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The third Wednesday of each month, 8:15 p.m. at the Natural History Society of Maryland (except May—August, third Saturday of each month, 8:00 a.m.). The Department of Herpetology meets informally on all other Wednesday evenings at the NHSM at 8:00 p.m.

BULLETIN OF THE MARYLAND HERPETOLOGICAL SOCIETY

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SNAKEBITE IN THE LESSER ANTILLES

Kenneth L. Gosner

The pit vipers *Bothrops caribbaeus* and *Bothrops lanceolatus*, occurring on Saint Lucia and Martinique respectively, are the only poisonous snakes known from the West Indies (Lazell 1964 and Gosner 1987). Both snakes were formerly synonymized with *Bothrops atrox*, and the common name "fer-de-lance", invented by Lacepede, appears in popular accounts of these and closely related species, although the name is almost nowhere, even in French-speaking areas, the colloquial one in local use. *B. lanceolatus* is called simply "le serpent", the only other snake extant on Martinique being the secretive, wormlike *Leptotyphlops bilineata*; the names "trigonocephale" and "vipère jaune" are also used by local people. According to Lazell "le serpent" is also current on Saint Lucia where creole French is still widely spoken. (In 1776, when both islands belonged to France, an official coat-of-arms was proclaimed consisting of a blue field divided by a cross with a stylized white snake reared in threatening manner in each quadrant.)

Several factors make these snakes a potential hazard; they grow to a large size, are locally common, and share habitat with humans. Lazell (1964) reported maximum lengths in excess of two meters for both species and found the Saint Lucian form abundant "almost beyond belief". *Bothrops lanceolatus* is not scarce, as indicated by Raboteau's (1968) report that 5776 to 8314 bounty claims were paid annually in the years 1960 to 1967, almost a century and a half after such rewards were introduced in 1820. (The current bounty is 30 French francs or about $3 US in 1985.)

Most of the scant medical information available for the Antillean species is obscurely located or unpublished. My purpose is to summarize the material which includes data from preantivenin and contemporary accounts.

As is usual with snakebite information, the data pose problems in interpretation. Estimates of the frequency of bites and of mortality rates in the Antilles, as elsewhere, are clouded, since an unknown number of accidents go unreported. In the nineteenth century Tyler (1849) estimated about 20 deaths per year on Saint Lucia in a population of 25,000, while Rufz (1859) guessed at least 25 per annum, more probably twice that, and possibly as many as 60 on Martinique with an 1853 population of almost 130,000. If accurate these estimates represent very high rates; calculated as deaths per 100,000 population, the figure for Saint Lucia is 80 and for Martinique, 19 to 46. In contrast, and without taking into account changes in social and other conditions, Raboteau's modern estimate of 0.33 deaths per 100,000 for Martinique is actually low compared to Swaroop and Grab's (1954) figures of 0.8 to 4.10 for six mainland Tropical American countries with a substantial "snake problem". The latter estimates, however, include non-ophidian bites and stings that make a substantial contribution to statistics from some areas.

Modern data are not available for Saint Lucia as a whole, but Long et al. (1980) estimate 12 bites per year in the "environs" of the single village of Anse La Raye which has a population of about 2000 according to civil authorities. Judgment of the percentage of fatalities among those bitten is also difficult. In the earlier accounts Tyler noted one fatality in 30 bites suffered by his troops, and he judged that 19 out of 20 Saint Lucian victims recovered, while Rufz estimated one fatality in 50 bites, yielding 19th century rates of 2–5%. Raboteau's 1968 prediction of one fatality in 30 to 40 incidents annually on Martinique falls in the same range, as does Klauber's 1956 estimate of 3% fatalities among those bitten by rattlesnakes in the United States.

Turning to specific examples, Valette (1982) recorded seven deaths on Martinique between 1973 and 1982 equalling almost 6% of 114 snakebite admissions to L'Hôpital Clarac (the central "clearing house" for such accidents). This may be compared with Klauber's report of a Central American mortality rate in United Fruit Company hospitals of 4.9% in the period 1938 to 1951. It is perhaps axiomatic that, in Klauber's words, "the serious cases are the ones likely to reach hospitals", and this bias advises caution in making extrapolations. Thus, Valette's observation of 5 deaths in 35 reported incidents in Martinique in 1981 and Long et al.'s observation of 5 deaths in 33 incidents at Anse La Raye yield appreciably higher death rates (14–15% of those bitten) compared to earlier testimony.

