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SPECIAL ISSUE, PART IV:
A Tribute to Henry S. Fitch



CAMERON B. ROGNAN

This is the typical pattern of Banded Gila Monsters (*Heloderma suspectum cinctum*) in Washington County, Utah, where an unusually dark individual was seen (see front cover and article on p. 236).



JEFFREY W. ACKLEY

The terrestrial wildlife of Galápagos, such as this Land Iguana (*Conolophus subcristatus*), has a seemingly reckless disregard for the danger that humans can present (see travelogue on p. 242).



CHRISTOPHER R. GUILLETTE

This adult female Oustalet's Chameleon (*Furcifer oustaleti*) (UF 163071) was collected in Florida City, Miami-Dade County, Florida, where this Madagascan species has apparently become established (see article on p. 248).



MATTHEW E. GIFFORD


Red-footed Tortoises (*Chelonoidis carbonaria*) on Union Island appear to be smaller than those in mainland and other insular populations (see the survey of the reptiles of Union on p. 222).



PEDRO DA COSTA SILVA


An Amazon Treeboa (*Corallus hortulanus*) hanging above the water's surface prior to submerging a portion of its head, presumably foraging for fish (see article on p. 218).

Front cover: Cameron B. Rognan



An unusual dark-phase adult Banded Gila Monster (*Heloderma suspectum cinctum*) from Washington County, Utah. See the article on p. 236.

Back cover: Jeffrey W. Ackley



Marine Iguanas (*Amblyrhynchus cristatus*) pay little attention to what crawls on them, as demonstrated by this Sally Lightfoot Crab (*Grapsus grapsus*). See article on p. 242.



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ROBERT W. HENDERSON

Henry S. Fitch and a Boa Constrictor; February 1972 in Chiapas, Mexico.

A TRIBUTE TO HENRY S. FITCH

With this issue of *Reptiles & Amphibians* we complete our tribute to the late Henry S. Fitch. Although originally envisioned as a two-issue memorial, the response from the herpetological community was so enthusiastic that the number of contributions could only be accommodated in four issues of the journal. Dr. Fitch's influence, and the esteem in which he was (and is) held, have been reflected in the taxonomic and geographic breadth of the submissions. Contributors ranged from graduate students to well-known senior scientists with spectacular publication records. At least 22 U.S. states and ten additional nations (Australia, Brazil, Canada, China, Costa

Rica, Czech Republic, India, Mexico, South Africa, and Taiwan) were represented. Every author in some way wanted to pay respect to a man that might have been mentor, colleague, friend, and/or source of inspiration. Although this marks the end of our dedicated tribute, we are confident that future contributions to this and many other journals will, to one degree or another, reflect the boundless enthusiasm and high level of scholarship displayed in the natural history publications of Henry Fitch.

The Editors of *Reptiles & Amphibians*

Population Size and Sex Ratio of Snapping Turtles on the Crescent Lake National Wildlife Refuge

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Abstract.—Mark and recapture studies of Common Snapping Turtles (*Chelydra serpentina*) on the Crescent Lake National Wildlife Refuge in the Sandhills of western Nebraska revealed a sex ratio strongly biased toward males by a factor of two, an average density of 2.32 adults and subadults per hectare, and a standing crop biomass of 19.35 kg/ha. Sex ratios were most biased (7.5:1.0) in July–August. Density and biomass were comparable to values from previously studied lakes, and were inversely related to wetland size across all studies of snapping turtles.

Common Snapping Turtles (*Chelydra serpentina*) are known predators of waterfowl (review in Ernst and Lovich 2009), and hence are a concern for wildlife managers charged with maximizing waterfowl production. In order to assess the potential impact of snapping turtles on waterfowl populations, knowledge of the population dynamics of the turtle is necessary, in addition to data on feeding habits.

On the Crescent Lake National Wildlife Refuge in Nebraska, unpublished data (Iverson and French) revealed that 45% of 49 snapping turtles contained avian body parts, although American Coots (*Fulica americana*) were the only identifiable bird species, and determining whether the birds were taken alive or as carrion was not possible. To evaluate the potential impact of snapping turtles on waterfowl, the Refuge authorized this study of the density and biomass of these turtles in one of the largest lakes on the refuge.

Methods

Using mark-recapture techniques, we studied the snapping turtle population of Island Lake on the Crescent Lake National Wildlife Refuge in Garden County, Nebraska during 2008 and 2009. Island Lake is a shallow 298-ha water-table lake, with a maximum depth of about 3 m, and about 209 surface hectares with depths less than one meter (CLNWR records). The perimeter of the Lake is cattail or bulrush marsh, and numerous "islands" (one up to 6 ha) of emergent vegetation occur in open water areas. The lake is managed for gamefishing and for waterfowl production. Immediately prior to this study (early June 2008), 87 subadult and adult snapping turtles (mean carapace length 332 mm; range 254–412; mean body mass, 8,250 g [total sample mass = 717.75 kg]) were culled from Island Lake for dietary analysis (n = 48) or removal and translocation to wetlands off the Refuge (n = 39).

Snapping turtles were captured in baited fyke nets (n = 40, plus 5 recaptures), incidentally by hand (e.g., while nesting; n = 24, plus two recaptures), or dip-netted from an airboat during transects undertaken at approximately weekly intervals to collect bird carcasses for avian flu monitoring (n = 184, plus 68 recaptures). Fyke nets baited with pieces of rough fish were deployed on 24–28 June 2008 and 20–24 June 2009 along the eastern or western shores of the lake. In addition, airboat sampling was undertaken on 9 days in 2008, and 20 days in 2009. For simplicity, sampling was initially divided into 10 time periods (Table 1), and only turtles with carapace lengths (CL) > 225 mm were included in this analysis.



Snapping turtles captured in single fyke net set for 24 h.



JOHN IVERSON

A nesting female with characteristic spoil mounds. These mounds (one behind each rear leg) always remain after the female has completed the nesting process, making location of nests very easy for humans and predators.

Each captured turtle was measured (maximum carapace length and plastral length to the nearest mm), some were weighed (body mass [BM] to the nearest 50 g), and all were marked individually by screwing a numbered circular metal tag into the right rear margin of the shell. All turtles were released where caught, typically within 15 min of capture.

Table 1. Sex ratios for snapping turtle samples from Island Lake, Nebraska, based on airboat (number of days indicated) or fyke net captures of sexable turtles over 225 mm carapace length. Captures of females at nesting areas in June are excluded. Sample sizes include recaptures and so some individual turtles are represented more than once in these tallies. * $P < 0.05$; ** $P < 0.01$.

Sample period	Males	Females	Ratio (M/F)
June 2008 (fyke)	17	10	1.70
July 2008 (1 day)	10	1	10.00**
September 2008 (6 days)	41	19	2.16**
October 2008 (2 days)	31	15	2.07*
April–May 2009 (5 days)	25	6	4.17**
June 2009 (fyke/1 day)	15	20	0.75
July–August 2009 (4 days)	20	3	6.67**
1–15 September 2009 (2 days)	13	3	4.33*
28 September–5 October 2009 (2 days)	19	4	4.75**
16 October–18 November 2009 (7 days)	23	15	1.53
All periods	214	96	2.23**
All airboat captures	186	69	2.70**
All fyke net captures	28	17	1.65
July–August only	30	4	7.50**
September only	44	22	2.00**
October–November only	73	34	2.15**

To estimate the population size, capture/recapture data were divided into five sampling periods: June–July 2008, September–October 2008, April–June 2009, July–15 September 2009, and 28 September–18 November 2009. These data were subjected to Schumacher-Eschmeyer, Schnabel, and Modified Leslie Method analyses (Krebs 1999). For density and biomass comparisons, we used the average population size estimate of these three estimates. Chi square analyses were used to test sex ratio bias in samples.

Results

We marked a total of 250 subadult and adult snapping turtles and made 69 recaptures (319 total captures). For 286 snapping turtles (CL range 120–442 mm) from Island Lake and Gimlet Lake, BM (g) was related to CL (mm) by the equation $BM = 0.0003847CL^{2.909}$ ($r = 0.97$; $P < 0.0001$). Mean CL for the first capture only of all subadult and adult Island Lake snapping turtles was 333 mm (range 226–462 mm). Application of the BM-CL equation estimates average BM as 8,373.6 g.

Sex ratios were male-biased in every sample but one that included mainly incidental captures of nesting females in June 2009 (Table 1). With one notable exception, about twice as many males were captured as females during a given sampling period. Samples in July–August in both 2008 and 2009 included very few females, and a combined male to female sex ratio of 7.5:1.0. This latter sex ratio is significantly male biased ($P = 0.016$), even if the expected sex ratio was that of all samples combined (2.23:1.0; Table 1).

Population estimates of subadults and adults based on the capture/recapture data were 606 (95% Confidence Interval 485–804; Schumacher-Eschmeyer), 622 (95% CI 448–1,018; Schnabel), and 580 (Leslie Method). The average of these estimates suggests a population of 603 subadults and adults. Assuming a mean BM of 8,374 g per individual and an estimate of 603 subadult and adult turtles in Island Lake suggests a standing crop



REBECCA PROSEER

Typical adult male Common Snapping Turtle (*Chelydra serpentina*) from Island Lake.

Table 2. Variation in sex ratio (males/females) among populations of *Chelydra serpentina* arranged by declining latitude. Note the absence of a latitudinal pattern in sex ratio. * $P < 0.05$; ** $P < 0.01$.

Location	Body of Water	Latitude	Males	Females	M/F Sex Ratio	Source
Ontario	Lake Sasajewun	45.5	17	26	0.654	Galbraith et al. 1988
Ontario	Broadwing Lake	45.5	5	4	1.250	Galbraith et al. 1988
Quebec	Lake Champlain	45	27	28	0.964	Mosimann and Bider 1960
Michigan	Lower Peninsula	43–44	74	77	0.961	Lagler and Applegate 1943
Ontario	West Pond	43.25	47	24	1.958**	Galbraith et al. 1988
New York	Hudson River Bay	42	75	46	1.630**	Kiviat 1980
Michigan	ES George Reserve	42	97	80	1.213	Congdon et al. 1986
Nebraska	Island Lake	41.7	214	96	2.229**	This paper
Nebraska	Blue Creek Pond	41.5	15	14	1.071	Iverson et al. 2000
Illinois	Gilbert Lake	40	16	3	5.333**	Tucker and Lamer 2004
Illinois	Swan Lake	40	18	16	1.125	Tucker and Lamer 2004
Illinois	Lower Stump	39	13	3	4.333**	Tucker and Lamer 2004
West Virginia	Pond 39 and Pond 40	38	23	26	0.885	Major 1975
Tennessee	Tennessee River	33.9	14	8	1.750	Froese and Burghardt 1975
South Carolina	Savannah River Plant	33	21	8	2.625**	Congdon et al. 1986
South Carolina	Savannah River Plant	33	55	21	2.619**	Gibbons and Lovich 1990
Florida	McCord Pond	30.5	30	25	1.200	Aresco et al. 2006
Florida	Canal System	25.25	25	24	1.042	Johnston et al. 2008



MATT LACHUSA

Juvenile snapping turtles, at least in the western Sandhills, often are washed ventrally with orange or yellow-orange pigment, possibly a reflection of diet.

Table 3. Density and biomass estimates for snapping turtles.

Location	habitat (ha)	density (#/ha)	biomass (kg/ha)	Source
Ontario	bog (5.5)	2.73	17.94	Galbraith et al. 1988
Ontario	lake (27.5)	2.03	13.5	Galbraith et al. 1988
Ontario	marsh (261)	4.4	25.8	Hogg 1975, Galbraith et al. 1988
Ontario	pond/marsh (9.8)	65.91	341.3	Galbraith et al. 1988
Wisconsin	lake (18.0)	1.9–2.2	—	Pearse 1923, Petokas 1981, Galbraith et al. 1988
South Dakota	lake (23.9)	1.2	9.1	Hammer 1969, Iverson 1982
South Dakota	lake (91.1)	1.01	8.9	Hammer 1972, Galbraith et al. 1988
New York	tidal marsh (154)	4.0	23.0	Kiviat 1980
Michigan	swamp/pond (7.3)	13.3	30.0	Congdon et al. 1986
Michigan	marsh (4.0)	12.8	33.9	Congdon et al. 1986, Congdon and Gibbons 1989
Michigan	farm/pond (0.6)	6.8	15.9	Congdon et al. 1986
Michigan	lake (40.5)	4.69	21.91 ^a	Lagler 1943
Michigan	lake (16.2)	1.54	6.42 ^a	Lagler 1943
Michigan	lake (8.1)	2.59	—	Lagler 1943
Nebraska	pond (0.71)	50.7	242	Iverson et al. 2000
Nebraska	lake (298)	2.32	19.35	This study
West Virginia	pond (0.4)	55.0	—	Major 1975
West Virginia	pond (0.4)	67.5	—	Major 1975
Indiana	swampy bay in lake (4.5 ha)	4.44	25.51	Smith et al. 2006, and unpublished
Illinois	lake (30)	4.99	19.01	Dreslik et al. 2005
Illinois	pond (2)	6.5	21.5	Reehl et al. 2006
Illinois	lake (125)	0.104	0.434	Tucker and Lamer 2004; Tucker, pers. comm.
Illinois	lake (101)	0.188	1.497	Tucker and Lamer 2004; Tucker, pers. comm.
Illinois	lake (1174)	0.029	0.207	Tucker and Lamer 2004; Tucker, pers. comm.
Oklahoma	pond (2.1)	22	52	Stone et al. 2005
Oklahoma	pond (1.0)	10	17	Stone et al. 2005
Oklahoma	pond (0.4)	49	166	Stone et al. 2005
North Carolina	pond (0.4)	27.5	153	Brown 1992
Tennessee	pond (0.81)	59	181.3	Froese and Burghardt 1975, Iverson 1982
South Carolina	Carolina bay (10.0)	8.0	21.6	Congdon et al. 1986, Congdon and Gibbons 1989
South Carolina	farm/pond (1.1)	7.3	20.6	Congdon et al. 1986
Florida	pond (1.5)	43.0	261	Aresco et al. 2006
Florida	pond (0.5)	22.0	69.5	Aresco et al. 2006
Florida	pond (1.0)	3.0	10.6	Aresco et al. 2006
Florida	lake (405)	0.04	0.10	Aresco et al. 2006
Florida	canal (0.18)	34.3	72.6	Johnston et al. 2008

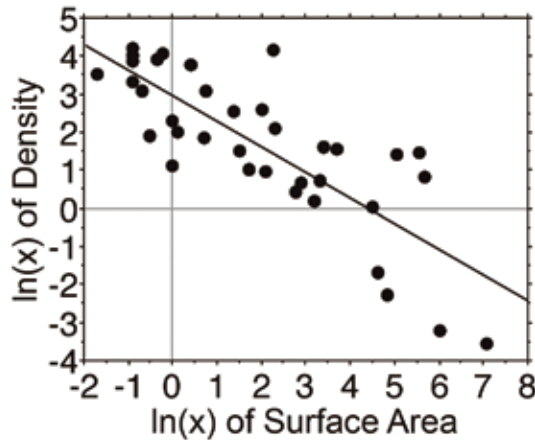
^a estimated from CL/BM regression in Iverson (1984) based on Lagler and Applegate (1943) for Michigan turtles.

biomass of 5,049 kg. However, since 87 turtles (717.5 kg) were removed from Island Lake at the beginning of the study, a more justifiable estimate of the subadult and adult population of snapping turtles in the lake would be 690 (603 + 87), estimated to weigh approximately 5,767 kg.

These estimates would suggest a density of 2.32 subadults and adults per ha in Island Lake (or 3.30 per ha if the area with depths over 1 m are excluded). Similarly, standing crop biomass across the entire lake would be estimated at 19.35 kg/ha (27.59 if the area over 1 m depth is excluded).

Discussion

Sex ratios of fyke net and airboat samples were decidedly male-biased in our study, a pattern observed in most (but not all) other studies of snapping turtles (Table 2). Because we believe that airboat captures are likely to be more random than fyke net captures, we are confident that the sex ratios in our samples reflect the true population sex ratio. That every statistically significant sex ratio reported in this study (Table 1) and in the literature (Table 2) was male-biased is noteworthy.



Relationship of the natural log of wetland area and the natural log of snapping turtle (Table 3) density for 36 study populations ($r = -0.67$; $P < 0.0001$).

Given that snapping turtles exhibit temperature-dependent sex determination (i.e., sex is determined by nest temperatures during the middle third of incubation; Yntema 1979), the bias at our site may be a consequence of typical incubation temperatures. Snapping turtle nests at our field site average 174 mm to the top and 257 mm to the bottom of the eggs (mean 215.5 mm; Iverson et al. 1997). Mean hourly July soil temperatures at 20 cm depth at our refuge temperature station in full sun on the side of a south-facing sandhill (i.e., the warmest possible site available) averaged 25.68 °C in 1997, 21.01 °C in 1999, 28.78 °C in 2003, and 26.18 °C in 2004, most being well below the male-female pivotal temperature expected at this latitude (ca. 28 °C) and within the range of temperatures producing mostly males (Ewert et al. 1994). Hence, the skew in sex ratio in at least this population may most likely be explained by incubation temperatures rather than biased sampling, differences in age at maturity, differential mortality, or differential movements (Gibbons 1990).

Seasonal variation in the sex ratio of samples of snapping turtles has not previously been reported. Our July/August samples were about four times more skewed toward males than our other seasonal samples (Table 1). This suggests a distinctive post-nesting niche and/or activity difference between the sexes that deserves further study.

The density (2.32/ha) and biomass (19.35 kg/ha) of snapping turtles in Island Lake was similar to that reported for other lakes across the species' range (Table 3). Densities in 12 other lakes ranged from 0.03 to 4.99 per ha (mean 1.71), and standing crop biomass in 10 other lakes ranged from 0.10 to 21.91 kg per ha (mean 8.11 kg). Galbraith et al. (1988) showed that snapping turtle density was inversely related to wetland surface area for 16 published studies. Our analysis of density data for 36 studied populations of snapping turtles supports the conclusion of Galbraith et al. (1988). This pattern no doubt reflects the facts that: (1) Smaller wetlands can be more completely sampled than larger ones; (2) smaller wetlands are likely to have higher overall primary productivity, because production is presumably lower in the open water of larger water bodies; and (3) snapping turtles typically exploit shallow water environments, and in larger, deeper wetlands, most of the surface area may actually be only rarely used by turtles.

Although our work and those of others suggest that snapping turtle densities are relatively low in large lakes such as Island Lake, given the high incidence of birds in their diet, their impact on managed waterfowl species is still unclear. Snapping turtles might depredate only small, unmanaged species such as coots, but only detailed feeding studies (including fecal analysis) of telemetered turtles will reveal the impact of snapping turtles on managed species such as ducks, geese, and swans.

Acknowledgments

Although Henry Fitch published very little on turtles, his autecological approach to studies of reptiles provided the early (and essential) inspiration for Iverson's career path. Refuge managers Neil Powers and Mark Koepsel authorized this study; Monty Shaul and Charley Chadwick piloted the airboats; and Marlin French collected the data from the airboat captures. John Tucker provided valuable unpublished data. Joe Augustin of Lilly Library at Earlham tracked down obscure publications.

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Some Natural History Notes on the Brooding Behavior and Social System of Two Oklahoma Skinks, *Plestiodon fasciatus* and *Plestiodon obtusirostris*

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Photographs by the senior author.

The purpose of this study was to quantify the social and reproductive behavior of *Plestiodon fasciatus* and *P. obtusirostris*. We conducted laboratory experiments with brooding behavior and field experiments to test for mate-guarding and territoriality. To determine the use of space by both species, we conducted a mark-recapture study. We constructed two permanent 1-ha trapping grids of can pitfall traps and cover-boards, with an inter-trap distance of 10 m. One was in a mixed woodland-grassland habitat and one in a grassland habitat. We manipulated the hydric environment to determine parental behavior of brooding female *P. obtusirostris*. We size-matched male *P. fasciatus* and *P. obtusirostris* for dyadic encounters with and without females and both on and off home ranges in order to determine social behavior. Change in hydric conditions did not induce female *P. obtusirostris* to move eggs to more suitable nest sites in our experiments. *Plestiodon fasciatus* exhibited behavior associated with mate-guarding. *Plestiodon obtusirostris* did not display behavior associated with territoriality, and our experiment examining mate-guarding calls for a more intensive study.

