The Snake Rake: A New Tool for Collecting Reptiles and Amphibians

Conant and Collins (1991) described several useful tools for collecting reptiles and amphibians including traditional snake hooks and potato rakes. The most useful tools in the field are often those that can serve more than one purpose. Unless one is planning on a single activity such as pinning snakes or raking through leaf litter, a multipurpose tool is advantageous. I have designed a simple, multipurpose tool for use in the field.

The snake rake, as I call it, is constructed from a 120 cm length of 19 mm diameter aluminum pipe and two 25 cm long pieces of 6.5 mm diameter steel round stock (Fig. 1). The two pieces of round stock are each bent 90 degrees at a point equidistant from the ends. The two pieces of round stock are then welded together along one length with the unattached ends directed roughly 25 degrees away from each other. The head is then attached to the end of the aluminum pole using two 27 mm hose clamps seated over the welded portion. This creates a two-tined fork that can be used to rake through leaf litter, roll logs and rocks, pin snakes and lift bark and boards. This design is convenient when traveling since it can be disassembled for transport.

The snake rake can be constructed at home with a few tools. If welding materials are not available contact a local welding shop. Using heads that were constructed by a welding shop, I have assembled several rakes for less than twelve dollars each.

I have used snake rakes in habitats ranging from Ecuadorian cloud forests to Californian deserts and have found it to be a strong walking stick as well as a versatile tool. Low cost of construction and availability of materials add to the appeal of this design.

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A Photographic Mark-Recapture Method for Patterned Amphibians

Studies involving mark-recapture in amphibians have employed a variety of techniques that facilitate the identification of individuals (Donnelly et al. 1994; Ferner 1979). The most widely used of these has been toe-clipping (Hillis and Bellis 1971; Twitty 1966; Wells and Wells 1976) and tagging (Elmgren 1989; Massey 1970; Nickerson and May 1973; Woolley 1973). More recent innovations include fluorescent marking (Nishikawa and Service 1988; Taylor and Deegan 1982), radioisotope tagging (Hardy 1985; Semlitsch 1981), and PIT (passive integrated transponder) tagging (Camper and Dixon 1988).

Ferner (1979) suggested the ideal method of recognizing individual salamanders was to use their variation in integument pattern. Hagstrom (1973) photographed ventral patterns of Triturus cristatus and T. vulgaris to identify individuals, and Healy (1975) used differences in dorsal spot pattern to distinguish between individual Notophthalmus viridescens. Loofman (1991) described a technique by which individual spotted salamanders (Ambystoma maculatum) could be recognized by their spot pattern.

Herein I describe an inexpensive photographic technique in which individual amphibians can be recognized by their dorsal patterns. Advantages of the technique include: 1) Animals are not physically harmed in any way, 2) animals are permanently "marked," and 3) the technique is easy to use, relatively time-efficient, and inexpensive.

A camera box (15 X 18 cm X 25 cm high) is constructed of 1.6 cm thick plywood, with a hole (7.1 cm diam) in the top to fit a 35-

Fig. 1. (A) Detail of head of snake rake. (B) View of weld joining tines in plane of shaft. (C) Snake rake (120 cm).
mm camera lens (Fig. 1). A second hole (1.5 cm diam), also in the top, allows the insertion of a penlight. The bottom of the apparatus is removable and holds a small box in which specimens are placed (Fig. 1). The specimen box is sized appropriately to preclude movement during photography. A strap with a snap holds the bottom in place while the box is being carried or not in use. The stage (bottom) is painted black and is equipped with an adhesive label that can be numbered each time a different animal is photographed. The penlight eliminates the need for using a flash, which would require a more elaborate design. Although amphibians could be photographed without such an apparatus, the box allows consistency in photographic quality, and helps keep salamanders motionless while being photographed.

I have successfully employed the technique in the mark-recapture of 128 adult Ambystoma opacum in south-central Louisiana in 1991-92. Nesting females placed on their nests (after being photographed) were found to reattend their eggs in nearly all cases. Eight salamanders (6%) were identified as recaptures using the technique. Sampling bias (due to subterranean nesting) is believed responsible for the low recapture rate.

Salamanders were recognized by their distinct barring, including appearance and number of bars on the dorsum. No apparent ontogenetic change in pattern (an assumption of the technique) was seen over a one-year period, use of the technique with juvenile A. opacum would not be informative. As with A. maculatum (Loftman 1991), the head patterns alone of A. opacum in this study were often (80% of the time) different enough to distinguish between individuals.

A 35-mm camera and color print film (200 ASA) were used. Prints were easier to compare than were slides, and were placed in a photo album where they were labelled accordingly. Photographs of recent captures could then be compared to each previous photograph in the album.

Because individual A. opacum often display digit anomalies such as varying numbers of toes or branching of regenerated toes (pers. obs.), and because regeneration of toes can present problems in the identification of marked individuals (Ferner 1979), toe-clipping was not used. Ambystoma opacum metamorphs and juveniles show variable regeneration rates depending on the nature of the clip, but the technique is at least somewhat successful, and may be effective on adults (D. Scott, pers. comm.).

Pit-tagging is desirable because marking is permanent, the procedure is simple, and the tags are reliable. However, both the initial cost (tag reader) and individual tags are relatively expensive (Table 1).

<table>
<thead>
<tr>
<th>Technique</th>
<th>Initial cost</th>
<th>Cost/salamander</th>
<th>Total**</th>
</tr>
</thead>
<tbody>
<tr>
<td>toe-clipping</td>
<td>$5</td>
<td>no cost</td>
<td>$5</td>
</tr>
<tr>
<td>photography</td>
<td>$12</td>
<td>$1.06*</td>
<td>$330</td>
</tr>
<tr>
<td>PIT-tagging</td>
<td>$950</td>
<td>$5.75</td>
<td>$1725</td>
</tr>
</tbody>
</table>

Donnelly et al. (1994) recommended consideration of time and resources (as well as characteristics of the target organism) as important in the choice of marking technique for amphibians. Where expense is not a factor, PIT-tagging may be the preferred marking technique, particularly when very large numbers of animals are to be marked. Given a funding constraint, one is left with either toe-clipping or photography as a marking technique. Toe-clipping, while the most inexpensive (Table 1), is impeded by regeneration and may adversely affect the animal. Photography as a marking technique is intermediate in cost compared to other methods (Table 1), and is the least damaging of the available techniques.

Pitfalls of the photographic technique include the expense of film (ca. $0.29/picture) and film processing (ca. $0.42/print), and the box is slightly cumbersome in the field (approx. wt. = 2090 g). Overall the box has been shown to be reliable for identification of A. opacum, was used successfully on several A. maculatum and a few Rana utricularia, and may be useful for a number of patterned amphibians as a preferred method in mark-recapture studies, particularly those constrained by money.

Acknowledgments.—I thank Jeanne Young, Daniel Doody, Jim Armacost, and Jeff Tampin for their assistance in the field.

** Table 1. Comparative costs (in US $) of photography and the two most widely used techniques for marking salamanders (* = based on 50% recapture rate, ** = example for N = 300 salamanders marked).**
A Method for Catching Lizards in Trees and Rock Crevices

A number of methods have been described for catching diurnal, active, and easily seen lizards, including pitfall traps, nooseguns, and rubber bands (Cogger 1992; Simmons 1987). A baited noose and rubber bands (Cogger 1992; Simmons 1987) have been presented as capture methods by Strong et al. (1993). None of these methods is particularly successful on sedentary animals that inhabit tree hollows or rock crevices. To date the only method for extraction of these animals from their refugia has been through general harassment until the animal moves out. On many occasions this method results in the destruction of habitat, and/or harm to the animal.

During the wet season (November 1992—March 1993), a study commenced on the spotted tree goanna (Varanus timorensis similis) (Christian, unpubl. data). This is a pygmy goanna with a maximum snout-vent length of 230 mm and a maximum mass of 200 g. Average size is 186 mm SVL (SD = 26.2, N = 70) and 84 g (SD = 36.1, N = 69). The study site was located 30 km east of Darwin, Northern Territory, Australia. The goannas were found to frequent the hollowed center of wooden posts in an abandoned fence line. The depth of the central hole ranged from 200 mm to 1500 mm.

The two materials used in the extraction of the lizards from the hole were a set of stainless steel forceps (500 mm) to grasp the animal, and a length of wire (1500 mm long) with a hook at one end. The wire was a piece of plain fencing wire 2, 3, or 4 mm diameter (16, 10, or 8 gauge) bent to form a U-shape at one end. The sharp end of the U was bent back upon itself so that it did not have any rough or sharp edges (Fig. 1). A handle was made by bending 80 mm of wire at the top at 90°. The handle was bent in the same direction as the hook section so that when the hook was down a hole, it was possible to determine the direction it was facing.

An animal was first sighted in a hole using a small flashlight, with note taken of its depth and orientation. The hook was then passed down the hole over the back of the animal until it was in line with the anterior third of the animal's tail, but below the legs, assuming the animal was facing the entrance of its hole. The hook was then turned so the tail was encompassed by the hook. At this point the legs acted as a towing point so when the hook was lifted it was positioned around the base of the tail and held by the back legs. The lizard was then lifted in a smooth motion to the top of the hole. The constant pressure on the hook when lifting the animal prevented it from turning around. When the animal was in reach it could either be grasped by the head with the forceps or pulled completely from the hole with the hook. Sometimes an animal turned around in the hole or was facing the wrong direction. A little more care was then needed to extract the animal; in most instances the animal was lifted at mid-body to a point where it could be grasped with the forceps and manipulated to allow the hook to pull it completely from the hole. Lizards could be extracted from shallow holes using only the forceps.

The combination of forceps and hook is the most effective method used by us to date for the capture of V. timorensis similis. During a twelve-month period, over 200 animals were caught using this method. The average time taken to catch an animal using this method was 3 min. Circumstances determined which type of wire was used. We were successful using both stiff and soft wire. Some words of caution should be expressed. Although this method is less damaging to the habitat and offers substantial benefits in reduced capture time of animals, it is possible to injure the animal. The most important point is to always make sure the hook is blunt with NO sharp or protruding edges. The hook should be around the base of the tail of the animal before pulling upward. It is an easy mistake to think the hook is around the tail when it has actually penetrated the cloaca. Therefore it is necessary to watch the progress of the hook using the flashlight during the initial positioning around the tail. The same caution holds for animals facing away from the opening. It is possible for an animal to open its mouth in an aggressive stand when facing this way, and the hook to enter its mouth. When first developing the hook system, we encountered penetration of the cloaca three times; however, all animals survived and were released at the point of capture.
We believe this technique should be applicable to both tree and rock-inhabiting lizards.

**Literature Cited**


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**Evaluation of a New Miniature Temperature Data Logger**

Peterson and Dorcas (1994) described the advantages of using data loggers to measure variation in the environment. Scientists may be reluctant to use data loggers in field studies until their usefulness and reliability have been demonstrated. We used a new, miniature temperature data logger to measure the temperatures of nests and hibernacula of wild desert tortoises (Gopherus agassizii) at Yucca Mountain, Nye County, Nevada. Here we report on the accuracy, reliability, and ease of use of these data loggers. Reference to a company or product name does not imply approval or recommendation of the product by the U.S. Department of Energy to the exclusion of others that may be suitable. Quoted costs are from a published price list and are reported in U.S. dollars.

We obtained 30 reusable, temperature data loggers (Hobo-Temp, Onset Computer Corporation, Pocasset, Massachusetts; cost $99 ea.), contained in cylindrical plastic cases (35-mm film canisters) that were 3.3 cm in diameter and 5.3 cm long. Each unit with its case weighed 28 g. Measurable temperature range was -39 to 123°C, although other standard and custom ranges were available. Specified accuracy was 0.6°C from 0–40°C, 0.8°C at -10°C, and 1.0°C at -20°C. We chose units with internal thermistors, though units with an external thermistor were available for an additional $1.8 per unit. Each data logger could store 1800 measurements in nonvolatile memory. The data loggers could be programmed to measure temperatures over 31 possible durations from 15 min to 360 days with corresponding time intervals of 0.5 s to 4.8 h; they could not be programmed to measure temperatures at rounded intervals such as every hour. We used DOS and Windows versions of the program BOXCAR and a package of DOS programs called HOBO-PC (cost $49 ea.) to set sampling duration and other options and to download data. Data loggers were connected to a computer using a 9-pin to 3.5-mm stereo-jack cable (cost $9). We sealed the cases with cloth tape and/or silicone sealant to prevent the lids from leaking or coming off.

We tested the accuracy of the data loggers at 10°C intervals from -20 to 46°C using an oven (Delta Design, model 3900) and a calibrated thermometer (Instrulab, model 4202, system accuracy ≤0.04°C within tested range). Accuracy averaged 0.34°C (SD = 0.23°C) with a maximum error of 1.03°C. The data loggers were within manufacturer's specifications on 94% of the measurements, and the maximum deviation from the specifications was 0.2°C.

We used the data loggers in the field to measure temperatures of desert tortoise nests and hibernacula. In January 1993, we glued data loggers to the carapaces of three radio-marked, hibernating tortoises that were near their hibernacula entrances. We set the data loggers to record temperatures for 90 days at intervals of 1.2 h. We placed glue (Devcon Plastic Welder) on the data logger case and then pressed the case against the carapace without moving the tortoise. We pried the data loggers from the carapace of each animal after it left its hibernaculum in March 1993.

We placed 23 data loggers in desert tortoise nests at depths of 3–24 cm during May-July 1993 to measure nest temperatures. We programmed these units to record temperatures for 122 days at intervals of 1.6 h.

We judged the reliability of the data loggers based on whether all data were acquired by each data logger. No data loggers placed on tortoises or in nests failed. All data were within expected ranges.

We judged ease of use of the software subjectively. All programs were simple to use and worked well. We found that the delayed start-up option, whereby data sampling could be initiated without a computer by removing and re-inserting the battery, was not ideal because the time recorded by the data logger automatically started at midnight of 1 January 1980 and had to be corrected after the data were downloaded. If the start time and date were not recorded manually, this information was lost. For this reason, we preferred using a laptop or handheld computer to start data loggers in the field. We had to ensure the computer's internal clock was accurate because that is where the data loggers obtained the start time and date.

We preferred using the Windows version of BOXCAR when first learning how to start-up and download data loggers because all of the options were visible on a menu. However, when starting-up or downloading many data loggers or when translating many files to a spreadsheet format, the programs included with HOBO-PC were beneficial because options could be set using a batch file. This reduced the chance of selecting an incorrect option.

We found the Hobo-Temp to be a reliable and easy-to-use temperature data logger. A more advanced product now available features rounded sampling intervals (e.g., an interval of one minute or one hour), a switch for starting units in the field without a computer and without loss of time data, programmable start times, averaging of multiple samples, and storage of up to 32,000 measurements. In addition, similar products are available for measuring relative humidity, light intensity, voltage, pressure, and vibration. A waterproof case that is made for the temperature and light intensity data logger may enable use in wetter climates and aquatic habitats, but the relatively large size of the waterproof case (6 cm in diameter and 10 cm long) reduces the advantage of the data logger's small size. Though, data loggers will undoubtedly evolve into smaller and more feature-rich units, biologists already have access to useful miniature data loggers that are valuable tools for field studies.

Acknowledgments.—This work was funded by the U.S. Department of Energy, Yucca Mountain Site Characterization Project, under contract No. DE-AC08-93NV11265. Permission to handle desert tortoises was granted by the U.S. Fish and Wildlife Service through permits PRT-683011 and
The Texas salamander, *Eurycea neotenes*, is one of several hemidactyline neotenic plethodontid salamanders endemic to the waters of the Edwards Aquifer of south central Texas (Chippindale et al. 1992). They are distributed throughout the aquifer (Dixon 1987), and their taxonomy is currently being evaluated (Chippindale et al. 1992).

The Edwards Aquifer is a subterranean reservoir with outflow water surfacing at many points. The waters of the aquifer have been taxed heavily in recent years by cities, farms, and industries. Five species found in the aquifer are listed as endangered; consequently there is much concern for the welfare of the endemic wild-life of the area. Proper management of this aquifer is vital to the survival of these species.

In the spring of 1990, during a prolonged drought and continued heavy human use of water, parts of the Comal Springs began to dry rapidly. The Edwards Aquifer Research and Data Center (EARDC) at Southwest Texas State University organized the field collection of 80 *E. neotenes* during June 1990. A conference was called to receive input and opinions regarding the depletion of the aquifer’s water and the resulting threats to the environment. United States Fish and Wildlife Service, EARDC, San Marcos National Fish Hatchery, Texas Parks and Wildlife, and four North American zoos/aquariums were represented at the conference. Salamanders collected prior to the conference were distributed among interested institutions with the hope that detailed data could be collected regarding the husbandry and reproductive strategies of this little known species. Naturally deposited eggs of neotenic *Eurycea* found in the Edwards Aquifer have never been discovered in the wild, despite concerted efforts.

