Lepidoptera. Peter J. Herlan of the Nevada State Museum and his wife Barbara assisted greatly during field work in Nevada. Oakley Shields and Scott Ellis assisted in field collection of material.

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FIELD OBSERVATIONS ON *COLIAS ALEXANDRA* EDWARDS (PIERIDAE)

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In recent years there has been vigorous interest in all aspects of the biology of North American species of *Colias*. *Colias alexandra* Edwards, a widespread species of the western foothills and mountains has attracted increased attention. Hovanitz (1950a) described its distribution, and (1950b) plotted frequencies of the dimorphic females. Ae (1959) induced laboratory crosses between *C. alexandra* and *C. eurytheme* Boisduval. Masters (1970) and Ferris (1972, 1973) examined the taxonomy of the species. John M. Burns (unpubl.) has studied the electrophoretic variation of esterase in different *Colias* species, including *alexandra*. An attempt is made here to augment this work with notes on foodplants, population structure, and behavior in *Colias alexandra*. Observations were made on 35 *C. alexandra* populations during 1971 and 1972 in Colorado, Utah, Nevada, Idaho, and Montana.

Colias alexandra is widely distributed along the axis of the Rocky

Mountains from New Mexico to Alberta and British Columbia, with outlying populations to the west in the Great Basin areas of Utah, Nevada, Idaho, eastern California, and then northward into eastern Oregon and Washington. East of the Rockies isolated populations occur in western Nebraska and the Black Hills of South Dakota. If *christina* Edwards is accepted as a subspecies of *alexandra*, the range is extended northeastward from Montana to Manitoba and northward to the Yukon River to approximately 67°N. For a distribution map and current taxonomic treatment, see Ferris (1973). *C. alexandra* is found in dry, open associations of the Transition and Canadian zones, most frequently from 7500–9000 ft. in the Colorado Rockies to 2000 ft. in northern Idaho.

Oviposition Records. Edwards (1897) lists *Thermopsis* (Leguminosae) and *Astragalus* (Leguminosae) as natural foodplants. He found clover *Trifolium repens* L. (Leguminosae) to be a satisfactory laboratory host. Edwards received *alexandra* ova from several workers in Colorado. Edwards noted in his entomological journals that he received *alexandra* ova on 27 July 1884 laid on *Astragalus* from Nash at Rosita, Wet Mtns., Custer Co., Colorado. He also received eggs from Prof. G. H. French at Central City, Gilpin Co., laid 27 July 1886 on *Thermopsis*. Edwards (1873) reports that Mead observed *alexandra* ovipositing on *Lupinus* (Leguminosae) in the northern part of South Park, probably in present-day Park Co., Colorado. From my experience with *alexandra* over much of its range, it appears that members of *Lupinus* are unlikely foodplants. Mead had only limited experience with the Colorado flora at the time of his observation, and may have misidentified the foodplant. McDunnough (1922) notes an oviposition by *Colias christina* in Alberta on a "small species of lupine with a greenish-white flower." This vague description might apply to *Astragalus canadensis* L. var. *mortonii* (Nutt.) S. Watson, a foodplant for *alexandra* in northern Idaho and western Montana. Klots, in Ehrlich & Ehrlich (1961), lists *Astragalus* and *Medicago* as foodplants. Shields & Emmel (1969) observed oviposition on *Astragalus miser* Dougl. in the Wasatch Range in Sanpete Co., Utah. Ferris (1973) cites *Astragalus serotinus* as a foodplant. Barneby (1964) considers *serotinus* (Gray) a variety of *Astragalus miser*.

Unpublished oviposition records unsubstantiated by herbarium determinations include *Thermopsis pinetorum* Greene from the White Mountains, Arizona, by Kilian Roever; *Thermopsis divaricarpa* A. Nels., Rampart Range Road, NE of Woodland Park, Teller Co., Colo., by F. M. Brown (photograph of ovum on plant). No ovipositions have yet been observed on *Thermopsis montana* Nutt., a species widespread west of the continental divide in Colorado. Kearney & Peebles (1951) consider *T. pinetorum* "doubtfully distinct" from *T. montana*. Mike Fisher ob-

served oviposition on *Oxytropis lambertii* Pursh. (Leguminosae) near Parker, Douglas Co., Colorado.

