Ectoparasites in the endangered Utila spiny-tailed iguana (*Ctenosaura bakeri*)

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Ectoparasites of adult spiny-tailed iguanas (*Ctenosaura bakeri*) from Isla de Utila, Honduras, an endemic lizard listed as Critically Endangered under IUCN criteria, were studied for the first time. Three ectoparasitic species were identified: *Amblyomma dissimile*, *Ornithodorus talaje*, and *Hirstiella boneti*; the latter two are reported from Honduras for the first time. Of 125 iguanas examined, 60% were infested: *A. dissimile* occurred on 2.4%, *O. talaje* (larvae only) on 43.2% and *H. boneti* on 40% of individuals. Preferred attachment sites of *H. boneti* were the ear openings (18.4%) and the limbs (16%), while the nidicolous *O. talaje* larvae occurred only in the nostrils. Male iguanas were significantly more often infested than females when considering all three parasites (77.2% and 45.6%, respectively), *O. talaje* (61.4% and 28%, respectively) and *H. boneti* (56.1% and 26.5%, respectively); infestation prevalence of both species increased significantly with body size in males. Heavily infested animals or visual evidence for direct pathogenic effects in *C. bakeri* were not observed, suggesting that ectoparasites currently do not pose a serious risk to this endangered iguana.

Key words: Ctenosaura bakeri, ectoparasites, Honduras, Iguanidae, parasite-reptile association, prevalence

INTRODUCTION

Ectoparasites are widespread in lizards and can affect their natural populations in a variety of ways, resulting in lower growth rates (Curtis & Baird, 2008), skin lesions (Goldberg & Bursey, 1991) or increased offspring mortality (Sorci & Clobert, 1995). Ectoparasites can also transmit pathogens such as *Schellackia occidentalis* (Bonorris & Ball, 1955) and *Plasmodium mexicanum* (Schall & Smith, 2006), both reducing red blood cell volumes and haemoglobin values. Parasites and parasitic diseases therefore may pose a major threat to endangered species. However, the importance of parasites remains a relatively neglected topic in wildlife biology, and relevant data are often not available (McCallum & Dobson, 1995).

Ectoparasites of the highly endangered Utila spiny-tailed iguana (*Ctenosaura bakeri*) have not previously been documented. This lizard is endemic to the small Isla de Utila, Honduras, where it exclusively inhabits three isolated mangrove areas of about 10 km^2 total size (Gutsche & Streich, 2009). Due to its peculiar habitat specialization, limited range, fragmented habitat, hunting pressure and habitat loss, *C. bakeri* is categorized as Critically Endangered in the IUCN Red List of Threatened Species (Pasachnik et al., 2010). Without management, a significant decline of the *C. bakeri* population within the next 20 years has been predicted (Gutsche & Streich, 2009). Ammermann (1999) investigated the general health status, parasites and blood parameters of wild *C. bakeri*. He found evidence of amoeba, hemogregarines and reptilian paramyxovirus, but did not report any ectoparasites. Accordingly, this is still an unknown factor in the ecology of *C. bakeri*.

The purpose of this study was to identify the ectoparasitic fauna, their attachment sites, and their infestation prevalence in male and female *C. bakeri*. Additionally, we searched for visual signs of parasitoses. This information will provide data for understanding possible risks facing this threatened species for further conservation activities.

MATERIALS AND METHODS

Isla de Utila is located about 30 km off the Caribbean coast of Honduras (16°6′ N, 86°56′ W). This coralline island is largely flat with a hilly landscape in the eastern region, with Pumpkin Hill (74 m) and Stuart Hill (51 m) as its highest points. Semi-evergreen tradewind forest, beach vegetation and extensive mangrove and marsh areas are the major habitat types. The climate is tropical with distinct rainy (August–February) and dry seasons (March–July). Average annual precipitation during the study period was 2.675 mm, with a peak in autumn (Gutsche & Streich 2009).

The study was conducted in three different mangrove areas (Blue Bayou, Big Bight Pond and Iron Bound), each with a study site of 1 ha in size. The mangrove forest consisted of three tree species (*Avicennia germinans*,

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Laguncularia racemosa and *Rhizophora mangle*) and associated plants (e.g. *Batis maritima*, *Brassavola nodosa*, *Tillandsia* sp.). The mangrove areas had no open contact to the sea, but were influenced by tide and periodically flooded. Distances between the three sites ranged from 2.3 to 2.7 km, distances to the town East Harbour (Utila Town) ranged from 1.0 to 2.2 km.