The Dallas Aquarium acquired 20 specimens from the EARDC, a portion of which were divided into presumed pairs. Three pairs were housed individually in separate 3.8 L aquaria with a constant flow of fresh water from the aquifer well. Temperature of the well is a constant 22°C with pH ranging from 7.5-8.0 (Table 1). Overflow ports were fitted to the back of the aquaria to allow for water drainage. Wild specimens of *E. neotenes* have been collected in gravel substrate, dense submerged aquatic vegetation, and under rocks (Bruce 1976; Sweet 1977), so tank furniture was varied for each enclosure. Additionally some *Eurycea* spp. are known to deposit their eggs on the underside of buried rocks (Ireland 1974). The first aquarium was furnished with a 7 cm gravel substrate, the second was heavily planted with *Vesicularia dubyaana* and *Hygrophiha* sp., and the third was half filled with partially buried rocks and rock shards. The remaining individuals were housed in a 189.3 L aquarium with constant water flow and no furnishings other than several 25 cm sections of 1.3 cm (1/2 in) PVC pipe. All aquaria were positioned under a skylight to provide natural photoperiods. No other lighting was provided. Live foods offered included tubificid worms, *Gammarus* spp., and adult *Artemia* sp. Salamanders were observed feeding at various times of the day on all food types.

### TABLE 1. Dallas Aquarium water composition.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>pH</strong></td>
<td>7.5</td>
</tr>
<tr>
<td><strong>Turbidity (NTU)</strong></td>
<td>0.04</td>
</tr>
<tr>
<td><strong>Chlorine</strong></td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Total suspended solids</strong></td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Total dissolved solids</strong></td>
<td>635.</td>
</tr>
<tr>
<td><strong>Total alkalinity as CaCO₃</strong></td>
<td>353.</td>
</tr>
<tr>
<td><strong>Phenol alkalinity as CaCO₃</strong></td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Total hardness as CaCO₃</strong></td>
<td>451.</td>
</tr>
<tr>
<td><strong>Calcium hardness as CaCO₃</strong></td>
<td>432.</td>
</tr>
<tr>
<td><strong>Chloride as Cl</strong></td>
<td>61.</td>
</tr>
<tr>
<td><strong>Sulfate as SO₄</strong></td>
<td>86.</td>
</tr>
<tr>
<td><strong>Ammonia as N</strong></td>
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</tr>
<tr>
<td><strong>Organic as N</strong></td>
<td>0.18</td>
</tr>
<tr>
<td><strong>Nitrate as N</strong></td>
<td>4.4</td>
</tr>
<tr>
<td><strong>Nitrite as N</strong></td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Ortho phosphate as P</strong></td>
<td>0.07</td>
</tr>
<tr>
<td><strong>Total phosphate as P</strong></td>
<td>0.11</td>
</tr>
<tr>
<td><strong>Total BOD</strong></td>
<td>0.9</td>
</tr>
</tbody>
</table>

All results are in mg/L except pH, or as indicated.

Little activity was observed during daylight hours. Nocturnal activity was recorded on videotape with tinted red lighting as a source of illumination. Salamanders were observed feeding and moving throughout the enclosures with very little interaction noted between individuals. On 22 August 1990 an adult female in the planted tank exhibited obvious egg development, visible through the translucent abdominal wall. The following day a presumed male was observed chasing this female, but no other breeding or courtship behavior was observed. In the following months all animals were closely observed for egg development and/or courtship behavior. Nothing significant was recorded during this period.

During the evening hours of 18 and 19 February 1991, an gravid female deposited 19 white eggs. 2 mm diam, each surrounded by...
a gelatinous envelope, and fixed singly to live plants. The eggs were moved to a separate tank to ensure there would be no predation by the adult salamanders or snails present within the breeding enclosure. After a period of 48 h, the incubation tank was covered with black polyurethane to exclude light, addressing the concern that light intensity might have any deleterious effect on the egg development. Embryonic development was documented by photomicrographs. Several eggs developed a fungal growth and were preserved. Between 5-10 March 1991, four eggs hatched. One larva was deformed and expired immediately. Upon hatching, the larval ground color was a creamy white with scattered pale tan dorsal speckling. The larva possessed rudimentary external gills, no limbs, and an unpigmented iris. TL of hatchlings was 7 mm. Front limb development began with buds visible two days post hatching. Within four days, front legs were complete with digits, and larvae exhibited brown dorsal pigmentation with paired light colored vertebral spots. Hind limb development was observed on 15 March with digits visible on all four legs by 24 March. At 30 days post hatching, larvae were 15 mm TL and began feeding on live newly hatched brine shrimp nauplii, confirmed by the bright orange color of the brine shrimp visible through their translucent abdominal skin. At age two months, the young salamanders were 26 mm TL, and by 6 months of age the largest offspring measured 60 mm TL and showed signs of ova development. At one year post-hatching, two of the three offspring were obviously gravid with fully developed eggs. The third individual showed no ovarian development and was presumed to be a male. No other reproductive behavior was seen in the adults for a period longer than 1.5 yrs. The cues that triggered the first reproduction are unknown.

![Schematic of artificial aquifer](image)

The EARDC found that *E. nana* larvae of different ages can be collected in nets positioned over spring upwellings (Glenn Longley, pers. comm.). Our extended underwater observations in Comal Springs led us to hypothesize that the salamanders travel downward into the spring upwellings to deposit their eggs.

To test this hypothesis, we constructed an artificial aquifer consisting of a 122 cm long, 15.2 cm diam acrylic tube filled with limestone shards and fitted to the bottom of a 18.9 L aquarium (Fig. 1). Water was pumped upwards through the tube and exited through a screened overflow at the top of the aquarium. Flow rate for the artificial aquifer was measured at 5.5 L/min. The tube was equipped with a removable opaque covering to simulate the darkness of an underground aquifer and to permit periodic observations.

One of the original pairs and one F₁ pair were placed in the artificial aquifer on 23 February 1993. The original male was 91 mm TL and the female was 74 mm; the F₁ male was 76 mm TL and the F₁ female was 65 mm TL. Eggs laid by the F₁ female were discovered 38 days (2 April 1993) after the animals had been placed in the aquifer. Based upon rate of development of the previous clutch, the eggs appeared to be 2-4 days old. They were attached singly to rock shards in the lower portion of the aquifer. Hatching occurred ca. 12-13 April. On 10 May 1993 the founder female deposited more than 40 eggs in the artificial aquifer. The larval development subsequent to this oviposition differed from the two previous reproductions. A few of the larvae hatched, unpigmented and with no limb development on 30 May, but the majority of the larvae hatched between 6 and 13 June. The latter group of larvae hatched in a more advanced state with pigmentation of skin and iris diaphragm, and development of front limb buds. After hatching, 20 of the larvae were removed and placed in a separate aquarium for rearing. The remainder of the larvae were left in the parent enclosure for approximately two months. No predation on larvae by the adults was observed during this time. Neonates were then removed from the aquifer and divided between two rearing tanks.

On 13 March 1994 the founder female deposited at least 50 eggs in a similar fashion to her first reproduction on May 1993 in the artificial aquifer. Five eggs were removed to facilitate close observations of larval development.

We believe these three ovipositions in the artificial aquifer represent the "normal" reproductive mode of this species and may explain the difficulty of observing their eggs in nature. This propagation technique is now being tested by the U.S. Fish and Wildlife Service in an attempt to reproduce the closely related, but endangered San Marcos salamander, *Eurycea nana*.

**Acknowledgments.**—Support for this study was generously funded by the Dallas Zoological Society. We thank Dr. Glenn Longley of EARDC for hydrologic and hydrochemical data of the Edwards Aquifer and for photographs of the habitat. We also thank Dr. Tom Brandt and Casey Berkhouse of the National Fish Hatchery at San Marcos for their expertise, David Whately of the New Braunfels Parks and Recreation Department, the Texas Parks and Wildlife Department, and the United States Fish and Wildlife Service for all necessary permits. Finally we thank the staff of the Dallas Aquarium, the Dallas Zoo Department of Herpetology, and L. Ardell Mitchell, for helpful suggestions on this manuscript. Without such cooperation, this study would not have been possible.

**LITERATURE CITED**

In this report I describe hazards and precautions one should take when collecting harvester ants, as well as three successful methods of collecting Pogonomyrmex spp. in large numbers. Also, I explain methods for feeding harvester ants to horned lizards in indoor and outdoor enclosures. The Pogonomyrmex species most commonly collected near Tucson and Portal, Arizona, were P. rugosus, P. occidentalis, and P. desertorum.

Caution must be exercised in handling Pogonomyrmex ants as they are capable of inflicting severe stings (Schmidt 1986), to which some people may have an allergic reaction. People with known allergic reactions to hymenopterans should not try to collect Pogonomyrmex ants. Harvester ants defend attacks on their colonies by orienting toward and climbing tall objects. If this is the collector, they will sting. Frequent stamping of the feet effectively dislodges ants from shoes (sandals/thongs should not be worn).
to prevent long exposure to direct sunlight and desiccation of ants on the surface.

The third technique takes advantage of seasonal windfalls of alate ants congregating at lek sites. This requires knowing the timing, climatic stimuli, and lek siting of particular species of Pogonomyrmex (Holldobler 1976). Flying, alate harvester ants of high caloric value can be netted with an insect net. When large numbers of reproductives are collected they can be refrigerated to extend the period of use as live food.

Lizards maintained indoors should be in enclosures at least one meter square, and equipped with proper heating and ultraviolet lighting (Sherbrooke 1987). A sand substrate facilitates burrowing by the lizards. Because excited ants prefer to climb, an elevated “hill” away from the sides and towards one end of the cage serves to keep ants more or less concentrated at one location in the cage during feeding. The concentration of ants, and the maintenance of ant-free areas are critical to stimulating feeding by the lizards. Initially, lizard feeding behavior may be inhibited by the presence of an observer, but after several days the lizards associate the observer with ants, alleviating the problem.

The rate of introduction of ants into the enclosure is critical, and is dependent on the rate of consumption of ants by the lizards. Initially only small numbers of ants (5-10) should be introduced, then following ingestion by the lizards, they can be replaced and augmented. The number of ants in a cage should never be so great that their activity results in ants becoming dispersed throughout the cage. When ants surround lizards on all sides the lizards may stop feeding, and may attempt to escape the enclosure. Non-feeding lizards may become objects of ant attack, and, although they have resistance to ant stings (Schmidt et al. 1989), mandibular bites appear to cause the lizards some discomfort.

Feeding can be facilitated, especially of ants dug up with soil, by maintaining lizards in outdoor enclosures. This eliminates the need for artificial lighting and heating in areas and seasons where the climate is appropriate. Enclosure walls must be buried deeply enough and be high and smooth enough to prevent lizard escape. In addition, enclosures must be protected from predators (wire mesh enclosure covers work well), and large enough to allow entry for feeding and other care of the lizards. In recent years I have used 4.5 m x 5.5 m x 2.2 m high cage, divided into four 2.65 m x 2.13 m compartments, each surrounded by 0.6 m high sheet metal (28 gauge) walls. A 0.3 m cement footing-wall prevents subterranean escape of lizards and entry of predators.

These large enclosures are ideal for feeding ants mixed with soil in 5-gallon (18.9 L) buckets. The contents of the bucket, or several buckets (depending on numbers of ants and lizards) can be dumped on the center of the cage floor, building an elevated hill over time (which eventually must be removed). Lizards learn to approach this rise and feed on descending ants, while still having the entire periphery of the cage as a retreat. Ants frequently begin building burrows into the loose soil of the mound and, once established below the surface level, live for several days or longer without dying of desiccation. Ants in buckets can be maintained for a few days if the soil is kept damp and the buckets are not in direct sunlight.

Utilizing harvester ants with other foods (other ants, crickets and mealworms), I have maintained in captivity all seven species of horned lizards that occur in the United States for periods of weeks, months, and even several years. The best dietary mix varies with species of Phrynosoma (Montanucci 1989a; Pianka and Parker 1975). The numbers of lizards held was usually between fifty and one hundred, mainly for season-long behavioral studies.
Captive Breeding of Two Species of Eleutherodactylus (Anura: Leptodactylidae) from Puerto Rico, with Notes on Behavior in Captivity

Frogs of the genus Eleutherodactylus comprise an extremely successful and speciose group in the tropical Americas and the Caribbean. While the biology of several of the 500-plus known species has been investigated, little or nothing is known of the majority of these frogs, and new species are regularly being reported (e.g., Flores 1993; Hedges and Thomas 1992; Wiens and Coloma 1992). As a tool for the study of Eleutherodactylus, methods are described here which have been used to successfully breed in captivity two common species from Puerto Rico, E. coqui and E. cochranae.

Eleutherodactylus coqui is an ecological generalist occurring nearly island-wide in Puerto Rico, on adjacent islands, and in small introduced populations in Florida and Louisiana (Conant and Collins 1991; Rivero 1978; Schwartz and Henderson 1991). Eleutherodactylus cochranae is a much smaller and relatively unstudied frog, apparently restricted to the lowlands of Puerto Rico and several of the Virgin Islands (Rivero 1978; Schwartz and Henderson 1991). Both species were collected from backyards and gardens in the coastal town of Dorado, Puerto Rico during 1991–1993. Typical habitats in the collecting area consisted of moist bromeliads and ferns in cultivated gardens.

In captivity, frogs were housed in 10-gallon glass aquaria—51 cm (length) x 26 cm (width) x 32 cm (height)—with special provisions for the provision of suitable retreat sites, moisture, heat, and light. The substrate of the cages consisted of a single, level layer of approximately 1 cm diam natural stream pebbles, partially covered by ca. 1 cm of moist, untreated peat moss, both of which were obtained from local pet or garden supply stores. Smaller diameter pebbles were avoided as they posed a danger of ingestion during feeding. Retreat sites were provided by placing one or more small, locally purchased, potted bromeliads in each tank (Guzmania or Vriesea species). Care was taken to wash the bromeliads thoroughly to remove any pesticide or fertilizer residue prior to their placement in the aquaria. Cages were kept at a temperature of approximately 25–27°C. The lights were placed on a timer to provide a 12 h diel cycle.

An attempt was made to provide as diverse a diet as possible to the frogs. During warm weather, adult frogs were fed a variety of moths attracted to outdoor lights, various hand caught spiders, grasshoppers, termites, and other easily captured insects. During the winters, the diet consisted almost entirely of locally purchased crickets (Acheta domesticus), house flies (Musca domestica), and locally cultured fruit flies (Drosophila melanogaster). While activity continued year round for both species, frogs showed decreasing interest in any one food type after prolonged feeding in the absence of other varieties. Feeding frequency was adjusted to accommodate the relative hunger level of each frog. For general maintenance this usually consisted of a sufficient quantity of items to equal approximately one fifth the frog’s weight, twice a week.

In captivity, both species of frogs appeared to call normally and engage in apparently typical behaviors. Male advertisement calling, satellite behavior, and territory and retreat defense, as well as mating and parental care were all observed. Male E. coqui and E. cochranae both gave advertisement calls similar to those previously described (Drewery and Rand 1983). However, the calls of E. coqui collected at Dorado were of higher frequency than those previously reported from frogs at El Yunque (Drewery and Rand 1983; Narins and Capranica 1976; Stewart and Rand 1992). This is in agreement with the observed altitudinal variation in call frequency reported by Narins and Smith (1986). During aggressive interactions and territorial and retreat defense in captivity, E. coqui males gave multi-note extensions of their mating calls, similar to those reported by Stewart and Rand (1991, 1992) and Stewart and Bishop (1994). Female E. coqui in captivity also gave occasional aggressive calls as previously described (Stewart and Rand 1991).

Aggressive physical interactions observed between E. coqui consisted of butting and biting behaviors also previously described (Stewart and Rand 1991; Townsend et al. 1984). In contrast, male E. cochranae in captivity used a very different behavior during physical encounters. This consisted of "shoveling" under the opponent and attempting to dislodge the opponent from the substrate. This may be an adaptation making use of the flattened morphology of E. cochranae. Also unlike E. coqui, both sexes of E. cochranae gave a retreat defense call differing in pitch and timing from the typical male E. cochranae advertisement call.

Both species showed extreme satellite male behavior in captivity. Extra males placed within a tank with a mating pair caused disturbances in the normal mating activities. The extra males engaged in aggressive calling and physical interactions with the resident male. These behaviors usually prevented courtship and nesting. However, on several occasions more than one male was found in a nesting retreat attempting to amplex the female. Females occasionally deposited eggs in these circumstances (as evidenced by thinness and the lack of egg masses seen through the skin the following day), but the eggs were always eaten in those circumstances, apparently by the competing males. Conspecific cannibalism has been reported in E. coqui (Townsend et al. 1984), but mating interference as a satellite male strategy has not. However, mating interference has been observed in dense populations of E. johnstoni in Barbados (Ovaska and Hunte 1992). It is likely that these behaviors in captivity are a consequence of the confined conditions.

During courtship and mating, males of both species produced soft, repetitive calls similar to those mentioned previously for E. coqui (Townsend and Stewart 1986). These calls apparently served to attract the female to the nesting site and initiate amplexus. In captivity, amplexus was maintained by pairs of both species until the following day and undisturbed males remained with the eggs in the nest site during development and for as long as 5 days after hatching of the young frogs, as reported by Townsend et al. (1984) and Townsend and Stewart (1986). In captivity, male frogs protected their egg clutches in a manner similar to previous reports (Taigen et al. 1984; Townsend et al. 1984). During dry periods the fathers moved to other leaf axils containing water, then back to
the nest to rehydrate the eggs. Fathers defended their nests vigorously against intrusion from other frogs, insects, or inanimate objects. Eggs in the care of a male frog seldom developed bacterial or fungal infections; however, removing the eggs to another location nearly always produced infections.