Foodplant-butterfly Relationships. Repeated ovipositions on a plant species in one locality, or oviposition on the same plant species in different localities is considered here to be a strong confirmation that the oviposition plant is the foodplant. No obvious oviposition mistakes were seen. *Astragalus eremiticus* is the only foodplant listed for which there is only a single oviposition sighting.

Many members of the genus *Astragalus* and *Oxytropis* are known to accumulate toxic compounds in their systems, especially the element selenium. *Colias alexandra* oviposited on *Astragalus miser*, *A. bisulcatus*, and *Oxytropis lambertii*, which are frequently poisonous to livestock. The toxicity of *A. miser* appears to vary as a function of the selenium concentration of the many different types of soil the plant inhabits. Barneby (1964) notes that "*miser* var. *oblongifolius* is often browsed, even where innocuous feed is plentiful, at least in the Colorado Rocky Mountains." For *A. bisulcatus*, Barneby (1964) states that: "On warm days and while drying in the press, the herbage gives out a strong smell of selenium disagreeable to most people and to some actually nauseating. It is one of the most dangerous and widely dispersed of the seleniferous stock poisons." A study of the biochemical relationship between *C. alexandra* and *A. bisulcatus* might prove rewarding, particularly if selenium is metabolized and stored in the immature and adult stages of the butterfly.

The ranges of *C. alexandra* foodplants often greatly exceed the range of the butterfly. Of particular interest is the absence of *alexandra* in most parts of Arizona, especially on the Kaibab Plateau north of the Grand Canyon (Kilian Roever, pers. comm.) where varieties of *A. lentiginosus*, *A. miser*, and *A. bisulcatus* are known to occur. *C. alexandra* is known from the nearby mountains in southwestern Utah. *Astragalus canadensis* has one of the widest ranges of any North American *Astragalus*, embracing nearly the entire eastern half of the United States, ranging south to the coast of Texas. *A. lentiginosus* is a highly polymorphic species that lives in a great range of environments and altitudes, and includes several varieties that occur in the deserts of southern Arizona and California. It is possible that *C. alexandra* has a physiological intolerance to the higher temperatures of desert areas, although a population at 5600 ft. in the arid Henry Mountains of southern Utah indicates that *alexandra* should be sought in comparable environments in northern Arizona. Much of eastern Colorado, Wyoming, South Dakota, eastern Montana, and Alberta remain for further foodplant investigations.

Many members of the genus *Astragalus* are pioneer or "fugitive" spe-

cies, often colonizing barren ground unacceptable to other plant species, and then disappearing as more competitive species enter the area (Barneby, 1964). Several parallel cases of local abundance of a *C. alexandra* foodplant appeared to be the result of disturbance of the plant community by man and his animals. In the La Sal Mountains of Montrose Co., Colorado, large stands of *Lathyrus leucanthus* were found growing next to stumps of *Pinus ponderosa* Lawson cut within the previous two years. In Piute and Juab Counties, Utah, *Astragalus lentiginosus* was found most abundantly along road cuts and in areas where sage *Artemesia tridentata* had been cleared. *C. alexandra* females were observed ovipositing on *A. lentiginosus* growing in the rubble of an abandoned highway. *A. miser* at Black Canyon, Montrose Co., Colorado, was found in eroded gullies and in sage flats heavily grazed by cattle.

