THE EFFECTIVENESS OF THE NEST OF A DESERT WIDOW SPIDER, *LATRODECTUS REVIVENSIS*, IN PREDATOR DETERRENCE

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INTRODUCTION

Most nocturnally-active arthropods rest during the day in concealed and protected locations. The nests or retreats of nocturnal spiders are often in vegetation or beneath stones. The widow spider *Latrodectus revivensis* of the Negev desert of Israel (Levy and Amitai 1983), builds a conspicuous, cone-shaped nest in bushes up to 1 m high (Shulov 1948, Lubin *et al.* in prep.). The nest is attached by bridging threads to a horizontal capture platform, which in turn is attached to nearby stones or shrubs (Fig. 1). The most notable feature of the nest is the array of extraneous material, mainly arthropod carapaces, snail shells and feces, and dried plant material, placed on the outside. This material obscures the spider from view even in the early stages of nest construction when the dense silk layer of the upper portion of the cone (Fig. 1) has not yet been laid down.

There may be several functions of this layer of extraneous material, namely:

(a) to shade the spider, and its eggs and young, from the high insolation experienced in the desert in summer,

(b) to provide mechanical protection from predators by strengthening the nest,

(c) to make the nest cryptic,

(d) to obscure the spider from the gaze of predators.

We have examined elsewhere (Lubin *et al.*, in prep.) the function of the extraneous material on the nest in the regulation of temperature inside the nest. We found that this material plays a significant

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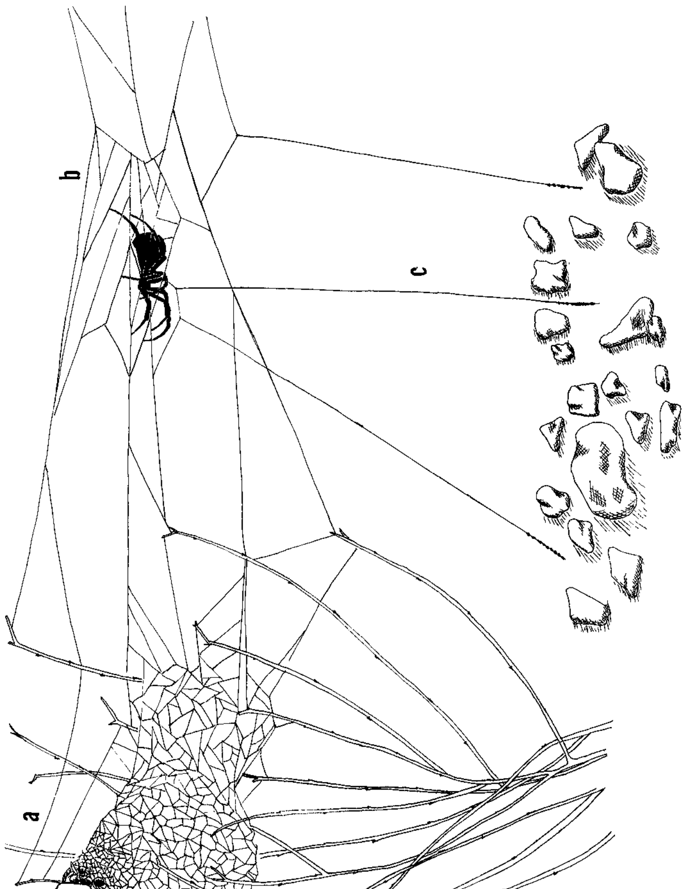

Figure 1. Web of *Latrodectus revivensis* consisting of (a) nest with dense, debris-covered upper portion and open-mesh, lower portion, (b) capture platform, and (c) vertical capture threads which are sticky near their attachment to the ground. At night the spider sits under the capture platform to monitor the sticky threads.

role in reducing the temperature of the nest, and of the spider, during the summer by shading the nest.

We then turned to the role of the nest covering in predator avoidance and deterrence. Natural history observations of the nests of *L. revivensis* indicated that the visually-orienting Great Grey Shrike, *Lanius excubitor,* was an important predator of this spider. We set out to test the ability of the Great Grey Shrike to detect and capture the spiders in nests with different amounts of extraneous material.

Methods

We captured 4 adult Great Grey Shrikes in the vicinity of Sede Boqer, Israel (30°52′N,34°57′E) and placed them individually in aviaries (4 m × 1.5 m by 2.5 m high). In addition, two juvenile shrikes were captured from a single brood and reared in captivity until fledging and then used in the experiments in the same manner as the adults. Each aviary was separated from the adjacent ones by black plastic sheeting to prevent the shrikes from learning from the behavior of their neighbours.