Long et al. (1980) reported the usual cause of death from *B. caribbaeus* bites to be "uncontrolled gangrene and irreversible shock, either hemorrhagic (hypovoluemic) or vascularly mediated". Further, they reported that in three cases death resulted from "circulatory collapse", while two victims expired from "gangrene with septic shock" and "gangrene with renal failure". In a sixth, nonfatal case involving gangrene an amputation was required. Rufz's extensive observations on *B. lanceolatus* poisoning, including two postmortems, also indicate a panoply of largely haemotoxic effects associated with bothropic poisoning (Russell 1980). When envenomization is directly responsible, death may occur within a few hours.

In contemporary medical practice in Martinique, according to Valette, antibiotic and other supportive treatment is coupled with efforts to relieve the immediate effects of poisoning. Long et al. (1980) say "prophylactic antibiosis and limb elevation for drainage should be the mainstay of all treatment in which gross oedema is encountered" as it was in 64% of cases.

The role of serotherapy in these reports is ambiguous. The St. Lucia data omit any mention of antivenin beyond recommending that local health centers be stocked with it, while Valette's (1982) report, containing testimony from at least six local physicians, suggests a conflict of opinion in Martinique. The principal practitioner at L'Hôpital Clarac, to which most snakebite cases were referred, advocated serotherapy only in grave situations. There is also conflict in the indicated choice of antivenin. In Valette's report Wyeth's anticrotaline polyvalent is cited as "the primary serum in use", while the head of medical services for the military stated that Instituto Butantan's antibothropic serum is normally part of the emergency kit of helicopters used by the *gendarmerie*. Physicians at L'Hôpital Clarac indicated a similar preference, "when available", suggesting a problem in supply.

While noting the use of anticrotalic polyvalent, Valette's report questioned its efficacy ("Son activité semble contestée") and, advocated the reintroduction of a monovalent serum for *B. lanceolatus*. This serum, locally produced, was available from about 1966 to 1977, and Raboteau (1986) reported favorably on the initial 28 cases treated. Doye (1985) writes that L'Institut Merieux in Lyon, France is considering a resumption of production. I have no evidence that this monovalent serum was ever tried on Saint Lucia.

About half of the cases in Long et al.'s (1980) study had been treated, apparently exclusively, by native healers—with a recovery rate equal to that of the professionals in this small sample. Their technique has changed little since the 19th century; Rufz (1859) recorded the details of folk therapy. In addition to the "cut and suck" therapy that goes in and out of vogue in modern practice most healers rub the wound with lime juice and salt and use rum-herbal poultices externally plus a variety of potions internally. The one common ingredient of the latter, according to Rufz, was "tafia" or rum. Tyler

(1849) also advocated the administration of rum internally to the point of intoxication but omitted the native addition of gunpowder to this "punch". Long et al. concede a possible calming effect in more moderate doses.

With regard to the herbal practice of local "panseurs", Rufz concluded, without entirely excluding useful possibilities, that a comprehensive list of plants in use for snakebite "would constitute a complete flora of Martinique". Several plant species, however, tend to recur in these folk recipes including the following that also appear in Ayensu's (1981) review of West Indian medicinal plants: "poivre de guinea" (*Amomum cordiflora* and *A. melequeta*); "guaco" (*Mikania micracantha*); and "trefle" (*Aristolocha trilobata*).

As for circumstances under which bites occur, Long et al.'s tabulation shows wounds on the feet, 52.4% of total; legs, 21.4%; and hands, 23.8%. Rufz also indicated a preponderance of bites in the lower extremities. These data support the interpretation that most accidents occur during agricultural work and that both species are essentially terrestrial, although both also show arboreal tendencies. The Saint Lucian study, for example, noted "numerous bites on the upper torso from snakes resting in low branches".

While it is clear that the island species are potentially dangerous, the references also indicate that most bites are not serious, and in most cases recovery is rapid and complete. A common inference is that these widely feared snakes often refrain from exerting their full capability, an impression echoing Archie Carr's now classic account (1969) of his encounter with the closely related Costa Rican "terciopelo", *B. asper*.

Acknowledgments

Dr. A. J. D'Sousa, Director of Health Services, Saint Lucia, and J. Chevance and S. Doye of the Préfecture de la Martinique replied to inqueries and provided photocopies of unpublished reports, and Le Centre de Récherches Caraïbes at Fond St. Jacques provided lodging and library facilities during visits to Martinique.

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* photocopy deposited in the reprint file of the Department of Herpetology, American Museum of Natural History, N.Y.

