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ASPECTS OF THE BIOLOGY AND ECOLOGY OF *DIGUETIA MOJAVEA* GERTSCH (ARANEAE, DIGUETIDAE)

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ABSTRACT

A large colony of the spider *Diguetia mojavea* Gertsch was studied during the summer of 1980 at Indio, California. Unreported color markings for this species are described. The web structure, some aspects of the biology, mortality factors, behavior, and diet of *D. mojavea* are compared with other *Diguetia* spp. The influence of abiotic and biotic factors on web site selection are analyzed. The diet and fecundity of *D. mojavea* at the Indio study site were compared with individuals found scattered at lower densities in surrounding desert areas.

INTRODUCTION

Diguetids are distributed from the southwestern United States into southern Mexico (Gertsch 1958), with an isolated additional species from Argentina (Mello-Leitão 1941, Gerschman de Pikelin and Schiapelli 1962). The family was revised by Gertsch (1958). The biologies and web characteristics of four of the nine species in this primitive, monogeneric family have been described: *Diguetia canities* McCook (Cazier and Mortenson 1962), *D. albolineata* O. P.-Cambridge (Eberhard 1967), *D. imperiosa* Gertsch and Mulaik (Bentzien 1973), and *D. catamarquensis* (Mello-Leitão) (Mello-Leitão 1941, Gerschman de Pikelin and Schiapelli 1962). *Diguetia mojavea* Gertsch was found to be a common predator of *Coleophora parthenica* Meyrick (Lep.: Coleophoridae), a stem-boring insect introduced into California from Pakistan for the biological control of Russian thistle (*Salsola australis* R. Brown, Chenopodiaceae) (Goeden et al. 1978, Nuessly and Goeden 1983). The biology and ecology of *D. mojavea* were investigated during field and laboratory studies of this predation.

METHODS

Field studies were conducted on a 30-ha, undeveloped industrial tract located within 1.5 km of the 1974 colonization site of *C. parthenica* at Indio in the Coachella Valley of southern California (Goeden et al. 1978). The principal plant species at this disturbed, low-elevation, Sonoran Desert site were Russian thistle, *Atriplex canescens* (Pursh)

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Nuttall, *Chenopodium album* L., *Bassia hyssopifolia* (Pallas) (Kuntze (all Chenopodiaceae), *Cynodon dactylon* (L.) Persoon (Gramineae), and annual grasses.

Two hundred and eighty *D. mojavea* webs were mapped in June, 1980, to facilitate season-long study of the spiders. Individuals were identified with numbered, cardboard tags attached to plants a short distance from each web. The species of plant colonized by each spider and the dimensions and locations of the webs on the plants were recorded for analyses of microhabitat preferences and prey captures. The webs were then monitored at least weekly for three consecutive months until the last of three annual generations of *C. parthenica* moths had emerged and died in September, 1980.

The spiders used the carcasses of their prey in the construction of retreats, which provided records of the numbers and types of prey consumed throughout the season. The retreats of spiders that died or abandoned their webs during the summer were collected and stored for laboratory study. Most of the remaining retreats and spiders were collected at the completion of the field study period. Retreats were stored individually at 2-3°C in 60-cm^3, ventilated plastic vials until dissection to prevent hatching of spider eggs contained within the retreats. Accurate inventories of the contents of retreats were facilitated by dissolving the webbing in a 3:1 solution of distilled water:Chlorox® bleach (Nuessly and Goedon 1983).

Although only the *D. mojavea* population was regularly monitored, the spiders also were studied at 11 other locations in three other parts of the Coachella Valley. Empty residential lots and undeveloped tracts of desert land south of Indio and near the cities of Coachella and La Quinta were surveyed for *D. mojavea* from October to December, 1980. Densities of the spiders were determined and 35 retreats were collected at these 11 locations to compare their contents with retreats collected at the Indio study site.

