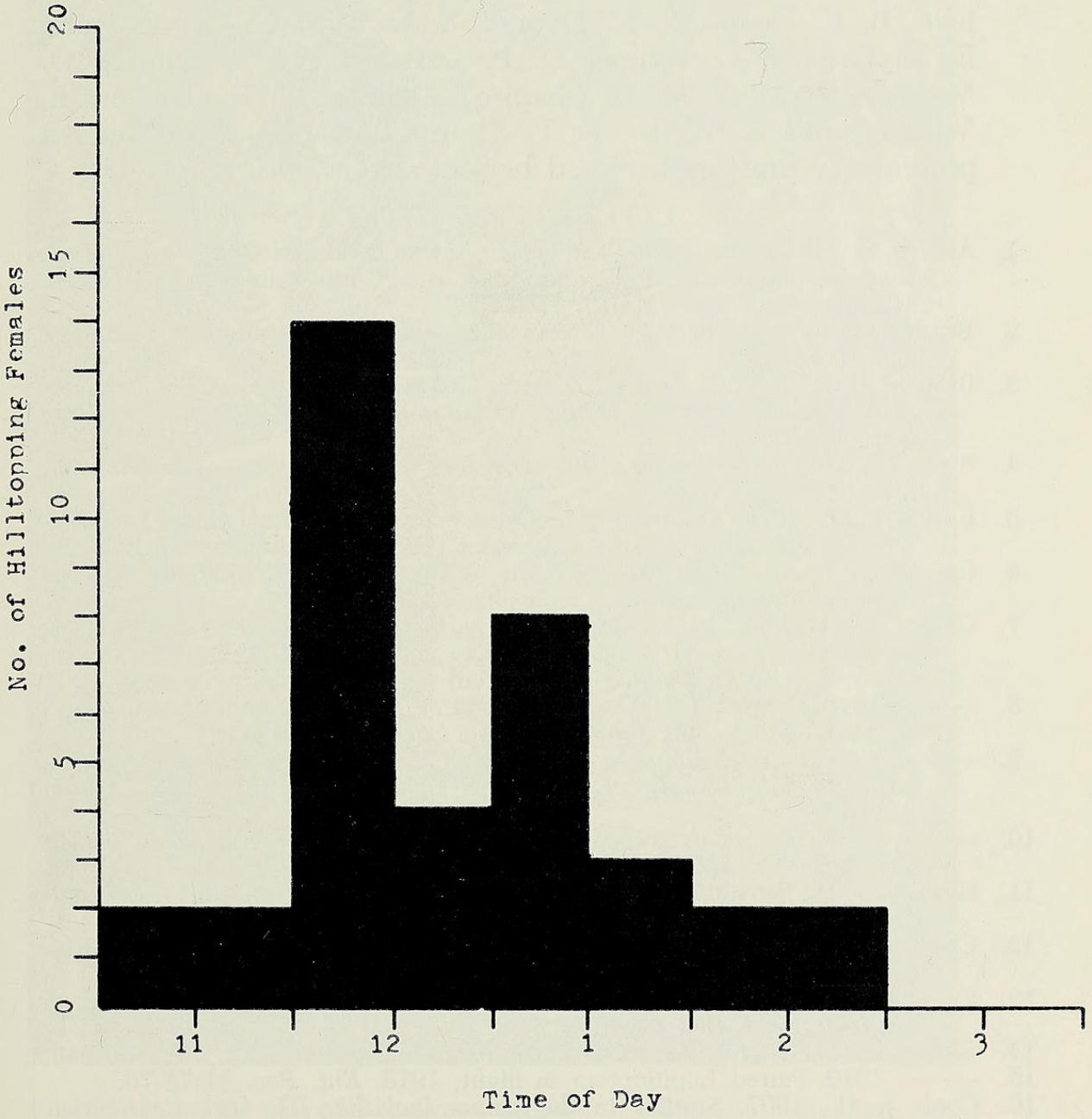

Fig. 2.—Numbers of *Erynnis tristis* females that were present on the summit of Dictionary Hill during the day (see also Table 8).

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Fig. 3.—*In copulo* pair of *P. zelicaon* perched in a *Rhus* bush on Dictionary Hill summit, female up, male down.

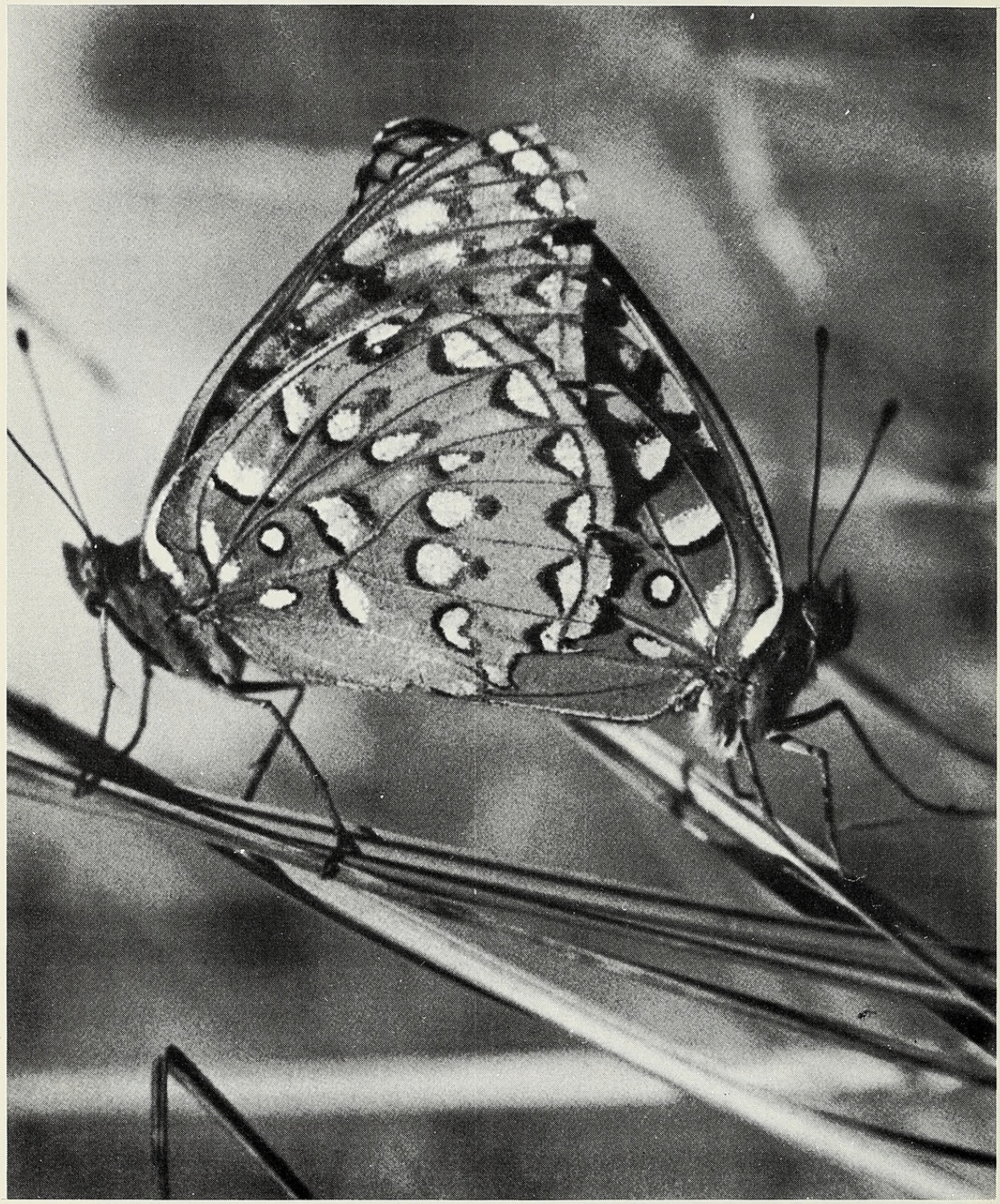

Fig. 4.—*In copulo* pair of *Speyeria nokomis apaeheana*, 1 mi. W. of Gull Lake, Mono Co., Calif., VIII-27-70, 1:10 p.m. (PST), male up, female down.

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Fig. 5.—*In copula* pair of *Satyrium sylvinus*, Stonyford, Colusa Co., Calif., VI-5-69, 3:45 p.m. (PST), female left, male right.

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TABLE 1 List of "carrying pair" records for butterflies

Species	male carried female	female carried male	Alternating	References	Realm
PAPILIONIDAE					
Papilioninae					
Papilio dardanus Brown		1+		6	Eth.
Papilio dardanus cenea Stoll.		1		7	Eth.
Papilio echerioides Trimen		1+		6	Eth.
Papilio jacksoni Sharpe		1+		6	Eth.
Papilio machaon L.		1+		71	Pal.
Papilio polytes L.		1+		6	Ori.
Papilio polyxenes Fab.		2		28, 69	Nea.
Papilio rudkini Comstock		2		69	Nea.
Papilio zelicaon Lucas		2		69, 83	Nea.
Parnassiinae					
Parnassius apollo L.		1		98	Pal.
Zerynthia polyxena Schiff.		1+		24	Pal.
Zerynthia rumina L.		1+		24	Pal.
PIERIDAE					
Pierinae					
Anthocaris cethura F. and F.	1			83	Nea.
Aporia crataegi L.		14+		24, 71, 77, 97	Pal.
Appias drusilla (Cr.)	1			56	Neo.
Belenois creonia severina (Stoll)	10+			8, 21	Eth.
Belenois gidica Godt.	1			8	Eth.
Catasticta nimbice (Bdv.)	1			56	Nea.
* Colotis achine Cram.	3			8	Eth.
* Colotis ducissa Dogu.	1			8	Eth.
Colotis euippe omphale Godt.	1			7	Eth.
Colotis evagore Klug	1			8	Eth.
Colotis evenina casta Gerst.	17			8	Eth.
Dixeia charina simana Hopff.	34	1		8	Eth.
Dixeia pigea Bdv.	1			21	Eth.
Eronia cleodora Hubn.	1			7	Eth.
Glycestha aurota F.	10			8	Eth.
Pieris beckerii Edw.	1			69	Nea.
Pieris brassicae L.	10+			14, 21, 24, 34, 35, 75, 98	Pal.
Pieris mannii Mayer	1			97	Pal.
Pieris napi L.	24+			4, 14, 21, 26, 35, 44, 69, 71, 77, 97, 98, 104	Nea. Pal.
Pieris protodice Bdv. and LeC.	4			69, 83	Nea.
Pieris rapae L.	31+			13, 14, 15, 21, 24, 35, 44, 56, 71, 77, 104, 108	Nea. Pal.
Pieris sisymbrii Bdv.	4			69	Nea.
Pieris virginiensis Edw.	2			56	Nea.
Pinacopteryx eriphia Godt.	1			8	Eth.
Pontia daplidice L.	1+			24	Pal.
Coliadinae					
Catopsilia florella F.	2			8	Eth.
Colias crocea Fourcr.	3+	1+		18, 24, 56, 98	Pal.
Colias eurytheme Bdv.	2			56, 69	Nea.
Colias hyale L.	4+	1+		18, 24, 71, 77	Pal.
Colias occidentalis chrysomelas Edw.	1			69	Nea.
Colias palaeno L.	1+			91	Pal.
Colias phicomone Esp.	1			98	Pal.
Colias philodice (Godart)	1+			108	Nea.