Parasites were collected during a mark-recapture study on adult *C. bakeri* (snout-vent length [SVL] 150–315 mm). A total of 125 iguanas (57♂, 68♀) were captured between 1 August 1999 and 14 June 2000; 67 animals (31♂, 36♀) were captured in the rainy season, and 58 (26♂, 32♀) in the dry season. Iguanas were collected during daytime with a noosing pole, and processed with the aid of a field assistant at the site of capture. The SVL was measured to the nearest 1 mm with a steel tape measure. All body parts of the lizards were visually examined for ectoparasites using a hand lens (10x magnification) and a small flashlight. The individual infestation status (non-infested/infested with one or more ectoparasites), and the attachment sites of ectoparasites on the host animals were recorded. We also searched for signs of parasitoses (skin lesions, inflammation or bad physical condition). Samples of all ectoparasites from various attachment sites were collected using tweezers, preparation needles or a small, flexible plastic scoop. To reduce stress to the lizards, the entire procedure was limited to ca. 10–15 min; after processing, all lizards were released at the site of capture.

Removed ectoparasites were stored in labelled vials containing a mixture of 70% ethanol and 5% glycerin until clearance with lactic acid and mounting on microscope glass slides in Canada balsam. They were later visually examined with a fluorescence microscope (Zeiss Imager M1) using identification keys in Barnard & Durdon (2000), Montgomery (1966), Wenzel & Tipton (1966) and Hoffmann (1990). Voucher specimens of the ectoparasites were deposited in the arachnid collection of the Museum für Naturkunde Berlin, Germany (ZMB) under the accession numbers ZMB 48369–48379.

Data were analyzed using SPSS 16 software for Windows (SPSS, Chicago, IL). The *U*-test was applied to identify differences between SVL of different gender or different infestation prevalence, respectively. Stepwise binary logistic regression served to test for the potential association of the infestation prevalence with SVL, gender and study site in multiple variable approaches.

RESULTS

All ectoparasites recovered from adult *C. bakeri* were acarines, belonging to three different species: *Amblyomma dissimile* (Acari: Ixodidae), *Ornithodorus talaje* (Acari: Argasidae), and *Hirstiella boneti* (Acari: Pterygosomatidae). Of 125 iguanas captured, 60% were infested by ectoparasites. Infestation with a single species occurred in 35.2% (19♂, 25♀), 24% exhibited double infestation (24♂, 6♀), and 0.8% (1 male) presented triple infestation. Ectoparasitic infestations were more frequent in males than in females: 77.2% of all males (*n*=57), and 45.6% of all females (*n*=68) were infested. Of all infested males (*n*=44), 56.8% were found in the rainy season, and 43.2% in the dry season, while the number of infested females (*n*=31) was similar in both seasons (51.6% in the rainy season vs. 48.4% in the dry season). We never observed heavily infested animals, and none of the iguanas showed any evidence of ectoparasitic diseases or bad physical condition.

Only three individuals of the hard tick *A. dissimile* were found on three iguanas at the Iron Bound study site, representing 2.4% of all adult iguanas caught (Table 1). Therefore, no statistical analyses were conducted. Of these three infested lizards, a male individual (SVL 280 mm) had an adult male tick attached on the right ear opening, a female iguana (SVL 200 mm) had a tick larva in the fold of the cloaca, and a second female (SVL 210 mm) had a tick nymph at the scales of the outer part of the right hind leg.

Of the soft tick *O. talaje*, only larval stages were found. They occurred exclusively in the nostrils of the iguanas. Infestation ranged between one and seven larvae per host. A total of 54 (43.2%) adult iguanas from all three study sites were infested with *O. talaje*. The infestation prevalence varied considerably between sites and gender with male-biased ratios at all three sites (Table 1): 61.4% of all males and 28% of all females were infested.

