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## TAXONOMIC REVISION OF THE SPECIES *dorcas* KIRBY AND *helloides* BOISDUVAL IN THE GENUS *Epidemia* SCUDDER (LYCAENIDAE: LYCAENINAE)<sup>1</sup>

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### INTRODUCTION

Recent study by L. D. Miller of the higher classification of the Lycaeninae in North America indicates that the taxa *dorcas*, *epixanthe*, *helloides* and *nivalis* should be assigned to the genus *Epidemia* Scudder, with *epixanthe* Boisduval & LeConte as the types species. Only *cupreus* W.H. Edwards and the Old World *phlaeas* Linnaeus are assigned to *Lycaena* Fabricius (cf. Sibatani, 1974). While *epixanthe* and *nivalis* Boisduval are morphologically distinct from their two congeners, *dorcas* Kirby and *helloides* Boisduval are very similar. They exhibit slight differences in facies and they differ in voltinism. East of the Rocky Mountains, these two species are easily separated. *E. helloides*, in the males, exhibits a bold orange crenulate band dorsally along the margin of the HW and the dark margins on both wings tend to be narrow. The females display a bright yellow-orange ground color. Larval hosts are members of the Polygonaceae and this species is multivoltine. Habitats include moist meadows, the banks of sloughs and along roadsides where the hosts grow. By contrast, *E. dorcas* has a dusky aspect. The crenulate band of *helloides* appears only as a small orange tornal spot, sometimes absent, and sometimes extending along the wing border for a few cells as loosely connected lunules. The dark margins are wide on both wings. The females are dusky in aspect with brownish or dark yellow-tan ground color. Members of the genus *Potentilla* (Rosaceae) serve as larval hosts and *dorcas* as univoltine. Habitats include salt marshes, sphagnum and black spruce bogs.

This seemingly straight-forward and simple situation becomes very complex along the Front Range of the Rocky Mountains and westward. A variety of phenotypes may be found from northern New Mexico to the shores of the Beaufort Sea and westward to California and Alaska. The solid differentiating characters of facies, host plant specificity and voltinism, so useful in the East, break down, and the entire concept of what constitutes a species becomes clouded. Frequently species are defined from the biological viewpoint ( $F_1$  hybrids between two species

are sterile or fail), or based upon clear morphological differences. The evolution of species from a common ancestor is thought to come about by geographic isolation, behavioral changes, olfactory adaptation, ecological changes (treated by some as microgeographic isolation), complex genetic changes and other factors (Mayr, 1942, 1947; Dethier, 1952). The *dorcas/helloides* complex in western North America tests all of these concepts.

The organization of this paper is as follows: host plant studies, oviposition studies, biology, genitalic studies, spectroscopic and related studies, possible glaciation factors, conclusions derived from the foregoing, taxonomic decisions.

### HOST PLANT STUDIES

Although some species of Lepidoptera are polyphagous, especially among the moths, many butterflies are monophagous and this has been considered by many workers as the *sina qua non* for species separation (Mayr, 1942, 1947). This is the Hopkins "host selection principle" (Hopkins, 1916, 1917) which has now been discredited (Wood, 1963; Mayr, 1969). Most of the Lycaenidae are reported to be either monophagous, or at most, oligophagous (Slansky, 1976). A basis for distinguishing *dorcas* and *helloides* has been respective larval preference for the Rosaceae (*Potentilla*) and the Polygonaceae (*Polygonum/Rumex*), two morphologically rather unrelated plant families. Oviposition studies, as reported subsequently, have proved inconclusive. To test the host plant specificity theory, several biochemical studies were conducted on three plant species. These were

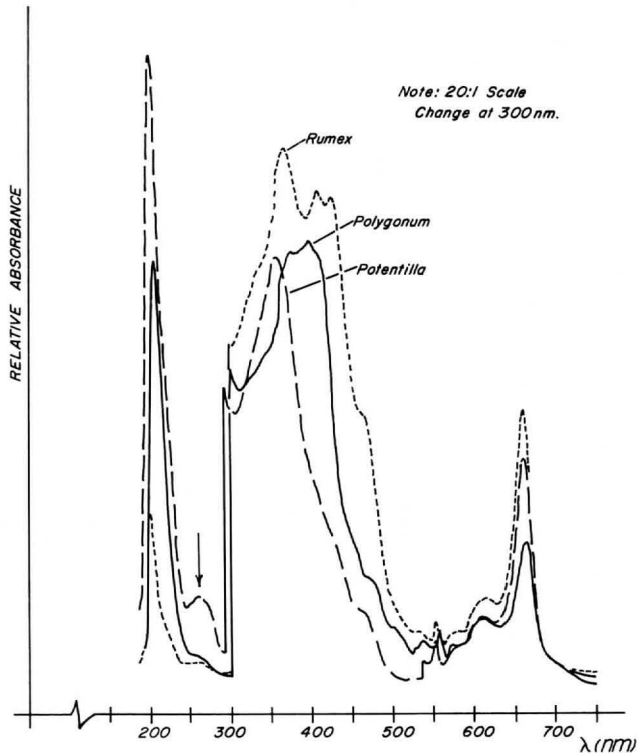


Figure 1: spectral signatures of *Polygonum*, *Potentilla* and *Rumex*. The arrow points to flavonoid absorption.

*Polygonum amphibium* L., a known host of *helooides* in northern Illinois, *Rumex triangulivalvis* (Danser) Rechinger, the suspected host of *helooides* in SE Wyoming, and *Potentilla fruticosa* L., a known host of *dorcas* in several localities. The main reference source for plant biochemistry by species (Gildemeister, 1956-61) was devoid of information.

Ethanol extractions from the leaves were scanned over the range 200-750 nm using a Beckman 25 double-beam scanning spectrophotometer. Except for concentration differences, the spectral signatures, as shown in Figure 1, are very similar. The absorption peak at ca. 670 nm is chlorophyll; the weak absorption ca. 550 nm and the broad absorption centered around 350-370 nm are unclear. The seemingly weak absorption at 250-260 nm (note that there has been a 20:1 scale change in the trace) results from flavonoid compounds (benzene ring aromatics with attached hydroxyls); the very strong absorption at ca. 210 nm represents organic oxygen compounds. Both Dethier (1952) and Ehrlich & Raven (1964) have cited flavonoids as olfactory attractants in the Lepidoptera.

To confirm the presence of flavonoids, two-dimensional descending paper chromatography studies were conducted using Whatman No. 1 chromatography paper as the substrate. 46 x 57 cm sheets were used with the alcohol extract sample spotted in one corner. Solvent 1 indicated as the vertical axis in Figure 2 was by volume 3 parts tertiary butyl alcohol, 1 part glacial acetic acid, 1 part distilled water. The longer length of the paper was used for this 24 hour vertical axis run. For the 4-5 hour horizontal axis run shown in Figure 2, 15% glacial acetic acid was used. The R<sub>f</sub> values were determined, after reading the chromatogram over ultraviolet light, and plotted in Figure 2. The solid symbols represent flavonoid compounds, probably flavones (C<sub>15</sub>H<sub>10</sub>O<sub>2</sub>) which appear as "dust" on leaves and stems. As a check, the spots represented by "1" in the figure were eluted with methanol and scanned. Both exhibited strong absorption at ca. 252 nm, characteristic of flavonoids, and both absorbed strongly at ca. 210 nm, characteristic of organic oxygen compounds.

To recover any volatile oils from the plant specimens, steam distillations of freshly collected samples of the *Potentilla* and *Rumex* were carried out. This was not done for the Illinois *Polygonum* specimens as they had dried out and were of insufficient volume initially. The very small amounts of residue obtained were dissolved in chloroform for the spectrophotometric scans shown

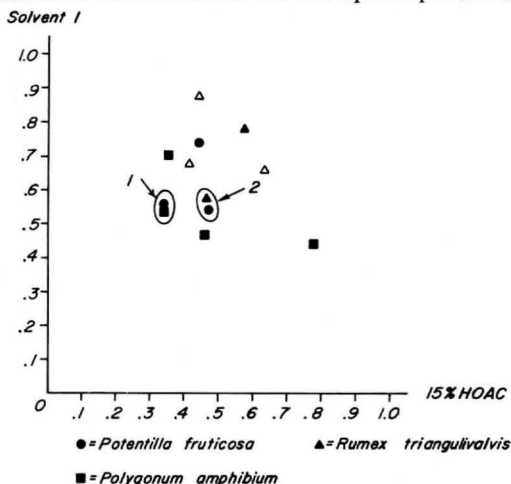


Figure 2: two-dimensional chromatogram of the compounds present in the three plant species studied. The axis coordinates are the R<sub>f</sub> values. The open triangles represent non-flavonoids; the solid symbols are flavonoids.

in Figure 3. The strong absorption *ca.* 250 nm is characteristic of a benzene ring aromatic, probably a flavonoid. Two compounds, with slightly separated absorption lines, are probably present accounting for the "knee" in the traces at *ca.* 260 nm. Chromatographic cross checking was impossible because of the very low concentrations of the samples.

The conclusions which can be drawn from this study are as follows: Biochemically, *Polygonum*, *Rumex* and *Potentilla*, used as hosts by *helooides* and *dorcas*, are very similar. *Pot. fruticosa* and *Pol. amphibium* appear to have a common, or very closely related, flavonoid compound as shown in Figure 2. Within the accuracy of the chromatography technique used, *Pot. fruticosa* and *R. triangulivalvis* may also have a compound in common as indicated by "2" in the figure. The volatile oils study indicates that *R. triangulivalvis* and *Pot. fruticosa* (and presumably *Pol. amphibium*) are very similar if not identical. All three plants contain benzene ring aromatics as indicated by their spectroscopic signatures. If *dorcas* and *helooides* females depend upon olfactory stimuli in host plant selection, then it would seem that either *Potentilla* or *Rumex/Polygonum* could be selected as oviposition substrates. This does appear to be the case, under laboratory conditions, as subsequently discussed. It then appears that host plant specificity is not necessarily valid in this instance. Biochemical specificity would appear to be the mechanism for host selection.

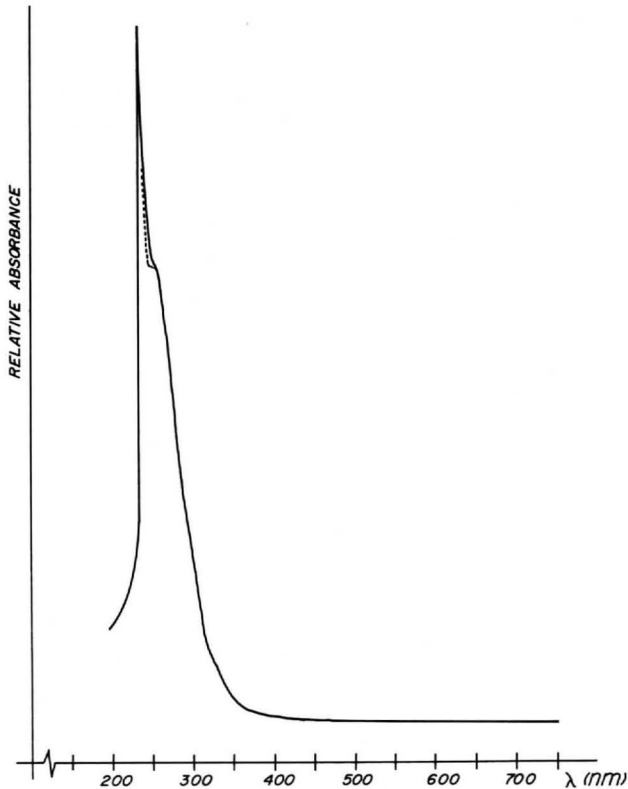


Figure 3: spectrophotometric signatures of chloroform extractions of the steam distillates of *Potentilla* and *Rumex*.

## OVIPOSITION STUDIES

Two oviposition studies on *dorcas* and *helooides* have been reported in the literature (Chambers, 1963; Shapiro, 1974). The Chambers work is inconclusive because the experiments were improperly controlled. Females from an alpine population of *castro* Reakirt (cited as *florus* W. H. Edwards in the paper) were confined over *Potentilla fruticosa*, *Rumex* species, *Polygonum douglassii* Greene and several other plants indigenous to the Gothic, Colorado area. The females were initially confined with all of the plants, and then alternately confined with *Potentilla* and *Rumex*. Oviposition occurred generally on either *Potentilla* or *Rumex*, but also on the *Polygonum*, on one of the "control" plants (*Chenopodium album* L., Chenopodiaceae) and on the soil. Oviposition preference was for *Rumex* over *Potentilla* in a ratio of approximately 2:1. Of 329 ova thus obtained, none produced larvae. In another experiment, females of low altitude *helooides* were confined over a *Rumex* in late August. Ova were obtained and the larvae were successfully reared on *R. crispus* L. The indication here is that multivoltine *helooides* was the species involved. These females, however, were not presented with *Potentilla* which also grew in the area where they were collected, and Chambers assumed *helooides* to be sedentary (cf. Shapiro's mark-recapture study cited below). The author's inference was that the high altitude ova entered diapause but died over the winter. The ova placed upon *Potentilla* were on the upper leaves and stems, while the flowers and seeds were the oviposition sites for *Rumex*. While ova successfully overwinter on *Potentilla*, as the leaf clusters drop to the base of the plants (Newcomb, 1911), by spring *Rumex* seeds and flower stalks have been scattered to the winds, reducing or eliminating survival. Coolidge (1924) stated that the Polygonaceae-feeding *helooides* hibernates as pupae.

There is some evidence, however, that *helooides* may hibernate as ova or larvae in the Rocky Mtn. region. In the wild, oviposition is thought to occur on the leaves and stems at the base of the host plant, rather than on the upper portions observed under laboratory conditions. This would prevent wind dispersal of the ova with the "volatile" portions of the plant. Because of the confusion between *dorcas* and *helooides* experienced by many observers, the early stages of *helooides* in the Rockies are not entirely clear.

Regarding the 2:1 preference exhibited by *castro* females for *Rumex* over *Potentilla*, it is possible that *P. fruticosa* was not the host of choice. Some field studies that I have conducted in northern Wyoming indicate that *P. gracilis* Dougl. may serve as the larval host in that region.

The Shapiro study (1974) is quite interesting in that a *Potentilla*-feeding multivoltine entity is involved. In facies, the imagines are intermediate between *castro* and *helooides*. In the wild, oviposition occurs on *Potentilla egedei* Wormsk. var. *grandis* (Rydb.) Howell although Polygonaceae are present adjacent to the salt marsh habitat. Wild females from this population confined over both *Potentilla* and *Rumex crispus* oviposited on both, but with a marked preference (7:1 ratio for 154 ova) for *Potentilla*. Larvae were obtained and reared to adults on both foodplants with approximately equal survival rates. In another experiment, typical *helooides* females from a nearby "vacant lot" population and other sites were confined over *Potentilla* and *Rumex*. In this case, *Rumex* was the preferred oviposition substrate (13.7:1 ratio for 352 ova), although the larvae were reared successfully on both plants with roughly equal survival rates.

These experiments tend to support the conclusion stated above that biochemical similarity is the mechanism for host selection in this group. Several observations can be made from the somewhat scanty data available regarding female preference for suitable hosts. Olfactory conditioning is certainly a factor and has been demonstrated in the Lepidoptera (Dethier, 1952). Host preference may be behaviorally rather than genetically controlled as Shapiro has noted. Intrinsic barriers to dispersal, as cited by Ehrlich (1961) may also be a factor in host plant

selection. Relatively sedentary species may not range sufficiently far to encounter more than one host. Shapiro's mark-recapture studies on *helooides*, however, indicate that it is highly vagile for the *Polygonum*-association populations. From my own field observations in the Rocky Mountains, I would concur on *helooides*, but would note that *dorcas* appears to be rather sedentary. Since *Potentilla fruticosa* is a perennial shrub, it occurs in the same place every season. Many *Polygonum* and *Rumex* are associated with disturbed soils and the seeds are widely dispersed. They do not necessarily occur in the same spots year after year. Even during a single season, *helooides* must range widely in many areas to find suitable food sources for each of the successive broods.

Until further evidence is presented, one is led to conclude that either *Potentilla* or *Polygonum* and *Rumex* can serve as larval host plants for the species *dorcas* and *helooides*. Oviposition preferences have developed in the various populations, but they may not be genetically controlled. Environmental conditions may have forced dispersal of adults in some areas, and hence a change in host, while relatively unchanged environments associated with salt marshes, sphagnum/black spruce bogs and some alpine willow bogs has made dispersal unnecessary. In the cases of isolated forest bogs and alpine bogs surrounded by forest, dispersal is additionally limited by the forest barrier. The Hopkins "host selection principle", *ie.* differing hosts mean differing species does not apply here.

## BIOLOGY

The life histories of both *dorcas* (Newcomb, 1911) and *helooides* (Coolidge, 1924) have been published. From their descriptions, the early larval instars are similar, but slight differences occur in the later instars. How significant these differences are remains to be seen, as some Lycaenidae larvae are polymorphic. Newcomb reared *dorcas* on *P. fruticosa*. Coolidge cited several hosts including *Polygonum aviculare* L., *P. persicarioides* H.B.K. and *P. hydropiperoides* Michx. Various *Rumex* are noted, including *crispus*, and *Oxytheca spergulina* (A. Gray) Greene, another member of the Polygonaceae [cited by Tietz (1972) as *Eriogonum spergulinum* Gray]. A member of the unrelated Onagraceae, *Gayophytum diffusum* T. & G. is also cited on the authority of another worker. Tietz cited *Oenothera binnis* L. (Onagraceae) which I have been unable to verify.