TABLE 1 (cont.)

Species	male carried female	female carried male	Alternating	References	Realm
Eurema brigitta Cr.	1			7	Eth.
Eurema desjardinsii regularis Btlr.	1			8	Eth.
Eurema hecabe senegalensis Bdv.	1			8	Eth.
Eurema lisa Bdv. and LeC.	4			56	Nea., Neo.
Eurema nicippe (Cr.)	1			69	Nea.
Nathalis iole Bdv.	1			69	Nea.
Phoebis sennae (L.)	1			69	Nea.
Zerene cesonia (Stoll)	2			69	Nea.
SATYRIDAE					
Satyrinae					
Aphantopus hyperanthus L.		6+		71, 77, 101, 104,	Pal.
Brintesia circe F.	1+			95	Pal.
Cercyonis pegala (F.)		1		56	Nea.
Cercyonis pegala boopis (Behr)		1		69	Nea.
Chazara briseis L.	1			35	Pal.
Coenonympha arcania darwiniana Stgr.		1		98	Pal.
Coenonympha gardetta de Prunner		2		97, 98	Pal.
Coenonympha pamphilus L.		5+		13, 24, 35, 44, 101	Pal.
Coenonympha tullia californica (Westwood)		3		69	Nea.
Coenonympha tullia tiphon Rott.		1		97	Pal.
SATYRIDAE					
Satyrinae (cont.)					
Erebia aethiops Esp.		1		97	Pal.
Erebia alberganus ceto Hbn.		2		98	Pal.
Erebia claudina Borkhausen		2		98	Pal.
Erebia euryale Esp.		1		97	Pal.
* Erebia goante Esp.		1+		91	Pal.
Erebia gorge Esp.		4		97, 98	Pal.
Erebia manto Esp.		2		97	Pal.
Erebia medusa Schiff.		3+		71, 77	Pal.
Erebia oeme Hbn.		2		97	Pal.
Erebia stirius Godart, ssp. stelviana		1		98	Pal.
Euptychia cymela (Cr.)		2		56	Nea.
Euptychia hermes (F.)		1		56	Neo.
Hipparchia neomiris God.		1		98	Pal.
Hipparchia semele L.		3		14, 15, 21	Pal.
Lasiommata maera L.		4+		91, 97, 98	Pal.
Maniola jurtina L.	1+	36+		13, 14, 15, 18, 21, 24, 34, 35, 43, 44, 56, 71, 97, 101, 102, 104	Pal.
Melanargia galathea L.	4+	10+		34, 35, 71, 77, 92, 97, 101, 104	Pal.
Minois dryas Scopoli		9		77, 97	Pal.
Pararge aegeria L.		4+		71, 89, 101	Pal.
Pararge hiera L.		1		97	Pal.
Pierella helvina incanescens God. and Salvin		1		56	Neo.
Pierella luna (F.)		1		56	Neo.
Pyronia cecilia Vallantin		1		98	Pal.
Pyronia tithonus L.		9+		13, 15, 97, 98, 104	Pal.
Satyrus actaea Esper		1+		24	Pal.
Ypthima asterope Klug		1		7	Eth.

TABLE 1 (cont.)	male carried female	female carried male	Alternating	References	Realm
NYMPHALIDAE					
Danainae					
Danaus chrysippus L.	19			9	Eth.
Danaus gilippus berenice (Cr.)	78			3, 65	Nea.
Danaus gilippus strigosus (Bates)	5			56, 69	Nea, Neo.
Danaus plexippus (L.)	14+	1+		56, 69, 71, 93	Nea.
Acraeinae					
Acraea caldarena Hew.	26	1		7, 9	Eth.
Acraea chilo Godman		1		104	Eth.
Acraea encedon L.		6		7, 9, 78, 79	Eth.
Acraea natalica Bdv.		2		7	Eth.
Acraea oncaea Hopff.	1			7	Eth.
Nymphalinae					
Adelpha bredowii Geyer		1+		71	Nea.
Anartia fatima (F.)	1			56	Neo.
Anartia jatrophae luteipicta Fruhst.		1		56	Neo.
Apatura iris L.		1+		45	Pal.
Argynnis paphia L.	43+	14+		14, 22, 23, 34, 35, 44, 57, 71, 77, 92, 97, 100, 101, 103, 104	Pal.
Asterocampa leila (Edw.)		1		56	Neo.
Boloria pales arsilache Esp.		1+		35	Pal.
Boloria pales palustris Fruhst.		1		98	Pal.
Brenthis daphne Schiff.		1+		24	Pal.
* Byblia goetzius Herbst.	1			7	Eth.
Chlosyne californica (Wright)		1		69	Nea.
Chlosyne damoetas malcolmi (Comstock)		1		69	Nea.
Chlosyne gabbii (Behr)		3		69	Nea.
Chlosyne leanira fulvia (Edw.)		1		69	Nea.
Clossiana euphrosyne L.		1		60	Pal.
Clossiana selene Schiff.	1+			34	Pal.
Clossiana titania cypris Meigen		1		98	Pal.
Euphydryas aurinia Rott.		1+		44	Pal.
Euphydryas aurinia glaciegenita Vrty.		2		98	Pal.
Euphydryas chalcedona (Doubleday)		6		69	Nea.
Euptoieta claudia (Cr.)	2	2		56, 69	Nea.
Fabriciana adippe Schiff.	3+	2+	1+	21, 22, 101, 102,	Pal.
Fabriciana niobe L.	2+	1		34, 92	Pal.
Hamanumida daedalus F.		2		7	Eth.
Hypolimnas misippus L.		1+		6, 78	Eth.
Issoria lathonia L.	4+	1+		34, 35, 77, 92	Pal.
Junonia coenia (Hbn.)		1		69	Nea.
Melitaea cinxia L.		1+		44	Pal.
Melitaea diamina Lang.	1			98	Pal.
Melitaea didyma O.		6+		24, 35, 44, 92, 97	Pal.
* Melitaea helvetica Ruhl		2		98	Pal.
Mellicta asteria Freyer		1		98	Pal.
Mellicta athalia Rott.	1+	2+		24, 34, 97	Pal.
Mellicta varia M. -Dur.		2		98	Pal.
Mesoacidalia aglaja L.	5+	5+		24, 34, 35, 91, 92, 97, 101, 102	Pal.
Microtia dymas Edw.		2		69	Nea.
Neptis "agatha" Cr.		1		7	Eth.
Pandoriana pandora Schiff.		1		98	Pal.
Phyciodes campestris (Behr)		3		69	Nea.
Phyciodes mylitta (Edw.)		2		69	Nea.
Phyciodes tharos (Drury)		1		56	Nea.
Precis actia Dist.		1		7	Eth.
Precis clelia Cr.		1+		78	Eth.

TABLE 1 (cont.)

Species	male carried female	female carried male	Alternating	References	Realm
Pseudacraea poggei Dew.		1		7	Eth.
Speyeria aphrodite (F.)		1		56	Nea.
Speyeria callippe (Bdv.)		2		69	Nea.
Speyeria callippe comstocki (Gunder)		1		69	Nea.
Speyeria cybele (F.)		1		56	Nea.
Speyeria cybele leto (Behr)	1			69	Nea.
Speyeria egleis (Behr), ssp.		1		69	Nea.
Speyeria hydaspe (Bdv.), ssp		1		69	Nea.
Speyeria idalia Drury		1+		108	Nea.
Speyeria mormonia arge (Strecker)	1	1		69	Nea.
Speyeria nokomis (Edw.)	1+	1+		56	Nea.
Speyeria nokomis apacheana (Skinner)	4			69	Nea.
LYCAENIDAE					
Riodininae					
Apodemia mormo virgulti (Behr)		2		69	Nea.
Lycaeninae					
Agrodiaetus damon Schiff.	3			97, 98	Pal.
* Alaena interposita Butl.		1		7	Eth.
Albulina orbitulus Prun.	5			97, 98	Pal.
* Argus escherii Hbn.	1+			24	Pal.
Aricia agestis Schiff.	1			15	Pal.
Axiocerses amanga Westw.		1		7	Eth.
Chrysophanus titus (F.)		1		56	Nea.
Cupido minimus Fuessly		2		98	Pal.
Cupido osiris Meigen	1			97	Pal.
Cyaniris semiargus Rott.		1		97	Pal.
Eumedonia eumedon Esper		1		98	Pal.
Everes alcetas Hoffmannsegg	1			97	Pal.
Everes comyntas texanus Chermock		3		56	Neo.
Glaucopsyche alexis Poda	1			97	Pal.
Leptotes marina (Reakirt)		1		69	Nea.
Lycaena arota (Bdv.)	1			69	Nea.
Lycaena editha (Mead)	1			69	Nea.
Lycaena phlaeas L.		1		97	Pal.
* Lycaena subslpina Spr.	1			97	Pal.
Lysandra bellargus Rott.	3+			24, 97, 101	Pal.
Lysandra coridon Poda	22+			13, 15, 24, 35, 86, 89, 97, 98, 101, 104	Pal.
Maculinea arion L.		2+		71, 97	Pal.
Meleageria daphnis Schiff	1+			24	Pal.
Nordmannia acaciae F.		1+		24	Pal.
Nordmannia ilicis Esper		1+		24	Pal.
Palaeochrysophanus hippothoe eurydame Hoffmannsegg		1		97	Pal.
Philotes battoides (Behr), ssp.	5	1		69	Nea.
Philotes battoides oregonensis Barnes and McDunnough		2		69	Nea.
Philotes enoptes ancilla Barnes and McDunnough	1			69	Nea.
Philotes enoptes dammersi Comstock and Henne	2			69	Nea.
Philotes enoptes smithi Mattoni	1			69	Nea.
Philotes rita (Barnes and McDunnough)	1			69	Nea.
Philotes rita pallescens Tilden and Downey	1			69	Nea.
Plebejus acmon (Westw. and Hew.)	6	1	1	69	Nea.

