

THE DISCOVERY OF *APONOMMA ELAPHENSIS* LARVAE
(ACARINA: IXODIDAE) ON
ELAPHE SUBOCULARIS (REPTILIA: COLUBRIDAE)

In 1952 I found ticks parasitizing the Big Bend (Texas) population of *Elaphe subocularis*. Price (1958) later described the tick as *Aponomma elaphensis* which established the first record of the genus occurring naturally on the North American continent. Only one other new world species of the genus, *A. quadricavum* Schulze from Cuba and Haiti, is presently recognized (Anderson et al., 1981). The known species of *Aponomma* are most often associated with reptiles but mammals, both wild and domesticated, serve as hosts for some species; even birds are occasionally parasitized. Larvae of one species were found on the blow-fly, *Calliphora erythrocephala*, in India but this may serve as a dispersal method for the tick rather than a case of parasitism (Nagar and Raizada, 1977). Some species of *Aponomma* are host specific whereas others may parasitize a variety of hosts (Degenhardt and Degenhardt, 1965).

Until now the larvae of *A. elaphensis* have been unknown. Recently I examined a series of fourteen *Elaphe subocularis* (UNM 34,224-34, 237) for *Aponomma*. These snakes were collected by Robert P. Reynolds during the summers of 1975, 1976, and 1977 along Highway 16 from Villa Aldama to El Pastor, Chihuahua, Mexico. All but three of the specimens had ticks attached, six of these had larvae, and one had over sixty larvae remaining on the snake. Larvae are easily determined due to the presence of six legs versus the eight legs found on nymphs and adults. A diagnosis of the adults and nymph with the first description of the larva will be published elsewhere. The six snakes supporting larvae were collected between July 22 and August 22 suggesting a summer egg-laying time for *A. elaphensis* since eggs of other species of *Aponomma* have taken 2 months to hatch at room temperatures under laboratory conditions (Anderson et al., 1981).

The discovery of larvae on *E. subocularis* is significant in that we now know that all stages of the *Aponomma elaphensis* life cycle can be associated with a single host species. I would like to thank Dr. Thomas H. Fritts and an unknown reviewer for their useful comments on this report.

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TRUNK VS. GROUND FEEDING IN CACTUS WRENS
(*CAMPYLORHYNCHUS BRUNNEICAPILLUS*, TROGLODYTIDAE)

The cactus wren (*Campylorhynchus brunneicapillus*) is a common bird throughout the hot deserts of North America, often found in vegetation characterized by the presence of prominent succulent species. Most accounts of this species' foraging behavior describe the cactus wren as a versatile feeder that forages on the ground and in a variety of plants (Raitt and Maze, 1968; Ricklefs and Hainsworth, 1968). While conducting a more comprehensive study of desert shrubland bird communities, I observed cactus wrens in a high elevation desert community in California foraging primarily on the trunks of Joshua tree (*Yucca brevifolia*), spending little time on the ground. In contrast, cactus wrens in several low elevation shrublands foraged primarily on the ground. The goal of this study was to examine the relationship between the trunk and ground foraging habits of cactus wrens and vegetation structure.

TABLE 1—Vegetation cover of the three study areas (expressed as percentage of the ground covered).

Study Area	Total Plant Cover (%)	Total Herbaceous Cover (%)
Queen Valley	29.0	14.1
Cholla Garden	17.0	4.3
Organ Pipe	28.2	0.3

The principal study site, Queen Valley, at 1341 m elevation in Joshua Tree National Monument, California, was a three-layered community with a tall, dense herbaceous layer dominated by *Hilaria rigida*, a shrub layer dominated by *Coleogyne ramosissima*, *Hymenoclea salsola*, *Ephedra nevadensis*, and scattered taller Joshua trees. The feeding behavior of cactus wrens in two other sites was observed for comparison. Cholla Garden, at 658 m elevation in Joshua Tree National Monument, contained a nearly pure stand of *Opuntia bigelovii*. Organ Pipe, at 511 m elevation in Organ Pipe Cactus National Monument, Arizona, was a diverse community that consisted of a shrub layer dominated by *Larrea tridentata* and *Franseria deltoidea*, interspersed with small trees and stem succulents, including *Cercidium microphyllum* and *Carnegiea gigantea*.

Plant cover for each area was determined by the line intercept method (Canfield, 1941). A 20 m transect was randomly oriented in each of 40 0.1 km segments along the long axis of a 4.0 by 0.25 km study plot at each site. Cover data were recorded by species for all plants intersecting the transect lines. Raw cover values for each species were converted to percentage of ground covered.

