damage to elicit a defensive response.

We could not carry out statistical tests on our final hypothesis, that the ants respond more vigorously to a crushed Acacia leaf smear than to a smear of crushed leaves from another plant, because time constraints prevented us from obtaining a sufficient sample size. However, it seemed clear that the ants responded more vigorously to both plant smears than to any other treatment in this one trial.

One possible interpretation for our findings is that the presence of a foreign insect arouses the ants but that a full defensive response is elicited only when leaf damage accompanies the presence of the foreign insect.

There were several possible sources of error in our study. The most correctable source of error is our small sample size. More trials could give statistical significance to our observed trends. A more difficult problem to compensate for is the possible difference in tree and colony size between trials. Another major source of error was the logistical problem of keeping track of lots of small ants running around in a confined area. The large degree of variance in our ant counts suggests that this was a relevant factor.

Table 1 The four treatments we analyzed statistically are shown (below) here with mean visitation rates (x), standard deviations (sd) and the results of the Mann-Whitney U ($U=49$, $p<0.05$).

Treatment	X_1	X_2	sd.	M-W U
grasshopper(1) vs. mud(2)	0.875	2.44	0.783	52
grasshopper(1) vs. lotion(2)	0.625	1.25	0.313	51
grasshopper(1) vs. dragon fly(2)	0.690	0.938	0.124	38
clipped leaves(1) vs. nonclipped leaves(2)	0.940	0.675	0.133	262

EFFECTS OF SPACING ON FORAGING RATE IN FEEDING GROUPS OF BLACK NECKED STILTS

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Abstract (C.G.)

Black-necked stilts (Himantopus mexicanus) feed primarily in groups. We tested whether stilt feeding rates were affected by proximity to nearest neighbors. Within a feeding group, feeding rates increased with increased distance from nearest neighbors. However, the stilts were shown to spend more time at closer, less efficient feeding distances than at farther distances. We conclude that some factor other than feeding efficiency causes these stilts to feed together.

Introduction (V.V. and A.B.)

We examined the relation between distance from closest neighbor and foraging rate in Black-necked stilts (Himantopus mexicanus). We observed that the stilts forage at varying distances from their conspecific neighbors.

The stilts are social and forage in loose groups (Stiles and Skutch, 1989). There are both costs and benefits of sociality: an individual can benefit from protection from predators and care for the young. Increased transmission of disease and possibly more intense intraspecific competition for mates, food, and nesting sites are potential costs of sociality.

Close spatial associations may increase foraging success by flushing prey or may reduce foraging success because of intraspecific competition. Both the positive and negative effects on foraging success are likely to be distance dependent. However, the optimal distance from nearest neighbors would depend on the relative strengths of these factors, and how rapidly they change with distance to nearest neighbor. Because we have no information on the detailed spatial trends, we could not predict a priori whether foraging success would increase or decrease with distance, within the range of observed nearest neighbor distances. Our hypothesis was: as the distance from a bird to its closest neighbor changes, its foraging rate will change.

Methods (V.V. and A.B.)

We observed Black-necked stilts situated east of the bird tower (approx. 200m east of the OTS Station) in the marsh at Palo Verde on January 10th 1991. We were situated at the foot of the tower and observed the birds from 8 am to 11 am. The stilts were aggregated into two groups. One densely packed group, of approximately 60 birds in an area of 6m x 2m, did not appear to be feeding. The other group was less dense, contained approximately 15 birds in an area of 6m x 3m, and was feeding regularly. We collected data on the feeding group.

We randomly selected a bird and observed it for 5 min. One pair of observers estimated and recorded the distance between the focal bird and its closest conspecific neighbor every 10 sec. The other pair simultaneously measured foraging behavior by recording the time of each peck. We performed 10 of these 5 min. trials.

We calculated the foraging rate for each bird for each 10 sec. period. We compared this foraging rate to the distance between that bird and its closest neighbor. The distances were grouped into wide (40cm) intervals to reduce the effects of bias or observer error in estimating distances. We then calculated the mean foraging rate for each distance interval, for all 10 birds combined. We determined in which distance interval the greatest number of pecks occurred within the 5 min. trial, and in which distance intervals the birds spent the most time.