Natural history is ultimately the foundation of all research at the organismal level. Without a basic understanding of a species' natural history, conclusions regarding the toxicology, population genetics, developmental biology, or physiology of that species cannot be drawn, nor can any knowledge in these fields or others be placed in proper context. Yet the study of natural history has increasingly become less popular in lieu of more specialized fields. The bloom of natural history studies dealing with herpetofauna in the United States mostly took place in the 1940s and 1950s. These days, natural history information on U.S. herpetofauna is still gathered, but usually subsidiary to other main objectives, such as conservation status, ecological genetics, or phylogeography. The herpetofauna of the United States is arguably the most well known in the world. Despite this and the fact that *Scincella lateralis*, for example, is one of the most common lizards in the southeastern United States, little is known of its ecology (most of which is anecdotal), and what research has been done is contradictory (Fitch and Greene 1965, Lewis 1951, Fitch 1970, Collins and Conant 1998).

Much of our current knowledge of skink natural history is built upon anecdotal evidence based on single observations without regard to the rigor of the account; very little of our knowledge is based on detailed field studies or experimental work. The recent taxonomic elevation of *Plestiodon septentrionalis* subspecies into the full species *P. septentrionalis* and *P. obtusirostris* (Powell et al. 1998) raises the question of whether these two species might differ in their natural history and behavior. *Plestiodon obtusirostris* report-

edly exhibits coiling around and brooding of eggs, manipulation or retrieval of eggs, communal care of eggs or young, and, because it is a close relative of *P. septentrionalis*, possibly shows hydroregulation and thermoregulation of the nest site, oophagy of bad or unfertilized eggs, parental assistance and



Cover-board being checked for skinks at the grassland site near Stillwater, Oklahoma.

grooming of neonates during hatching, and care of neonates (Somma 1985, Somma 2003).

In recent years, some skink taxa, for example *P. laticeps*, have been shown to exhibit mate-guarding (Cooper and Vitt 1993, Cooper 1999). Mate-guarding is the social system in which a male associates with a female after copulation in order to prevent rival males from obtaining subsequent copulations via intrasexual selection (Cooper and Vitt 1993, Birkhead and Møller 1998). On the other hand, territoriality is the social system exhibited most commonly in lizards. Territoriality is a system of space use in which a defined area and the resources within (including mates) are defended from conspecifics (Stokes 1974). We do not know if mate-guarding, territoriality, or some other form of social organization is present even in the common North American skinks that often occur in close proximity to humans and their yards and gardens. This is especially true of the recently-elevated *P. obtusirostris*. *Plestiodon obtusirostris* males and females often are found in the same refuge and most of the species' ecology resembles that of *P. fasciatus* (Breckenridge 1944). However, the social system of even the more intensely studied *P. fasciatus* is ambiguous. Fitch (1954) suggested that *P. fasciatus* could not exhibit territoriality due to the habitat constraint of visual obscurity, preventing the detection of intruders into the territory, but this was never tested. *Plestiodon fasciatus* females have been reported to breed with multiple males in a matter of just a few days (Fitch 1970), an observation that argues against mate-guarding.

The purpose of this study was to quantify the social and reproductive behavior of *P. fasciatus* and *P. obtusirostris*. We conducted laboratory experiments to test for brooding behavior and field experiments to test for mate-guarding and territoriality.

Methods and Results

We constructed two permanent 1-ha trapping grids of can pitfall traps and cover-boards, with an inter-trap distance of 10 m, near Oklahoma State University in Payne County, Oklahoma: One in a mixed woodland-grassland habitat and one in a grassland habitat. Can traps were 978-ml metal cans buried in the soil so the lid of the can was flush with the surface. Traps had perforated bottoms and the cavities beneath the cans were lined with gravel to facilitate drainage. Wooden lids supported above can-traps furnished shade for trapped animals. Traps were checked every other day. At each site, we also had 100 cover-boards (1.22 x 0.61 m) placed between the can traps. Skinks were captured by hand under cover-boards on the sites, under debris, or moving in the litter. Sex, mass, head-body (SVL) and tail length, and age class of skinks captured for the first time were recorded and they were toe-clipped and implanted with a PIT tag (see below). Date, time, and location were also recorded for these first-time subjects, and for subsequent relocations. Animals were released 3 m from the trap in a ran-



Skink after being implanted with a PIT-tag. Notice the small incision site.

Table 1. Behavior exhibited by *Plestiodon* during dyadic interactions.

Behavior	Weighted Score
Approach	1.0
Bite	1.0
Supplant	1.0
Superimposition	1.0
Tail wag low to ground	0.5
Tongue flick	0.5
Flee	-1.0

dom direction, or at the point of capture if captured by hand. Can traps were closed during inclement weather or when not in use.

Individual skinks were uniquely marked by toe clipping and those >40 mm in SVL and in good body condition were also implanted with a 8.5 x 2.12-mm PIT tag (Passive Integrated Transponder — a miniature transponder that emits a unique number when activated by a radio signal in the portable antenna). Subjects with PIT tags survived as well as those marked in other ways and appeared to show normal behavior in all respects. Skinks are small and delicate and repeated handling can be detrimental, causing stress, tail autotomy, or other injuries. The PIT tags were used to identify skinks that escaped into litter or were hidden under the cover-boards, without the stress of hand capture (Cavalieri and Fox, in review).

Egg-brooding.—The goal of this laboratory experiment was to describe egg-brooding in *P. obtusirostris* and to test for increased egg survival under induced suboptimal moisture conditions through parental care by the mother. If the mother moves the eggs from a suboptimal nest site to an optimal nest site, this is evidence of parental care. Anecdotal accounts report that female *P. laticeps* and *P. fasciatus* will move a nest when flooded by a natural rain event (Vitt and Copper 1989). We wanted to determine if female *P. obtusirostris* would do the same.

During spring 2008, we made multiple relocations of a female *P. obtusirostris* under a single cover-board. She was first captured on 19 May 2008. All subsequent relocations of this individual were made by using the PIT-tag reader to scan the cover-board. She was relocated six times at cover-board 81 on the grassland site. On 26 May, the female was found in a cavity under that cover-board. On 26 June 2008, the female, 16 eggs, and natal soil were excavated and removed to the laboratory. The nest was placed inside a plastic shoebox within a 37.9-l aquarium, with the natal soil spread over the bottom of the shoebox. The eggs were placed at one end within a depression and lightly covered with soil. A semi-transparent red glass tile was placed over the soil to act as a cover object but allow viewing of the female and eggs without disturbance. The female was placed in the shoebox and she had freedom to move from the shoebox to the surrounding aquarium space. The laboratory was maintained at 22–25 °C and was illuminated by normal overhead fluorescent ceiling lighting, supplemented by 40-watt Vitalites® over racks of aquaria. In addition, we mounted a 40-watt incandescent bulb for added warmth 20 cm over the shoebox in the aquarium containing the lizard. The female was fed crickets in the aquarium space and given water every other day. After one week, the female had rearranged the eggs and was brooding them. At this point, we added deionized water to one end of the shoebox to induce an excessively hydric state without standing water. We kept the soil moisture high by adding 200 ml of water as needed, usually every other day. The opposite end of the shoebox soil remained at the same moisture level as the excavated natal soil by means of a vertical waterproof cardboard divider that extended to just below the surface of the soil, thereby giving the female opportunity to move her eggs from the over-wetted end to the other end with optimal con-



Hatchling *Plestiodon obtusirostris* emerging from eggs.



Hatchling *Plestiodon obtusirostris*.

ditions. However, the female did not move her eggs. The eggs hatched six days later. Between 1700 h on 8 July and 1500 h on 9 July, five hatchlings emerged from the eggs over a 2-day period. They were lethargic and sickly. None survived past the 24th day after hatching.

The following summer, while monitoring cover-boards, we found 17 small, freshly laid eggs on top of the ground near a shallow depression under a cover-board at 1215 h on 11 June 2009. We first believed them to be *Aspidoscelis* eggs, because they were small, oblong, and lying on top of the ground; *Aspidoscelis* was the second-most common lizard in the area next to skinks. We carefully replaced the cover-board, and when we returned at 1535 h, the eggs were buried in the depression and covered. As we carefully excavated the chamber, an adult skink bolted from the chamber. We carefully replaced the cover-board, backed up several paces, and waited about 10 min before quickly lifting the cover-board and capturing the adult, which was readjusting the disturbed nest. It was an adult female *P. obtusirostris*, which we placed in a cloth bag and stowed in an ice chest for transport. We also carefully removed the nesting chamber, including the eggs and natal soil, and took them directly to the laboratory. We placed the natal soil in a three-chambered nesting box within a 37.9-l aquarium. As above, we placed the eggs in one end chamber of the nesting box in a cavity of natal soil covered lightly with soil and the overlaid semi-transparent red glass tile. The area surrounding the nesting box was filled with moistened peat moss so that it was level with the nesting box. We released the female into the aquarium, and maintained her under the same conditions as described above. The female skink and eggs were left undisturbed for

one week to allow the female to start brooding the eggs once more. At that time, the female had clearly rearranged the eggs and was actively brooding. Again, the side of the nest box with the eggs was flooded by adding 200 ml of deionized water and kept excessively moist by periodic addition of water. After 21 days, when it became apparent that the eggs had died and that the female had abandoned brooding, the trial was stopped. As in the previous trial, the female did not move the eggs.

Mate-guarding.—At least one species of North American skink (*P. laticeps*) is not territorial. Instead, males move around an area in search of receptive females, with which they mate and then guard against rival males (Cooper 1999). We wanted to test for mate-guarding in *P. fasciatus* and *P. obtusirostris*. If mate-guarding were exhibited, we expected: (1) Males attending females to act more aggressively toward introduced males than males not attending, and (2) territoriality would not be in evidence (see below).

Plestiodon fasciatus.—Once home ranges were established by multiple locations of identified individuals on the study site, size-matched male skinks were paired for dyadic encounters. We introduced a resident male *P. fasciatus* without a female into an arena (0.75 x 0.75-m hardware cloth cage with 6.4-mm mesh) overnight, positioned the arena on the ground at the cover-board of last capture, and put the cover-board on top of the arena for shade. The resident was allowed 24 h to acclimate to the arena before an intruder male *P. fasciatus* from at least 20 m distant was placed in the arena. After a 10-min acclimation period, we conducted a 30-min trial. Behavior was scored by using pre-assigned weighted values for specific types of behav-



Three-chambered nest box used in the second experiment with the brooding female *Plestiodon obtusirostris*.

ior (Table 1), and level of aggression followed Fox and Baird (1992) and Husak and Fox (2003). After the trial, the intruder was removed and the resident was left in the arena overnight with a female collected from no more than one cover-board away from the resident (within the resident's home-range and thus presumably a mate). The intruder was kept in the laboratory for 24 h. The following day, the intruder male was introduced to the resident male and female. Again, after a 10-min acclimation period and a 30-min trial, behavior was scored as above. A sum of the weighted scores was calculated for each pair of males, and then compared in a pairwise fashion.

Our intent obviously was to conduct paired trials with a sizeable set of males, but inclement weather within a narrow time frame of opportunity to conduct these trials in the field worked against us. In the end, we managed to complete a paired trial with only one resident. The resident *P. fasciatus* showed more aggression toward the intruder with a female (resident, 8.0; intruder, 5.5) than without a female (resident, 1.5; intruder, 0.5). The resident male exhibited both aggressive and submissive behavior.

Plestiodon obtusirostris.—We size-matched males for dyadic encounters as above. A resident male *P. obtusirostris* and a female *P. obtusirostris* collected from no more than one cover-board away from the resident (within the resident's home-range, presumably a mate) were allowed to acclimate in the arena as above. An intruder male *P. obtusirostris* was introduced after 24 h and a 30-min behavioral trial was conducted after a 10-min acclimation period. At the end of the trial, we removed the female from the arena and released her. We kept the intruder male in the laboratory and the resident male in the arena overnight. After 24 h, the intruder male was reintroduced to the resident male and a behavioral trial was conducted as above. The sum of the weighted scores (Table 1) was calculated for each pair of males, and then compared in a pairwise fashion.

Unfortunately, for the same reasons as listed above, we completed one paired trial also for only one resident. The resident *P. obtusirostris* showed no aggressive behavior either with or without a female (both scores were 0). The intruder *P. obtusirostris* showed slightly more aggressive behavior with the female present (8 with female and 6 without female). The only aggressive behavior exhibited was approach and superimposition. No submissive behavior was exhibited.

Territoriality.—Many species of lizards are territorial (Martins 1995). Territoriality is indicated if home ranges are mutually exclusive with little overlap (i.e., defended home ranges). As such, residents in their own territories are more aggressive than when the same individuals become intruders in another lizard's territory. Additionally, under territoriality, residents in



Arena at the woodland site near Stillwater, Oklahoma.

their home range are expected to exhibit similar levels of aggression toward an intruder whether they are in consort with a female or not.

We conducted three paired field trials to test for territoriality in *P. obtusirostris* between 4 June and 11 June 2009. We placed a resident male into an arena (0.75 x 0.75-m hardware cloth cage with 6.4-mm mesh) at the cover-board where it was collected for a least an hour to acclimate before introducing a size-matched intruder male from at least 20 m away. After a 10-min acclimation period, we conducted a 30-min trial. Behavior was scored by using pre-assigned weighted values as before (Table 1), and level of aggression followed Fox and Baird (1992) and Husak and Fox (2003). At least an hour of recovery time was given to both males after each trial. After this time, the male that was the intruder in the earlier trial was placed in the arena on its home range, thereby becoming the resident. An hour for acclimation was allowed. The resident male from the previous trial was introduced into the arena, thereby becoming the intruding male in this second trial. Trials were conducted and scored as above and an aggressive score was calculated for each individual (aggressive score = number of aggressive motor patterns minus number of submissive motor patterns). Aggressive scores as an intruder and as a resident for each individual were a pair for the Wilcoxon signed-rank test. No hint of territoriality was evident ($Z = -0.52$, $P = 0.60$, 6 pairs).

Discussion

As a consequence of logistical problems, mostly associated with unsuitable weather and a very short window of opportunity for field and laboratory experiments, our sample size is extremely limited. Nevertheless, because so little is known about the brooding behavior and social organization of *Plestiodon obtusirostris* and *P. fasciatus*, we feel that our studies have done a little, at least, to advance our understanding of the natural history of these two skinks. Our experiments confirmed what Somma (2003) stated in his literature review, namely that *P. obtusirostris* coils around and broods eggs, as well as manipulates and retrieves eggs. Both females rearranged the eggs after we placed them in the nesting chambers; however, we were unable to determine from our experiments if *P. obtusirostris* exhibits supplemental parental care as reported in sister taxa, such as communal care of eggs or young, hydroregulation and thermoregulation of the nest site, oophagy of bad or unfertilized eggs, parental assistance and grooming of neonates during hatching, and care of neonates (Somma 1985, 2003). We did not see any evidence that female *P. obtusirostris* will move eggs to a more hydrologically suitable nest site as other congeners are reported to do, but our sample size was too small to draw conclusions. We suspect that the first female did not move her eggs in response to the treatment of her nest site with excess moisture because the eggs were too close to hatching (hatching six days after treatment). On the other hand, we expected that the second female would



Female *Plestiodon obtusirostris* and nesting experiment set-up. Eggs are visible beneath the semi-transparent red glass tile.



Male *Plestiodon obtusirostris* before dyadic interaction.

move her eggs in response to the same treatment because these eggs were much younger and the benefit of moving the eggs to a better site would seem to outweigh the risk of damaging developing embryos (i.e., moving them would have greater impact on their survival since they had to remain in the nest longer). Other studies have suggested that brooding behavior increases survival of eggs in changing hydric environments (Fitch 1954, Telford 1959, Fitch and Fitch 1974). Somma (1985) noted a significant difference in female *P. septentrionalis* contact with eggs and behavior three days after ovipositing, depending on soil moisture conditions. Lang (1990) showed that female *P. septentrionalis* will move eggs away from overly warm or cold temperatures to more favorable sites. We suggest that more effort should be placed into quantifying the brooding behavior of *P. obtusirostris*. The natural history of *P. obtusirostris* and its relatives has been neglected despite the fact that these lizards exhibit active parental care, a behavior rare in reptiles (Somma 2003). We would certainly benefit from knowing whether all of the skink species in North America exhibit egg-brooding, if some have developed it to a greater extent than others, and, indeed, if egg-brooding independently evolved more than once (De Fraipont and Barbault 1996).

With respect to social organization, our single trial with *P. fasciatus* showed some evidence for mate-guarding: the resident male was more aggressive with a female present than without. Further study obviously is needed, but this one trial suggests that mate-guarding might be part of the social system in this species. The interaction with *P. obtusirostris* showed no strong evidence of mate-guarding, but a little more aggression was shown when a female was present. Nevertheless, we do not believe that this one interaction says much about the mating system of *P. obtusirostris*. On the other hand, *P. obtusirostris* showed no hint of territoriality. This is not surprising given that the better-studied congener, *P. laticeps*, exhibits mate-guarding (Cooper and Vitt 1993), not territoriality. For future studies, we again suggest that efforts focus on mate-guarding in these species.

Formal natural history studies in the field are often difficult to conduct properly because they require the coordination of many different free-ranging animals and a bit of luck, but the knowledge gained is invaluable. Secretive animals compound the problem, and the natural history of these secretive skinks has been neglected. To offset the difficulty of field experiments, we suggest that laboratory experiments first be conducted, such as the rich set of laboratory experiments conducted by Jaeger and his students on salamander aggression (e.g., Jaeger 1984, Gabor and Jaeger 1995, Kohn et al. 2005). Subsequently, one can take the knowledge and experience gained from the laboratory to the field and verify the behavior in a more natural

setting. Our collective knowledge and technology has advanced since the yesteryear bloom of natural history. We should finish what we started then and take a second look at what we think we know through new eyes.

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An Observation of Pigmy Rattlesnakes (*Sistrurus miliarius*) Mating in Alabama

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Because of the secretive nature of many snakes, often little is known about their reproductive behavior. Pitvipers can be especially elusive due to the lack of movement associated with their ambush mode of foraging and because of their cryptic coloration (May et al. 1996). Therefore, most information on timing of mating in these species is derived from the accumulation of anecdotal information over time (Aldridge and Duval 2002). These data have been used in attempts to determine which factors have led to the development of contrasting unimodal (late summer/fall) and bimodal (late summer/fall and spring) mating patterns in North American pit vipers (Aldridge and Duval 2002, Schuett et al. 2002).

Because of the increased number of males found during the fall (Dalrymple et al. 1991), most workers have assumed that Pigmy Rattlesnakes (*Sistrurus miliarius*) mate at that time. Observations of copulation in Florida include three pairs of *S. m. barbouri* in central Florida on 21 September, 28 September, and 27 October 1992 (Farrell et al. 1995). May et al. (1996) observed four copulating pairs in central Florida between late September and early November. However, observations of copulating pairs are lacking in other parts of the range of the species.

Since reproductive behaviors can vary within a species at different latitudes (Aldridge and Duval 2002), reports of copulation across a species' range are necessary to develop an understanding of reproductive patterns. Here we report an observation of a copulating pair of Carolina Pigmy Rattlesnakes (*Sistrurus miliarius miliarius*). The pair was observed at Horseshoe Bend National Military Park in east-central Alabama (Tallapoosa County, Alabama; 32° 58' 15" N, 85° 44' 18" W) on 25 September 2009 at ~1500 h CST. The pair was in the shade at an air temperature of ~21 °C. This site is north of the Fall Line and in the Piedmont physiographic province of Alabama. The general habitat type is mixed pine-hardwood, and this observation was in a recently (February 2009) burned stand.

The pair of snakes was inactive when we discovered them. We concluded that the pair was copulating due to the close proximity of the cloacae. The snakes remained in position for 30 min while being photographed. However, the male soon began tongue-flicking while rubbing his mental scales along the dorsum of the female. At one point during the observation, the male rattled, at which point we discontinued the observation. The total length of both individuals was estimated to be ~30 cm. The body of the male was generally positioned above that of the female. The female had an olive-brown ground color, whereas the male was more brightly marked with coloration typical of *S. miliarius*. This difference in color is typical in this species (Ernst and Ernst 2003) and is not attributable to sexual dimorphism (Bishop et al. 1996).