RESULTS AND DISCUSSION

Description.—The form and coloration of *D. mojavea* at Indio closely matched the description of Gertsch (1958). Several additional characteristic markings were observed. A distinct, black, V-shaped band extended from the median groove of the carapace to the eyes. The legs were white to yellow-orange and usually marked with distinct reddish-brown to black annulations at the joints and near the middle of tibia I-IV. Faint, black, sinuous lines occasionally interrupted the medial region of the otherwise uniform mat of thick white scales on the dorsum of the abdomen of most specimens. The spinnerets were reddish-brown to black and appeared as a dark spot on the ventral tip of the abdomen. The venter of the abdomen was covered with white scales, with the exception of a brown band connecting the reddish-brown to black epigastric furrow to the small pair of tracheal spiracles located anterior to the spinnerets, 1/3 the distance to the epigastric furrow.

The general appearance of immature male and female spiders observed in the field was similar. Males could not be positively identified until they had reached the penultimate stage; whereupon, the legs became noticeably longer and the pedipalps enlarged and became distinctly hook-shaped.

Webs.—The spiders were common throughout the study site, where they reached a maximum density of 170/ha. The webs were most easily located in the early morning or late afternoon when illuminated by the sun at a low angle. Webs were found on most plants growing at the study site. Russian thistles were the plants most frequently colonized, but these weeds also were the most common plant species present. Cazier and Mortenson (1962) found that Russian thistle was a favored plant for *D. canities* colonies at Portal, Arizona.

Webs of *D. mojavea* were constructed between plants or in large openings between branches of plants with open crowns. The webs showed four structural features common to all the *Diguetia* spp. studied to date (Bentzien 1973): sheet webbing, a retreat, guy lines, and tangle webbing.

The web consisted of a roughly horizontal, oval sheet web that extended outward and slightly downward from a vertically oriented, conical, hollow retreat. The average (± S.E.) maximum diameters of 223 sheet webs (average length of longest diameter and the longest perpendicular cross-diameter along that axis of the web) were 34.5 ± 0.80 (range: 10-95) cm and 24.7 ± 0.55 (range: 10-49) cm. The largest sheet webs were no greater than 0.3 m^2 in area. This approximated the largest web area calculated by Bentzien (1973) for *D. imperiosa* from Mexico. The mesh of the sheet webs was tight along the perimeter of the sheets, but became increasingly loose nearer to the retreats. Several large holes around the mouths of the retreats afforded access to the higher parts of the webs.

The retreats were suspended from a series of strong guy lines which extended outward from the top 1/3 to 1/2 of the retreats to the branches that supported the perimeter of the sheet webs. The retreat was always oriented vertically between widely separated branches. The retreats usually were displaced to one side of the sheet web rather than constructed in the center of the sheet as described for *D. albolineata* (Eberhard 1967).

Retreats of immature *D. mojavea* tended to be trumpet-shaped, gradually expanding from top to bottom, with the opening somewhat flared. As the spiders matured and more arthropods and plant parts were gathered, the sides of the retreats became more parallel, except near the top where they tapered to a point. Cazier and Mortenson (1962) reported that the tops of *D. canities* retreats were loosely closed, but the tops of *D. mojavea* retreats were tightly woven and usually tended to curve in those of mature females.

The retreats of 75 mature *D. mojavea* females collected in October, 1980, averaged 6.2 ± 0.15 (range: 3.0 - 9.0) cm in length; whereas, abandoned retreats of 117 immatures and males averaged 3.1 ± 0.09 (range: 1.0 - 5.5) cm. The mouths of the hollow retreats were large enough to allow spider entry and averaged 1.1 ± 0.02 cm (n = 192) in diameter (range: 0.4 - 2.1 cm). The retreats of *D. mojavea* were longer than those reported for either *D. canities* (2.0 - 4.5 cm) or *D. catamarquensis* (≤ 6.0 cm) by Cazier and Mortenson (1962) and Gerschman de Pikelin and Schiapelli (1962), respectively.