I quantified feeding activities of cactus wrens inhabiting each study area during the breeding season of 1980 by using a tape recorder and stop watch. I collected data in 30- to 45-second observation periods, making notations on the height and species of the foraging substrate, substrate changes, frequency and mode of movement, and distance moved. Consecutive observation segments on the same individual were avoided. All wrens were approached cautiously and observed from no closer than 20 m in order to reduce behavioral modification. At least 40 observations (≥ 1300 seconds) per site were recorded. I used Tukey multiple comparison tests for differences in means (Zar, 1984) to determine whether significant differences occurred in cactus wren feeding behavior between Queen Valley and the other two sites. I used chi-square analysis (Walker and Lev, 1953) to ascertain whether use of the plant species for foraging in Queen Valley was random or selective, with expected values generated by multiplying the relative cover of plant species (i.e., the proportion of total woody plant cover) by the total number of observations. The significance level for all statistical tests was $p < 0.01$.

To assess the possibility that the sample of cactus wren foraging bouts in Queen Valley was biased because of reduced visibility of the ground surface, I made five longer, continuous observations of wren foraging behavior (totaling 52 minutes) in that site. I observed wrens for several successive changes of foraging substrates in the hope that ground foraging would be detected and included if it occurred.

In addition, I searched each study plot twice in 1980 (and again in 1983 for Organ Pipe) for cactus wren nests and recorded the location of each by plant species.

Differences in the areal extent (Table 1) and height of herbaceous cover existed between Queen Valley and the other two sites. Herbaceous cover in Queen Valley was more than three times as extensive as in Cholla Garden, the site with the second highest herbaceous cover value. *Hilaria*

TABLE 2—Differences in cactus wren feeding behavior among the three study areas (expressed as means \pm standard deviations).

Aspect of Feeding Behavior	Queen Valley (n=56)	Cholla Garden (n=42)	Organ Pipe (n=52)
Percentage of foraging time on ground	1.9 \pm 2.1	85.4 \pm 5.3	95.6 \pm 3.7
Percentage of foraging time in flight	9.8 \pm 2.5	1.5 \pm 2.2	0.8 \pm 1.4
Hops/minute	26.7 \pm 4.0	30.2 \pm 4.2	31.9 \pm 4.2
Flights/minute	3.4 \pm 1.2	0.5 \pm 1.1	0.3 \pm 0.8
Distance/move (m)	1.1 \pm 1.2	0.1 \pm 0.5	0.2 \pm 0.4
Distance moved/minute (m)	21.7 \pm 3.7	4.8 \pm 2.7	6.1 \pm 2.0

TABLE 3—Results of Tukey cactu

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*Significant to $p < 0.01$.

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I thank A. J. Parker, R.) comments and statistical advi

TABLE 3—Results of Tukey multiple comparison tests for differences in means of five aspects of cactus wren feeding behavior in the three study areas.

Aspect of Feeding Behavior	Queen Valley- Organ Pipe	Queen Valley- Cholla Garden	Organ Pipe- Cholla Garden
Percentage of foraging time on ground	32.41*	27.18*	3.27
Percentage of foraging time in flight	16.20*	14.07*	1.28
Number of flights/minute	19.56*	17.29*	1.12
Distance/move	10.22*	10.55*	0.33
Distance moved/minute	14.38*	14.68*	1.15

*Significant to $p < 0.01$.

rigida, which accounted for 81.1% of the herbaceous cover in Queen Valley, is a tussock grass typically attaining several decimeters height, whereas *Euphorbia polycarpa*, which accounted for 94.4% of the herbaceous cover in Cholla Garden, is a small, spindly herb that only reaches a height of several centimeters. Paralleling these differences in extent of ground cover, the time that cactus wrens spent foraging on the ground was significantly greater in Organ Pipe and Cholla Garden (> 85%) than in Queen Valley (< 2%) (Tables 2 and 3).

Wrens in Queen Valley foraged on the trunks of Joshua tree 86.3% of their total foraging time, although Joshua tree accounted for only 4.8% of the total plant cover at this site. Results of the chi-square analysis showed that use of the plants for foraging by wrens in Queen Valley was significantly different from random ($\chi^2 = 89.3$). When wrens foraged on Joshua tree, they probed the dried, recumbent leaf blades that form the outer trunk with their bills and occasionally sallied to catch insects flushed from under the desiccated leaves. Wrens spent 84.8% of the foraging time at heights between 2.0 m and 3.5 m. During the longer observation periods, cactus wrens spent 77% of the foraging time on Joshua tree trunks. They spent the remaining time foraging on the ground (6%) or flying between foraging substrates (17%).

