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MUTUAL EXCLUSION BY DOLICHODERINE ANTS ON A RICH FOOD SOURCE

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Some species of ants recruit rapidly to rich food sources and may exclude other species from that food source (Holldobler and Wilson, 1990). These ant species interfere with other ant species by using chemical repellents or by physical means. For example, the dolichoderine ant *Forelius pruinosus* usually displaces the formicine honeypot ants, *Myrmecocystus* spp., at food baits (Holldobler, 1982). Interference competition should be most intense where densities of ant colonies are high and when food reserves are limited.

The dolichoderine ant *Conomyrma insana* is the most abundant species in the ant communities of Chihuahuan Desert grasslands, and occurs at densities of more than 100 colonies per hectare (WGW, unpublished data). These ant communities also include several species of generalists (*Solenopsis* spp., *Myrmecocystus* spp., and *Forelius* spp.) that feed on honeydew, plant exudates and insects. In the summer before the advent of monsoonal rains, the availability of liquid food sources for ants is limited. However, fruits and flowers of yucca (*Yucca elata*) support between 114 and 700 flowers per stalk (James et al., 1993), and the floral nectaries and the aphids that feed on the petals of the flowers provide a rich resource for liquid-feeding ants. As yucca fruits develop, their surface tends to be injured by a variety of herbivores and the wounds exude liquids and gum-like materials, both of which are collected by ants.

We studied the ants on flowers and fruits of yucca in fifteen 0.5 ha plots on the Jornada Experimental Range, 26 km N of Las Cruces, NM. In 8 of the plots, mesquite shrubs (*Prosopis glandulosa*) were removed during the 1993–94 winter months. Data collection took place on 18 and 25 July 1995.

We identified and recorded the species of all ants on the fruits and flowers of each yucca within a plot. A total of 1034 stalks on 519 yuccas was sampled (1.99 ± 1.30 *SD* stalks/plant). There were an average of 34.6 ± 17.2 *SD* yucca plants (range 4 to 68, Table 1) per plot. Data on ant presence were collected between 0730 h and 1100 h MDT when soil and air temperatures were within the range for activity of the ants. Each stalk was recorded as flowering, fruiting, both flowering and fruiting, or no flowers and fruits. Data on relative frequency of ant species within plots were obtained from pitfall traps in a 7 × 7 trap grid with 10 m trap spacing. Traps were plastic vials 38 mm in diameter and 68 mm deep containing approximately 45 ml of a 70:30 (V:V) ethanol : glycerol mixture. Traps were collected after 24 h and ants were identified to species in the laboratory.

At our study site, the ant genera *Conomyrma* and *Forelius* each contain two species which are indistinguishable in the field. For each genus the two species are morphologically similar and overlap in behavior and habitat utilization in the area studied. The genus *Conomyrma* includes *C. bicolor* and *C. insana*; *Forelius* includes *F. foetidus* and *F. pruinosus*. *Myrmecocystus* includes three indistinguishable species: *M. depilis*, *M. mimicus*, and *M. romainei*. A fourth *Myrmecocystus* species, *M. mexicanus*, is easily identified in the field.

Of 1034 yucca stalks, 528 had only the *Conomyrma* species group present, 348 had only *Forelius* spp., 62 had only *Myrmecocystus* spp., and 15 had only *Solenopsis* (Table 2). Three yucca stalks had both *Conomyrma* and *Forelius*, five had *Conomyrma* and *Myrmecocystus*, one had *Conomyrma* and *M. mexicanus*, and eleven had *Forelius* and *Myrmecocystus* (Table 2). On one fruiting stalk a small number of *Conomyrma* were initially present with large numbers of *Forelius*. During a 5 minute period, the *Conomyrma* jumped from the stalk to the ground, abandoning the stalk to the *Forelius*. We did not observe aggressive interactions between the

TABLE 1—The frequency of occurrence of ants on *Yucca elata* stalks and in pitfall traps on fifteen 0.5 ha plots. On eight of the study plots, mesquite shrubs were removed 1.5 years prior to the study. Con = *Conomyrma* spp., For = *Forelius* spp., Myr = *Myrmecocystus* spp. and Sol = *Solenopsis* spp.