Additional strong silk strands transversed irregularly among the guy lines to form a very loose, tangled series of webs (tangle webbing) separated from the sheet webbing by at least the length of the retreats. Beneath the sheet web and often extending to the ground was another layer of tangle webbing. This separation of the tangle webbing from the sheet webbing by *D. mojavea* was different from *D. imperiosa,* which filled the area above and below the sheet webbing with tangle webbing (Bentzien 1973). The average height of 223 of these complex *D. mojavea* webs was 20.8 ± 0.51 (range: 7 - 47) cm.

Life History.—In mid October, 1980, immature spiders (body length ca. 1 mm) emerged from egg sacs within retreats collected in September and held at ca. 24°C in the laboratory. It is not known whether the eggs hatched prematurely or concurrently with those in the field, where the first stage nymphal spiders never were observed. The characteristic webs of these spiders were not constructed until early June. These webs were built by spiders with a body length of 6-7 mm (unknown instar). *Diguetia mojavea* nymphs smaller than 6 mm were not observed in the field. After overwintering, the immature spiders apparently pass several instars in inconspicuous microhabitats before producing their large, expansive sheet webs.

Table 1.–Diets of *D. mojavea* on different plants based on the number of the different prey found in retreats collected at Indio, CA, July to October, 1980.

	Types of plants colonized						
	Live Russian thistle (n=122)			Dead Russian thistle (n=54)		Other plant spp. (n=9)	
Arthropod prey	% occurrence among retreats	Mean No. prey per retreat	% of diet	Mean no. prey per retreat	% of diet	Mean no. prey per retreat	% of diet
Isopoda	1.1	<0.1	<0.1	0.0	0.0	0.0	0.0
Arachnida	33.0	0.4	0.7	0.4	0.6	0.2	0.2
Insecta:							
Lepidoptera							
Coleophoridae							
C. parthenica	98.4	42.3	68.0	45.1	72.1	100.8	83.1
other families	8.6	0.4	0.6	0.1	0.2	0.0	0.0
Homoptera							
Cicadellidae	95.7	9.2	14.8	7.2	11.6	7.1	5.9
Fulgoroidea, Membracidae	8.1	0.1	0.2	0.1	0.1	0.1	0.1
Hemiptera							
Lygaeidae	85.9	5.6	8.9	4.2	6.7	6.8	5.6
Coreidae, Miridae, Nabidae, Rhopalidae	28.6	0.1	0.2	0.2	0.4	0.1	0.1
Pentatomidae, Phymatidae, Reduviidae	26.5	0.3	0.4	0.1	0.2	0.4	0.4
Embioptera	46.5	0.7	1.2	1.6	2.5	2.2	1.8
Orthoptera	6.5	0.1	0.1	0.1	0.1	0.1	0.1
Dermaptera, Neuroptera	6.5	0.1	0.1	0.1	0.2	0.1	0.1
Coleoptera							
large: Buprestidae, Carabidae, Coccinellidae, Elateridae, Pyrochroidae, Scarabaeidae, Tenebrionidae	33.5	0.5	0.8	0.6	1.0	1.3	1.1
small: Chrysomelidae, Cleridae, Curculionidae, Melyridae, Mordellidae, Staphylinidae	41.6	0.7	1.1	0.5	0.8	0.9	0.7
Diptera, Isoptera	16.8	0.1	0.2	0.4	0.7	0.1	0.1
Hymenoptera							
Formicidae	42.7	0.8	1.3	0.9	1.5	0.3	0.3
other families	25.4	0.3	0.6	0.5	0.9	0.3	0.3

The immature *D. mojavea* molted three times after their discovery in June before reaching the adult stage. Molting was observed only in the mornings and probably began before daylight. Molting usually occurred on the web between the retreat and supporting plant, or on the plant itself.

Diguetia mojavea hung upside down at the entrance to their retreats in the morning hours. During the afternoon they moved onto the sheet webs or into the plant crowns and shade of retreats and branches. The nocturnal activities of these spiders were not investigated.

Males presumably left their own webs in search of females upon reaching maturity; however, this behavior was never observed. The sex ratio was not determined, but mature

Table 2.–Mean (± S.E.) number of prey, *C. parthenica*, and egg sacs in 185 *D. mojavea* retreats collected from different types of plants at Indio, CA, July to October 1980. Means not followed by the same letter differ significantly at 5% level. Means compared vertically.