It seems reasonable to assume that *Colias alexandra* must be a highly mobile species in some parts of its range as it follows the expansion and contraction of populations of its *Astragalus* foodplant. Evidence from capture-recapture studies at Gothic, Colorado, where *alexandra* feeds on *L. leucanthus*, indicates that *alexandra* has a strong tendency to disperse as compared to the more sedentary *Colias meadii* Edwards (Ward B. Watt, pers. comm.). It was found from extensive travel over the range of *alexandra* that this species generally occurred in widely dispersed populations, with occasional local, large concentrations. A "large concentration" was one in which the density of adult *alexandra* was estimated at 20 or more individuals/100 m^2. A large concentration of *C. alexandra* was nearly always accompanied by a local abundance of a foodplant. A "local abundance" was one in which patches of the foodplant occurred at high densities within small areas that ranged from 100 m^2 to several km^2. *Astragalus canadensis* in Idaho was found in densities up to 100 stems/m^2 in some patches. In dry areas of Utah, clumps of *A. lentiginosus* were scattered, but individual plants were often 0.2 m or more wide.

Timber management practices in northen Idaho and Montana offer an explanation for the changes in population size of *Astragalus canadensis*, and for the spotty occurrence of *C. alexandra*. Closely related to the Siberian *A. uliginosus* L., *A. canadensis* var. *mortonii* is a conspicuous species, often reaching 0.8 m in height, with a head of greenish-white flowers which later form a cluster of small, erect ellipsoid pods. The outstanding characteristic of *canadensis* is its occurrence in large patches as a result of vegetative spread by rhizomes. Patches of the species are easily seen while driving at high speeds along the highway. *A. canadensis* grows most abundantly in lodgepole pine, *Pinus contorta* Dougl., forest that has just been logged and cleared. Dense stands of

TABLE 1. Oviposition Records for *Colias alexandra*.[1]

Plant Species	Locality	Associated Vegetation, Geologic Formation
1. *Astragalus miser* Dougl. var. *oblongifolius* (Ryd.) Cron.	(A) COLORADO: Montrose Co., Hwy. 90 above E. Fk. of Dry Creek, Uncompahgre Plateau, S. 2, T. 47N., R 96W. 8100′ 29 June 1971 Ovip. 1100 MST on leaves at tip of stems. (CU) SLE	scrub oak *Quercus gambelli* Nutt., sage *Artemesia tridentata* Nutt., on Dakota Sandstone: Cretaceous
	(B) COLORADO: Montrose Co., Crystal Dam Road, 1 mi. S. of Black Canyon Natl. Mon. Boundary, NE ¼ of SE ¼ S. 8, T. 49N., R. 7W. 8530′ 21 July 1971 Ovip. 1200 MST on leaves. (CU) SLE	*Q. gambelli*, service-berry *Amelanchier* sp., on the Wanakah Formation, bedded between the Morrison and Dakota Sandstones
2. *Astragalus bisulcatus* (Hook.) A. Gray var. *haydenianus* (Gray)	(A) COLORADO: San Miguel Co., Sand Rock Road, nr. Bell Canyon Reservoir, SW ¼ of SE ¼ S. 9, T. 42N., R. 18W. 8015′ Uncompahgre Natl. Forest. 12 July 1971 Ovip. 1030 MST on leaves. (CU) SLE	*Q. gambelli*, *A. tridentata*, wild buckwheat *Eriogonum* sp., on Dakota Sandstone
3. *Astragalus lentiginosus* Dougl. in Hook.		
var. *diphysus* (Gray) Jones	(A) UTAH: Wayne Co. Bull Creek Pass Road, N. Side Henry Mtns. NW ¼ of S. 20, T. 30S., R. 18W. 5600′ 11 May 1966 Ovip. 1030 MST on leaves. SLE	scattered Juniper, short grasses, on alluvial gravel derived from diorite porphry
var. *araneosus* (Sheld.) Barneby	(A) UTAH: Piute Co., Hwy. 153, 1 mi. W. of Junction. 6000′ 20 June 1972 Ovip. 1130 MST on leaves. (CU) #7219 SLE	sage (*Artemesia*)—covered flats, on sandy alluvium in disturbed soil
	(B) UTAH: Juab Co., Hwy. 6-50, Jericho Turnoff. 5400′ 25–26 June 1972 Ovip. 1200, 1330 MST (CU) #7220 SLE	sage-covered flats, scattered *Juniperus* sp., on sandy, disturbed soil and in openings among sage
var. *salinus*[2] (Howell) Barneby	(A) IDAHO: Twin Falls Co., Magic Hot Springs Road, 4 mi. E. of Rogerson. 4500′ 1 July 1972 SLE	sage flats, sandy soil derived from basalt
	(B) IDAHO: Butte Co., 2 mi. NW of Atomic City, Hwy. 26. 4500′ 6 July 1972 SLE	sage flats, sandy soil derived from basalt
	(C) IDAHO: Cassia Co., Hwy. 77, 0.5 mi. N. of Junction with Elba-Malta Road. 5000′ 3 July 1972 (CU) #7221 SLE	sage flats, road cuts in sandy alluvium