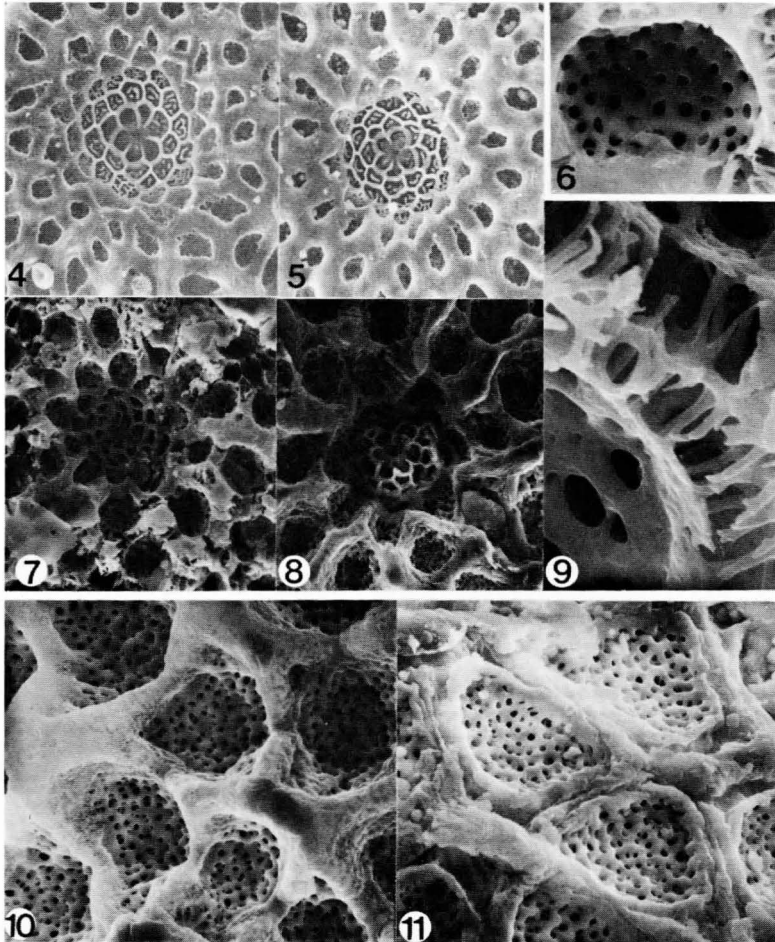
Newcomb stated that the ova of *dorcas* overwinter. They are deposited on the undersides of the *Potentilla* leaflets and fall to the ground when the leaves are shed in the fall. In Michigan, the larvae emerge in April, complete five instars by mid-June to early July, and emerge as adults in July. According to Coolidge, *helooides* passes the winter in the pupal stage.

I have examined *dorcas* and *helooides* ova and, within the framework of the experimental conditions, can detect no significant differences between them in the structure of either the chorion or the micropyle. SEM photographs are shown in Figures 4-11. Some of the ova were naturally oviposited while others were dissected from the oviducts of dried specimens. Although some slight (and expected) differences occurred when dissected material was compared with natural ova, intercomparison of dissected ova yielded no significant differences (Figs. 10-11). There is some variation in the number of leaves in the micropylar rosette; five or six is the usual number. The chorion is perforated as shown in enlarged scale in Figs. 6 & 9, and perhaps respiration takes place through these pores, as the chorion ridge intersections lack the aeropyles associated with other species.

The ova are prepared for the SEM by attaching them to a small piece of double-sided tape which is previously affixed to a standard JEOL button. Small amounts of conductive paint are applied from the egg to the brass button. The tape edges are sealed with the same paint to insure proper grounding of the sample. The samples are then coated with 60-40 gold-palladium in a V-E 10 evaporator, while being rotated on a "Samspin" unit, under a vacuum of  $10^{-5}$  Torr.

Voltinism appears to be important in the species complex. With the exception of Shapiro's Suisun Slough population, the *Potentilla*-feeding *dorcas* is univoltine

and overwinters as ova. The Polygonaceae-feeding *helooides* is multivoltine, with as many as seven broods (Coolidge, 1924), and overwinters as pupae. The multivoltine *Potentilla*-feeding Suisun Slough, Solano Co., California population and several apparent intergrade populations in western and southern Colorado and northern New Mexico remain enigmas. These will be treated further in the taxonomic discussion.



Figures 4-11: scanning electron micrographs of eggs. 4, micropylar rosette and chorion of Suisun Marsh ovum (x169); note pollen grains and apparent erythrocyte (lower left corner). 5, same, but rosette has one less petal. 6, chorion pores in *dorcas* ovum from Ogoki, Ontario (x563). 7, micropylar rosette and chorion structure of dissected *dorcas* ovum from Ogoki, Ontario (x169). 8, micropylar rosette and chorion structure of dissected *dorcas* ovum from Michigan (x169). 9, chorion ridge structure of dissected *dorcas* ovum from Michigan (x169). 10, chorion structure of dissected Michigan *dorcas* ovum (x338). 11, chorion structure of dissected Albany Co., Wyoming, *helooides* ovum (x563).

## GENITALIC STUDIES

Extensive genitalic dissections were carried out on both sexes of *dorcas* and *helooides*. While there is some slight variability within populations and across populations, no significant diagnostic characters could be established in either sex to differentiate the two species. Genitalic structures are illustrated in Figures 12-16.

## SPECTROSCOPIC AND RELATED STUDIES

The reflective dorsal wing surfaces of males were subjected to ultraviolet photography, scanning electron microscopy and reflectance spectrophotometry. With regard to the UV study, the variability in reflected UV pattern in *helooides* was equal to the variability in *dorcas* with overlapping results, as shown in Figures 17-32, 79-80; but especially in the one-on-one comparisons of Figures 33-40. Variable amounts of melanin, apparent in the visible light patterns, disappear in the UV patterns. The strikingly different *helooides* and *dorcas florus* (Figs. 36, 38, 40) appear almost identical when viewed under UV light. The dark spots, so apparent in visible light, may nearly disappear under UV illumination as the specimens in Figures 33-34, 40 indicate. The explanation for this is simply that the dentate scales comprising the melanic spots are partially over-scaled with violet-reflecting spatulate scales. The number of violet scales varies among specimens. As expected, the orange bands of *helooides* and the tornal lunules of

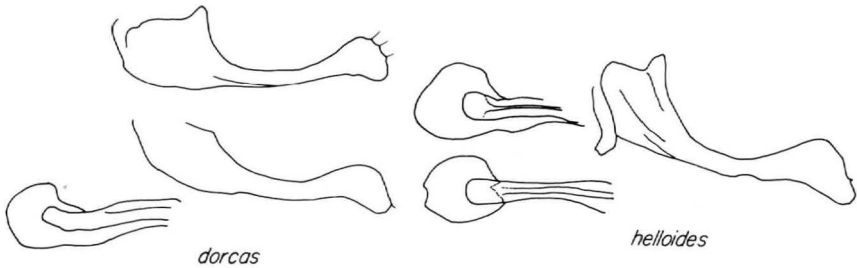


Figure 12, coecum penis and valvae in *dorcas* and *helooides*. (Extreme examples to indicate range of variability).

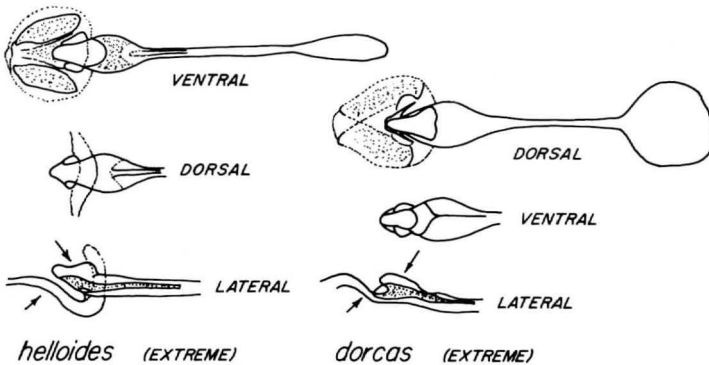
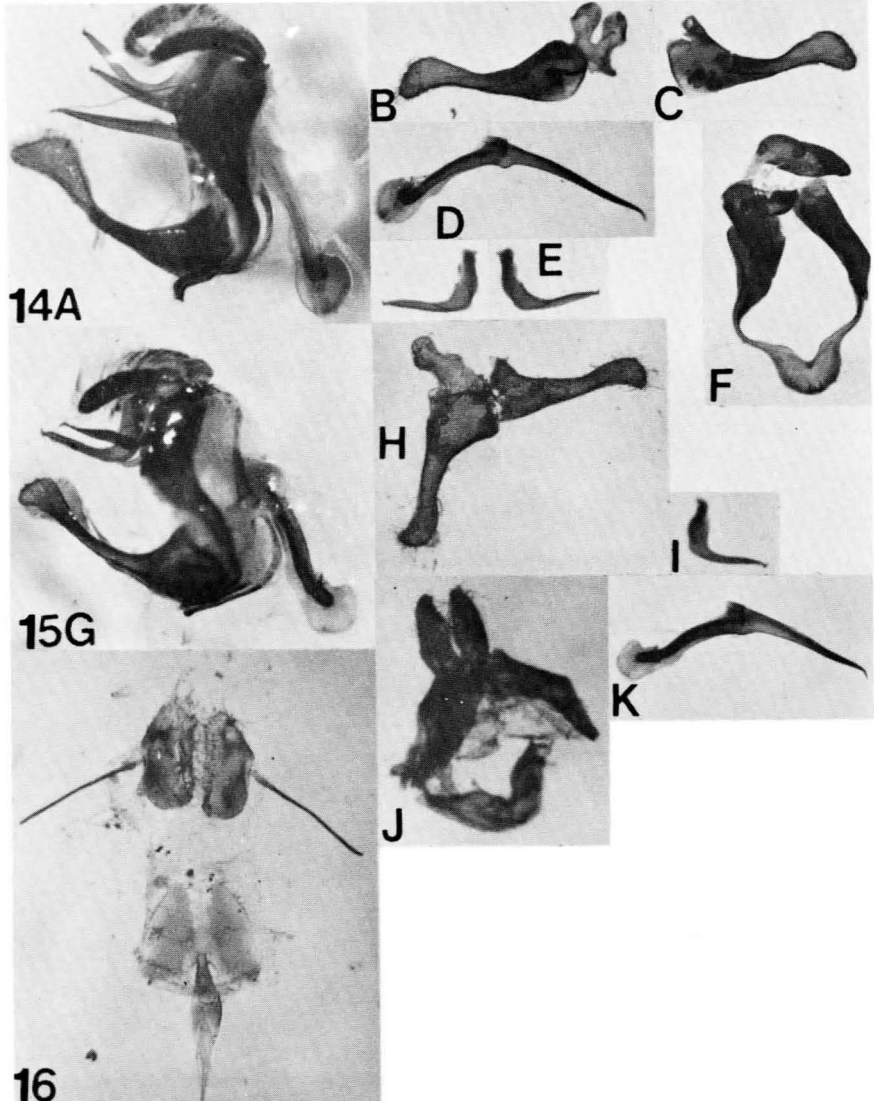


Figure 13, female genitalia in *dorcas* and *helooides*. (Extreme examples to indicate range of variability). The differences in the ostia bursarum and adjacent structures are not consistent, and both forms occur in *dorcas* and *helooides*.

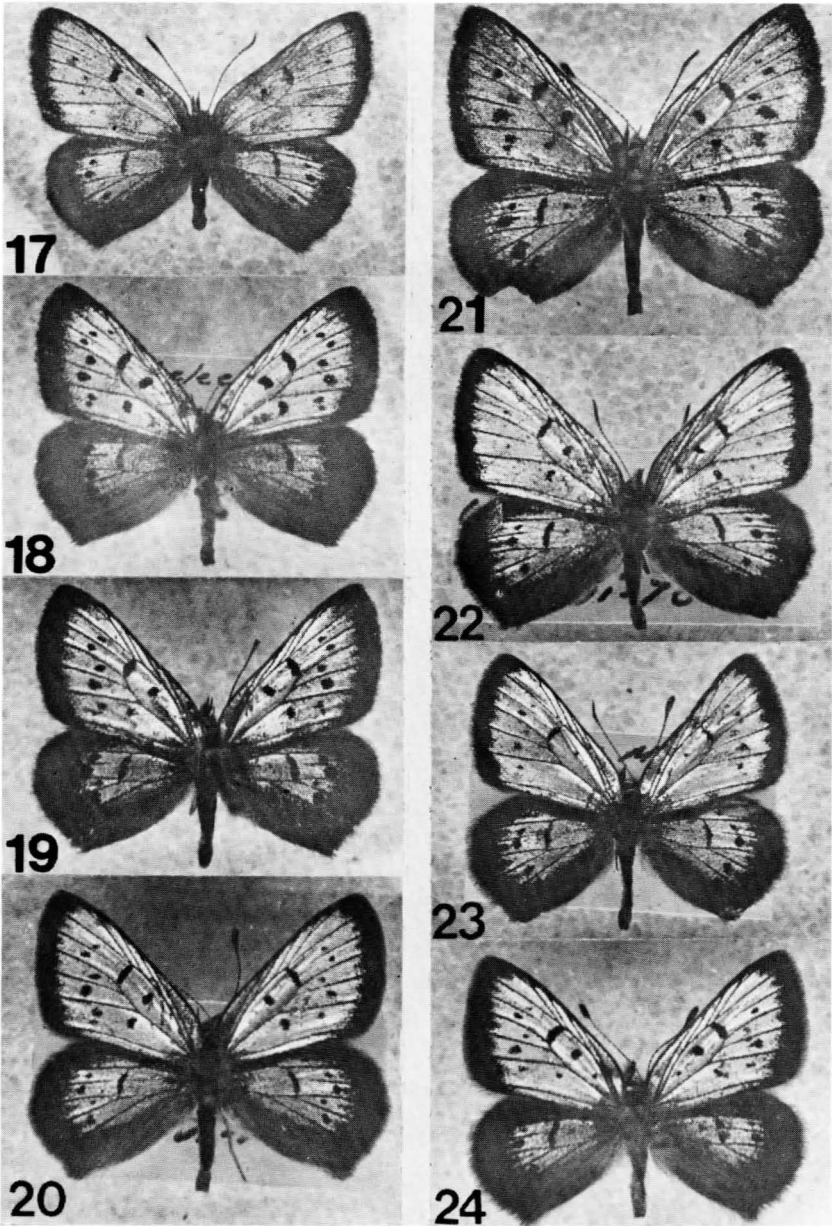


*dorcas* are UV absorbing and are replaced by black in the UV photographs. The females are essentially non-UV reflective as Figures 78, 81 show. This study indicates that the UV reflective patterns of *dorcas* and *helloides* are of notaxonomic aid.

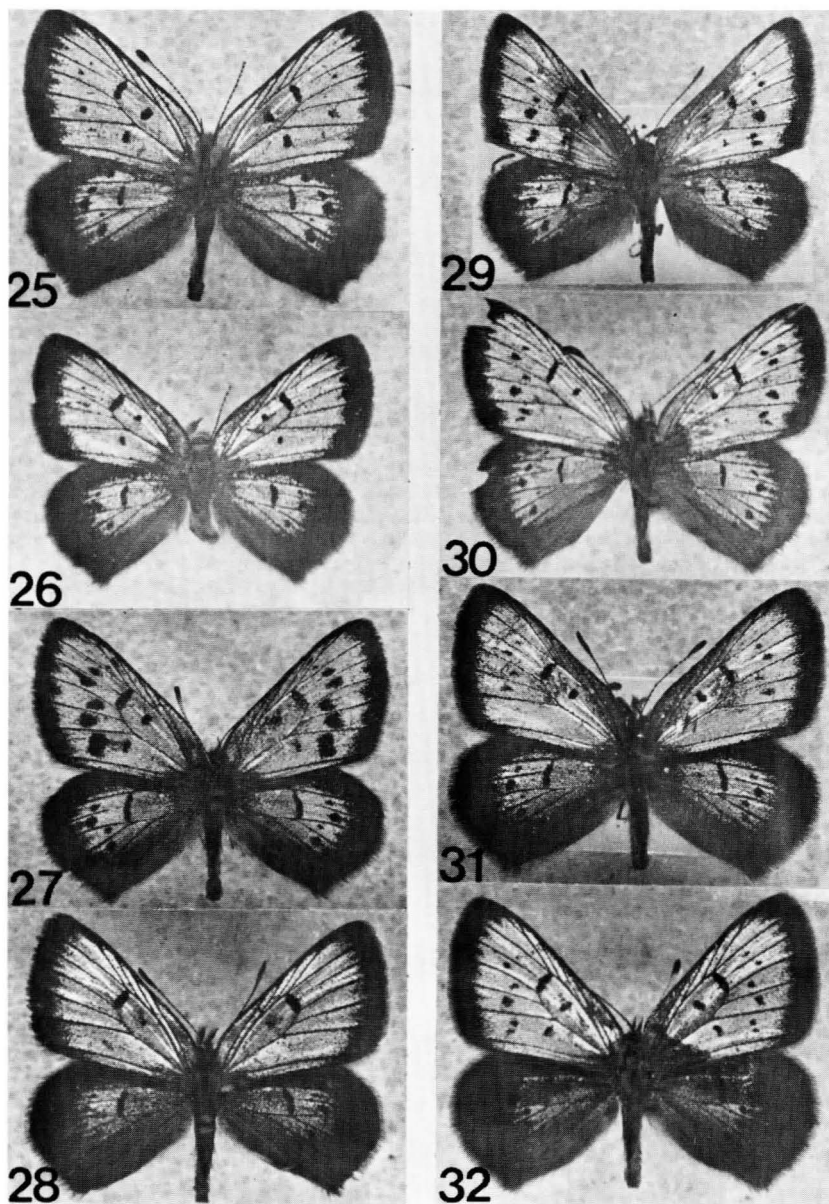
The ultrastructure of the violet-reflecting scales was visualized by scanning electron microscopy. The wings were mounted directly on JEOL buttons, using conductive paint. They were then coated as described above for ova.