Bushes containing nests of widow spiders were removed from the same study area and placed on the floor of the aviaries in positions simulating those in the field. As adult *L. revivensis* were not abundant enough for repeated trials, we used large mealworms (*Tenebrio molitor* larvae) which were hung on a fine wire hook in the top of the nest cone (in the position where the spider would normally rest during the day). Immediately after placing a bush in the aviary, the observer withdrew to a position about 10 m from the aviary and recorded the subsequent behavior of the shrike for at least 20 min (or until the prey was captured). We allowed 5 min between successive trials with the same bird, during which time the shrub was removed from the aviary.

All birds were tested once initially with shrubs containing real nests of *L. revivensis.* The four adult birds were then given shrubs with artificial nests (nest-sized cones made of opaque white parachute cloth), each containing a mealworm, daily for a period of 5 days. Testing with real widow-spider nests was resumed after this initial period of training. Juveniles were not trained on artificial nests. A total of 38 presentations were made of nests with two densities of cover (about 10% and 90%).

Differences between treatments were tested with Kruskal-Wallis non-parametric analyses of variance, with the exception of the binomial data for capture success which were compared with a Wilcoxon signed-ranks test. The 95% confidence level was the significance level chosen for all tests. All means are represented ±S.E.

RESULTS

The shrike first observed the bush from its perch about 1.5 m above the floor of the aviary, then flew down to the ground beneath the bush. The bird then attempted to peer into the widow spider's nest from below, often changing position on the grond below the bush to gain a better angle. If no prey was detected, the shrike returned to its perch. Upon detecting prey in the nest, the shrike hopped up to the branches of the bush and attempted to grab the prey, either through the nest opening (n=4) or by inserting the bill through the mesh of the side of the nest cone (n=12). The prey was seized and swallowed on the spot.

The degree of cover of the nest significantly influenced capture success (Wilcoxon signed-ranks test, $Z = 3.38$, $p < 0.001$). The birds detected and captured the prey in all trials with nests with little debris cover ($n = 20$), but were successful in only one of 17 trials with densely-covered nests. Significantly more capture attempts were made (Kruskal-Wallis test, $H = 17.68$, $p < 0.001$) with densely-covered nests ($x = 4.3 \pm 0.54$) than with lightly-covered nests ($x = 1.65 \pm 0.34$). However, repeated attempts to capture prey in densely-covered nests may have reflected conditions in captivity, where alternative prey items were not available. For lightly-covered nests, the mean time to capture a prey item was 44.5 ±9.9 s from the time the shrike landed on the ground beneath the shrub (i.e. recognition + handling time). The sequence of presentation to the shrikes of nests with different amounts of cover influenced neither the number of attempts nor capture success, nor was there significant variation among the birds ($p > 0.4$ in all tests).

Hand-reared juvenile shrikes treated the widow spider nests in the same manner as the adults. It is possible that, prior to fledging, these juveniles may have observed their parents capture widow spiders. However, they would have had no experience of their own of locating and capturing spiders. The approach and attack behaviour of adult and juvenile shrikes was invariable, although the young birds appeared less adept at removing the prey from the nest once it was detected.

Discussion

Chew (1961) suggested that the predominance of hunting spiders (particularly Thomisidae and Salticidae) over web-spinning spiders in deserts was probably due to the sparseness of the vegetation, which provides few sites for webs and leaves the latter group exposed to predators. Many desert-dwelling web-builders conceal themselves in vegetation, in burrows or in nests (Cloudsley-Thompson 1983). While most widow spiders (genus *Latrodectus*) construct retreats under stones or in burrows, two desert-inhabiting species occurring in the Middle East, *L. revivensis* and *L. pallidus,* place their nests in exposed locations near the tops of scattered bushes (Shulov 1948, Szlep 1965). These spiders, nonetheless, are hidden from the gaze of visually-orienting predators by the debris-covered walls of their nests. We have suggested that desert widow spiders build nests in bushes to allow cooling by convection, where wind speeds increase with height above ground (Lubin *et al.* in prep.). However, by doing so, the spiders expose themselves to visually-orienting predators. The results of these experiments support the hypothesis that the debris cover of *L. revivensis* nests has an anti-predator function, providing both concealment and mechanical protection against a visually-orienting diurnal predator, the Great Grey Shrike.

Many spiders are known to use extraneous material in their webs or nests. Prey exoskeletons and plant material are incorporated in stabilimenta of some orb-web spiders and appear to conceal the spider at the hub or at its resting place near the web (Hansell 1984 and references therein). Prey remains are incorporated into the nest wall in other *Latrodectus* species, including those with concealed retreats (e.g. *L. tredecimguttatus,* pers. obs.). The function of the extraneous material in concealed nests is not known. In *L. revivensis* (and possibly *L. pallidus*), the role of concealment and protection may have evolved secondarily with the adoption of above-ground nest-construction.