Types of plants colonized	No. prey per retreat	No. *C. parthenica* per retreat	% of prey comprised of *C. parthenica* per retreat	No. egg sacs per retreat
	In all retreats (n = 185)			
Live Russian thistle	62.3 ± 4.43a	42.3 ± 3.97a	56.0 ± 2.49a	2.4 ± 0.33a
Dead Russian thistle	62.5 ± 5.78a	45.1 ± 5.63a	61.2 ± 3.45a	2.3 ± 0.45a
Other plant spp.	121.2 ± 20.56b	100.8 ± 19.04b	70.4 ± 9.61a	4.4 ± 1.00a
	In retreats with egg sacs (n = 74)			
Live Russian thistle	113.5 ± 6.15a	88.5 ± 6.15a	75.0 ± 2.45a	6.7 ± 0.41a
Dead Russian thistle	103.4 ± 8.22a	84.4 ± 7.67a	79.0 ± 3.31a	6.3 ± 0.50a
Other plant spp.	132.9 ± 19.21a	111.1 ± 18.12a	81.4 ± 4.13a	5.7 ± 0.67a

males were observed in 17% of 280 webs surveyed. In comparison, Bentzien (1973) found that males represented 27% of the *D. imperiosa* population sampled in Mexico. Usually only one, but occasionally two male spiders were observed together in the web of a single female. Mating was never observed and probably took place at night. Males usually inhabited the webs of females for several (up to 6) days before they disappeared. Dissection of retreats suggested that males rarely were taken as prey by the females.

Mature females began preparations for the deposition of eggs within the retreats by first gradually covering the exterior of the retreats with a series of vertically oriented strands of silk. This probably served to insulate the eggs from the sun, or to protect them from egg predators. Oviposition began in mid August, but was never observed. An average of 176 (range: 50-251) eggs was contained in each of 75 loosely woven, ovoid, pillow-shaped sacs examined. The sacs appeared much like those described for *D. imperiosa* by Bentzien (1973). The sacs were constructed on the interior of the north or northeast sides of the retreats and may have served to insulate the eggs further. Additionally, the exterior surface of the shaded side of the retreats subsequently was covered with large quantities of silk. The egg sacs were constructed overlapping in the retreat beginning a short distance from the top and ending at the mouth.

Seventy-four *D. mojavea* females at Indio each produced an average of 6.4 (range: 1-14) egg sacs. This level of egg sac production is higher than that reported for either *D. imperiosa* ($\bar{x}$ = 3.6, Bentzien 1973) or *D. canities* ($\bar{x}$ = 4.6, Cazier and Mortenson 1962).

Mortality Factors.–Death associated with molting was the only mortality factor actually observed for *D. mojavea*. Many spiders died before they completely shed their old cuticles. Perhaps, in these cases, the molting process was begun too late in the morning and the desert heat and aridity dried the molting fluids before the spiders could completely shed their cuticle (M. H. Greenstone, pers. comm.). Many dead spiders found hanging in their webs and lacking apparent injuries may have died of excessive solar exposure. Many webs were found abandoned and in disrepair during the summer. Insect predators in the families Mantidae, Pompilidae, Sphecidae, and Vespidae were common throughout the summer at our study site and possibly preyed on *D. mojavea*. As with *D. canities* (Cazier and Mortenson 1962) and *D. imperiosa* (Bentzien 1973), other species of

Table 3.–Percentage of *D. mojavea* webs facing different compass headings on different types of plants at Indio, CA, 1980. Means not followed by the same letter differ significantly at 5% level.