TABLE 1 (cont.)

Species	male carried female	female carried male	Alternating	References	Realm
Plebejus argus L.	8+			14, 34, 71, 77, 98, 101, 104	Pal.
Plebejus argyrognomon Bgstr.	1+			101	Pal.
Plebejus argyrognomon ricei (Cross)	1			69	Nea.
Plebejus saepiolus (Bdv.)			1	69	Nea.
Plebejus shasta (Edw.)	1	1		69	Nea.
Plebicula dorylas Schiff.	5			97, 98	Pal.
Polyommatus eros O.	1			98	Pal.
Polyommatus icarus Rott.	29+			13, 14, 15, 21, 26, 34, 35, 44, 71, 77, 86, 89, 97, 101, 104	Pal.
Strymonidia spini schiff.		1+		24	Pal.
Syntarucus telicanus Lang.	1	4		7	Eth.
HESPERIIDAE					
Hesperiinae					
Atrytone conspicua Edw.		1+		108	Nea.
Hesperia harpalus leussleri Lindsey		1		69	Nea.
Hesperia juba Scudder		3		54, 69	Nea.
Hylephila phyleus (Drury)		1		56	Nea.
Ochlodes sylvanoides (Bdv.)		1		69	Nea.
Ochlodes venatus Turati		1+		44	Pal.
Polites peckius (Kirby)		2		56	Nea.
Polites sonora (Scudder)		1		69	Nea.
Thymelicus sylvestris Poda		3		56, 77	Pal.
Pyrginae					
Cogia calchas (Herrich-Schaffer)		1		56	Neo.
Erynnis brizo lacustra (Wright)		1		69	Nea.
Erynnis funeralis (Scudder and Burgess)		1		69	Nea.
Erynnis juvenalis (F.)		2		56	Nea.
Erynnis tages L.		3		97	Pal.
Erynnis tristis (Bdv.)		7		69, 83	Nea.
Pholisora catullus (F.)		1		69	Nea.
Polythrix asine (Hew.)		1		56	Neo.
Pyrgus alveus Hbn.		1		98	Pal.
Pyrgus alveus ryffelensis Oberth.		1		97	Pal.
Pyrgus carlinae Rambr.		1		98	Pal.
Pyrgus communis (Grote)		2		69	Nea.
Pyrgus malvae L.		1		97	Pal.
Pyrgus serratulae Rambr.		1		98	Pal.
Thorybes diversus Bell		1		69	Nea.

Comments: A "+" by the number of pairs refers to an unspecified additional number or the possibility thereof based on the wording. We attempted to update the genera and species names to current usage but found no recent treatment of the few names with an asterisk. In Papilio polyxenes, ref. no. 28, it is almost certainly this species, and not P. bairdii as originally reported, in our opinion Nea. = Nearctic, Neo. = Neotropical, Pal. = Palearctic, Eth. = Ethiopian, Ori. = Oriental.

TABLE 2 Distance travelled by in copulo pairs in flight

Species	Distance	Source
Aporia crataegi L.	over 30m (2X, same pair), 70 - 80m	77
Pieris napi L.	over 20m, 50m	77
Pieris protodice Bdv. and Lec.	ca. 20 yards	new
Pieris rapae L.	10-20m, 15-20m, 40-50m, ca. 50m, over 50m, over 60m, over 200 strides	77
Colias hyale L.	40m, 50-60m	77
Aphantopus hyperanthus L.	3-4m	77
Lasiommata megera L.	4-5m 8m, ca. 10m (2X, same pair), 20-30m	75, 77
Maniola jurtina L.	ca. 3-4m, 6-8m	77
Melanargia galathea L.	5-10m, over 20m	77
Minois dryas Schopoli	10m, ca. 40m, ca. 50m (2 pairs)	77
Danaus gilippus berenice (Cr.)	well over 1000' (max. 80' high; variable in height and distance)	3
Argynnis paphia L.	"the pair flew a great distance", ca. 20m	34, 77
Issoria lathonia L.	5-6m	77
Polyommatus icarus Rott.	2-3m	77
Erynnis tristis (Bdv.)	10', ca 10 yards (2X, same pair), ca. 50' (2 pairs)	new

TABLE 3 Interspecific pairings in butterflies

COMBINATION (male X female)	Sources
different species:	
1. Pieris rapae L. X Pieris protodice (Bdv. and LeC.)	107
2. Colias eurytheme Bdv. X Colias philodice Godart	47
3. Colias hyale L. X Colias crocea Geoffroy ab. pallida	36
4. Coenonympha hero L. X Coenonympha arcania L.	33
5. Dira clytus L. X Dira mintha Geyer	20
6. Chlosyne neumoegeni (Skinner) X Chlosyne californica (Wright)	70
7. Limenitis archippus Cr. X Limenitis astyanax F.	64
8. Lycaena thoe Guerin-Meneville X Lycaena phlaeas americana Harris	85
9. Plebejus icarioides (Bdv.) X Plebejus melissa (Edw.)	25
different genera:	
1. Maniola jurtina L. X Aphantopus hyperantus L.	48
2. Maniola jurtina L. X Minois dryas Scopoli	48
3. Pyronia tithonus L. X Aphantopus hyperantus L.	89 (p. 149)
4. Pyronia tithonus L. X Lasiommata megera L.	17
5. Fabriciana adippe Schiff. X Argynnis paphia L.	34, 57
6. Chlosyne gorgene carlota Reakirt X Polydryas pola arachne Edw.	109
7. Vanessa atalanta (L.) X Aglais urticae L.	73
8. Plebejus icarioides montis Blackmore X Everes amyntula (Bdv.)	32
9. Lysandra coridon Poda X Polyommatus icarus Rott.	99
10. Callophrys dumetorum (Bdv.) X Incisalia iroides (Bdv.)	107
different families:	
1. Aglais urticae L. X Maniola jurtina L.	94
2. Argynnis paphia L. X Quercusia quercus L.	38
3. Chlosyne acastus (Edw.) X Lycaena cupreus snowi Edw.	25
4. Maniola jurtina L. X Mesoacidalia aglaja L.	29, 48
5. Mesoacidalia aglaja L. X Mesoacidalia aglaja L. Maniola jurtina L.	61
6. Maniola jurtina L. X Aglais urticae L.	33, 48, 106
7. Lycaena dispar Haworth X Pieris brassicae L.	109
butterfly X moth (male X female):	
1. Anthocaris cardamines L. X Bapta temerata (W. V.)--white geometrid	76
2. Erynnis tages L. X Ectypa glyphica L. --brown noctuid	19
intra-sex (male-male):	
1. Maniola jurtina L. X Minois dryas Scopoli	29
2. Brenthis daphne Schiff. X Mellicta athalia Rott.	74

TABLE 4 Mating time records for butterflies

Species	Times	Sources
PAPILIONIDAE		
Papilioninae		
Battus philenor hirsuta (Skinner)	10:50	69
Papilio eurymedon Lucas	11:20, 11:35, 12:05, 12:34, 12:54, 1:22, 1:34	69
Papilio indra pergamus H. Edwards	between 9:00-9:30, ca. 12:00	69
Papilio machaon L.	1-2	71
Papilio multicaudatus Kirby	2-3	71
Papilio polyxenes Fabr.	ca. 4:30	28
Papilio rudkini (J. A. Comstock)	12:40, 12:45	69
Papilio zelicaon Lucas	See Table 6	69
PIERIDAE		
Pierinae		
Anthocaris cethura (Felder and Felder)	11:42 (see also Table 7)	69
Aporia crataegi L.	10:30, 3:00, ca. 3:15, 4:30	77
Appias drusilla (Cramer)	2:25	56
Catasticta nimbice (Bdv.)	12:30	56
Pieris beckerii Edwards	12:20	69
Pieris napi L.	between 10:55-11:20, 1:00(2), 2:15, 2:30, 3:00 (2), bet. 3-4 (2), 3:30, 4:00 (2), 4:30, 5:30 (2)	69, 77
Pieris occidentalis Reakirt	12:00	69
Pieris protodice Bdv. and LeC.	8:00, 8:54, 9:30, 9:30-10:00 (many), 10:58, 12:35, 1:55, 1:58	28, 56, 69, 83
Pieris rapae L.	bet. 10-12, 10:30, 10:45, 11:35, 1:00, 2:00, bet. 2-4, 2:30, 3:00, 3:35, 3:45, 4:30, 5:00, 5:30, 6:00pm	56, 77
Pieris sisymbrii Bdv.	9:20, 11:45, 2:30, 2:33	69
Pieris virginiensis Edw.	1:20, 1:30	56
Coliadinae		
Colias croceus Fourcroy	ca. 2:30	56
Colias eurytheme Bdv.	1:05, 1:25	69
Colias hyale L.	ca. 2:30-2:45(2), 3:15	77
Colias meadii Edw.	8:45	69
Colias occidentalis chrysomelas H. Edwards	12:13	69
Eurema daira (Godart)	2:40	56
Eurema lisa Bdv. and LeC.	10:55, 12:55, 1:45	56
Eurema nicippe (Cramer)	11:20	69
Gonepteryx rhamni L.	bet. 1-3	77
Nathalis iole Bdv.	3:50	69
Phoebis sennae (L.)	10:45	69
Zerene cesonia (Stoll)	10:35, 4:20	69
SATYRIDAE		
Satyrinae		
Aphantopus hyperantus L.	10:00(2), 4:00	77
Cercyonis pegala pegala (Fabr.)	1:30	56
Cercyonis pegala boopis (Behr)	10:00	69
Cercyonis pegala maritima (Edw.)	1:00	56
Coenonympha tullia californica (Westw.)	9:06, 10:50, 12:20	69
Erebia callias Edw.	12:45	69
Erebia medusa Schiff.	5:00	77
Euptychia cymela (Cramer)	12:45, 1:30, 2:00	56
Euptychia hermes (Fabr.)	1:30	56

TABLE 4 (cont.)