Figures 14-16: male (14-15) and female (16) genitalia. 14, male of *helloides* from McHenry Co., Illinois. 15, male of *dorcas* from Dexter Township, Michigan. 16, female of *helloides* from McHenry Co., Illinois.



Figures 17-24: ultraviolet photographs of males. 17, *helloides*, Albany Co., Wyoming. 18, *helloides*, Cass Co., Michigan. 19, *helloides*, Campbell Co., Wyoming. 20, *helloides*, Placer Co., California. 21, *helloides*, Elko Co., Nevada. 22, *helloides*, Wasatch Co., Utah. 23, *dorcas-helloides* intergrade, Moffat Co., Colorado. 24, *dorcas castro*, Taos Co., New Mexico.



Figures 25-32: ultraviolet photographs of males. 25, *dorcas dospassosi*, Bathurst, New Brunswick. 26, *dorcas claytoni*, Penobscot Co., Maine. 27, *dorcas castro*, Santa Fe Co., New Mexico. 28, same taxon, same locality. 29, same taxon, Grand Co., Colorado. 30, *helloides*, Daggett Co., Utah. 31, *dorcas castro*, Albany Co., Wyoming. 32, same taxon, Elko Co., Nevada.

Figure 41 shows the violet spatulate scales and the brown or black dentate scales from area Cu<sub>2</sub> proximad to the Cu<sub>2</sub> branch of the FW. The fine structures of these scales are shown in Figures 42 and 43 respectively. The four-layered structure of the spatulate scales is seen in Figure 44. Ghiradella (et al., 1972; 1974) has discussed in detail the ultrastructure of UV-reflecting butterfly scales. Wing-scale morphology and diffraction structures have been studied by Downey and Allyn (1975) and Allyn and Downey (1976). Basically, each scale is an optical interference filter. Huxley (1975; 1976) reported both optical (diffraction) and pigmental phenomena in several species of *Papilio*.

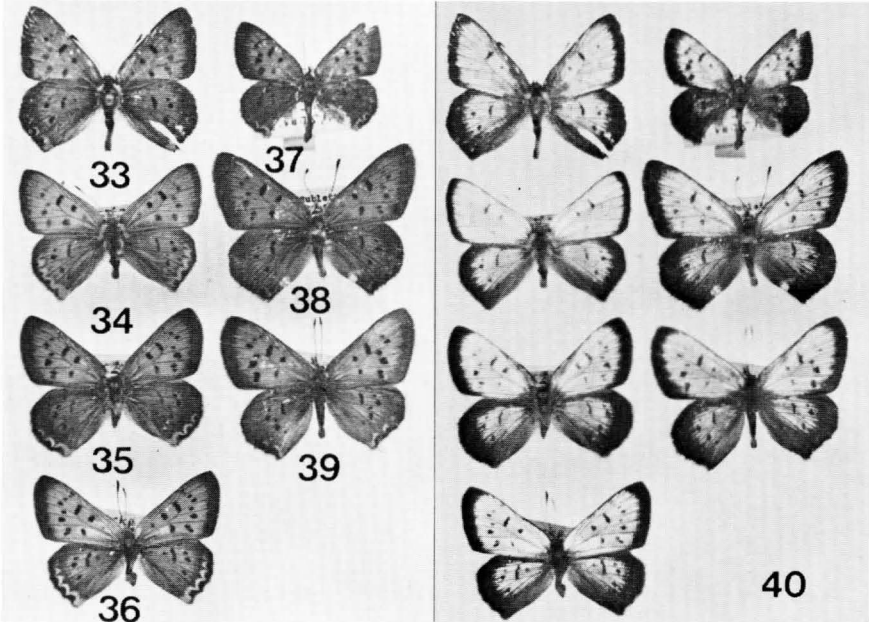
The spatulate scales of *dorcas* and *helooides* strongly reflect in the near ultraviolet with a lesser visible violet reflectance or iridescence. If the thin film formula is applied to the parameters measured from the SEM scans, the wavelength of the reflected light can be calculated from

$$= 2T(n^2 - \sin^2 \theta)^{1/2}/M$$

where: T = thickness = 133.3 nm; n = index of refraction = 1.6;  $\theta$  = specular angle = 10°; M = integer = 1 in this case.

The wavelength of the reflected light, computed from this formula, is 424 nm. There are potential errors in the use of the formula which result from measurement errors and parallax in using the SEM.

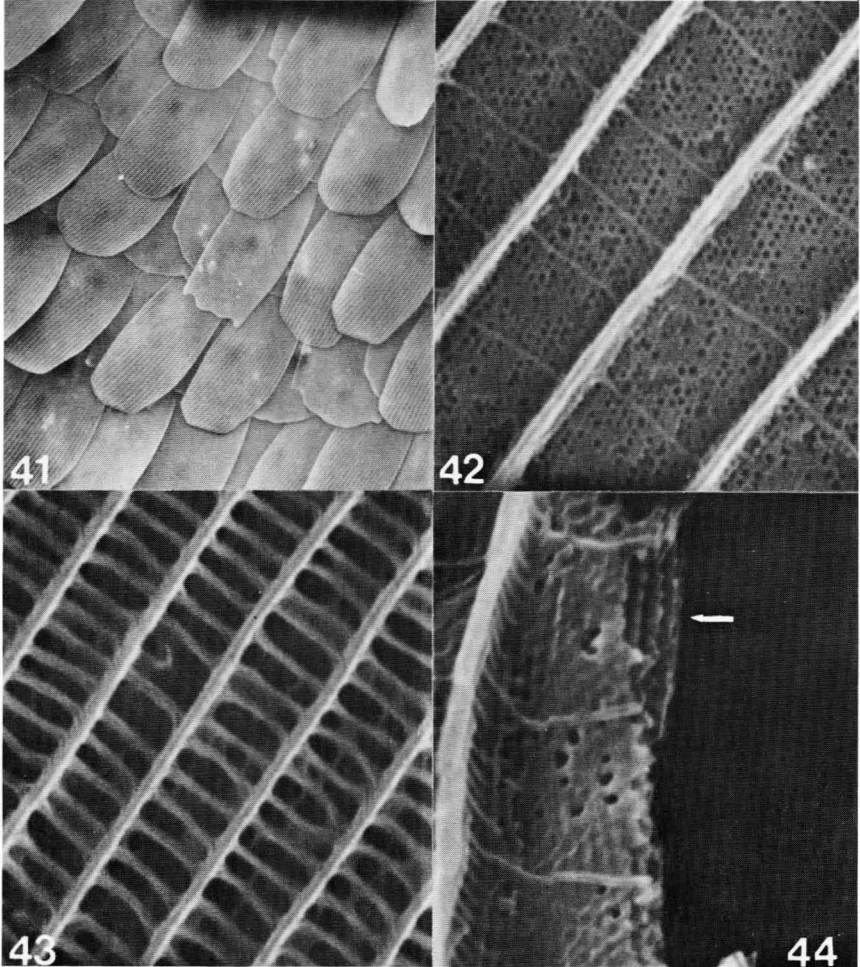
To verify the SEM results, the wings of six specimens of *dorcas* and *helooides* were scanned, under visible light, using a one meter Czerny-Turner spectrophotometer. Focused light from a tungsten filament illuminated the specimens. Figure 45 illustrates the results. The wavelength of maximum reflection varied from 420-428 nm. Again there is some parallax error depending upon the tilt of the wing relative to the incident light and the angle of the grating in the spectrophotometer.



Figures 33-40: males under visible (33-39) and ultraviolet (40) light. 33, Siusun Marsh population, Yolo Co., California. 34, *helooides*, Riverside Co., California. 35, same taxon, Vancouver Island, British Columbia. 36, same taxon, Livingston Co., Michigan. 37, *dorcas*, Lake Atikanieg, Manitoba. 38, *dorcas florus*, Sublette Co., Wyoming. 39, *dorcas castro*, Ouray Co., Colorado. 40, ultraviolet photos of the specimens in Figs. 33-39.

Traces 3 and 3A of Fig. 45 require some explanation. Two areas of the wings of this specimen were scanned. Generally the scans were conducted along a postdiscal bar region of the FW and HW. The reflected light was focused by a lens on the entrance aperture (slit) of the spectrophotometer, thus producing the bar scan. For the specimen under discussion, this method of scanning produced trace 3. The specimen exhibited a strong pale violet or lilac reflectance basally. When this was scanned, trace 3A resulted, showing an expected shift to longer wavelength.

When viewed under sunlight, *dorcas* and *helloides* frequently appear to reflect different colors of violet, with *dorcas* a duller and deeper hue than *helloides*. With the exception of occasional specimens, such as represented by traces 3-3A, this is only a visual artifact as demonstrated in Figure 45. Generally the wings of



Figures 41-44: scanning electron micrographs of wing scales of Michigan *d. dorcas*. 41, dentate black-brown and spatulate violet reflecting scales. 42, violet scale reflecting area (x6428). 43, non-reflecting dentate scale (x6428). 44, broken violet reflecting scale showing the four layers (x12856).

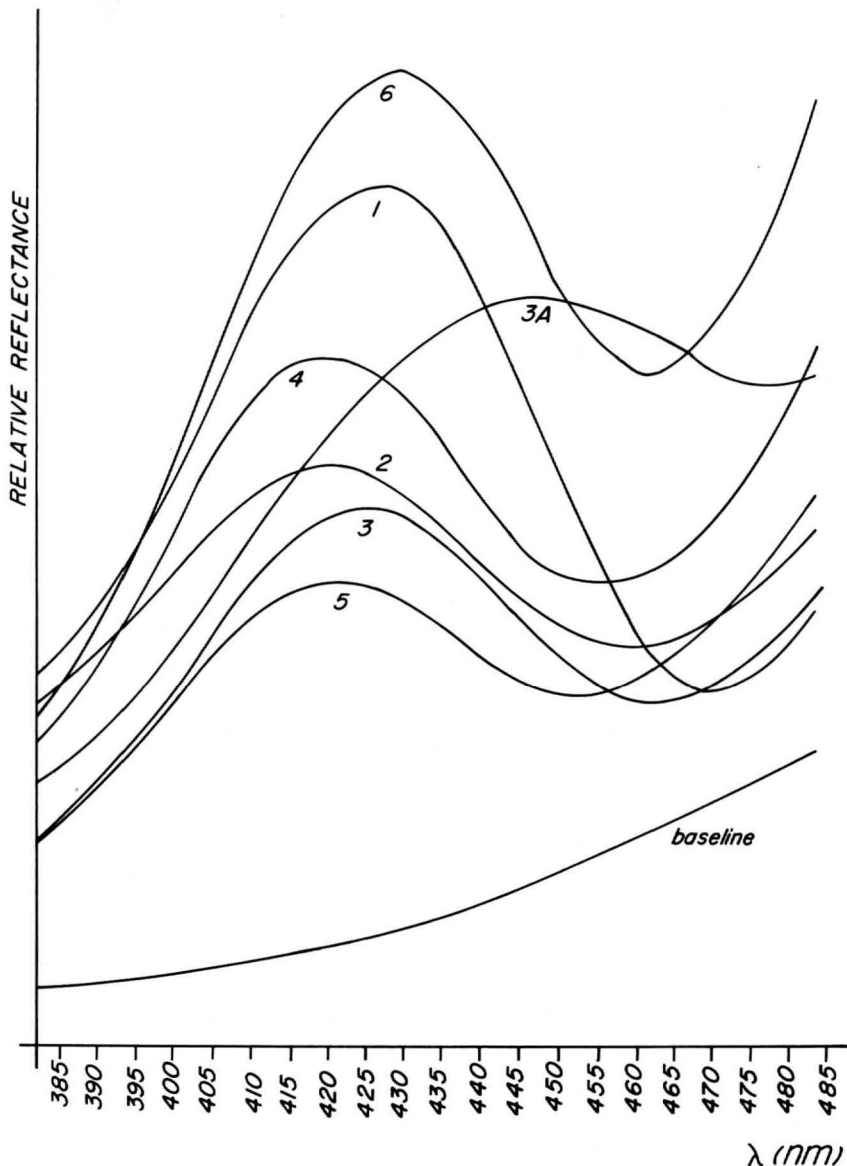


Figure 45: Reflectance spectra from dorsal surfaces of male *dorcas* and *helloides*. The peaking wavelengths  $\lambda$  are noted in parentheses. 1, *dorcas*, Dexter Township, Michigan (427.5 nm); 2, *helloides*, McHenry Co., Illinois (421 nm); 3, 3A, *helloides*, Lake Tahoe, California (3,426 nm; 3A, 448 nm); 4, Siusun Marsh population, Yolo Co., California (420 nm); 5, *dorcas megaloceras*, Sheridan Co., Wyoming (422 nm); 6, *dorcas florus*, Yellowstone N.P., Wyoming (428 nm). The baseline trace was obtained by monitoring the incident light from the incandescent source reflected from an optically black surface.

*dorcas* carry more melanic scales than *helooides* which produces the illusion.

These spectroscopic studies indicate that there is no significant structural difference between the wing scales of *dorcas* and *helooides*.

## GLACIATION

The monographs contained in Wright and Frey (1965) present an excellent summary of our knowledge of the Quaternary Period of geologic time (Pleistocene and Holocene Epochs). Matters relating to the geomorphology, vegetation and dispersal of animal and plant species following the retreat of the Wisconsin glaciation are treated in some detail. Of particular interest is the article by Ross on insects as related to Pleistocene events. Equally useful are the articles contained in Dort and Jones (1968) which examine the Quaternary Period in the central Great Plains, especially those articles by Ross, Wells and Wright. The postglacial vegetational history of the Great Plains is nicely summarized by Wells (1970). Dillon (1956) has succinctly summarized Wisconsin climate and North American life zones.

The picture of our continent that emerges from these studies is interesting. As indicated in Figure 46, the undifferentiated Wisconsin ice in the West extended to just south of the Canadian Border (there were actually four major glacial periods

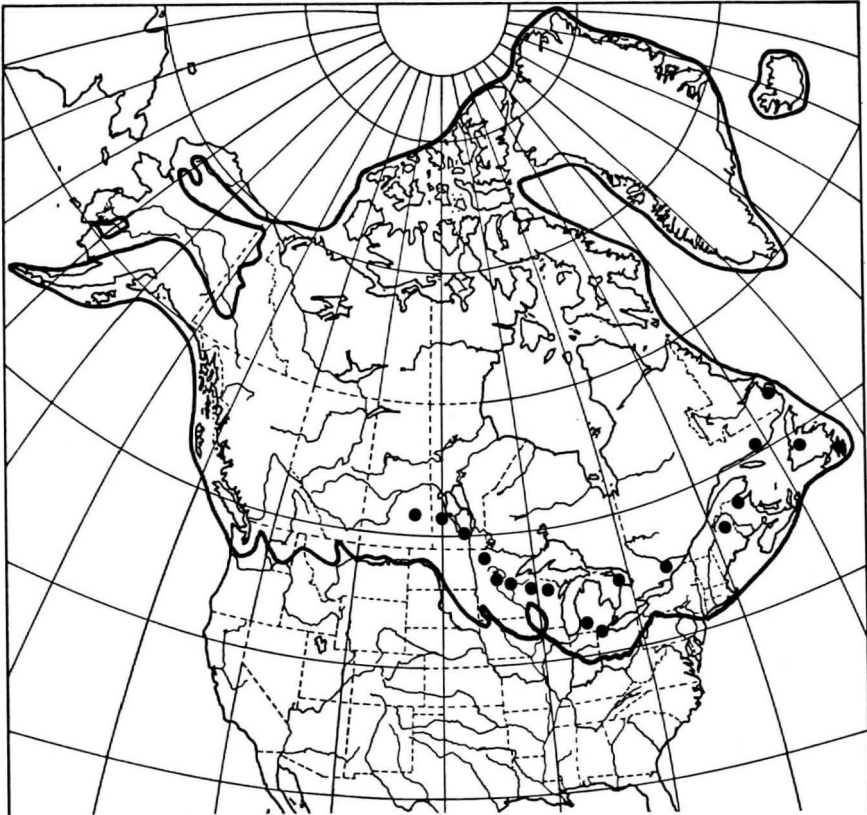


Figure 46: southern extent of *dorcas* relative to the southern boundary of the undifferentiated Wisconsin glaciation.

- Nebraskan, Kansan, Illinoian, Wisconsin - with interposed deglaciations between the Tertiary and Quaternary Periods). At about the 100th meridian, the ice advanced sharply south to about the 40th parallel and extended eastward to the Atlantic Ocean. The present grassland areas of central North America were occupied by boreal conifer forests characteristic of those which now exist in the Canadian taiga (Wells, 1970). The period of maximum glaciation occurred from about 20,000 to 14,000 B.P. Depending upon latitude, from about 12,500 to 9500 B.P., the boreal forests gave way to temperate deciduous forests. About 8000 B.P., grassy regions developed in the East with fully developed prairies extending into central Minnesota. About 6000-7000 B.P., a climatic reversal caused the prairie to withdraw westward with a return of deciduous forest in the East (Wright, 1968). In the western Great Plains, radiocarbon dating indicates that the now arid and barren Laramie Basin and related areas supported pine and juniper forest from about 5600 to a recent  $205 \pm 95$  B.P. (Wells, 1970). Prairie grassland fires are thought to be the reason why wooded and forested areas in the western Great Plains are scarp-restricted. The escarpments provided the only natural barriers to the fires and provided refugia for trees and shrubs.