This observation is consistent with other observations that suggest that the mating season of this species occurs in the fall. However, this is the first report of mating in *S. m. miliarius*, and in this species outside Florida.

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A copulating pair of Pigmy Rattlesnakes (*Sistrurus miliarius miliarius*) on 25 September 2009 at Horseshoe Bend National Military Park in Tallapoosa County, Alabama.

Clutch Sizes in Two Populations of the Eastern Garter Snake (*Thamnophis sirtalis*) in Pennsylvania

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The Common Garter Snake (*Thamnophis sirtalis* Linnaeus 1758) is a geographically widespread species in North America (Conant and Collins 1998), with at least nine currently recognized regionally distinct subspecies (Collins and Taggart 2009). The Eastern Garter Snake (*T. s. sirtalis* Linnaeus 1758) is widespread and the only member of the *T. sirtalis* clade of Garter Snakes in Pennsylvania (Hulse et al. 2001, Meshaka and Collins 2009). Despite its ubiquity in the commonwealth, systematic studies on the life history of the Eastern Garter Snake are rare (Meshaka 2010, Meshaka et al. 2009). The objective of our research was to examine clutch sizes of *T. s. sirtalis* from two different Pennsylvania populations: One in south-central and the other in western Pennsylvania. We also compared data from these locations with those of Pennsylvania generally (Hulse et al. 2001).

Methods

Using cover boards in 2009, we captured female Eastern Garter Snakes for individual identification as part of a long-term ecological study at Powdermill Nature Reserve (PNR), Westmoreland County in western Pennsylvania (Meshaka 2010, Meshaka et al. 2009) and at Letterkenny Army Depot (LEAD), Chambersburg, Franklin County in south-central Pennsylvania (Delis et al. 2010; Meshaka and Delis, unpubl. data). Both sites are comprised of a mosaic of grasslands or shrublands, coniferous and mixed hardwood forests, as well as a variety of lentic and lotic aquatic systems. Most human-mediated habitat modification at PNR consists of mowing to maintain grasslands. LEAD is subjected to a variety of anthropogenic disturbances derived from its military mission and mild agricultural and silvicultural activities.

We employed palpation as a method to estimate clutch size from 21 females from PNR on 22 July, and 10 females from LEAD on 1 (n = 8),

13 (n = 1), and 18 (n = 1) July. Body sizes (snout-vent lengths, SVL) are presented in cm, and means are presented \pm one standard deviation. We compared female body sizes and clutch sizes by using F-tests for variance and *t*-tests for means, respectively (Sokal and Rohlf 1981). In light of differences in location, food bases, and sample sizes, we expected inter-site differences in female body sizes and clutch sizes, and the *t*-test analyses were consequently one-tailed. We used ANCOVA on SYSTAT 11 to remove the effect of body size in order to determine if individuals of about the same size in the two populations were producing more or fewer young.

Results

Mean body size of females at PNR (49.3 ± 6.0 cm; range = 39.4–64.8 cm; n = 21) was significantly smaller ($t = -2.334$; $df = 30$; $P < 0.01$) than those from LEAD (55.1 ± 7.6 cm; range = 42.6–65.4 cm; n = 10). Likewise, mean clutch size from PNR (13.0 ± 5.4 ; range = 7–29; n = 21) was significantly smaller ($t = -1.735$; $df = 30$; $P < 0.05$) than that at LEAD (16.4 ± 5.4 ; range = 8–24; n = 10). Body size was a statistically significant predictor of clutch size in each of the two sites (see graph on facing page). ANCOVA revealed no location effect in clutch size (mean-square = 0.417; F ratio = 0.100; $P > 0.05$). These statistical tests taken together mean that, although PNR females were on average smaller in body size and produced on average smaller clutches than those from LEAD, females from both sites that were similar in body size to one another produced similar clutch sizes.

Discussion

These data are interesting because body size (Fitch 2004) and clutch size (Seigel and Fitch 1985) of garter snakes can be affected by food supply. Consequently, we wondered if the smaller body sizes of Eastern Garter Snakes



BETTY FERSTER

Field and mixed hardwood forest at Powdermill Nature Reserve, Westmoreland County, Pennsylvania.



PABLO R. DELIS

Field overlooking mountain at Letterkenny Army Depot, Franklin County, Pennsylvania.



PABLO R. DELIS

Walter E. Meshaka, Jr. processing two female Eastern Garter Snakes (*Thamnophis sirtalis sirtalis*) from Letterkenny Army Depot, Franklin County, Pennsylvania. Snakes were palpated to estimate clutch sizes.



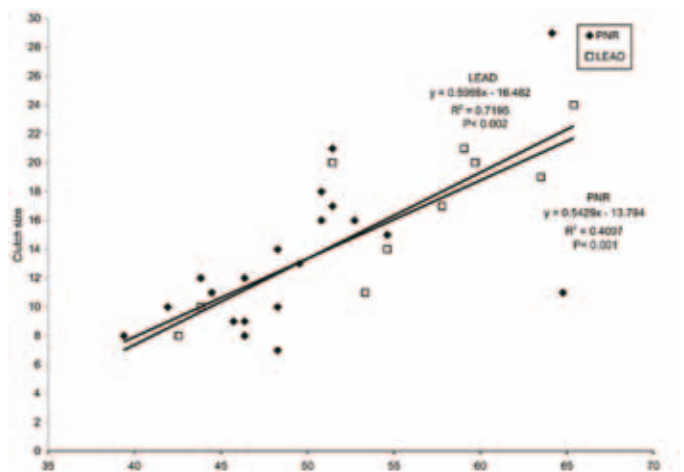
WALTER E. MESHAKA, JR.

Pablo R. Delis holds a gravid Eastern Garter Snake (*Thamnophis sirtalis sirtalis*) and a Milk Snake (*Lampropeltis triangulum*) from Letterkenny Army Depot, Franklin County, Pennsylvania. These two snake species were occasionally found together at both study sites.

from PNR was related to their overall greater relative density at that site (Delis et al. 2010; Meshaka 2010; Meshaka et al. 2009; Meshaka and Delis, unpubl. data). The inference is that the greater densities of Eastern Garter Snakes at PNR, perhaps combined with limited food resources, are stunting growth. Another likely reason for the body size disparity between the sites could be that predation pressures differed at the two sites. This hypothesis suggests that before reaching large body sizes, more female Eastern Garter Snakes were killed at PNR than at LEAD. In this scenario, the suggestion is that snakes at LEAD are on average larger and older because of higher survivorship than those at PNR. Of course, a genetic component to body size might exist, explaining the inter-site differences in body sizes. Female Eastern Garter Snakes at PNR might be genetically programmed, with negligible influence from other factors, to be smaller in body size than those at LEAD. Regardless of the cause of body-size differences, the result was a reduction in fecundity — but, according to our data, only because PNR females were smaller. Those PNR females similar in body size to those from LEAD produced similar clutch sizes. Therefore, the ability of PNR females to produce larger clutch sizes seems to be hampered only because of their smaller body size.

Combined, females from both sites averaged 51.1 ± 7.1 cm and produced an average clutch size 14.0 ± 5.4 young. Larger samples of female Eastern Garter Snakes taken in Pennsylvania generally averaged 43.9 ± 6.3 cm (range = 36.0–64.0, n = 52; Hulse et al. 2001). From a sample of 39 Pennsylvania female Eastern Garter Snakes of unreported body sizes, clutch sizes, as estimated by dissections of museum specimens, averaged 22.4 ± 2.6 young (range = 4–30; n = 39) and was positively associated ($r = 0.76$; $P < 0.001$) with female body size (Hulse et al. 2001).

The Eastern Garter Snake is a very adaptable animal, for which traits such as body size and clutch size can vary among populations and over years. Our findings from PNR and LEAD suggest that body size difference alone was responsible for the inter-site difference in fecundity. These sorts of research questions, whether examined between sites during the same year or within sites



Relationship between clutch size and female body size in the Eastern Garter Snakes (*Thamnophis sirtalis sirtalis*) at two sites in Pennsylvania in 2009; Powdermill Nature Reserve (PNR) and Letterkenny Army Depot (LEAD).

between years, provide a better understanding of the range of responses in the life history traits of this species. We believe that our study might have implications for the assessment of future demographic trends and potential habitat management for the ubiquitous Eastern Garter Snake. Furthermore, given the current and widespread biodiversity crisis, additional long-term studies focused on life history traits and the systematics of northeastern ophidians are necessary to confirm or complement our current findings.

Acknowledgments

We extend our gratitude to Jack Leighow, Director of the State Museum of Pennsylvania, and to the crew at Powdermill Nature Reserve for support and camaraderie in this field research. We also thank the Letterkenny Army Depot Natural Resources Department, especially Randy Quinn and Craig Kindlin, as well as the Base Commander, Col. Cherri A. Provancha. Their constant support has made this and our ongoing research at PNR and LEAD possible.

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Homosexual Reproductive Behavior in the African Brown House Snake (*Lamprophis fuliginosus*)

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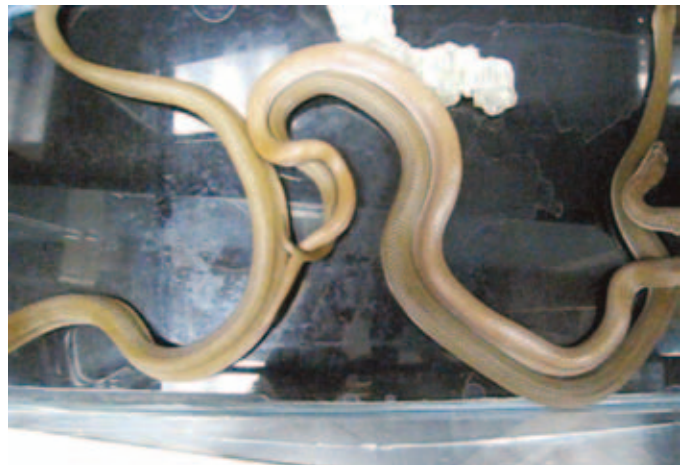
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The occurrence of homosexual behavior in male snakes is complicated by the presence of female-like reproductive pheromones in at least one species, *Thamnophis sirtalis*. The production of female-like pheromones by male *T. s. sirtalis* was first described by Noble (1937) in the “homosexuality” section of his paper. Noble (1937) suggested that males may have evolved female odors to confuse other males or that perhaps the courting males were conditioned to court by exposure to attractive females. Mason and Crews (2005) studied the occurrence and function of female-like reproductive pheromones in male *T. s. parietalis* from Manitoba, Canada, and concluded that the production of female-like pheromones by males (termed she-males) was a reproductive strategy that enhanced the mating frequency of males producing these pheromones.

Although males produce female-like pheromones, copulation between males is rare. Pfrender et al. (2001) observed a copulatory plug in the cloaca of a male *T. s. parietalis* that was being courted by several other males and postulated that this male, because it was courted by several males, was a she-male. They added that because of its moribund condition, this male might have been unable to resist copulation by the courting males. We do not consider male courtship of she-males an example of true homosexual behavior.

For species in which males are not known to produce female-like pheromones, male-male courtship or copulation has been observed only in captivity. Hardy (1998) described male-male copulation in *Crotalus scutulatus*. He suggested that the copulation might have resulted from the presence of female pheromones from the male’s body or from the cage floor. Shaw

(1951) described male-male courtship in captive *Pituophis melanoleucus* and postulated that this could have been due to the failure of chemical discrimination. Smith (1968) suggested that homosexual mating in snakes



Male African Brown House Snake (*Lamprophis fuliginosus*) courting another male. Note that the bodies are parallel, the head of the courting male is along the dorso-lateral surface of the target male and Male 1 is performing a tail search of the target male. A freshly shed skin of the courted male is present.

is a captivity-dependent behavior that occurs because the male's sexual discriminatory powers, which are largely olfactory and chemosensory, are dull and confused. The purpose of this paper is to describe true homosexual behavior in a snake.

The Aldridge lab has conducted over 300 trials designed to study the biology of sex pheromones in the African Brown House Snake (*Lamprophis fuliginosus*; Aldridge et al. 2005). The snakes were implanted with PIT tags (Trovan) for identification. The typical experimental design consisted of acclimating two males in an aquarium for about 10 min, then introducing a female. The snakes were then observed for a minimum of 30 min (in early experiments) to an hour or more in later experiments. The reproductive behaviors (modified from Gillingham 1979) were categorized as: (1) Tongue-flicking of the attractive snake; (2) chin-rubbing along the dorsolateral surface of the attractive snake; (3) writhing, the movement of the male's body when parallel with the attractive snake; (4) tail-searching on the attractive snake; and (5) copulation. The time of each specific behavior and the individuals involved was recorded. In all observations, male behavior was focused on the female. Any male behavior involving the other male in the aquarium appeared incidental.

Male 1, the subject of this note, was hatched in 1997. At the time of testing, the snout-vent length (SVL = 565 mm) and mass (94 g) of this male were within the normal range (SVL 590 ± 659 mm; mass 91.5 ± 24 g) of adult males in the colony. Male 1 was used in 42 trials in 2006 and 2007. In no instance did we observe behaviors aimed at the other male in the test arena. In January of 2008, Male 1 was observed courting and attempting to mate with another male (Male 2, SVL 580 mm, mass 134 g). The behaviors Male 1 displayed towards Male 2 were identical to courtship displays males typically displayed toward females. Male 1 chin-rubbed the dorsolateral section of the body of Male 2, and tail-searched and everted his hemipenis several times while courting Male 2. Later in January, Male 1 focused his attention on another male (Male 3), tail-searching and biting Male 3 on the neck. In a third trial, Male 1 primarily courted the other male in the aquarium, but mated with the female. The mating of Male 1 with this female may be the result of Male 1 attempting to mate with the male. A female mating with two males simultaneously is relatively rare in our trials (2 of 61 matings).

We assumed that the unusual behavior exhibited by Male 1 was due either to the presence of female sex pheromone residue on the skin of the courted males from previous trials or to the production of female pheromones by these males similar to those found in "she-male" *T. s. parietalis* (Mason and Crews 2005). To test these hypotheses, we tested the snakes courted by Male 1 with other male snakes. The protocol was similar to previous experiments, but instead of introducing a female, we introduced one of the courted males in each trial. In all of these trials ($n = 6$), neither of the males courted by Male 1 were attractive to other males. We concluded that the courtship of the males by Male 1 was not due to contamination of the male's skin with female pheromones or the presence of female-like pheromones in these males.

Male 1 was tested again with a male and an attractive female. Male 1 courted the male and not the female, and at 16 min into the trial, released uric acid while chin-rubbing the male, which is typical of males courting attractive females (Aldridge et al. 2005). At 65 min into the trial, both males were mating simultaneously with the female.

Male 1 was tested again in January 2009. In trial one, two males were acclimated for 10 min in the aquarium. These males ignored one another. After 10 min, Male 1 was added. Six minutes later, one of the males began to shed and completed the shed within 4 min. During and following the shed, Male 1 courted this male intensely. The other male was ignored. At 31 min, Male 1 excreted uric acid and continued to court the shed male for an additional 10 min when the trial was terminated. Within an hour, the shed male was then tested with two additional males to determine attractiveness. Neither of these males courted the shed male. A female was added to the aquarium at 30 min to determine if the males would court a female. All



Two male African Brown House Snakes (*Lamprophis fuliginosus*) simultaneously mating with a female.

three males courted the female, and two of these males released uric acid, suggesting that these males were sexually attracted to the female. In trial three, Male 1 and another male were acclimated to the aquarium for 10 min before the introduction of the same recently shed male. Male 1 again courted only the recently shed male. Thirty minutes into this trial, a female was added to determine if these males would court the female. All of the males, including Male 1, courted the female; however, only Male 1 also courted the recently shed male.

We conclude from these experiments and observations that the behavior of Male 1 represents an aberrant and rare reproductive behavior. This behavior was not due to the contamination of female pheromones on other males nor associated with production of female sex pheromones by these males. The behavior was not congenital because Male 1 only courted females during the latter two years of trials. The stimulus that triggered the reproductive behavior of Male 1 appeared to be pheromones on the dorsolateral surfaces of other males — and male sex-specific pheromones have been identified in *T. sirtalis* (Mason et al. 1989). However, additional test males did not find these male pheromones attractive. The courted males made no efforts to dislodge or escape from the courting male, perhaps indicating that homosexual behavior is so rare that mechanisms to discourage it have not yet evolved.

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Further Notes on Growth of Juvenile Timber Rattlesnakes in Northeastern Kansas

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Introduction

Since April 2003, we have studied a small population of Timber Rattlesnakes (*Crotalus horridus*, Fig. 1) resident at the field station of The University of Kansas Environmental Reserves, considerably expanding on knowledge of the species summarized in Fitch (1999). Our earlier papers involved few recaptures of Timber Rattlesnakes marked by HSF from 1990–2002, although one notable recapture was of an adult male (Fig. 2) marked by HSF in 1978 (Fitch and Pisani 2002). Although eastern Kansas is the western limit of the distribution of *Crotalus horridus*, based upon life history parameters for this population (Fitch and Pisani 2006, Pisani and Fitch 2006), the species in northeastern Kansas does not appear to be at an area of climatic limitation as reviewed by Martin (2002). The area is a mosaic of wooded limestone ledges and open fields of mixed forbs

and grasses, with an abundant potential prey base of small rodents (Fitch and Pisani 2006, Pisani and Fitch 2006).

Fitch and Pisani (2006) documented the expected high correlation between rattle base-segment width and snout-to-vent length (SVL) of Timber Rattlesnakes in this population. In their Figure-1, they presented a population growth curve, in part utilizing data from incomplete rattles placed by employing a modification of Klauber's (1956) "tree ring" approach; pros and cons of the methodology were briefly discussed by Fitch (2002). Use of a capture-processing protocol that attempts to minimize stress to the snakes has resulted in a considerable number of new records and recaptures (for a discussion of the *intimidation factor* see Brown 2008; we referred to this as *investigator effect* in Fitch and Pisani 2006). In the 54 years prior to 2003, HSF collected a total of 151 Timber Rattlesnake



GEORGE R. PISANI

Fig. 1. Female *Crotalus horridus*, second recapture in 14 months on 11 June 2006, 910 mm SVL, 506 g, Jefferson County, Kansas. Segments 11 + button. Note two copper wires on rattle secured to mark string at this capture and 22 April 2006. This female added 2 segments and 50 mm SVL from 15 April 2005–22 April 2006. She had moved ~190 m east, contained 8 embryos, and added one segment (and 30 mm SVL) since April 2006.



GEORGE R. PISANI

Fig. 2. Male *Crotalus horridus*, first recapture after 24 years on 22 May 2002, 1,200 mm SVL, 1,600 g, Jefferson County, Kansas. Segments 10, with many missing. Marked by HSF on 14 October 1978 at 995 mm SVL, segments 7 + button (see Fitch and Pisani 2002).

records from these same properties, whereas in the years 2003–2009, we have added 228 additional records. In our present database of 379 records, 123 are recaptures.

W.H. Martin (pers. comm. to GRP, October 2009) suggested the qualified applicability of Base50 Growing Degree Days (Base50-GDD) to *C. horridus* growth comparisons throughout the range of the species. He indicated that, as Base50-GDD is an agricultural metric and therefore plainly not by itself a sole determinant of *C. horridus* activity, a model incorporating such data should be explored. Correlations exist in many areas, suggesting that the abundant local Base50-GDD data available throughout the range of the species could be useful for approximating seasonal activity.

Growing degree day accumulations involve the amount of accumulated heat required for organisms to engage in normal metabolic life-cycle events (feeding and digestion, courtship, etc). Calculations of the Base50 growing degree day for a 24-hour period involve the following formula: $\text{Maxtemp} + \text{Mintemp}/2 - \text{Base temp (e.g., 50)} = \text{GDD}$. For a more extensive example, see: www.wunderground.com/about/faq/degreedays.asp.

The goals of this study were to revisit our conclusions in Fitch and Pisani (2006) and to compare the growth correlations mentioned therein with subsequent data from longer-term recaptures in the same population.

Methods

Data from the 59 records (largely recaptures) accumulated since Fitch and Pisani (2006) allow a more accurate assessment of growth, especially the

rapid growth shown by snakes of both sexes bearing rattles of up to button + 4 segments. We combined data on snakes with known growth histories with similar data collected since 1948 (Fitch Archive Database, Kansas Biological Survey). We then plotted and compared growth rates of male and female *C. horridus* to a generalized model of pit viper growth (Beaupre 2002), as well as to our 2006 papers.