Types of plants colonized	Total no. webs	% of webs (and % spiders that produced at least 1 egg sac) facing different compass directions							
		N	NE	E	SE	S	SW	W	none-web overgrown
Live Russian thistle	183	1.6 (66.7)	6.0 (54.5)	27.9 (39.2)	19.7 (50.0)	30.6 (51.8)	3.3 (33.3)	3.3 (33.3)	7.7 (57.1)
Dead Russian thistle	80	2.5 (100.0)	7.5 (50.0)	30.0 (29.2)	21.3 (58.8)	22.5 (50.0)	5.0 (25.0)	0.0 (-)	11.3 (77.8)
Other plant spp.	17	0.0 (-)	0.0 (-)	41.2 (71.4)	17.7 (100.0)	17.7 (66.7)	0.0 (-)	11.8 (100.0)	11.8 (100.0)
Webs: mean %		1.38a	4.50ab	33.02d	19.52c	23.58c	2.76ab	5.01ab	10.22b
Survivorship: mean %		83.35b	55.25ab	46.60ab	69.60ab	56.17ab	29.15a	66.65ab	78.30ab

spiders (salticids, in our case) were occasionally found inhabiting *D. mojavea* retreats. *Diguetia mojavea* were missing from such retreats and may have been killed or otherwise displaced by the salticids.

No predators of *D. mojavea* eggs were found in any of the 74 retreats containing eggs collected at Indio. Although Bentzien (1973) also found no egg predators of *D. imperiosa*, Cazier and Mortenson (1962) reported Hymenoptera and Coleoptera as egg predators of *D. canities*.

Behavior.–The spiders reacted to vibrations of the web in different ways. Slight movements in any part of the web usually induced attack behavior. Larger disturbances involving several structural parts of the web caused the spider to dash head-first into its retreat. Males inhabiting webs of females occasionally tried to run into retreats when the webs were disturbed. If the male entered the retreat first, he would leave soon after the female arrived. If the female entered first, the male was denied entry and immediately was expelled from the mouth of the retreat. This behavior was also observed with *D. imperiosa* in Mexico (Bentzien 1973). Males usually hid in web areas used during molting.

Severe disturbance of webs during collection of retreats often caused immature spiders or females without egg sacs to fall to the ground without spinning a dragline. Once on the ground, they lay motionless with their legs held close to their bodies. Females with eggs in their retreats were very protective and not prone to leave their webs. They either crawled as far as possible into the egg-laden retreats or ran out onto the sheet webs or up into the tangle webbing above the sheet webs.

Observations of prey trapped in the sheet and tangle webbing were made during daylight hours. During this time, spiders usually reacted only to prey that fell onto the sheet webbing. Occasionally, however, a prey individual trapped in the upper tangle webbing was attacked by a spider that moved into this layer through one of the holes in the sheet webbing surrounding the mouth of the retreat.

Once a prey individual became trapped in the sheet web, the spider ran very quickly along the underside of the web to the prey. However, if a large prey was causing a great disturbance in the web, the spider hesitated momentarily, then rapidly vibrated the sheet web up and down. This web motion apparently caused the prey to become more entangled. The spider thrust its first three pairs of legs through the web to grasp and pull the

Table 4.–Mean (± S.E.) number of prey, *C. parthenica*, and egg sacs in 185 *D. mojavea* retreats facing different compass directions at Indio, CA, July to October, 1980. Means are not significantly different at 5% level.

Compass heading	No. prey per retreat	No. *C. parthenica* per retreat	% prey comprised of *C. parthenica* per retreat	No. egg sacs per retreat
N	94.0 ± 80.00	76.5 ± 70.50	63.7 ± 20.81	4.5 ± 4.50
NE	57.7 ± 20.78	42.9 ± 18.80	46.6 ± 11.97	2.0 ± 1.04
E	55.1 ± 5.53	38.8 ± 4.96	57.3 ± 3.40	1.9 ± 0.42
SE	62.2 ± 8.15	45.4 ± 7.46	63.9 ± 4.40	2.5 ± 0.61
S	65.7 ± 6.80	45.3 ± 6.30	57.4 ± 3.72	2.6 ± 0.52
SW	47.5 ± 18.46	27.8 ± 13.08	52.9 ± 10.65	1.5 ± 1.50
W	96.0 ± 35.31	74.0 ± 26.15	76.0 ± 5.27	3.0 ± 1.78
none, web overgrown	75.1 ± 10.36	52.1 ± 10.69	56.5 ± 7.05	4.5 ± 0.86