South of the Canadian Border in the West, the continent was virtually free from ice, but not totally as Figure 46 would lead the reader to believe. Glacial ice existed throughout the higher mountains of the Rockies, in the Sierras, Cascades,

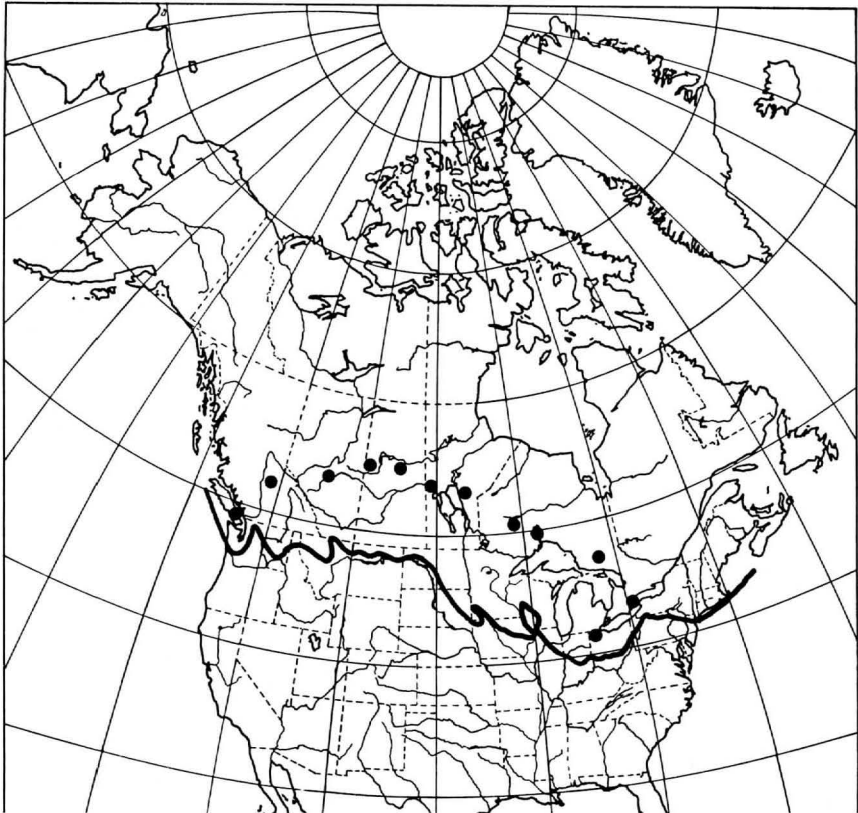


Figure 47: northern extent of *hesperomys* relative to the southern boundary of the undifferentiated Wisconsin glaciation.



etc. It penetrated to the Sacramento Mtns. of southern New Mexico (lat. 33°20' N) during the Pleistocene and to the Sangre de Cristo Mtns. (35°40' N) during recent times. At 49° N, glacial ice descended to 4200-5400' (1260-1620 m); at 33°20' N, the descent was more shallow to 10,200-11,400' (3060-3420 m) (Richmond, 1965). Montane glaciers may also have occurred in Arizona and Mexico, but authorities disagree on the extent of glacial ice in the western Cordillera.

In Wyoming, the Big Horn Mtns. were apparently not affected by the two late stages of the Pleistocene, but boulder gravel found in the region indicates a much older stage of glaciation, perhaps dating back to the Irvingtonian Age, which began about 1.8 million B.P.,<sup>1</sup> during which the Nebraskan and Kansan glaciations occurred (Flint, 1945). Elsewhere during the Quaternary, individual valley glaciers were widespread in the Rockies with local ice caps to lat. 37° in a number of mountain ranges. Five Pleistocene glaciations (Washakie Point, Cedar Ridge, Sacagawea Ridge, Bull Lake, Pinedale) are recognized, with the last glaciation subdivided into three minor advances separated by brief remissions. The final recession of the late Pleistocene ice was followed by the Altithermal interval (a warm dry episode), in turn followed by two minor episodes of cirque glaciation known as the Neoglaciation (Temple Lake and Gannett Peak Stades). During the late Pleistocene, the temperatures in the Rocky Mtns. are thought to have been from 16.5-17° F (8-9° C) colder in the summer from current norms; winter temperatures were approximately the same as today (Richmond, 1965).

Johnson (1975) has presented an interesting analysis of butterfly relicts and post-Pleistocene environments as related to the extreme western Great Plains. His paper relates, primarily, to montane coniferous forests from Colorado and Nebraska north to the Canadian Border.

## CONCLUSIONS

Based upon the foregoing studies, few solid conclusions can be drawn concerning the *dorcas/helloides* complex. There is clearly a multivoltine Polygonaceae-association entity and a univoltine Rosaceae-association entity, although the host plant affinities apparently break down under laboratory conditions, and may well also do so in the wild under some circumstances. Spectroscopic studies of the imagines indicate that males of both entities exhibit approximately the same numbers of violet-reflecting spatulate scales dorsally. Comparison of white light patterns, however, indicates that the *dorcas* phenotypes appear to contain a greater concentration of melanin in the scales than do the *helloides* phenotypes. This appears to be thermal adaptation to the montane and boreal environments in which *dorcas* occurs. As is the case with North American *Colias*, the genitalic structures provide no significant taxonomic information, but are perhaps useful in terms of evolutionary considerations. Documented intermediate populations occur in some areas, such as Suisun Slough in California, and apparently in several other areas based upon examination of museum specimens, although such material can be misleading.

Various theories can be postulated concerning the evolution of the *dorcas/helloides* phenotypes. At the present time, because of genitalic and other structural similarities, I consider *dorcas* and *helloides* as sibling species which diverged from a common ancestor during glacial times. Multivoltine populations are referred to *helloides*, while the univoltine populations are referred to *dorcas* with the recognition of several subspecies. These subspecies have evolved as a consequence of geographic isolation. In several localities, intergrades appear that cannot be placed exactly. In the Rocky Mtns., these may result from introgressive hybridization between low-elevation *helloides* and montane *dorcas* such that relatively stable, but local intergrade forms occur. Isolates such as the Suisun Slough colony are difficult to explain. It is possible that this colony is a *dorcas* relict derived from the southern Coast Ranges and has developed multivoltinism in response to local climatic conditions, while *helloides* found in neighboring areas may be a relatively

recent introduction. *E. dorcas* appears to be a rather sedentary species associated with boggy habitats, while *helloides* is vagile, and in some areas, rather transitory. It is quite probable that man has assisted in the dispersal of *helloides* through road building and land clearing for agriculture. Soils disturbed in this manner have proved fertile for *Rumex*, and *helloides* has undoubtedly followed the spreading of its plant hosts.

Based upon the Big Horn Mtns. population, it seems possible that *dorcas* and *helloides* diverged during one of the interglacial periods rather than at the time of the most recent glaciation. It is not entirely clear whether the common ancestor was a savanna *helloides* type or a boreal *dorcas* type. In view of the wide distribution of *dorcas* (Figure 48), I favor a boreal form which was driven south by the advancing ice. When the ice retreated, *dorcas* then dispersed northward and into the higher elevations of the Rocky Mtns. where it found a suitable ecological niche. Adaptation to a warmer and drier environment is manifested in *helloides*. Because of the somewhat ephemeral nature of its host plants, it developed a vagility, not found in *dorcas*, which permitted its dispersal.

Based upon phenotypes, I suspect that the focus from which *dorcas* and *helloides* dispersed with the retreat of the glacial ice was somewhere in the Midwest, perhaps in the area just west of Lake Michigan or in the central Great Plains.

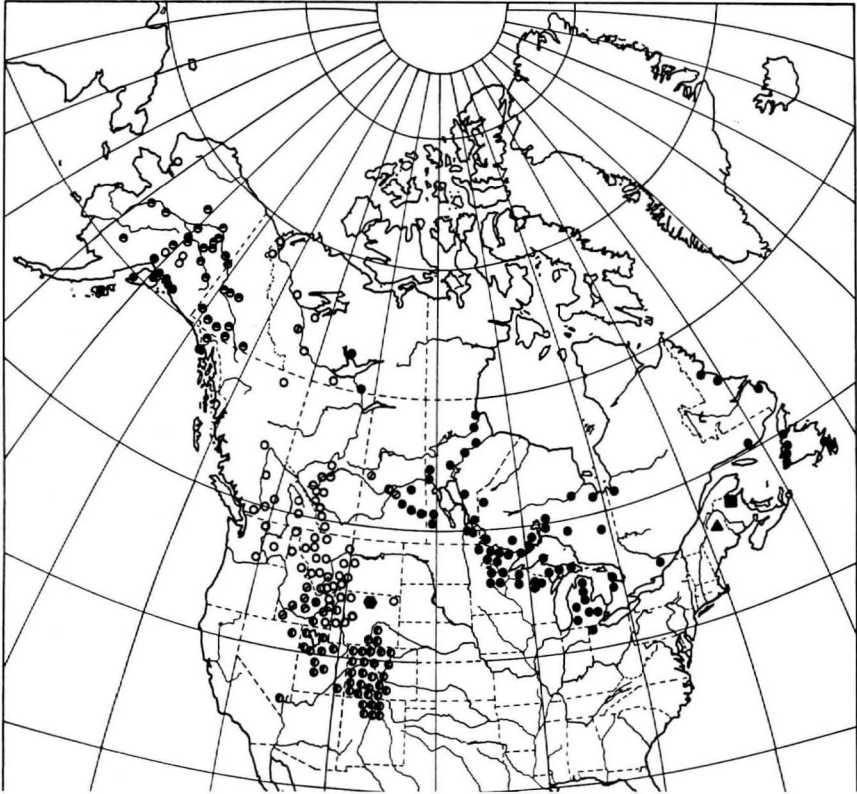


Figure 48: distribution of *E. dorcas* in North America. Solid circles: *dorcas*; open circles: *florus*; half-open (side) circles: *castro*; half-open (bottom) circles: *arcticus*; square: *dospassosi*; triangle: *claytoni*; hexagon: *megaloceras*; circle with diagonal line: intergrade forms.

The arctic population that appears restricted to the Yukon River drainage is an enigma. It may actually be closer to the common ancestor than either *dorcas* or *helloides*. Although I have placed it as a *dorcas*, it exhibits, in facies, characters of both species. Vast areas in central Alaska, including the valley of the Yukon River, remained unglaciated during Quaternary time. Apparently glaciation was more extensive during the Illinoian Period than during the Wisconsin (Péwé, *et al.*, 1965). Thus in this butterfly, we may see something close to the common ancestor of present day *dorcas* and *helloides*.

While other equally plausible theories can be advanced, the one presented above for the evolution and dispersal of *dorcas* and *helloides* fits the available data. Until such time as extensive breeding and biological studies are conducted, we can do little more than speculate. Controlled studies need to be carried out in which photoperiod, temperature and other environmental factors are varied and their effects upon phenotype examined. To do this for all of the known phenotypes would occupy a lifetime. Johnson and Balogh (1977) have presented a detailed discussion of Pleistocene paleobotany and glaciation with respect to several other species of North American Lycaeninae. They have dealt with a more complex problem in some respects, but have been aided by genitalic differences, at the subspecies level, which do not occur in *dorcas* and *helloides*. It appears that *dorcas* and *helloides* have been more recently isolated than some other species. The genus *Epidemia* has perhaps evolved in more recent times than other North American genera of

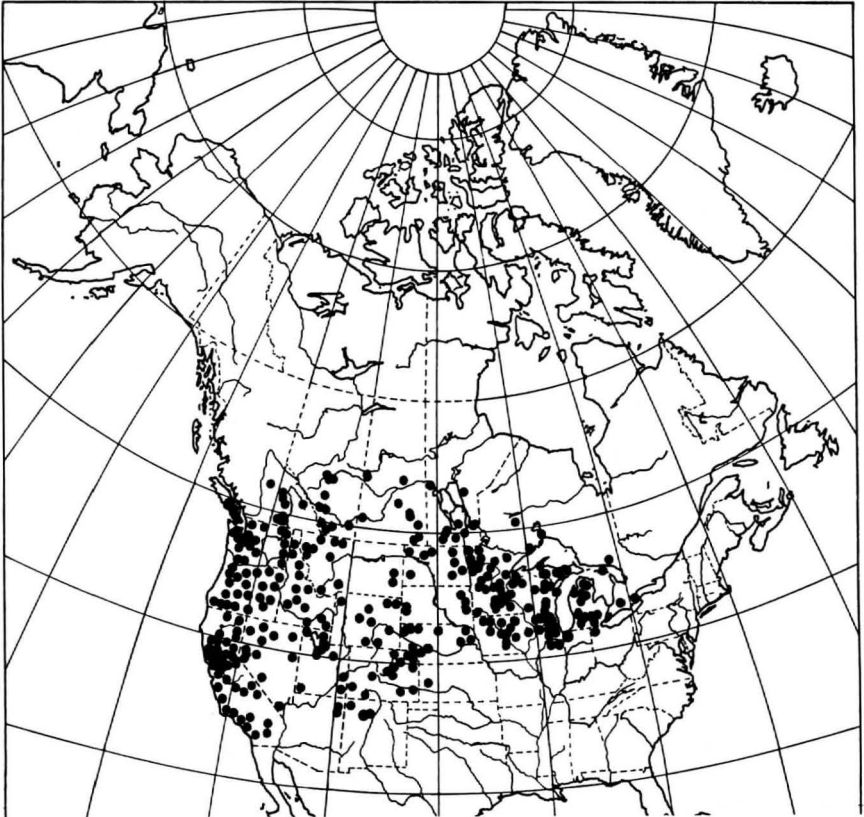


Figure 49: distribution of *E. helloides* in North America.

Lycaeninae. The earlier evolved genera exhibit more structural differences among their associated species than occur in *Epidemia*.

#### TAXONOMY

##### *Epidemia helloides* (Boisduval)

*Polyommatus helloides* Boisduval 1852:291 TL "San Francisco, California"

*Lycaena helloides*: Kirby 1871:342; Barnes & Benjamin 1926:18 (no. 412);  
McDunnough 1938:24 (no. 432); dos Passos 1964:61 (no. 440)

*Epidemia helloides*: Scudder 1876:128 (no. 296); Dyar 1902:41 (no. 396)

*Chrysophanus helloides*: Strecker 1878:102 (no. 162)

*Heodes helloides*: McDunnough 1922:136; Comstock 1927:174

*Tharsalea helloides*: Field 1938:160; Howe 1975:314

**Location of Type.** National Museum of Natural History, Smithsonian Institution, Washington, D. C. Illustrated in Figure 50.

**Diagnosis.** Males. This sex is characterized dorsally by narrow dark wing borders and bright violaceous scaling, prismatic in origin. There is a pronounced

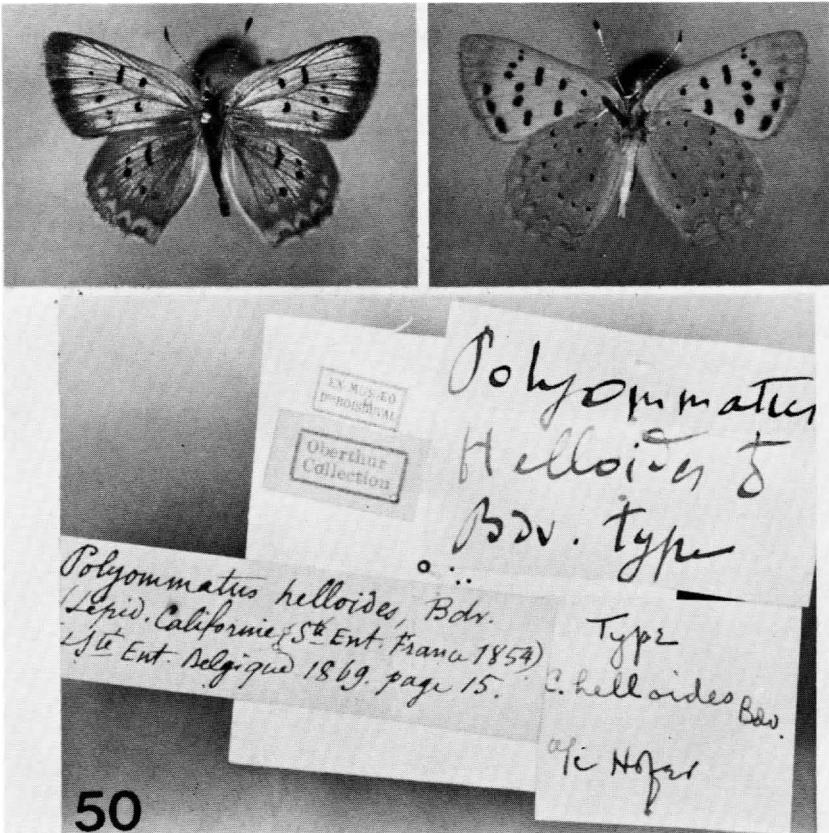
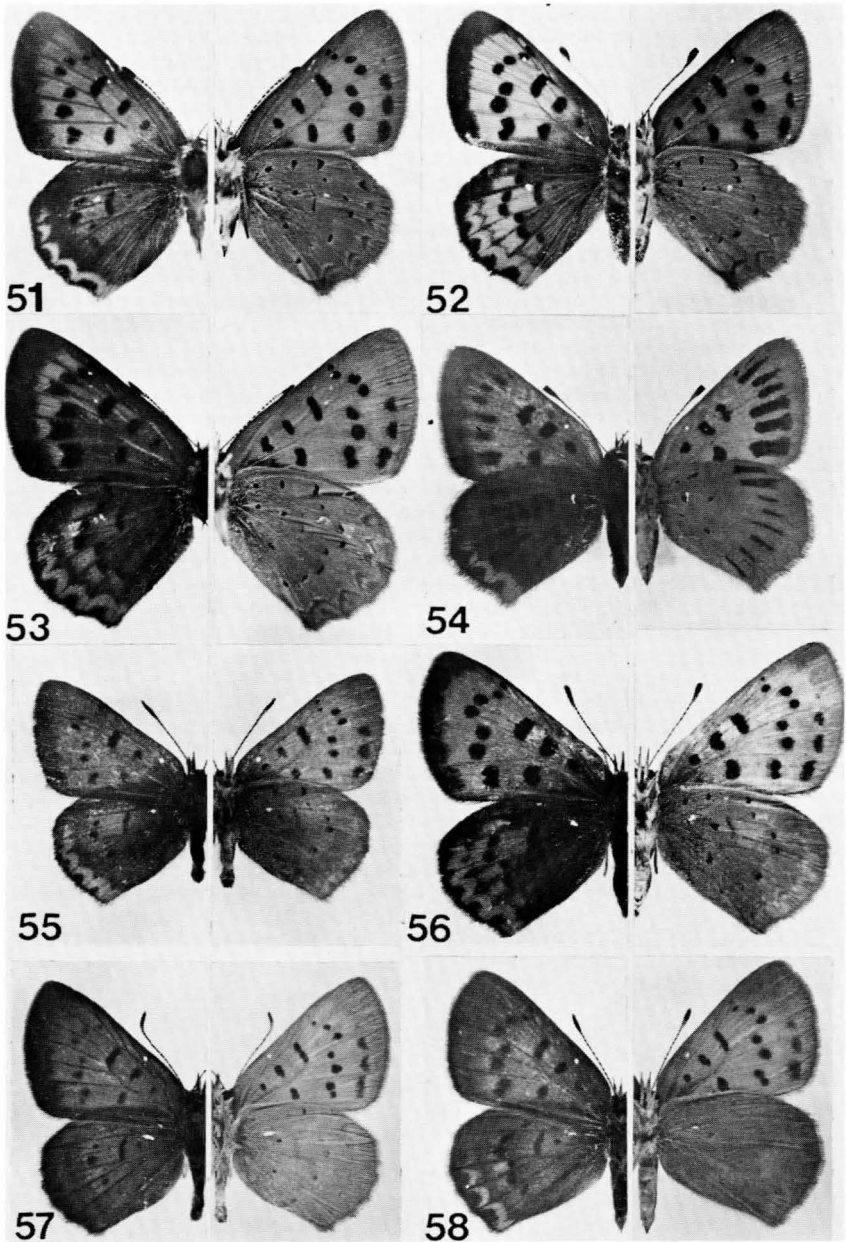


Figure 50: holotype ♂ of *E. helloides* (Boisduval).