When possible, we examined prey and compared sizes of prey taken with those of snakes. We palpated females to determine the presence of enlarged ovarian follicles.

We examined the potential seasonal activity of *C. horridus* in this small population using the regional data for Base50-GDD (between 1 March and 19 October, typically the limits of adult *C. horridus* activity at our site), and used repeated measures ANOVA to compare that to Base50-GDD over equivalent time periods in several eastern portions of the species’ range, where growth is far more gradual (Table 1). Our values are from NOAA airport databases (NOAA—National Climatic Data Center, www.airnav.com/airports/, last accessed 31 October 2009) at the localities in Table 1. We used the FAA Identifier to extract data from NOAA databases through Weather Underground (www.wunderground.com/history/airport/, last accessed 31 October 2009). Selecting the Custom tab and then specifying the dates retrieved the needed data. Base50-GDD data examined were for years 2003, 2004, 2008, and 2009. We began our detailed study of these snakes in 2003, which was characterized by typical spring and fall weather and an exceptionally warm dry summer. The following year was somewhat cooler, with considerably more precipitation (998 mm in 2004 versus 647 mm in 2003). Years 2008 and 2009 were the most recent years of our ongoing study. We used StatView software (Abacus Concepts 1991) to conduct statistical tests and produce graphical representations.

Results and Discussion

Local Potential Activity Season.—*Crotalus horridus* at our site experiences a significantly (Repeated Measures ANOVA; $p < 0.01$) longer potential activity season than at four comparison sites: two eastern localities at approximately the same latitude as Lawrence, and two from more northerly latitudes (Table 2; Fig. 3). All paired comparisons except MRB versus CKB differed significantly ($p = 0.05$). In general, the Base50-GDD decreases significantly and clinally to the northeast. We emphasize our agreement with W.H. Martin (pers. comm., 2009) that this metric, although useful for geographically broad comparisons, is not definitive for snakes that routinely thermoregulate behaviorally (see discussion in Huey 1991).

Feeding.—Fitch (1999) attributed the bulk of *C. horridus* prey biomass to larger rodents or lagomorphs, although he acknowledged that only the largest snakes (primarily males) fed on subadult Cottontails (*Sylvilagus*) or adults of genera of local larger rodents like *Sigmodon*, *Neotoma*, and *Sciurus*. However, given the small sample size (14 snakes

Table 1. Locations chosen for Base50-GDD comparisons.

FAA Airport Identifier	Name & Location	Latitude/Longitude (NAD83 Datum)	Elevation
LWC	Lawrence Municipal	39.0111111	833 ft/253.9 m
	Lawrence, KS 66044	-95.2164722	(surveyed)
MRB	Eastern WV Regional/Shepherd Field	39.4019031	565 ft/172 m
	Martinsburg, WV 25405	-77.9846686	(estimated)
CKB	Clarksburg Municipal	39.2966389	1217 ft/370.9 m
	Clarksburg, WV 26330	-80.2280833	(surveyed)
MGJ	Orange County Regional	41.5099722	364 ft/111 m
	Montgomery, NY 12549	-74.2646389	(estimated)
GFL	Floyd Bennett Memorial Airport	43.3412222	328 ft/100.0 m
	Glens Falls, NY 12804	-73.6103056	(surveyed)

Table 2. Mean Base50-GDD by station and paired comparisons between stations (LSD= Least Significant Difference); * significant at p = 0.05, ** significant at p = 0.01, ns = not significant.

Location	Mean Base50-GDD	Standard Deviation	Standard Error
LWC	3684.25	233.9606	116.9803
MRB	3158.00	152.0855	76.0428
CKB	3026.50	169.3960	84.6980
MGJ	2579.25	58.6025	29.3012
GFL	2085.25	88.3794	44.1897

Paired Comparison	Mean Difference	Fisher LSD test	F-test
MRB vs. MGJ	578.75	**	**
MRB vs. GFL	1072.75	**	**
MRB vs. LWC	-526.25	**	**
MRB vs. CKB	131.50	ns	ns
MGJ vs. GFL	494.00	**	**
MGJ vs. LWC	-1105.00	**	**
MGJ vs. CKB	-447.25	**	*
GFL vs. LWC	-1599.00	**	**
GFL vs. CKB	-941.25	**	**
LWC vs. CKB	657.75	**	**

of varying sizes in Fitch 1999), biomass may not be the best indicator of prey significance.

Although the number of identifiable stomach samples in our most recent data still is not large (28 of 379 snakes [7.4%] examined since 1948 contained 30 identifiable prey items), our data indicate that adults of rodent genera such as *Microtus* and *Peromyscus* are a dietary staple of adult *C. horridus* in this location. This is consistent with the broader studies of Clark (2002), among others. We earlier (Pisani and Fitch 2006) indicated that



Fig. 3. Old dark-phase male Timber Rattlesnake from Washington County, New York (estimated SVL 1,200 mm); the rattle has 16 segments with many missing (photographed in September 2007).

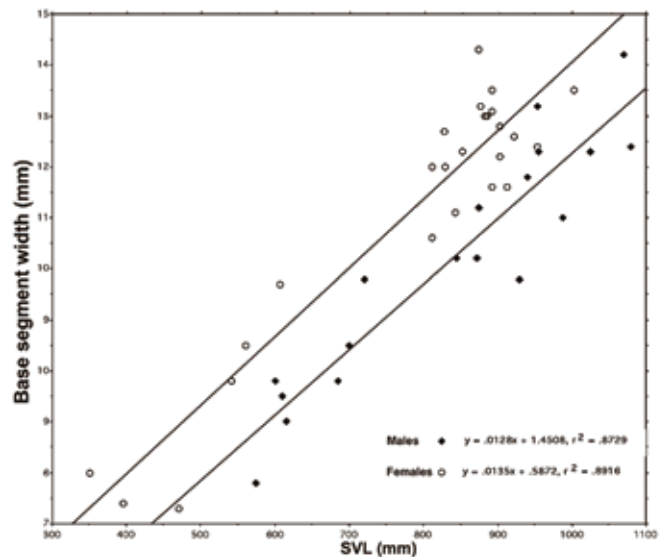


Fig. 4. Male and female SVL versus rattle base segment width and regression equations for *Crotalus horridus*, Jefferson County, Kansas with known growth histories.

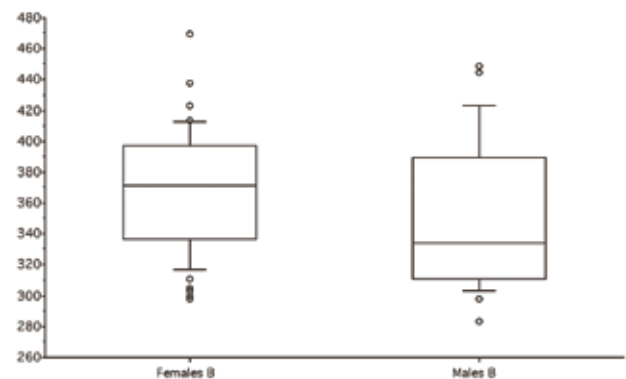


Fig. 5. SVLs (mm) compared for button-only stage female (n = 52) and male (n = 25) *Crotalus horridus*, Jefferson County, Kansas.

the structural complexity of the habitat utilized by our *C. horridus* population probably contributes to an abundant prey base. Such complexity has been reviewed for *Peromyscus leucopus* in a different locale by Anderson et al. (2003); their highest *P. leucopus* densities were in such habitat. Of the 30 identifiable prey items in our cumulative sample through 2009, 21 (70%) were microtines or soricids (*Blarina*, *Cryptotis*) found in 19 records with snake SVL range of 370–1,100 mm. The 9 “large prey” (*Sigmodon*, *Neotoma*, and *Sciurus*) were found in snakes 883–1,270 mm SVL (6 of the 9 with SVL > 1,000 mm). Most (234 of 330) *C. horridus* records in this area have been of snakes \leq 900 mm SVL.

Given the relatively long potential activity season of our population, the opportunity for neonates to feed and assimilate a meal prior to hibernation cannot be discounted. Nor can this be conclusively established, as just one of our neonates (female, 370 mm SVL) contained prey (*Cryptotis*). Martin (2002) stated that neonates in his High Allegheny Plateau population of *C. horridus* did not feed until the following spring.

Growth and Age at Maturity.—Male and female sizes as correlated with rattle base segment width change equivalently with age (slopes are insignificantly different, p = 0.05; Fig. 4). Average sizes at varying growth stages differ from our 2006 data with the addition of these new records (Table 3). SVLs of sexes in this population are neither significantly different at the “button-only” stage (Fig. 5), nor at subsequent stages of growth (Table 3, Fig. 6). Comparison of our Table 3 with similar data in Martin

Table 3. Rattle segments and mean SVL (mm) for male and female *Crotalus horridus* in Jefferson County, Kansas.

Males Segments	Mean (n; range; SE)	Females Segments	Mean (n; range; SE)
Button only	351.04 (25; 283–449; 9.58)	Button only	367.23 (52; 298–470; 5.34)
1 + button	492 (3; 464–530; 19.70)	1+ button	438.5 (2; 382–495; 56.5)
2 + button	587.17 (12; 525–632; 10.46)	2+ button	569.7 (10; 520–610; 8.18)
3 + button	643.75 (11; 570–712; 14.91)	3+ button	631.71 (7; 570–718; 19.19)
4 + button	723.25 (8; 647–816; 19.43)	4+ button	706 (4; 504–807; 69.23)
5 + button	769.25 (4; 658–845; 41.03)	5+ button	810 (2; 810; 0)
6 + button	753.25 (4; 716–800; 17.99)	6+ button	789.0 (11; 644–900; 27.69)
7 + button	894.75 (4; 820–999; 37.52)	7–11+ button	914.25 (4; 890–957; 14.82)
8 + button	864.6 (5; 790–921; 21.18)		
9–15 + button	1,000.75 (4; 910–1170; 60.14)		

(2002: Table 5) indicates that snakes in this Kansas population generally grow faster through rattle stages 5 + button (Fig. 7). However, not all snakes are able to attain maximal growth despite generalized prey abundance and a generally favorable thermal regime. Five of our snakes were at stage 1 + button (all taken in different years), and four of those were captured in June–July; the fifth (female, 495 mm SVL) was an October capture and likely was completing her first full season.

Our few snakes with known growth histories since their birth years confirm the rapid potential growth of neonates as reported in Pisani and Fitch (2006). Those data, combined with our new records for snakes bearing complete rattles, allow a more accurate picture of rattle segment number and growth in this population (Table 3), revising our results in Fitch and Pisani (2006: Table 3). For example, a female (646 mm SVL at first capture) added 72 mm SVL and one rattle segment from April–September 2003. Another female, born fall 2002 and marked (button only, 403 mm SVL) in April 2003, gained 487 mm SVL and had added 9 segments (average 54 mm per segment) when killed by a vehicle at the field station in September 2006. Through that time, she had added an average of three rattle segments per year and an average annual SVL increase of 162 mm. A third female (605 mm SVL in April 2006, segments 3 + button) had grown to 810 mm SVL by May 2009 and added five segments (average 41 mm per segment). These three females averaged an increase in SVL of 56 mm



Fig. 7. Rattle of young male *Crotalus horridus* (715 mm SVL), DOR, Jefferson County, Kansas, 8 September 2006. Rattle has 3 + button segments.

per rattle segment. Two other young snakes collected in May 2009 (both at rattle stage 2 + button) had SVLs of 550 mm (male) and 520 mm (female); an April 2006 female in the same 2 + button class measured 560 mm SVL.

Our four smallest females known to contain enlarged ovarian follicles averaged 822 mm SVL (range 803–834 mm). The smallest of these (five enlarged follicles) had eight rattle segments, with an indeterminate number missing. Another measuring 820 mm SVL had a 12-segment rattle lacking just the button. The five females having both enlarged ovarian follicles and complete rattles averaged 868 mm SVL (range 820–890 mm) with rattles averaging 7.6 (+ button) segments.

Cumulatively, these observations indicate that females in this population may readily add three segments per year through their third year and will have the potential to mate that year and bear a first litter during their fourth year, consistent with our earlier inference (Fitch and Pisani 2006). Taylor and DeNardo (2008) and Beaupre (2008) reviewed the relation among foraging success, growth (increased SVL), and reproductive effort in (respectively) *Crotalus atrox* and *C. horridus*. Evaluating our data in light of these studies supports our conclusion that female *C. horridus* in our population generally experience high foraging success.

In Table 4, we have added pooled button-only (indicated simply as “B”) records (Fitch Archive Database, Kansas Biological Survey) to our most recent records of snakes with known growth histories. Not unexpectedly, the great preponderance of B records are concentrated in the fall (September–November). However, 18.4% (9 of 49) female B records are

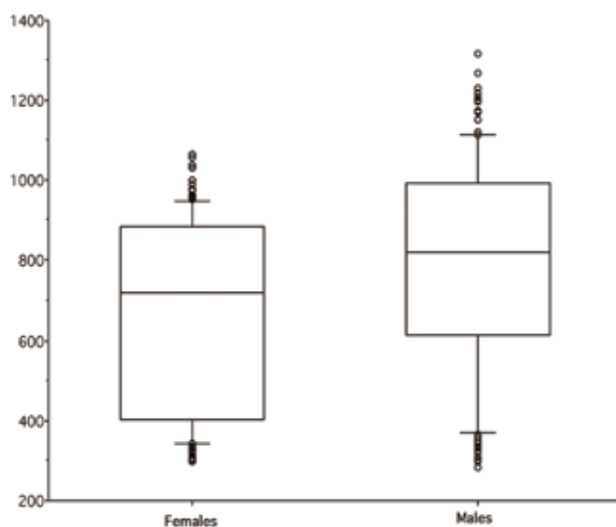


Fig. 6. Absence of significant sexual size dimorphism in *Crotalus horridus* from Jefferson County, Kansas. Females: mean \pm SE 664.93 \pm 18.86 mm (n = 163; r = 298–1065); males: Mean \pm SE 791.42 \pm 20.41 mm (n = 167; r = 283–1318).

Table 4. Distribution of rattle segment classes by sex and month of *C. horridus*, Jefferson County, Kansas. B = button.

April	May	June	July	August	September	October–November
Males						
3 + B (n = 5)	2 + B (n = 2)	1 + B (n = 1)	1 + B (n = 2)	2 + B (n = 1)	B (n = 7)	B (n = 12)
4 + B (n = 1)	3 + B (n = 1)	2 + B (n = 1)	3 + B (n = 1)	4 + B (n = 1)	2 + B (n = 3)	2 + B (n = 4)
5 + B (n = 1)	4 + B (n = 2)	3 + B (n = 2)	6 + B (n = 1)	8 + B (n = 1)	3 + B (n = 1)	3 + B (n = 1)
6 + B (n = 1)	5 + B (n = 1)	7 + B (n = 2)	7 + B (n = 1)		5 + B (n = 1)	4 + B (n = 4)
8 + B (n = 2)	10 + B (n = 1)		8 + B (n = 1)		6 + B (n = 1)	5 + B (n = 1)
	12 + B (n = 1)				7 + B (n = 1)	6 + B (n = 1)
					8 + B (n = 1)	
					9 + B (n = 1)	
					15 + B (n = 1)	
Females						
B (n = 9)	B (n = 3)	B (n = 1)	6 + B (n = 1)	B (n = 1)	B (n = 15)	B (n = 20)
2 + B (n = 2)	2 + B (n = 2)	1 + B (n = 1)		2 + B (n = 3)	5 + B (n = 1)	1 + B (n = 1)
3 + B (n = 1)	3 + B (n = 2)	3 + B (n = 1)		4 + B (n = 1)	7 + B (n = 1)	2 + B (n = 3)
6 + B (n = 3)	6 + B (n = 2)	4 + B (n = 1)		5 + B (n = 1)	9 + B (n = 1)	3 + B (n = 3)
8 + B (n = 1)		6 + B (n = 3)		6 + B (n = 1)		4 + B (n = 2)
		11 + B (n = 1)				

in April, with 10% (5 of 49) more recorded in the months of May, June, and August. As elaborated above, not all snakes are able to attain maximal rate of growth. Although 100% of male B records (n = 19) are fall-only, we presently feel that this is an artifact of the greater number of females in our sample.

Growth Rate and Models.—Beaupre (2002) presented a generalized model of pit viper growth. Underlying assumptions of the model are: (1) Large, infrequent meals, and (2) abrupt asymptotic reallocation of resources from growth to reproduction in females. The model was not intended to be all-inclusive, and did not consider such factors as an energy value for female annual maintenance activities (i.e., foraging to accumulate sufficient energy reserves for daily activity or for successful hibernation). Beaupre (2002) stated that: “It seems clear that food availability and temperature interact in complex ways to affect growth.”

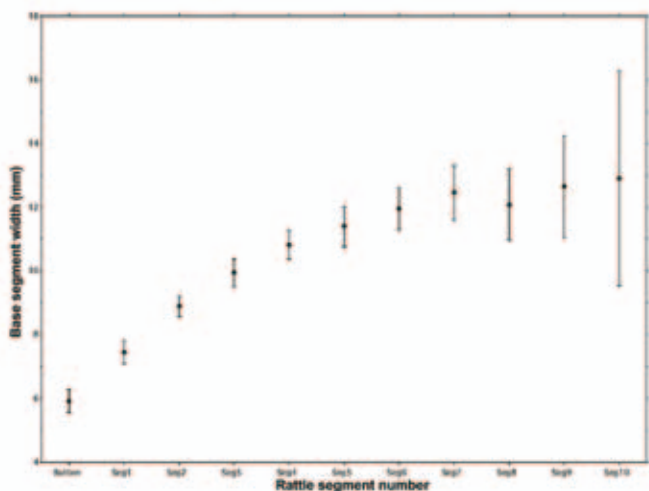


Fig. 8. Means and 95% confidence bars of rattle segments from *Crotalus horridus*, Jefferson County, Kansas with known growth histories (sample sizes as in Fig. 4).

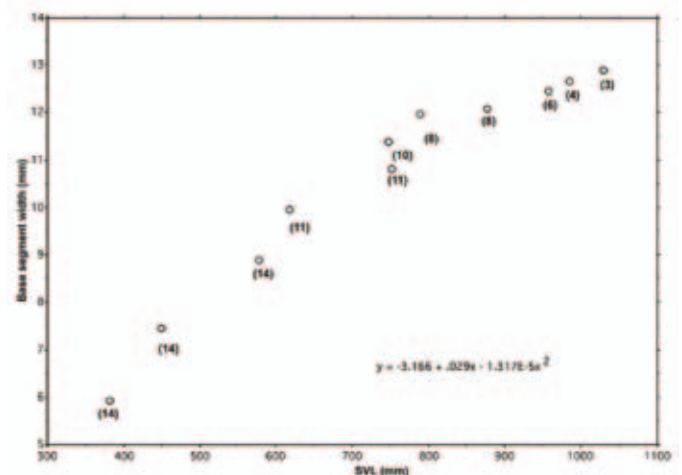


Fig. 9. Growth trajectory and 2nd-order polynomial equation for *Crotalus horridus*, Jefferson County, Kansas (circles are mean base segment width versus SVL, parenthetical numbers are sample sizes).

Older females in our population, as predicted by Beaupre’s (2002) model, seem to cease their rapid early SVL increase (Table 3), although ecdysis may remain frequent. One example is an 840-mm SVL female (rattle stage 8 + button, April 2005) that had added just 70 mm SVL by June 2006, but four rattle segments (average 17.5 mm per segment).

Using our data from 2006–2009 (pooled sexes) of snakes with complete (button present) rattle strings or snakes with known growth histories, we plotted increases in SVL and width of base rattle segment (Figs. 8 & 9). The best-fit second-order polynomial regression of those data (Fig. 9) using mean values at each rattle segment is favorably comparable to the “tree rings” plot of our data in Fitch and Pisani (2006, Fig. 8), giving us increased confidence in our 2006 conclusions. Pooled (male + female) growth trajectory data from our snakes (Figs. 8 & 9) seem to us to be most similar to that of males in Beaupre’s (2002) model, with higher Mean Foraging Success of 0.050–0.075 and a +4 to +8 °C thermal regime.

