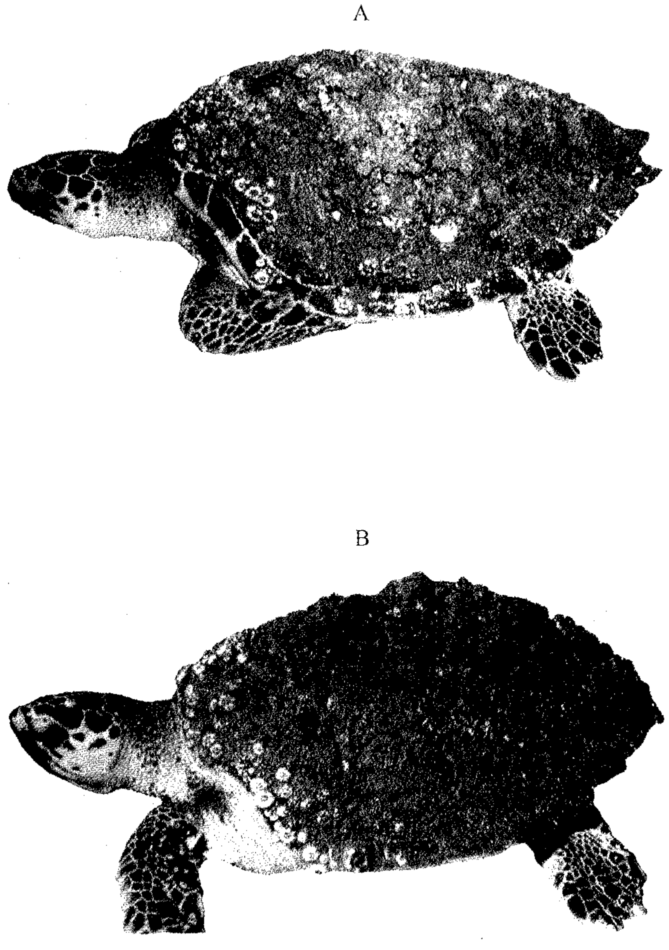

FIG. 2. Immature hybrid hawksbill-loggerhead turtle at first capture (A) and after 711 days (B), illustrating extensive epibiont growth.

and inhabited a habitat more typical of a loggerhead than hawksbill.

Acknowledgments.—We thank Steven A. Karl and Tonia Schwartz for providing genetic analysis and interpretation expertise, and Anne Meylan for suggesting that this turtle might be a hybrid. We also thank Brian W. Bowen for providing comments on this manuscript.

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Herpetological Review, 2003, 34(4), 325–327.

Observations of Mating Behavior and Reproduction in the Scincid *Carlia jarnoldae*

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We observed the mating behavior of *Carlia jarnoldae* during austral summer (January–March 1999) in Townsville, Queensland, Australia (19°19'S, 146°45'E). *Carlia jarnoldae* are relatively small (mean snout–vent length 40 mm), terrestrial, diurnal lizards (Cogger 2000). Adults are sexually dimorphic: males are heavier (2.4 g vs. 1.9 g), but not longer (adult males average 44 mm SVL, 68 mm tail length; females average 43 mm SVL, 64 mm tail length), and males are more colorful than are females (Cogger 2000). Breeding males have an orange-brown dorsum with 4–6 narrow black stripes, a black dorsolateral field scattered with small blue spots, and a reddish-orange lateral stripe. The labial scales and throat of males are pale greenish-blue. Females are brown above with scattered black and white flecks tending to form longitudinal lines, and a bright white lateral stripe bordered above and below by black stripes.

We observed 16 social interactions in which a single adult female was placed into a 1000 L (200 x 100 x 50 cm) oval, semi-natural outdoor enclosure with an adult male. We also made observations of ten individuals in nature. Observations were conducted from behind a freestanding hessian blind. Four copulations were observed in the experimental enclosures (one of these took place under a shelter and could not be observed) and two in the wild.

Courtship.—Males tongue-flicked females during courtship. This behavior occurs in other lizards and suggests an important role of chemical cues in sexual identification and stimulation (Carpenter and Ferguson 1977; Mason 1992; Perrill 1980). Courtship was observed in seven of the social interactions conducted in the enclosures, but resulted only once in copulation.

A courting male would often pursue or approach a female (also while moving with a slow, jerky motion, and tongue flicking), and if the female showed no interest, the male would run to the top of one of the shelters, usually in the sun, and display their lateral coloration by laterally presenting and dorsoventrally compressing their bodies, tilting to the side towards the female. Male throat coloration was displayed by tilting their heads to expose their gular coloration in the direction of the female, before again approaching the female. Copulations not preceded by courtship behavior were initiated shortly after the female was encountered. In cases in which the females did not appear receptive, they would flee from males and hide under shelters or leaves. The male would then search for the female (either simply approaching the female, approaching the female in a slow, jerky motion, or approaching the female while tongue flicking).