Species	Times	Sources
Lasiommata megera L.	10:00, 12:00, 1:30, 3:00(2) 4:00(2), 6:00pm, "late afternoons"	77, 89
Maniola jurtina L.	10:15, bet. 1:30-3:00(2), 2:00, 2:15, 2:30, 3:00(2)	56, 77
Melanargia galathea L.	7:15, 9:30, 10:00	77
Minois dryas Scopoli	11:30, 1:30(2), 2:45, 3:00(3)	77
Oeneis melissa lucilla Barnes and McDunnough	11:45	69
Pierella helvina incanescens Godman and Salvin	11:00	56
Pierella luna (Fabr.)	11:00	56
NYMPHALIDAE		
Danainae		
Danaus gilippus strigosus (Bates)	"afternoon" (2pr.), 3:30, 4:40, 5:15	56, 69
Danaus plexippus (L.)	7:25, 12:30, 12:55, 3:30, 4:30-4:45 (12-15 prs.), "afternoon".	56, 69
Nymphalinae		
Adelpha bredowii Geyer	2-3	71
Aglais urticae L.	2-3	71
Anartia fatima (Fabr.)	bet. 10-12	56
Anartia jatrophae luteipicta Fruh.	11:00	56
Argynnis paphia L.	usually at ca. 10; ca. 11:15, bet. 2-3, 3:00, 6:00 pm	77, 100
Asterocampa leila (Edw.)	11:00	56
Chlosyne californica (Wright)	10:30	69
Chlosyne damoetas damoetas (Skinner)	12:45	69
Chlosyne damoetas malcolmi (J. A. Comstock)	9:35	69
Chlosyne gabbii (Behr)	12:30, 1:05, 1:40	69
Chlosyne leanira fulvia (Edw.)	1:30	69
Euphydryas chalcedona (Doubleday)	10:10, bet. 11:30-12:00 (3) 11:19, 12:01, 12:06, 12:56, ca. 2:00, 3:03	69
Euphydryas editha (Bdv.), ssp.	10:30	69
Euphydryas editha baroni (Edw.)	10:30	69
Euptoieta claudia (Cramer)	10:30, 11:10, 11:20, 3:45	56, 69
Inachis io L.	2-3	71
Issoria lathonia L.	ca. 4:15	77
Junonia coenia (Hubner)	1:13	69
Microtia dymas Edw.	12:00, 12:10	69
Nymphalis antiopa L.	2-3 (2)	71
Nymphalis polychloros L.	2-3	71
Phyciodes campestris campestris (Behr)	12:00	69
Phyciodes campestris camillus Edw.	12:20	69
Phyciodes mylitta (Edwards)	10:30, 1:30	69
Phyciodes phaon (Edwards)	10:00	56
Phyciodes tharos (Drury)	12:00, bet. 1-2	56
Polygonia c-album L.	2-3	71
Speyeria aphrodite (Fabr.)	12:30	56
Speyeria callippe callippe (Bdv.)	11:09, 11:17	69
Speyeria callippe comstocki (Gunder)	10:50	69
Speyeria callippe harmonia dos Passos and Grey	10:25	69
Speyeria cybele leto (Behr)	11:30	69
Speyeria egleis (Behr), ssp.	10:15, 11:00, 11:55	69
Speyeria hydaspe (Bdv.)	10:30	69
Speyeria mormonia arge (Strecker)	1:20	69
Speyeria nokomis nokomis (Edw.)	1:05, 2:30	56, 69
Speyeria nokomis apacheana (Skinner)	bet. 12:30-1:30 (4)	69
Speyeria nokomis nitocris (Edw.)	bet. 11-1	28

TABLE 4 (cont.)

Species	Times	Sources
Vanessa atalanta L.	4:15	71
Vanessa cardui (L.)	3:33, 6 pm, 7:30pm	71, 83, 89
Vanessa carye Hubner	3:13	83
LIBYTHEIDAE		
Libytheinae		
Libytheana bachmannii (Kirtland)	10:05 pm, 10:35 pm(2), 11:15 pm, 11:45 pm, (at U-V light)	42
LYCAENIDAE		
Riodininae		
Apodemia mormo mormo (Felder and Felder)	2:05	69
Apodemia mormo virgulti (Behr)	12:13, 12:28	69
Lyceninae		
Callophrys dumetorum (Bdv.)	10:10, 10:18, 10:40	69, 83
Callophrys viridis (Edw.)	1:10, 1:53	69
Callophrys lemberti Tilden	1:50	69
Chrysophanus titus (Fabr.)	bet. 12-2	56
Celastrina argiolus echo (Edwards)	10:26, 11:55, 12:10, 1:28	69
Celastrina argiolus pseudargiolus (Bdv. and LeC.)	bet. 11:30-1:30	56
Everes amyntula (Bdv.)	11:20	69
Everes comyntas (Godart)	6:30 pm	56
Everes comyntas texanus Chermock	bet. 11-1(2), 3:05	56
Hypaurotis crysalus (Edw.)	bet. 7:00-7:40 pm (2)	11
Incisalia henrici (Grote and Robinson)	10:30	16
Incisalia iroides (Bdv.)	bet. 3:00-3:42, 4:15, 4:20(2), 4:30	67, 68
Leptotes marina (Reakirt)	10:21	69
Lycaena arota (Bdv.)	9:30, 1:26	69
Lycaena editha (Bdv.)	10:50	69
Lycaena phlaeas americana Harris	1:15	56
Maculinea arion L.	10:00	77
Mitoura nelsoni muiri (H. Edw.)	2:50	69
Mitoura loki (Skinner)	1:50	69
Philotes battoides (Behr), ssp.	9:40, 10:27, 11:10(2), 11:15, 11:25, 11:30, 1:05. 1:20, 1:55, 2:20, 2:30, 2:35, 2:40, 2:55	69
Philotes battoides intermedia Barnes and McDunnough	1:15(2)	69
Philotes enoptes ancilla Barnes and McDunnough	9:15, 3:10, 3:25, 3:55	69
Philotes enoptes dammersi Comstock and Henne	10:15, 10:20, 10:25(2), 10:40, 10:50, 2:30	69
Philotes enoptes smithi Mattoni	1:10	69
Philotes rita rita (Barnes and McDunnough)	11:50	69
Philotes rita (Barnes and McD.), ssp.	1:18, 1:25, 1:45, 2:07, 2:10, 4:20	69
Philotes rita pallescens Tilden and Downey	10:40, 1:35, 2:00	69
Philotes sonorensis Felder and Felder	1:25	69
Plebejus acmon (Westw. and Hew.)	10:10, 10:30, 12:00, 1:15(2) 1:20, 1:50, 2:12, 2:50	69
Plebejus argus L.	bet. 1-2	77
Plebejus argyrognomon anna (Edw.)	1:10	69
Plebejus argyrognomon ricei (Cross)	1:40	69
Plebejus melissa (Edw.)	2:00	56

TABLE 4 (cont.)

Species	Times	Sources
Plebejus saepiolus (Bdv.)	11:30	69
Plebejus shasta (Edw.)	12:30, 12:50, 2:50	69
Polyommatus icarus Rott.	2:30, 3:00	77, 89
Satyrium acadica (Edw.)	"evening", 6-7pm, (several)	
	6-8 pm (several)	11, 56
Satyrium sylvinus (Bdv.)	bet. 3:30-3:45 (2)	69
Strymon melinus Hubner	bet. 10:10-10:45 pm (at U-V light)	42
HESPERIIDAE		
Hesperiinae		
Atrytonopsis hianna (Scudder)	bet. 11-2	81
Hesperia columbia (Scudder)	2:15	54
Hesperia harpalus leussleri Lindsey	12:45	69
Hesperia juba (Scudder)	1:30	69
Hylephila phyleus (Drury)	ca. 4	56
Ochlodes sylvanoides (Bdv.)	9:35	69
Polites peckius (Kirby)	3:20, 4:20	56
Thymelicus sylvestris Poda	10:15, bet. 1:30-3:00 (2)	56, 77
Pyrginae		
Cogia calchas (Herrich-Schaffer)	3:30	56
Erynnis brizo lacustra (Wright)	12:28	69
Erynnis funeralis (Scudder and Burgess)	1:57, 4:33	69
Erynnis juvenalis (Fabr.)	1:20, 2:00, 4:00	56
Erynnis tristis (Bdv.)	11:43, 12:18; see also Table8	69
Pholisora catullus (Fabr.)	10:15	69
Pholisora libya (Scudder)	9:40	69
Polythrix asine (Hewitson)	bet. 11-12	56
Pyrgus communis (Grote)	11:42, 2:05	69

Includes time that in copulo pairs encountered and time that unattached females of hilltopping species at summits. The sources that designated Standard Time or Daylight Savings Time (all converted to Standard Time here) include 11, 28, 42, 67, 68, 69, 83, 89; not so designated include 16, 54, 56, 71, 77, 81, 100. Number of pairs (if more than one) in parantheses. Times are am(morning) to pm (afternoon) unless designated "pm" (evening).

TABLE 5. Mating times; carrying pairs; virgin female appearance times at hilltops (observed by OS unless otherwise indicated)

I. PAPILIONIDAE
Papilioninae

1. Battus philenor hirsuta (Skinner). 3rd mi. E. of Berryessa Reservoir; Yolo Co., Calif., III-14-72 (A. Shapiro and O. Shields), 10:50 am. (PST), ♀ up, ♂ down.

2. Papilio polyxenes Fabricius. Gates Pass, near Tucson, Ariz., II-24-63 (R. W. Breedlove), ♀ carried ♂.

3. Papilio rudkini (J. A. Comstock). Ca. 4 mi. E. of Jacumba, 3200', San Diego Co., Calif., III-27-66, 2 in cop. pairs: 12:40 and 12:45 p. m. (PST), ♀ carried ♂ in both.

4. Papilio zelicaon Lucas (see Table 6).

5. Papilio indra pergamus H. Edwards. Tecate Mt. summit, San Diego Co., Calif., V-30-64 (S. K. Dvorak), ca. 12:00 pm. (PST); V-16-67 (R. W. Breedlove), between 9:00-9:30 am. (PST).

6. Papilio eurymedon Lucas. a. Dictionary Hill summit, 1064', Spring Valley, San Diego Co., Calif., II-5-67, fresh virgin ♀, 11:20 am. (PST); III-12-67, fresh virgin ♀, 12:34 pm. (PST); IV-22-67, fresh virgin ♀, 12:54 pm. (PST); II-22-68, fresh virgin ♀, 1:22pm. (PST). b. Summit of Hill 997', 1.7 mi. SSE of El Cajon P. O., San Diego Co., Calif., II-6-67, worn virgin ♀, 11:35 am. (PST). c. Cowles Mountain summit, San Diego Co., Calif., VI-6-67, fresh virgin ♀, 12:05 pm. (PST). d. Monument Peak summit, Laguna Mts., San Diego Co., Calif., V-7-67, fresh virgin ♀, 1:34 pm. (PST).