Conclusions

Our most recent data confirm the pattern of growth in this population of *C. horridus* noted in our 2006 papers (very rapid growth through the fourth post-button shed; Fig. 10). By that stage, males have attained an average SVL of 723 mm and females an average SVL of 706 mm. This would seem to be a result of the abundant prey base in a habitat mosaic, combined with a significantly longer average potential growing season than at eastern localities of the same latitude and similar altitudes, or at more northerly latitudes (Fig. 11).

Rapid growth facilitates earlier female reproduction in our population than *C. horridus* shows at parts of its range characterized by shorter growing seasons (Brown 1993, Martin 2002). A potentially longer activity season and a rich resource base also no doubt facilitate female accumulation of sufficient energy reserves to reproduce more frequently than in localities more limited in energy and/or thermal resources.

The growth curve presented by Fitch and Pisani (2006), although based largely on averaging rattle segment data and fitting snakes to presumptive size-age classes, accurately compares to the present more restricted calculations using only snakes with known growth histories and/or complete rattle strings. Continued studies will refine applicability of mathematical models to observed growth in this population.

We will continue to explore weather variables that are collected both locally and nationally and that, when combined with Base50-GDD, will allow better approximation of actual microclimates available to *C. horridus* in this population. The ability to use widely available historical weather data relevant to *C. horridus* life history would allow refinement of modeling through the range of the species.

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Fig. 10. Male *Crotalus horridus* (Douglas County, Kansas), August 2006. Estimated SVL 1,000 mm, rattle has 6 segments with many missing.



Fig. 11. Female yellow-phase *Crotalus horridus* (Washington County, New York), September 2007. Estimated SVL 600 mm, rattle has 7 + button segments. This snake is considerably older than a female from Jefferson County, Kansas at a comparable rattle stage.

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GEORGE R. PISANI

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ALEJANDRO J. SÁNCHEZ MUÑOZ

The Baoruco Long-snouted Anole (*Anolis bahorucoensis*) occurs on the island of Hispaniola in the Sierra de Baoruco (Dominican Republic) and the Massif de la Selle (Haiti). When Henry Fitch became aware of this slight, brilliantly patterned lizard, he wondered why it has such a weakly developed dewlap. He spent time in the Dominican Republic (Fitch and Henderson, 1987. *Amphibia-Reptilia* 8:69–80) recording perch characteristics, movements, and behavior — and noted that displays were muted when compared to those of most anoles. The explanation for the small dewlap and inobtrusive displays became obvious when he put some of these little lizards in inflated plastic bags and watched much larger *Anolis coelestinus* and *A. cybotes* try to attack them. He had a great time.



ALEJANDRO J. SÁNCHEZ MUÑOZ

Puerto Rican Crested Anoles (*Anolis cristatellus*) were introduced into the city of La Romana during the U.S. occupation of the Dominican Republic in 1916–1924. They became ubiquitous throughout the city during the following decades. Intrigued by the possible effects on endemic Hispaniolan anoles, Henry Fitch spent time monitoring the distribution, perch characteristics, and behaviors of La Romana's introduced and native anoles (Fitch et al. 1989. *Amphibia-Reptilia* 10:307–320). The Hispaniolan Stout Anole (*A. cybotes*) was completely displaced from areas occupied by its Puerto Rican counterpart. Northern Green Anoles (*A. chlorocyanus*; illustrated here) co-existed with *A. cristatellus*, but were restricted to trees with smooth bark, on which the invasive anole was at a disadvantage due to its less-developed adhesive toepads.



Amazon Treeboa (*Corallus hortulanus*) with a portion of its head submerged, possibly foraging for fish.

Observations on Habitat, Activity, Foraging, and Diet in the Amazon Treeboa, *Corallus hortulanus*, on Batatas Island, Parnaíba Delta, Piauí, Brazil

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Photographs by the senior author except where indicated.

Batatas Island represents a small portion of Parnaíba Delta, measuring 15 km², bordered to the west by the Rio Parnaíba and to the east by Lontras and Mirim creeks. Most of the land is devoted to agriculture, rice in the region that comprises gallery forest, and sugarcane and banana plantations in the interior.

Between June 2009 and September 2010, 80 encounters with Amazon Treeboas (*Corallus hortulanus*) resulted in a total of 144 hours of observations of individuals in size classes ranging from juveniles to large adults. Forty percent of observations were of adults, 50% subadults, and 10% juveniles.

Habitat. During the day, 22 individuals of *Corallus hortulanus* (coiled with head hidden) were observed on branches of various tree species (e.g., *Rhizophora mangle*, *Inga* sp., *Avicennia germinans*, and *Montrichardia linifera*) along creeks (igarapés). They were usually in shade, possibly rendering it difficult for potential predators to see them, but also minimizing diurnal heat load (Henderson 2002). Minimum and maximum nocturnal perch heights varied according to high and low tides; some individuals were observed at 1.2–1.9 m on moonless nights, but during the full moon, perch heights were 2.3–4.1 m. During the full moon, only few individu-



Corallus hortulanus habitat on Batatas Island.



One of several creeks meandering through mangrove habitat on Batatas Island.

als were observed, and birds, rodents, and other reptiles seemed to prefer spending those nights in deep shade in the interior of the island. Likewise, Henderson (2002) found *C. grenadensis* activity depressed on bright moonlit nights in Grenada, and W.W. Lamar (in Henderson 2002) observed *C. hortulanus* foraging in deep shadows on moonlit nights in Amazonian Peru.

Activity, Foraging, and Diet. Most foraging activity occurred between 1800 h and 2330 h. Between 2400 h and 0545 h, activity decreased and only ten active boas were observed while 15 were partially coiled with the head facing down. These observations of nocturnal activity are remarkably similar to those for *C. grenadensis* on Grenada: Peak nocturnal activity between 1800 h and 2400 h, and a decline from 2400 h to 0535 h (Henderson and Winstel 1997, Henderson 2002, and references therein).

On 29 July 2009 at 1945 h in the Igarapé das Lontras, Ilha do Camaço, an adult *C. hortulanus* (about 1.90 m total length) was observed after capturing a Great Ani, *Crotophaga major* (Cuculidae). The elapsed time from capture to completion of deglutition was 30 min. The boa then spent the next seven days coiled in a tree along the creek. *Crotophaga major* is an abundant bird in the area and frequently uses trees along the banks of creeks for nesting. This is the first record of *C. hortulanus* preying on *C. major* (Henderson 2002, Pizzatto et al. 2009, and references therein).

On 4 September 2010, at 2030 h at Morros da Mariana creek, a juvenile *C. hortulanus* (~40–45 cm total length) was observed hanging by its tail, with a portion of its head submerged. During 15 min of observation, it submerged its head three or four times. Although a prehensile-tailed snake suspending its body to the surface of a body of water in order to drink

would not be unusual, for one to submerge a substantial portion of its head below the water's surface — and especially for a prolonged span of time — is highly unusual. Chippaux (1986) listed fish as occasional prey of *C. hortulanus* in French Guiana, and we suspect that the young boa might have been foraging for small fish. Although other Neotropical boids are known to prey on fish, they are largely aquatic snakes (i.e., Anacondas; *Eunectes* spp.). Hetherington (2006) observed *Oxybelis aeneus*, an arboreal vine snake, after it had captured a fish, and, like the small *C. hortulanus*, it was suspended from a branch above the water. *Oxybelis aeneus* is largely a lizard predator, and fishes are not typical prey. *Corallus hortulanus* is euryphagic, exploiting frogs, lizards, birds, and mammals (including bats) (Pizzatto et al. 2009). A young (i.e., inexperienced) snake might be especially opportunistic in prey choice. A *C. hortulanus* in the 40–45 cm size range is likely an active forager, searching for sleeping lizards and small birds. Submergence of its head below the water's surface might have been triggered by movement in the water while foraging above it or by observing activity below the water's surface while drinking. Alternatively, this might have been a foraging behavior used successfully on prior occasions.

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Corallus hortulanus in the process of shedding. Although the tree in which this snake is shedding is *Montrichardia linifera*, the senior author often observed shedding *C. hortulanus* in thorn-equipped *Machaerium lunatum*.



JORGE ARTUR DOS SANTOS

Corallus hortulanus swallowing a Great Ani (*Crotophaga major*).

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MATTHEW E. GIFFORD

Like many male anoles, Grenada Bush Anoles (*Anolis aeneus*) from Union Island erect nuchal and dorsal crests when reacting to another male or a perceived threat, which in this instance was the photographer.

The Reptiles of Union Island, St. Vincent and the Grenadines

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Union Island is located on the Grenada Bank midway between Grenada and St. Vincent and is equidistant from Barbados, Trinidad, and Martinique. Archeological studies show that Amerindian tribes settled here as early as 5400 BC and, since that time, used it as a stop-off point on their journeys until Europeans arrived in the 1750s (Homer and Collins 2008). In the late 18th century, slave traders and plantation owners cleared the land. Most was devoted to the farming of export crops (e.g., cotton; Howard 1952). Consequently, the island's forests are secondary, with the oldest extant forest (above Chatham Bay on the western side of the island) dating to 1834, when slavery was abolished and some of the island's large-scale cultivation came to an end. However, the plantation system continued until at least 1891, when Union is reported to have produced 34,200 lbs of cotton (Howard 1952). Presently, Union has a human population of about 3,000 and remains relatively undisturbed, especially above Chatham Bay and on the slopes of Mt. Taboi, the highest peak on the island.

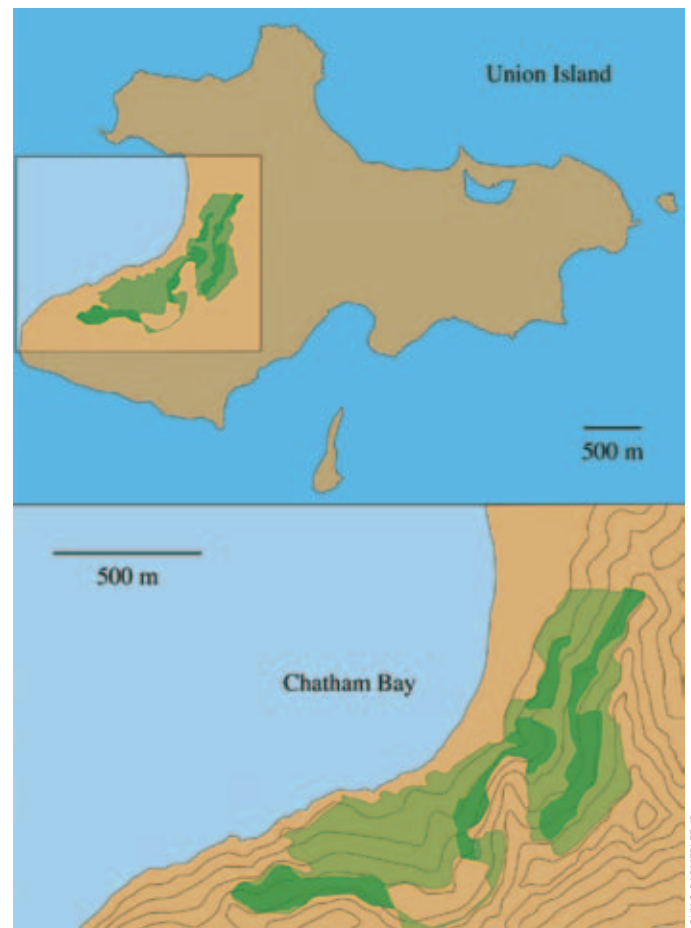
With an area of approximately 8.4 km² and a maximum elevation of only 330 m, Union is not high enough to "snag" cloud and trigger rainfall; an average of only 1,000 mm annually renders it a "dry island" (Daudin and de Silva 2007). As a result, its native vegetation is characterized as seasonal dry forest (Fiard 2003). Consequently, and in sharp contrast to the larger and more topographically diverse islands in the region, Union lacks native amphibians altogether, although drought-tolerant reptiles are locally abundant and surprisingly diverse.

Few herpetofaunal studies have been conducted on Union. Herein we present a summary of our June 2010 observations of Union's reptilian diversity, including some yet unpublished data. Our intent is to facilitate future research, a better understanding of small-island ecology, and the implementation of management plans capable of regulating or preventing potentially harmful development, especially in sensitive and important habitats such as the slopes above Chatham Bay. This habitat not only contains the highest diversity on Union (all species in this checklist are known to occur at this site with the sole exception of *Gymnophthalmus underwoodi*), it also contains the only known population of the Union Island Gecko, *Gonatodes daudini* (Powell and Henderson 2005, Daudin and de Silva 2007). Preservation of this area is a key to the conservation of Union's reptilian diversity.

Turtles (Reptilia: Testudines)

Chelonoidis carbonaria (Spix 1824). Family Testudinidae. English common name: Red-footed Tortoise. Neotropical endemic. Most likely introduced by Amerindians from the South American mainland (Daudin and de Silva 2007, Hansen 2010). The carapace is domed and varies from hatchling lengths of 45–63 mm to a maximum of 600 mm for males and 400 mm

for females (Ernst and Leuteritz 1999). Union turtles are smaller (adult males average 301 mm, adult females 264 mm; Hedman et al., in press). *Chelonoides carbonaria* is abundant in various habitats throughout the island. This species is omnivorous, but tends more toward herbivory, feeding on fruit, leaves, flowers, carrion, and even feces (Daudin and de Silva 2007). Listed in CITES Appendix II.



Map of Union Island, emphasizing the critically important habitat on the slopes above Chatham Bay (green) and areas providing habitat for the Union Island Gecko (*Gonatodes daudini*) with moist litter associated with rocky outcrops (dark green).



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The most frequently observed posture of Union Island Geckos (*Gonatodes daudini*) is hanging upside-down in a rock crevice above dense leaf litter.



ROBERT POWELL

Clifton Harbor is the largest town on Union Island. Carriacou, one of the Grenada Grenadines is visible in the distance.



ROBERT POWELL

A view of a fringing reef and nearby Palm Island from Union Island. The airport runway is just out of the image to the lower left.



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Critical habitat is provided by the old secondary forests in the area above Chatham Bay, on the northwestern slope of Mt. Taboi. Clearings for agricultural or residential purposes are evident near the far (northern) end of the area and a resort, currently servicing the yachts that anchor in the bay, can be seen expanding up the slope.

Lizards (Reptilia: Squamata)

Hemidactylus mabouia (Moreau de Jonnés 1818). Family Gekkonidae. Local name: Wood Slave. English common name: Tropical House Gecko.



ROBERT POWELL

Although Red-footed Tortoises (*Chelonoidis carbonaria*) are utilized as a food resource throughout much of their range (Farias et al. 2007), Union islanders shun the consumption of Red-footed Tortoises because of their indiscriminate diet that can include carrion and feces (Daudin and de Silva 2007).

Originating in the Eastern Hemisphere, these geckos are widely distributed in the Americas. The Union Island population is probably introduced, but might be descended from ancestors that arrived via natural overwater dispersal from the South American mainland or they could be of mixed origins. Tropical House Geckos are known to feed on arthropods, particularly dipterans, but might take small vertebrates and have even been known to engage in cannibalism (Bonfiglio et al. 2006). Like many geckos, *H. mabouia* varies in color. Typically very pale at night, individuals can be dark with light to dark brown crossbands. Although superficially similar to a small Turnip-tailed Gecko (*Thecadactylus rapicauda*), the two species can be distinguished by their toes. *Thecadactylus* digits are strongly dilated and webbed, and its retractile claws can be sheathed in a fold of skin, whereas toes of *Hemidactylus* are less widely expanded, not webbed, and lack retractile claws.

Thecadactylus rapicauda (Houttuyn 1782). Family Phyllodactylidae. Local name: Wood Slave (often confused with *H. mabouia*). English common name: Turnip-tailed Gecko. This Neotropical endemic (Russell and Bauer 2002) is most likely native to Union. These relatively large geckos (maximum SVL on St. Vincent 121 mm; Treglia 2006) are superficially similar to *H. mabouia*, but, in addition to size, can be distinguished by sheaths over their claws and a distinctive swollen tail when regenerated, hence the common name. Geckos on Union appear to be smaller than those known from elsewhere in the species' range. Predominantly nocturnal, these geckos are mostly encountered on tree trunks on Union. In regions where *H. mabouia*



JON BOONE

Native to Sub-Saharan Africa but widely distributed in mainland South America, *Hemidactylus mabouia* might have arrived in the West Indies either by natural over-water dispersal or as a hitchhiker with Amerindians (Jesus et al. 2001). These geckos thrive in disturbed areas that include human structures and dwellings (e.g., Ávila-Pires 1995, Vanzolini 1968).

does not reside, *T. rapicauda* tends to be edificarian (found on and in buildings) as well (Vitt and Zani 1997). Most activity occurs before midnight (Germano et al. 2003, Vitt and Zani 1997). Primarily insectivorous, *T. rapicauda* is an ambush forager (Cooper 1994, Cooper et al. 1999). Studies of other sympatric gecko species have found high rates of spatial competition on man-made structures (Case and Bolger 1991). Although known to co-occur on buildings on other Antillean islands (e.g., Howard et al. 2001,

Daniells et al. 2008), competitive interactions between *T. rapicauda* and *H. mabouia* might be partly responsible for their distribution on Union, where no *T. rapicauda* was seen on or in human-made structures.

Sphaerodactylus kirbyi (Lazell 1994). Family Sphaerodactylidae. English common name: Grenadine Sphaero. This Grenada Bank endemic (Powell and Henderson 2005) has a maximum SVL of 29 mm. *Sphaerodactylus kirbyi* is diurnal and lives in leaf litter, under rocks and fallen logs, and near termite mounds. On Union, it appears to be restricted to the relatively lush forests above Chatham Bay, where it is associated with areas of deep litter, in contrast to the ecologically similar Union Island Gecko, which is found primarily on and around rock outcroppings. Its diet consists of small arthropods. Dorsal ground color is gray-brown with markings varying from numerous small dark gray blotches to patternless. The venter is dark gray with faint stripes around the neck. In most individuals a V-shaped gray-black line begins in the area of the hind legs and extends onto the tail. The underside of the tail is a slight rosy-orange. Chin, throat, and sides of the head are yellowish.

Gonatodes daudini (Powell and Henderson 2005). Family Sphaerodactylidae. Local name: Union Island Gecko. English common name: Grenadines Clawed Gecko. Apparently a Union Island endemic (known only from the island) and the only member of the genus endemic to the Antilles (Powell and Henderson 2005), this small gecko (average SVL = 27.8 mm, average mass = 0.56 g) presumably feeds on arthropods (based on habits of other congeners; e.g., Vitt et al. 2000). With a bright red-orange iris and dorsolateral white spots surrounded by black and larger



MELI RIVERA RODRIGUEZ

The Turnip-tailed Gecko (*Thecadactylus rapicauda*) is frequently confused with the Woodslave (*Hemidactylus mabouia*), although its large, swollen regenerated tail and sheathed claws readily distinguish the two.



MEL J. RIVERA RODRIGUEZ

The Grenadine Sphaero (*Sphaerodactylus kirbyi*) is the smallest reptile on Union, weighing an average 0.3 g.



concentric red rings on a dark green ground color (Powell and Henderson 2005), these little lizards appear to have been decorated for the holidays. Apparently crepuscular, *G. daudini* seems to cease activity when ambient air temperatures exceed those under boulders and logs or in the crevices of rock outcroppings where geckos seek shelter during the day. The slopes above Chatham Bay provide the only habitat where a population is known to exist.



ROBERT POWELL

The Grenada Bush Anole (*Anolis aeneus*) is ubiquitous throughout Union, and the most commonly encountered species on the island. Found on trees, deadfall and other debris, and man-made structures such as fences and buildings, this arboreal lizard is not timid, and is known to direct territorial displays toward humans who venture too close.



MEL J. RIVERA RODRIGUEZ

Known to occur only on the slopes above Union's Chatham Bay, the Union Island Gecko (*Gonatodes daudini*) could be driven to extinction if proposed plans for developing the bay area are implemented (Daudin and de Silva 2007).

Anolis aeneus (Gray 1840). Family Polychrotidae. Local name: Tree Lizard. English common name: Grenada Bush Anole. Endemic to the Grenada Bank, the largest individual recorded (SVL = 73 mm) on Union was slightly smaller than the maximum size of individuals from Grenada (SVL = 77 mm; D. Crews in Stamps 1977) and an introduced population in Guyana (SVL = 80 mm; Lazell 1972). Tolerant of both xerophilic and mesophilic conditions (Schwartz and Henderson 1991), these lizards are active from dawn to dusk and are ubiquitous in natural and human-altered habitats on



MATTHEW E. GIFFORD

Although not as large as conspecifics on some other islands, Green Iguanas (*Iguana iguana*) are the largest reptiles on Union. These bulky lizards are diurnal but were frequently seen at night sleeping in tree canopies.