Different stages (larvae, nymphs, males and females) of the mite *H. boneti* were found on adult iguanas. A total of 50 iguanas (40%) of all three study sites were infested with *H. boneti*. Again, the infestation prevalence varied with site and gender, with male-biased ratios (Table 1): 56.1% of all males and 26.5% of all females were infested. *Hirstiella boneti* occurred singly or in small groups. Observed numbers of mites per host ranged from one to ca. 40 individuals. The mites were preferentially

Table 1. Number of adult *Ctenosaura bakeri* parasitized by ectoparasites.

Study site	No. *C. bakeri* examined	No. parasitized by *A. dissimile*	No. parasitized by *O. talaje*	No. parasitized by *H. boneti*
Blue Bayou	♂ 11	0	5	9
	♀ 9	0	2	1
Big Bight Pond	♂ 20	0	12	11
	♀ 18	0	3	6
Iron Bound	♂ 26	1	18	12
	♀ 41	2	14	11

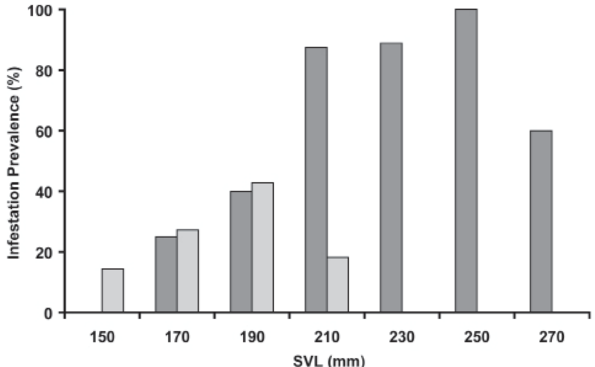

Fig. 1. Relationship between snout-vent lengths (SVL) in adult *Ctenosaura bakeri*, and infestation prevalence for *Ornithodorus talaje* (dark grey bars for males, light grey bars for females).

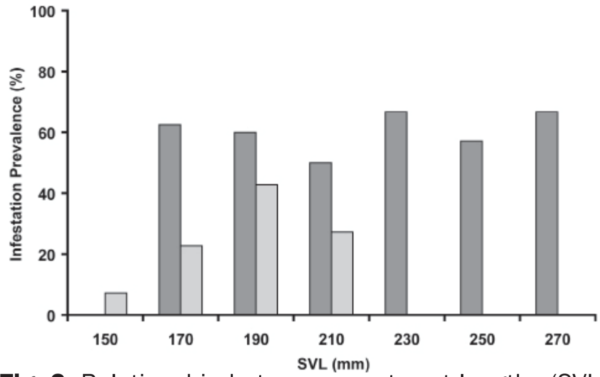

Fig. 2. Relationship between snout-vent lengths (SVL) in adult *Ctenosaura bakeri*, and infestation prevalence for *Hirstiella boneti* (dark grey bars for males, light grey bars for females).

located around the ear opening of the hosts (18.4% of all iguanas), in the skin folds of the limbs (16%), between the dorsalia (3.2%), on the flanks (2.4%) and on the heads and the lateral parts of the tails (both 1.6%).

A highly significant difference occurred between male and female iguanas with respect to their SVL (*U*-test, $p<0.001$, $n=125$). Accordingly, gender and SVL should not be used simultaneously in a multiple logistic regression approach with infestation prevalence as the dependent variable. We therefore set up separate stepwise logistic regression approaches for the infestation prevalence (infested/non-infested) as this depends from the study site combined with SVL or gender, respectively, as independent variables.

The regression model showed no association between infestation prevalence and study site, but indicated potential associations in *O. talaje* for SVL ($p<0.001$, $n=125$) and gender ($p<0.001$, $n=125$), and also in *H. boneti* for SVL ($p<0.001$, $n=125$) and gender ($p=0.001$, $n=125$). For *O. talaje*, the SVL of non-infested individuals was significantly smaller than for the infested animals in male (*U*-test, $p=0.006$, $n=57$), but not in female iguanas (*U*-test, $p=0.371$, $n=68$) (Fig. 1). The same tendency was observed for *H. boneti* (males: $p=0.059$, $n=57$; females: $p=0.076$, $n=68$; Fig. 2).