Copulation.—Once he located the female, the male initiated copulation. The female often struggled at the onset of these copulations, but became motionless after ~1 min. In the single case that copulation followed courtship, the female allowed the male to approach, initiate a flank bite, and copulate without struggling. When courtship displays did not result in copulation, it was usually because of rejection by the female (i.e., she would flee to a shelter and hide). The copulatory position was similar in all cases, and resembled that described for other skinks (*Carlia* [*Leiolopisma*] *rhomboidalis*, Wilhoft 1963a; *Carlia rostralis*, Whittier 1994; *Eulamprus* [*Sphenomorphus*] *kosciuskoi*, Done and Heatwole 1977; *Eumeces fasciatus*, Fitch 1954; *Eumeces obsoletus*, Evans 1953). To assume a position for copulation, males initiated a flank bite and placed the hind leg nearest the female over the base of her tail, while bringing the base of his tail up and under hers so that their cloacae were opposed (as illustrated in Whittier 1994). The male would thrust his tail and pelvic region as a single hemipenis was inserted into the female and copulation commenced. Pelvic thrusting continued for most of the time the cloacae were in opposition, but ceased before the flank was released. Copulations lasted an average of 3.92 min (± 0.18 SE), which is considerably shorter than the 90 min reported for the skink *Eumeces egregius* (Mount 1963), but similar to the 3–5 min reported for the more closely related skink, *Carlia rostralis* (Whittier 1994). The number of thrusts was recorded for only two mating events (N = 22 for the one observed in the enclosures and N = 36 for the one in the field), and occurred at a rate of 5–6/s. This rate is faster than that observed in *C. rostralis*, which spasmed at a rate of 1 thrust/s, but this increased to 1–4/s in the final 30 s of intromission (Whittier 1994). Mating ceased when the male released his grasp on the female. The male then dragged his cloaca along the substratum with his hemipenis everted. This behavior may function to clean the hemipenis of seminal fluid, or possibly to leave chemical messages for other individuals (Beck 1990). Hemipenes remained everted for up to 2 min after copulation.

Female Receptivity.—Our data suggest that female *C. jarnoldae* are receptive to males after laying eggs, but not while they are gravid. During midsummer three of the four females that were observed copulating in the enclosure had deposited their eggs 1–7 days before mating. These females were exposed to different males prior to laying, but refused courtship advances from these males and did not allow copulation to occur. In all cases of rejection, females were observed to perform a characteristic behavior: females positioned themselves in front of the male, facing away, but with their tails directed towards him. In this position, females waved their tails in a horizontal plane, held posterior to the body, so that their tails waved near his face. If the male moved, the female would often move in front of him and again wave her tail in his face. Usually this caused the male to cease courtship, and resume foraging or basking behaviors. Although this behavior may simply signal that the female is not receptive, it may also provide pheromonal cues (Mason 1992; Shine et al. 2000) because the males often tongue flick the female's cloaca following this display. Regardless of their purpose, these behaviors warrant further study.

Clutch Size.—Females produced one (N = 4) or two (N = 5) small, white eggs under the shelters provided in the enclosures. *Carlia* spp. typically produce two eggs (Cogger 2000; Zug et al. 1982), although it is possible that in cases where only one egg was found, the second was deposited at a later stage (Zug et al. 1982). Only one egg was hatched in the laboratory, 10 d after being found in the enclosure (we checked under the shelters for eggs approximately every 3 d). The hatchling was 19 mm SVL, with a 29 mm tail, and weighed 0.2 g. In the Townsville region, *Carlia jarnoldae* reproduce annually, with oviposition occurring in the late spring or summer (November to June), coinciding with the wet season (James and Shine 1985; Wilhoft 1963b; Zug et al. 1982; TL and LS, unpubl. observations).

Acknowledgments.—This manuscript was greatly improved by the comments of F. Seebacher, R. Swain, and one anonymous reviewer. We also thank N. Peterson for field observations. The research presented here adhered to the Guidelines for the Use of Animals in Research, the legal requirements of Australia, and the guidelines for James Cook University, Townsville. Ethics approval was obtained from James Cook University Ethics Committee: certificate number A515. Animal collection was covered by a Scientific Purposes Permit number NO/001257/96/SAA.

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Herpetological Review, 2003, 34(4), 327–328.