Results (C.G.)

There was a positive correlation ($r^2 = 0.094065$, $p < 0.05$) between pecking rate and distance from nearest neighbor (Figure 1). There was a negative correlation ($r^2 = 0.3756$, $p < 0.01$) between a bird's distance from its nearest neighbor, and the amount of time that it spent at that distance, during the five minute trial. The birds spent less time at distances away from each other than near (Figure 2).

Discussion (A.M.)

The results indicate that: 1) black necked stilts forage more rapidly when they are further away from other foraging stilts, and 2) despite the incurrence of a lower foraging rate, the stilts spend most time feeding in closely packed groups.

The first result is probably due to less competition for prey at greater distances. However, by feeding closely together the stilts may benefit from a prey flushing effect (foraging birds may chase prey away from themselves but towards other birds feeding close by). Our results indicate that such a flushing effect is not an important contributing factor to feeding rate. Feeding rate cannot increase immediately with distance. Our influences were restricted to the range of nearest-neighbor distances (0.2-4.5m) within our defined feeding group.

Although the stilts are faster foragers at greater distances, the stilts spend most of their feeding time in close groups. Apparently the benefits of remaining close to one another outweigh the costs of a lower feeding rate. Such benefits may include protection from predators, which apparently explains many occurrences of flocking. Observations of the birds in the non-feeding group showed that they stay within 0.5m of each other, indicating a preference for close association when not feeding.

An assumption inherent in our observations and analyses is that whenever the bird is not in a resting (non-feeding) group it is trying to capture prey. Perhaps capture rate is not as important to the birds as we assumed. If food were not limiting there would be little or no cost involved in foraging close to other stilts.

Another assumption of our analysis that would have an impact on the validity of our conclusions is that peck rate is proportional to foraging rate.

It was difficult to determine precise distances between the stilts from a distance. Although our initial measurements were eventually grouped into larger, more general categories, inaccuracies may still have influenced our analysis.

In conclusion, there appear to be other factors that outweigh the reduction in foraging rate incurred by feeding near conspecifics. In the black necked stilts such factors may conclude a lower risk of predation as well as benefits of social interactions such as care for young and mating.

Figure 1 Effect of distance from a bird's nearest neighbor on the bird's feeding rate.

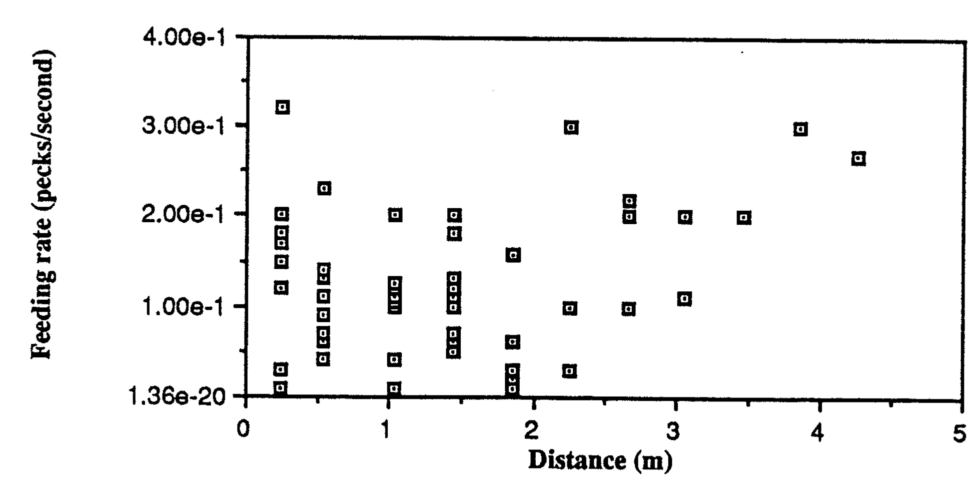

Figure 2 Time spent at various distances from a nearest neighbor (out of a possible 300 seconds).