Union. *Anolis aeneus* is predominantly insectivorous, but larger individuals on Grenada engage in herbivory (Schoener and Gorman 1968). Ground color varies from dark gray to green and pale tan, and some individuals have spots and/or dorsolateral stripes. Males have a bright yellow dewlap. Males especially are approachable, do not frighten easily, and will perform push-ups, dewlap extensions, and head-bobbing, all considered signs of territoriality (Stamps and Barlow 1972), when approached by people. When disturbed, however, these lizards tend to “squirrel” around to the opposite side of their perch, but eventually move upward, often to the highest branches of a tree.

Iguana iguana (Linnaeus 1758). Family Iguanidae. Local name: Iguana. English common name: Green or Common Iguana. These Neotropical endemics are the largest reptiles on Union. They are diurnal, spending nights sleeping in tree canopies. We saw few adults on Union, where they are hunted for food. In contrast, individuals of all ages are abundant where they are protected on nearby islands (e.g., Palm Island and Tobago Keys). While coloration varies from pale tan to bright green, and many adults have black or white transverse bars, the smaller individuals on Union were uniformly green. A dorsal crest and a large scale below each ear opening are prominent. Iguanas are completely herbivorous (Troyer 1984), although some reports indicate that juveniles will take insects and some individuals will scavenge (Henderson and Powell 2009). Very agile for their build, iguanas will tail-whip in defense, but typically will not bite unless incited (Swanson 1950). Listed in CITES Appendix II.

Mabuya sp. (Lacépède 1788). Family Scincidae. Local name: Snake Servant. English common name: Lesser Antillean Skink. The taxonomic status

of West Indian populations currently assigned to the genus *Mabuya* is poorly resolved, and populations on each island bank should be considered endemic to that bank until detailed studies have been conducted. Skinks are rare on all islands save Dominica (Malhotra et al. 2007). Antillean skinks usually are associated with tropical dry scrub and arid regions (e.g., Rivero 1978). Although primarily terrestrial, they readily climb into high vegetation or even on buildings. With a bronze ground color and a dark lateral stripe, skinks superficially resemble *Gymnophthalmus underwoodi*,



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The Lesser Antillean Skink (*Mabuya mabouya*) is primarily terrestrial; however, it will readily climb trees, boulders, and buildings to bask or forage.



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ROBERT POWELL

To escape predators, the Ground Lizard (*Ameiva ameiva*) will bipedal and can reach peak speeds approaching 300 cm/sec. Adults (left) are not territorial and frequently forage in close proximity to one another, although fights and chases occasionally ensue when paths converge. Juveniles (right) have a distinct striped pattern, which blends well with surroundings as individuals move through grass or open vegetation.

with which they are sometimes confused. However, skinks are substantially larger (maximum SVL = 87 mm for males and 93 mm females; Schwartz and Henderson 1991). Exclusively diurnal, with an activity peak at midday (Rocha et al. 2009), these active foragers feed mostly on insects and wood lice (Malhotra and Thorpe 1999).

Ameiva ameiva tobagana (Cope 1879). Family Teiidae. Local name: Ground Lizard. English common name: Giant Ameiva. These large (average male SVL on Union = 98 mm, average female SVL = 89 mm) Neotropical endemics are often heard scurrying through vegetation. They tend to thrive in warm/dry environments (e.g. grassy beaches, dry shrub, and under beachside *Coccoloba* trees). The head is large and narrow and a bifurcated snake-like tongue is used to find food. *Ameiva ameiva* is an omnivorous active forager, rooting in leaves and gravel for small arthropods and seeds. They have been seen scavenging road-killed animals on Union. The ground color is gray laterally and ventrally suffused with blue or green, with the blue color most prominent in males. Active predominantly during the morning and early afternoon, activity is curtailed and stops altogether by late afternoon. If threatened, these lizards take flight with surprising speed and often run on their hindlimbs.

Gymnophthalmus underwoodi (Grant 1958). Family Gymnophthalmidae. Local name: Snake Servant (often confused with *Mabuya* sp.). English common name: Smooth-scaled Worm Lizard. These Neotropical endemics are most likely native on Union. However, they are adept colonizers and are being recorded from an increasing number of Antillean islands. Colonization is facilitated by parthenogenic reproduction (i.e., all individuals are females and can reproduce without a male; Hardy et al. 2005). These are small lizards (maximum SVL = 48 mm) with a tail as long or longer than the head and body. Quite heat-tolerant and active by day, Worm Lizards are encountered mostly in and under leaf litter (e.g., Germano et al. 2003), especially in areas with an open canopy that allows sunlight to penetrate. They are bronze/brown dorsally with the sides a shade darker. The tail is long and slender and breaks easily, which appears to serve as a means of escaping predators. These lizards are quick and evade capture by running, turning sharply, and porpoising through leaf litter.

Bachia heteropa alleni (Barbour 1914). Family Gymnophthalmidae. Local name: Unknown. English common name: Earless Worm Lizard. This Neotropical endemic occurs on the South American mainland, Trinidad, Tobago, and the Grenada Bank (Dixon 1973, Henderson and Powell



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Often confused with skinks, Smooth-scaled Worm Lizards (*Gymnophthalmus underwoodi*) are substantially smaller, with a maximum head-and-body length of less than 5 cm.

Earless Worm Lizards (*Bachia heteropa*) move in a serpentine fashion, using their long tails for locomotion when on the surface; their reduced legs might serve as anchors when burrowing underground.



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ROBERT POWELL

We encountered only a few light yellow-orange colored Grenada Bank Treeboas (*Corallus grenadensis*; left), most snakes on Union had a taupe ground color with a dark pattern (right). Population densities are relatively low in the dry forests of Union compared to densities on larger, more mesic islands on the Grenada Bank.

2009). Individuals on Union reach a SVL of ~50 mm, with a tail that can be as much as 1.5 times as long as the head and body. The long tails are used in escape behaviors, such as tail-slapping and burrowing (John et al., in press). The basic pattern of the subspecies that occurs on the Grenada Bank involves three dark longitudinal dorsal lines that extend from the back of the head onto the tail. The sides are dark brown to blackish and the venter is light brown. Populations are locally dense on Union, especially in the shaded forests on the slopes above Chatham Bay. They are always under cover (logs, termite mounds, rocks; e.g., Germano et al. 2003), where they feed on small arthropods.

Snakes (Reptilia: Squamata)

Corallus grenadensis (Barbour 1914). Family Boidae. Local name: Congo Snake. English common name: Grenada Bank Treeboa. This Grenada Bank endemic occurs in a wide range of habitats from mature forest to dry scrub, but requires a contiguous canopy as they are loathe to descend to the ground (Henderson 2002). Nocturnally active, juveniles actively forage for sleeping anoles whereas adults feed almost exclusively on small rodents (Yorks et al. 2003a). Colors vary dramatically (Henderson 2002); on Union, most individuals are taupe with darker markings, but we encountered a few yellow snakes. Population densities on Union are low compared to most

habitats on Grenada, but comparable to the drier habitats on the larger island (Quinn et al., in press). Boas are readily detected by their reflective eye-shine when in a beam of light. Although calm when approached, boas readily bite and musk if handled. Listed in CITES Appendix II.

Mastigodryas bruesi (Barbour 1914). Family Colubridae. Local name: White Snake. English common name: Windward Tree Racer. This species is endemic to the Grenada and St. Vincent island banks (Greene et al. 2003). The diet of these slender-bodied diurnally active snakes consists primarily of frogs and lizards (mostly *Eleutherodactylus* and *Anolis*; Henderson and Powell 2009); however, due to the absence of frogs on Union, *M. bruesi* most likely feeds exclusively on lizards. Dorsal coloration is bluish gray to brown with light lateral stripes, a light venter, and a dark eye line. They are typically arboreal when sleeping but are regularly spotted on the ground sunbathing or traveling between stands of trees during the day. When threatened, however, individuals on Union escape almost exclusively by climbing rapidly into trees (Rivera Rodríguez et al., in press-a).

Tantilla melanocephala (Linnaeus 1758). Family Colubridae. Local name: unknown. English common name: Black-headed Snake. Native to the Neotropical mainland, Trinidad, and Tobago and introduced on Union



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JON BOONE

The White Snake (*Mastigodryas bruesi*) is the only one of Union's snake species that is active and frequently encountered during the day.

The Black-headed Snake (*Tantilla melanocephala*) is a small, inconspicuous species only recently introduced onto islands of the Grenada Bank.



MEL J. RIVERA RODRIGUEZ

Until its rediscovery this year in the Chatham Bay area on Union Island, the Grenada Bank Blind Snake (*Typhlops tasymicris*) was known previously from only two individuals collected on Grenada in 1968.

(Henderson and Powell 2006), probably with shipments of gravel or sand used in road construction. Found on Union under rocks in moist, loose soil along rock ledges in shade (J. Boone in Henderson and Powell 2009). Their small size and secretive nature renders these snakes inconspicuous and difficult to detect. They feed primarily on small invertebrates (Boos 2001). Although probably no threat to other snakes on Union, if *T. melanocephala* populations increase significantly, they could compete with insectivorous lizards (Berg et al. 2009).

Typhlops tasymicris (Thomas 1974). Family Typhlopidae. Local name: N/A (newly discovered on Union). English common name: Grenada Bank Blind Snake. Little is known about this Grenada Bank endemic (Germano et al. 2003, Yorks et al. 2003b). Until rediscovered on Union in 2010 (Rivera Rodríguez et al., in press-b), only two subadult females caught in 1968 on Grenada were known to science. All Union Island snakes were under cover in moist substrate on the slopes above Chatham Bay. Two were found under deep leaf litter, two (including an individual that escaped) under rocks, and one under a termite mound. These fossorial snakes have blunt heads with eyes covered by scales, hence the common name. A spike at the end of the very short tail is used as an anchor in burrowing. The overall appearance is very similar to an earthworm, with which Blind Snakes are often confused.

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A Northern Ringneck Snake (*Diadophis punctatus edwardsii*) from Algonquin Provincial Park, Ontario.

Burying Beetles as Parasitoids of Northern Ringneck Snakes

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Photographs by the senior author.

The Burying Beetle (*Nicrophorus pustulatus* [Coleoptera: Silphidae]) has been identified as a parasitoid of the eggs of Eastern Rat Snakes (*Scotophis alleghaniensis*, formerly assigned to *Elaphe obsoleta*) (Blouin-Demers and Weatherhead 2000, Keller and Heske 2001), the only known breeding medium for this beetle species in the wild (Blouin-Demers and Weatherhead 2000, Smith et al. 2007). However, *N. pustulatus* has been found in areas devoid of Eastern Rat Snakes, albeit in low numbers (LeGros and Beresford 2010, Brousseau et al. 2010), suggesting that *N. pustulatus* must breed on some other medium.

Although *N. pustulatus* can be reared on carrion in captivity, the species shows a preference for snake eggs (Smith et al. 2007). Because of this, recent authors (Smith et al. 2007, LeGros and Beresford 2010) have suggested that this parasitoid could have a negative impact on Eastern Rat Snake populations and other threatened oviparous snakes.

On 19 July 2010, while randomly searching under stones during a survey of the local herpetofauna, a nest of snake eggs was found near the Algonquin Park Visitor Centre in Algonquin Provincial Park, Sproule Township (W 4535156, N 07821511). The nest was located on soil beneath a flat slab of granite (75 x 50 cm by 20 cm thick) in a small clearing of moss-covered granite within a forested area comprised of Sugar Maple (*Acer saccharum*), Red Oak (*Quercus rubra*), and White Pine (*Pinus strobus*).

The eggs were identified as those of the Northern Ringneck Snake (*Diadophis punctatus edwardsii*). Clutches of *D. punctatus edwardsii* are usually comprised of 3 or 4 eggs (Logier 1970), but a maximum of 10 has been recorded. Also, communal nesting of several females is known in this species (Blanchard 1942, Gilhen 1970). We counted 19 eggs in the nest, all of which had been killed. *Nicrophorus pustulatus* larvae were feeding amidst the ruined eggs. A single adult male *N. pustulatus* was collected from the nest, and a second adult escaped into a cavity in the soil below.

This is the second species of snake eggs on which *N. pustulatus* larvae have been observed feeding in the wild. Our results explain why the range

of *N. pustulatus* is not limited to the distribution of *Scotophis alleghaniensis*, but might include any oviparous snake. Given this evidence, research into *N. pustulatus* is potentially important for the conservation of endangered or rare snake species (Smith et al. 2007). Indeed, we see no reason to exclude investigation of the eggs of other taxa (e.g., turtles, which have been shown in the laboratory to be a suitable, albeit not a favored host of *N. pustulatus*; Smith et al. 2007) as potential hosts for this beetle parasitoid in a natural setting.

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Two Burying Beetle (*Nicrophorus pustulatus*) larvae amidst empty eggshells.



Intact Northern Ringneck Snake eggs in a nest in Algonquin Provincial Park, Ontario.



A dark-phase adult Banded Gila Monster (*Heloderma suspectum cinctum*) from Washington County, Utah.

Dark-phase Banded Gila Monsters (*Heloderma suspectum cinctum*) in Southwestern Utah

Cameron B. Rognan

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Photographs by the author.

On 18 May 2010, I observed a darkly colored Banded Gila Monster (*Heloderma suspectum cinctum*) in the Red Cliffs Desert Reserve, about 10 km northeast of St. George, Washington County, Utah. This location is near the very northeastern limit of the species' distribution. This Gila Monster was a small adult, measuring approximately 380 mm in total length, with a SVL of approximately 260 mm. The banding pattern and other dark markings on this lizard do not fit the original description of *H. s. cinctum* (Bogert and Martín del Campo 1956). However, the coloration does resemble a similarly dark individual that was collected in 1982 approximately 11 km to the southwest (Beck 1982). One notable exception to the pattern of this Gila Monster is the presence of black dorsal mottling that blends in with the more typical bands. While adults in the reticulated subspecies (*H. s. suspectum*) lose their juvenile bands, most *H. s. cinctum* adults retain their juvenile banding pattern. As is the case with this Gila Monster, remnants of juvenile bands are visible, but they are largely masked by the presence of black mottling.

The Gila Monster was observed walking and occasionally resting under rocks or shrubs over entirely red-colored sand and sandstone. While this substrate differs from the black basaltic rock where Beck collected a dark-phased Gila Monster in 1982, an abundance of black cryptobiotic crust in the vicinity may still provide fitting camouflage. The dark mottling pattern on this Gila Monster effectively blended in with the interspersed cryptobiotic soil crust. Additionally, a black basaltic lava flow was only 350 m away, potentially within the Gila Monster's home range. These local

habitat features may create a selective force that is strong enough to support darker and mottled dorsal patterns in a geographic area where the light and distinctly banded pattern normally dominates. In New Mexico, where the reticulated pattern of *H. s. suspectum* should dominate, several observations of distinctly banded and light colored Gila Monsters have been recorded (Beck 2005). The variation in the dorsal patterns of *H. suspectum* is perhaps more diverse, even at the extremes of their distribution, than originally presumed when the subspecies were first described. These recent observations, in addition to genetic evidence (Douglas et al. 2010), suggest that the subspecies recognition of *H. s. cinctum* and *H. s. suspectum*, based on morphology alone, might not be warranted.

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The presence of black dorsal mottling that blends in with the more typical bands is unusual in Banded Gila Monsters (*Heloderma suspectum cinctum*).



Typical pattern of Banded Gila Monsters (*Heloderma suspectum cinctum*) in Washington County, Utah.



AGEL KWET

Male *Bokermannohyla hylax* from Blumenau, Santa Catarina, Brazil.

Use of Natural Marks to Identify Individual *Bokermannohyla hylax* (Amphibia: Anura)

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Photographs by the senior author except where noted.

Abstract.—Of 16 *Bokermannohyla hylax* (13 males and three females) assessed during a seven-month field study in Blumenau, Santa Catarina, Brazil, five were recognized visually by natural marks when recaptured and the other eleven from photographic records of the flanks and dorsum. This is the first time that identification by natural marks has been used to individually identify frogs. To test this method, waistbands with colored plastic beads were tied to the frogs' waists to verify individual recognition upon recapture. Photographic identification is a scientific tool that consists of cataloging photographs of the animal for individual recognition and

later identification in studies of behavior and population dynamics. Many individuals displayed thanatosis upon handling and some vocalized. Such vocalization is distinct from those associated with territoriality, advertisement, and release calls. The identification of individual *B. hylax* using digital images was an efficient, low-cost, and non-invasive method that might be of benefit in the study of other amphibian species.

Some marking techniques currently used in studies of amphibians are extremely aggressive and are not recommended for certain taxonomic groups due to dermal sensitivity, small size, or the potential for dermal regeneration. Given amphibian physiology, these limitations extend to care in using subcutaneous pigments (Donnelly et al. 1994). Most tags, such as plastic or metallic plates used for some reptiles and amphibians, have



Male *Bokermannohyla hylax* with a waistband bearing a unique combination of beads used for individual identification of frogs.



Bokermannohyla hylax with a waistband in natural habitat.



Male *Bokermannohyla hylax* in a bromeliad.



Individuals were released immediately after waistbands were attached.

been adapted from studies of birds or fish, but the relative size of such tags compromises behavior in small individuals. Their use in amphibian studies is consequently questionable (Raney 1940, Woodbury 1956).

A commonly used and inexpensive method for marking amphibians is toe-clipping. Among reptiles, the natural loss of toes justifies the use of this method (Middelburg and Strijbosch 1988, Hudson 1996); however, the natural loss of toes does not indicate the absence of trauma. Even though the amputation apparently does not affect the overall performance of some lizards (Guttman and Creasey 1973), a study by Clarke (1972) showed that a low recapture index as well as a low survival rate was displayed by anurans of the genus *Anaxyrus* (formerly *Bufo*) that had been toe-clipped. Clarke (1972) also noticed that the recapture index had an inverse relation to the number of clipped toes, and that affected frogs demonstrated lower dexterity while handling prey. With salamanders, the problem is the quick regeneration of amputated parts, making the permanent identification of individuals much more difficult.

Clearly, researchers need to develop a new and efficient marking technique for amphibians, one that will not cause physiological, biological, or behavioral harm, and does not qualitatively or quantitatively affect data. The use of unique natural marks for identification in herpetological research is one alternative. Some limitations exist. In chelid turtles, plastral marks might be vulnerable to ontogenetic variation and care must be taken to mark areas that do not change with age (Cabrera and Colantonio 2001). The objective of our research was to record unique characteristics of individual *Bokermannohyla hylax*, enabling “mark”-recapture population studies of this species.

Methods

The study was conducted in Parque Natural Municipal São Francisco de Assis (26°55'07.71" S, 49°04'33.79" W), a conservation unit in Blumenau, Santa Catarina State, Brazil. The study area consists of steep hillsides cov-

ered by dense mesic forest (Veloso et al. 1971) in different successional stages. The 23-ha park, which is bisected by a stream, is a fragment of the Brazilian Atlantic Forest and located downtown in the city of Blumenau.

Sampling took place from June 2006 to May 2007. A total of 26 bi-weekly assessments were performed at pre-determined sites. Efforts to locate nocturnally active *Bokermannohyla hylax* extended from 2030–0230 h and involved a total of 156 person-hours.

All sites were sampled during each visit, generally in the following order: Lake at the entrance of the park, dock beach, dock stream, lower quadrant, and stream hill. This sequence was occasionally inverted due to active vocalization at various sites. We searched for frogs in trees, bromeliads, shrubs, and water lilies in and in proximity to permanent or temporary bodies of water. All environments are favorable for anuran mating. Individuals were located primarily by their calls. Once found, a flashlight was used to capture vocalizing males.

