

**1995 MIGRATION OF *CYNTHIA CARDUI* (L.)
(LEP.: NYMPHALIDAE) IN NORTH AMERICA, WITH SPECIAL
REFERENCE TO INYO COUNTY, CALIFORNIA**

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THE BEHAVIOURAL activities of migrating Painted Ladies *Cynthia cardui* are proving to be extremely complex, although more is being learned about these in the occasional years when it migrates in noteworthy numbers (Giuliani & Shields, 1995, 1997a, b). Here we report field observations on its migrations during the 1995 season for North America, particularly for Inyo County and, to a lesser extent, Mariposa County, of central California. Methods and terms follow Giuliani and Shields (1995), except that 24-hour time is employed.

North America

Southwest Weather

By March 1995 there was good rainfall in the Sonoran Desert areas of southern Arizona and northern Mexico and in the low desert areas of southern California (J. Emmel). On 13-14 February there were heavy rains in Baja California between Tijuana and Catavina (O. Shields). Rainfall was 200 to 500% above normal in January and March in many areas throughout California, causing widespread flooding and triggering numerous landslides and mud-slides, the wettest year there since 1983 (Bedrossian, 1996). A strong El Niño warm water intrusion was responsible for the increase in storm activity, the third El Niño event in four years (*Los Angeles Times*, 25 January 1995).

Baja California

On 10 February 1995, 27 km SW of El Arco, small numbers of *C. cardui* migrated WNW (R. Wells & O. Shields). The desert shrubbery in Baja California Norte was very green from earlier rains all along Mexican Highway 1, with good wildflower displays on the Viscaïno Desert. On 14-15 April, going south from the U.S./Mexico border to Santa Rosalia, few migrators were observed until the Viscaïno Desert, where very large numbers were migrating northward (J. Mori). From 16 April to 12 May at San Lucas (15 km S. of Santa Rosalia), they were present in low numbers and not migrating (J. Mori).

South-eastern California and Western Arizona

On 25 February 1995, a large fresh adult *C. cardui* was observed perching on a shrub in the Orocochia Mountains, 460m, Riverside County, California (J. Emmel). On 18 March a large migration headed west between Blythe and the Colorado River under partly cloudy conditions with moderate winds (A. Halford). On 20 March a large northward migration was noted along Highway 30 between Barstow and Needles (R. Larson).

In Arizona, large migrations were observed along Highway 93 from Kingman to Phoenix on 20 March (R. Larson) and between Wikieup and Wickenburg on March 27 (J. Brock), migrating N-NW, becoming a sparse migration on the desert N. Wickenburg by 20 April (Tuttle, 1996). At Lake Havasu during the entire month of April, *C. cardui* migrated N-NW between 09.00-15.00 h (R. Gillmore).

Southwestern California

On 13 March 1995, 1-3 per minute were counted while driving from Perris to Mojave, mostly migrating NNW (J. Mori). That same day at Hemet, small numbers flew NNW in mid-morning, and fresh to worn adults were seen on *Lantana* Linnaeus (Verbenaceae) flowers (J. Emmel). Occasional non-migrating adults were observed near Ventura during the first two weeks of March, then occasional NW migrators on 13 March (T. Dimock). On 18 March at Hemet, many migrated NNW (c. 1-2 per minute through yard), with several dozen visiting flowers (J. Emmel). At Los Angeles, singletons were reported migrating during 12-31 March, briefly becoming commoner on 26 March (often in twos and threes) (J. Donahue). On 5-6 April between Adelanto and Walker Pass, small numbers were observed migrating NNE-WNW (R. Wells).

Mariposa County, California

At Jerseydale, 1100m, the first *C. cardui* migrators of the season appeared on 9-11 April (occasionals, mostly going NNW-NW), then two migrators on 22 April. From 25-29 May, migration rates were 1/5min/15m, directions variable but mainly NE-NW, briefly increasing to 2/5min/15m on 26 May. They occasionally landed, interacted, or briefly nectared or oviposited on various annuals before migrating on. The rate continued at 1/5min/15m during June 2-3, then migration ceased. One or two, not migrating, were seen on some days during July to mid September, with 6-12 on some days in the second half of September. Occasionals nectared on asters throughout October and November, with one or two migrating SE on October 20. The last one of the season was observed on December 9, with rains on December 11 finally breaking a long warm, dry spell.