prey against the sheet web, then bit the prey through the webbing. The spiders were never observed to release small prey (< 1.5 cm) once grasped. Small prey were rapidly immobilized by the venom and the spider remained no more than 30 seconds (n = 25) on the web with each such prey. These small prey were pulled through the elastic sheet webs and quickly carried to the mouths of the retreats, where a strand of webbing was attached to the retreat and then slowly wrapped several times around the prey. This tethering allowed the spider to leave previously captured prey to attend to additional prey caught in the web. Apparently the spiders were very efficient at handling the abundant *C. parthenica* moths, as less than 15 seconds (n = 30) were required for a spider to respond to a struggling moth, capture and bite it, and carry it to the retreat.

Adult Pentatomidae ("stink bugs") often became trapped in the webs when flushed from Russian thistles upon which they fed. The audible blasts from the defensive scent glands of these bugs caused *D. mojavea* to momentarily retreat 2-3 cm from the bugs. Eventually the spiders succeeded in biting the bugs, usually on a leg. The spiders then backed away until the venom began to take effect; whereupon, the biting was repeated until the violently struggling bugs stopped moving. It is unclear whether feeding on these medium sized prey occurred back at the retreat or out on the sheet web. Both may occur as dead stink bugs were observed on the sheet webs as well as in the retreats.

Carcasses of small prey were incorporated into the retreats after feeding was completed. Plant stems, leaves, flowers, and seeds from surrounding plants also were added to the retreats. Prey carcasses usually were arranged horizontally in the retreats.

Although the captures were never observed, the spiders also fed on other larger insects up to 3 cm in length, e.g., adult grasshoppers, large tenebrionid and buprestid beetles, and immature mantids. These large prey also were observed on the sheet webs and at the retreats. After feeding was completed, most of these larger carcasses were cut from the sheet webs and discarded into the tangled layer of webbing below, but some of these prey were incorporated into the retreats. Discarded prey in the lower tangle webbing were collected and included in the diet analyses along with the retreat contents.

Diet and Retreat Contents.–The leaves, stems, and seeds of Russian thistle were the plant materials most frequently used in retreat construction. Small pebbles and dirt were found in 68% of the retreats. This inert material possibly was gathered from the ground, as pebbles dropped onto the sheet webs were attacked by spiders but quickly discarded.

Table 5.—Mean (± S. E.) number of prey, *C. parthenica*, and egg sacs in 185 *D. mojavea* retreats from webs with different amounts of exposure at Indio, CA, July to October, 1980. Means not followed by the same letter differ significantly at 5% level. Means compared vertically.

Web exposure	No. prey per retreat	No. *C. parthenica* per retreat	% prey comprised of *C. parthenica* per retreat	No. egg sacs per retreat
	In all retreats (n = 185)			
completely	62.9 ± 4.60a	43.6 ± 4.07a	59.0 ± 2.52a	2.2 ± 0.29a
partially	61.7 ± 6.31a	41.7 ± 5.71a	57.7 ± 3.64a	2.7 ± 0.56ab
engulfed	63.3 ± 9.95a	39.0 ± 9.66a	49.9 ± 7.41a	4.4 ± 1.03b
	In retreats with egg sacs (n = 74)			
completely	118.4 ± 6.32b	94.2 ± 5.97b	80.7 ± 1.55b	6.2 ± 0.35a
partially	106.8 ± 7.95ab	81.8 ± 8.10ab	74.7 ± 3.72b	6.9 ± 0.74a
engulfed	83.4 ± 10.19a	56.4 ± 11.33a	57.5 ± 8.69a	6.8 ± 0.80a

Rodent fecal pellets also were found in the retreats and probably were gathered in the same manner. Although plant material and inert substances were found in most retreats, arthropod carcasses comprised the major portion of these structures.