The contrast in foraging substrates between wrens of Queen Valley and the other two study areas was accompanied by differences in mode of locomotion during foraging. Wrens in Queen Valley made significantly more flights per minute, spent a greater percentage of time in flight, and covered a greater distance per move and per minute than wrens in Organ Pipe and Cholla Garden (Tables 2 and 3). No significant differences were apparent between wrens in Organ Pipe and Cholla Garden in these aspects of their foraging behavior.

The reduced frequency of ground foraging by wrens in Queen Valley can be interpreted as a response to differences in the height and extent of the herbaceous cover between Queen Valley and the other sites. In Organ Pipe and Cholla Garden, where there was no extensive cover of tall herbaceous plants, wrens spent most of their foraging time running and hopping on the ground. In Queen Valley, cactus wrens foraged most often on Joshua tree, spending a long period of time on each substrate before flying to the next. The extensive cover of tall grass may impede rapid ground foraging movements and sufficiently increase energetic costs of locating food items to induce a shift to trunk foraging, which may be reinforced by locally abundant food resources along Joshua tree trunks. The pattern of reduced ground foraging in Queen Valley can be linked more directly to such differences than to competitive pressures. In Texas, Roth (1979) reported a similar shift in foraging location from ground to shrubs and air by mockingbirds (*Mimus polyglottos*) in habitats with a thick herbaceous cover.

If habitat structure is the chief cause of trunk feeding among wrens in Queen Valley, why do cactus wrens occupy a habitat where extensive herbaceous cover limits ground feeding? The cactus wren is a generalized feeder but a specialized nester that shows a strong preference for stem and leaf succulents as nest sites (Anderson and Anderson, 1973). Indeed, all of the 62 cactus wren nests observed in the three study sites (47 in Organ Pipe, 10 in Cholla Garden, and 5 in Joshua Tree) were located in leaf or stem succulents. For specialized nesters the availability of suitable nesting materials or substrates may serve as the primary criterion for habitat occupation (Hildén, 1965). In Queen Valley the presence of leaf succulents that provide preferred nesting substrates may act as the principal stimulus that triggers occupation of the Joshua tree community by wrens. Their feeding behavior is sufficiently flexible that they can adapt to a habitat with a dense ground cover by adopting the trunk feeding habit.

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MICROARTHROPODS AND NEMATODES
IN KANGAROO RAT BURROWS

Kangaroo rats are primarily grainivorous, and many of the large species store substantial quantities of seeds in underground caches. The caches of *Dipodomys spectabilis* have been found to house at least 23 species of fungi under environmental conditions (Kay and Whitford, 1978) which can promote mold growth and the production of beneficial or detrimental byproducts (Reichman et al., 1986). In laboratory experiments, the rodents prefer slightly moldy seeds to non-moldy and very moldy seeds (Rebar and Reichman, 1983; Reichman and Rebar, 1985), and have been shown to move seeds to differing humidities based on their levels of moldiness (Reichman et al., in press).

Caches of seeds and fungi also attract storage product pests such as acarid mites (Astigmata). The microbes growing on the seeds can provide a potential food resource for many species of microarthropods and nematodes. It is possible that the kangaroo rats have evolved behaviors to protect their seeds and the molds from these competing organisms. We indirectly tested this

TABLE 1—Microarthropods and nematodes from active and empty kangaroo rat burrows.

Invertebrate Group	Trophic Status ¹	Mean Number per 100 cm ³ (std. error)	
		Active Burrows (n=13)	Empty Burrows (n=10)
Prostigmata (total)	F/P	135.2 (35.8)	327.9 (141.0)
Scutacaridae	F	78.2 (27.4)	154.0 (26.3)
Astigmata	F	17.8 (12.9)	41.2 (31.9)
Oribatida	F	99.5 (68.6)	28.5 (16.2)
Mesostigmata	P	127.5 (30.1)	35.6 (6.8)
Collembola	F	121.7 (52.5)	70.6 (22.8)
Misc. arthropods ²	P	15.6 (4.7)	6.0 (1.1)
Total Arthropods		517.3 (74.9)	509.8 (181.3)
Rhabditoid nematodes	B	9389 (4235)	9700 (2446)
Aphelenchoid nematodes	F	3783 (1192)	6300 (1791)
Total Nematodes ³		13172 (5195)	16000 (3860)

¹F = fungivore; P = predator; B = bacterivore.

²Includes mostly pseudoscorpions, pselaphid beetles and staphilinid beetles.

³Sample size = 11 for active burrows, 4 for empty burrows.

TABLE 2—Density

	Sample Size
Caches	7
Nests	7
Debris	9

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