II. PIERIDAE
A. Pierinae

1. Pieris beckerii Edwards. Ca. 5 1/2 mi. N. of Mountain Home, at turnoff to Yellowstone Creek, along Lake Fork Creek, Duchesne Co., Utah, VIII-17-69 (JFE and OS), 12:20 pm. (MST), ♂ carried ♀.

2. Pieris sisymbrii Boisduval. a. Del Puerto Canyon, 1700', 18 road mi. W. of Patterson, Stanislaus Co., Calif., III-7-70 (D. Bragg, R. F. Denno, E. E. Grissell, and OS), 2:30 pm. (PST), ♂ carried ♀. b. Canyon 1 air mi. W. of Mexican Mine, 4600-4800', near Mitchell Caverns State Park, Providence Mts., S. 21, T. 10N., R. 14E., San Bernardino Co., Calif., III-25-70 (JFE and OS), 9:20 am. (PST), ♂ carried ♀, flying on slope near wash, from bush to bush. c. Hill W. of road, ca. 1 road mi. S. of jct. Whitney Portal Rd. and Tuttle Creek-Lone Pine Rd., W. of Lone Pine, Alabama Hills, Inyo Co., Calif., III-28-70 (JFE and OS), 11:45 am. (PST), ♂ carried ♀, on ridge crest. d. Canyon just W. of Devil's Gulch, S.-facing slope of Snyder Ridge above Skelton Creek, Mariposa Co., Calif., III-29-70 (JFE and OS), 2:33 pm. (PST), ♂ carried ♀, along jeep trail on canyon slope.

3. Pieris protodice Boisduval and Le Conte. a. 3 mi. SW of Warner Hot Springs, San Diego Co., Calif., X-17-65, many mating pairs in dry field, between 9:30-10:00 am (PST). b. 841' hill summit, near Dictionary Hill, Spring Valley, San Diego Co., Calif., I-9-67, 1:55 pm. (PST), ♂ carried ♀; c. Dictionary Hill summit, 1064', Spring Valley, San Diego Co., Calif., 1-27-67, 1:58 pm. (PST), ♂ carried ♀; V-28-65, ♂ carried ♀. d. Summit of Desert Butte, 2822', Los Angeles Co., Calif., III-23-68 (JFE), 12:35 pm. (PST).

4. Pieris occidentalis Reakirt. North Schell Peak and ridge to NW, Schell Creek Range, 11,000-11,883', White Pine Co., Nev., VIII-1-69 (JFE and OS), 12:00 pm. (PST).

5. Pieris napi (Linnaeus). Bog at Gothic, Gunnison Co., Colo., VII-6-67 (JFE and OS), between 10:55-11:20 am. (MST), ♂ carried ♀.

6. Anthocaris cethura (Felder and Felder) (see also Table 7). Tecate Mt. summit, San Diego Co., Calif., IV-9-67, fresh virgin ♀, 11:42 am. (PST), 56° F., 76% R.H.

TABLE 5 (cont.)

B. Coliadinae

1. Colias meadii Edwards. Cumberland Pass, 12,000', Gunnison Co., Colo., VII-28-67 (JFE and OS), 8:45 am. (MST).

2. Colias eurytheme Boisduva l. a. Davis, Yolo Co., Calif., X-5-69 (R. F. Denno and OS), 1:05 pm. (PST), ♂ carried ♀. b. Thompson Canyon, just NE of Monticello Dam, Yolo Co., Calif., IV-9-69, 1:25 pm (PST), ♂ carried ♀ (albinic).

3. Colias occidentalis chrysomelas H. Edwards. Canyon Creek Canyon, ca. 3 mi. SE of Ochoco Ranger Station, Ochoco Mts., Crook Co., Ore., VII-10-70 (S. K. Dvorak and OS), 12:13pm. (PST), ♂ carried ♀.

4. Zerene cesonia (Stoll). a. Box Canyon (near bridge), Santa Rita Mts., Pima Co., Ariz., VIII-29-70 (S. L. Ellis, OS, and M. E. Toliver), 4:20 pm. (MST), ♂ carried ♀. b. Proctor Ranch, lower end of Madera Canyon, Pima Co., Ariz., IX-21-70 (D. P. Levin and OS), 10:35 am. (MST), ♂ carried ♀.

5. Phoebis sennae (Linnaeus). Proctor Ranch, lower end of Madera Canyon, Pima Co., Ariz., IX-21-70 (D. P. Levin and OS), 10:45 am. (MST), ♂ carried ♀ 4 X.

6. Eurema nicippe (Cramer). 13 road mi. N. of Lemitar, at La Joya State Game Refuge exit of Hwy. 25, Socorro Co., N. M., VIII-21-70 (S. L. Ellis, OS, and M. E. Toliver), 11:20 am. (MST), ♂ carried ♀ (♀ with wet, fully-expanded wings, incapable of flight).

7. Nathalis iole Boisduval. Box Canyon (near bridge), Santa Rita Mts., Pima Co., Ariz., VIII-29-70 (S. L. Ellis, OS, and M. E. Toliver), 3:50pm. (MST), ♂ carried ♀.

III. NYMPHALIDAE

A. Satyrinae

1. Coenonympha tullia californica (Westwood). a. 1/2 mi. E. of Briceburg, along old RR bed, Mariposa Co., Calif., IV-11-70 (J. Mori and OS), 12:20 pm. (PST), ♀ carried ♀, flew rapidly for ca. 100 yards high in air, alighted in tree once then alighted in weeds. b. N.-facing slope 1.0 air mi. W. of Yellow Bluff, 700-850', Fort Baker Military Res., S. of Sausalito, Marin Co., Calif., IV-18-70 (JFE), 9:06 am. (PST), ♀ carried ♂. c. Thompson Canyon, just NE of Montrello Dam, W. of Winters, Yolu Co., Calif., VI-16-71, 10:50 am. (PST), ♀ carried ♂.

2. Cercyonis pegala boopis (Behr). Canyon Creek Canyon, ca. 3 mi. SE of Ochoco Ranger Station, Ochoco Mts., Crook Co., Ore., VII-16-70 (S. K. Dvorak and OS), 10:00 am. (PST), ♀ carried ♂.

3. Oeneis melissa lucilla Barnes and McDunnough. Cottonwood Pass, Chaffee Co., VII-28-67 (JFE and OS), 11:45 am. (MST).

4. Erebia callias Edwards. Guanella Pass, 11,700-11,800', 11 road mi. S. of Georgetown, Clear Creek Co., Colo. VIII-25-68 (JFE and OS), 12:45 pm. (MST).

B. Danainae

1. Danaus plexippus (Linnaeus). a. Ash Creek Spring, 3800', W. of Las Vegas, Clark Co., Nev., VIII-31-67 (JFE and OS), 7:25 am. (PST), ♂ carried ♀. b. Sand dunes W. of intersection of Palm Ave. and Lake Dr., Marina Beach, Monterey Co., Calif., III-21-70 (JFE and OS), ca. 12:30 pm. (PST), long, high flight seen. c. 1/2 air mile N. of Monticello Dam, Vaca Mts., Yolo Co., Calif., IV-18-70 12:55 pm. (PST), ♂ carried ♀, inspected after alighted low in tree after flight over open slope, both sexes worn. d. Paradox Creek, 1/2 mi. S. of Paradox, Montrose Co., Colo., VIII-8-70 (S. L. Ellis and OS), 3:30 pm. (MST), ♂ carried ♀ 3X. e. Ca. 1 mi. NW of Carrizozo, Lincoln Co., N. M., VIII-21-70 (S. L. Ellis, OS, and M. E. Toliver), 4:30-4:45 pm. (MST), 8 pairs, ♂ carried ♀ in all, mostly flying around and alighting on E. side of 4 tamarisk trees at roadside, about 12-15 pairs seen altogether.

2. Danaus gilippus strigosus (Bates). a. Ash Creek Spring, 3773', W. of Las Vegas, Clark Co., Nev., VI-25-68 (JFE and OS), 4:40 pm. (PST), ♂ carried ♀. b. Proctor Ranch, lower end of Madera Canyon, Pima Co., Ariz., VIII-28-70 (S. L. Ellis, OS, and M. E. Toliver), 5:15 pm. (MST), ♂ carried ♀.

TABLE 5 (cont.)

C. Nymphalinae

1. Junonia coenia (Hubner). Thompson Canyon, just NE of Monticello Dam, W. of Winters, Yolo Co., Calif., IV-4-71, 1:13 pm (PST), ♀ carried ♂ 3 X, a long dirt road in canyon bottom where ♂♂ territorial.
2. Euptoieta claudia Cramer. a. 1-4 road mi. N. of Lincoln Nat. For. boundary, on road to El Paso Gap, Eddy Co., N. M., VIII-23-70 (S. L. Ellis, OS, and M. E. Toliver), 11:20 am. (MST), ♂ carried ♀. b. 2 road mi. NE of Oracle Junction, Pinal Co., Ariz., VIII-30-70 (S. L. Ellis and OS), 11:10 am. (MST), ♀ carried ♂. c. Ca. 4 road mi. NNW of Dewey, rd. between Hwy. 69 and 89A, Yavapai Co., Ariz., IX-19-70 (D. P. Levin, L. M. Martin. and OS), 3:45 pm. (MST), ♀ carried ♂.

3. Speyeria nokomis (Edwards). Ca. 5 1/2 mi. N. of Mountain Home, at turnoff to Yellowstone Creek, along Lake Fork Creek, Duchesne Co., Utah, VIII-17-69 (JFE and OS), 1:05 pm. (MST), ♂ perched up, ♀ hanging down, in wet meadow.

4. Speyeria nokomis apacheana (Skinner). Pine Creek Road, Round Valley, Inyo Co., Calif., VIII-27-65 (JFE and OS), 4 in copulo pairs, between 12:30-1:30pm. (PST), ♂♂ carried ♀♀.

5. Speyeria cybele leto (Behr). Crocker Ridge, ca. 7 air mi. SSW of Mather, Tuolumne Co., Calif., VIII-3-65, 11:30 am. (PST), ♂ carried ♀.

6. Speyeria mormonia arge (Strecker). a. Carnegie Experimental Garden, Slate Creek Valley, 10,000', Mono Co., Calif., VIII-9-64, ♀ carried ♂. b. NW above Tioga Pass, Mono Co., Calif., VIII-22-65, 1:20 pm. (PST), ♂ carried ♀.