The arthropod contents of 185 *D. mojavea* retreats collected at the study site are listed in Table 1. All the common spider species found at the study site fell prey to *D. mojavea.* Males of *Pellenes tranquillus* Peckhams (Salticidae) were the most common spider prey. As the females of *P. tranquillus* are the same color as *D. mojavea,* these males may have mistaken them for female congeners. Although spiders comprised < 1% of the diet (by number) of *D. mojavea* at Indio, they were found in 33% of the retreats examined. Therefore, spiders were much more common prey for *D. mojavea* than for either *D. canities* (Cazier and Mortenson 1962) or *D. imperiosa* (Bentzien 1973), for which spider prey were reported from only 4% and 6% of the retreats, respectively.

Coleophora parthenica were found in 98% of the retreats examined and comprised 68% to 89% ($\bar{x}$ = 71%) of the diet (Table 1). Cicadellidae and Lygaeidae also were well represented, as they were found in 96% and 86% of the retreats, respectively. They were the only other insects constituting a significant part of the diet (< 24%). Embioptera, Coleoptera, and Formicidae were found in > 35% of the retreats, but comprised < 3% of the diet. Therefore, 92% of the diet of *D. mojavea* consisted of *C. parthenica,* cicadellids and lygaeids. Cazier and Mortenson (1962) reported that retreats of *D. canities* in Arizona also contained large numbers of cicadellids and other small prey. They suggested that the size of the prey rather than prey quality governed prey selection by these spiders, as other, larger, potential prey species were common at their study sites. This selective capture of prey also apparently occurred with the webs of *D. mojavea* at Indio, where larger potential prey also were present but not captured in substantial numbers. However, such other factors as the strength, visual acuity, and evasive behavior of prey also must be involved in prey capture by the webs.

Limited differences were found in types and abundance of prey captured by *D. mojavea* on different types of plants (Table 1). Initial analysis indicated that more prey and more *C. parthenica* were captured on plants other than Russian thistle (Table 2), but these spiders also lived longer than those with webs on either live or dead Russian thistles.

Plant-sucking bugs were found in slightly higher numbers and percentages in the retreats of spiders on live Russian thistles. The other types of prey were randomly distributed among spiders on all the plants.

Web Site Selection.—The above results suggest that *D. mojavea* did not choose their web sites exclusively on the basis of prey availability. Other factors, e.g., exposure to wind and sun, and structural constraints imposed by web design, probably were important factors influencing web placement.

Web location data suggested that web sites were chosen with reference to the direction of the prevailing winds. *Diguetia mojavea* webs were distributed non-randomly on the plants (Table 3), with 77% of the webs found on the leeward sides (i.e. south, southeast, east) of plants. These locations offered the greatest protection from the prevailing southeasterly winds in the Coachella Valley. Contradictory to the above findings, we discovered that *D. mojavea* with webs on the windward sides of plants had slightly higher survivorship rates (Table 3). Afternoon temperatures often reached > 55°C during the months of July and August, and webs located on the shaded side of the plants (generally the windward side) may have temporarily benefited more than those on the leeward (sunny) side. Bentzien (1973) observed that *D. imperiosa* most commonly placed its webs on the west sides of plants, but offered no explanation for this orientation.

Overall, wind damage avoidance may be a greater selective force for web location than exposure to the sun. Distribution data for the genus indicates that these spiders are found only in hot, arid environments. The development of highly reflective scales on their bodies and their avoidance of the direct rays of the hot afternoon sun are obvious adaptations for desert survival. In his study of *D. imperiosa*, Bentzien (1973) found that more than three days were required to rebuild destroyed webs, during which time prey capture would have been severely reduced. As prey presumably would be needed to maintain body fluid levels in this hot, dry environment, web placement in reference to potentially destructive, prevailing winds must be an important consideration.

In examining the effects of web orientation, no significant directional differences were observed in the number of prey caught or the number and percentage of *C. parthenica* in the diet (Table 4). The small sample size limited comparison of these parameters with surviving spiders to only four compass headings and no differences were detected.