** copy in the library of the Centre de Récherches Caraïbes, Fond St. Jacques, Ste. Marie, Martinique.

A NOTE ON THE REPRODUCTION OF *Bothrops tzotzilorum*

Recently Campbell (1985) described a new species of highland Pitviper, *Bothrops tzotztilorum*, which is endemic to the Meseta Central of Chiapas, Mexico, and is considered to be the smallest crotaline in the New World. Although a number of specimens have been collected and most are deposited in various U. S. Herpetological Collections, no information is currently available on the reproduction of this snake.

Here we present data on the reproduction of *B. tzotztilorum* based on a female specimen (INIRB-590) which measured 369 mm in total length, 324 mm in snout vent length, weighed 42 gm, and was collected from Rancho Nuevo Caves Park, 9 Km S.E. of San Cristobal de Las Casas, Chiapas, at an elevation of 2400 m, under a rock in a Pine Forest, 19 June 1984, at 1200 hrs. by J. H. Vega. Its coloration represents one of the two phases described by Campbell (1985), dark grayish brown. Upon dissection, two days after collection, the snake contained, within the oviduct, two unfertile eggs (parallel to each other) and two fully developed embryos (parallel to each other) in a frontoventral disposition respectively. The eggs were oval in shape and pale yellow in coloration, the embryos yolk sac was translucid, and their coloration was essentially the same as that of the female, dark grayish brown, but with a stronger contrast in the pattern of blotches along the body. Weights and measurements of eggs and embryos are presented in Table 1. The eggs (2.7 gm) and embryos (6.4 gm) accounted for 21.6% (9.1 gm) of the female's weight. The month (June) of collection corresponds to the first annual peak in rainfall and temperature, according to monthly average temperature and rainfall from San Cristobal de Las Casas (Garcia, 1981:90). To our knowledge this is the first record on the female size at sexual maturity, number and size of offspring and reproductive season of *B. tzotztilorum*.

Table 1. Measurements and weights of infertile eggs and embryos of *Bothrops tzotztilorum*. Average measurements are represented by the numbers in parenthesis.

	LENGTH	WIDTH	WEIGHT
EGG 1	22mm	9mm	1.2 gm
EGG 2	24mm	11mm	1.5 gm
	(23mm)	(10mm)	(1.35 gm)

	TOTAL LENGTH	SNOUT VENT LENGTH	WEIGHT WITH YOLK SAC	WEIGHT WITHOUT YOLK SAC
EMBRYO 1	141mm	123mm	3.2 gm	2.4 gm
EMBRYO 2	142mm	124mm	3.2 gm	2.3 gm
	(141.5mm)	(123.5mm)	(3.2 gm)	(2.35 gm)

Specimens are deposited at INIREB's Herpetological Collection.

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Campbell, J. A.
1985. A New Species of Highland Pitviper of the Genus *Bothrops* from Southern Mexico. J. Herpetol. 19 (1):48-54

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—Marco A. Lazcano-Barrero and Eleuterio Gongora-Arones, *Instituto Nacional de Investigaciones Sobre Recursos Bioticos (INIREB). Apartado Postal 219, San Cristobal de Las Casas, Chiapas 29200, Mexico.*

Received: 23 December 1987
Accepted: 30 December 1987

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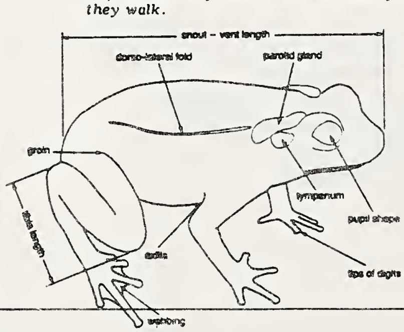

The main external features of the frog.

* *The earliest frog-like creatures, known as "Triadobatrachus," measured about 8", had a wide, flat skull (as modern frogs do) and a short tail. Found in Madagascar and dating back to the Triassic Period (about 250-300 million years ago), it appears to have been an aquatic species or a metamorphosing tadpole. After Triadobatrachus there is an enormous gap of 50-60 million years before the next fossil frogs appear.*

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* *The largest frog in the world is probably "Conraua goliath," the Goliath frog, from West Africa, which may exceed 12" in length (frogs are measured from the tip of their nose to their vent). However, in New Guinea, local tribesmen talk of a frog known as "carn-pnay" which may exceed this. The "Psyllophryne didactyla," from Brazil is currently recognized as the smallest at the average size of just under 4".*

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CHRIS MATTISON is a member of both the British and International Herpetological Societies and has lectured on reptiles and amphibians for more than twenty years. He is also the author of an earlier volume in this Series, Snakes of the World.