	Yucca elata										
		#	#	% ants on stalks				% ants in pitfall traps			
Plot	# Plants	Flower stalks	Fruit stalks	Con	For	Myr	Sol	Con	For	Myr	Sol
				Mesquite removed							
2	45	23	69	62.1	21.1	5.3	9.5	59.2	53.0	42.8	30.6
3	26	11	33	69.6	19.6	8.7	0	72.9	91.7	27.1	70.8
4	21	1	44	33.3	66.7	0	0	46.9	61.3	12.2	67.3
6	36	20	61	61.8	34.2	3.9	0	88.1	69.0	47.2	14.3
7	24	3	63	78.2	20.0	1.8	0	73.5	79.6	20.4	20.4
12	25	18	32	59.3	18.6	13.6	0	69.4	83.7	44.9	69.4
15	17	8	22	21.9	71.9	0	3.1	61.2	81.6	22.4	36.6
17	41	27	47	10.1	69.6	20.3	0	23.4	44.7	19.1	29.7
Mean				49.5	40.2	6.7	1.6	61.8	70.6	29.5	42.4
				Mesquite intact							
1	48	23	50	77.9	17.6	1.5	1.5	58.3	54.2	29.2	8.4
5	68	28	83	75.3	21.6	1.0	0	88.9	48.9	26.7	22.3
10	52	52	46	66.3	19.2	8.7	1.9	71.4	44.9	26.5	40.8
11	37	23	40	54.4	27.9	10.3	2.9	60.4	70.9	20.9	43.8
13	19	18	28	40.5	50.0	9.5	0	34.7	65.3	18.3	71.4
16	4	0	5	75.0	25.0	0	0	79.6	77.5	22.4	42.9
18	56	52	52	26.9	64.6	3.8	0	55.3	55.3	25.5	27.7
Mean				59.5	32.3	5.0	0.9	64.1	59.6	24.2	36.8
Total mean				54.2	36.5	5.9	1.3	62.9	65.4	27.0	39.8

dolichoderines (*Conomyrma* and *Forelius*) and the honeypot ants (*Myrmecocystus* spp.). It is surprising that we recorded overlap between *Conomyrma* and *M. mexicanus* because *M. mexicanus* is nocturnal (Whitford, 1978) and is not usually seen foraging during daylight hours. Because our observation period started more than 2 hours after sunrise, the presence of *M. mexicanus* on a flowering stalk is indicative of the value of this resource to a liquid-feeding species.

There were four records of the native southern fire ant, *Solenopsis xyloni*, on the same stalks as *Forelius* (Table 2, 1.1% of all *Forelius* sampled). However, the occurrence of *S. xyloni* in pitfall traps averaged 39.8% (range 8.4–71.4%, Table 1). In two of the sample plots, the frequency of pitfall captures of *S. xyloni* was greater than either of the dolichoderines. Despite the very aggressive nature of fire ants, the dolichoderines probably occur more frequently on yucca stalks because they recruit more total foragers to the site.

Even though the *Myrmecocystus* have a larger body size and had a high relative frequency in pitfalls (average 27%, range 12–48%, Table 1), they were virtually absent from yucca stalks. On those stalks where they occurred with dolichoderines, they occurred in low numbers. The rapid recruitment of small dolichoderines to the yucca resource and the chemical repellents of these ants (Holldobler and Wilson, 1990) are probably largely responsible for the low frequency of honeypot ants on the yuccas.