We recorded weight, tympanum diameter, toe-disk diameter, snout-vent length, and foot length (using a Vernier Caliper 50 x 0.05 mm/6x1/128") for each individual, noted any abnormalities, and documented ambient conditions (temperature, relative humidity, atmospheric pressure). Following measurement, the flanks and dorsum of each frog were digitally photographed to record individual patterns of crossbands and other marks. This process was facilitated by the species' habit of employing thanatosis, an adaptive behavior meant to mimic death. Along with thanatosis some males vocalized in a fashion quite distinct from calls associated with territoriality, advertisement, or release. Subsequently, we tied a waistband of polyester string and numbered colored beads around the inguinal region of each animal. All animals were released at the exact site of capture. Upon recapture, the pattern of crossbands and circles on each individual



An individuals employing thanatosis after release.

was compared to photographs, and the number on the inguinal band was used to confirm identity.

Results and Discussion

The patterns of *B. hylax* are unique. Crossbands can be continuous or fragmented, displaying the same width along the entire stripe or tapering either at the beginning or end of the stripe. The crossbands can be straight or



curved and with or without intervening irregular circular or ovoid shapes along the inguinal flanks. The shapes, number, pattern, and position of the marks vary individually. Combinations of unique characters enabled the accurate identification of 16 individuals in nature and another 11 individuals in the herpetological collection of the Laboratory of Zoology of Fundação Universidade Regional de Blumenau (FURB). When two individuals possessed similar marks on the same side, they could be differentiated by examining the inguinal regions or by using photographs taken with their legs extended. Of the frogs examined in the field, four displayed a combination of crossbands and oval shapes or irregular circular shapes. Of the individuals analyzed from the FURB herpetological collection, six displayed a combination of crossbands and oval or irregular circular or oval shapes and five displayed a pattern consisting solely of crossbands. No two patterns were identical.

Posterior, lateral, and dorsal views of the hindlimbs showing the crossbands that can be straight or curved and with or without intervening irregular circular or ovoid shapes along the inguinal flanks. Note the wart-like node on the distal inner surface of the tibio-fibula of the left leg; such anomalies were used in addition to pattern variables when identifying individual frogs.

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In this study, the use of natural marks to recognize individuals was extremely satisfactory, enabling the recognition of individuals in the field and lab. Although nine animals required comparisons of multiple photographs, we quickly learned to identify many individuals without resorting to photographs at all.

The use of natural marks may be limited to only some species, namely those that display distinct and variable patterns. Color photographs worked best (Bradfield 2004), but black-and-white images or even drawings would be adequate for this and at least some other species. Stevens et al. (2007) stressed care when choosing the camera and when manipulating images in order to guarantee consistent representation of patterns.

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Although usually a dark gray or black, some Marine Iguanas (*Amblyrhynchus cristatus*) also have patches of green and red (known as "Christmas tree coloration"). Iguanas pay little attention to what they crawl over; piles of basking lizards can be three or four animals deep.

TRAVELOGUE

Who Watches the Watchers? A Pilgrimage to Darwin's Archipelago

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Photographs by the author.

When it comes to conservation, menacing and unstable political regimes can be a good thing. While superficially a democratic republic, Ecuador (to which the Galápagos Islands belong) has scrapped and rewritten its constitution 20 times in fewer than 200 years. Our tour guide regaled us with stories of how the president went as far as taking a television station off the air and suing a newspaper for describing his political arsenal as “turmoil, rocks, and sticks.”

Although one might think one consequence of such political upheaval would be the neglected stewardship of Ecuador's natural resources, Ecuador in 2008 became the first nation to grant ecosystems legal protection in



A male Great Frigatebird (*Fregata minor*) feeds his chick, less than a foot away from a commonly used footpath. Frigatebirds have the largest wingspan to bodyweight ratio of any bird, allowing them to stay airborne for over a week. They also are known as Man O' War Birds because of their kleptoparasitic feeding behavior, i.e., they steal food from other seabirds in midair as a dietary supplement. Frigates produce little oil with which to coat their feathers, cannot swim, and usually die if they hit the water while chasing food items.



While the terrestrial wildlife has a seemingly reckless disregard for the danger that humans can present, the fish of the Galápagos have a justified fear of snorkelers. This Mexican Hogfish (*Bodianus diploaenia*) turned and escaped as soon as I saw it while freediving. A fast exposure froze its face, but not its fins.

their constitution. Nature is now provided with basic civil liberties, such as the rights to “exist, persist, and regenerate.” While these environmental protections are recent developments, the Galápagos National Park dates from 1959, when only 1,000 people lived on the islands. The second largest marine reserve in the world surrounds Galápagos, and human habitation is restricted to less than 3% of the land area. Ecuador also has prohibited immigration to the islands; the only way to become a resident these days is to be born there. Enforcement of environmental laws in the Galápagos has been problematic at times, but overall the continual growth of ecotourism has resulted in stronger conservation measures. Ecuador realized early on that they were sitting on a valuable natural resource and took steps to both protect it and profit from it.

As a graduate student in herpetology, I have traveled to a number of tropical conservation areas to chase snakes, lizards, turtles, and the occasional frog, but I have never had my daily activities monitored and restricted as tightly as in the Galápagos. Land accommodations are very limited, so we only had one night on shore. We were permitted to visit each site only once for a limited amount of time, and could only go ashore a certain number of times per day. Most islands have markers along the shoreline that signify zones for tourism, local fishermen, and areas that are completely off-limits. Our boats were even equipped with GPS transmitters that were monitored by the park service to make sure we never deviated from our schedule. We could touch nothing, collect nothing, and were not permitted to step off the few existing trails in uninhabited areas. Some guides even forbid flash photography.

Of Tortoises and Goats

While environmental legislation has curtailed the ecological damage a foreign tourist (or researcher) can cause, fewer restrictions limit what the local



A Giant Tortoise (*Geochelone nigra*) finishes lunch at the Charles Darwin Research Station on Santa Cruz, which breeds tortoises from across the Galápagos. The 100-person facility also is home to Lonesome George. George is thought to be the only extant tortoise from Pinta Island (aka Abingdon Island; *G. nigra abingdoni* is one of 11 existing subspecies) and is considered to be the rarest animal in the world.

human population can do. High birth rates have helped a population of 1,000 people grow to over 20,000 in 50 years. Non-native plant species are more diverse than native species in areas designated for human settlement. Sadly, introduced species do not acknowledge those boundaries. Wild goats are a particularly problematic example, as they are capable of removing nearly all edible vegetation from an area, including any climbable trees. Goats were introduced to the Galápagos as a human food source, but their highly efficient foraging abilities drove the iconic Giant Tortoise (*Geochelone nigra*) dangerously close to extirpation at several localities.

Thankfully, a series of wild goat extermination efforts have allowed tortoises to make a comeback. Organized hunts with dogs were reasonably effective at culling 90% of the goat herds, but the remaining animals quickly reproduced and goat populations rebounded. This continued until a new multi-million dollar plan involving “Judas” goats was implemented. A female Judas goat is captured, sterilized, injected with chemical hormones, fitted with a radio-tracking collar, and then released back into the wild. This “super-sexed” animal attracts other goats, and every month, a park service helicopter mounted with a rifle tracks down the radio beacon, and a sharpshooter kills all the goats except for the Judas (using ammunition supplied by NATO). Judas goats occasionally strand themselves on cliff-faces, and are relocated by helicopter to find new herds. Although time intensive and expensive, this wildlife management program has resulted in the complete removal of goats from several islands.

Don't Tread on Me

Many of the low-elevation islands receive little rainfall, and are a mix of sand, exposed rock, and thin scrub vegetation. They look quite barren



Galápagos Sea Lions (*Zalophus wollebaeki*), according to our guide, “prefer an interactive diving experience.” A snorkeler doing rolls, somersaults, and other maneuvers will find that Sea Lions quickly follow suit, and have no fear of swimming quite close to humans. Weighing several hundred pounds and capable of burst swimming speeds of over 10 m/sec, having these animals race by within a few centimeters of your dive mask is quite an experience.

VARIATION ON A THEME

Geologically, the Galápagos Islands were never in contact with another landmass and emerged barren from the sea a scant 5 million years ago. Sometime thereafter, a pregnant Lava Lizard or a clutch of eggs survived a ~1,600-km journey from South America to the Galápagos on a log floating in the Humboldt Current. Without natural selection, this highly unlikely sea journey would have had to happen six more times, as seven currently recognized species of Lava Lizards are distributed across the islands. A simpler explanation for this pattern is that the first lizard species colonized all the remaining islands, as the longest journey between them was only 100 km. Isolated from one another, each founder population then adapted to local conditions, gradually diverging into distinct species. Subtle differences between islands and the subtle differences between lizards now inhabiting them are evidence of natural selection (although Charles Darwin noted differences only in tortoises and birds in his *Voyage of the Beagle*). Currently, *Tropidurus (Microlophus) albemarlensis* lives on the large central islands (which may have been connected at one point), while the other species are endemic to smaller islands that lie mostly on the periphery of the archipelago.

Many of Galápagos' celebrated endemic species are unique to (and named for) a single island. This has resulted in something of a taxonomic and geographic nightmare as many of the islands have multiple names. Each has at least one English name (many of them the names of pirates) from the period when Charles Darwin visited the archipelago. While the English names are commonly used today,

Ecuador has officially renamed the islands in Spanish. Natural history observations are particularly challenging. Using Lava Lizards as an example, this female *T. albemarlensis* (top, note the unusual tail regeneration) is named for the island of Albemarle (aka Isabela), but it was photographed on Indefatigable (aka Santa Cruz). It occurs on most of the central islands, each of which has one, two, or three geographic names. This male *T. grayi* (bottom) occurs only on Charles, but the same island is also referred to as Floreana and Santa Maria.



from afar, and yet the birds and reptiles are often so crowded that zoos and pet stores look spacious by comparison. While far from tame, a lack of natural predators and human persecution renders most animals completely unafraid of people. Marine Iguanas (*Amblyrhynchus cristatus*) are one of the worst offenders in this regard. The seemingly careless behavior of Galápagos wildlife, coupled with its staggering density, means that your feet must be placed with extreme care to avoid stepping on a carpet of tails, nests, eggs, and wings, interspersed with the occasional cactus.

Open space is at a premium on most islands and tour groups are regularly forced to walk within a few inches of animals mating, sleeping, eating, and nesting on the narrow paths. So, despite not being able to leave the trail, opportunities for macro photography abound. Almost anything you might wish to take a picture of can be found on the paths, including 1000-pound Galápagos Sea Lions (*Zalophus wollebaeki*). Most species seem to pay as much attention to rocks as to large cameras, and are nearly as cooperative as flowers to photograph.

Getting There

Many companies offer package deals that couple a trip to the Galápagos with a tour of mainland Ecuador or Peru. An internet search will provide you with a number of companies that operate live-aboard charter boats, which vary by group size (10–70 people), trip length (5 days–2 weeks), and price (\$1,500–7,000). Most trips leave from Ecuador's capital of Quito; flight costs to Quito (~\$1,000) are generally not included. The city is at an



A Galápagos Land Iguana (*Conolophus subcristatus*) was kind enough to pose in front of some Galápagos Carpet Weed (*Sesuvium edmonstonei*) and one of the live-aboard catamaran tour boats.



Though somewhat less iconic than Blue-footed Boobies (*Sula nebouxi*), the red feet and eye rings of Swallow-tailed Gulls (*Creagrurus furcatus*) are an even more vibrant color. Few visual differences distinguish males and females; however, females in the Galápagos can be identified by the dirty footprints on their backs from mating. Sexual encounters are over almost as quickly as they begin; according to our guide, an average male gull will get approximately 30 sec of cloacal contact in a normal year of mating.



Waved Albatrosses (*Phoebastria irrorata*) mate for life, but have trouble recognizing their partners after long separations required for feeding trips. A call-and-response style courtship dance is used by albatrosses in part to reduce the confusion of look-alike birds. The dance consists of alternating bows, beak fencing, hoots, wing-raises, and synchronized open beaks (shown). Mates with a practiced routine will usually dance in perfect synchronization for several minutes, while dances between birds that mistake each other as mates will usually fall apart after a few moves. The albatross pictured on the left is actually dancing with the wrong bird, as its mate looks on from the right. Shortly after the photo was taken, the right bird chased off the middle bird, and then completed a perfect dance with the left (correct) bird.

elevation of ~3,000 m, so be aware that altitude sickness can be a problem. The local currency is the US dollar. Snorkeling is a common daily activity; water temperatures are usually 60–70 ° F. A limited selection of wetsuits

and snorkel gear may be available for rent; I would strongly recommend bringing your own fitted gear from home, including a full-length 3–6 mm wetsuit with a hood and booties.



A few miles below the equator, the Pointe Vicente Roca cliff face reflects a sunset on Isabela.

Blue Iguana Story in Print !

Award-winning conservation biologist Fred Burton has released a fascinating new book about saving one of the most endangered reptiles species on earth. *“The Little Blue Book: A Short History of the Grand Cayman Blue Iguana”* is a true story of how a noble and charismatic iguana is rescued from the brink of extinction. An engaging read and a beacon of hope for conservation of reptiles.

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INTRODUCED SPECIES

Oustalet's Chameleon, *Furcifer oustaleti* (Mocquard 1894) (Chamaeleonidae), a Non-indigenous Species Newly Established in Florida

Christopher R. Gillette¹, Kenneth L. Krysko², Joseph A. Wasilewski³, Guy N. Kieckhefer III⁴, Edward F. Metzger III⁵, Michael R. Rochford⁴, Daniel Cueva⁵, and Dustin C. Smith⁶

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Oustalet's Chameleon, *Furcifer oustaleti* (Mocquard 1894), is indigenous to Madagascar (Henkel and Schmidt 2000). This species is typically found in open savannas and forest habitats, and has been verified growing up to 700 mm total length (Henkel and Schmidt 2000).

On 20 December 2000, KLK and Anthony T. Reppas visited an animal importer's facility at 36490 SW 192nd Avenue, Florida City, Miami-Dade County, Florida. While in business, it specialized in importing amphibians and reptiles from Madagascar, and we were told at that time



CHRISTOPHER R. GILLETTE

Adult male Oustalet's Chameleon (*Furcifer oustaleti*) (UF 163067), collected on 20 November 2010 in Florida City, Miami-Dade County, Florida.

that chameleons had been released in the avocado orchard in the back of the property. In the summer of 2009, JAW acquired a dead adult *Furcifer oustaleti*, which was collected in the vicinity of the former animal importer's facility, and which, upon dissection, was discovered to be a gravid female. On 20, 22, 29, and 30 November and 1 December 2010, we conducted night-time surveys of adjacent areas and collected 19 *F. oustaleti* between 1930–0049 h. Our specimens (UF 163066–163084) were found sleeping between 1.7–4.5 m above the ground on Lancewood (*Nectandra coriacea*), White Leadtree (*Leucaena leucocephala*), and Avocado (*Persea americana*) trees, and represented juveniles to adults (83–241 mm SVL, 171–546 mm total length) of both sexes. Digital images of our live specimens were sent to William B. Love (pers. comm.), who confirmed our identification. After speaking with current property owners, we must advise that much of the area, including the former animal importer's facility is posted as no trespassing, thus permission to collect on these or other private properties must be obtained beforehand.

The introduction pathway for *Furcifer oustaleti* in Florida is the pet trade. The presence of juveniles to adults of both sexes, apparently persisting for at least one decade, including surviving through the atypical prolonged cold winter temperatures in January 2010 that killed many individuals of both indigenous and non-indigenous species (Mazzotti 2010), suggests that *F. oustaleti* is firmly, albeit locally, established in southern Florida. This is the second verified established chameleon in Florida (Krysko et al. 2004).

Acknowledgments

We thank Anthony T. Reppas and Mark Parry for assistance in the field and William B. Love for confirming the identity of the species. Gad Perry, Robert Powell, and an anonymous reviewer provided helpful comments on this paper.



GUY N. KIECKHEFER III

Adult Oustalet's Chameleon (*Furcifer oustaleti*) (UF 163083), *in situ* collected on 1 December 2010 in Florida City, Miami-Dade County, Florida.

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DUSTIN C. SMITH

Juvenile Oustalet's Chameleon (*Furcifer oustaleti*) (UF 163082), collected on 1 December 2010 in Florida City, Miami-Dade County, Florida.

O B I T U A R Y

Ernest (Ernie) A. Liner (1925–2010)

Dr. Ernest A. Liner, one of Louisiana's most noted herpetologists among the many who have lived there, died at the age of 85 on 23 September 2010, in Houma, Louisiana. Ernie was born on Weeks Island in Iberia Parish on 11 February 1925, and lived most of his life in Houma within 60 miles of New Orleans. He spent his early years in the late 1940s and early 1950s associated with the herpetological contingent at Tulane University. These were the years following World War II, during which he served as a U.S. Marine and received a Purple Heart after being shot in the elbow on Iwo Jima. Although Ernie made a living as a pharmaceutical salesman, he was the consummate professional herpetologist in all aspects of scientific publishing, attending national and regional meetings and contributing valuable scientific specimens to museums. He received an Honorary Doctor of Science at the University of Colorado in 1998 in recognition for his lifetime contributions to herpetology, a well-deserved honor.



One of his proudest moments, Dr. Ernest (Ernie) A. Liner receiving an honorary Doctor of Science at the University of Colorado in 1998.



GEORGE R. ZUG

Ernie Liner in the office of the Division of Amphibians and Reptiles, National Museum of Natural History, Smithsonian Institution (July 1998).

Ernest A. Liner will continue to be a recognized name in herpetology because of his more than 100 scientific publications and his two famous cookbooks — *A Herpetological Cookbook: How to Cook Amphibians and Reptiles* and *The Culinary Herpetologist*. Many of his scientific publications address the amphibians and reptiles of Mexico, where Ernie spent much of his vacation time in pursuit of herpetological adventures.

Although widely respected and well noted for his herpetological achievements, Ernie Liner is equally well characterized by those who knew him as a man with a gracious nature and generous spirit. From my own experience as a youngster on into adulthood, I remember Ernie Liner as one of the most gentle, benevolent, and friendly herpetologists I ever met. I caught my first slider turtle in a seine haul with him in 1952 when I was in grammar school. He and I were on one end of the seine and Don Tinkle was on the other. That same year, Ernie turned over a log near New Orleans and let me catch the first Pigmy Rattlesnake I had ever seen. I distinctly remember that he let me be the one to “catch” these and many other of my first herps rather than claiming them for himself in the competitive “look what I caught” game. This is but one measure of the generosity that has been noted by many others. Following his death, many of Ernie's colleagues posted statements referring to his personal character, which included “most considerate person I have ever known,” “his kindness will be missed,” “he was truly a humble man,” “he loved to share and help others,” and “he was an intelligent and always friendly person.” Collectively, these and similar statements do indeed characterize the essence of Ernie Liner. Clearly, he will be missed not only as a fine herpetologist, but also as a very fine person.

J. Whitfield Gibbons

Savannah River Ecology Laboratory
Aiken, South Carolina

CONSERVATION RESEARCH REPORTS

Mortality in the Only Population of the Critically Endangered Frog, *Xenopus longipes*

Contemporary global declines and mortality events in amphibian populations have been often attributed to infectious disease and climate change, separately and in combination. **BLACKBURN ET AL.** (2010. *African Journal of Herpetology* 59:111–122) reported an enigmatic mortality event in the only known population of the critically endangered Lake Oku Clawed Frog (*Xenopus longipes*). This aquatic and biologically distinctive species is restricted to Lake Oku, a high-elevation crater lake on Mt. Oku in Cameroon. Neither a quantitative PCR-based screen nor histopathological analysis revealed the presence of the chytrid fungus (*Batrachochytrium dendrobatidis*), which is believed to be responsible for many declines and mortality events in amphibian populations around the world. Histopathology revealed widespread epidermal hyperplasia and multifocal saprolegniasis, suggesting that the animals have been exposed to a source of skin irritation. These sources might include acidified surface waters, perhaps derived from inorganic fertilizers or other human-related pollutants, or to local geological processes distinctive of the Cameroonian Volcanic Line. Currently, the causes underlying this mortality event remain obscure.

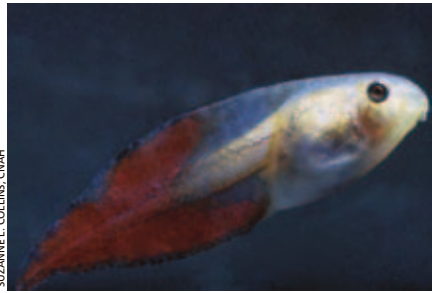


VACLAV GVOZDIK

An enigmatic mortality event in the only known population of the critically endangered Lake Oku Clawed Frog (*Xenopus longipes*) is associated with an undiagnosed skin irritation.