[1] All records followed by (CU) were determined by Dr. W. A. Weber of the University of Colorado Herbarium. Records followed by field numbers indicate that the plant specimens have been deposited in the C.U. Herbarium collection. Distribution and determination of *Astragalus* varieties were greatly aided by the comprehensive work of Barneby (1964).

[2] This variety is inferred to be a foodplant by its association with *Colias alexandra* populations, and by the fact that *alexandra* oviposited on other members of the *A. lentiginosus* complex.

TABLE 1. (*Continued*)

Plant Species	Locality	Associated Vegetation, Geologic Formation
4. *Astragalus eremiticus* Sheld.		
Complex	(A) NEVADA: White Pine Co., Berry Cr., Schell Creek Range, 7800′, Humboldt Natl. Forest 28 June 1972 Ovip. 1530 PST (CU) #7223 SLE	sage flats and grassy hillsides, on gravel soil derived from limestone
5. *Astragalus canadensis* L.		
var. *mortonii* (Nutt.) S. Watson	(A) IDAHO: Kootenai Co., Bunco Cr. Road Cutoff, 0.5 mi. S. of Farragut State Park on Lake Pend Oreille. 2100′ 13 July 1972 Ovip. 1000 PST (CU) #7224 SLE	thinned stands of lodgepole pine *Pinus contorta* Dougl., roadsides and clearings in sandy glacial till
	(B) IDAHO: Boundary Co., Intersection Herman Lake Road with U.S. Hwy. 2, 3 mi. W. of Montana border. 2500′ 16 July 1972 In assoc. with *C. alexandra*. (CU) #7225 SLE	recently logged stand of lodgepole pine in sandy soil, burnpile ashes
	(C) MONTANA: Mineral Co., Cabin City Campground Rd. off Old U.S. 10, 3 mi. SE of De Borgia. 3300′ 23 July 1972 Ovip. 1500 MST (CU) #7226 SLE	in mixed lodgepole pine-Douglas fir *Pseudotsuga* sp. forest, along road cut, sparsely under trees in rocky soil
6. *Lathyrus leucanthus* Rydb.	(A) COLORADO: Montrose Co., 2 airline mi. N. of Buckeye Reservoir, La Sal Mtns. T. 48N., R. 20 W. 8000′ 27 June 1971 Ovip. 1230 MST (CU) SLE	recently cut stand of ponderosa pine *P. ponderosa* Lawson, clay soil on Dakota sandstone
	(B) COLORADO: Mesa Co., SOB Creek, 8 mi. W. of Hwy. 65, Lands End Road, Grand Mesa. 10,000′ 7 July 1971 Ovip. 1300 MST (CU) SLE	sage flats, *Lupinus*, *Wyethia*, *Penstemon*, *Castilleja*, rocky soil derived from basalt
	(C) COLORADO: Gunnison Co., base of Crested Butte. 9000′ 13 July 1967 J. F. Emmel & A. O. Shields (JFE #2, deposited Dudley Herbarium, Stanford U.)	sage flats, rocky soil

canadensis were observed growing in the ashes of burn piles, and in still-visible tractor tracks. Young stands of *P. contorta* are thinned for optimum growth, and *A. canadensis* and many other species of herbs cover openings in the thinned forest. *A. canadensis* becomes much less frequent in mature or stagnant lodgepole pine stands, or in dense Douglas fir, *Pseudotsuga menziesii* (Mirb.) Franco–Western red cedar, *Thuja plicata* Bonn, forest. Direct comparisons for butterfly abundance were made between adjacent logged and unlogged stands. *C. alexandra* was found commonly only where *A. canadensis* was abundant, although large patches of *A. canadensis* were found where no *C. alexandra* were seen. It seems possible that present timber maintenance methods have replaced a natural fire cycle which opened up clearings for invasion of *A. canadensis*, an early seral stage plant.