DISCUSSION

We found 60% of all *C. bakeri* infested by ticks and/or mites. In contrast, Ammermann (1999) examined 42 specimens in March/April, and reported no ectoparasites. The reasons for this difference remain unclear. Like Ammermann (1999), we found no visual signs of direct pathogenic effects due to ectoparasites. All iguana-parasite associations reported herein represent new host-parasite records.

A low level of infestation of *C. bakeri* with *A. dissimile* was recorded. This tick is a widespread ectoparasite of Neotropical reptiles (Guglielmone & Nava, 2010). For example, Rivas (2008) found 95% of 20 *C. similis* (mean 56 ticks/host) infested in Costa Rica, Durden & Knapp (2005) reported mean numbers of 36.6 ticks/host on *Cyclura c. cyclura* from the Bahamas, and Dunn (1923) found 84% of the lizards on the Isthmus of Panama to be infested. As support for the low infestation, Gutsche (unpublished data) found no *A. dissimile* on further 347 *C. bakeri* captured during behavioural studies, despite heavy tick loads on other reptiles outside the mangrove area. The low presence of *A. dissimile* on *C. bakeri* suggests that it is an accidental parasite due to the habitat conditions in mangroves.

Ornithodoros talaje has been collected from several reptiles across the Neotropical region, and we present the first record of this species from Honduras (Nava et al., 2007). These ticks occur mainly on burrow-inhabiting animals (e.g. rats, bats, rodents, snakes), and are sensitive to fluctuations in temperature and humidity (Dunn, 1933). Accordingly, *C. bakeri* and *O. talaje* share the same ecological niche since the iguana's shelter and sleep at night in tree hollows. Adult *Ornithodoros* ticks feed mainly at night and drop off quickly, which might explain their absence on iguanas during the day. Other potential burrow-inhabiting hosts were rare in the mangrove (bats and opossums, *Didelphis virginiana*), while *C. bakeri* occurs in estimated densities of 35–114 adults/ha (Gutsche & Streich, 2009).

The mite *H. boneti* has been reported so far only from two species of spiny-tailed iguanas from Mexico, *C. acanthura* (Cunliffe, 1952) and *C. pectinata* (Montgomery, 1966). Accordingly, *C. bakeri* can be added as the third *Ctenosaura* species known to be parasitized by this mite. This is also the first collection of *H. boneti* in Honduras.

The attachment sites of the ectoparasites in this study were very specific, especially for the larval *O. talaje*. Besides possible effects like competition, grooming, feeding and mating success of parasites (Chilton et al., 1992) or different scale morphology (Werman, 1983), we also suspect mechanical and ecological reasons. The arboreal iguanas wedge themselves in the narrow tree hollows by inflating their abdomen, and when moving through the habitat they climb up or slip down the rough tree trunks. Such behaviour might result in abrasive contact with the substrate and therefore hamper exposed attachment of parasites. In contrast to the adults, *Ornithodoros* larvae usually remain attached for several days on the host. The iguanas often bask in the sun for hours, and their skin temperature can reach about 45 °C

(Gutsche, unpublished data). Under these conditions, iguana nostrils certainly offer shelter, lower temperature and adequate humidity for the survival of the *O. talaje* larvae.

Males were more often infested with ectoparasites than females, and infestation prevalence increased significantly with body size in males perhaps because of testosterone and activity ranges. High testosterone levels in male lizards can reduce their immune response and therefore increase their susceptibility to ectoparasitic infestation (e.g., Salvador et al., 1996; Klukowski & Nelson, 2001). This might be true also for *C. bakeri*, since infestation and prevalences differed by gender at all three sites and in both seasons. Adult male *C. bakeri* are significantly more active, and have larger ranges than females (Gutsche & Streich, 2009). They come into contact with more animals, places and questing parasites while defending a territory and mating with several females, and might encounter more ectoparasites during movements. Differences in the seasonal distribution of the parasites could reflect ecological effects.

It is not known whether the ectoparasites reported herein transmit pathogens to their hosts. Ball et al. (1969) reported laboratory transmission of the hemogregarine *Hepatozoon fusifex* to *Boa constrictor* by *A. dissimile*, and also *Hirstiella* species can transmit hemogregarines causing blood infections in lizards (Lewis & Wagner, 1964). Given the moderate infestation and the lack of visual signs of parasitoses, we suggest that ectoparasites currently do not pose a serious risk and conservation threat to this highly endangered iguana.

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