One worn individual was observed migrating NW a few km N. of Fresno on 15 or 16 March. On 26 May near Midpines Summit, a NNE-NNW migration reached densities of 3-5/5min/15m in the morning. Between Coarsegold and Fresno on 24 October, occasional *C. cardui* migrated SE.

Northern California

On 23 April very occasional *C. cardui* migrated eastward N. of Vacaville. On 24-26 April, occasional individuals migrated E-NW in the Corning-Red Bluff area, sometimes ovipositing on orchard weeds and visiting mud. Adults were resident there on 19-21 May. On 16 May north of Vacaville, occasionals migrated NW-ENE and visited creek mud. On 23 May, near Merced, 4-8/km migrated NW; most appeared fresh (O. Shields, above observations). On 26-28 May at Camp Connell, Stanislaus County, they nectared on *Arctostaphylos* Adanson (Ericaceae) flowers by the thousands while migrating N; many were fresh specimens (J. Mori).

Northern Nevada

On 9-11 May, in the Silverpeak and Toiyabe Ranges of Esmeralda and Nye Counties, there were moderate migrations to the N-NW. On 10 July on the Geiger Grade and its Summit, 1700-2075m, Storey and Washoe Counties, mostly fresh *C. cardui* were nectaring and migrating NW. On 21 July at Sand Mountain, 1160m, Churchill County, a few migrated northward. Numerous fresh adults were also seen nectaring at Mill City in Pershing County on 18 July and Iron King Mine Road in Humboldt County on 20 July (R. Langston, above observations).

Summer 1995

During the summer months, *C. cardui* was widespread across the United States (although apparently absent from E. Texas to Georgia and Florida) and was present in low numbers in southern Canada from British Columbia to Ontario (Swengel & Opler, 1996; Tuttle, 1996). The furthest north reports were for Quesnel, British Columbia (C. Guppy) and Churchill, Manitoba (Swengel & Opler, 1996). States with localities reporting >70 in one day during the summer surveys were California, Arizona, Oregon, Wyoming, Colorado, Iowa, Minnesota, and Illinois (plus Saskatchewan). During the second half of summer, SW-ward migrations were observed in E-central Nevada (D. Giuliani), SE Wyoming (J. Scott), and central Colorado (J. Scott), at various elevations. In Arizona, thousands of adults nectared or patrolled between Kingman and the Hualapai Mountains in August (R. Gillmore), when they were also abundant in the Atascosa Mts., Patagonia, and Huachuca Mts. (Swengel & Opler, 1996).

Autumn 1995

A return southward migration has sometimes been observed in previous years for *C. cardui* during the summer and autumn months in western North America (Emmel & Wobus, 1966; Shapiro, 1980; Myres, 1985; Nelson, 1985; Giuliani & Shields, 1995). Autumn southward migrations in 1995 were observed "in noticeable numbers" during September and October at UC Riverside (D. Hawks), and in "sparse numbers" in the desert N. of Wickenburg, Arizona, on 29 September (Tuttle, 1996).

In southern California, adults were numerous on *Chrysothamnus* Nuttall (Asteraceae) flowers in the Santa Rosa Mts., 2285-2380m, Riverside County, on 24 September, and a dozen adults were observed both in the San Jacinto Mts. (2165m) and at Edwards AFB (700m) in early October, also on *Chrysothamnus* (J. Emmel). From 2 September to 10 December at Hemet, there were small numbers of adults on *Lantana* daily when the days were warm and sunny, with increases on 4 and 19 November (J. Emmel). At Miramar NAS in San Diego County, adults were observed as singletons throughout the winter after October, not migrating (J. Brown). In SE Arizona it nectared abundantly on *Chrysothamnus* in the Huachuca Mts. and Palominas in late October to early November (R. Bailowitz).

Inyo County

Spring Migrations

No migrations of *C. cardui* were seen during 1994 in Inyo County, with only very low migration levels there in 1996 and 1997. In 1995, migrators were first observed

on 21 March near Big Pine, and the first measurable migration occurred there on 17 March (1-5/5min/15m).

Flight densities and directions for the 1995 spring migrations were monitored in Inyo County (0-2600m elevation). Individuals were observed in migratory flight from 06.50-17.50h and were medium to small in size. Migration flights appeared on both calm and windy days and under clear skies to completely overcast conditions, though none was observed during rains or after sunset. Maximum flight densities were recorded as follows: 12-31 March, 9/5min/15m; 1-15 April, 77/5min/15m; 16-30 April, 18/5min/15m; 1-20 May, 5/5min/15m. Flight directions were measured with a compass for 1153 spring migrators. Their median geographic flight direction during 12 March - 16 May was to the NNW (see Figure 1), 82% having a northward vector (with 56% in the NW quadrant alone).