7. Speyeria egleis (Behr) ssp. a. Jarbidge Peak summit, 10,789', Jarbidge Mts., Elko Co., Nev., VII-22-69 (JFE and OS), 11:55 am. (PST). b. Bald Mtn. summit, 11,562', N. end of Snake Range, White Pine Co., Nev., VII-30-69 (JFE and OS), 2 in copulo pairs: 10:15 am. (PST), ♀ carried ♂, and 11:00 am. (PST).

8. Speyeria callippe callippe (Boisduval). NE-facing slope 0.4 air mile SSW of Midway Village School, on hilltop at 400', above Guadelupe Canyon Parkway, San Bruno Mts., San Mateo Co., Calif., VII-4-71 (JFE), 2 in copulo pairs: 11:09 am. and 11:17 am. (PST), ♀ carried ♂ in both.

9. Speyeria callippe comstocki (Gunder). Cowles Mt. summit, San Diego Co., Calif., VI-6-67, 10:50 am. (PST), ♀ carried ♂, 67° F., 71%. R. H.

10. Speyeria callippe harmonia dos Passos and Grey. North Schell Peak and ridge to NW, Schell Creek Range, 11,000-11,883', White Pine Co., Nev., VIII-1-69 (JFE and OS), 10:25 am. (PST).

11. Speyeria hydaspe (Boisduval) ssp. 7.2 road mi. E. of Parker Mtn. Pass, along Hwy. 66, Klamath Co., Ore., VII-8-70 (S. K. Dvorak and OS), 10:30 am. (PST), ♀ carried ♂.

12. Euphydryas editha (Boisduval) ssp. Bunker Hill and ridge to the SW, 10,000-11,474', Toiyabe Range, Lander Co., Nev., VII-11-69 (JFE and OS), 10:30 am. (PST).

13. Euphydryas editha baroni (Edwards). MacDonald Ranch, 4 road mi. S. of Pope Valley, Napa Co., Calif., V-15-69 (OS and R. Wells), 10:30 am. (PST), on bush in firebreak on a slope.
14. Euphydryas chalcedona (Doubleday). a. Dictionary Hill summit, 1064', Spring Valley, San Diego Co., Calif., II-26-67, fresh virgin female, 11:19 am. (PST); IV-17-67, in copulo pair on bush, ♀ horizontal, ♂ down, 10:00 am. (PST), ♀ carried ♂, 63° F., 69%. R. H.; IV-27-67, worn virgin female, 12:56 pm. (PST); V-6-67, in copulo pair horizontal on weed, 12:01 pm. (PST) b. Tecate Mt. summit, San Diego Co., Calif., IV-9-67, fair virgin female, 12:06 pm. (PST). c. Ravine 0.3 air mi. SE of highest peak, 1050', on NE slope of San Bruno Mts., San Mateo Co., Calif., IV-8-70 (JFE), 3:03 pm. (PST), ♀ carried ♂. d. 2 air mi. NW of jcts. of Bear Valley Rd. and Hey. 20, near Wilbur Springs, Colusa Co., Calif., IV-25-70 (R. F. Denno), ca. 2:00 pm. (PST), ♀ carried ♂, along road. e. 1/2 air mi. E. of Briceburg, along old RR bed, Mariposa Co., Calif., IV-25-70 (J. Mori), between 11:30-12:00 am. (PST), 3 in copulo pairs, ♀ carried ♂ in all.

TABLE 5 (cont.)

15. Microtia dymas Edwards. Proctor Ranch, lower end of Madera Canyon, Pima Co., Ariz., IX-21-70 (D. P. Levin and OS), 2 pairs; 12:00 and 12:10 pm. (MST), ♀ carried ♂ in both.

16. Chlosyne damoetas (Skinner). Cottonwood Pass, Chaffee Co., Colo., VII-28-67 (JFE and OS), 12:45 pm. (MST).

17. Chlosyne damoetas malcolmi (J. A. Comstock). Above Upper Gaylor Lake, NW of Tioga Pass, Tuolumne Co., Calif., VIII-29-65 (JFE and OS), 9:35 am. (PST), ♀ carried ♂.

18. Chlosyne gabbii (Behr). Sand dunes W. of Marina, 60-100', Monterey Co., Calif., V-9-70 (JFE and OS), 3 in copulo pairs: 12:30 pm., 1:05 pm., and 1:40 pm. (PST), ♀ carried ♂ in all.

19. Chlosyne leanira fulvia (Edwards). Ca 1 mi. SW of Placitas, along Hwy. 44, Sandoval Co., N. M., VIII-17-70 (S. L. Ellis and OS), 1:30 pm. (MST), ♀ carried ♂.

20. Chlosyne californica (Wright). Bonanza King Mine Canyon, E. side Providence Mts., San Bernardino Co., Calif., IX-17-70 (D. P. Levin and OS), 10:30 am. (PST), ♀ carried ♂.

21. Phyciodes mylitta (Edwards) a. 4.3 road mi. S. of jct. of Tolman Creek Rd. and Ashland St., just S. of Ashland, Jackson Co., Ore., VII-8-70 (S. K. Dvorak and OS), 1:30 p.m. (PST), ♀ carried ♂, ♀ feeding on yarrow flowers. b. Thompson Canyon, just N. E. of Monticello Dam, W. Winters, Yolo Co., Calif., VI-16-71, 10:30 am. (PST), ♀ carried ♂, along dirt road in canyon bottom.

22. Phyciodes compertris (Behr). Carnegie Experimental Garden, 4600', 1 mi. E. of Mather, Tuolumne Co., Calif., VI-23-64, ♀ carried ♂; VII-14-64, ♀ carried ♂; VII-5-65, 12:00pm. (PST), ♀ carried ♂.

23. Phyciodes campestris camillus Edwards. 3.1 mi. W. of junction Colo. Hwy. 149 and U. S. 50, near Iola, Gunnison Co., Colo., VIII-27-67 (JFE and OS), 12:20 pm. (MST).

IV. LYCAENIDAE

A. Riodininae

1. Apodemia mormo (Felder and Felder). 7 road mi. SE of Fredonia, 5000', along highway 89A, Coconino Co., Ariz., VIII-30-69 (JFE and OS), 2:05 pm. (MST).

2. Apodemia mormo virgulti (Behr). Dictionary Hill summit, 1064', Spring Valley, San Diego Co., Calif., III-30-66, 12:13 pm. (PST), ♀ carried ♂, 86° F., 63% R. H.; II-5-67, 12:28 pm. (PST), ♀ carried ♂.

B. Lycaeninae

1. Satyrium sylvinus (Boesduval). Stonyford, Colusa Co., Calif., VI-5-69 (J. Mori and OS), between 3:30-3:45 pm. (PST), 2 in copulo pairs along road where adults abundant on milkweed (see figure 5).

2. Mitoura nelsoni muiri (H. Edwards). About 4 1/2 road mi. SW of jct. of Brim Rd. and Bear Valley Rd., Walker Ridge Public Lands area, SW of Leesville, Lake-Colusa Co. line, Calif., IV-17-72 (OS and S. Sims), 2:50 pm. PST, on cypress during overcast.

3. Mitoura loki (Skinner). Ca. 4 mi. E. of Jacumba, 3200', San Diego Co., Calif., III-27-66, 1:50 pm. (PST), ♀ walked ♂ in her direction when on ground, found on juniper.

4. Callophrys viridis (Edwards). Sand dunes W. of Marina, 60-100', Monterey Co., Calif. V-9-70 (JFE and OS), 2 in copulo pairs: 1:10pm. and 1:53 pm. (PST), in small ravines on Eriogonum latifolium, abdomens forming a 90° angle during mating.

TABLE 5 (cont.)

5. Callophrys dumetorum (Boisduval). Bobs Gap, ca. 6 air mi. SE of Pearblossom, Los Angeles Co., Calif., III-22-70 (C. Henne, JFE, and OS), 10:40 am. (PST), in copulo pair on dried Eriogonum fasciculatum flower, in wash where males territorial and common.

6. Callophrys lemberti Tilden. 1 mi. S. of Fredericksburg, 5100', Alpine Co., Calif., IV-9-72 (OS and R. Wells), 1:50 pm. (PST).

7. Lycaena arota (Boiscuval). a. Cottonwood Canyon, 7000', S. of Bodie, Mono Co., Calif., VIII-19-65, 9:30 am. (PST), ♂ carried ♀. b. No Name Creek, near Glenwood Springs, Garfield Co., Colo., VIII-24-67 (JFE and OS), 1:26 (MST).

8. Lycaena editha (Mead). SW side of Lake Spalding, Nevada-Placer Co. line, Calif., ca. 6000', VII-20-65, 10:50 am. (PST), ♂ carried ♀.

9. Plebejus acmon (Westwood and Hewitson). a. Crocker Ridge, ca. 7 air mi. SSW of Mather, Tuolumne Co., Calif., VIII-3-65, 12:00 pm. (PST), ♂ carried ♀. b. Carnegie Experimental Garden, 4600', 1 mi. E. of Mather, Tuolumne Co., Calif., VIII-7-65, 1:20 pm. (PST), ♀ carried ♂; IX-3-66, 10:30 am. (PST), ♂ carried ♀. c. Skelton Creek, 3400', Jerseydale, 8 1/2 air mi. NE of Mariposa, Mariposa Co., Calif., VIII-1-68, 10:10 am. (PST), ♂ carried ♀. d. Canyon 1 mi. NE of Monticello Dam, Vaca Mts., W. of Winters, Yolo Co., Calif., III-19-70, 2:12 pm. (PST), ♂ carried ♀ 2 X when disturbed. e. Mud Creek, 2000-2200', near Ponderosa Way, SE 1/4 S. 26, T. 24N., R. 2E., Butte Co., Calif., IV-5-70 (JFE, S. O. Mattoon, and OS), 2:50 pm. (PST), ♂ carried ♀. f. Ca. 3 mi. W. of N. Fk. Merced River, 11 road mi. E. of Coulterville, Mariposa Co., Calif., V-29-70 (J. Mori and OS), 1:50 pm. (PST), ♀ carried ♂, alighted, then ♂ carried ♀, g. Near ridge summit W. above Thompson Canyon, N. of Monticello Dam, W. of Winters, Yolo Co., Calif., VII-1-71, 2 in copulo pairs, 1:15 pm. (PST), ♂ carried ♀ in one, ♀ carried ♂ in other (both pairs "flighty"), along road on ridge.

10. Plebejus shasta (Edwards). W. end of Dana Plateau, 11,000-11,400', above Tioga Pass, Mono Co., Calif., VII-8-69 (JFE and OS), 3 in copulo pairs: 12:50 pm. (PST), ♀ carried ♂, 12:30 pm. (PST), ♂ carried ♀, and 2:50 pm. (PST) on ground.