Figures 51-58: upper (left) and under (right) surfaces of *helooides* (51-56) and *dorcias castro* (57-58). 51, ♂, McHenry Co., Illinois; 52, ♀, same locality; 53, ♀, dark form, same locality; 54, ♀, melanic aberrant, Albany Co., Wyoming; 55, ♂, same locality; 56, ♀, same locality; 57, ♂, Elko Co., Nevada; 58, ♀, same locality.

orange crenulate band extending along the HW margin from the tornus to cell  $M_1$  with occasionally a very faint spot in Rs. Black spots appear in varying numbers and intensity. There is a prominent FW cell-end spot, one in the middle of the cell and usually a faint spot basad. There is a large spot in cell  $Cu_2$  just below the junction of vein  $Cu_2$  with the FW cell. Postmedian spots of varying intensity are found in cells  $Cu_2-M_1$  and occasionally in  $R_5$ . On the HW, there is a prominent crescentic cell-end spot and a weaker postdiscal row of spots in cells  $Cu_2-Sc+R_1$ . Ventrally, *helloides* is quite variable. The ground color of the FW is yellow-orange ochraceous while the HW is grayish-ochre with the dorsal orange crenulate band narrowly repeated. Western specimens are more nearly unicolorous beneath, while eastern specimens tend to have the gray-ochre repeated in the FW apical area. The dorsal black spots are repeated in varying degrees beneath.

Females. Dorsally the general maculation is similar to the males, although the black spots are bolder and larger and the FW borders are considerably wider. The basic ground color, however, is orange (without any prismatic effect) occasionally heavily suffused with brownish scales. On the HW, there is always considerable brownish suffusion basally. Ventrally, the females resemble the males, but the colors tend to be brighter. The antennae are encircled alternately with black and white; the club is black with an orange tip. There is some variation according to brood. Expanse (FW costal margin length): males 1.25-1.6 cm; females 1.2-1.65 cm. Examples of *helloides* appear in Figures 51-56.

**Biology.** The life history of *helloides* was described by Coolidge (1924). The butterfly is multivoltine with as many as seven broods in southern California (March-November) and fewer in cooler regions, with perhaps only two in some parts of the Rocky Mtns. Various species of *Polygonum* and *Rumex* serve as larval hosts with demonstrated oviposition preferences, perhaps as a result of olfactory conditioning, in some regions where both plants grow together. Winter hibernation as pupae is reported.

**Distribution.** As shown in Figure 49, *helloides* is widely distributed from the Great Lakes region westward into all of the western states and southern Canada. Penetration into southern Canada may be relatively recent and partly a result of land clearing for agriculture. Although numerous allopatric colonies exist, I do not feel subspecies recognition is warranted, unless genotypic differences can be demonstrated. There are some slight phenotypic differences between populations from the Pacific Coast and the Great Plains. The latter are usually more boldly and brightly marked than material from west of the Rockies. Occasional specimens from the Sierran, Cascade and Intermountain populations show definite *dorcas* traits and may represent the appearance of recessive genes. This variation does not appear to be of climatic origin.

### **Epidemia dorcas dorcas (Kirby)**

*Lycaena dorcas* Kirby 1837:299 TL "Taken in Lat. 54°"

*Lycaena dorcas*: Strecker 1878:101 (no. 160 as synonym of *epixanthe*); Barnes & Benjamin 1926:18 (no. 413); McDunnough 1938:26 (no. 433); dos Passos 1964:61 (no. 441)

*Chrysophanus dorcas*: Doubleday-Hewitson 1850-52:498

*Epidemia dorcas*: Scudder 1876:128 (no. 297); Dyar 1902:41 (no. 397)

*Heodes dorcas*: McDunnough 1922:136

*Tharsalea dorcas*: Howe 1975:314

*Lycaena anthelle* Boisduval Mss, Westwood 1847:55 = *dorcas* Kirby

**Location of Type.** The female designated as the type of *dorcas* by Kirby is

apparently lost. McDunnough (1922) was unable to find it in the Canadian National Collection. At one time, the type may have resided in the collection of the Royal Entomological Society (London), but that collection was dispersed in various ways during the last century, with some of the material going to the British Museum (NH), and some *via* Stevens auction (R. L. Vane-Wright, *in litt.*). The type is not in the British Museum and is thus presumed lost.

The Type Locality of 54° N is generally accepted to be the vicinity of The Pas, Manitoba (H. K. Clench, *in litt.*).

**Neotype.** A female specimen in the Canadian National Collection from The Pas, Manitoba, collected by G. S. Brooks 19-vii-40, has been designated the neotype. It is shown in Figure 59 along with the labels attached to the pin. The neotype label is red and lettered in black ink; the locality label is white and lettered in black. This specimen compares favorably with the specimen Kirby illustrated. Kirby's text description, although appearing detailed, leaves much to be desired because of his terminology. The FW costal margin length of the neotype is 1.2 cm.

**Diagnosis.** Males. *E. dorcas dorcas* is characterized dorsally by wide dark brown marginal borders. The violaceous coloring, as found in *helloides*, appears quite dark because of the melanin in the scales. The black spots appear approximately as in *helloides*, but they are usually more pronounced. The orange crenulate band on the HW is absent; typically there is only a small orange spot at the tornus, which may be obsolete, and in some examples it may extend as a very weak band into neighboring cells. Ventrally the colors are darker than *helloides*. There is a dark tawny aspect with a suggestion of violaceous overscaling, especially on the HW, in fresh specimens. The HW appears brownish-ochraceous and the orange crenulate band, absent dorsally, is quite evident extending into cell M<sub>1</sub>.

Females. The dorsal ground color is medium tawny brown. The dark spots are placed as in the males and the females of *helloides*, but are less clearly defined. In some specimens, distad of the postmedian row of spots, the cells are filled with orange-ochraceous spotting. The orange crenulate band, found in *helloides*, is absent. Some specimens exhibit a small orange spot at the tornus as in the males. A few specimens show a small and poorly developed band, while in many specimens, there are no orange markings. Fresh specimens frequently display a faint violaceous reflection. Ventrally the females are similar to the males. The antennae are alternately ringed in black and white; the club is black and the tip orange. Generally

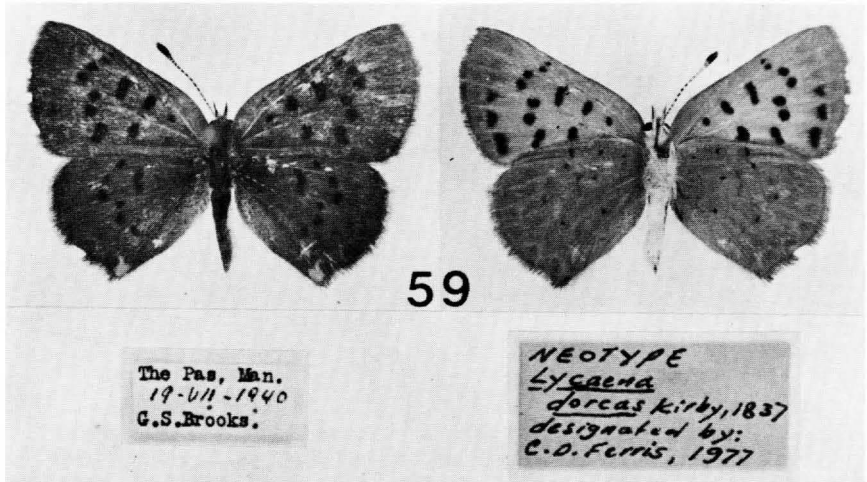
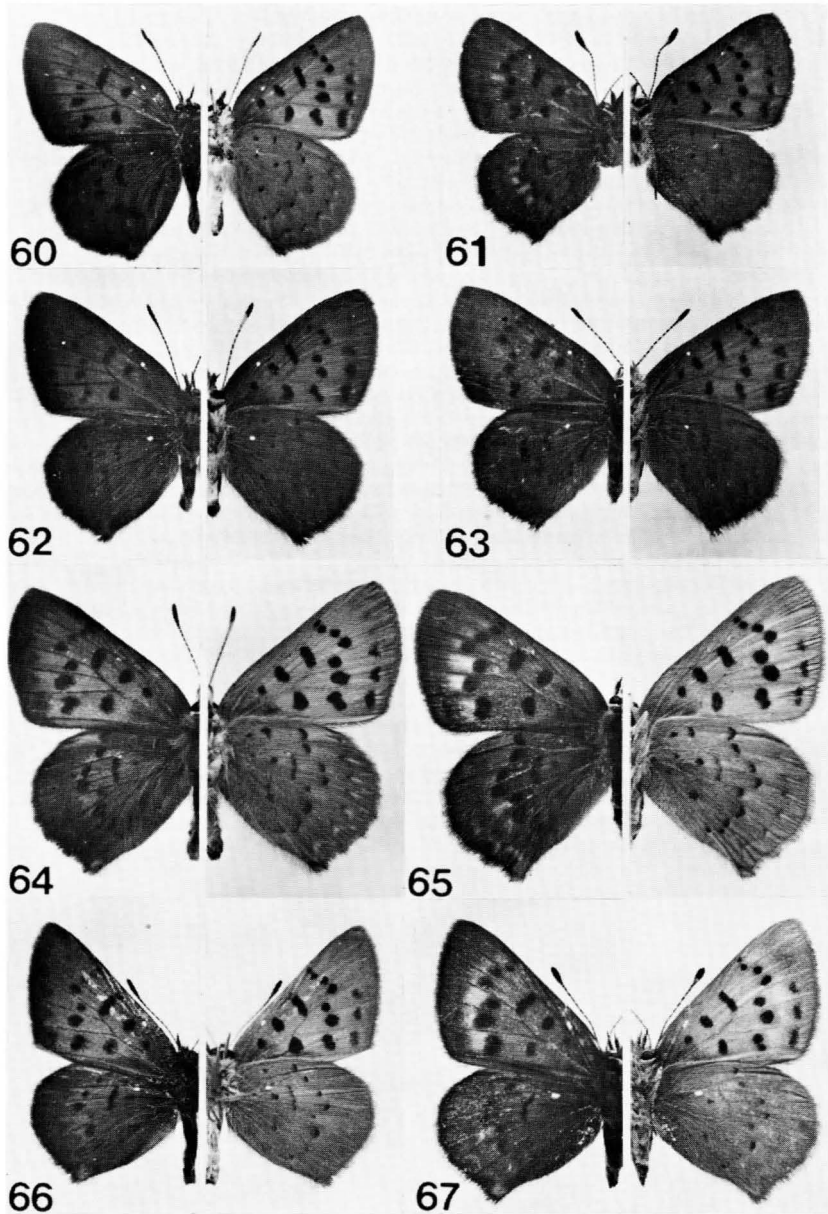


Figure 59: neotype ♀ of *E. d. dorcas* (Kirby); The Pas, Manitoba.



Figures 60-67: upper (left) and under (right) surfaces of various *dorcas* sub-species. 60, *dorcas*, ♂, Dexter Township, Michigan; 61, same, ♀, Washtenaw Co., Michigan; 62, *claytoni*, ♂, Penobscot Co., Maine; 63, same, ♀, same locality; 64, *dospassosi*, ♂, Bathurst, New Brunswick; 65, same, ♀, same locality; 66, *castro*, ♂, Grand Co., Colorado; 67, same, ♀, same locality.



*dorcas* is smaller than *helooides*. Males are on the order of 80% as large as *helooides*; the females are more variable. A typical FW costal margin length is 1.2 cm for *dorcas* males against 1.5 cm. for *helooides*. Expanse (FW costal margin length): males 1.05-1.3 cm; females 1.25-1.4 cm. Typical specimens are shown in Figures 60-61.

**Biology.** As noted previously, the life history of *dorcas* was described by Newcomb (1911). The larval host plant is *Potentilla fruticosa*. Hibernation occurs as ova. The species is univoltine with adults typically on the wing from mid-July to mid-August.

**Distribution.** *E. d. dorcas* is basically a low-altitude species associated with boreal forests. It inhabits sphagnum (acidic) bogs or Muskegs. As shown in Figure 46, the southern limit for *dorcas* is north of the southern extent of the undifferentiated Wisconsin glaciation. As Figure 48 shows, the range of this butterfly extends from the Beaufort Seacoast southeast to Saskatchewan and eastward to Labrador and Newfoundland. Isolated *dorcas* phenotypes occur along the southern coast of Alaska, and on Kodiak Island.

Some workers have stated that ventrally *dorcas* has a bicolorous aspect while *helooides* is unicolorous. This is not the case as, depending upon brood, *helooides* can be quite variable ventrally. Generally the HW in *helooides* has a "washed out" aspect in comparison with *dorcas*, but many *helooides* are brightly and contrastingly marked beneath.

#### **Epidemia dorcas castro** (Reakirt) [New Combination]

*Polyommatus castro* Reakirt 1866:148 TL "Rocky Mountains, Colorado Territory"

*Lycaena castro*: Kirby 1871:342; Barnes & Benjamin 1926:18 (no. 412 as synonym of *helooides*); McDunnough 1938:26 (no. 432 as synonym of *helooides*); dos Passos 1964:61 (no. 440 as synonym of *helooides*)

*Chrysophanus castro*: Mead 1875:781

*Epidemia castro*: Scudder 1876:127-128 (no. 295 as synonym of *zeroe* Boisduval; no. 296 as synonym of *helooides*); Dyar 1902:41 (no. 396 as synonym of *helooides*)

*Polyommatus castro*: Strecker 1878:102 (no. 162 as synonym of *helooides*)

**Location of Type.** The type series of 3 males and 2 females is in the Strecker collection, now housed at the Allyn Museum of Entomology, Sarasota, Florida. The specimens are shown in Figures 68-72 with their labels. The specimen shown in Figure 69 was designated a lectotype by Barnes and Benjamin, but they did not publish their action. The specimen shown in Figure 68 best fits Reakirt's original description and I have designated it as the lectotype. The label is red handwritten in black ink as shown.

**Diagnosis.** Reakirt provided a detailed and accurate description of both sexes. The illustrations of the type series and Figures 57-58, 66-67, 73-76 suffice to show the general maculation.

**Males.** The basic coloration dorsally is that of *dorcas*, but not quite so heavily suffused with melanic scales. The orange crenulate band is present in varying degrees. In a few specimens, it is reduced to an orange tornal spot. In most specimens, it is not as wide as in *helooides* and it is clearly defined in cells  $Cu_2-M_3$  only; some specimens have a bright lunule in  $M_2$ . Ventrally the FW are yellowish-ochraceous shading to grayish at the apex and along the outer margin. The HW are brownish-gray to reddish-gray and quite uniform in ground color in fresh specimens. The orange crenulate band is frequently present, but rather narrow and sometimes very poorly defined to obsolete. The dorsal dark spots are repeated ventrally.

Females. In many respects, the females are dorsally similar to *helloides*, but the colors are more subdued. The black maculations present in the males are more boldly displayed in the females and the FW outer marginal borders much enlarged. On the HW, the marginal orange crenulate band is usually clearly defined and not merged with the background color as in *helloides*. The basic ground color is dark orange or fulvous, although some examples are quite dark as in nominate *dorcas*. The basal and discal areas of the HW are generally quite dark in color. Ventrally, the females are similar to the males, but frequently more subdued in their markings. The antennae are as in *dorcas*. In size, *castro* and *helloides* are comparable. Expanse (FW costal margin length): males 1.3-1.5 cm; females 1.3-1.6 cm.

**Biology.** The life history of *castro* is unknown. In my experience, the host plant association is *Potentilla* in northern New Mexico, northern Colorado and southern Wyoming. The previously noted data reported by Chambers (1963) are ambiguous. James Scott (*in litt.*) has suggested Polygonaceae association in southern Colorado. It is not clear if his observations related to a high altitude *helloides* or to *castro*. The butterfly is univoltine with hibernation apparently as ova. Adults are typically on the wing in late July and early August, depending upon altitude and weather conditions. Based upon facies and bionomics, I am placing *castro* as a subspecies of *dorcas*. In describing *castro*, Reakirt noted "Closely allied to both *Epixanthe*, and *Helloides*, but constantly distinct from either."