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By Chris Mattison
Publication date: December 11, 1987; Price: $22.95, hardbound, (In Canada: $26.95); ISBN# 0-8160-1602-X. 192 pp. 6½ X 9½; 120 illustrations, including 60 in full color. Classification Guide. Index. Bibliography.

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DEPARTMENT OF HERPETOLOGY

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CONTENTS

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The third Wednesday of each month, 8:15 p.m. at the Natural History Society of Maryland (except May—August, third Saturday of each month, 8:00 a.m.). The Department of Herpetology meets informally on all other Wednesday evenings at the NHSM at 8:00 p.m.

OCCUPATION OF *OVOPHIS* BURGER (Serpentes: Viperidae)

Hobart M. Smith and David Chiszar

Abstract

Ovophis Burger genus novum is described by quotation from his unpublished 1971 doctoral dissertation, in order to forestall possible future usage of the name in such a way as inadvertently (or deliberately) to make the name nomenclaturally available under some other authorship. This unconventional step is taken in response to the acceptance by some authorities of the validity of Burger's concept of generic status of a group of certain species formerly placed in *Trimeresurus*.

Inclusion of the nominal genus *Ovophis*, attributed to Burger's 1971 dissertation, in Welch's 1988 checklist of the snakes of the Orient, again documents the hazards of failing to publish promptly any new names proposed in dissertations. The purpose at present is to make this particular name, *Ovophis* Burger, nomenclaturally available with its proper authorship.

Dissertations are not themselves publications in a nomenclatural sense, nor are reproductions thereof (Art. 9 of the International Code of Zoological Nomenclature). Therefore *Ovophis* cannot, under the Code, be attributed to Burger (1971a). Abstracts of dissertations published in Dissertation Abstracts International (or other similar series or journals) *do* qualify nomenclaturally, but in this particular case, Burger (1971b) did not include the "description or definition that states in words characters that are purported to differentiate the taxon" that is required by the Code (Art. 13) to make any new name proposed after 1930 nomenclaturally available.

Hence the nominal genus *Ovophis* does not exist nomenclaturally through either of Burger's works, nor through Welch's usage (1988: 133, 134), for the same reason. We are not aware that any other work would make the name available, but it is clear that Burger's dissertation has been widely disseminated through University Microfilms and has found considerable favorable reception in spite of the fact that the work was never published. The basic outline of Burger's arrangement of American genera of pit vipers was published in such a manner as to credit him for it, by direct quotation from his dissertation, in Pérez-Higareda et al. (1985).

Under present circumstances we regard it expedient similarly to make the name *Ovophis* nomenclaturally available with its proper authorship (Burger alone), although it will date from the present, not from 1971.

We thus quote verbatim from Burger (1971a: 104–106, as follows.

"*Ovophis* new genus

"*Type species.*—*Ovophis monticola* is hereby designated type species of the genus *Ovophis*.

"*Diagnosis.*—Asiatic rattleless, scale-snouted pitvipers; nasal pore situated prominently near external rim of nasal pad; supraocular scales small; gular scales smooth; subcaudals single and paired; border of maxillary cavity having rounded projection forming two distinct curvatures; ectopterygoid having truncate anterior dorsolateral projection; pterygoid teeth extending nearly to posterior margin of articulation with ectopterygoid; basal portion of pterygoid shorter than ectopterygoid (Figure 5); splenial fused to angular; nasal pore near external rim of nasal pad.