11. Plebejus argyrognomon anna (Edwards). W. side of Loon Lake, ca. 15 air mi. N. of Kyburz, El Dorado Co., Calif., VII-25-71 (OS and R. Wells), 1:10 p.m. (PST), on Trifolium sp. flower.

12. Plebejus argyrognomon ricei (Cross). Lost Prairie, SW of Santiam Junction, along Hwy. 20, Linn Co., Ore., VII-17-70 (S. K. Dvorak and OS), 1:40 pm. (PST), ♂ carried ♀.

13. Plebejus saepiolus (Boisduval). Mendocino Pass, 5000', along road to Covelo, Glenn Co., Calif., VII-3-70 (S. K. Dvorak and OS), 11:30 am. (PST), ♀ carried ♂ when first disturbed, then ♂ carried ♀ many times when further disturbed.

Genus Philotes--genitalically determined by OS: final subspecific placement on some and foodplant determinations will be reported elsewhere in a monograph.

14. Philotes sonorensis Felder and Felder. Chili Bar, cal. 1000', ca. 4 road mi. N. of Placerville, on Calif. Hwy. 193, at crossing of South Fork American River, El Dorado Co., Calif., II-22-70 (OS and R. Wells), 1:25 pm. (PST), ♀ horizontal, ♂ slightly down on dried weed 1' from Dudleya cymosa.

15. Philotes battoides intermedia Barnes and McDunnough. Peak S. of Castle Lake, N.-facing slope, 5600'-6400', Siskiyou Co., Calif., VII-18-68 (JFE and OS), 2 in copulo pairs at 1:15 pm. (PST), on Eriogonum sp.

16. Philotes battoides oregonensis Barnes and McDunnough. 7/10 mi. SE of jct. of Crater Lake Nat'l Park boundary (S.) and Hwy. 62, on Hwy. 62, Klamath Co; Ore. VII-17-71 (C. Goodpasture, OS, and B. Villegas), 2 in copulo pairs: 12:03 pm. and 12:30 pm. (PST), ♀ carried ♂ in both, on flower-heads of Eriogonum sp; VII-18-71 (same collectors), 2 in copulo pairs: 11:45 am. and 12:15 pm. (PST), on flower-heads of Eriogonum sp.

TABLE 5 (cont.)

17. Philotes battoides (Behr) ssp. a. 7-8 road mi. ESE of Fredonia, 5000', along Hwy. 89A. Coconino Co., Ariz., VIII-30-67 (JFE and OS), 5 in copulo pairs: 11:10, 11:10, 11:15, 11:25, and 11:30 am. (MST), associated with Eriogonum sp.; VIII-30-69 (JFE and OS), 5 in copulo pairs: 1:55 pm. (MST), alighting on Eriogonum sp. flowers; 2:20 pm. (MST), ♂ carried ♀; 2:30 pm. (MST), ♂ carried ♀ when disturbed from position of male slightly up from female and facing into sun, horizontal on Artemisia bush; 2:35 pm. (MST), ♂ carried ♀, alighting on Eriogonum sp. flowers; and 2:40 pm. (MST), ♂ carried ♀, landed on twig. b. 1 mi. E. of Glendale, on road to Fourmile Hollow, 6200', Kane Co., Utah, IX-4-68 (JFE and OS), 1:20 pm. (MST), on flower-head of Eriogonum sp. c. 14 road mi. SW of Mexican Hat, 5400', San Juan Co., Utah, IX-3-68 (JFE and OS), 1:05 pm. (MST), on flower-head of Eriogonum sp. d. 9.5 road mi. NE of Winona, on hwy. to Leupp, Coconino Co., Ariz., IX-1-70 (S. L. Ellis and OS), 10:27 am. (MST), on extremity of Eriogonum sp. plant. ♂ carried ♀ when disturbed. e. 7.7 to 8.1 road mi. ENE of Kayenta (from jct. hwy. 464 and 164), just SE of Church Rock, Navajo Co., Ariz., IX-2-70 (S. L. Ellis and OS), 9:40 am. (MST), ♀ carried ♂. f. 11 road mi. NNW of Mexican Hat, base of Cedar Mesa, along Hwy. 261, San Juan Co., Utah, IX-2-70 (S. L. Ellis and OS), 2:55 pm. (MSY), on Eriogonum sp. extremity.

18. Philotes enoptes dammersi Comstock and Henne. a. 1 1/2 mi. S. of Banning, 2300', along Hwy. R1, Riverside Co., Calif., IX-10-69 (JFE and OS), 6 in copulo pairs: 10:15, 10:25, 10:25, 10:40, 10:50 am. (PST), all on Eriogonum sp., and 10:20 am. (PST), ♂ carried ♀. b. Mid Hills, 5100', NW exposure of ridge, T. 13N., R. 15E., NE1/4 of S. 31, along road, San Bernardino Co., Calif., IX-16-70 (D. P. Levin and OS.), 2:30 pm. (PST), on terminal branch of Eriogonum sp., ♂ carried ♀ when disturbed.

19. Philotes enoptes smithi Mattoni. Dunes at NW end of Olympia Ave., Seaside, Monterey Co., Calif., VIII-2-70 (D. P. Levin and OS), 1:10 pm. (PST), ♂ carried ♀.

20. Philotes enoptes ancilla Barnes and McDunnough. S.- and W.-facing slopes of Victorine Canyon, 8000-10,000', S. side of Bunker Hill, Toiyabe Range, Lander Co., Nev., VII-11-69 (JFE and OS), 4 in copulo pairs: 9:15 am. (PST), on Eriogonum sp.; 3:10 pm. (PST), in flight; 3:25 pm. (PST), in flight; and 3:55 pm. (PST), on Eriogonum sp., ♂ carried ♀ when disturbed.

21. Philotes rita pallescens Tilden and Downey. a. SE base of Sand Mountain, 4000', T. 17N., R. 32., ca. 7 air mi. WNW of Frenchman, Churchill Co., Nev., VII-13-69 (JFE and OS), 10:40 am. (PST) on upper part of Eriogonum sp., ♂ carried ♀ when disturbed. b. Sand hills 3 road mi. SW of Johnsons Pass, 5200', E. side of Skull Valley, T. 6S., R. 7W., Tooele Co., Utah, VIII-13-69 (JFE and OS), 2 in copulo pairs: 1:35 and 2:00 pm. (MST), on Eriogonum sp.

22. Philotes rita (Barnes and McDunnough). 18 road mi. WNW of Silver City, along Hwy. 180, Grant Co., N. M., VIII-26-70 (OS and M. E. Toliver), 11:50 am. (MST), ♂ carried ♀ when disturbed, on Eriogonum sp.

23. Philotes rita (Barnes and McDunnough) ssp. a. At SW base of a bluff, 3 road mi. N. and 1 road mi. E. of Bluff, San Juan Co., Utah, VIII-25-69 (JFE and OS), 2 in copulo pairs: 2:07 and 2:10 pm. (MST), vertical and horizontal on stems of Eriogonum sp. b. Poison Spring Canyon, 1 mi. S. of Wayne Co. line, along Hwy. 95, 18 road mi. SE of Hanksville, Garfield Co., Utah, VIII-26-69 (JFE and OS), 1:18 pm. (MST), vertical on stem of Eriogonum sp. c. Summit of road to 1 1/2 mi. E., of Little Flat Top, 5500', T. 26S., R. 14E., ca. 10-11 mi. SE of Utah highway 24, Emery Co., Utah, VIII-26-69 (JFE and OS), 4:20 pm. (MST), vertical on stem of Eriogonum sp., ♂ up, ♀ down. d. 2 1/2 road mi. N. of Joseph City, Navajo Co., Ariz., VIII-31-70 (S. L. Ellis and OS), 1:25 pm. (MST), up on stem of Eriogonum sp. e. 6.8 road mi. SW of Mexican Hat, along Hwy. 163, San Juan Co., Utah, IX-2-70 (S. L. Ellis and OS), 1:45 pm. (MST), on extremity of Eriogonum sp.

24. Everes amyntula (Boisduval). Bog at Gothic, Gunnison Co., Colo., VII-6-67 (JFE and OS), 11:20 am. (MST).

25. Leptotes marina (Reakirt). Dictionary Hill summit, 1064', Spring Valley, San Diego Co., Calif., III-30-67, 10:21 am. (PST), ♀ carried ♂.

TABLE 5 (cont.)

26. Celastrina argiolus echo (Edwards). a. Tecate Mt. summit, San Diego Co., Calif., IV-9-67, 10:26 am. (PST), 56° F., 65%. R. H. b. Dictionary Hill Summit, 1064', Spring Valley, San Diego Co., Calif., IV-22-67, Virgin female, 1:28 pm. (PST); V-6-67, 12:10 pm. (PST). c. Monument Peak summit, Laguna Mts., San Diego Co., Calif., VI-12-68, 11:55 am. (PST).

IV. HESPERIIDAE

A. Hesperiinae

1. Ochlodes sylvanoides (Boisduval). Jerseydale, 81/2 air mi. NE of Mariposa, Mariposa Co., Calif., IX-2-71, 9:35 am. (PST), ♀ carried ♂ 5 X, in sunlit clearing.

2. Polites sonora (Scudder). Carnegie Experimental Garden, 4600', 1 mi. E. of Mather, Tuolumne Co., Calif., VIII-7-64, ♀ carried ♂.

3. Hesperia harpalus leussleri Lindsey. Ravine 1/4 mi. N. of Horse Flats Campground, N. of Chilao Rec. Area, 5900', San Gabriel Mts., Los Angeles Co., Calif., VI-27-70 (S. K. Dvorak and OS), 12:45 pm. (PST), ♀ carried ♂.

4. Hesperia juba (Scudder). Boiling Springs, Laguna Mts., San Diego Co., Calif., IV-30-66, 1:30 pm. (PST), ♀ carried ♂.

B. Pyrginae

1. Pholisora catullus (Fabricius). U. C. Davis, Yolo Co., Calif., VIII-25-71, 10:15 am. (PST), ♀ carried ♂ 2 X, on lawn.

2. Pholisora libya (Scudder). Lovelock-Unionville Road, ca. 4 air mi. NE of Spring Valley, on boundary between sects. 20 and 29, T. 29N. R. 35E., E. side of Humboldt Range, Pershing Co., Nev., VII-19-69 (JFE and OS), 9:40 am. (PST), where adults commonly feeding along roadside.