**Distribution.** *E. d. castro* is a montane subspecies which is at home above 9000' (2745 m). It occurs in the Canadian and Hudsonian Zones in the mountains of northern New Mexico, throughout Utah and Colorado at suitable elevations, and into southern Wyoming. Typical *castro* phenotypes occur in southern Idaho,

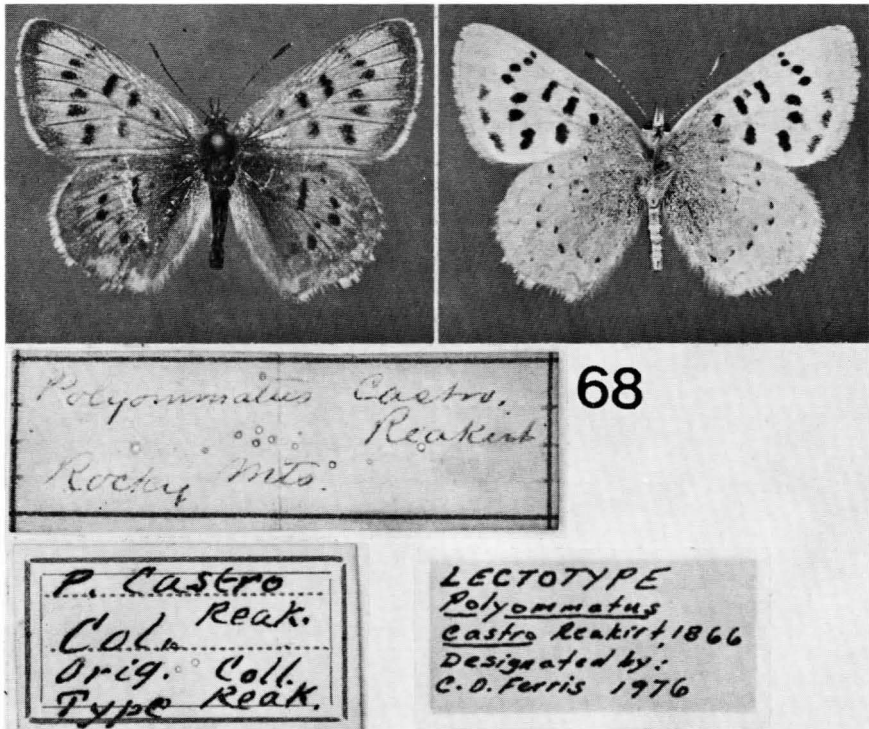


Figure 68: lectotype ♂ of *dorcas castro* (Reakirt).

Cassia Co. in particular. It is typically found at the edges of alpine willow bogs and in wet meadows where *Potentilla* grows.

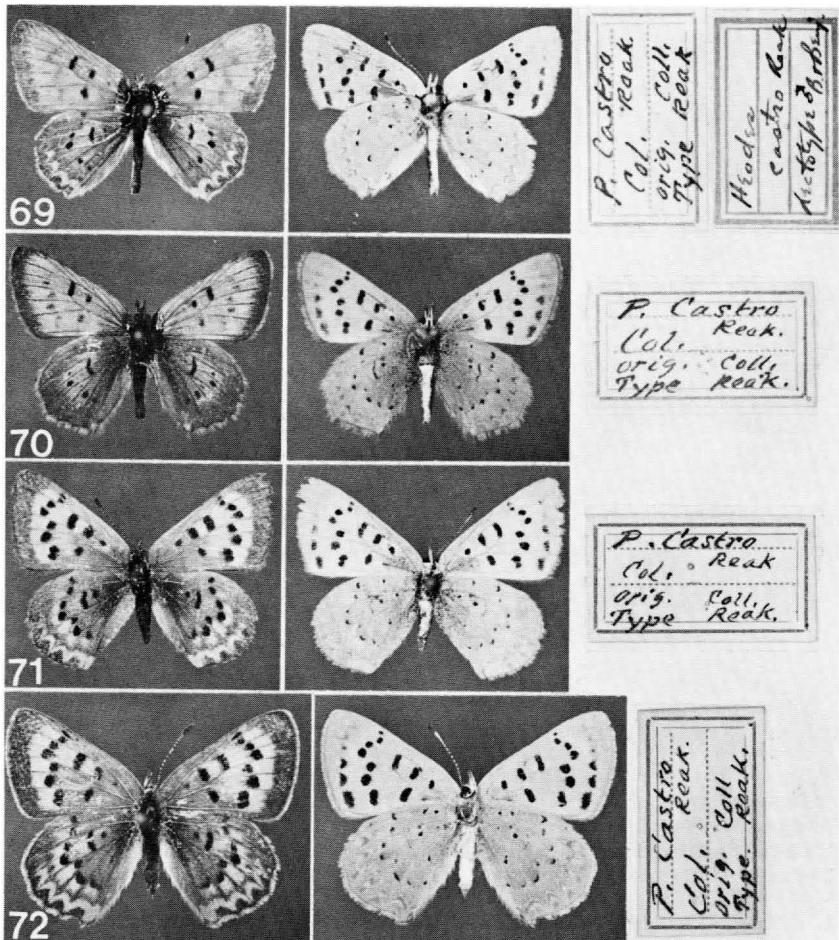
***Epidemia dorcas florus* (W. H. Edwards)**

*Chrysophanus florus* W. H. Edwards 1883:210 TL "Taken on Red Deer River B. Am., by Captain Geddes" - later restricted by Edwards to "Garrett's Ranche, Br. Amer."; actually Didsbury, just north of Calgary, Alberta.

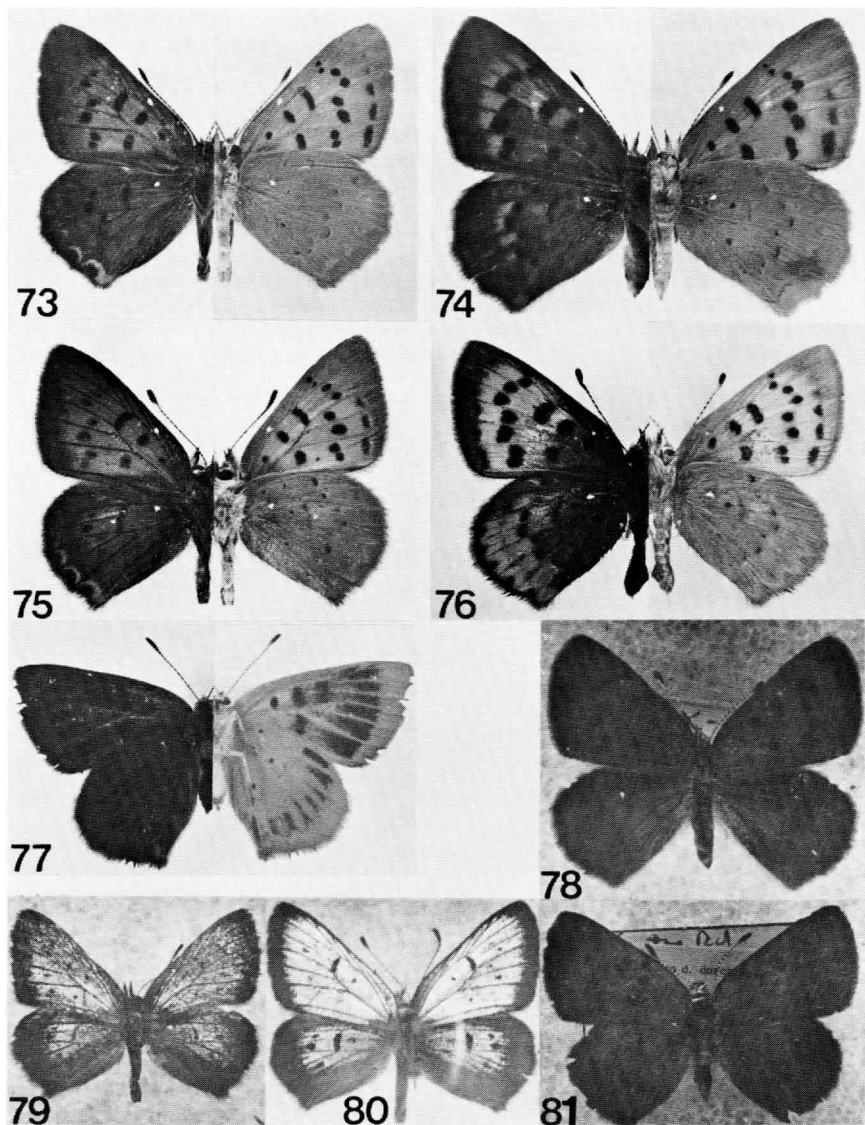
*Epidemia florus*: Dyar 1902:41 (no. 397a as subspecies of *dorcas*)

*Heodes florus*: McDunnough 1922:136 (as subspecies of *dorcas*)

*Lycaena florus*: Barnes & Benjamin 1926:18 (no. 412a as subspecies of *helooides*); McDunnough 1938:26 (no. 432a as subspecies of *helooides*); dos Passos 1964:61 (no. 441a as synonym of *dorcas*); Brown 1969:172 (as subspecies of *helooides*)



Figures 69-72: paralectotypes of *dorcas castro*.



Figures 73-81: photographs of *dorcas* subspecies (73-77; 79-81) and *helloides* (78) under visible light (73-77) and ultraviolet light (78-81); visible light pictures with upper (left) and under (right) surfaces. 73, *dorcas castro*, ♂, Elko Co., Nevada; 74, same, ♀, same locality; 75, same, ♂, Taos Co., New Mexico; 76, same, ♀, pale form, Clear Creek Co., Colorado; 77, *dorcas dorcas*, ♀, melanic aberrant, Ontario; 78, *helloides*, ♀, McHenry Co., Illinois; 79, *dorcas arcticus*, ♂, Yukon Territory; 80, *dorcas megaloceras*, ♂, Sheridan Co., Wyoming; 81, *dorcas dorcas*, ♀, Dexter Township, Michigan.

**Location of Type.** The original type is lost and Brown (1969) designated a male neotype which is placed in the Canadian National Collection; this was figured by Brown (Fig. 5, page 173). The collection locality for the neotype is Calgary, Alberta, by Geddes on 4 July, 1883.

**Diagnosis.** Males. Similar to *castro* dorsally, but generally larger and with a more dusky aspect. The orange crenulate band is generally absent and reduced to a simple orange spot at the tornus, which is frequently absent in Wyoming specimens. Ventrally *florus* is similar to *castro*, but more unicolorous and frequently paler in color. The orange crenulate band along the outer margin of the HW is often obscure to absent.

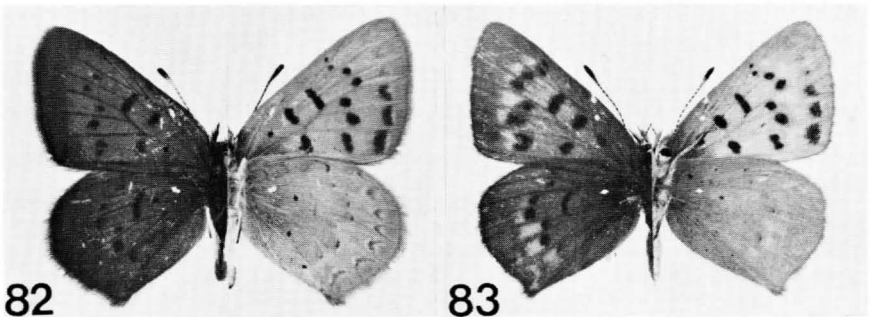
Females. Similar to *castro* dorsally, but much darker in color. Some resemble large *dorcas*. When light color is present, it is a more tawny-yellow than distinctly orange; specimens from some colonies are very pale to almost white. In fresh specimens, there is some violaceous scaling at the bases of both wings. Ventrally the sexes are similar. The antennae are as in *dorcas*.

In designating the neotype, Brown mentioned difficulty in finding a male which reached the wing expanse of 1.3 inches (3.3 cm) noted by Edwards. If specimens are mounted with the FW inner margin perpendicular to the axis of the body, many Wyoming and Montana specimens attain this expanse. Expanse (FW costal margin length): males 1.3-1.65 cm; females 1.35-1.7 cm. Specimens are shown in Figures 82-83.

**Biology.** The life history of *florus* is unknown. It is univoltine and associated with *Potentilla*.

**Distribution.** *E. d. florus* ranges from northern Wyoming (excluding the Big Horn Mtns.) through Montana and northern Idaho into Alberta and British Columbia. Local *florus* phenotypes occur in Washington. Phenotypic intergrades between *florus* and *castro* occur in southern Idaho. In Wyoming, there is a clear separation between the two subspecies because of the barrier to dispersal provided by the Red Desert. The habitats of *florus* are similar to those of *castro*, but at reduced elevations with increasing latitude. The time of disjunction between these two subspecies may relate to the Hypsithermal Age which occurred 6000-4500 B.P.

Although Brown presented arguments for placing *florus* as a subspecies of *heloïdes*, I cannot agree. There are distinct phenotypic differences, especially in the females. In Alberta, both species occur (allopatrically) and the altitudinal gradients between habitats are substantially reduced, which can lead to confusion. It is quite possible that both interbreeding and interdigitation are occurring as roads are pushed through the forested areas, thus permitting the dispersal of *heloïdes* and its larval hosts, and consequent contact with *florus*.



Figures 82-83: *dorcas florus*, ♂ (82) and ♀ (83), upper (left) and under (right) surfaces; Sublette Co. (82) and Lincoln Co. (83) Wyoming.

**Epidemia dorcas dospassosi** (McDunnough) [New Combination]

*Lycaena dorcas dospassosi* McDunnough 1940:130 TL Bathurst, N.B., 6 August, 1939

*Lycaena dorcas dospassosi*: dos Passos 1964:61 (no. 441b)

*Tharsalea dorcas dospassosi*: Howe 1975:315

**Location of Type.** The holotype (no. 5092), allotype and paratypes are placed in the Canadian National Collection.

**Diagnosis.** This subspecies is of large size, comparable to *florus*. Males. Dorsally the black spots are very large and dark. The HW ternal spot is rather dull to obsolete, rarely extended beyond the tornus as a partial band. Otherwise the insect resembles *dorcas*. Ventrally the color is duller than in *dorcas* and the black spotting is very pronounced, while the HW orange lunules are subdued.

Females. Except for their large size, the females are dorsally similar to *dorcas*, but the orangish quadrate spots distad of the postmedian black spot row are more pronounced in most specimens. Ventrally the sexes are similar. The antennae are as in *dorcas*. Expanse (FW costal margin length): males 1.3-1.5 cm; females 1.4-1.55 cm. Specimens are shown in Figures 64-65.

**Biology.** The life history is unknown. McDunnough observed oviposition on *Potentilla* and placed ova in cold storage for the winter; it is not known if he achieved rearing. Although D. C. Ferguson reported the host plant as *Potentilla pacifica* T. J. Howell (*in litt.*), this is a West Coast species. The Bathurst plant is *P. egedii* var. *groenlandica* (Tratt.) Polunin. The butterflies may be found in late July and early August.

**Distribution.** This subspecies is a salt marsh relict apparently restricted to the type locality.

**Epidemia dorcas claytoni** (Brower) [New Combination]

*Lycaena dorcas claytoni* Brower 1940:138 TL Springfield [Penobscot Co.], Maine, 27 July, 1938

*Lycaena dorcas claytoni*: dos Passos 1964:61 (no. 441c)

*Tharsalea dorcas claytoni*: Howe 1975:315

**Location of Type.** The holotype, allotype and some paratypes are in the collection of the National Museum of Natural History, Smithsonian Institution, Washington, D. C.

**Diagnosis.** This subspecies is smaller than typical *dorcas*. Males. Dorsally darker, more purplish-red, and less maculated than *dorcas*. HW orange ternal spot faint-to-absent. Ventrally *claytoni* shows less spotting than in *dorcas*, the color is more orange lacking the violaceous reflection, and the HW orange crenulate band is faint.

Females. Dorsally the females are somewhat darker than *dorcas* and generally lack the colored spots in the postmedian areas. The sexes are similar ventrally. The antennae are as in *dorcas*. Expanse (FW costal margin length): males 1.1-1.3 cm; females 1.2-1.35 cm. Specimens are shown in Figures 62-63.

**Biology.** The life history is unknown, but oviposition has been observed on *Potentilla fruticosa* (A. E. Brower, *in litt.*).

**Distribution.** This subspecies appears to be a relict that has adapted to "old field" habitats in which Shrubby Cinquefoil grows. So far, it is known only from Lee and Springfield in Penobscot Co., Maine. Muskegs in the same region are populated by *E. epixanthe* only.