Cloud shadows had the effect of decreasing migration numbers to few or none, with migration resuming as the sun reappeared. Cold, windy weather also decreased migration numbers to few or none and caused them to land on the ground. During a light migration near Olancha on 26 March, migrators arrived in waves, with often long periods of few or none, under alternating calm to breezy conditions.

C. cardui migrations were heading toward peak numbers by 7 April, but successive weather fronts came through Owens Valley during the second week of April, producing very cold temperatures and very strong winds. Great numbers of non-migrating *C. cardui* were observed N. of Bishop in a canyon on 10 April and in a dry wash on 15 April. These likely were migrators that had accumulated there for protection from the harsh conditions, the beating they had received from the wind apparently curtailing their migration tendency. Many were worn, torn, and faded and flew up and down the canyon as huge streams (963-1875/5min/15m). Many were also on the ground and on *Amsinckia* Lehmann (Boraginaceae) flowers. After these strong winds, many highly worn *C. cardui* were seen throughout Owens Valley, including some that were almost totally disabled.

On 23 April, a northward migration was encountered W. of Lone Pine in the early afternoon. An elevational relationship was observed when counting individuals per mile (1.6 km) while driving westward up a grade, as follows:

| distance | elevation | number |
|------------|------------|--------|
| 1st 1.6 km | 1130-1190m | 0 |
| 2nd 1.6 km | 1190-1280m | 1 |
| 3rd 1.6 km | 1280-1370m | 5 |
| 4th 1.6 km | 1370-1465m | 10 |
| 5th 1.6 km | 1465-1555m | 23 |
| 6th 1.6 km | 1555-1645m | 28 |
| 7th 1.6 km | 1645-1770m | 12 |
| 8th 1.6 km | 1770-1890m | 2 |
| 9th 1.6 km | 1890-2010m | 0 |

During some spring migrations, occasional individuals would stop to nectar at *Amsinckia*, *Encelia* Adanson (Asteraceae), and *Prunus* Linnaeus (Rosaceae) flowers, and sometimes these would fly up to passing migrators and follow them. However, on 23 April, SW of Independence, none of a light migration, which flew all morning, visited the abundant flowers of *Prunus andersonii* Gray (Rosaceae), usually a favoured nectar source.

Rainfall and *Amsinckia*

From late September to December, 1994, Big Pine (which averages 14 cm per year) received 3 cm of rain, then 11.5 cm during January, 1995 and little rain in February. On 9-10 March, 10.5 cm of rain fell, the heaviest March amount in the last 50 years. There was dense germination near Bishop of *Amsinckia*, the primary larval hostplant in Inyo County, by mid-November 1994, and all over Owens Valley during warm weather in February 1995, which then bloomed in April and May. *Amsinckia* is a spring annual that germinates in the winter and flowers in the spring (Went, 1948). By early May, the wildflowers in Owens Valley were extra numerous, with more biomass and flowers and buds per plant than in the past 25-50 years, in response to the heavy winter rains. Storm fronts and periods of unseasonably cool temperatures in March and April, along with some overcast days in early May, allowed the *Amsinckia* plants to remain green into early May.

C. cardui eggs on *Amsinckia* were scarce in Owens Valley in early April, but there were many eggs on the *Amsinckia* searched during 10-17 April. By mid-May, larvae were present on several species of hostplants throughout the area. No eggs were laid above 2195m during the spring migrations as leaves had not yet appeared on hostplants above that elevation. In early July to early August, however, some immatures were found on hostplants between 2195-3050m.

Bishop emergence site

On 17 April at the Bishop emergence site, many *C. cardui* eggs were present on the *Amsinckia* leaves, along with very occasional 1st instar larvae. The eggs, scarce there on 4 April, were probably deposited 10-11 April when many eggs were first found at several other locations in Owens Valley.