Phosphates Have No Effect on Tadpoles

Phosphate pollution has no effect on the tadpoles of Cope's Gray Treefrog (*Hyla chrysoscelis*). A 15-day study by **EARL AND WHITEMAN** (2010. *Journal of Herpetology* 44:201–208) exposed tadpoles to phosphates resulting from agricultural runoff and urban water and discovered that phosphates might not be toxic to this species at levels associated with anthropocentric issues. The authors concluded that high levels of phosphate could even be beneficial to the tadpoles because they enhance the growth of algae, which tadpoles consume.



SUZANNE L. COLLINS, GWI/AA

Cope's Gray Treefrog (*Hyla chrysoscelis*) tadpoles are not affected negatively by levels of phosphates resulting from agricultural runoff or urban water.

Climate Change Threatens Genetic Variability

The Iberian Emerald Lizard (*Lacerta schreiberi*) is projected to lose strong genetic variability by the year 2080. Suitable habitat for this lizard consists of river or stream margins that are covered with dense vegetation and found near montane areas with cool, humid climates. **RODDER AND SCHULTE** (2010. *Biodiversity Conservation* 19:2651–2666) noted that more genetically diverse populations in the south-central portions of the Iberian Peninsula are more likely to be affected negatively by climate change than the less diverse northwestern populations. The southern populations will be at greater risk of extinction because they are already fragmented, and increasingly hotter climate will decrease humidity, which will result in even less suitable habitat. The more northerly populations live near mountains where conditions are cooler.



ADRIAN IRESON

Southern populations of the Iberian Emerald Lizard (*Lacerta schreiberi*) will be at greater risk of extinction than more northerly montane populations because they are already fragmented and increasingly hotter climate will decrease humidity, which will result in even less suitable habitat.

Projected Loss of a Salamander Diversity Hotspot as a Consequence of Global Climate Change

Significant shifts in climate are considered a threat to plants and animals with significant physiological limitations and limited dispersal abilities. The southern Appalachian Mountains

are a global hotspot for plethodontid salamander diversity. Plethodontids are lungless ectotherms, so their ecology is strongly governed by temperature and precipitation. Many plethodontid species in southern Appalachia exist in high-elevation habitats that might be at or near their thermal maxima, and might also have limited dispersal abilities across warmer valley bottoms. **MILANOVICH ET AL.** (2010. *PLoS One* 5:1–10) used a maximum-entropy approach (program Maxent) to model the suitable climatic habitat of 41 plethodontid salamander species inhabiting the Appalachian Highlands region (33 individual species and eight species included within two species complexes). The authors evaluated the relative change in suitable climatic habitat for these species in the Appalachian Highlands



USGS

Significant loss of habitat is projected for many salamander species, such as this Southern Dusky Salamander (*Desmognathus auriculatus*), that currently occupy the Appalachian Highlands.

from the current climate to the years 2020, 2050, and 2080, using both the HADCM3 and the CGCM3 models, each under low and high CO₂ scenarios, and using two-model threshold levels (relative suitability thresholds for determining suitable/unsuitable range), for a total of eight scenarios per species. Although models differed slightly, every scenario projected significant declines in suitable habitat within the Appalachian Highlands as early as 2020. Species with more southerly ranges and with smaller ranges had larger projected habitat loss. Despite significant differences in projected precipitation changes to the region, projections did not differ significantly between global circulation models. CO₂ emissions scenario and model threshold had small effects on projected habitat loss by 2020, but did not affect longer-term projections. Results of this study indicate that choice of model threshold and CO₂ emissions scenario affect short-term projected shifts in climatic distributions of species; however, these factors and choice of global circulation model have relatively small effects on what is significant projected loss of habitat for many salamander species that currently occupy the Appalachian Highlands.

Habitat Preferences and Home-range Size

Effective wildlife conservation plans should consider both the habitat needs and spatial requirements of the species in question. Studies that focus on the correlation between the habitat preferences and movement patterns of wildlife, particularly snakes, are uncommon. **KAPFER ET AL.** (2010. *Journal of Zoology* 282:13–20) attempted to determine how habitat preferences or quality influenced movement patterns of snakes. To answer this question, the authors created a case model that incorporated habitat preference or avoidance information rigorously obtained for Bullsnares (*Pituophis catenifer sayi*) from 2003 to 2005 at a site in the upper mid-western US and compared it with minimum convex polygon estimates of home-range size. They employed geographical information systems to model the amount of preferred (open bluff faces) and avoided (agricultural fields and closed canopy forests) habitats within each estimated home range and compared them via multiple linear regression. They also tested the influence of gender, length, and weight on home-range size. Results indicated that home-



JOSHUA M. KAPFER

A case model that incorporated habitat preference or avoidance information for Bullsnares (*Pituophis catenifer sayi*) supported the hypothesis that habitat quality has an impact on wildlife movement patterns, and the relationship between habitat needs and spatial requirements should be considered when conserving or managing species.

range size increased primarily as a function of the amount of avoided habitat. Those data supported the hypothesis that habitat quality has an impact on wildlife movement patterns, and the relationship between habitat needs and spatial requirements should be considered when conserving or managing species.

Conservation Status of the World's Vertebrates

Using data for 25,780 species categorized on the International Union for Conservation of Nature (IUCN) Red List, **HOFFMANN ET AL.** (2010. The Impact of Conservation on the Status of the World's Vertebrates. *Science*, published online 26 October 2010) presented an assessment of the status of the world's vertebrates. One-fifth of species are classified as Threatened, and the authors demonstrated that this figure is increasing. On average, 52 species of mammals, birds, and amphibians move one category closer to extinction each year. However, this overall pattern conceals the impact of conservation successes, and they showed that the rate of deterioration would have been at least one-fifth as much again in the absence of these. Nonetheless, current conservation efforts remain insufficient to offset the main drivers of biodiversity loss in these groups: Agricultural expansion, logging, over-exploitation, and invasive alien species.

Ranavirus Infections in Wild Common Frog Populations

Amphibians are declining worldwide, and one factor is infectious diseases. Mass mortalities caused by a virus or a group of viruses belonging to the genus *Ranavirus* have occurred in wild Common Frogs (*Rana temporaria*) in England since the 1980s, and ranaviral disease is widespread in amphibians in North America, where it can also cause mass die-offs. Although numerous reports of *Ranavirus*-associated mass mortal-

ity events have been reported, no study has yet evaluated the long-term impacts of this disease. **TEACHER ET AL.** (2010. *Animal Conservation* 13:514–522) examined archived records of English Common Frog mortalities likely caused by *Ranavirus*. Preliminary indications suggest that Common Frog populations respond differently to the emergence of disease; emergence can be transient, catastrophic, or persistent with recurrent mortality events. The authors subsequently focused on populations that had recurring mortality events ($n = 18$), and they reported median declines of 81% in the number of adult frogs in those populations from 1996 to 2008. Comparable uninfected populations ($n = 16$) showed no change in population size over the same time period. Regressions indicated that larger frog populations might be more likely to experience larger declines than smaller populations, and linear models showed that percentage population size change is significantly correlated with disease status, but that habitat age (a possible proxy for environmental quality) had no significant effect on population size change. The results provided the first evidence of long-term localized population declines of an amphibian species that appeared to be best explained by the presence of *Ranavirus* infections.



CARL FARMER

Mass mortalities caused by a virus or a group of viruses belonging to the genus *Ranavirus* have occurred in wild Common Frogs (*Rana temporaria*) in England since the 1980s.

NEWS BRIEFS

Search for Lost Amphibians

Teams of scientists around the world have launched an unprecedented search in the hope of rediscovering 100 species of “lost” amphibians — animals considered potentially extinct but that may be holding on in a few remote places. This search, which is taking place in 14 countries on five continents, is the first ever coordinated effort to find such a large number of “lost” creatures and comes as global amphibian populations are suffering a shocking decline — with more than 30% of all species threatened with extinction. Many of the amphibians that the teams of scientists are looking for have not been seen in several decades, and establishing whether populations have survived or not is vital

for scientists looking to understand the recent amphibian extinction crisis.

Amphibians provide many important services to humans such as controlling insects that spread disease and damage crops, and helping to maintain healthy freshwater systems — the chemicals in amphibian skins have also been important in helping to create new drugs with the potential to save lives, including a painkiller 200 times more potent than morphine.

“Amphibians are particularly sensitive to changes in the environment, so they are often an indicator of damage that is being done to ecosystems,” explains Conservation International’s Dr. Robin Moore, who has organized the search for IUCN’s Amphibian Specialist Group. “But this

role as the global ‘canary in a coal-mine’ means that the rapid and profound change to the global



CHARLES H. SMITH

The Golden Toad (*Incilius periglenes*) is perhaps the most famous of the lost amphibians. This Costa Rican endemic was last seen in 1989.

environment that has taken place over the last fifty years or so — in particular climate change and habitat loss — has had a devastating impact on these incredible creatures. We've arranged this search for 'lost' species that we believe may have managed to hang on so that we can get some definite answers — and hopefully learn about what has allowed some tiny populations of certain species to survive when the rest of their species has been lost." The problems amphibians face from habitat loss have been massively exacerbated by a pathogenic fungus, which causes chytridiomycosis, a disease that has wiped-out entire populations of amphibians and in some cases whole species.

Dr. Moore and his team have drawn up a list of the "top-10" species that he believes would be particularly exciting to find. He said: "While it's very challenging to rate the importance of one species against another we have created this top-10 list because we feel that these particular animals have a particular scientific or aesthetic value."

Golden Toad (*Incilius periglenes*), Costa Rica. Last seen in 1989. Perhaps the most famous of the lost amphibians. Went from abundant to extinct in a little over a year in the late 1980s.

Gastric Brooding Frog (*Rheobatrachus vitellinus* and *R. silus*), Australia. Last seen in 1985. Had unique mode of reproduction: Females swallowed eggs and raised tadpoles in the stomach. Gave birth to froglets through the mouth.

Mesopotamia Beaked Toad (*Rhinella rostrata*), Colombia. Last seen in 1914. Fascinating frog with a distinctive pyramid-shaped head.

Jackson's Climbing Salamander (*Bolitoglossa jacksoni*), Guatemala. Last seen in 1975. Stunning black and yellow salamander — one of only two known specimens is believed to have been stolen from a California laboratory in the mid-1970s.

African Painted Frog (*Callixalus pictus*), Democratic Republic of Congo/Rwanda. Last seen in 1950. Very little is known about this animal, which is thought never to have been photographed.

Rio Pescado Stubfoot Toad (*Atelopus balios*), Ecuador. Last seen in April 1995. May well have been wiped-out by chytridiomycosis.



The Gastric Brooding Frog (*Rheobatrachus silus*) from Australia was last seen in 1985.



A rare Yucatán Spiny-tailed Iguana (*Ctenosaura defensor*) hitched a ride on a shipment of auto parts from Mexico, landing at Ford's Van Dyke Transmission Plant in Sterling Heights. It's now at the Detroit Zoo.

JOSEPH P. BURGESS

Turkestanian Salamander (*Hynobius turkestanicus*), Kyrgyzstan, Tajikistan, or Uzbekistan. Last seen in 1909. Known from only two specimens collected in 1909 somewhere "between Pamir and Samarkand."

Scarlet Frog (*Atelopus soriano*), Venezuela. Last seen in 1990. Known from a single stream in an isolated cloud forest.

Hula Painted Frog (*Discoglossus nigrivent*), Israel. Last seen in 1955. A single adult collected in 1955 represents the last confirmed record of the species. Efforts to drain marshlands in Syria to eradicate malaria may have been responsible for the disappearance of this species.

Sambas Stream Toad (*Ansonia latidisca*), Borneo (Indonesia and Malaysia). Last seen in the 1950s. Increased sedimentation in streams after logging may have contributed to the decline.

Dr. Claude Gascon, co-chair of the IUCN Amphibian Specialist Group and Executive Vice-president of Conservation International



Jackson's Climbing Salamander (*Bolitoglossa jacksoni*) from Guatemala was last seen in 1975.

CALPHOTO

said: "This is something that has never been done before, and is hugely significant, not only because of the threats that amphibians face and our need to understand what has been happening to them better, but also because it represents an incredible opportunity for the world's amphibian scientists to rediscover long-lost species. The search for these lost animals may well yield vital information in our attempts to stop the amphibian extinction crisis, and information that helps humanity to better understand the impact that we are having on the planet."

To follow the search for the lost amphibians visit: www.conservation.org/lostfrogs.

IUCN, 11 August 2010

Detroit Zoo by Way of the Yucatán

A stowaway from Mexico made it all the way to Sterling Heights in a shipment of auto parts before getting caught and given a new home in Royal Oak — at the Detroit Zoo. The foot-long rare reptile called a Yucatán Spiny-tailed Iguana (*Ctenosaura defensor*) was spotted scooting across a loading dock on 29 July at Ford Motor's Van Dyke Transmission Plant in Sterling Heights.

"This is a unique and rare rescue situation," said Detroit Zoo curator of reptiles Jeff Jundt. The species is found only in a small area of the Yucatán Peninsula, in a section of 1,200 square miles.

After glimpsing the gray-and-blue critter, a Ford safety engineer called Sterling Heights Animal Control officers, who caught the iguana and housed it temporarily at the Sterling Heights

Nature Center. Sterling Heights then asked the Detroit Zoo to provide a permanent home for the creature, which is rarely seen in zoos.

The adult male has a 5-inch body and 7-inch tail and is being held in quarantine to make certain it is healthy before joining the Detroit Zoo's Black Iguana (*Ctenosaura similis*) at the Holden Museum of Living Reptiles. Jundt said he expected the male's coloration to brighten "with more hues of blue" after it is released into the larger, more comfortable quarters with the female Black Iguana.

Bill Laitner, *Detroit Free Press*

Disney "Hero" Conserves Guatemalan Lizards

The Disney Worldwide Conservation Fund (DWCF) announced the recipients of the "Disney Conservation Heroes" award for 2010 during the annual meeting of the Association of Zoos and Aquariums (AZA). The award recognizes citizens around the world for their tireless efforts at the local level to save wildlife, protect habitats, and educate the communities around them.



Zootropic's Gilberto Salazar (far right) is announced as one of this year's recipients of the "Disney Conservation Heroes" award. Seated to his left are Brad Lock (Zoo Atlanta) and Christian Fernando Beza Beza (Zootropic).

Among this year's honorees is Don Gilberto Salazar, field technician for Project Heloderma and Project Palearis, conservation programs established by Guatemalan NGO Zootropic and Zoo Atlanta with support from the IRCF. Salazar has transitioned from a poacher to an active conservationist, playing a critical role in all aspects of the lizard conservation programs in Guatemala. Project Heloderma was launched in 2002 as a long-term, integrated conservation program dedicated to saving the rare Guatemalan Beaded Lizard (*Heloderma horridum charlesbogerti*). Researchers traveled to villages and interviewed locals about the presence of Beaded Lizards in the area. They came across a newspaper photo of Salazar that described him as a poacher who hunted and sold the lizards to traders. Zootropic located Salazar, who agreed to show researchers the lizard habitats. A valuable asset to the pro-

gram, Salazar has promoted lizard conservation in 35 schools reaching more than 35,000 villagers. He works long hours in hot temperatures to restore lizard habitat and conducts research that is critical to preserving biodiversity within the unique dry forest and thorny scrub of the Motagua Valley in eastern Guatemala.

Candidates for the award are nominated by nonprofit environmental organizations and AZA zoos and aquariums committed to field conservation programs. Each award recipient and their nominating organization will share a \$1,000 award from the DWCF.

Houston, Texas (15 September 2010)

Amphibians Rediscovered After Decades Lost to Science

Scientists on a global quest to rediscover "lost" amphibian species have returned from their first set of expeditions having rediscovered three species that had not been seen for decades, Conservation International (CI) and the IUCN Amphibian Specialist Group (ASG) announced on 22 September.

Searches are continuing around the globe for 100 species of amphibians that had been thought extinct, but that scientists believe may be surviving in small populations. While the discoveries are a cause for celebration as the world prepares for the Convention on Biological Diversity (CBD) that will be held in Nagoya, Japan in October 2010, they also highlight the shocking decline in the world's amphibian species in recent decades, with more than a third of all amphibians threatened with extinction.

The three animals that have been rediscovered so far include a Mexican salamander not seen since it was discovered in 1941, a frog from the Ivory Coast not seen since 1967, and another frog from Democratic Republic of Congo not seen since 1979.

Dr. Robin Moore, who has organized the Search for the Lost Frogs for CI and the ASG said: "These are fantastic finds and could have important implications for people as well as for amphibians. We don't know whether study of these animals could provide new medicinal compounds — as other amphibians have, and at least one of these animals lives in an area that is important to protect as it provides drinking water to urban areas. But these rediscovered animals are the lucky ones — many other species we have been looking for have probably gone for good." The rediscovered animals are:

Cave Splayfoot Salamander (*Chiropterotriton mosaueri*). **Hidalgo Province, Mexico.** Not seen since the discovery of a single individual in 1941. Pink-footed brown salamander that is believed to live underground in cave systems. Several were found by scientist Sean Rovito

from the Universidad Nacional Autónoma de México, in a cave system that is accessible only by descending down a large pothole.

Mount Nimba Reed Frog (*Hyperolius nimbae*). **Ivory Coast.** Last Seen in 1967. Small and well-camouflaged brown frog rediscovered by local scientist N'Goran Kouame from the University of Abobo-Adjame.

Omaniundu Reed Frog (*Hyperolius sankuruensis*). **Democratic Republic of Congo.** Last seen in 1979. Beautiful frog with bright green — almost fluorescent — spots on a dark brown background. Rediscovered by Jos Kielgast from The Natural History Museum of Denmark.

Dr. Moore added: "It's pretty extraordinary to think about just how long it has been since these animals were last seen. The last time that the Mexican Salamander was seen, Glen Miller was one of the world's biggest stars, while the Mount Nimba Reed Frog hasn't been seen since the year the Beatles released Sgt. Pepper's Lonely Heart Club Band and the Omaniundu Reed Frog disappeared the year that Sony sold its first ever Walkman."

IUCN SSC e-bulletin, September 2010



Three species of amphibians have been rediscovered after not having been seen in many years: (1) The Cave Splayfoot Salamander (*Chiropterotriton mosaueri*), (2) Mount Nimba Reed Frog (*Hyperolius nimbae*), and (3) Omaniundu Reed Frog (*Hyperolius sankuruensis*).



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Editors' Remarks

In past years, only a few research-oriented articles submitted to *Reptiles & Amphibians* (previously *IGUANA*) were subjected to external review. However, the year-long tribute to Henry Fitch and the new section on introduced species often required expertise beyond that of the editor in charge of a particular article or note. Consequently, external review has become the norm rather than the exception not only for research articles but also for feature articles and notes as well as any submissions to the introduced species section. While we rely heavily on one another and members of the editorial board, several additional individuals have provided reviews of content in the past year. We thank **Robert D. Aldridge, Daniel D. Beck, Matthew E. Gifford, Walter E. Meshaka, Jamie K. Reaser, and Gerard van Buurt.** In addition, the following editors and members of the editorial board have provided formal reviews during 2010: Arthur C. (Sandy) Echternacht, Robert W. Henderson, John B. Iverson, Gad Perry, Robert Powell, and Thomas Wiewandt.

The Editors of *Reptiles & Amphibians*

STATEMENT OF PURPOSE

The International Reptile Conservation Foundation works to conserve reptiles and amphibians and the natural habitats and ecosystems that support them.

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The IRCF encourages contribution of articles, letters to the Editor, news items, and announcements for publication in *REPTILES & AMPHIBIANS*. General articles can deal with any aspect of reptilian or amphibian biology, including conservation, behavior, ecology, physiology, systematics, or husbandry. Submission of photographs to accompany articles is encouraged. Guidelines for submissions and figures are at www.ircf.org/about/submissions. Manuscripts may be submitted via e-mail (send to AJ@IRCF.org). Authors of one page or more of print will receive a free copy of the journal in which their contribution appears, and will receive a PDF file of their article for distribution.

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ROBERT POWELL

Ground Lizards (*Ameiva ameiva tobagana*) on Union Island in the Grenadines are frequently heard scurrying through vegetation, especially in open areas where they can exploit patches of sunlight to bask. See article on p. 222.