During two years of captivity over 30 E. coqui clutches and over 20 E. cochranae clutches were observed. Breeding activity took place year-round. E. coqui laid 12–30 eggs per clutch (mean = 23), which took 15–33 days to hatch (mean = 22). The much smaller E. cochranae laid 5–10 eggs per clutch (mean = 8) which took 16–20 days to hatch (mean = 18). The eggs of both species were of approximately the same size (4–6 mm at hatching, mean = 5, N = 10 for each species). For females of both species, the time between each mating and oviposition was dependent on food supply. In one instance, it took only six days for a female E. coqui to lay a new clutch. Seven and eight-day intervals between clutches were not uncommon for either species when food was supplied in sufficient quantity. Since female E. coqui have been reported to deposit all of their mature eggs at each oviposition (Townsend and Stewart 1986), these times are indicative of the minimum maturation time for a clutch of ova, and thus the minimum breeding interval. If retreat sites, not food supply, limit natural populations (Stewart and Pough 1983), female eleutherodactylidys may be able to produce clutches nearly three times faster than males can incubate them. This minimum breeding interval is considerably longer than the 59-day average interclutch interval reported from three female frogs at El Yunque (Townsend and Stewart 1994).

Similar to reports for E. coqui in the field (Townsend et al. 1984), males of both species in captivity rarely moved from their eggs during incubation, and appeared uninterested in insects as food items during brooding. However, fathers regularly consumed a small number of eggs during the course of the incubation. It is not clear whether this is a biologically significant behavior or an artifact of captivity, as males often ate their entire clutches if they or their nests were disturbed. Females of both species were voracious feeders, and appeared capable of consuming nearly their own weight in food items in a single evening, especially after egg deposition.

Hatchling frogs of both species measured 4–6 mm SVL (mean = 5, N = 10 for E. coqui, and 5 for E. cochranae). They remained in the nest, guarded by the father for several days after hatching, at which point they began to disperse. The fathers of hatchling frogs remained uninterested in most insect food items, and did not attempt to eat the young frogs. On the other hand, the mothers were a significant source of predation if left in the same aquarium with hatchlings.

A major problem arose in feeding the juvenile frogs, as they were generally too small to eat even fruit flies (Woolbright and Stewart 1987). Oddly, juveniles of the smaller species, E. cochranae, were often capable of taking larger food items than juveniles of E. coqui of the same age and size. Without a consistent supply of tiny food items, mortality at the hatching stage was high, generally greater than 95%. Proglets that were capable of eating fruit flies were raised in moss-filled 150 mm x 20 mm petri dishes placed under the plastic wrap on top of the adult frog aquaria until they were approximately 10 mm SVL. They were then transferred to an aquarium and fed pin-head crickets and small house flies. Information on adult E. cochranae raised under these conditions is lacking as juveniles of this species began to develop unidentified neurological problems at 10–15 mm SVL. Symptoms included inability to capture food items, unsteady movements, muscle spasms, and a soft enlargement of the head between the eyes. No captive born E. cochranae has survived long enough to reproduce. The reasons for this defect in development are unclear. However, juvenile E. coqui developed without difficulty and males reached sexual maturity in approximately 5–6 months, as evidenced by calling. Female E. coqui grew to a larger size than males, developed egg masses, and bred at approximately 12 months. Second generation captive E. coqui have also bred and produced normal offspring. The oldest frog in captivity was a male E. coqui that was collected as an adult in September 1991, and died in July 1994. This individual called somewhat atypically in 1993 and 1994, but was otherwise active and healthy, with no obvious cause of death.

Artificial environments of this type should prove useful for the propagation and study of other species of Eleutherodactylus. While the biological significance of observations made in artificial settings must be confirmed in the natural habitat, interesting behaviors noted in captivity can provide excellent direction towards the design and interpretation of field experiments. Captive breeding of these species has allowed intimate observations to be made during evidently normal behavior. These observations have indicated likely differences in biology between these two species, including differences in development, clutch size, call patterns, and aggressive interactions. In addition, captive breeding may be useful for conservation of drastically endangered species, since many species of Eleutherodactylus inhabit extremely restricted ranges that have been negatively affected by human activities.

**Literature Cited**


Health and Welfare of Captive Reptiles

Edited by Clifford Warwick, Institute of Herpetology, Worcester, UK. Frederic L. Frye, Fund for Clinical Research, Davis, California, and James B. Murphy, Dallas Zoo, Texas

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NATURAL HISTORY NOTES

The Natural History Notes section (formerly Life History Notes) is analogous to Geographic Distribution. Preferred notes should: 1) Focus on observations with little human intrusion; 2) represent more than the isolated documentation of developmental aberrations; and 3) possess a natural history perspective. Individual notes should, with few exceptions, concern only one species, and authors are requested to choose a keyword which best describes the nature of their note (e.g., Reproduction, Longevity, Morphology, etc.). Use of figures to illustrate any data is encouraged, but should replace words rather than embellish them. The section's intent is to convey information rather than demonstrate prose. Articles submitted to this section will be reviewed and edited prior to acceptance. Send two copies of manuscript, double-spaced, directly to the appropriate section co-editor (addresses on inside front cover). Manuscripts concerning reptiles should be sent to Lee A. Fitzgerald; those concerning amphibians should be sent to Charles W. Painter.

Standard format for this section is as follows: SCIENTIFIC NAME, COMMON NAME (for the United States and Canada as it appears in Collins 1990). Standard Common and Current Scientific Names for North American Amphibians and Reptiles, 3rd ed., Herb. Circ. 19:1-41; for Mexico as it appears in Liner 1994, Scientific and Common Names for the Amphibians and Reptiles of Mexico in English and Spanish, Herb. Circ. 23:1-113. KEYWORD. DATA. On the animal, Place of deposition or intended deposition of specimen(s), and catalog number(s). Then skip a line and close with SUBMITTED BY (give name and address in full—spell out state names—no abbreviations). (NCN) should be used for common name where none is recognized. References may be briefly cited in text (refer to this issue for citation format).


CAUDATA


Submitted by MICHAEL REDMER, 21 West 103 Par Lane, Itasca, Illinois 60143, USA.

AMBYSTOMA TIGRINUM (Tiger Salamander). REPRODUCTION. Nussbaum et al. (1983). Amphibians and Reptiles of the Pacific Northwest. Univ. of Idaho Press, Moscow, p. 57.) reports that little is known about the life history of tiger salamanders in the Pacific Northwest, and gives an account of eggs being found in April in Medical Lake, Spokane Co., Washington. On 26 March 1994 we found approximately 75 eggs attached to stems of spikerush (Eleocharis sp.) and fallen branches in a roadside swale on the N side of the Frenchman Hills, Grant Co., Washington, SE 1/4 Sec. 16, T17N, R26E (Verified by R.A. Nussbaum, UMMZ 205809). Of almost 20 eggs examined, all embryos were at stage 38 (Duellman and Trueb 1985. Biology of Amphibians. McGraw-Hill Book Company, New York, p. 131). indicating they had been deposited approximately two weeks earlier. All eggs had been attached singly, although it was common to see several eggs beside...
PLETHODON GLUTINOSUS (Slimy Salamander). MORPHOLOGY. On 29 June 1992, while collecting salamanders as part of a long-term capture recapture study, I collected a juvenile Plethodon glutinosus 2.5 km W Hwy 160 near Big Black Mountain Ridge Road in Harlan County, Kentucky. The salamander exhibited extreme scoliosis but otherwise appeared in good health. Based on SVL (41 mm from tip of snout to posterior angle of vent), the age of this individual was estimated to be 2 or 3 yrs (Sembitsch 1980. Herpetologica 36:6-16). This estimate may be conservative since the SVL measurement did not include bends in the vertebral column. The salamander was photographed and released. On 20 July 1993 I recaptured this individual (identity verified by spot pattern record) about 1.5 m from the capture point of the previous year. I photographed the salamander (Fig. 1, top) and recorded its SVL (50 mm). It still appeared in good health. A radiograph confirmed external observations that the vertebral column exhibited extreme lateral arches which were most severe behind the forelimbs (Fig. 1, bottom). Thus, the vertebral column abnormality apparently did not inhibit growth or survival under natural conditions. I thank R. G. Wilson for providing the radiograph and C. McCallister for providing photographs.

Submitted by GLENN A. MARVIN, Department of Zoology, University of Oklahoma, Norman, Oklahoma 73019, USA.

ANURA

BUFO TERRESTRIS (Southern Toad). OOPHAGY. On 28 March 1993 I observed a congregation of tadpoles feeding on a dead adult female Bufo terrestris. I collected the female and tadpoles (N = 114) to examine the nature of the feeding. I also found a second dead female nearby; however, no tadpoles were feeding on it. I collected this female and an additional 200 tadpoles to determine whether the tadpoles would eventually feed on the second female. After 3 days with the carcass and no other food supply, no feeding was observed.

I haphazardly selected 10 tadpoles captured with the first female and measured SVL and stage. Tadpoles were between 6 and 9 mm SVL, and stages 29 to 31 (Gosner 1960. Herpetologica 16:183-190). The first female toad was missing the right front and rear legs (jagged bones were exposed) and her stomach cavity was open. Tadpoles concentrated feeding activity around the opened venter. Within the body cavity the intestines and stomach were intact, but the female was gravid and many eggs were loose. I inspected 10 tadpoles to determine if they were feeding on the eggs. The presence of eggs in 3 of the tadpoles confirmed that the tadpoles were feeding on the eggs.

Cannibalism or oophagy by tadpoles has been documented in numerous species (Crump 1983. Am. Nat. 121:281-287). Polis and Myer 1985. J. Herpetol. 19:99-107). In some species, cannibalism or oophagy can be an important and regular feature of tadpole life history, while in others it may simply be an opportunistic food source. This observation represents the latter, as this type of oophagy is probably rare for Bufo terrestris tadpoles.

Submitted by KIMBERLY J. BABBITT, Department of Wildlife and Range Sciences, University of Florida, Gainesville, Florida 32611, USA.

HYLODES PHYLODES (NCN). PREDATION. Picinguaba (23°22'S 48°45'W), southeastern Brazil, embraces an area of Atlantic slope rainforest. The small diurnal leptodactylid frog Hyloides phylodes Heyer and Cocroft (SVL 27.5-35.5 mm) is commonly found on or among rocks and roots along small overgrown streams. The pisaurid spider, Trechalea keyserlingi F.O. Pickard-Cambridge, is predominantly nocturnal and is also associated with flowing water.

On 9 December 1991, between 1630 and 1700 h, we observed a subadult T. keyserlingi (13.8 mm body length) vertically positioned upside down on the side of a rock next to a stream. This spider caught a young H. phylodes (17.2 mm SVL) by one of its hind limbs as it passed on the leaf litter about 50 cm below. The frog tried unsuccessfully to get away but was eventually immobilized by the spider's toxin. At that moment both were collected and preserved. The spider was placed in the Instituto Butantan Collection (IBU 5319) and the frog in the Museu de Zoologia da Universidade de São Paulo (MZUSP 69850).

The frequency of predation on H. phylodes by T. keyserlingi is unknown but may be common, because both species appear to occupy the same microhabitat. Also, while both species attain larger sizes, predation might include adult frogs. Other pisaurid spiders eat fish and tadpoles (McCormick and Polis 1982. Biol. Rev 57:29-58) suggesting that this species also could prey on Hyloides larvae.

Although spiders are often cited as important predators of small frog larvae, few published records simultaneously identify predator and

Submitted by F.O. Pickard-Cambridge, Instituto Butantan, Ribeirão Preto, S.P., Brazil.
prey species (McCormick and Poils, op. cit.). We found no literature concerning such interactions for Atlantic forest species.

Submitted by LUIS CESAR SCHIESARI, FLORA ACUÑA JUNCA and GUSTAVO DE MATTOS ACCACIO, Departamento de Zoologia, Instituto de Bicociências, Universidade de São Paulo, 20520, 01452-990, São Paulo-SP, Brazil.

LEPTODACTYLUS ALBILABRIS (Caribbean White-lipped Frog). LARVAL DIET. Leptodactylus albilabris is a common frog throughout Puerto Rico. It produces foam nests and its tadpoles occur in a variety of still and slowly flowing waters (Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies, Descriptions, Distributions, and Natural History. Univ. of Florida Press, Gainesville. 720 pp.). Little is known of the larval biology of this species and nothing has been reported of the dietary habits of the tadpoles. On 19 May 1994, we observed L. albilabris tadpoles of sizes from approximately 6 mm (newly emerged from a nearby foam nest) to 13 mm in a shallow (<5 cm deep) stream at the bottom of a steep ravine in relatively undisturbed wet forest at an elevation of 700 m in the Reserva Forestal Carite (Guavate), Sierra de Cayey, Commonwealth of Puerto Rico (66°02'30"N, 18°05'45"W). Larger tadpoles in two separate pools in the stream were feeding. In one pool larvae were feeding on a dead earthworm (length ca. 100 mm). In the other they were removing flesh from the nearly fully skeletonized carcass of an anole (estimated intact SVL 60 mm). Features of the lizard’s skull were consistent with those of Anolis gundlachi, which was abundant in the vegetation surrounding the stream. The only other anole observed near the stream was A. evermanni. Although few tadpole species are obligate carnivores (Bragg 1965. Gnomes of the Night, the Spadefoot Toads. Univ. of Pennsylvania Press, Philadelphia. 127 pp.), facultative carnivory is more widespread and can occur in species showing no obvious morphological feeding specializations (Heyer et al. 1975. Biotropica 7:100-111). Documentation of tadpole predation or scavenging on vertebrates is rare, but Leptodactylus pentadactylus preys on the tadpoles of other anurans (Heyer et al., op. cit.; Kluge 1981. Misc. Publ. Mus. Zool. Univ. Michigan 160:1-170). Scavenging of terrestrial vertebrates by larvae is less well-documented, but Lechriodus fletcheri tadpoles have been observed to feed on adults of the same species (Martin 1967. Aust. Nat. Hist. 15:326-330). Although the observation of scavenging on a terrestrial vertebrate carcass by Leptodactylus albilabris tadpoles is an isolated event, it suggests that facultative carnivory may be more widespread among members of the genus Leptodactylus than previously recognized. Further, it highlights the dietary plasticity and opportunistic feeding behavior capable by relatively generalized tadpoles.

Submitted by RICARDO LEBRON, A. TINA BATRA, JAMES BONTEMPO, CHRISTIAN BUCKLEY, MITCHELL CRON, LINDA FENSTERMACHER, CHRISTINA MAHONEY, LINDA SCHMITT, and AARON M. BAUER, Biology Department, Villanova University, 800 Lancaster Avenue, Villanova, Pennsylvania 19085, USA.

PELTOPHRYNE GUENTHERI (NCN). PARASITISM. In the course of a dietary study of the endemic Hispaniolan toad, Peltophryne guentheri, we examined the stomach contents of 204 specimens. In three adult males from different sites in Haiti (Arbonite, near Los Poteaux) and the Dominican Republic (Independencia, near Lago Enriquillo; Monte Cristi, near Copey), we found immature nematodes (Skrijabinoptera sp., Physalopteroidae) and ingesta. Prevalence was 1.5% (3 of 204 specimens examined). Intensities ranged from 1-4 (mean = 2.0) parasites per host. Total lengths of nematodes ranged from 1.7-2.4 mm (mean = 1.93 mm), maximum diameter from 14-15 μ (mean = 14.3 μ).

Skrijabinoptera has not been found previously in any amphibian (Baker 1987, Mem. Univ. Newfoundland Occ. Pap. Biol. No. 11), but S. leiocephalorum has been found in Hispaniolan lizard hosts. This parasite was originally described from Leiocephalus schreibersii and L. barahonensis (Greve and Powell 1989, J. Parasitol. 75:677-679; Powell et al. 1990, J. Helminthol. Soc. Washingon 57:75-77). Powell et al. (1990. Herpetol. Rev. 21:60-61) noted its occurrence in L. semilineatus. Fobes et al. (1992. Carib. J. Sci. 28:200-207) and Moster et al. (1992. Bull. Maryland Herpetol. Soc. 28:150-161) found S. leiocephalorum in Anolis cybotes and A. brevirostris, respectively. That so many diverse lizards support this parasite suggests that a common prey item is the vector (probably one or more species of insect). Peltophryne guentheri may feed on the same prey. However, the low prevalence and the fact that all parasites were juveniles may reflect the inadequacy of P. guentheri as a final host.

We thank William E. Duellman and John S. Simmons, University of Kansas Museum of Natural History, for access to speci-
Submitted by KEELEY J. PARSONS and ROBERT POWELL, Department of Natural Sciences, Avila College, Kansas City, Missouri 64145, USA, and JOHN H. GREVE, Department of Veterinary Pathology, Iowa State University, Ames, Iowa 50011, USA.