The single factor of foodplant abundance as a cause of large *alexandra* populations is insufficient in itself. Increased nectar sources, and an open habitat for increased adult interaction may contribute to large populations. It was noted that *Lycaena mariposa* Reakirt, *Lycaeides argyrognomen* Bergstrasser, and *Colias interior* Scudder were often extremely common in northern Idaho forest openings where *C. alexandra* was abundant.

W. H. Edwards discovered that *C. alexandra* enters a 3rd instar diapause. This may be an adaptation in response to desiccation of the foodplant. In Juab and Piute Counties, Utah, at the end of June 1972, *Astragalus lentiginosus* var. *araneosus* was found in an advanced stage of desiccation, with most small plants completely withered. A few large plants, on which *C. alexandra* was ovipositing, held mature pods on some stems, and were still blooming on others. No new growth was observed, and leaves were hard and leathery. With high evaporation rates and scant rainfall in this part of Utah, the risk of drought is great during the summer months. Even in an area of comparatively high rainfall such as Gothic, Gunnison County, Colorado, C. L. Remington (pers. comm.) has noted that *Lathyrus leucanthus* withers toward the end of July.

There was little opportunity for field observations on choice of foodplants by *alexandra*. In most populations where ovipositions were observed, only one species of *Astragalus* or *Lathyrus* was found, although search for other species was made. In many areas two or more acceptable foodplants surely must occur within the range of one *alexandra* population. In the Schell Creek Range of White Pine Co., Nevada, Barneby (1964) records varieties of *Astragalus lentiginosus* and *A. miser* within the area where *alexandra* was found ovipositing on *A. eremiticus*. In Cassia County, Idaho, at 5000 ft. on 3 July 1972, *C. alexandra* was

found abundantly in a small field (75 × 75 m) of alfalfa, *Medicago sativa* L. Between 1000 and 1200 MST *alexandra* was estimated at a density of 150–200 individuals in the field at one time. Such large numbers of this species had not been encountered previously, and it occurred to me that *alexandra* might be using *Medicago* as a foodplant in this locality. Careful observation of nearly thirty females during the prime oviposition time of late morning revealed only nectar-seeking behavior, and no oviposition or courtship behavior. Scattered *Astragalus lentiginosus* var. *salinus* plants were found along the road cut, and among sage shrubs bordering extensive sage and juniper flats. This discovery led me to believe that the source of the *alexandra* population was a colony of the *Astragalus* growing in the sage flats, with *alexandra* adults moving into the alfalfa field to feed.

Voltinism. *Colias alexandra* is a univoltine species over most of its range. Emergence times vary for different populations, with western Colorado ones generally appearing several weeks before those in the Great Basin, Arizona, and in the northern Rockies. Lengths of emergence vary from 3 weeks in populations from dry areas in western Colorado to 2 months along the Front Range in eastern Colorado.

Mike Fisher discovered a bivoltine *alexandra* population on the high plains near Parker, Douglas Co., Colorado. Confining dates for the two broods are, first brood: 25 May–22 June; second brood: 25 July–19 August, with no stragglers between broods. *C. alexandra* oviposited on *Oxytropis lambertii* in this area, although *Astragalus* species may be used as well.