Defensive Strategies of Texas Horned Lizards (*Phrynosoma cornutum*) Against Red Imported Fire Ants

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The Texas horned lizard (*Phrynosoma cornutum*), a state-listed threatened species, historically occurred throughout most of Texas, but its distribution and abundance has declined dramatically (Henke 2003). Possible reasons for the decline include widespread use of broadcast insecticides, excessive commercial collection, loss of habitat from urbanization and/or agriculture, and the invasion of the red imported fire ant (*Solenopsis invicta*; Donaldson et al. 1994). Potentially, fire ants can negatively impact Texas horned lizards indirectly through competition with harvester ants (*Pogonomrymex* sp.), the main prey item of Texas horned lizards, or directly by their venomous sting (Allen 1993). Similar decline of coastal horned lizards (*Phrynosoma coronatum*) in southern California has been attributed to the invasion of Argentine ants (*Linepithema humile*; Suarez and Case 2002).

Nonaggressive defensive strategies of Texas horned lizards include reliance on cryptic coloration, burrowing into the soil to avoid detection, retreating from predators using a sprint-and-freeze tactic, inflating their body with air, and various defensive stances (Peslak 1985; Pianka and Parker 1975; Reeve 1952; Sherbrooke 1981). Aggressive strategies include hissing and lunging at the predator, biting, jabbing with the occipital horns, or ejecting blood from the conjunctival sac located near the eye (Lambert and Ferguson 1985; Middendorf and Sherbrooke 1992; Sherbrooke and Middendorf 2001). Because Texas horned lizards have not evolved with red imported fire ants, novel defensive strategies may be used to cope to this exotic invertebrate.

We describe two defensive strategies exhibited by Texas horned lizards against red imported fire ants. The two strategies appear to be dependent on the number of ants involved in the attack. Our observations of encounters with Texas horned lizards and fire ants occurred in central and southern Texas (Atascosa, Brooks, Coryell, Frio, Kleberg, and LaSalle counties) from 16 June 2000–20 September 2001. Horned lizards were encountered while observers were conducting reptile and ant surveys. Observers did not disturb horned lizards or ant mounds and maintained ~1.5 m distance from lizards, until lizards buried themselves. At this point, observers would closely inspect the location where lizards were buried. The first strategy, referred to as the consumption strategy (N = 5), occurred when ≤ 12 fire ants were present (Table 1). When adopting this strategy, horned lizards remained very still with their eyes shut, occasionally twitching or jerking their heads as the ants ran across their eyelids. When the ants ran onto or around a lizard's mouth, the lizard would consume them. This continued until the majority of the ants were consumed or retreated from the lizard. The second defensive strategy, referred to as the flee-and-bury strategy (N = 6), occurred when > 20 fire ants were involved in the attack (Table 1). Twenty to > 50 fire ants swarmed onto the body of a horned lizard when the lizard disturbed a fire ant mound. Horned lizards that encountered > 20 fire ants sprinted 2.5–7 m from attack sites and quickly buried themselves, tail first, into the soil. Soils ranged from sandy, sandy-loam, gravelly loam, to clay loam soil, dependent upon location. Horned lizards wagged their tails and shifted their bodies from side to side until they were completely buried below the surface. Fire ants would then appear, within 15 s, on the surface above where the lizard was buried. Horned lizards re-emerged between 5–15 min afterwards.

Both strategies thwarted the attacks of fire ants on Texas horned lizards. We consider the consumption strategy to be a defensive strategy rather than a primary means of obtaining food. Texas horned lizards are considered dietary specialists (Whitford and Bryant 1979), with 69% of their diet consisting of harvester ants (Pianka and Parker 1975). Texas horned lizards appear resistant to the venom of harvester ants (Schmidt et al. 1989). Although Texas horned lizards consume other species of insects (e.g., crickets, grasshoppers, beetles, centipedes, bees, and caterpillars; Milstead and Tinkle 1969; Munger 1984), they do not actively prey on fire ants (S. E. Henke, unpubl. data). Argentine ants were never de-

TABLE 1. Defensive strategies of Texas horned lizards when attacked by red imported fire ants in Texas. Attacking ants were either consumed or returned to the soil surface after the horned lizard buried itself (see outcome column).

Sex	Snout–vent length (mm)	Number of ants in attack	Strategy	Outcome
Female	65	7	Consumption	5 consumed
Male	72	9–10	Consumption	5 consumed
Male	63	6	Consumption	4 consumed
Male	68	6–8	Consumption	4 consumed
Female	75	12	Consumption	9 consumed
Male	62	25–30	Flee and bury	20+ to surface
Female	78	20–25	Flee and bury	15 to surface
Female	69	25–30	Flee and bury	25 to surface
Male	47	20–25	Flee and bury	18 to surface
Female	65	25–30	Flee and bury	20+ to surface
Male	62	50+	Flee and bury	35+ to surface