**Pseudacris Regilla** (Pacific Chorus Frog). **Reproduction.** On 28 and 29 August 1993, I observed *Pseudacris regilla* tadpoles in weakly brackish (~1.0%) (*brackish* sensu Remane and Schlieper 1971, Biology of Brackish Water. Wiley, New York. 327 pp.) supratidal pools on Frank Island and at South Beach, west-central Vancouver Island, British Columbia, Canada. Some inland populations of *P. regilla* frequent and presumably breed in brackish water (Brues 1928. Proc. Am. Acad. Arts Sci. 63:138-228; Brues 1932. ibid. 67:184-303; Murray 1958. Herpetologica 11:33-48), but reproduction in brackish supratidal pools has not previously been reported. The Vancouver Island breeding pools appear similar to those used by *Bufo calamita* in Sweden (Andrén and Nilson 1985. Amphibia-Reptilia 6:137-142); pools are small (<3 m²), shallow (<45 cm), and not connected to the ocean. At high tide they are no higher than 4 m above sea level and as close as 5 m to the water's edge. Salt spray and inundation of sea water during storms apparently adds salt water to these pools, but heavy rainfalls and surface runoff probably maintain salinities at dilute levels.

Although at least seven other amphibian species are sympatric with *Pseudacris regilla* across west-central Vancouver Island (Nussbaum et al. 1983. Amphibians and Reptiles of the Pacific Northwest. Univ. Press of Idaho, Moscow. 332 pp.), I found only *P. regilla* tadpoles and aquatic arthropods in the supratidal pools. Tadpoles ranged in density from one to about 25 individuals per pool and stages 28 to 42 of Gosner (1960. Herpetologica 16:183-190). The late stage larvae suggest that metamorphosis successfully occurs; however, I failed to locate any metamorphosed frogs. I deposited seven voucher tadpoles from Frank Island in the University of Alberta Museum of Zoology (UAMZ 3001), Edmonton, Alberta.

I thank Josie Cleland (Clayoquot Biosphere Project, Tofino) for bringing the Frank Island tadpole pools to my attention, Dick Pereschitz for conveying a relevant paper, Gertie Hutchinson (Univ. Alberta) for raising burrows in vegetation-free areas in suitable sandy habitats is a useful method for locating specimens of the highly secretive *P. s. illinoensis* both at choruses (our record) and away from breeding sites (Axtell and Haskell's report).

Between 24 May and 12 June while conducting a survey of the site for transforming chorus frogs, 42 burrows containing newly transformed frogs were excavated in a wheat field near the natural pond. Twenty-three of these were in bare sand, but 19 were within 0.5 cm of wheat plants. No burrows were in heavy vegetation at the margins of the wheat field or between the wheat field and natural pond. Most burrows were less than 2 cm long (mean =


On 20 April 1993 at 2230 h we dug one adult male (35 mm SVL) from a burrow 2.9 cm from a breeding pond. This burrow was 45 cm long and 11 cm below the soil surface at its terminus. It appeared to be level with depth being produced by its location on a slope. The opening was semi-oval in shape (2.2 cm wide and 1.4 cm high) with a loose sand apron. Apparently, the loose sand was pushed from the burrow. The terminus consisted of a slightly enlarged chamber with damp but not saturated sand. The frog was well hydrated and active. We heard no calling from the vicinity of the burrow. Underground calling has been reported for *P. ornata* (Brown and Means, op. cit.).

The burrow was in an area of unvegetated sand. We excavated similar burrows (38), but found no other frogs. No excavated burrows were within 5 cm of plants. Some burrows could have been made by toads; choruses of *Bufo americanus* and *B. woodhousii fowleri* were present. Three male *B. americanus* were also dug from two burrows the same night. The larger burrows occupied by toads differed from the burrow made by the chorus frog in that their openings were circular with sand pushed up all around the margin of the opening. Toad burrows also dipped at a steeper angle. One toad burrow was 18 cm long and 12 cm deep; the other was 20 cm long and 10 cm deep.

Axtell and Haskell (op. cit.) reported that burrows of *P. s. illinoensis* dipped at a steep angle (20 cm deep with 10 cm lateral displacement) or were nearly vertical (2 of 3 burrows). The openings of those three burrows were similar to the one that we observed. The depths of the four (3 from Axtell and Haskell and one we report) known burrows of *P. s. illinoensis* averaged 15.2 cm (range 11-20 cm). Axtell and Haskell (op. cit. p. 2) also noted that burrows containing frogs were located in areas devoid of vegetation. These details are important because excavation of likely-looking burrows in vegetation-free areas in suitable sandy habitats is a useful method for locating specimens of the highly secretive *P. s. illinoensis* both at choruses (our record) and away from breeding sites (Axtell and Haskell's report).

Between 24 May and 12 June while conducting a survey of the site for transforming chorus frogs, 42 burrows containing newly transformed frogs were excavated in a wheat field near the natural pond. Twenty-three of these were in bare sand, but 19 were within 0.5 cm of wheat plants. No burrows were in heavy vegetation at the margins of the wheat field or between the wheat field and natural pond. Most burrows were less than 2 cm long (mean =

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3.8 cm, range 1.2–15 cm, N = 22) and shallow, but one was 15.0 cm long and 4 cm deep at its terminus. Many froglets were seen at the mouth of burrows. When we approached, froglets usually fled by hopping into the open rather than into the burrow. All burrows were excavated during daylight and may have been temporary refuges constructed to avoid desiccation during a post-transformation migration.

Burrows containing either adult or newly transforming frogs were not found in heavy vegetation. Our observations support the hypothesis that sod or compacted soils are incompatible with the frog's burrowing life history (see Brown et al., op. cit.; Axtell and Haskell, op. cit.). If these contentions are true, vegetation in habitats used by P. s. illinoensis should be managed to prevent thickening or sod formation. Compaction of sandy soils by human or natural means may be detrimental to the persistence of the frog.

We thank K. Brockmeier, Brockmeier Sod Farms, for allowing unrestricted access to his property to conduct this study. L. E. Brown, D. Moll, G. L. Paukstkis, and G. B. Rose read drafts of this paper. C. H. Theiling allowed us to use Long Term Resource Monitoring program facilities. G. Kruse expedited the granting of permits necessary for this research. This research was supported by Illinois Department of Transportation contract 1-5-90179 with the Illinois Natural History Survey, J. K. Tucker and D. P. Philipp, Co-Principal Investigators.

Submitted by JOHN K. TUCKER, JAMES B. CAMERER, and JAMES B. HATCHER, Illinois Natural History Survey, 1005 Edwardsville Road, Wood River, Illinois 62095, USA.

RANA CATESBEIANA (Bullfrog). DIET. True toads (Bufoidae) are infrequently reported in the diet of Rana catesbeiana (see review by Bury and Whelan 1984. U.S. Dept. Interior Fish and Wildlife Serv. Res. Pub. 155). On 31 July 1992 (2100 h), I collected two adult female bullfrogs (180 mm and 156 mm SVL, respectively) in a temporary roadside pool formed by overflow from a permanent irrigation pond, 12 km ESE of Hermanas, Luna County, New Mexico. Chorusing males of Scaphiopus couchii, Spea multiplicata, Bufo cognatus, B. debilis, and Gastrophryne olivacea were also present in this or nearby pools. The stomach of the larger bullfrog contained a B. cognatus (70 mm SVL), a B. debilis (42 mm SVL), and two tenebrionid beetles. The second frog had eaten an anuran, a mouse (both unidentified), a centipede (Scolopendra sp.), and several beetles. The B. debilis had been only recently ingested, whereas the B. cognatus probably had been eaten the previous night as it was partially digested.

Brown (1974, Southwest. Nat. 19:335-336), and Tucker and Sullivan (1975. Trans. Illinois State Acad. Sci. 68:167) noted that Bufo are apparently unpalatable to bullfrogs due to their toxic parotoid gland secretions which may cause regurgitation of the prey item or even immobilization of the predator. I shot both bullfrogs and therefore could not determine if the larger specimen exhibited symptoms of poisoning. It is noteworthy, however, that this frog, perhaps due to its large body mass, was able to consume the B. debilis after ingesting and partially digesting the B. cognatus. Similar observations of ingestion and digestion of Bufo valliceps by bullfrogs were reported recently by Platt and Fontenot (1993. Bull. Chicago Herpetol. Soc. 28:189-190).

The bullfrogs were collected under permit from the New Mexico Department of Game and Fish and are deposited (with stomach contents) in the Museum of Southwestern Biology, University of New Mexico (MSB 54999-55000). I thank W. G. Degenhardt, R. D. Jennings, and C. W. Painter for comments.

Submitted by JAMES N. STUART, Museum of Southwestern Biology, University of New Mexico, Albuquerque, New Mexico 87131, USA.

RANA TEMPORALIS (Golden Frog). ECOLOGY. Five adult (SVL 35.0–73.5 mm; mean = 53.80 ± SE 7.36 mm) Rana temporalis ( Günther 1864) were collected 28 August 1990, from a forest in the vicinity of Tirunelveli (8° 25'-35' N, 77° 25'-35' E), Tamil Nadu State, India. The frogs were found on boulders along an intermittent stream bed. Two were males with enlarged testes (SVL 41.6 and 51.4 mm) and three were females with developed ovaries (SVL 67.5, 35.0 and 73.5 mm). Two of the females were gravid, one with SVL 67.5 mm contained 838 eggs (1.81% of body weight; mean = 0.07 mm, N = 3), another SVL 73.5 mm contained 1225 eggs (0.20-1.46%, respectively, of the total body weight). A total of ten prey items were recovered from the five frogs reported here. Prey length ranged between 1.60–7.90 (mean = 4.66 ± SE 1.01) mm, and included two caddisflies (including a stalk-eyed fly), two spiders, two cockroaches, two termites, and two unidentified insects (one with eggs). The average number of prey items was 2 (SE 0.45, range 1–3 items).

Submitted by INDRANEIL DAS, Centre for Herpetology, Madras Crocodile Bank Trust, P.O. Bag 4, Mamallapuram, Tamil Nadu 603 104, India.
**TESTUDINES**


A juvenile *C. p. belli* (60 mm plastron length) was collected on 9 April 1993 while it was basking on a log in the littoral zone of Lone Star Lake (a 79 ha reservoir 20 km from Lawrence, Douglas Co., Kansas). The turtle was brought back to the laboratory, placed in a 19 L aquarium filled to a depth of 15 cm, and left overnight. A student placed a mixture of zooplankton in the aquarium and noticed that the turtle began to feed immediately. On 17 April 1993, I conducted an experiment to look at feeding behavior. After withholding food for 24 h, I placed 50 lab-cultured *Daphnia magna* (2-2.5 mm) in the aquarium (density = 5/L; water temperature = 20.5°C). I then observed the turtle for 5 min and counted the number of attacks and the number of successful attacks. Ten minutes after the trial was completed, I added 15 additional prey items of the same size to estimate the distance at which the turtle could locate *Daphnia*.

The turtle reacted immediately to the presence of prey, and attacked 39 *Daphnia* during the 5 min trial with a capture success of 92% (feeding rate = 7.2/min). During a typical feeding sequence, the turtle located a *Daphnia* while swimming underwater, oriented toward it, swam to within ca. 2 cm, retracted the head, and immediately lunged the head forward (termed a "head-lunge" by Brown, op. cit.) to capture the prey. The mean distance at which the turtle located *Daphnia* was 10 cm (range 4-11.5 cm). The turtle was released at the site of capture on 18 April 1993. I thank Thomas Berendonk for his initial observations.

Submitted by ERIC F. MAURER, Department of Systematics and Ecology, University of Kansas, Lawrence, Kansas 66045, USA.

**ERETMOCHELYS IMBRICATA** (Hawksbill). **PREDATION.** Records of shark predation on sea turtles are scarce, especially on the hawksbill (Witzell 1983. FAO Fish. Sinop. 137, Rome, 77 pp.). In the tropical eastern Atlantic Ocean the tiger shark, *Galeocerdo cuvier*, is a major predator on hawksbills (Cadenat 1977. Inst. Fr. Afr. Noire 19 (1):274-294). Here we report on a hawksbill eaten by a tiger shark in the western Atlantic Ocean, between Nova Vicosa and the Parcel de Abrolhos (18° 00' S, 39° 02' W), Bahia, eastern Brazil. On 2 March 1994 a whole juvenile hawksbill with carapace 34 cm long and 27 cm wide (curved measurements) was found by fishermen in the stomach of a shark with body mass 120 kg (estimated total length 250 cm, diameter of the jaws 31 cm) caught near reefs at a depth of about 15-20 m. The Nova Vicosa fishermen informed us that they frequently find sea turtles in the stomachs of tiger sharks. Predation on hawksbills by tiger sharks may be common, since both the turtle and the shark are associated with reefs and shallows (Böhleke and Chaplin 1968. Fishes of the Bahammas and adjacent Tropical Waters, Livingston Publ., Wynnewood, 771 pp.; Witzell, op. cit.). The turtle carapace and pieces of the shark jaws are deposited at the Museu de História Natural, Universidade Estadual de Campinas (ZUEC 1693 and 1960).

We thank I. Verjovsky, A. Batalha, and P. Bonino for introducing us to the fishermen of Nova Viçosa, G. de Jesus for information on tiger sharks, M. Martins for comments on the manuscript, and the CNPq for financial support.

Submitted by JOÃO LUIZ GASPARINI, Departamento de Biologia, Universidade Federal do Espírito Santo, 29040-090 Vitória, Espírito Santo, Brazil, and IVAN SAZIMA, Departamento de Zoologia, Universidade Estadual de Campinas, 13081-970 Campinas, São Paulo, Brazil.

**HYDROMEDUSA MAXIMILIANI** (Maximilian's Snake-necked Turtle). **JUVENILE MORPHOLOGY.** *Hydromedusa maximiliani* occurs in southeastern Brazil, from Espírito Santo to São Paulo (Ernst and Barbour 1989. Turtles of the World. Smithsonian Institution Press, Washington, D.C. 313 pp.), living in shallow streams inside rain forests in mountainous regions. Although adults have been described in detail (Ernst and Barbour, op. cit.) there is no information on hatchling or juvenile morphology of this species.

From June to December 1993, several specimens (hatchlings, juveniles and adults) of *H. maximiliani* were observed and measured in the wild at Carlos Botelho State Reserve, São Paulo (24° 03' S; 47° 39' W). The mean carapace length of hatchlings and juveniles was 89.7 mm (N = 33; SD = 20.7 mm; range = 47.3-122.5 mm) and their mean mass was 78.2 g (N = 33; SD = 40.6 g; range = 15.0-160.5 g). Adult carapace length was 160.1 mm on average (N = 52; SD = 17.9 mm; range = 129.0-197.5 mm). The plastron color of hatchlings and juveniles was either completely dark with a yellowish bridge or yellowish with peripheral dark spots. The carapace was uniformly brown or dark gray, with the lower border of marginal scutes yellowish, with black sutures in some animals. Maxilla and mandible were blackish or yellowish (in adults, jaws are cream to yellow). The iris was black in all individuals. Dorsal and lateral parts of the head and neck and dorsal side of the limbs were brown or olive gray; ventral side of the limbs was yellowish or cream colored, similar to adults.

The main feature of the carapace morphology in juveniles is the marginal scutes, which from the seventh scutes posteriorly makes a serpiform shape of the carapace rim. This characteristic disappears as the animal grows. None of the traits that exhibit sexual dimorphism in adults (Guix et al. 1992. Bol. Asoc. Herpetol. Esp. 3:23-25) was found to differ between male and female juveniles.

I thank to Dr. Bento V. M. Neto and Instituto Florestal for logistical support, Dr. A. S. Abe and an anonymous reviewer for commenting on the manuscript, and CNPq (grant 132400/93-6).

Submitted by FRANCO LEANDRO DE SOUZA, Universidade Estadual Paulista, Departamento de Zoologia, 13506-900 Rio Claro, SP, Brazil.

**HYDROMEDUSA TECTIFERA** (South American Snake-necked Turtle). **PREDATION.** On 12 November 1990, I observed a giant otter, *Pteronura brasiliensis* eating an adult (25 cm carapace length) *Hydromedusa tectifera*. The animals were in a 10 X 15 m, 3 m deep pool formed by a moderately fast-flowing, 10 m wide
river located inside Tropical Atlantic Forest in southern São Paulo State, Brazil (25°03'S, 48°04'W), elevation 150 m. The otter held the turtle with its paws, keeping itself partly in the pool, while biting the anterior part of the turtle's carapace mainly around its borders. Upon detecting me, the otter left the carcass and disappeared. The turtle's head, neck and legs had been eaten. About 1.5 km downstream I found a turtle plastron 15 cm long which had been gnawed by an otter. There is no published information on the natural enemies of eastern Brazil Hydromedusa (Ernst and Barbour 1989. Turtles of the World. Smithsonian Inst. Press, Washington, D.C., 313 pp.). The rare giant otter has been observed, in the Atlantic Forest, to disturb dead leaves which accumulate at the bends of rivers, a favorite habitat for H. tectifera (pers. obs.). These observations suggest that otters may be an important predator of H. tectifera in southeastern Brazil.

I thank F. Olmos for comments on the first draft of the manuscript.

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LACERTILIA


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Submitted by MICHAEL J. MCCOID, Division of Aquatic and Wildlife Resources, P. O. Box 2950, Agana, Guam 96910, USA. Current Address: Caesar Kleberg Wildlife Research Institute, Texas A&M University, Kingsville, Texas 78363, USA.