### ***Epidemia dorcas megaloceras* Ferris [New Subspecies]**

**Types and Locations.** This subspecies is described from 243 specimens. The male holotype is shown in Figure 84 with its attached labels. The identification label is red, machine-printed in black. The TL is 5-Spring Creek, 9100' (2775 m), Big Horn Co., Wyoming. The specimen was collected by F. M. and H. H. Brown on 17 July, 1934. The female allotype (Figure 85) was collected at Little Goose Creek, 7600' (2315 m), Big Horn National Forest, Sheridan Co., Wyoming on 1 August, 1953. The identification label is yellow, machine printed in black. The paratypes are from the following localities in the Big Horns Mtns. of northern Wyoming: Big Horn Co.: 5-Spring Ck., 17-vii-34, 5m, 1f; 5-Spring Canyon, 20-vii-36 1f; Head of Wyoming Gulch, 9300' (2835 m), 17-vii-34, 1m; T54N, R88W, 8100' (2469 m), 19-vii-36, 1f; Shell Creek Canyon, 7500' (2286 m), 14-viii-75, 1m, 30-vii-76, 2m. Johnson Co.: Hat Ranch, 8000' (2440 m), Head N. Fk. Powder River, 14-viii-49, 2m, 12f; Milepost 60, U. S. Hwy. 16, Big Horn Nat. For., 8000' (2440 m), 30-vii-76, 1 pr. Sheridan Co.: Little Goose Creek, Big Horn Nat. For., 7600' (2315 m), 1-viii-53, 6m, 14f; N. Fk. Tongue River, 7900' (2407 m), 19-vii-36, 5m, 2f; Ranger Ck. Camp, 18 mi. SW of Big Horn, 7800' (2377 m), 16-vii-59, 68m, 14-vii-62, 4m, 1f, 15-vii-62, 45m; 12-16 mi. SW Big Horn, 7700-8000' (2345-2440 m), 19-vii-69, 7m; 13-15 mi. SW Big Horn, 7700-7900' (2345-2407 m), 17-vii-62, 3m; Long Park, 20 mi. SW Big Horn, 8100' (2469 m), 15-vii-62, 1m; Bald Mtn. Camp, 17 mi. W. and 2 mi. N. of Burgess Jct., 8800-9700' (2684-2959 m), 7-8-vii-75, 4m; Burgess Jct., 8000' (2440 m), 26-vii-69, 1m, 29-vii-76, 42m, 15f. Steamboat Rocks, Big Horn Mtns., 12-vii-62, 1m, 18-vii-62, 1m. The holotype, allotype and a series of paratypes are placed in the collection of the Allyn Museum of Entomology, Sarasota, Florida. A very long series of paratypes is in the American Museum of Natural History collection. Other paratypes are in the Carnegie Museum, the National Museum of Natural History, the Canadian National Collection and the author's collection.

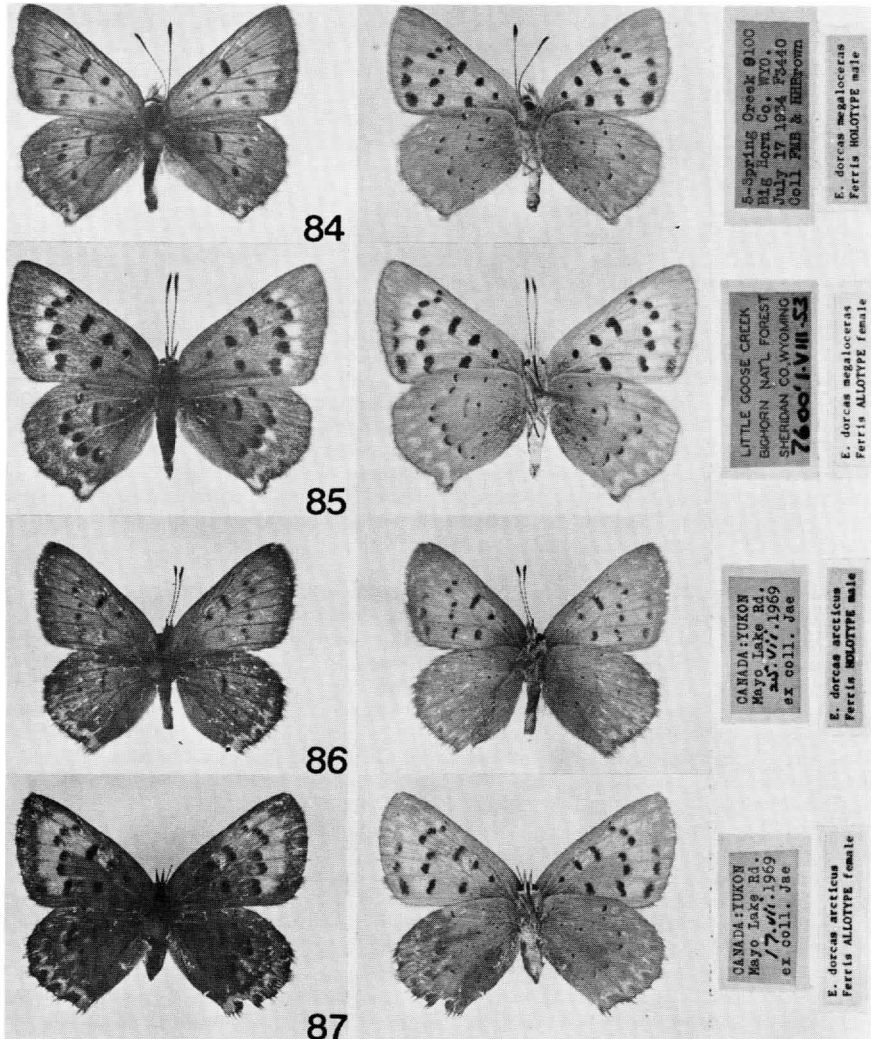
**Diagnosis and Description.** Size and dark markings dorsally generally as in *florus*. Males. Dorsally generally similar to *florus* with the exception of the HW colored tornal spot. This spot is frequently obsolete to absent, and when present, it is usually a "washed out" orange. In older specimens, it fades to pale ochre, and is quite evident in the field when the butterflies are flying. Rarely the spot extends into a band of 2-3 lunules. Ventrally this subspecies differs from all other *dorcas*. The ground color is distinctly pale gray-ochre, slightly lighter on the FW. The black dots are prominent on the FW, less so on the HW. The marginal orange crenulate band is weakly present. Expanse (FW costal margin length): holotype male 1.35 cm; male range 1.3-1.55 cm.

Females. Dorsally the females vary considerably and the polymorphism is rather striking. The darkest examples resemble *dospassosi* but the postmedian quadrate spots are yellow-ochre to almost white, rather than yellow-orange. In the palest examples, the ground color of the FW is pale ochre except for the basal area between the body and the first two spots (in the cell and in cell  $Cu_1$ ). This area is dark tawny-brown and matches the wing borders. On the HW, the pale areas are generally restricted to quadrate spots in the cells just distad to the postmedian black spot band. The tornal spot may be completely absent; when present, it is pale ochre. In some examples, there is a narrow ochraceous crenulate band as in *florus*, but much paler in color. It contrasts strongly against the dark marginal border. In fresh specimens, there is some faint violaceous scaling at the bases of both wings. Ventrally, the sexes are similar, but the females are more brightly marked. The butterflies fade rather rapidly on the wing. The antennae are as in *dorcas*, but the

tip is quite pale and not clearly orange. Expanse (FW costal margin length): Allotype Female 1.5 cm; female range 1.2-1.72 cm.

**Biology.** The life history of *megaloceras* is unknown. It is associated with both *P. fruticosa* and *P. gracilis*. It flies from mid-July to early August and is sympatric and synchronic with *Gaeides editha montana* (Field) and *Chalceria heteronea klotsi* (Field). *G. e. montana* is reported to feed on *Horkelia* and *Potentilla*, while the larvae of *C. h. klotsi* use *Eriogonum*. The adults of *klotsi* were feeding upon what appeared to be *Eriogonum subalpinum* Greene.

**Distribution.** To date, this subspecies has not been found outside of the tri-



Figures 84-87: new *dorcas* subspecies. 84-85, *E. dorcas megaloceras*, new subspecies, holotype ♂ (84) and allotype ♀ (85). 86-87, *E. dorcas articus*, new subspecies, holotype ♂ (86) and allotype ♀ (87).



county area (Johnson, Sheridan, Big Horn) which straddles the Big Horn Mtns., in northern Wyoming. It may also occur in the vicinity of Meadowlark Lake in eastern Washakie Co., but has yet to be collected there. This subspecies appears to be a glacial relict from a period prior to the Wisconsin glaciation. The Big Horn Mtns. are isolated from other mountains ranges by arid expanses of grass-lands. While *castro* occurs in the mountains to the south, and *florus* to the north, east and west, it is highly unlikely that any interaction has occurred since *megaloceras* was isolated. *E. helloides* has been recorded from Washakie Co., but at a substantial distance from the mountains. Figure 88 illustrates the known distribution of this subspecies.

Faded specimens of *florus* may sometimes be mistaken for *megaloceras*, but examination of the undersides, unless the specimens are badly faded, should easily separate the two.

**Etymology.** The name is derived from the modern Greek *megalo* (big) + the classical Greek *ceras* (horn). The form *megalo* was used for purposes of euphony.

#### ***Epidemia dorcas arcticus* Ferris [New Subspecies]**

**Types and Locations.** This subspecies is described from a long series, of which 125 specimens comprise the type series. The male holotype is shown in Figure 86 with its attached labels. The identification label is red, machine-printed in black. The TL is Mayo Lake Road, Yukon Territory, Canada, 29 July, 1969. The specimen

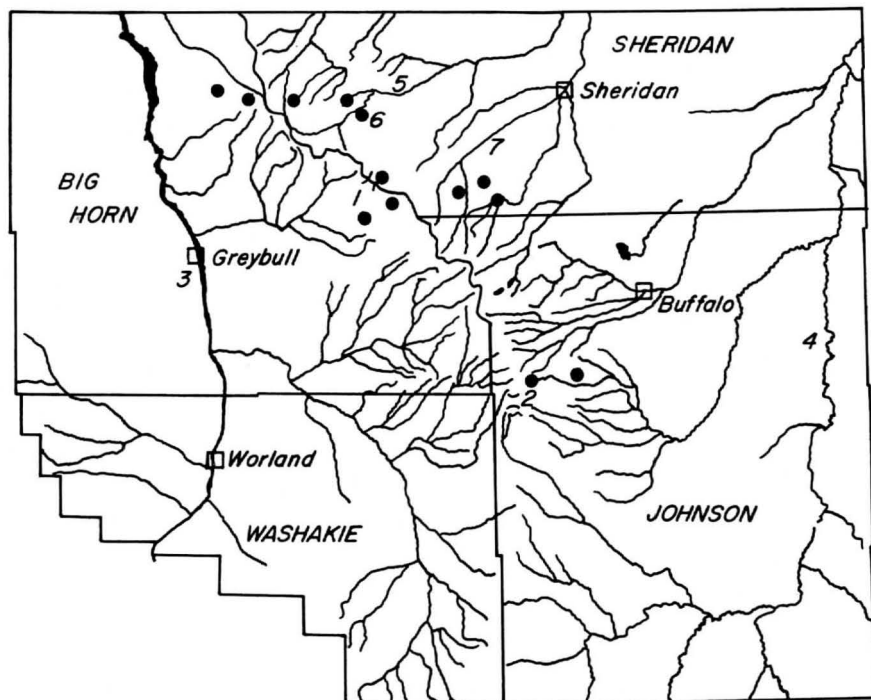


Figure 88: distribution of *E. dorcas megaloceras* in northern Wyoming. Locality legend: 1, Granite Pass; 2, Powder River Pass; 3, Big Horn River; 4, Powder River; 5, Tongue River; 6, Burgess Jct.; 7, Goose Creek.

was obtained by R. J. Jae from J. A. Ebner, who maintained a collector in the Yukon. The female allotype is shown in Figure 87 with its attached labels. The identification label is yellow, machine-printed in black. It is from the same locality as the holotype on 17 July, 1969. The paratypes are from the following localities: Yukon Territory: Mayo Lake Rd., 5-vii-68, 1m, 16-vii-69, 1m, 17-vii-69, 1f, 25-vii-69, 4m; Mayo, 7-vii-49, 1f; Halfway Lakes, Mayo, 3-viii-49, 1m; Rampart House, 30-31-vii-51, 6m, 7f; Whitehorse, 9-vii-48, 1m, 11-vii-48, 1m, 18-vii-49, 1m, 20-vii-49, 1f, 26-vii-49, 2m, 27-vii-49, 1m; Rancheria-Swift River, 14-16-vii-48, 1m; Marsh Lake, 10-vii-48 1m; Dawson, 18-26-vii-49, 8m, 3f; Dry Creek, 25-vii-48, 2m 7f; Kluane, 28-vii-48, 1f; Haines Jct., 2-viii-48, 1f; Rock Creek, 22-vii-49, 1m; Gravel Lake, 58 mi. E. of Dawson, 13-viii-62, 2m, 1f; Tepe Lake nr. Head of Wolverine Creek, 16-viii-14, 1f. British Columbia: Chilkat Pass (Haines Hwy.), 16-vii-48, 1m. Alaska: Hunter Creek, Rampart, 2-vii-16, 1m, 10-vii-16, 7m, 12-vii-16, 15m, 4f, 17-vii-16, 3f, 18-vii-16, 5f; Rampart, 28-vi-03, 1m, 8-vii-16, 1m; Ft. Yukon, 30-vi-16, 1m; Eagle, 10-vii-01, 1m; Fairbanks, 31-vii-05, 1f, 7-vi-05, 1m; Ruby, 21-vi-16, 1 pr.; Birch Lake nr. Fairbanks, 7-vii-51, 3m, 1f; King Salmon, Naknek River, 16-viii-52, 1m; Central, 17-vii-66, 1m, 2f; vic. Circle Hot Spgs., 15-vii-67, 1m, 12-vii-69, 1f; Sheep Creek Rd., Goldstream Creek, NW of Fairbanks, 12-vii-66, 1m, 14-vii-66, 1m, 11-vii-67, 1m, 13-vii-67, 1m, 20-vii-68, 1f. The holotype, allotype and 6 paratypes are in the collection of the Allyn Museum of Entomology, Sarasota, Florida. A male paratype is in the author's collection. The remaining paratypes are in the collections of the Carnegie Museum, Alaska Lepidoptera Survey, National Museum of Natural History and the Canadian National Collection.

**Diagnosis and Description.** This subspecies is characterized by its small size and distinctive markings. Males. Dorsally the males superficially resemble a small *helooides*. In fresh specimens, the violaceous scaling is quite bright. The brown borders on both wings are not so wide as in typical *dorcas* and they are clearly defined rather than shading into the ground color basally. There is a pronounced orange crenulate band on the HW, composed of three distinct lunules, which extends from the tornus to cell  $M_3$ . In some specimens, faint lunules may be seen in cells  $M_2$ ,  $M_1$  and rarely in Rs. The black dots in the cells, common to both *dorcas* and *helooides*, are small and quite faint in many examples. Ventrally the coloration is very similar to *dorcas*. The FW are warm ochre with a mere suggestion of grayish at the apex. The HW are grayish-ochre with a distinct red-violaceous scaling. The marginal orange crenulate band is narrow but distinct. The FW black spots are small, but distinct; the HW black spots are very faint. Expanse (FW costal margin length): Holotype male 1.3 cm; male range 1.1-1.45 cm.

Females. Dorsally the females are polymorphic. They range from quite dark specimens, close to *dorcas*, to rather brightly marked examples. In the pale extreme, the FW ground color is orange offset by a wide marginal brown band with brown suffusion basally. In typical specimens, the FW is brown except for the region between the postmedian spots and the border in cells  $Cu_2$ - $M_3$ . The pale color also occurs in the region defined by the cell-end spot, the costal margin, the outer marginal border and vein  $M_3$ . The color varies from orange-brown to pale orange. The HW are brown with orange spots distad of the postmedian dark spot band in typical specimens. In some examples, these are absent. There is a distinct orange crenulate band extending from the tornus, as in the males, but rather more pronounced. Ventrally the sexes are similar. The antennae are ringed as in *dorcas*, but only faintly tipped with yellow-orange. Expanse (FW costal margin length): Allotype female 1.45 cm; female range 1.2-1.6 cm.

**Biology.** Nothing is known of the life history of this subspecies. *Potentilla* occurs in some of the areas where it has been collected. The flora of the remaining collection sites is unknown. The flight period extends from early June to mid-August, depending upon seasonal climatic conditions.

**Distribution.** This subspecies occurs broadly throughout the Yukon River drainage. It has been taken at several localities along the river, including Circle, Alaska. As noted previously, it may have been isolated during the Pleistocene in the unglaciated regions of Alaska along the Yukon River. As a consequence, it may closely resemble the parent species of *dorcas* and *helooides*. In facies, it exhibits characters of both species. Because it is univoltine and possesses other characters similar to *dorcas*, I have assigned it to that species.

**Etymology.** The name *arcticus* is derived from the Latin adjective meaning arctic.

#### VARIETAL FORMS

Several infraspecific and aberrant forms of both *dorcas* and *helooides* have been described. These have no standing with the I.C.Z.N. The ab. *gunderi* Rudkin cited by dos Passos (1964, no. 440) with the date 1933 and assigned to *helooides* was described by Rudkin in 1932 as a form of *xanthoides* Boisduval.

The Gunder (1927) taxa *sternitzkyi* and *williamsi* apply to aberrational forms of *helooides*; *sternitzkyi* to a form in which yellow replaces the orange, and *williamsi* to a form deficient in spots. Gunder actually listed *sternitzkyi* as a form of *thoe* Guerin-Meneville = *hyllus* Cramer, a species which does not occur in California, from which the aberration was described.

Field's names, *hulbirti* and *sternitzkyi* (1927), apply to the polymorphic female forms of *florus*; *hulbirti* applies to the very pale phenotype, while *sternitzkyi* applies to the strongly orange phenotype.

In the many thousands of specimens examined during this study, very few aberrants were noted. In a few females, the dorsal black spots were produced or elongated. A few males were seen in which the dorsal orange crenulate band was smeared, thus forming a solid band rather than a connection of lunules. Two strongly melanic female aberrants, one of *helooides* (Figure 54) and one of *dorcas* (Figure 77) were examined. In these melanic forms, it is interesting to note that the orange toral markings disappeared in *dorcas* but remained in *helooides*.

#### ISOLATES AND INTERGRADES

The Suisun Slough, Solano Co., California population appears to be a relict that exhibits characteristics of both *dorcas* and *helooides*. The specimens which I examined were not unlike *castro*. The oviposition substrate of preference is *Potentilla egedei* Wormsk. var. *grandis* (Rydb.) Howell, although the females oviposit on Polygonaceae when presented with the plants. It is multivoltine. Since *helooides* is highly vagile and occurs in the same general area, it is possible that it has interacted with the probably sedentary Suisun population, which could account for the presently known behavior of the colony, or as noted previously, climatic adaptation to multivoltinism may have occurred. The specimens cannot be assigned accurately to either *dorcas* or *helooides*.