The tendency of May larvae to crawl over the ground was strongly correlated with successive desiccation of the *Amsinckia* plants. On 1 May, the larvae were 2nd instars and the plants were large and green with some patches drying out. On 9 May, a great many 2nd-5th instar larvae were present, up to three dozen per plant at some spots, with some larvae crawling on the ground in the morning, though crawlers were only a small fraction of the total present. Most *Amsinckia* was still in good condition, and patches of dead ones and isolated healthy plants had no larvae. On 16-18 May, large numbers of 2nd-5th instar larvae were crawling in the mornings after deliberately climbing down, or dropping, to the ground. Large areas of *Amsinckia* were turning brown, and isolated healthy plants now had clusters of large larvae. On 24 May, few larvae were crawling on the ground, all 5th instars, and a few pupae and freshly-emerged adults were present. Most *Amsinckia* were now brown and brittle, though many green ones were still available to larvae. The *Amsinckia* was

heavily eaten, though not as severely as in some previous years. On 30 May, newly-emerged adults radiated outward from the emergence site, and only three 5th instars could be found on the very few *Amsinckia* that remained green, and but one crawler.

Density of crawling larvae at this site was tabulated in a 1.5 m x 1.5 m square on the ground on 17-18 May. Maximum densities (9-17) were reached between 08.25 - 09.20h at 15-20°C, with crawlers present between 06.45-11.00h. Larval crawl speeds (n=12) were 0.3 to 2.2 m/min and were greatest for medium to large-sized larvae and at higher temperatures. A plot of random crawl directions (n=199), measured on 17 May at 07.00-08.00h, showed the fewest number (17%) in the quadrant opposite to the sun's direction, with greater numbers (27-28%) in each of the other three quadrants.

As had been seen in previous years, each larva maintained a straight line in a fixed direction whenever it crawled. When exposed to a second sun, as reflected by a large mirror, larvae turned to new crawl directions by angles dependent on position of the mirror. It was found that direction of turn (clockwise or counterclockwise) was independent of the original larval orientation and depended solely on whether the mirror was on one side or the other of the sun's direction line through the larva.

At this site during middle and late May, many whiptail lizards (*Cnemidophorus tigris* Baird & Girard), a flock of yellow-headed blackbirds (*Xanthocephalus xanthocephalus*), a few crows (*Corvus brachyrhynchos*), and antelope squirrels (*Ammospermophilus leucurus* Merriam) appeared to be searching for larvae and/or pupae of *C. cardui* in the *Amsinckia* areas. Several species of *Calosoma* Weber (Carabidae) were also potential predators. An unidentified, large parasitoid wasp was present in large numbers, actively searching for crawling *C. cardui* larvae. Each would sting a 5th instar larva, then carry the paralysed larva back to a hole it had already dug in wet sand. After removing a pebble that plugged the hole, the wasp would then pull the larva head-first down the hole. Many paralysed larvae were also left lying about abandoned and were ignored by all passing wasps. Some larvae were able to avoid the wasp's sting by instantly coiling and exuding fluid or by speeding up and climbing into a nearby *Amsinckia* plant.

Local emergence

Local emergence (Fig. 1) began in early May in southern Owens Valley, progeny of the earlier spring migrations. At the Bishop emergence site, however, the first local migration began on May 18 and peaked in late May when large numbers of newly-emerged adults radiated outward in all directions from the site, flying very slowly. The density at 08.00 h on 30 May reached 46/5min/15m, with migration ending by 09.30 h and with very few migrators seen there the next day. Similar migration densities (23-43/5min/15m, going NNW-NNE) were observed at 2075-2195m in the Sylvania Mts., CA/NEV border, on 26 May. On 1 June in the White Mountains at 2285m, 81-117/5min/15m mainly went N-ENE. In Owens Valley in early June, migrations became light in density and ceased altogether after 10 June. Few *C. cardui* were observed in Owens Valley during the summer, and during autumn, only occasional individuals were seen.