GALLOTIA GALLOTI (Canary Islands Lizard). NECTAR FEEDING. All four species of Galloita (Lacertidae) currently living in the Canary Islands have been reported to eat a substantial amount of vegetable food (Krefft 1950. Zool. Anz. 145(Suppl.):426-444; Molina-Borja 1991. Vieraea 20:1-9; Molina-Borja and Barquin 1986. Vieraea 16:233-236; Naranjo et al. 1991. Rev. Esp. Herp. 6:45-48). Plant parts consumed include leaves, flowers, flower buds, fruits and seeds, but there are no published accounts of any Galloita feeding on nectar. In fact, observations of nectarivory in lizards are scarce and only a handful of species, mostly geckos, are known to regularly visit flowers to feed on nectar (Whitaker 1987. N. Z. J. Bot. 25:315-328). Here we report observations of nectar feeding in G. galloita, a medium-size lacertid (145 mm maximum SVL) inhabiting the westernmost islands of the Canarian archipelago (Barbadillo 1987. La Guia de Incafo de Canarias. Incafo, Madrid, 674 pp.).

Recently, Petran et al. (1993. Science 259:354-358) concluded that behavioral exclusion by Hemidactylus frenatus affected local distributions of the native Lepidodactylus lugubris. McCoid and Hensley (1993. Herpetol. Rev. 24:87-88) augmented this portrait, using the same species, with observations of predation. It seems likely that local distributions of native scincids on Guam are being affected by introduced Carlia through similar competitive mechanisms. Behavioral exclusion, aggression, and predation on native scincids by Carlia probably all are important in altering the distribution of E. caeruleocauda on Guam.

GALLOTIA GALLOTI (Canary Islands Lizard). NECTAR FEEDING. All four species of Galloita (Lacertidae) currently living in the Canary Islands have been reported to eat a substantial amount of vegetable food (Krefft 1950. Zool. Anz. 145(Suppl.):426-444; Molina-Borja 1991. Vieraea 20:1-9; Molina-Borja and Barquin 1986. Vieraea 16:233-236; Naranjo et al. 1991. Rev. Esp. Herp. 6:45-48). Plant parts consumed include leaves, flowers, flower buds, fruits and seeds, but there are no published accounts of any Galloita feeding on nectar. In fact, observations of nectarivory in lizards are scarce and only a handful of species, mostly geckos, are known to regularly visit flowers to feed on nectar (Whitaker 1987. N. Z. J. Bot. 25:315-328). Here we report observations of nectar feeding in G. galloita, a medium-size lacertid (145 mm maximum SVL) inhabiting the westernmost islands of the Canarian archipelago (Barbadillo 1987. La Guia de Incafo de Canarias. Incafo, Madrid, 674 pp.).

Observations were conducted in Loro Parque, a privately owned zoological park located in the Punta Brava district of Puerto de la Cruz (Tenerife, Canary Islands). Galloita galloita occur at relatively high densities throughout the park, but they are most conspicuous alongside the walkways in plots dominated by cactus and palm trees (Phoenix sp.), with no ground cover. The lizards are relatively undisturbed and tolerate close-range inspection by an observer. Adult G. galloita were seen carrying dates and other fruit in their mouths and occasionally picking up handouts provided by the visitors. Between 1400 and 1500 h on 23 August 1992 we noticed several G. galloita climbing through a hedgerow of crown of thorns (Euphorbia millii (= E. splendens), Euphorbiaceae), a thorny, woody-stemmed spurge from Madagascar. As many as five lizards were observed clinging to the shrubs, some ca. 50 cm from the
ground, sequentially lapping the nectar from several flowers. All the lizards foraging for nectar were juveniles; the dense branching and the sharp thorns may limit access to the flowers to all but the smallest individuals. Although E. miti is an exotic ornamental, the Canarian flora is rich in indigenous Euphorbiaceae that may be exploited as a natural source of nectar. Previous reports described adults of G. galloti feeding on leaves and flowers of Euphorbia balsamifera (Molina-Borja 1981. Doñana, Acta Vertebrata 8:43–78), adult G. steinheli from the island of Gran Canaria eating buds of E. obtusifolia and dry leaves of Rcinus communis (Molina-Borja 1986. Vieraia 16:23–26), and juvenile G. simonyi from El Hierro Island taking flowers of E. obtusifolia (Machado 1985. Bonn. Zool. Beitr. 36:429–470).

Most observations of lizard nectarivory have occurred on islands (e.g., geckos: Whitaker, op. cit.; Cnemodrophus marinus: Dearing 1993. J. Herpetol. 27:111–114). Among lizards, nectar feeding has been described in Podarcis dugesii, the Madeiran lizard (Elvers 1978. Botaniska Notiser 131:159–160), and P. lilfordi from Nitge (Menorca, Balearic Islands) (Brown et al. 1992. Oecologia 91:500–504). This note documents nectar feeding in another insular lizard species and reiterates the ability of Gallotia galloti to exploit a variety of food sources. We thank Matt Kramer, Statistical Research Division, U.S. Bureau of the Census, for his comments on this manuscript.

Submitted by ENRIQUE FONT and MARIA JOSE FERRER, Departamento de Biologia Animal, Universidad de Valencia, 46100 Burjasot, Valencia, Spain.

KENTROPYX ALTAMAZONICA (NCN). COLOR. Museu de Zoologia da Universidade de São Paulo, numbers 57891–57892. The “calcarata” group within the teiid genus Kentropyx have bright green stripes on the head and forehead at hatching which gradually become fainter with age. Adults are patterned with shades of brown, black, or grey which camouflage them among leaf litter (K. calcarata and K. pelviceps) or muddy river banks (K. altamazonica). In contrast, K. striata, which occurs in savannas and islands on the lower reaches of the Amazon River, has bright green coloration along the posterior dorsal surface of the body (Gallagher and Dixon 1992. Bullot Museo regional de Ciencen naturai-Torino 18:125–171). Here we report the color of K. altamazonica which were encountered in flooded grasslands on islands in the central part of the Amazon River near Manaus Amazonas, Brazil (3°05'S, 60°00'W). At least 4 lizards were seen 16 June 1981 and two were shot with an air rifle and one was photographed to allow an accurate description of its color. The adult male had a brownish grey head with a faint green mid-dorsal stripe. Its flanks were grey with faint blue-green blotches. A rich brown dorsolateral stripe commencing at the hind legs broke up into large black blotches at mid-body and faded out so that it was barely distinguishable at the level of the forelimbs. Its extension to the eye was only discernable from tiny black irregularly distributed black blotches and a faint green stripe along its lower edge. The dorsal surface of the hindlimbs was brown with white blotches. The dorsal surface of the body lacked stripes and blotches. The nape of the neck was sky blue, becoming lime green at the level of the forelimbs. The lime green extended onto the tail about as far as the knee reaches when the hindlimb is extended backwards. The rest of the tail was light brown.

Scalation indicated that the lizard was definitely a K. altamazonica or, if a new cryptic species, at least a member of the “calcarata” species group. The sky blue on the nape of the neck has no equivalent among other species of Kentropyx but the generally uniform green dorsal surface is much more similar to that of K. striata than other members of the “calcarata” group. We speculate that the occupation of islands with flooded grassland habitat has resulted in color convergence between some populations of K. altamazonica and K. striata.

Submitted by WILLIAM E. MAGNUSSON and ALBERTINA P. LIMA, Departamento de Ecologia, Instituto Nacional de Pesquisas da Amazônia, CP 478, 69011-970 Manaus AM, Brazil.

PSAMMODROMUS ALGIRUS (Large Psammomorus). PHONOTAXIS. Psammomorus algorius is distributed throughout Iberia and parts of south western France. It is a medium-sized lacertid (8 cm SVL) with a robust body and large head (Arnold and Burton 1978. A Field Guide to the Reptiles and Amphibians of Britain and Europe. Collins, London, 272 pp.).

Seven adult male P. algorius were released into an enclosure at the Museo de Ciencias Naturales Field Station at El Ventorrillo, Madrid province (1000 m above sea level) in the Sierra de Guadarrama, central Spain. This enclosure was 65 m² and contained vegetation typical of the area (brooms: Cytisus scoparius, Genista florida and ‘jara’, Cytisus laurifolius) and in all respects reflected a normal habitat for P. algorius. These lizards are known to eat a wide variety of insects (Salvador 1985. Guadarrama. Unigraf, Madrid, 212 pp.) and I observed them eating two of the commoner species of orthopterans found at the site: Oedipoda caerulescens (Acrididae) and Stereoporus stellius (Tettigoniidae). S. stalli is a plump, flightless bushcricket about 2.5 cm long. The song of a male S. stalli is a chirp of 252–305 ms duration with a frequency of 9700 Hz (Hartley et al. 1974. Anim. Behav. 22:382–389). The sound pressure level is about 70 dB at one meter and there is an inter-chirp interval of four to eight seconds (Bateman, unpubl.).

The following experiments were done on successive days in September 1993. All trials were carried out twice. 1) A recorded song of a male S. stalli was played from a speaker situated in the center of the enclosure at ground level. 2) The song was played from the center of a bush approximately 30 cm above the ground. 3) This experiment was the same as experiment 1 except that a clear plastic container with four non-calling female S. stalli was placed on top of the speaker. 4) This experiment was the same as experiment 2 except that a clear plastic container with four non-calling female S. stalli was placed on top of the speaker. 5) The plastic container with the females (silent) was placed on the ground without the speaker. 6) Finally, three singing males were put in a small gauze box placed at ground level. In all cases speaker and/or bushcrickets were left for 30–40 minutes and no reaction by the lizards was noted in that time the trial was terminated.

In experiments 1, 2, 3, and 4 there was a positive reaction to both trials. A male P. algorius was observed circling in towards the speaker when it was at ground level and circling in towards the base of the bush when the speaker was playing from above ground. The movement of these lizards appeared to be quite different from their behavior at other times when they were mostly making short runs into, or out of, shade. The lizard approached the speaker with the female bushcrickets on it more closely (within 10 cm) than the speaker without the bushcrickets (>20 cm). There was no reaction
to experiment 5 with the silent females and there was a single reaction to experiment 6 when a male again circled the gauze box and approached to within 10 cm before retreating again.

Several studies show that acoustic signallers run the risk of exposing themselves to predators, including calling Gryllid crickets being hunted by herons (Bell 1979. New York Ent. Soc. 87(2):126–127) and calling tropical bushcrickets being hunted by bats (Belwood and Morris 1987. Science 238:64–67). In Britain the frequency range of the call of the bushcricket Leptophyes punctatissima overlaps that of shrews (Soricidae) and four species of foliage-gleaning bats and thus all are potential predators (Robinson 1990. In W. J. Bailey and D. C. F. Rentz (eds.), The Tetrigonidae: Biology, Systematics and Evolution, pp. 112–119. Crawford House Press, Bathurst).

These experiments demonstrated that an acoustic signal from a Steropleurus is evidently used by eavesdropping P. algirus. Psammobromus algirus, therefore, appear to use auditory cues in hunting acoustic prey, and may also use visual or olfactory cues at closer range.

I thank the directors of the El Ventorrillo Field Station, Drs. Alfredo Salvador, Luisma Carrascal, and Eulalia Moreno.

Submitted by PHILIP W. BATEMAN, Animal Behaviour Research Group, Department of Biology, The Open University, Walton Hall, Milton Keynes, MK7 6AA, U.K.

TUPINAMBIS TEGUixin (Tegu Lizard). AQUATIC BEHAVIOR. On 5 November 1993, while snorkeling in search of freshwater fish in a mountain creek pool about 300 m elevation at Ilhabela State Park, São Sebastião Island, Brazil (23°50'S, 45°20'W), I discovered a sleeping Tupinambis teguixin sebastiani Muller 1968 (Die Herpetofauna der Insel von São Sebastião, Saarbrucken Zeitung Verlag u. Druckerei GmbH H., 68 pp.) about 1 m TL and 30 cm SVL, on the bottom of the pool, 1.8 m deep. The lizard lacked the enlarged neck typical of adult males and showed a bright, new skin. The pool was located in rugged terrain covered by old second-growth and primary Atlantic forest, and was fed by a clear water creek 4-6 m wide that ran over sand and rocks. The day was sunny with air temperatures between 25-30°C, and water temperature between 15-18°C.

After watching the lizard for 10 min, without it ever moving, I lightly pulled its tail, which caused it to open its eyes, stare at me for a while, and close them again. After another pull, the lizard walked toward a pile of dead leaves that accumulated on the otherwise sand and gravel bottom and partly buried itself. Moments later it walked along the bottom towards an emerging rock, which it climbed until its head was above the water. I avoided further disturbing the lizard, and after about 10 min of watching me, it dove towards a submerged rock 1.1 m deep and laid itself by the rock's side, closing its eyes and not moving for 12 min, when it again walked along the bottom and positioned itself under a rock 0.5 m under the water. After another 10 min, disturbed by my attempts of following and measuring it, the tegu dove to deeper waters, this time half walking, half swimming with lateral strokes of its tail, and I was unable to find it again.

Why a tegu, regarded as a terrestrial lizard, would choose to sleep underwater in a cold stream (despite using a wet suit I was shivering after half an hour in the water) has no easy explanation. Although it may be a strategy to evade predators, the many boulders on shore would also offer shelter. It seems unlikely that the lizard was just taking a break after searching for food, as the stream was notably poor on fish, crabs, and crayfish that could be prey for a tegu. Perhaps the cold water offered a thermally comfortable environment for the lizard, but as the area is entirely covered by humid forest, other opportunities for finding adequate microclimates were likely at hand.

Although my observations may be regarded only as an oddity (but see Achaval and Langguth 1976. Boletin Soc. Zool. Uruguay 2:107) I am aware of two instances of tegus being caught in gill nets set at sea near the rocky shores of São Sebastião Island.

Submitted by FABIO OLMOS, Parque Estadual de Ilhabela, r. Morro da Cruz 608, Ilhabela, SP, 11630-000, Brazil.


During an investigation of activity patterns and feeding habits of a population of Crotalus viridis viridis in the Nebraska Sand Hills (42°15'0''N, 101°07'3''W), males were observed accompanying females five times during the midsummer to early autumn mating period. Male-male combat was observed once on 1 Au-
August 1991. Field observations were not conducted between 17 May and 16 July 1991.

A single episode of courtship was observed in the spring on 6 April 1991 (this was not an observation of "commonly occurring spring mating" as misquoted by Duvall et al. 1992. In J. A. Campbell and E. D. Brodie, Jr., (eds.), Biology of the Pitvipers, pp. 321–336, Selva, Tyler, Texas). The female snake measured 835 mm SVL and weighed 428 g while the male measured 730 mm SVL and weighed 338 g. This pair of snakes was found 1 m from a prairie dog (Cynomys ludovicianus) burrow, containing the sloughed skin of the courted female. Ten meters away another fresh slough, that of the courting male, was found in the entrance of another prairie dog burrow. Dorsal patterns of slough and snake were matched for positive identification. The position of the skins suggested that they were sloughed as the snakes exited the burrows. Several loops of the male's body fell over the female's body and his tail was curled under and around the female's tail effecting cloacal apposition. The male intensively courted the female for 3.25 h. Sequence and duration of male courtship behaviors were consistent with those described previously for western rattlesnakes (Ernst, op. cit.; Hayes 1986. J. Herpetol. 20:246–249). The female was quiescent throughout the period of observation and did not tongue-flick, although she did exhibit the tail-whipping behavior described previously by Hayes (op. cit.). The snakes were courting when discovered at 1600 h and continued until 1915 h (sunset), at which time both snakes were collected. The snakes were not copulating at the time of collection. Eversion of the male's hemipenes was not observed, nor was intromission positively determined nor excluded.

Taken as a whole these observations suggest that most mating activity in this population occurs from mid-summer to early fall, consistent with previously published descriptions of mating pheno-

logy in this subspecies. While the observation of spring courtship may represent a relatively unusual event in this population, it raises the possibility that mating may occur in the spring as well as the fall for some populations of prairie rattlesnakes. Additionally, this observation agrees with the hypothesis that ecodysis and release of pheromones signalling female sexual receptivity may be linked.

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Submitted by ANDREW T. HOLYCROSS, Department of Zoology, Arizona State University, Tempe, Arizona 85287-1501, USA.

DIADOPHIS PUNCTATUS MODESTUS (San Bernardino Ridgetop Snake). DIET. In April, 1992, a single individual of *Diadophis punctatus modestus* was collected from under a small board just off Redlands Boulevard, 1.0 mile south of San Timoteo Canyon Road in northern Riverside County, California. Examination in the laboratory revealed the snake had consumed a single individual of *Anniella pulchra* (California legless lizard). The lizard was swallowed head-first and most of the anterior portion of the body (including the skull, cervical vertebrae, and perhaps 1 or 2 anter-

ior trunk vertebrae) was digested. Extensively degraded fragments of the left dentary and one or two cervical vertebrae remained. The snake measured 288 mm SVL (360 mm total length), the lizard approximately 130 mm (total remaining length). Neither speci-

cmen was weighed. To our knowledge, *Diadophis* has not previ-

ously been reported to prey upon *Anniella*. Specimens are curated in the University of California Museum of Paleontology (*Diadophis*, UCMP 140630; *Anniella*, UCMP 140631).