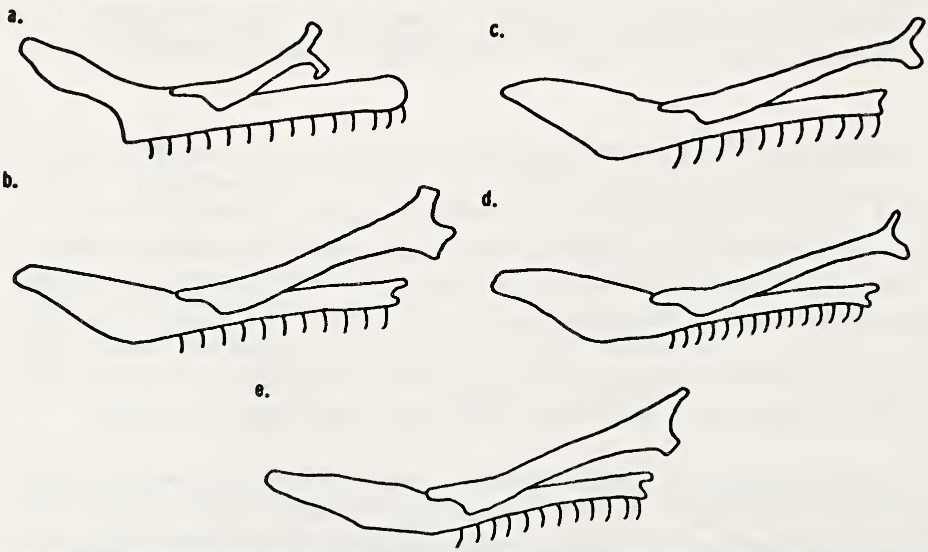

Fig. 1. Burger's (1971a) Fig. 5, "Comparison of pterygoid (toothed) and ectopterygoid (diagrammatic and not scaled): a, *Hypnale;* b, *Ovophis*; c, *Porthidium*; d, *Bothrops*; e, *Trimeresurus.*"

"In contrast *Tropidolaemus* has rudimentary nasal pore, strongly keeled gulars, and splenial separate from angular. *Trimeresurus* has a shorter series of pterygoid teeth than *Ovophis*.

"*Definition.*—Size moderate, total length to 1.1 m; dorsal pattern consisting of dark brown spots; cranium moderately wide, its greatest width greater than its length; border of maxillary cavity forming a simple curve; prootic sloping evenly ventrolaterally without distinct dorsolateral ridge; anterior foramen of prootic not divided by bony partition; palatine having 4 teeth; dorsal projection of palatine a broad, very much rounded triangle with highest point slightly posterior to three-fourths length of palatine; pterygoid teeth 11, extending to or nearly to posterior edge of articulation with ectopterygoid; basal portion of pterygoid longer than ectopterygoid; ectopterygoid curved and extremely broad with truncate dorsolateral projection; squamosal long and narrow, its greatest width about one-third its length; quadrate shorter than cranium; mandible with splenial separate from angular, having 17 teeth; hemipenis divided for about two-thirds length, basal two-thirds spinous, distal one-third calyculate.

"*Composition.*—Four species, one with three subspecies: *Ovophis chaseni* (Smith), *O. convictus* (Stoliczka), *O. monticola monticola* (Günther), *O. monticola mkazayazya* (Takahashi), *O. monticola tonkinensis* (Bourret), *O. okinavensis* (Boulenger).

"Distribution.—Mountains of the Indo-Chinese region from southern China to Nepal, Assam, Burma, Malaya, Formosa, Okinawa, and Borneo."

The key to genera of pit vipers in Burger's dissertation (1971a: 82–83) distinguishes *Ovophis* from *Trimeresurus* as follows:

"8. Subcaudals anteriorly entire, posteriorly divided; pterygoid teeth extending past midpoint of junction of ectopterygoid to pterygoid .... *Ovophis*

Subcaudals divided; pterygoid teeth extending to midpoint of ectopterygoid to pterygoid .... *Trimeresurus*"

Burger (1971a: 63–64) distinguished the preceding two genera from *Tropidolaemus*, the only other Asiatic genus of the subfamily Lachesinae, in part by the rudimentary nasal pore, and from all American genera of the Lachesinae (*Bothriechis*, *Bothriopsis*, *Bothrops*, *Lachesis*, *Ophryacus*, *Porthidium*) by the presence in them of the nasal pore on the *inner* margin of the nasal pad ("the flexible posterior wall of the nostril, which by moving forward acts as a valve"), whereas it is located on the *external* margin of the pad in *Ovophis* and *Trimeresurus*. *Sistrurus* and *Crotalus* lack the nasal pore, according to Burger (1971a: 64).

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POPULATION PARAMETERS OF RED–EARED TURTLES IN A TEXAS FARM POND

Donald A. Ingold and William E. Patterson

Abstract

A population of red–eared turtles in a 3–acre farm pond was studied intensively for one season. A total of 258 captures involving 113 different turtles provided data on seasonal activity, habitat preferences, individual movements, age and sex structures of the population, population density, and individual growth rates. It is hypothesized that the declining proportion of males in older age classes was due to differential emigration of males from this pond, A general hypothesis of broader applicability is that productivity of a pond for red–eared turtles is influenced by the relative amount of suitable shoreline habitat for turtles under 2 years old.