Interspecific Relationships with other *Colias*. Throughout its range *C. alexandra* is almost always sympatric with at least one other species of *Colias*, and in some areas up to four. *C. alexandra* and *C. philodice* are most often sympatric, although the peaks of their broods are not always synchronous. Ae (1959) states that in Colorado opportunities for interspecific mating are rare between widespread *Colias* species (*philodice* and *eurytheme*) and the "northern" species (*alexandra*, *scudderi* Reakirt, and *meadii*) due to seasonal isolation. In western Colorado, the peak of *alexandra*'s flight period occurs between the spring and summer broods of *C. philodice*. On Mesa Verde, Montezuma Co., on 26 May 1972, the *alexandra*:*philodice* ratio was 5:1, and on 16 July 1971 in the same locality, the same ratio was 1:8. In Cassia Co., Idaho, in an alfalfa field on 3 July 1972, the *alexandra*:*philodice* ratio was in the range of 100:1, with no *C. eurytheme* seen. In western Colorado *C. eurytheme* is quite rare when *C. alexandra* flies in late June, but becomes more common after *alexandra* disappears. Throughout the Great Basin *alexandra* flies with both *C. eurytheme* and *philodice*, and

in northern Idaho is sympatric with *C. interior* as well. Near Lake Pend Oreille, Kootenai Co., Idaho in thinned lodgepole pine forest on 14 July 1972, *Colias* collections were made along a 0.2 mile strip of logging road from 0900 to 1200 PST. In this limited area nearly 200 *C. alexandra* were seen and collected, as well as 10 *C. interior*, 6 *C. eurytheme*, and 2 *C. philodice* (all specimens seen of the last 3 species were collected). Several unsuccessful attempts by *alexandra* males to copulate with *interior* females were observed in this locality. Where *alexandra* and *interior* are sympatric, *alexandra* frequents open areas along roadways and meadows, while *interior* is found more often in the shade of pine woods. *C. interior* invades meadow habitats in localities where *interior* is more common than *alexandra.*

In Canyon Creek Canyon, Ochoco Mountains, Crook Co., Oregon, where *C. alexandra* and *C. occidentalis* Scudder are sympatric, A. O. Shields (in litt.) notes that the two species are easily separable on the wing, and that there are other behavioral differences. *C. occidentalis* "was more confined to openings and edges of woods than *alexandra*, though both taken commonly in open, broad meadows." In Canyon Creek Canyon on 10 July 1970, Shields observed oviposition by *C. occidentalis* on the leaf underside of *Lathyrus lanszwertii* Kell. (Shields #109, det. J. T. Howell, Calif. Acad. Sci.). Shields saw a species of lupine *Lupinus latifolius* J. G. Agardh. (Shields #86) in Canyon Creek Canyon, the same foodplant species used by *C. occidentalis* at Camp Ellendale, Glenn County, California.

Adult Nectar Sources. A study of nectar sources for several populations of *C. alexandra* indicates that the insect visits a variety of plant species. Throughout western Colorado and parts of Utah the greatest concentrations of *alexandra* were found on various species of thistle *Cirsium* (Compositae). One large population on the South Rim of the Black Canyon, Montrose Co., Colorado, was found almost exclusively on Canadian thistle, *Cirsium arvense* L. This plant population had been introduced during the previous five years after the construction of a new road. On 29 June 1971, on the Uncompahgre Plateau, Montrose Co., Colorado, *alexandra* was observed to ignore *Cirsium* sp. in favor of mules ears, *Wyethia arizonica* Gray (Compositae). In Cassia Co., Idaho, *alexandra* chose the blossoms of *Medicago sativa* and bindweed *Convolvulus arvensis* L. (Convolvulaceae) over those of a *Chrysothamnus* species (Compositae) which attracted *Satyrium fuliginosum* Edwards, *Speyeria zerene* Boisduval, *Cercyonis oetus* Boisduval, and *Hesperia harpalus* Edwards. In northern Idaho, *Cirsium* sp. was completely ignored, and *alexandra* was found most commonly on its foodplant, *Astragalus canadensis* var. *mortonii.*