Submitted by CHRISTOPHER J. BELL, Department of Integrative Biology and Museum of Paleontology, University of California, Berkeley, California 94720, USA, and JAMES K. BOWDEN, Division of Earth Sciences, San Bernardino County Museum, 2024 Orange Tree Lane, Redlands, California 92374, USA.


Here we document an aggregation of female *Hierophis viridiflavus* in central Italy. Observations occurred about 50 km N Rome, Oriolo Romano, Province of Viterbo, 450 m above sea level. The size was characterized by a partially dilapidated stone box (5.0 x 3.5 m) bordered by rich spiny vegetation (mainly *Rubus* sp.) and completely surrounded by cultivated fields. We initiated the study in September 1989 when we captured 23 newborn *H. viridiflavus* (18–22 cm total length) in an area of 50 m². We regularly surveyed this site during late June 1990, 1991, and 1992. This aggregation of newborn snakes was noteworthy because 1) this species is not commonly encountered in cultivated habitats at the study area, and 2) the number of neonate snakes was greater than could be produced by a single female. Female *H. viridiflavus* normally produce 3–7 eggs per year in this area.

In June 1990 we collected five gravid female *H. viridiflavus* (Table 1). Snakes were measured (total length), marked (using scale clip procedures described in Brown and Parker 1976. J. Herpetol. 10:247–249), radiographed to obtain clutch size information, and released at the site of capture. No males, non-gravid females, or juveniles were found.

During June 1991 we captured six gravid female *H. viridiflavus*, but still no males, non-gravid females, nor juveniles were observed. Gravid females were processed as before. Four of the six snakes were recaptures.

During June 1992, we captured two gravid females, while no other snakes were observed. Both females had been marked in 1990 and recaptured in 1991. This suggests that reproduction is annual at this site. There was a strong positive correlation between clutch size and female total length (r = 0.82, Y-intercept = -18.41, slope = 0.198, F = 22.80, P = 0.0005). Because growth was slow fecundity also increased slowly as snakes aged (see Table 1).

All female *H. viridiflavus* marked during this study were observed near the stone box only during June (i.e., shortly before egg laying; see Luiselli and Ruggeri 1990. Herpetozoa (Wien) 2:107–115), while absent during the rest of the year. On the other hand, juveniles were observed from late August to mid September (i.e., shortly after egg hatching), but not seen during other parts of the year.
Based on our observation we formulated preliminary conclusions: 1) The study site was regularly visited by female snakes for egg laying, possibly due to conditions favorable for incubation; 2) Nest site fidelity was high. Females used the site for egg laying in different years. We do not know if females stay in the area of the stone box during other times of the year. A telemetric study could resolve this question. If females use the area around the box only for nesting several questions remain unanswered. 1) How far do females travel from habitats used in other times of the year? 2) What conditions make the area around the stony box suitable as a nest site? 3) How do females navigate and recognize the nest site? We continue to study this phenomenon in order to answer these and other questions. Recently we discovered two other communal nest sites within a few kilometers of the study site, suggesting that communal nesting may be relatively common for H. viridiflavus.

TABLE I. Grass H. viridiflavus captured during June 1990, 1991, and 1992, respectively. Individuals are distinguished by letters (A, B, C, etc.). TL = total length (in cm); CS = clutch size.

<table>
<thead>
<tr>
<th>Snake</th>
<th>1990</th>
<th>1991</th>
<th>1992</th>
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</thead>
<tbody>
<tr>
<td>TL</td>
<td>CS</td>
<td>TL</td>
<td>CS</td>
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<tr>
<td>A</td>
<td>117.2</td>
<td>4</td>
<td>118.0</td>
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<td>B</td>
<td>121.3</td>
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<tr>
<td>C</td>
<td>115.8</td>
<td>5</td>
<td>116.9</td>
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<td>D</td>
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<td>E</td>
<td>126.4</td>
<td>7</td>
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<td>F</td>
<td>110.0</td>
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<td></td>
</tr>
<tr>
<td>G</td>
<td>115.5</td>
<td>5</td>
<td></td>
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</tbody>
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Submitted by MASSIMO CAPULA and LUCA LUISELLI, Dipartimento di Biologia Animale e dell‘Uomo, Università di Roma "La Sapienza," via A. Borelli 50, 00161 Roma, Italia.

LEPTOPHIS MODESTUS (NCN). MORPHOLOGY. On 19 July 1991, I collected a specimen of Leptopis modestus in Honduras, Departamento Comayagua, Cordillera de Montecillos, 1.6 km N, 0.2 km E Cerro San Juanillo, elevation 1960 m (14°29'43" N, 0.2 km E Cerro San Juanillo, elevation 1960 m (14°29'43" N, 87°53'03" W). It was active in vegetation 4 m above ground in cloud forest dominated by the trees Quercus skinneri, Matudea trinervia, Persea americana var. nubigena, and Podocarpus oleifolius.

The snake was an adult male, SVL 1201 mm, tail 802 mm, 386 g. Nasal was divided, loreal absent (fused with prefrontal which borders 2nd and 3rd supralabials); preoculars 2; postoculars 2, temporals 1-2; supralabials 8-8 with 4th and 5th entering orbit; infralabials 11-11; ventrals 177; anal divided; dorsal scales in 15-15-11 rows with 1st row smooth and all others strongly keeled. Dorsum was uniform green; keels dirty yellow-green, most conspicuous at midbody; overlapped edges of dorsals blue, posterior tips black; lower, anterior dorsals yellow; midbody and posterior dorsals with black lower and trailing edges, skin between dorsal scales black. Ventral bright yellow anteriorly grading to bluish and to pale green posteriorly. Rostral and supralabials yellow with green upper edges; a short, narrow postocular black bar on the upper edges of supralabials 7 L and 7-8 R, chin yellow cream grading to bright yellow on throat; iris golden with brown medial horizontal bar, tongue metallic blue.

Absence of a loreal plate and the presence of two preoculars instead of one adds to the range of morphologic variation reported for this species (Fig. 1). The specimen keys out to Leptopis ahaetulla occidentalis (using Peters and Orejas-Miranda. 1970. U.S. Natl. Mus. Bull. No. 297, 347 pp.). While the presence or absence of a loreal is a key character in diagnosing species, most of the species of Leptopis (= Thalerophis) exhibit variation (Oliver 1948. Bull. Amer. Mus. Nat. Hist. 92(4):160-280). This locality extends the known range 45 km to the east (Wilson et al. 1986. Milwaukee Publ. Mus. Contr. Biol. and Geol. No. 66, 8 pp). Identification was verified by Gustavo A. Cruz and the specimen is deposited at Universidad Nacional Autonoma de Honduras (UNAH 2747).

Submitted by PETER HOLM, Department of Ecology and Evolutionary Biology, University of Arizona, Tucson, Arizona 85721, USA.

LIASIS OLIVACEUS (Olive Python). ALBINISM. In March 1993 a female albino olive python (Liasis olivaceus) was collected near Woodcutters Mine, 80 km south of Darwin, Northern Territory, Australia. The animal is being kept alive at the Northern Territory University. The mining site is surrounded by small rocky hills dominated by eucalypt forest. At capture this animal was a subadult, ca. 1.5 m SVL (Shine 1992. Australian Snakes: A Natural History, Reed Books Pty Ltd., Balgowlah, 223 pp.). This python bears the pink eyes and tongue characteristic of an albino; however, the dorsal surface is cream-colored rather than white. The ventral surface is white. This is the first known report of albinism in this species.

Submitted by GAVIN S. BEDFORD, School of Biological Sciences, Northern Territory University, P.O. Box 40146 Casuarina, N.T., Australia, and ROB COWARD, Karama, N.T., Australia.

NERODIA SIPEDON SIPEDON (Northern Water Snake). FEEDING. On 24 June 1993 a young-of-the-year northern water snake was observed hunting smallmouth salamander (Ambystoma texanum) larvae in a small, shaded, temporary pond near the Charleston side-channel reservoir (NW1/4 Sec. 24, T11N, R9E), Coles Co., Illinois.

The pond (about 10 m long, 1 m wide, and 30 cm deep) was located at the bottom of a forested east-facing slope. A variety of aquatic macrophytes, insects, and Bufo larvae also inhabited the pond, but no fish were present. I observed the water snake for about fifteen minutes. The snake waited at the water’s surface supported by the vegetation. Its head

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was raised above the water in an s-shape. When the smallmouth salamander larva broke the surface of the water to breathe, the snake would strike and grab the salamander. The snake then proceeded to eat it. The foraging sequence was repeated about three times before the larva was captured.

Submitted by MALCOLM L. MCCALLUM, Department of Zoology, Eastern Illinois University, Charleston, Illinois 61920, USA.

RHADINAEA LACHRYMANS (NCN). PREY.
The diet of Rhadinaea lachrymans consists mainly of frogs, toads, and salamanders, in addition to terrestrial egg masses of frogs (Eleutherodactylus) and salamanders (Myers 1974. Bull. Amer. Mus. Nat Hist. 153(1):81). Here, we report an observation of *R. lachrymans* feeding on *Bolitoglossa engelhardti*. On 16 April 1992, a juvenile female (MZFC 5967: SVL = 307 mm, TL = 421 mm) was collected by Adolfo Navarro in a cloud forest at El Chiquihuite (Volcan Tacana), Union Juarez, Chiapas, Mexico, 2150 m elevation. Inspection of the stomach contents revealed a *Bolitoglossa engelhardti* (MZFC 5968: SVL = 29.6 mm). The body was intact and its tail had been broken into three pieces (1.6 + 7.6 + 19.0 = 28.2 mm).

Sazima et al. (1992. Herpetol. Rev. 23:120-121) suggested the small size, elongated head, and slender body of *Rhadinaea bilineata* make it well-suited for foraging on amphibians. The same generalizations apply to *Rhadinaea lachrymans*.

We thank Adolfo Navarro, Oscar Flores, and Mario Manella for comments on this manuscript and assistance in the field work. Financial assistance was provided by the Dirección General de Asuntos del Personal Académico (DGAPA) project IN201789.


SISTRURUS CATENATUS CATENATUS (Eastern Massasauga). REPRODUCTION. Throughout its range, the eastern massasauga (*Sistrurus catenatus*) demonstrates considerable variation in reproductive potential (Reinert 1981. Amer. Midl. Nat. 105:393-395). Mean litter size, for example, ranges from 5.3 in Texas to 11.1 in Wisconsin (Seigel 1986. Biol. Cons. 35:333-346). There are no published accounts of litter characteristics for the species in Ohio, where it is restricted to a few populations and currently recognized as a species of special interest, due largely to habitat loss.

Two pregnant *S. catenatus* were captured on 29 June 1993 at Area C of Wright-Patterson Air Force (WPAFB), Greene Co., Ohio. They were retained in individual enclosures heated to 27°C at the Dayton Museum of Natural History.

On 7 August 1993, the smaller female (500 mm SVL) gave birth to 9 neonates (6 male, 3 female) and 1 infertile ovum. Snout-vent length ranged from 154-190 mm (mean = 182.11, SD = 12.046). Body weight ranged from 7-8 g (mean = 7.556, SD = 0.527). On 21 August 1993 the larger female (565 mm SVL, 209 g) gave birth to 9 males. Snout-vent length ranged from 215-230 mm (mean = 223.667, SD = 5.788). Body weight ranged from 11-14 g (mean = 12.00, SD = 1.118). All neonates were sexed by probing. The offspring of the second female were significantly longer and heavier than those of the first female (ANOVA for SVL: df = 1, f = 87.015, p < 0.01; ANOVA for mass: df = 1, f = 116.364, p < 0.01 respectively). When the effects of body size were removed, there were no significant differences in weight between litters (ANCOVA for mass: df = 1, f = 0.099, p = 0.7571).

The mean litter size of these females is comparable with the mean reported for an Illinois population (mean = 9.5, SD = 3.209; Wright 1941. Amer. Midl. Nat. 25: 659-672). In terms of size at birth, these two litters were similar to the Pennsylvania population with mean for Ohio of 202.9 mm (SD = 23.26) and 206.2 mm (SD = 32.524) for Pennsylvania (Swanson 1941. Copeia 1933:37). Seigel and Fitch (1985. J. Anim. Ecol. 54:497-505) found litter size variation was higher within than between populations, and attributed this to female size differences. In the present case, the adult females differed in body size, but litter size did not. The variation in size at birth, however, could be attributed to difference in female body size, with larger females having larger neonates.

All animals used in this study were marked, photographed for dorsal pattern recognition, and released at the maternal capture site.

I thank T. Lucas and the rest of WPAFB Office of Environmental Management for logistic support and permission to capture rattlesnakes. I am grateful to the Dayton Museum of Natural History for providing lab space. This study was conducted under contract with The Nature Conservancy.

Submitted by GREGORY J. WATKINS-COLWELL, Department of Biological Sciences, Edison State Community College, 1973 Edison Drive, Piqua, Ohio 45356, USA.
GEOGRAPHIC DISTRIBUTION

*Herpetological Review* publishes brief notices of new geographic distribution records in order to make them available to the herpetological community in published form. Geographic distribution records are important to biologists in that they allow for a more precise determination of a species' range, and thereby permit a more significant interpretation of its biology. These geographic distribution records will be accepted in a standard format only, and all authors must adhere to that format, as follows: SCIENTIFIC NAME, COMMON NAME (for the United States and Canada as it appears in Collins 1990, Standard Common and Current Scientific Names for North American Amphibians and Reptiles, Third Edition. Herp. Circ. 19:1-41; for Mexico as it appears in Liner 1994, Scientific and Common Names for the Amphibians and Reptiles of Mexico in English and Spanish. Herp. Circ. 23:1-113), LOCALITY (use metric for distances and give precise locality data), DATE (day-month-year). COLLECTOR, VERIFIED BY (cannot be verified by an author — curator at an institutional collection is preferred), PLACE OF DEPOSITION (where applicable), use standardized collection designations as they appear in Leviton et al., 1985, *Standard Symbolic Codes for Institutional Resource Collections in Herpetology and Ichthyology*, Copeia 1985(3):802-832 and CATALOG NUMBER (required), COMMENTS (brief), CITATIONS (brief), SUBMITTED BY (give name and address in full — spell out state names — no abbreviations). Some further comments. This geographic distribution section does not publish "observation" records. Records submitted should be based on preserved specimens, which have been placed in a university or museum collection (private collection depository records are discouraged; institutional collection records will receive precedence in case of conflict). A good quality color slide or photograph may substitute for a preserved specimen only when the live specimen could not be collected for the following reasons: it was a protected species, it was found in a protected area, or the logistics of preservation were prohibitive (such as large turtles or crocodilians). Color slides and photographs must be deposited in a university or museum collection along with complete locality data, and the color slide catalog number(s) must be included in the same manner as a preserved record. Before you submit a manuscript to us, check Censky (1988, *Index to Geographic Distribution Records in Herpetological Review*: 1967-1986) to make sure you are not duplicating a previously published record.

Please submit any geographic distribution records in the standard format only to the Section Co-editors, Joseph T. Collins (USA & Canadian records only), Natural History Museum—Dyche Hall, The University of Kansas, Kansas City, Kansas 66045-2454, USA. (E-mail: jcollins@kuhub.cc.ukans.edu), or Jerry D. Johnson (the rest of the world), Department of Biology, El Paso Community College. P.O. Box 20500, El Paso, Texas 79998-0500, USA. Short manuscripts are strongly discouraged. Please submit any geographic distribution records to us. Submit a manuscript to us. Check Censky (1988, Handbook of Reptiles and Amphibian of Florida. Part Three. The Amphibians. Second ed. Windward Publishing, Miami, Florida. 191 pp.). Submitted by KRISTIN N. WOOD, Florida Game and Fresh Water Fish Commission, 663 Plantation Road, Perry, Florida 32347, USA.

**HEMIDACTYLIUM SCUTATUM** (Four-toed Salamander). CANADA: NOVA SCOTIA: Cumberland Co: Emery Meadows, 45°38'30"N, 63°46'W. 16 May 1993. S. C. Friet and M. D. MacDonald. Verified by John Gilhen, Nova Scotia Museum of Natural History (NSM 10248). County record. One adult female found guarding nest of 25 eggs; located in sphenogam and grass along NE edge of small pool at head of Emery Brook, NW corner of Emery Meadows Bog; Ducks Unlimited Canada marsh adjacent to Trans-Canada Highway 114, 45°41'30"N; 63°43'W. 26 June 1993. S. C. Friet and M. D. MacDonald.Verified by J. Gilhen. NSM 10249. One female guarding a nest of 15 eggs; found at the base of a spruce snag in sphagnum at NE edge of marsh. These two records greatly expand the known range in Nova Scotia and may offer a possible range link with New Brunswick. Submitted by STEPHEN C. FRIET and MICHAEL D. MACDONALD, Department of Biology, Life Sciences Centre, Dalhousie University, Halifax, Nova Scotia B3H 4J1, Canada.


**ANURA**

**BUFO PUNCTATUS** (Red-spotted Toad). USA: NEW MEXICO: Roosevelt Co: Melrose Bombing Range. 21.6 km S and 8.8 km E

Submitted by JAMES N. STUART and DAMIEN T. SCOTT, Museum of Southwestern Biology, University of New Mexico, Albuquerque, New Mexico 87131, USA.