Introduction

A prior study of this red–eared turtle (*Pseudemys scripta elegans*) population involved the application of a multiple census population estimation technique (Ingold et al. 1986). The present study focuses primarily on (1) seasonal activity patterns, (2) age and sex structure, and (3) spacing and distribution patterns.

Study Area & Methods

The study area is a 3–acre (1.2 ha) pond on the East Texas State University Agricultural Farm near Commerce in north–central Texas. The pond has a maximum depth of about 16' near an earthen dam which forms the northwestern boundary (Fig. 1). Secchi disc transparency is limited to about 10–12 inches in the summer due to luxuriant plankton blooms and the bottom consists of silt. Vegetation adjacent to the shoreline includes black willows (*Salix nigra*), various native oaks (*Quercus spp.*), and a variety of forbs and perennial pasture grasses.

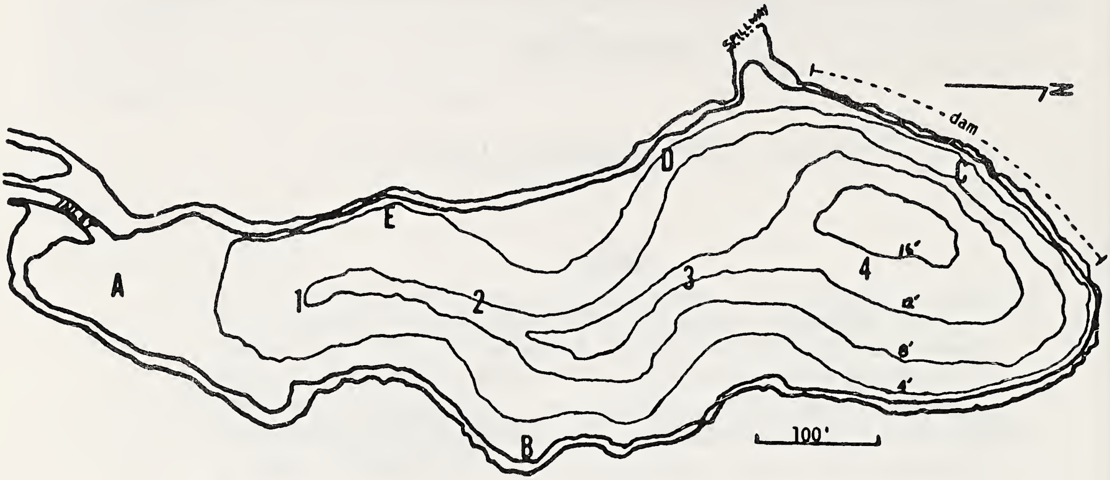

Figure 1. Study area showing four trapping stations in the center of the pond (1–4) and five stations along the shoreline (A–E).

A trapline with four stations (numbered 1 through 4) was established in the center of the pond, on the long axis, and a second trapline with five stations (designated by letters A through E) was established along the shoreline (Fig. 1). A large trap (90 cm x 75 cm x 60 cm) was used at the four stations in the center of the pond while a smaller trap (45 cm x 30 cm x 20 cm) was required for the shallow water of shoreline stations. Both were floating box–traps, constructed as previously described (Ingold et al. 1986). The interval between stations in the center of the pond was 150 ft (45.7 m) while the distance between shoreline stations was variable, but never less than 200 ft (60.6 m). A large segment of the shoreline that was commonly used by fishermen (between stations B and C) was not trapped. Woven wire bait baskets containing dead fish were suspended in the center of each trap. Although juvenile red–eared turtles are carnivorous and adults typically herbivorous (Clark & Gibbons, 1969), all age classes took advantage of the opportunity to scavenge on dead fish.

At the beginning of the second and fourth weeks of each month the large trap was placed at station #1 and the small trap at station A. On the following day the traps were moved to adjacent stations until, after 4–5 days, each station was trapped for 24 hrs. Turtles were marked as previously described (Ingold et al. 1986) and then measured, sexed, and released at capture sites. The study began in March and continued until two consecutive trap–weeks passed in November without capturing any turtles.

Results and Discussion

A total of 258 captures were made in nine months. This total involved 113 turtles, many of which were captured two or more times, for a total of 145 recaptures. About the same number of turtles were captured at each of five shoreline stations ($p > .05$). For the center trapline captures were less likely as the trap was moved toward the deep end of the pond near the dam. More turtles were captured at station #1 than at the other three center stations ($p < .01$) (Fig. 2).