The debris layer on *L. revivensis* webs increases in length and thickness, both with the duration of nest occupation (which ranges from a few days to more than three months) and with increasing spider size (Lubin *et al.*, in prep.). Widow spiders in newly-constructed nests are most susceptible to such predators. Indeed, of 40 widow spiders at a field site near Sede Boqer that relocated their webs and constructed new nests, 27.5% disappeared within 10 days. Another period when widow spiders may be very vulnerable to predation is in the hot parts of the day in the summer months when they leave the dense, upper portion of the nest and sit in the open, lower part of the nest. This behaviour occurs in order for the spider to cool convectively. The upper part of the nest is impervious to wind and is significantly hotter than the lower, open part of the nest entrance, whenever there is direct insolation (Lubin *et al.* in prep.). The nests of widow spiders have significantly larger areas covered by debris in summer than in winter (Lubin *et al.* in prep.). We hypothesize that this increase in debris covering of the nest is related to the increased risk of predation from visually-orienting predators during behavioral thermoregulation.

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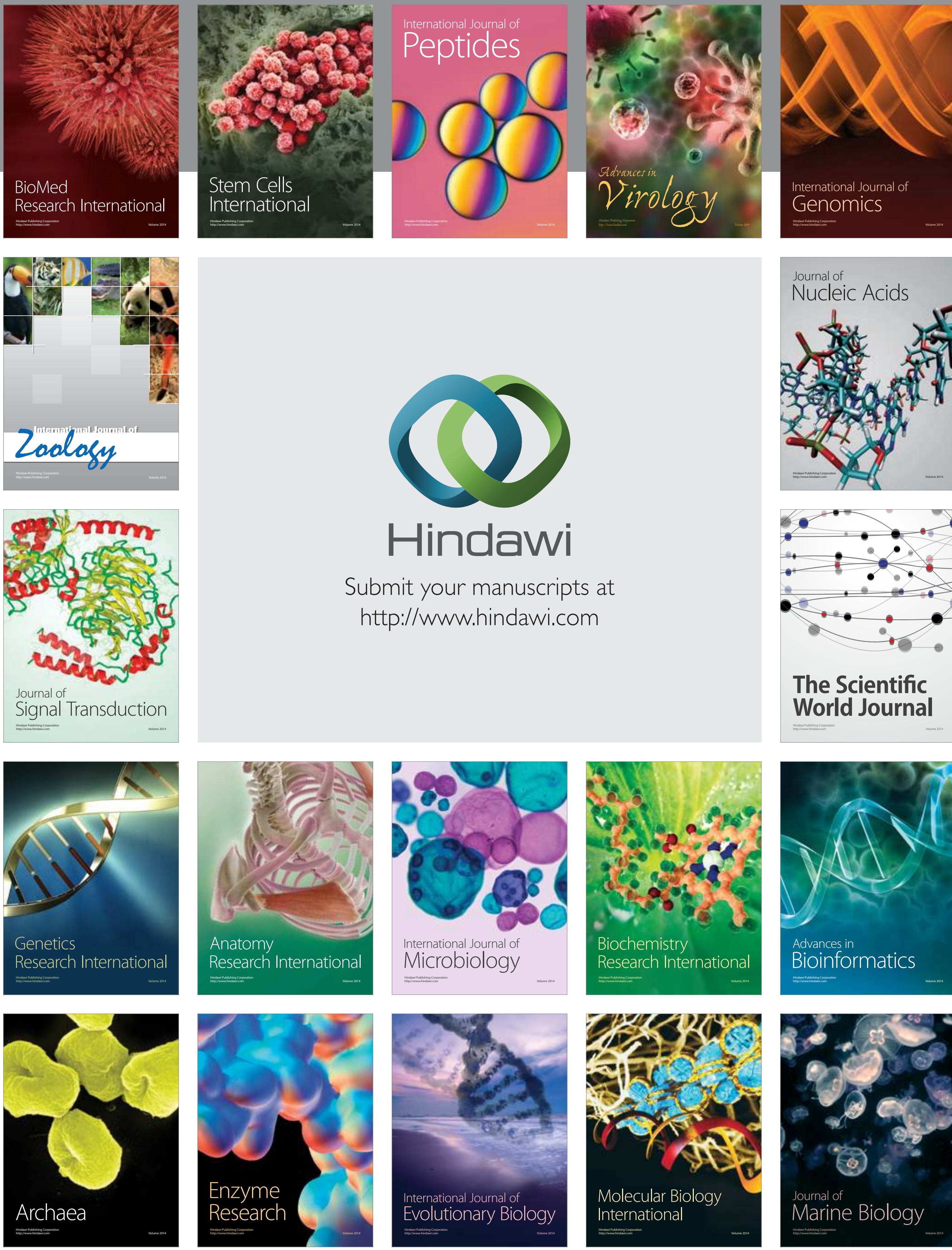
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