Submitted by KRISTIN N. WOOD, Florida Game and Fresh Water Fish Commission, 663 Plantation Road, Perry, Florida 32347, USA.


Submitted by KRISTIN N. WOOD, Florida Game and Fresh Water Fish Commission, 663 Plantation Road, Perry, Florida 32347, USA.


Submitted by JOHN K. TUCKER, Department of Zoology, Southern Illinois University at Carbondale, Carbondale, Illinois 62901, USA; JAMES B. CAMERER and JOHN K. TUCKER, Illinois Natural History Survey, Long Term Resource Monitoring Program, 1434 Alby Street, Alton, Illinois 62002, USA; and JEFFERY CAPPS, Department of Biological Sciences, Southern Illinois University at Edwardsville, Edwardsville, Illinois 62026, USA.


Submitted by J. ERIC WALLACE, Arizona Game and Fish Department, Nongame Branch, 2221 West Greenway Road, Phoenix, Arizona 85023, USA.


Submitted by RICHARD L. BUNN, Wildlife Branch, DECAM, AFZC-I-CM-NR, Building 302, Fort Carson, Colorado 80913-5000, USA.

CROCODYLIA


Submitted by PETER C. H. PRITCHARD, Florida Audubon Society, 400 Hwy 436 #200, Casselberry, Florida 32707, USA.

TESTUDINES


Submitted by HARLAN D. WALLEY, Department of Biology, Northern Illinois, DeKalb, Illinois 60115.


Submitted by HUMBERTO BAHENA-BASAVE, Dirección de Recursos Naturales, Centro de Investigaciones de Quintana Roo, Chetumal, Quintana Roo 77000, México.


Submitted by STEVEN G. GEORGE, JACK KILLGORE, and SHERRY L. HARREL, U.S. Army Engineer Waterways Experiment Station, ER-A, 3909 Halls Ferry Road, Vicksburg, Mississippi 39180-6199, USA.


Submitted by RONALD A. BRANDON, Department of Zoology, Southern Illinois University at Carbondale, Carbondale, Illinois 62901, USA, and KRISTINE JACOBSON, 276 Cedar Creek Road, Makanda, Illinois 62958, USA.


Submitted by HUMBERTO BAHENA-BASAVE, Dirección de Recursos Naturales, Centro de Investigaciones de Quintana Roo, Chetumal, Quintana Roo 77000, México.

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Submitted by ADRIAN NIETO MONTES DE OCA, Natural History Museum, University of Kansas, Lawrence, Kansas 66045-2345, USA, and FERNANDO MENDOZA QUIJANO, Museo de Zoología, Facultad de Ciencias, Universidad Nacional Autónoma de México, Apartado Postal 70-399, México, Distrito Federal 04510. México.


Submitted by KRISTIN N. WOOD, Florida Game and Fresh Water Fish Commission, 663 Plantation Road. Perry, Florida 32347, USA.


Submitted by LARRY K. KAMEES and DOUGLAS W. BURKETT, Cortez III Service Corporation, P.O. Box L. White Sands Missile Range, New Mexico 88002-9998, USA.


Submitted by KRISTIN N. WOOD, Florida Game and Fresh Water Fish Commission, 663 Plantation Road. Perry, Florida 32347, USA.


Submitted by GREGORY J. WATKINS-COLWELL and KELLIE A. WATKINS-COLWELL, Biology Department, Sinclair Community College, Dayton, Ohio 45402, USA.


Submitted by JOHN B. JENSEN, Florida Natural Areas Inventory, 1018 Thomasville Road. Suite 200-C, Tallahassee, Florida 32303, USA.


Submitted by GREG HORTSTMAN, Colorado Division of Wildlife, 711 Independent, Grand Junction, Colorado 81505, USA.


SERPENTES

LAMPROPELTIS TRIANGULUM

HETERODON NASICUS

nel trap array in a tobosa grassland. First county record and first

Survey, Long Term Resource Monitoring Program, 3134 Alby


Tucker. Both verified by C. Phillips. Illinois Natural History Sur-

Facility (living specimen). Specimen captured in a drift fence/fun-

Andrew

Collinsville, Illinois 62234, USA.

LINOIS: Jo Daviess Co: Savanna Army Depot, SW1/4 Sec. 24,
Street, Alton, Illinois 62002, USA.

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Continuous: known from southeastern (Fujian, Jiangxi, and Zhejiang) and south-central (Guangxi) China, but not Hunan or Guangdong in between (Zhao and Adler 1993, Herpetology of China. SSAR Contrib. Herpetol. 10:248). Also well known from the Hong Kong New Territories adjacent to Guangdong, but not Hong Kong Island (Karsen, Lau, and Bogadek 1986, Hong Kong Amphibians and Reptiles. Urban Council, Hong Kong, 100). Karsen et al. (idem.) mention Lantau Island, but Karsen reports (pers. comm.) that was a sight record.

Submitted by JAMES LAZELL, The Conservation Agency, 6 Swinburne Street, Jamestown, Rhode Island 02835, USA.

**PITUOPHIS CATENIFER DESERTICOLA** (Great Basin Gopher Snake). USA: COLORADO: Grand Co. 0.7 km W and 1.0 km S Radium, NW 1/4 SW 1/4 Sec. 27, T1S, R82W. 16 September 1994. G. Horstman. Verified by L. J. Livio. UCM Color Slide 90. New county record; extends range ca. 41 km NE of nearest record near Eagle, Eagle County, in the Colorado River drainage and is the easternmost record of this subspecies in the state (Hammerson 1986, Amphibians and Reptiles in Colorado. Colorado Division of Wildlife, Denver). 131 pp.).

Submitted by GREG HORSHTMAN, Colorado Division of Wildlife, 711 Independent, Grand Junction, Colorado 81505, USA.


Submitted by KURT SCHAFFER, Department of Biology, Panhandle State University, Goodwell, Oklahoma 73939, USA; DAVID CHISZAR, Department of Psychology, University of Colorado, Boulder, Colorado 80309-0345, USA; and HOBART M. SMITH, Department of EPO Biology, University of Colorado, Boulder, Colorado 80309-0334, USA.

**SISTRURUS CATENATUS TERGEMINUS X EDWARDSII** (Massasauga). USA: COLORADO: El Paso Co: school yard at Edison, September-October 1987 or 1988. Stephen T. Pegler. Verified by Richard L. Holland. UCM 57099. First county record (Hammerson 1986, Amphibians and Reptiles in Colorado. Colorado Division of Wildlife, Denver, 131 pp.). The first author's experience indicates that until 1989 the species was moderately common in El Paso County, but thereafter became rare and now experience indicates that until 1989 the species was moderately common in El Paso County, but thereafter became rare and now:

Submitted by STEPHEN T. PEGLER, Denver Seminary, 3401 South University Boulevard, No. 202, Englewood, Colorado 80110, USA; DAVID CHISZAR, Department of Psychology, University of Colorado, Boulder, Colorado, 80309-0345, USA; and HOBART M. SMITH, Department of EPO Biology, University of Colorado, Boulder, Colorado, 80309-0334, USA.


Submitted by KELLY J. IRWIN, 2218 West 2nd Street, Topeka, Kansas 66606, USA; and JOSEPH T. COLLINS, Natural History Museum, University of Kansas, Lawrence, Kansas 66045-2454, USA.


Submitted by KURT SCHAFFER, Department of Biology, Panhandle State University, Goodwell, Oklahoma 73939, USA; DAVID CHISZAR, Department of Psychology, University of Colorado, Boulder, Colorado 80309-0345, USA; and HOBART M. SMITH, Department of EPO Biology, University of Colorado, Boulder, Colorado 80309-0334, USA.


Submitted by HUMBERTO BAHENA-BASAVE, Dirección de Recursos Naturales, Centro de Investigaciones de Quintana Roo, Chetumal, Quintana Roo 77000, México.
New Island Records from Panay, Philippines

Even though the island of Panay ranks seventh in size in the Philippine Archipelago, until recently few faunal surveys had been done there (Gonzales and Kennedy 1990). From 1983 through 1989 the National Museum of the Philippines (PNM) sponsored several expeditions to Panay, the last being co-sponsored by the Cincinnati Museum of Natural History (CMNH). Fourteen new island records of amphibians and reptiles are reported below with specimens being deposited at either CMNH or PNM. Common names were taken from Alcala (1986) when available. Records were checked in Alcala (1986) and against the catalogs of the following collections: California Academy of Sciences, Carnegie Museum of Natural History, Field Museum of Natural History, National Museum of the Philippines, The Rabor Collection (University of the Philippines at Los Banos), U.S. National Museum of Natural History, and an unpublished list compiled by Ronald I. Crombie. Identifications were verified by Ronald I. Crombie.

ANURA


SAURIA


SERPENTES


Acknowledgments.—We thank R. I. Crombie for his patient assistance as we became more familiar with Philippine herpetofauna. The logistical support for this project provided by R. S. Kennedy is greatly appreciated. Thanks to R. S. Kennedy, J. Cabalquinto, E. Canada, M. Ebreo, R. Fernandez, J. Lasugas, M. Manuel, and V. Samaiza and numerous other assistants for their aid in the field. Financial support was generously provided by the Cincinnati Museum of Natural History and Thomas More College.

LITERATURE CITED


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Herpetological Review 26(1), 1995
New Distributional Records of Amphibians and Reptiles from New Hampshire

As part of ongoing surveys of the amphibians and reptiles of New England (Klemens 1993), a small collection of preserved amphibians and reptiles from New Hampshire was accumulated, representing both my efforts as well as those of several colleagues. Collections were deposited at the American Museum of Natural History (AMNH) and significantly augmented Taylor’s (1993) distribution maps of New Hampshire’s herpetofauna. Identifications were verified by Darrel R. Frost.

CAUDATA


ANURA


TESTUDINES


Acknowledgments.—David Carroll, Robert P. Cook, Mary Hake, Josephine Kelleher, Nicole S. Klemens, and Eugene Twaronite provided specimens and/or assistance with New Hampshire field work. All collections were made under the provisions of scientific collecting permits issued by the New Hampshire Fish and Game Department.

Recent Distribution Records for Amphibians and Reptiles in Illinois


Some Illinois counties for which Smith had few records have remained poorly known. Even some species considered to be com-
mon statewide or common in surrounding regions are undocumented for those counties (e.g., Boone, Clinton, Fayette, and JoDaviess).

This article includes new county records and recent records for several species in disjunct portions of their Illinois ranges. Several vouchers are included to confirm literature records not previously documented. Vouchers have been deposited in the herpetology collections of the following institutions: Illinois Natural History Survey (INHS, verified by C. Phillips); Milwaukee Public Museum Photo Collection (MPM, verified by G. S. Casper), and Southern Illinois University at Carbondale, Department of Zoology (SIUC, verified by R. A. Brandon).

**CAUDATA**


Siren intermedia nettingi (Western Lesser Siren). Fayette Co: 0.8 km E Hurricane Creek on County Road 800N (SW 1/4 Sec. 19, T5N, R1W). 8 May 1993. S. R. Ballard, A. Jones, B. Jones. SIUC H4448-49. New county record.

**ANURA**


Rana clamitans melanota (Green Frog). Marshall Co: 0.8 km N Woodford/Marshall County line on Rt. 26 and along RR Tracks (NW 1/4 Sec. 35, T39N, R3W). 20 June 1990. S. R. Ballard and D. Ferranti. SIUC H-3950-52. New county record; Randolph Co: Inns Road, ca. 1.8 km SW Zion Church and 2.5 km NE Woodford/Marshall County line on Rt. 26 and along RR Tracks. Rana catesbeiana melanota (Bullfrog). Boone Co: 0.8 km N Woodford/Marshall County line on Rt. 26 (NE 1/4 Sec. 27, T29N, R3W) and along RR Tracks. Rana catesbeiana (Bullfrog). Boone Co: 0.8 km N Woodford/Marshall County line on Rt. 26 (NE 1/4 Sec. 27, T29N, R3W) and along RR Tracks. Rana catesbeiana melanota (Bullfrog). Boone Co: 0.8 km N Woodford/Marshall County line on Rt. 26 (NE 1/4 Sec. 27, T29N, R3W) and along RR Tracks.

Clair Co: 0.8 km N Woodford/Marshall County line on Rt. 26 (NE 1/4 Sec. 8, T7S, R10E). 30 April 1989. M. Redmer. SIUC H-3437. New county record; first Illinois record from west of the Mississippi River.


**TESTUDINES**


Terrarana c. carolina (Eastern Box Turtle). Randolph Co: 3.2 km N of Rockwood on Rt. 3 (SW 1/4 Sec. 2, T8N, R6W). 22 July 1988. R. G. Week. SIUC R-2232. New county record; fills in gap between Monroe and Jackson counties.


**SAURIA**


**SERPENTES**


**Lampropeltis t. triangulum** (Eastern Milk Snake). Woodford Co: 1.6 km E Rt. 26, off upper Spring Bay Road, near Woodford/Tazewell county line (eastern Sec. 36, T27N, R4W). D. Holmes. SIUC R-2483. New county record.


**Crotalus horridus** (Timber Rattlesnake). Pope Co: nine-day trail ride to One Horse Gap Lake (Sec. 1/4 Sec. 32, T11S, R7E). 18 May 1990. E. Steward Work Crew. SIUC R-2220. New county record; fills gap between Johnson and Hardin counties.

**Acknowledgments.**—We thank R. A. Brandon, Southern Illinois University at Carbondale, for commenting on the manuscript and for his constant advice and encouragement. For permission to collect we thank the Illinois Department of Conservation, the United States Fish and Wildlife Service, and R. A. Brandon, pers. comm. Fills gap between Johnson and Hardin counties.
Service (Crab Orchard National Wildlife Refuge), the United States Forest Service (Shawnee National Forest), and the Forest Preserve District of DuPage County. Several individual collectors donated specimens reported herein to the herpetology collection, Department of Zoology, Southern Illinois University at Carbondale. S. J. Karsen accompanied MR in and supported herein to the herpetology collection, Department of Zoology. South-of-DuPage County. Several individual collectors donated specimens re-
extension of Me率先 and the Forest Preserve District Service (Shawnee National Forest), the United States For-

*Current Address: Division of Natural Heritage, Illinois Department of Conservation. 4321 Alton Commerce Parkways, Alton, Illinois 62012, USA.

**BOOK REVIEWS**


This volume is the outcome of a symposium devoted to the teiid genus Cnemidophorus. The symposium—conceived and organized by John W. Wright and held at the University of Oklahoma in August 1984 during the joint annual meetings of the American Society of Ichthyologists and Herpetologists, the Herpetologists’ League, and the Society for the Study of Amphibians and Reptiles—brought together a diverse assemblage of over 50 specialists who presented 30 papers on a broad spectrum of topics related to Cnemidophorus. The resulting volume (The Herpetologists’ League Special Publication No. 3), containing 15 separate papers by 22 authors, is dedicated to Charles H. Lowe and Richard G. Zweifel. Contributions have been revised and updated with additional findings through September 1992. The individual papers are not grouped under subject headings, but the topics covered include systematics, reproduction, physiology, behavior, ecology, and community level analyses. Not surprisingly, a pervasive topic is the differences and similarities between unisexual and bisexual species in aspects of their biology.

The preface by John Wright and Laurie Vitt explains that the decision to produce this volume was not reached until after the symposium, and that some of the symposium presentations were already in press or committed to be published elsewhere by that time. Included in the preface is a list of the authors and titles of all 30 papers that were presented at the symposium, as well as a list of 12 symposium papers that were published elsewhere and are thus not included in the present volume.

The first chapter is an introduction by Charles H. Lowe which provides an historical review of taxonomy and systematics of Cnemidophorus organized to cover three time periods from 1830 to 1990. Lowe’s chronological presentation recounts the considerable difficulties and confusion experienced by workers attempting to discriminate taxa and discusses the major contributions during each time period that led to our current understanding of the genus. In the author’s opinion, one of the most significant breakthroughs in discriminating Cnemidophorus taxa was the description of C. neomexicanus by Lowe and Zweifel (1952). For the first time, in addition to appearance in life and ecological information gathered in the field, discrimination of a Cnemidophorus species was based on statistical analysis of quantitative meristic data. The author further reviews the impact on Cnemidophorus research of the discovery of parthenogenesis in Lacerta by Darevsky, and more recently, the high level of taxonomic resolution achieved through chromosomal and molecular studies.

In Chapter 2, John W. Wright provides a summary of the evolutionary relationships of Cnemidophorus and a taxonomic arrangement partitioned into six species groups. The composition of each group is discussed and distribution maps and color photographs of representative taxa are provided. Wright reviews the origin and evolution of parthenogenesis in Cnemidophorus as well as the controversies surrounding nomenclature of parthenogenetic taxa. The lineages of parthenogenetic taxa are reviewed by species group, with particular reference to the results of mitochondrial DNA analyses. An alphabetical listing of the groups and their respective members, which contains over 100 taxa and includes over a dozen undescribed forms, differs substantially from the recent taxonomic arrangement of Maslin and Secoy (1986).

The next five papers present results of field investigations and literature reviews on the interrelated subjects of foraging ecology, thermoregulation, activity patterns, and locomotion.