There are several other localities in which intergrade populations have been observed, based upon examination of museum specimens and collection dates. These are near Vernal, Uintah Co., Utah, Jemez Springs, Sandoval Co. and Los Alamos Co., New Mexico. The material is phenotypic *castro*, but the collection dates indicate three broods. Host plant associations are unknown. A series of specimens which I collected on the Western Slope, near Craig, Moffat Co., Colorado on 13-viii-62 also appears intermediate in facies between *castro* and *helooides*. Specimens from Bogus Basin and the Boise region in Idaho are similar to the Craig specimens. It appears that in some areas, *dorcas* and *helooides* are not isolated and some genetic interaction is occurring. This may also be true in some areas of southern Colorado where *castro*-like high altitude specimens have been observed in association with Polygonaceae. Some material from Vancouver Island and northern Washington,

along the Canadian Border displays introgressive characters.

In all respects, *dorcas* and *helloides* represent a complex group. In the Great Lakes region, they are allopatrically isolated, while only *dorcas* occurs in the Northeast. In most areas of the Rocky Mtns., the two species are altitudinally isolated. In some areas of the Great Basin and the Pacific Northwest, phenotypic *dorcas* and *helloides* occur nearly sympatrically, with possible reuniting of the two. A similar situation appears to be occurring in Alberta in the front range of the Canadian Rockies.

The two poles of the *dorcas* complex are *castro* in the southern Rocky Mtns., and *dorcas* in the eastern and central arctic. *E. d. arcticus* in the northwestern arctic probably closely approximates the parent species from which *dorcas* and *helloides* evolved.

Brown (1969) adopted the viewpoint that *dorcas* and *helloides* represent subspecies derived from a common parent during the Wisconsin period. In view of the biology and relict populations associated with *dorcas*, I feel that the two entities should be treated as distinct sibling species derived from a common parent. It appears that recombination may be occurring in some localities. Should the two be considered as a single species, then by date priority, *helloides* must fall as a subspecies of *dorcas* in the combination *Epidemia dorcas helloides* (Boisduval).

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### DISTRIBUTION RECORDS

To conserve space, with the exception of arctic and Canadian records, detailed locality data are not included. Eight-five pages of maps, typewritten and manuscript notes are represented by the information given below. Those wishing to have more detailed information are requested to contact the author. Over 3500 specimens were examined during this study. United States localities are by county.

#### *Epidemia helloides*

CANADA. *Alberta*: Blackfalds; Bilby; Blairmore; Bragg Ck.; Brooks; Burdlett; Calgary; Carseland; Chain Lakes Reservoir; Cooking Lake; Cypress Hills Prov. Park; Devon; Dalroy; Edmonton; Foremost; Gleichen Station; Gull Lake; Hillcrest; Lacombe; Lake McGregor; Lamont; Leduc; Lethbridge; Little Bow Prov. Park; Manyberries; Marvel Lake; Milk River; Olds; Pincher Creek; Priddis; Purple Spgs.; Raymond; Red Deer; Springbank; Waterton Lakes; West Castle River. *British Columbia*: Canoe; Chase; Corfield; Duncan; Fish Lake; Garnett Valley (Summerland); Grand Forks; Headley; Jesmond; Kamloops; Kaslo; Keremeos; Merritt; Mt. Apex; Mt. Revelstoke; Okanogan Falls; Oliver; Osyoos; Pentiction; Qualicum; Summerland; Vernon. Material from Vancouver Island (Bevan; Comox; Nanaimo; Saratoga Beach; Victoria), Departure Bay (B.C. Biol. Sta.) and Salmon Arm exhibits intermediate features between *dorcas* and *helloides*. *Manitoba*: Aweme; Beach; Berens River; Beulah; Cartwright; Culross; Kelwood; Lundar; McCreary; Melita; Miniota; Riding Mtns.; St. Claude; The Pas; Victoria; Victoria Beach; Whiteshell Prov. Park; Winnipeg. *Ontario*: Ft. William; Hamilton; Hymers; Manitoulin Island; Nipegon; One Sided Lake; Paris; Pelican Lake (Pelican Lake Park); Sioux Lookout; Sudbury. *Saskatchewan*: Arcola; Battle River; Cappell; Dysart; Earl Grey; Estevan; Ft. Qu'Appelle; Harlan; Lloydminster; Nipewan Prov. Forest; Regina; Rivercourse; Swift Current. *UNITED STATES*. *Arizona*: Apache (Wheatfields Lake; White Mtns.). *California*: Alameda, Alpine, Amador, Butte, Colusa, Contra Costa, El Dorado, Fresno, Glenn, Inyo, Kern, Lake, Lassen, Los Angeles, Marin, Merced, Modoc, Mono, Monterey, Napa, Orange, Placer, Plumas, Riverside, Sacramento, San Bernardino, San Diego, San Joaquin, San Luis Obispo, Santa Barbara, Santa Clara, Siskiyou, Solano, Sonoma, Tehama, Tulare, Ventura, Yolo. *Colorado*: Adams, Arapahoe, Archuleta, Chaffee, Denver, Dolores, El Paso, Huerfano, Logan, Morgan, Otero, Phillips, Prowers, Sedgwick, Weld, Yuma. *Idaho*: Ada, Bannock, Bear Lake, Blaine, Boise, Bonner, Cassia, Idaho, Kootenai, Lemhi, Shoshone, Valley. *Illinois*: Boone, Cook, Du Page, Grundy, Iroquois, Kane, Lake, La Salle, Mc Henry, Stephenson. *Indiana*: Lake. *Iowa*: Black Hawk, Buena Vista, Clinton, Dickinson, Fayette, Floyd, Hancock, Hardin, Johnson, Osceola, Polk, Poweshiek, Story, Warren. *Kansas*: Scott. *Michigan*: Alger, Barry, Calhoun, Cass, Charlevoix, Cheboygan, Chippewa, Clinton, Dickinson, Houghton, Iron, Jackson, Kalamazoo, Kent, Leelanau, Lenawee, Livingston, Mackinac, Missaukee, Monroe, Montcalm, Muskegon, Newaygo, Oakland, Oscoda, Otsego, Ottawa, Presque Isle, Schoolcraft, St. Joseph, Washtenaw. *Minnesota*: Anoka, Becker, Beltrami, Carlton, Cass, Clay, Clearwater, Crow Wing, Dakota, Douglas, Hennepin, Isanti, Itasca, Kittson, Lake, Mahnomen, Marshall, Norman, Olmstead, Pope, Ramsey, Red Lake, Rice, Rock, Roseau, Saint Louis, Scott, Sherburne, Sibley, Stearns, Stevens, Todd, Watonwan. *Montana*: Beaverhead, Custer, Gallatin, Lake, Lewis and Clark, Liberty, Missoula, Prairie, Sanders, Toole. *Nebraska*: Brown, Cedar, Cherry, Dawes, Deuel, Douglas, Lincoln, Perkins, Platte, Sheridan, Sioux. *Nevada*: Clark, Churchill, Douglas, Elko, Esmeralda, Humboldt, Lander, Ormsby, Pershing, Storey, Washoe, White Pine. *New Mexico*: Los Alamos, Sandoval (Jemez Spgs.), San Juan (Chuska Mtns.). *North Dakota*: Bottineau, Cass, Cavalier, Griggs, Ramsey, Slope, Ward, Williams. *Ohio*: Paulding, Williams. *Oregon*: Baker, Benton, Clackamas, Columbia, Crook, Curry, Gilliam, Grant, Harney, Hood River, Jackson, Jefferson, Josephine, Klamath, Lake, Lane, Linn, Malheur, Morrow, Polk, Sherman, Tillamook, Umatilla, Union, Wallowa, Wasco, Washington, Yamhill. *South Dakota*: Brookings, Day, Lawrence, Minnehaha, Pennington. *Utah*: Box Elder, Davis, Grand, Salt Lake, San Juan, Sanpete, Summit, Uintah, Utah, Wasatch, Washington, Weber. *Washington*: Asotin, Chelan, Clark, Island, Jefferson, King, Kitsap, Kittitas, Lewis, Mason, Okanogan, Pend Oreille, Pierce, Skamania, Snohomish, Spokane, Stevens, Thurston, Whatcom, Whitman, Yakima. *Wisconsin*: Burnett, Dane, Dodge, Door, Douglas, Fond du Lac, Forest, Iowa, Jefferson, Kenosha, Marathon, Marinette, Monroe, Oconto, Portage, Racine, Sawyer, Saint Croix, Walworth, Waukesha, Winnebago. *Wyoming*: Albany, Campbell, Carbon, Crook, Fremont, Natrona, Platte, Teton, Washakie.

#### *Epidemia dorcas dorcus*

CANADA. *Labrador*: Cartwright; Davis Inlet; Hopedale. *Manitoba*: Agassiz Forest; Aweme; Berens River; Beulah; Churchill; Ft. Alexander; Gillam; Lake Atikanieg (20 mi. N. The Pas); Mt. 473 H.B.R.R. (Deer River); NE Rennie; Pikwitonei; Pine Ridge; Riding Mtns.; Telford (Whiteshell Prov. Park); The Pas; Transcona; Wabowden. *Newfoundland*: Bonne Bay (Lomond); Come-by-Chance; Corner Brook; Cow Head; Doyles Station; Kittys Brook; Petty Harbour; St. Pauls. *Northwest Territories*: Cameron Bay; Ft. McPherson; Ft. Simpson; Ft. Smith; Ft. Wrigley; Great Bear Lake; Great Slave Lake (Fairchild Pt.); Hay River; McKiver; Norman Wells; Reinder Depot (Mackenzie Delta); Yellowknife. *Ontario*: Bruce Peninsula (Lake Huron); English River; Finland; Geraldton; Hymers; Jelico; Lansdowne House; Low Bush; Malachi; McCoy Lake (Red Lake District); Moosonee; Nakina; Oba; Onakawana; St. Martin's Falls, Albany River; Savanne; Shanley Twp.; Smokey Falls; Southampton; Stokes Bay; Thunder Bay District. *Quebec*: Lake Island; Natashquan; Rupert House. *Saskatchewan*: Ft. Qu'Appelle; Harlan; Kelvington; Macdowall; Silver Park; Togo. Although listed in Gregory

(1975), no records could be found for New Brunswick, Nova Scotia, and Prince Edward Island. These records probably relate to *E. epixanthe* which does occur in these regions and it has been confused with *dorcas* by many workers in the past. **UNITED STATES. Michigan:** Alger, Barry, Cheboygan, Chippewa, Clinton, Delta, Dickinson, Emmet, Gladwin, Jackson, Kent, Keweenaw (and Isle Royale), Livingston, Mackinac, Montcalm, Newaygo, Oakland, Ogemaw, Osconda, Otsego, Schoolcraft, Shiawasee, Washtenaw. **Minnesota:** Aitkin, Beltrami, Carlton, Cook, Itasca, Kanabec, Koochiching, Lake, Lake-of-the-Woods, Pine, Roseau, St. Louis. **Ohio:** Williams. **Wisconsin:** Forest, Marathon, Oneida, Rusk, Sawyer. The New Hampshire record listed in Howe (1975) is assumed to be in error, as no records could be located, or perhaps it is a misidentification of *epixanthe*.

*Epidemia dorcas castro*

**UNITED STATES. Colorado:** Archuleta, Boulder, Clear Creek, Conejos, Costilla, Custer, Douglas, Eagle, Garfield, Gilpin, Grand, Gunnison, Huerfano, Jackson, Lake, La Plata, Larimer, Mineral, Mesa, Montezuma, Montrose, Ouray, Park, Pitkin, Pueblo, Routt, Saguache, San Juan, San Miguel, Teller. **Idaho:** Blaine, Cassia. **Nevada:** Clark (Charleston Park, 8000'), Elko. **New Mexico:** Colfax, Rio Arriba-Mora line (Trunches Mtn.), Sandoval, San Miguel, Santa Fe, Taos. **Utah:** Box Elder, Cache, Daggett, Emery, Salt Lake, San Juan, Sanpete, Sevier, Summit, Tooele, Uintah, Utah, Wasatch. **Wyoming:** Albany, Carbon, Converse.

*Epidemia dorcas castro/florus intergrades*

**UNITED STATES. Idaho:** Butte, Custer, Elmore, Franklin, Lemhi, Owyhee.

*Epidemia dorcas florus*

**CANADA. Alberta:** Bearberry Creek nr. Sundre; Beaver Mines Lake; Blackfalds; Mouth of Fish Creek, Calgary; Carbondale River; Crow's Nest Pass; Didsbury; Edmonton; Kananaskis Forest Reserve; Lake Louise (Laggan); Middle Kootenay Pass; Nordegg; Rocky Mountain House; Storey-Squaw-Norquay Saddle (nr. Banff); Waterton Lakes; West Castle River. **British Columbia:** "Alcan"; Cultus Lake; Emerald Lake; Field; Hope Summit; Jesmond; Kaslo; Mt. Cheam; Pete Lake; Summerland.

**UNITED STATES. Idaho:** Bannock, Bear Lake, Bonneville, Boundary, Caribou, Clearwater, Fremont, Kootenai, Teton. **Montana:** Beaverhead, Cascade, Choteau, Fergus, Flathead, Gallatin, Glacier, Granite, Jefferson, Lake, Lewis and Clark, Madison, Meagher, Missoula, Park, Ravalli, Sanders, Sweet Grass. **Washington:** Lincoln, Okanogan, Yakima. **Wyoming:** Crook, Fremont, Park, Sublette, Teton, Yellowstone N.P.

*Epidemia dorcas dospassosi*

**CANADA. New Brunswick:** Bathurst.

*Epidemia dorcas claytoni*

**UNITED STATES. Maine:** Penobscot (Lee, Springfield).

*Epidemia dorcas megaloceras*

**UNITED STATES. Wyoming:** Big Horn, Johnson, Sheridan.

*Epidemia dorcas arcticus*

**CANADA. British Columbia:** Atlin; Chilkat Pass. **Yukon Territory:** Dawson; Dry Creek; Gravel Lake, 58 mi. E. Dawson; Haines Jct.; Halfway Lakes, Mayo; Kluane; Last Chance; Marsh Lake; Mayo Lake Road; Rampart House; Rancheria-Swift River; Rock Creek; Tepe Lake nr. head Wolverine Creek; Whitehorse. **UNITED STATES. Alaska:** Alfred Creek; Birch Lake nr. Fairbanks; Central; Circle; Circle Hot Spgs.; Delta; Eagle; Fairbanks; Ft. Yukon; Goldstream Valley (nr. Fairbanks); Johnson River, mi. 1380 Alaska Hwy.; King Salmon, Naknek River; mouth of Charley River; Murphy Dome nr. Fairbanks; Noatak River delta, 6 mi. NW Kotzebue; Rampart (incl. Hunter Creek); Ruby; vic. Tok; Wonder Lake, McKinley N.P.; mi. 25 Chena Hot Springs Road; Nulato; Glenallen; Gulkana River ca. 10 mi. above jct. West Fork.

*Lycaena dorcas dorcas* phenotype: Alaska southern coastal relict

**Alaska:** Anchorage; Beluga; Cordova; Homer, Kodiak; Moose Pass, mi. 28 Seward Hwy.; Sitka; Tern Lake, mi. 38 Seward Hwy.; Valdez; Whitshed; Cook's Inlet.

These specimens (approximately 20) cannot be distinguished from nominate *dorcas* from the eastern arctic, and are therefore placed as a relict population. The zone of intergradation or introgression between this population and *arcticus* is presently unknown. Perhaps as more material is obtained from the Alaska Lepidoptera Survey, our knowledge of these populations will expand.

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*Notes in proof:* Dr. J.W. Tilden of San Jose, CA has recently informed me that he has observed *E. d. arcticus* ovipositing on *Potentilla fruticosa* in Alaska. These butterflies are quite sedentary, fly about the host plants and do not stray far from them.

J.R. Heitzman of Independence, MO reported that *E. helloides* was taken during the last week of April, 1977 in St. Louis Co., MO, a state record. Apparently *helloides* is expanding its range in Illinois and has now penetrated into Missouri.

J. Scott of Lakewood, CO has sent me oviposition data for an apparent *helloides* colony on the Toll Ranch, Gilpin Co., CO. He described the adults as vagile with the males ranging widely in search of mates, a characteristic of *helloides* and not *dorcas*. The records, taken 27-28 July, 1977 are: one egg on soil about 2mm

from stem of *Rumex acetosella* L.; one egg on tiny seedling stem within 5 cm of both *R. acetosella* and *Polygonum aviculare*; one egg laid at base of stem of *P. aviculare*. *Potentilla* was not observed in the immediate area. *G. editha* was seen in the same area ovipositing in the debris at the base of *R. acetosella*.

On July 18 and August 1-2, 1977, I collected a series of *dorcas* on the west slope of the Sierra Madre Range, Carbon Co., WY at 7400'-7800' (2255-2377m), a site not previously collected. Members of this colony are closer to *florus* than *castro*. In size, they equal *castro*, but the DHW orange in the males is very much reduced and the ground color of the females is dark warm brown with only a few individuals displaying dark orange. This locality is south of the Red Desert barrier. The foodplant association is *Potentilla gracilis*, which grows abundantly in the tall grass understory. No *P. fruticosa* grows in the area and no species of either *Polygonum* or *Rumex* was found. Several females were observed fluttering low through the understory with frequent settling upon and inspection of various plants, often grasses, but no oviposition was observed.

The taxon *mariposa* Reakirt is apparently also referable to *Epidemia*, based upon structure, although in facies it does not resemble the other four species cited in the introduction of this paper.