As these spiders constructed large, expansive webs, available space certainly was an important factor influencing the choice of web site. Most webs were constructed in locations that originally facilitated maximum exposure of the prey-capturing surfaces of the webs. Because the growing plants occasionally engulfed the webs and restricted their exposure, the webs were surveyed again in October to determine their exposure at the end of the growing season. The majority of the webs remained exposed, but 25% had been partly obscured by vegetation, and 6% were totally engulfed by plant growth. Although this did not affect spider survivorship, it did affect their diets. Surviving ovipositing spiders with webs that were fully exposed throughout the season captured significantly more total prey and more *C. parthenica* than those whose webs had become completely engulfed by vegetation (Table 5). The former group of spiders also had a larger proportion of *C. parthenica* in their diet than the latter group.

The number of egg sacs produced by the spiders did not significantly vary between types of plants colonized, compass placement about the plants, or web exposure (Tables 2, 4, and 5). However, when the numbers of prey captured by surviving female spiders were compared with the numbers of egg sacs produced, a small but significant ($P = 0.05$) correlation ($r = 0.3014$) was obtained. There was no correlation between the number of

Table 6.–Diet of *D. mojavea* based on the number of the different prey in 35 retreats collected at 11 locations in the Coachella Valley, CA, removed from the sites during October to December, 1980.

Arthropod prey	% occurrence among retreats	% of diet
Arachnida	5.7	0.2
Insecta:		
Lepidoptera		
Coleophoridae		
C. parthenica	68.6	19.8
other families	57.1	6.4
Homoptera		
Cicadellidae	100.0	34.9
Fulgoroidea, Membracidae	34.3	1.7
Hemiptera		
Lygaeidae	57.1	11.0
Coreidae, Miridae	34.3	1.7
Pentatomidae	20.0	0.8
Embioptera	28.6	3.2
Orthoptera	20.0	0.6
Dermaptera, Neuroptera	14.3	0.4
Coleoptera		
large: Buprestidae, Carabidae, Scarabaeidae, Tenebrionidae	65.7	4.8
small: Chrysomelidae, Cleridae, Curculionidae, Elateridae, Staphylinidae	48.6	2.5
Diptera, Isoptera	45.7	2.4
Hymenoptera		
Formicidae	51.4	45.7
other families	5.8	2.8

C. parthenica captured and the number of egg sacs produced. Therefore, the total number of prey captured by *D. mojavea* affected the number of egg sacs produced, but the quantity of the most common prey item alone was not responsible for the correlation.

Survey of other parts of the Coachella Valley found *D. mojavea* at much lower densities (2 - 75/ha) than at our study site. Suitable web sites apparently were not lacking at these locations, as the vegetation was similar to that found at our study site. However, examination of the Russian thistles at these 11 outlying locations revealed sparse populations of *C. parthenica*, which only recently had spread there from Indio (Goeden and Ricker 1979). One location southeast of Indio showed a higher density of *D. mojavea* at 50 - 75 spiders/ha, but the retreats of these spiders contained many *C. parthenica* as well as an unidentified small species of moth. These results suggested that *D. mojavea* were more abundant in areas where there was a constant, abundant source of food, and that high densities of introduced *C. parthenica* at our Indio study site may have been responsible for the increased local abundance of *D. mojavea.*

Examination of retreat contents of *D. mojavea* in these outlying areas also indicated a definite change in diet for these spiders with the introduction of *C. parthenica* (Table 6). Although *C. parthenica* were found in 69% of the retreats, they made up only 20% of the diet. All other prey items constituted a larger proportion of the diet for these spiders than at our study site. These data suggest the importance of the other insects in the usual diet of *D. mojavea.* Cicadellidae and Formicidae were the most common prey items and constituted ca. 35% and 46% of their diet, respectively. These spiders also used more plant material in the construction of their retreats.

Female spiders at these other locations also produced fewer egg sacs ($\bar{x}$ = 5.3, n = 29) (range: 2-11) than did females at our study site. This was probably the result of the number of prey captured, as individual female *D. mojavea* at our study site captured three times the total number of prey captured by those at outlying sites ($\bar{x}$ = 38.5).

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