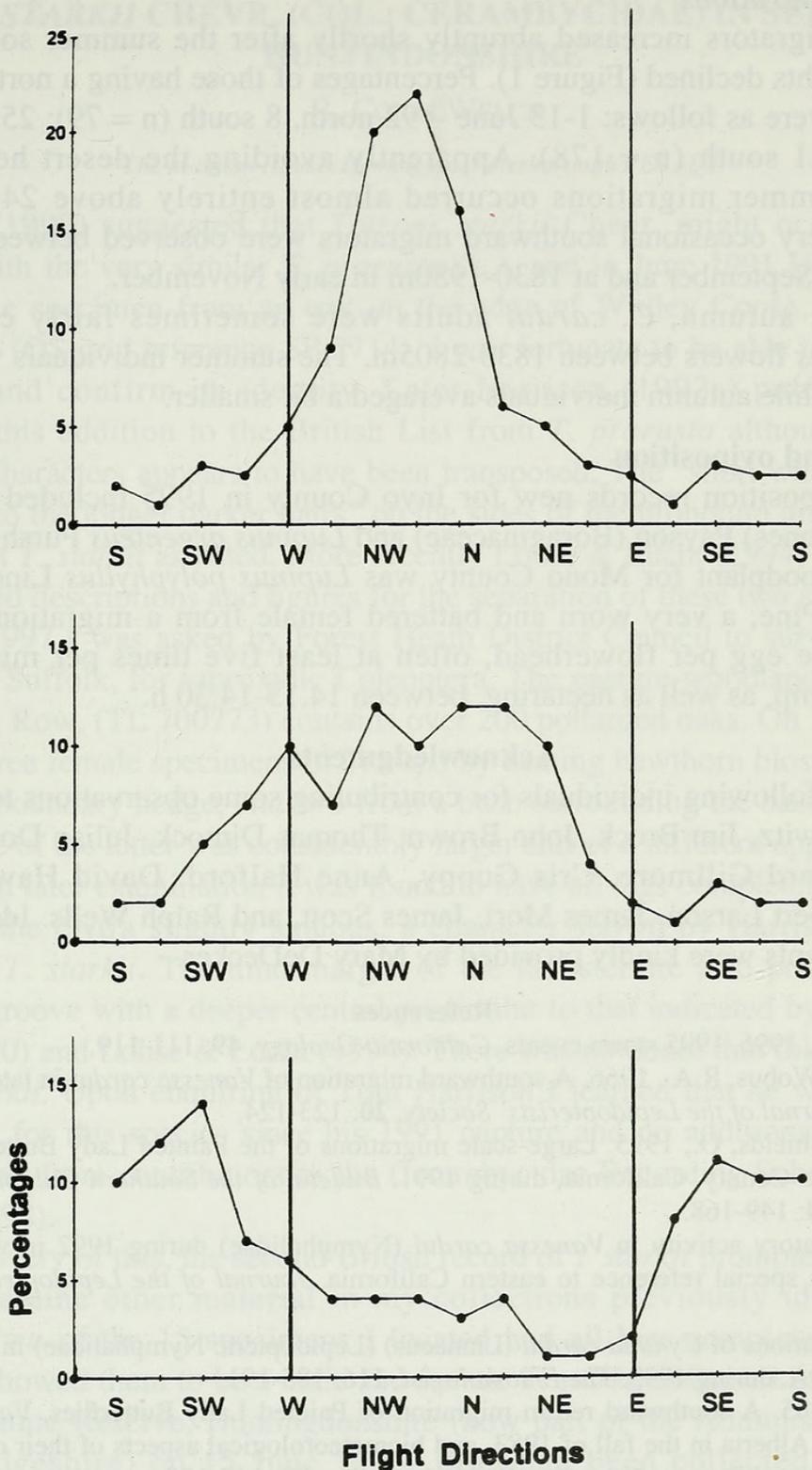


Figure 1.

Migrator geographic direction trends during the 1995 season in Inyo County:

(top) spring migrations, 12 March -16 May (n=799);

(middle) local emergence, 18 May -13 June (n=869);

(bottom) southern migrations, 25 June - 5 December (n=349).

The top graph is narrowly focused between N and NW, the middle is more spread out in the northward vector, and the bottom reverses to a predominantly southward vector.

Southward migrations

Southward migrators increased abruptly shortly after the summer solstice while northward flights declined (Figure 1). Percentages of those having a north or a south flight vector were as follows: 1-13 June – 92 north, 8 south (n = 79); 25 June-7 July – 19 north, 81 south (n = 178). Apparently avoiding the desert heat and low humidity, summer migrations occurred almost entirely above 2440m in the mountains. Very occasional southward migrators were observed between 1920 and 3935m in late September and at 1830-1980m in early November.

During the autumn, *C. cardui* adults were sometimes fairly common on *Chrysothamnus* flowers between 1830-2805m. The summer individuals were mostly large in size while autumn individuals averaged a bit smaller.

Foodplants and oviposition

C. cardui oviposition records new for Inyo County in 1995 included *Cryptantha virginiensis* (Jones) Payson (Boraginaceae) and *Lupinus argenteus* Pursh (Fabaceae), and a larval foodplant for Mono County was *Lupinus polyphyllus* Lindley. On 25 April at Big Pine, a very worn and battered female from a migration repeatedly oviposited one egg per flowerhead, often at least five times per minute, on an *Amsinckia* clump, as well as nectaring, between 14.15-14.30 h.

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