Web orientation and prey availability in orb-weaving spiders

J. D. MANISCALCO AND M. A. NOVELLO

Abstract . We surveyed web orientation in orb-weaving spiders along a marsh just south of the Palo Verde Field Station, Costa Rica. Artificial webs (sticky traps) were deployed to determine which orientation (horizontal, parallel to the marsh, or perpendicular to the marsh) caught the most insects. Artificial webs parallel to the marsh caught the most prey. Correspondingly, natural parallel webs occurred most frequently in the transect.

Key Words: habitat selection, foraging

INTRODUCTION

Spiders are exceptional among arthropods in the protein fiber structures they use for prey capture (Shear, 1986). Orb-weavers in particular construct highly organized, circular webs (Jackman, 1997).

Choice of web site by a spider may have a profound effect on growth, survival, and reproduction. A suitable site must satisfy a spider's physiological and web-support requirements, provide sufficient prey and minimize exposure to predators. For orb weaving spiders, optimal foraging is expressed as habitat selection (choice of web site), and the orientation of the web to maximize energy intake per unit time. Janzen (1983) found an increase in abundance of insects around marshes near tropical dry forest during the dry season. We therefore hypothesized that webs oriented towards the marsh would catch the most insects, and that this orientation would dominate in a sample of naturally occurring webs.

METHODS

To test whether the orientation of orbital webs influences capture of insects, we constructed experimental "webs", from sheets of acetate (14 cm x 21.75 cm) with one side coated in Tanglefoot™. Traps were suspended 6 m from the edge of the marsh just south of the OTS Field Station at Palo Verde National Park, Costa Rica. Traps were placed in 3 orientations: "parallel" (sticky side parallel to the marsh edge), "perpendicular" (sticky side perpendicular to marsh edge), and "horizontal" (sticky side facing upwards). For each of the 3 orientations, 4 traps were placed <50cm above ground ("low" traps) and 4 at heights between 100 and 200 cm ("high" traps), for a total of 24. After 24 hours, traps were collected and the insects counted.

We assessed natural web height and orientation using an 80 m transect parallel to and 6 m from the marsh edge. The orientation and height of each orb web within 1 m of either side of the transect were recorded.

RESULTS

Orientation of experimental webs had a significant overall effect on number of insects caught (X^2=7.21, P=0.03). Parallel and perpendicular traps caught more insects than horizontal ones (parallel vs. horizontal: X^2 = 5.38, P=0.02, perpendicular vs. horizontal: X^2 =5.14, P =0.02, Fig. 1a). Of the 91 natural webs, 44 were parallel, 29 were perpendicular, and 18 were horizontal. Natural web orientation was non-random, with parallel webs occurring most frequently (X^2=11.33, P=0.004, Fig. 1b).

Over all orientations combined, low sticky traps captured more insects than high traps (X^2=3.76, P=0.052). In the high natural webs (100 cm), web orientations were not signifcantly different from random (X^2=4.55, P=0.10); there was a non-significant trend toward more perpendicular webs. The low webs had a preponderance of parallel orientations (X^2=13.67, P=0.008). Of the 91 natural webs, 25 were low (50 cm), 20 were medium (50<X 100) and 46 were high (>100cm).

DISCUSSION

As predicted, more insects were captured in parallel than in horizontal traps, consistent with movement of insects from the marsh edge toward the forest. Surprisingly, many insects were also caught in perpendicular traps, perhaps owing to the prevailing winds, which blow parallel to the marsh edge.

Our second hypothesis was also supported, as spider web orientation mimicked the distribution of insect prey caught by the

experimental webs. Overall, our findings suggest strongly that web orientation is primarily determined by prey availablity.

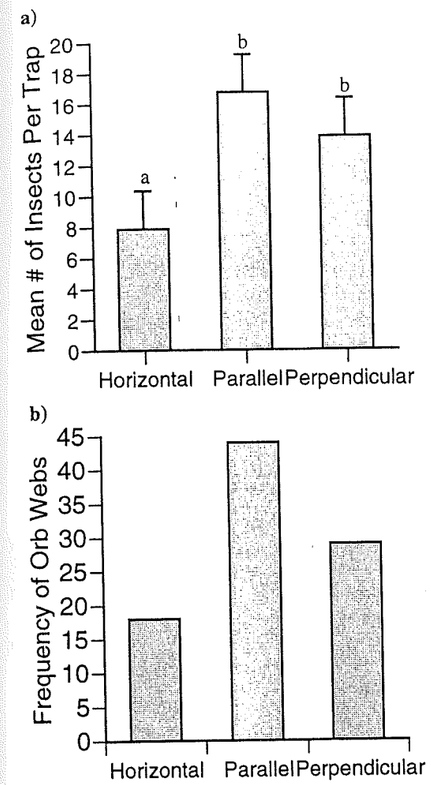

Fig. 1. a) Mean number of insects caught by artifical webs (sticky traps ca. 14 x 21 cm) in different orientations: vertical, parallel to the marsh edge; vertical, perpendicular to the marsh edge; and horizontal. Values are means over all heights < 2m, ± 1 SE. Different letters indicate significant differences (P < 0.03). b)Frequency of naturally occuring orbital webs <2 m above ground, at the three orientations.

Two alternative hypotheses could explain the non-random web orientations in nature. First, spiders may initially construct webs in random orientations, but those with parallel webs may capture more prey, leading to enhanced survival and the observed preponderance of parallel webs. The observed pattern could also devlop if spiders sample the environment to determine prey availability (Shear, 1986), by building trial webs in various orientations. Higher prey capture rates would then be experienced in parallel trial webs.

While patterns in prey availability matched natural web orientations closely, this was not the case for web heights. Natural webs tended to be higher than the traps that caught the most insects. This discrepancy may be explained by the availability of support structures, or by a greater exposure to predators nearer the ground.

LITERATURE CITED

Jackman, J. A. 1997. Texas Monthly Field Guide Series: A Field Guide to Spiders & Scorpions of Texas. Pp 70. Gulf Publishing Company: Houston, Texas.

Janzen, D. H. 1983. Chapter 11: Insects. Pp 624 *in* D. H. Janzen, ed. Costa Rican Natural History. University of Chicago Press: Chicago.

Riechert, S. E. and R. S. Gillespie. Habitat Choice and Utilization in Web-Building Spiders. Pp 31 *in* W. A. Shear, ed. Spiders: Webs, Behavior, and Evolution. Stanford University Press: Stanford, California.