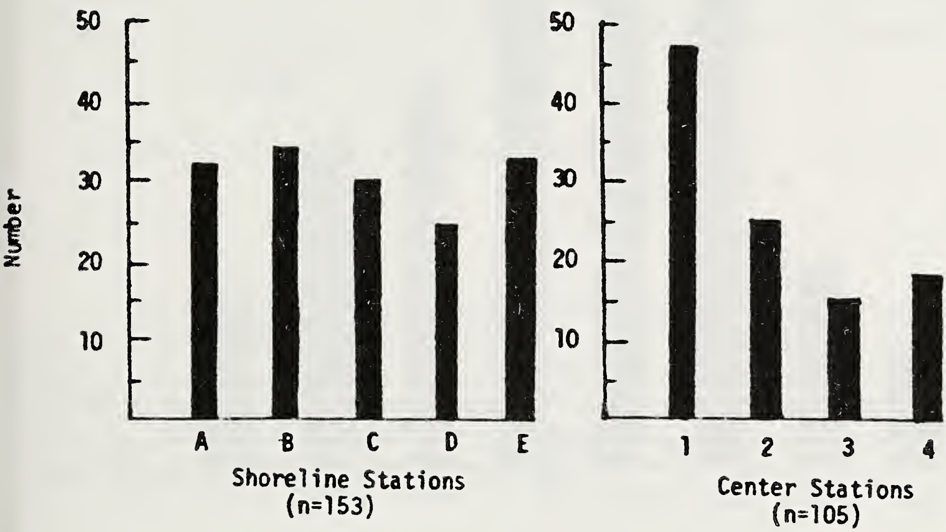

Figure 2. Number of Turtles Trapped Per Station (n = 258).

Because the trapping effort was the same each month, the capture rate per month should reflect seasonal foraging activity (captures occurred only when traps were baited). Capture rates were low in early spring, increased sharply in May, June and July, and declined gradually the rest of the season until a zero rate was recorded in November (Fig. 3). Surface and bottom water temperatures, recorded at each station twice a month, were not closely correlated with capture rates. Although capture rates declined in August, September, and October, mean surface water temperatures for these months were within the range of means recorded for the three months of peak activity (May, June, July), and the mean temperature for November when there were no captures was warmer than means for March and April (Fig. 3). The onset of foraging activity in March was associated with surface water temperature of 66°F while the cessation of activity in November was associated with surface water temperatures of 71–72°F. When water temperatures were within the range of 70–90°F, no correlation could be detected between temperatures and foraging activity. It was concluded therefore that variations in the intensity of foraging activity were controlled by biological and/or environmental factors that were not closely linked to changes in water temperature.

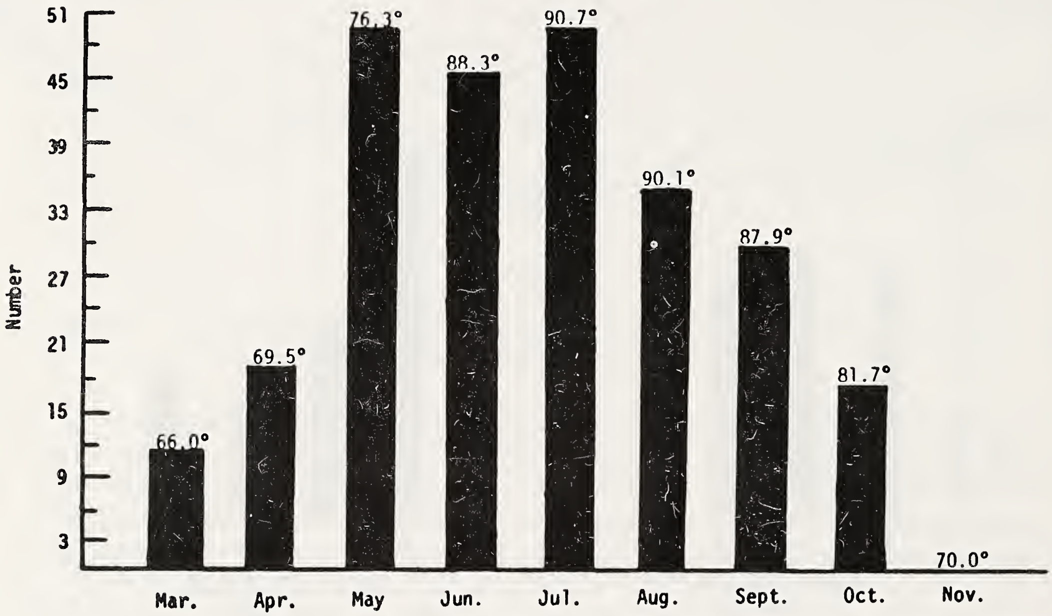

Figure 3. Total number of captures per month with mean surface water temperatures (degrees F.) for month at top of each bar.