There was no correlation between pitfall frequency and frequency on yucca stalks for *Forelius* ($r^2 = 0.025$, $P = 0.573$) and *Conomyrma* had a weak association ($r^2 = 0.557$, $P = 0.001$). Differences in foraging behavior may account for this. *Forelius* individuals move along foraging "highways", whereas individuals of *Conomyrma* spread out and search randomly. This results in higher numbers of individuals of *Conomyrma* than *Forelius* in pitfall traps, even though the percentage of each species group is about the same in pitfalls (Table 1). Addi-

TABLE 2—Total numbers of *Yucca elata* stalks occupied by ant groups. Con = *Conomyrma* spp., For = *Forelius* spp., Myr = *Myrmecocystus* spp., Sol = *Solenopsis* spp., Mon = *Monomorium minimum* (Buckley) and M. mex = *Myrmecocystus mexicanus*.

Plot	Con	For	Myr	Sol	Mon	Con + For	Con + Myr	For + Myr	For + Sol	Con + M. mex	Total
					Mesquite removed						
2	59	20	5	9	0	0	1	0	1	0	95
3	32	9	4	0	0	0	0	1	0	0	46
4	11	22	0	0	0	0	0	0	0	0	33
6	47	26	3	0	0	0	0	0	0	0	76
7	43	11	1	0	0	0	0	0	0	0	55
12	35	11	8	0	0	0	0	5	0	0	59
15	7	23	0	1	0	1	0	0	0	0	32
17	7	48	14	0	0	0	0	0	0	0	69
					Mesquite intact						
1	53	12	1	1	0	0	1	0	0	1	69
5	73	21	1	0	1	0	1	0	0	0	97
10	69	20	9	2	0	2	0	0	2	0	104
11	37	19	7	2	0	0	2	0	1	0	68
13	17	21	4	0	0	0	0	0	0	0	42
16	3	1	0	0	0	0	0	0	0	0	4
18	35	84	5	0	1	0	0	5	0	0	130
Total	528	348	62	15	2	3	5	11	4	1	979

tionally, there were more *Conomyrma* on yuccas in plots with mesquite present than in plots with mesquite removed ($\chi^2 = 4.0$, $P = 0.04$). This suggests that the *Conomyrma* may be utilizing exudates and honeydew from sucking insects on mesquite, in addition to the yucca resource, in these plots.

There were proportionally more *Conomyrma* on yucca stalks with fruits than those with flowers ($\chi^2 = 12.783$, $P = 0.002$), whereas *Forelius* prefered flowers over fruits ($\chi^2 = 7.615$, $P = 0.022$). This is evidence that different feeding preferences, in addition to different behavioral and foraging strategies, are determining the distributions of these two ant species on the yuccas. The third most abundant group in this study (*Myrmecocystus*) did not deviate from their expected distribution ($\chi^2 = 0.678$, $P = 0.712$) on fruits and flowers.

These data show that there is virtual exclusion of other dolichoderine species at a rich food source by either *Forelius* or *Conomyrma*. In addition, the presence of a dolichoderine on a flowering stalk either limits or eliminates access to that resource by other species of relatively abundant liquid feeding ants (e.g., *Myrmecocystus* spp.). The distribution of ants in this study is affected by the quality of the resource and by the behavioral characteristics of each ant species.

LITERATURE CITED

JAMES, C. D., M. T. HOFFMAN, D. C. LIGHTFOOT, G. S. FORBES, AND W. G. WHITFORD. 1993. Pollination ecology of *Yucca elata*, an experimental study of a mutualistic association. Oecologia 93:512–517.

HOLLDOBLER, B. 1982. Interference strategy of *Iridomyrmex pruinosum* (Hymenoptera: Formicidae) during foraging. Oecologia 52:208–213.

HOLLDOBLER, B., AND E. O. WILSON. 1990. The Ants. Belknap Press. Cambridge, MA.

WHITFORD, W. G. 1978. Structure and seasonal activity of Chihuahuan Desert ant communities. Insectes Sociaux 25:79–88.