Roger Anderson investigated foraging ecology of Cnemidophorus tigris at a six-hectare site in the Sonoran Desert of Riverside County, California, through systematic time-constrained field observations of foraging animals and quantitative assessments of vegetation, prey availability, and stomach contents. At this site, C. tigris was determined to be a wide forager that depended primarily on chemoreception to detect fossorial and hidden prey, but relied on vision to choose foraging pathways between and within patches of widely dispersed microhabitats. The results indicate that successful foraging in C. tigris is clearly not the result of opportunistic success during random wanderings.

Using experimental chambers, Richard Bowker explored questions relating to the brief daily activity periods of C. exsanguis and C. velox and the costs of their wide-foraging lifestyles by examining temperature regulation and the influence of water loss on activity times. Bowker discusses the relationships between maintaining precisely regulated body temperatures, the costs of activity, and the increase in water loss with increase in body temperature. The activity experiments indicated that water loss was proportional to length of activity, and Bowker concludes that water may be an important factor limiting daily activity in these animals.

Gustavo Casas-Andreu and Marco Gurrola-Hidalgo report on the comparative ecology of C. communis and C. lineatissimus at a tropical deciduous forest site in Jalisco, México. Average body temperatures for both species are slightly lower than those reported in a number of studies on Cnemidophorus from the southwestern United States, and daily activity patterns were unimodal, with greatest activity at mid-day during the entire year. Similar unimodal activity patterns have been found for other species of tropical tei-
ids, whereas bimodal activity patterns are reported for lizards from
the southwestern United States.

Kay Etheridge and Lawrence Wit examine the comparatively
short active season and the resulting long inactive period of adult
C. sexlineatus in Alabama and discuss evidence from the litera-
ture and their own field work regarding the factors affecting this
activity cycle. They conclude that the short annual activity period
of C. sexlineatus can be attributed to a lack of territorial behavior,
their wide-ranging foraging behavior and high foraging efficiency,
avoidance of negative energy returns when food is scarce, and
reduction of the risk of predation.

Locomotor performance and activity metabolism of C. tigris
are reviewed by Theodore Garland and compared to the available
quantitative data for other species of lizards. Results from the lab-

oratory work reported here show that the endurance capacity of C.
tigris is exceptionally high in comparison to that of other lizards,
and appears to exceed what is required for foraging alone. Gar-


land concludes that while the primary adaptive significance of high
endurance capacity in C. tigris is unclear, a variety of activities
other than foraging that may require high endurance capacities
must be considered. Garland points out that the available compar-

ative information is very limited and that additional data on
other arid habitat Caenidophorus are needed. Also, performance
capacities demonstrated in the laboratory need to be compared to
findings from the field.

The contributions by Vitt and Breitenbach, Trauth and Fager-
berg, and Crews and Moore provide information on reproduction
in Caenidophorus. Laurie Vitt and Gary Breitenbach present an
exhaustive review and synthesis of literature on reproduction and
life histories of Caenidophorus, emphasizing ecological aspects
of reproduction. They compiled literature information on repro-
ductive characteristics of 17 species of Caenidophorus and a list
of over 50 Caenidophorus populations from which the repro-
ductive data were obtained. The authors examine the available
information on clutch size and egg mass, seasonality in re-
production and clutch frequency, geographic and temporal vari-
ation in reproduction, and female investment to provide support
for five postulated differences in reproductive characteristics that
would be expected between Caenidophorus and typical wait-and-
ambush lizard species.

Stanley Trauth and Wayne Fagerberg looked at eggshell ultra-
structure of oviducal eggs from the hybrid species C. laredoensis
compared with the eggshell morphology of C. sexlineatus, one of
its parent species. In light of the results, the authors discuss the
potential application of stereological methods for resolving egg-
shell ultrastructure in order to detect inter- and/or intraspecific
differences in eggshells and as a means of correlating local envi-
ronmental conditions of nest sites.

The paper by David Crews and Michael Moore provides an
update on the ongoing investigations into the psychobiology of
parthenogenetic whiptails and describes the relationship between
pseudocopulatory behavior, hormonal correlates, and the ovarian
cycle in C. uniparens. The authors also defend their interpretations
of the causes and functions of pseudocopulatory behavior in par-
thenogenetic Caenidophorus in light of contentions that pseudocopulation is an artifact of crowding in captivity and that
reproductive condition is not associated with behavioral roles dur-
ing pseudocopulation.

Thyroid activity and metabolic rate in C. sexlineatus were stud-
ied by Lawrence Wit and Jeffrey Sellers using animals caught from
the wild over a 16-month period in Alabama and Georgia. They
suggest that the lowered metabolic rate and elevated plasma thy-
roxine titers found in hibernating animals are not simply con-
sequences of the animals becoming dormant in response to cold
temperatures. The authors conclude that the increase in plasma
thyroxine is due to decreased peripheral use of the hormone, as
indicated by oxygen consumption, rather than increased produc-

Beth Leuck's analysis of aggressive behavior between sympatric
diploid and triploid C. tesselatus represents an insightful approach
designed to investigate the effects of genetic relatedness on ag-
gressive behavior. Under experimental conditions, lizards in mixed
diploid and triploid trials had significantly more aggressive acts
towards each other than those of the same ploidy level. Based on
these results, Leuck concludes that diploid and triploid C. tesselatus
appear able to distinguish genetic relatedness.

Three papers focus on competitive interactions and resource
partitioning in communities with bisexual and parthenogenetic
whiptail species. Joseph Schall studied a community of five
Caenidophorus species, two parthenogenetic and three bisexual,
in southwestern Texas to test the hypothesis that all-female spe-
cies should use a broader range of habitats and resources, have
more patchy distributions, and live in more disturbed areas. The


two parthenogenetic species, C. exsanguis and C. tesselatus, had
microhabitat niche breadths approximately 25% larger than the
three bisexual species and were found in a much broader range of
macrohabitat types, but they were most common in disturbed ar-


areas. However, he found no evidence of a difference in diet be-
tween the bisexual and parthenogenetic species.

The remaining two papers report on field studies in southern
New Mexico that employed experimental population manipu-
lations to examine mechanisms of coexistence between C. tigris
and a sympatric unisexual whiptail. As part of a nine-year study,
Orlando Cuellar monitored the immigration of C. tigris into an
open sandy field from which C. uniparens was being systemati-
cally removed. The density of C. tigris at the site increased after
removal of C. uniparens but decreased when the latter was no
longer being removed. Cuellar concludes that the parthenogenetic
species was excluding the bisexual through competition, and that
parthenogenetic and bisexual whiptails coexist by inhabiting neigh-
boring but distinct microhabitats.

Andrew Price, Joseph Lapointe, and Wilt Atmar removed C.
tigris from one of three study grids and C. tesselatus from an-
other, with the third grid serving as a control. Because there was
no change in habitat use, their results indicated no microhabitat
segregation between the two species. Further, there was no measur-
able response by the parthenogenetic C. tesselatus through either
recruitment or increased reproduction to the removal of C. tigris.

The book measures 6 x 9 inches and is printed on nonreflective
paper in easy-to-read, single column format. It contains numerous
text figures, six distribution maps, and 48 color photographs of
representative taxa in six Caenidophorus species groups, includ-
ing some not previously illustrated. Literature citations are placed
at the end of each paper, whereas an index to subject matter and
scientific names was compiled for the entire volume.

The book suffers from a number of flaws in editing and produc-
tion. There are numerous typographical errors in the text. In ad-
dition, there are egregious omissions and errors with respect to
tables and figures. The most obvious omissions include a refer-
cence to table 2 on p. 57 when only table 1 is present in chapter 2.
Also, table 3 is absent from chapter 8 although it is referenced
once on p. 221 and twice on p. 225. In chapter 2, the legends for
figures 5, 7, 9, 11, and 13 all refer to figure 2 for specimen refer-
ces but none are provided with figure 2; the legend for figure 3
Amphibians and Reptiles of Alberta
does give information for specimens from the Natural History Museum of Los Angeles County, but does not have museum information for the acronyms listed in the other figure legends. An incorrect legend was placed with figure 8 on p. 272. The editors subsequently distributed to book purchasers a corrected legend for this figure.

These criticisms aside, I have high praise for this uniquely important book. It represents a culmination of efforts that started with John Wright's inspiration to organize and carry to fruition the first symposium on *Cnemidophorus*. The book provides superb summaries of evolutionary and ecological research that will prove indispensable for future work on whiptails, as well as especially useful to anyone doing field research on lizards in general. The extensive bibliographies will provide the reader the opportunity to become familiar with the primary literature on virtually any aspect of whiptail biology. I highly recommend the book to those interested in technical work on lizards. At $29, it represents a welcome bargain during times of ever-increasing book prices.

**LITERATURE CITED**


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How do you build a full length layman's book out of a herpetofauna of only 18 species? The Russell-Bauer solution is to incorporate much more than just a local field guide into their book. The *Amphibians and Reptiles of Alberta* is really a compact general herpetology text, with special focus on the problems of prairie poikilotherms. The subtitle (printed inside, but strangely not on the cover) accurately describes this volume as both a "field guide" and a "primer of boreal herpetology."

The field guide, i.e. the Keys and Species Accounts, is the smaller portion of the book. The greater portion, the primer, is distributed among assorted chapters with titles such as "Characterization of Amphibians and Reptiles," "Zoogeography of the Alberta Herpetofauna," "Coping with the Cold," and "The Challenge of Aridity."

The scope of this book will make it a valuable addition to every high school and college library in Alberta. In the high school setting this book should help raise student interest in herpetology. In this regard, Tony Russell and Aaron Bauer deserve particular praise for including in their Keys and Species Accounts *Ascaphus truei, Charina bottae, Chelydra serpentina, Coluber constrictor, and Charina bottae*. None of these species is yet reported in Alberta, but all could be there given their known ranges and ecology. By including these yet-to-be-found species in their book, Russell and Bauer challenge their readers to go out and find them. I can't imagine a better stimulus for neophyte herpetologists—in an admittedly herpetologically depauperate place like Alberta—than a chance to be the first to document a species' presence in the province.

To help the neophyte along, the field guide portion of this book is comprehensive, with good descriptions, keys, maps, natural history notes, glossary, etc. The authors include not just adults, but also eggs and larvae in their keys for amphibians. The Bibliography is much larger than in most existing state or provincial field guides. The color photographs by Wayne Lynch are first rate. They are esthetically pleasing and at the same time clearly reveal the features that distinguish the species.

On the negative side, too many of the line drawings are amateurish. All of the people involved in producing this book should—in good Canadian fashion—apologize to each other for the bizarre drawing on page 8, which shows a tadpole with gills growing out of its rump. Then they should agree to correct the drawing immediately, before any more copies of the book are printed.

In a similar vein, I was amused by two overly simplistic survivorship curves used to demonstrate the difference between r- and K-selection (Fig 7.5). The cartoon sketches of a frog (i.e., r-selected) and *Phrynosoma* (i.e., K-selected), incorporated in that figure, lead the reader to assume that "time," on the X-axis, is minimally one generation. However, if that were true, then we are very lucky not to be buried in short-horned lizards!

There are other problems with production. For example, my review copy of the paperback version had pages 119–126 printed twice.

In future editions the glossary should be expanded. Right now it includes only herpetological terms. But if readers need a definition for "tadpole," they probably need one for "taiga." And if "herpetofauna" deserves definition, then surely so does the "hypothalamus."

The couplet #9 in the Key to Larval Amphibians of Alberta has the word "anterior" where it should be "posterior." The correct information, however, is in the Species Accounts.

All of these flaws are minor and can be cleaned up in future editions. Overall, this is an important book that helps direct attention to boreal herpetology. Given the currently high public interest in a possible global decline of amphibians, this book is particularly timely. For if the issue of global decline is going to be rigorously assessed, we need to be especially attentive to shifts in the distribution of herps near the edges of their range. By informing the public of what is and is not known about the distribution of amphibians and reptiles at their northern limits, this book not only serves the people of Alberta but may ultimately help the 18 species of amphibians and reptiles that try to live up there with them.

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The boid fauna of the West Indies is unique and diverse, and includes some of the first species of reptiles to be recognized as endangered. Tolson and Henderson have produced an important and critically needed text on this subject. This book is a comprehensive, authoritative, and exhaustive analysis of these snakes, addressing their natural history, paleoherpetology, conservation status, and phylogeny.

The first section of the book addresses the natural history, geology, and geography of Greater and Lesser Antilles, with an analysis of each island group. The accounts of the geology and natural history of the Islands are interesting and provide an important framework for understanding the natural history of the boid taxa. The various habitats and biotopes are well illustrated by photographs and descriptive text. The chapter on the phylogeny of the boid fauna is thorough and accurate. The original hypotheses of relationship within this group proposed by Tolson have subsequently been corroborated by Kluge. A chapter on the zoogeography of the boid fauna reviews the fossil record and the phylogeny of this group with respect to the plate tectonics of the region. This information facilitates understanding of the modern distribution of these snakes.

The second section is a species account type of review. In addition to the strictly systematic information, the authors include range maps, natural history notes, food habits (both field observations and husbandry information) as well as reproductive husbandry information. Finally, notes on the conservation status of many of the taxa are included.

The third section is a review of the reproductive biology of Epicrates and Tropidophis, but does not include reproductive behavior of the two Boa taxa. This is not an exhaustive review, but includes interesting observations on captive behavior as well as some of Tolson’s seminal studies on the relationships between climate and male-male interactions and testosterone levels.

The fourth section addresses the conservation issues of this group. Interestingly, the authors note that historical errors in population assessments led to incorrect assumptions on the relative scarcity of some taxa. The authors also note that the deleterious effect of the mongoose has been exaggerated.

This text is a superb overview of the boid fauna of the West Indies. Additionally, it is an excellent summary of the geology and natural history of this region, making it useful reading for herpetologists interested in other organisms of this region. The breadth and scope of the authors’ analysis make this book fascinating and pleasurable reading, and it is a welcome departure from the traditional boiler-plate herpetology texts.

It is unfortunate that the publisher has priced this book at $75.00. It is also unfortunate that the quality of the illustrations is generally substandard. Many of the color photographs appear to have been improperly separated. The layout of the book is faulty; the top and bottom margins are crowded, and there is excessive white space in many areas. A glossary would have been helpful for those unfamiliar with some of the geologic terms.

These criticisms notwithstanding, this is an essential text for the student of herpetological natural history. It is easy and enjoyable reading, and is the definitive text on this subject.

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PUBLICATIONS RECEIVED

Australia’s Reptiles [Volume 1: Snakes and Monitors] is based on the book of the same title by Wilson and Knowles. This new CD-ROM contains over 250 photographs of Australian monitors and terrestrial snakes; the full text of every species; distribution maps; scientific and common names; and notes on the current status of most species, and more.

Reptiles can be selected for display by scientific name, common name, genus, or family. The CD-ROM also contains a reptile trivia quiz, a glossary of reptile terms, and notes on the treatment of snakebite in Australia. Fascinating video clips are included from many of the Australian reptile parks.

The CD-ROM is designed for herpetologists, schools, libraries, herpetological societies, and naturalists with an MRC standard IBM-type personal computer with CD-ROM drive.

Volume I is available for US$49 plus $3 shipping from Satronics Communications, P.O. Box 52261, Philadelphia, Pennsylvania 19115-7261, USA. Volume II was planned for issue by November 1994 and contains nearly 800 images of skinks, geckos, and dragons.

For additional information, please write or send Internet mail to: rmiller@tjuvm.tju.edu.


This hefty (ca. 5 lbs.) volume presents 115 individual species accounts for rare and endangered taxa (fish, amphibians, reptiles, birds, mammals, and invertebrates). Species of herps profiled by individual accounts include seven salamanders (Ambystoma macrodactylum rooseum, Plethodon sterni, Batrachoseps arubus, B. simatus, B. stebbinsi, Hydromantes shastae, and H. brunus), one anuran (Bufo exsul), the desert tortoise (Gopherus agassizii), four lizards (Coleonyx watsoni, Uma inornata, Gambia sila, and Xantusia riversiana), and four snakes (Chironia boleae umbratica, Masticophis lateralis euryxanthus, Thomasophis sinaloa tierentzii, and T. gigas). Interviews with prominent conservationists (such as Robert Stebbins and Kenneth Norris) and essays are included. The connections of Native American legends to wildlife are examined and illustrated. Although herpetologists are not likely to find much new information about their favorite animals here, this is a visually impressive volume that effectively conveys the magnitude of conservation problems facing Californians and their wildlife.

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*Herpetological Review* is a peer-reviewed quarterly that publishes, in English, articles and notes of a semi-technical or non-technical nature, as well as book reviews, institutional features, commentaries, regional and international herpetological society news, research requests of SSAR members, and letters from readers directed to the field of herpetology. Articles reporting the results of experimental research, descriptions of new taxa, or taxonomic revisions are not published in *HR*, but should be submitted to the *Journal of Herpetology* (see inside front cover for Editor's address).

Authors should submit an original and two copies of manuscripts. Manuscripts should be typewritten, double-spaced, on 21.5 x 28 cm (8.5 x 11 inch) white paper. Refer to this issue of *HR* for style and format information. Detailed information for submissions to Geographic Distribution, Natural History Notes, and Recent Population Changes appear in a recent issue of *HR* under their respective headings.

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