3. Pyrgus communis (Grote). a. Thompson Canyon, just NE of Monticello Dam, W. of Winters, Yolo Co., Calif., IV-23-70, 11:42 am. (PST), ♀ carried ♂, along road in canyon bottom. b. Footman Ridge summit, E. above Jerseydale, Mariposa Co., Calif., VII-22-71, 2:05 pm. (PST), ♀ carried ♂.

4. Erynnis brizo lacustra (Wright). Ridge crest ca. 3 road mi. W. of jct. of Brim Rd. and Bear Valley Rd., Walker Ridge Public Lands, SE of Leesville, Colusa-Lake Co. line, Calif., V-15-70 (R. F. Denno and OS), 12:28 pm. (PST), ♀ carried ♂, both worn.

5. Erynnis tristis (Boisduval) (See also Table 8). Summit of Hill 997', 1.7 mi. SSE of El Cajon P. O., San Diego Co., Calif., II-6-67, 2 in copulo pairs: 11:43 am. and 12:18 pm. (PST), ♀ carried ♂ in both.

6. Erynnis funeralis (Scudder and Burgess). a. Near "Two Mile Hill", Scissors Crossing, San Diego Co., Calif., II-22-67, 1:57 pm. (PST), ♀ carried ♂ in arroyo. b. Dictionary Hill summit, 1064', Spring Valley, San Diego Co., Calif., VI-14-68, 4:33 pm. (PST).

7. Thorybes diversus Bell. Carnegie Experimental Garden, 4600', 1 mi. E. of Mather, Tuolumne Co., Calif., VI-18-65, ♀ carried ♂.

TABLE 6. Female Papilio zelicaon, collected on the summit of Dictionary Hill
(74 Specimens)

DATE	(PST) TIME	(°F) TEMP.	% REL. HUM.	WING CONDITION	BEHAVIOR	SPERM-ATOPHORES
X-24-66	1:34	89	20	fresh	flying	1(new)
X-25-66	2:28	90	20	worn	flying	1(old)
XII-17-66	1:15	67	54	fresh	flying	0
XII-17-66	2:06	69	51	fresh	flying	0
XII-18-66	11:17	68	46	fresh	flying	0
XII-18-66	11:43	68	46	fresh	flying	0
XII-18-66	1:05	74	37	worn	--	1(old)
XII-18-66	2:10	72	35	fresh	flying	0
XII-19-66	12:30	71	34	fresh	flying	0
XII-19-66	1:25	73	39	fresh	courtship	0
XII-19-66	2:22	--	--	worn	flying	1 (large)
XII-24-66	12:35	61	68	fair	flying	0
XII-24-66	1:08	59	78	fresh	flying	0
XII-25-66	11:36	59	78	fresh	flying	0
XII-25-66	12:42	61	68	fresh	flying	0
XII-25-66	12:50	60	73	fresh	flying	0
XII-26-66	12:39	55	65	worn	flying	2 (old)
XII-28-66	11:07	54	48	fresh	flying	0
XII-28-66	1:00	57	47	worn	flying	1 (old)
XII-28-66	1:29	--	--	fresh	flying	0
* XII-31-66	12:50	62	51	fresh	in copulo	1 (new)
XII-31-66	1:58	61	50	fresh	flying	0
I-1-67	12:32	63	51	fresh	in copulo	0
I-7-67	1:14	--	--	worn	flying	0
I-9-67	12:40	65	40	fresh	flying	0
I-14-67	12:05	--	--	fresh	flying	0
I-14-67	12:16	--	--	fresh	flying	0
I-14-67	1:00	71	52	fresh	--	0
I-15-67	11:06	--	--	--	courtship	0
I-15-67	12:10	--	--	worn	flying	3 (2 old, 1 new)
I-15-67	1:00	77	39	fresh	--	0
I-27-67	1:46	--	--	fair	flying	1 (old)
I-28-67	12:06	--	--	fresh	flying	0
II-4-67	12:06	--	--	fresh	--	0
II-4-67	12:16	--	--	fresh	courtship	0
II-4-67	1:10	75	44	fair	--	1(old)
II-4-67	1:11	75	44	fresh	--	0
II-26-67	11:08	60	73	fresh	flying	0
II-26-67	11:38	60	68	fresh	courtship	0
III-5-67	12:08	58	72	worn	--	0
III-16-67	12:17	--	--	worn	courtship	1(old)
III-19-67	11:41	66	70	--	courtship	1(old)
IV-23-67	11:23	61	73	fair	in copulo	0
IV-30-67	12:16	62	69	fresh	flying	0
V-1-67	3:27	69	47	fresh	flying	0
V-4-67	10:09	66	62	fresh	in copulo	0
IX-13-67	12:13	80	57	fair	flying	2 (old)
IX-13-67	12:43	81	61	worn	--	2 (1 old, 1 new)
IX-13-67	2:14	82	62	fresh	flying	1 (new)
IX-28-67	12:37	78	71	fresh	flying	0
IX-28-67	12:59	78	71	fresh	in copulo	1 (new)

TABLE 6 (cont.)

DATE	(PST) TIME	(°F) TEMP.	°/. REL. HUM.	WING CONDITION	BEHAVIOR	SPERM-ATOPHORES
XII-17-67	1:40	--	--	fresh	in copulo	1 (new)
XII-22-67	12:17	62	37	fresh	in copulo	0
XII-22-67	12:30	--	--	fresh	flying	0
* XII-22-67	12:52	--	--	--	in copulo	1 (new)
XII-23-67	1:39	--	--	worn	flying	0
+ XII-27-67	12:54	--	--	fresh	flying	1 (new)
I-1-68	12:43	--	--	fresh	in copulo	1 (new)
I-11-68	12:21	--	--	fresh	in copulo	1 (new)
I-13-68	12:15	--	--	fresh	in copulo	1 (new)
I-13-68	12:37	--	--	fresh	in copulo	1 (new)
I-13-68	12:37	--	--	worn	in copulo	1 (new)
I-14-68	1:14	--	--	fresh	in copulo	1 (new)
I-21-68	12:15	--	--	fresh	in copulo	0
I-28-68	1:24	--	--	fresh	flying	0
II-2-68	10:30	--	--	fresh	alighted	0
II-19-68	1:37	--	--	fresh	flying	1 (old)
II-22-68	11:29	--	--	--	flying	0
II-23-68	11:43	--	--	fresh	flying	0
II-24-68	11:05	--	--	fresh	--	0
II-24-68	11:15	--	--	worn	--	3
II-24-68	11:39	--	--	--	--	0
II-24-68	12:32	--	--	worn	--	1
III-10-68	1:15	--	--	fresh	in copulo	1 (new)

* = ♀ carried ♀ (2).
+ = female flew off the summit in short "hops" as did females that departed after mating; therefore, she may have just mated.
All in copulo pairs approached had ♀ up, ♂ down, on vegetation, except for several that were horizontal. All "new" spermatophores were freshly deposited, so their transference probably occurred on the summit.

TABLE 7 Female Anthocaris cethura, collected on the summit of Dictionary Hill (11 specimens)

DATE	(PST) TIME	(°F) TEMP.	°/. REL. HUM.	WING CONDITION	BEHAVIOR	SPERM-ATOPHORES
II-20-67	10:20	--	--	fresh	feeding	0
II-28-67	11:02	76	45	--	in copulo	1 (new)
III-5-67	11:37	--	--	fresh	alighted	0
* III-16-67	12:09	77	56	fresh	in copulo	0
IV-22-67	12:41	57	77	fresh	flying	0
IV-23-67	10:01	--	--	fair	flying	0
IV-27-67	10:09	62	84	fresh	alighted	0
V-4-67	9:35	--	--	fresh	flying	0
V-14-67	8:45	76	42	fresh	alighted	0
II-23-68	11:04	--	--	fresh	flying	0
III-21-68	10:50	--	--	--	in copulo	1 (new)

* = ♂ carried ♀; in all 3 in copulo pairs, ♂ up, ♀ down.

TABLE 8. Female Erynnis tristis, collected on the summit of Dictionary Hill (37 specimens)

DATE	(PST) TIME	(°F) TEMP.	°/₀) REL. HUM.	WING CONDITION	BEHAVIOR	SPERM-ATOPHORES
IX-23-66	1:36	90	39	fresh	in copulo	-
I-15-67	12:16	77	39	fresh	flying	0
I-26-67	2:14	--	--	--	courtship	0
II-2-67	11:39	64	61	fresh	in copulo	1 (new)
II-2-67	11:55	66	66	fresh	in copulo	0
II-2-67	12:55	66	62	fresh	in copulo	0
II-2-67	1:18	66	62	fresh	in copulo	0
II-4-67	10:57	68	50	--	courtship	0
II-4-67	12:43	76	42	fresh	in copulo	0
II-4-67	12:43	76	42	fresh	in copulo	1 (new)
II-4-67	12:55	--	--	--	in copulo	0
II-5-67	12:10	62	74	--	in copulo	0
* II-11-67	11:34	76	52	fair	in copulo	1 (new)
II-11-67	12:07	76	52	fresh	in copulo	1 (new)
II-16-67	1:15	64	56	fresh	in copulo	0
II-22-67	(11:40-	--	--	--	in copulo	1 (new)
II-22-67	11:50)	--	--	--	in copulo	1 (new)
II-26-67	11:45	60	68	fresh	in copulo	0
II-26-67	11:55	60	68	--	in copulo	1 (new)
II-26-67	12:38	63	69	--	in copulo	0
II-26-67	12:38	63	69	--	in copulo	0
II-26-67	12:54	64	65	--	in copulo	1 (new)
II-27-67	11:04	71	45	--	in copulo	1 (new)
II-27-67	11:27	73	60	fresh	in copulo	0
* II-27-67	11:41	--	--	fresh	in copulo	1
II-28-67	11:36	80	38	fresh	in copulo	1 (new)
* III-16-67	10:39	73	54	fresh	in copulo	0
* III-16-67	11:36	76	59	fresh	in copulo	1 (new)
* III-16-67	11:55	76	55	--	in copulo	0
V-14-67	2:27	85	36	--	alighted	0
II-19-68	1:42	--	--	fresh	in copulo	--
II-22-68	11:57	--	--	--	in copulo	0
II-23-68	12:39	--	--	--	in copulo	0
II-23-68	1:07	--	--	--	in copulo	0
II-24-68	12:00	--	--	--	in copulo	0
II-25-68	11:59	--	--	fresh	in copulo	1 (new)
+ II-25-68	12:15	--	--	--	in copulo	0

* = ♀ carried ♂. (7)., + = ♂ carried ♀ (1). All spermatophores were freshly deposited, so their transference probably occurred on the summit; in all (33) in copulo pairs except one on the ground, ♀ above ♂ in resting position.