Nectar sources are especially significant in concentrating *alexandra* populations in arid country. The widespread introduction of weeds, especially *Cirsium* sp., along roadcuts may have local effects on the density of *alexandra* populations. At Jericho Turnoff from Hwy. 6-50, 5400 ft., Juab Co., Utah on 25 June 1972, *C. alexandra* was collected on two small thistle patches (tentatively identified as *Cirsium vulgare* L.) along an abandoned highway. This locality was extremely arid, with extensive sage flats changing to sand dunes a few miles to the west. No moisture in the form of mud or streams was available. The only other nectar sources utilized in this area were a few scattered blossoms in *Astragalus lentiginosus* clumps, and the flowers of a small introduced mint growing on the roadcut. It appeared that the thistle patches were recent introductions, owing to the lack of previous years' stalks, and the absence of other thistles for many miles in all directions. Twenty-five *C. alexandra* were collected on thistle flowers from the two patches. A return to the area the next day netted only four specimens. Subsequent travel north, south, and west for several miles in each direction indicated that *alexandra* was either very scarce, or non-existent beyond 0.2 mi. from the thistle patches, although scattered *A. lentiginosus* clumps were seen along the Little Sahara Sand Dunes road to the west of Jericho. It appeared that we had collected nearly the entire emerged population from a large area, indicating that the thistle blossoms were a powerful attractant. This observation raises the question of whether adult nectar sources may be a limiting factor in the size of arid-land *alexandra* populations. In some areas, *alexandra* may be limited to the flowers of its foodplant, a situation shared by some desert-dwelling *Philotes*, and *Apodemia mormo* Felder & Felder, which feed on fall blooming *Eriogonum* species (Polygonaceae).

Behavior. *Colias alexandra* followed a consistent behavioral pattern over its range. In open country on warm days individuals of both sexes arrived at nectar sources about 1030. Males were least wary at this time, and most easily collected. After 1200, both sexes began to leave the nectar sources. Males congregated on mud, or flew continuously over meadows or along the edge of the forest. Oviposition by females occurred most often between 1000 and 1330. The fast flight and large size of *alexandra* made it easy to separate from other *Colias* species on the wing. Beak-marked individuals were very rare, and no attacks by avian predators were observed. Although hundreds of *alexandra* were observed on nectar sources, no copulating pairs were found. This suggests that courtship and mating may take place at a distance from nectar sources. *C. alexandra* moved away from open areas during the hottest hours of the afternoon, and then another brief nectar feeding

period occurred in some populations at 1600. On the Uncompahgre Plateau in San Miguel Co., Colorado, an individual was flushed from inside a sagebrush clump at 0800 MST where it had apparently spent the night.

SUMMARY

1. *Colias alexandra* oviposits on members of at least four genera of the Leguminosae: *Thermopsis*, *Astragalus*, *Oxytropis*, and *Lathyrus*. *Lupinus* is considered a very doubtful foodplant. Clover, *Trifolium repens*, is known to be a laboratory host. Field observations indicate that alfalfa, *Medicago sativa*, is an unlikely foodplant.

2. *C. alexandra* oviposited on two species of *Astragalus*, and one of *Oxytropis* which are known to be toxic to livestock. At least one species, *Astragalus bisulcatus*, is known to be a selenium accumulator.

3. *C. alexandra* foodplants are characteristically perennial, and show a scattered or patchy distribution. Several are dependent on the availability of disturbed plant communities and early seral stages in forests for their optimum growth. Two species, *Thermopsis divaricarpa* and *Astragalus canadensis*, form dense patches due to spread by rhizomes.

4. *C. alexandra* occurs most frequently in widely dispersed populations. Occasional large, local concentrations are found. It is suggested that these large, local *alexandra* populations are primarily dependent on the local abundance of a foodplant. Other factors such as an open habitat and increased nectar sources may contribute to the support of large *alexandra* populations.

5. Although univoltine over most of its range, a bivoltine *alexandra* population is known from the High Plains-Front Range contact area in Douglas Co., Colorado.

6. *C. alexandra* is nearly always sympatric with one or more species of *Colias*. Limited data suggest that there are temporal and behavioral differences between *alexandra* and other species of *Colias*.

7. Available nectar sources, particularly introduced weeds, may strongly influence density and size of *alexandra* populations occurring in very arid areas.

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