Age Structure of the Population

Turtles were divided into four size classes based upon plastron lengths. At the time of hatching *P. scripta* plastrons are about 3.1 cm and these lengths double by the end of the first growing season (Webb, 1961). Thus yearlings should be about 6 cm or longer during their second growing season. Our smallest size class (plastrons from 6–10.4 cm) therefore consisted primarily of yearlings. This class clearly dominated the sample (captured) population. The 10.5–14.4 cm size class contained mature males and immature females with ages of perhaps 2–5 yrs., and the two largest size classes were ones in which all males and most females were probably sexually mature (Cagle, 1944, 1950; Webb, 1961) and most of these turtles were probably 4 yrs. or age or older (Table 1).

Table 1. Sexual Maturity in Relation to Selected Size Classes.

	Plastron Lengths (cm)			
	6.0–10.4	10.5–14.4	14.5–18.4	18.5 & >
Males	largest are beginning to mature	all mature	all mature	all mature
Females	all immature	all immature	largest are beginning to mature	all mature

The percentage of turtles captured in each of four size classes was: 6.0–10.4 cm = 53%, 10.5–14.4 cm = 30%, 14.5–18.4 cm = 13%, and those longer than 18.4 cm = 4%. Capture rates of turtles in the smallest class peaked in May, June and July. This 3-month period of heightened activity was less discernable for turtles in the next two size classes, and was not apparent among the largest turtles (Table 2).

Table 2. Total Number of Turtles Trapped Per Month in Four Size Classes (n = 258)

	Plastron Lengths (cm)			
	6.0–10.4	10.5–14.4	14.5–18.4	18.5 & >
March	1	6	2	2
April	8	7	3	2
May	30	13	5	2
June	26	13	5	1
July	30	14	6	0
August	18	9	6	2
September	17	8	3	2
October	7	7	3	0
November	0	0	0	0

Most of the large turtles were captured in the center of the pond while young turtles (6.0–10.4 cm) made up 72% of all captures along the shoreline (Fig. 4). While small turtles showed a consistent preference for shallow water along shorelines, those in the next size class (10.5–14.4 cm) showed a slight preference for deeper areas of the pond and were clearly transitional with respect to depth preference. Turtles in the two largest size classes showed a consistent preference for deeper portions of the pond. The mean size for all turtles taken at center stations was 13.47 cm while that for all turtles taken along shorelines was 9.83 cm.

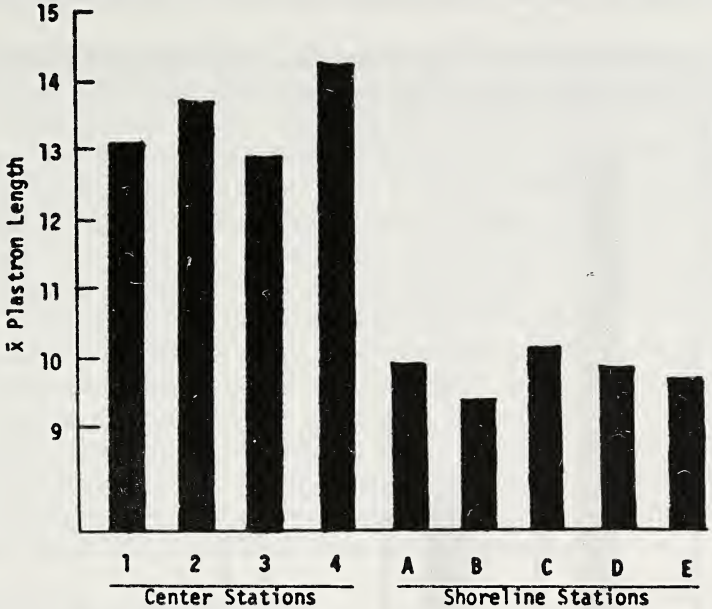

Figure 4. The mean size of turtles captured at nine stations (plastron lengths in cm).

Sex Structure of the Population

Monthly capture rates of males were different from those of females ($p < .01$). Capture rates for males were higher than for females in March and April and lower than for females in June, July, and August (Table 3).

Table 3. Number of Male and Female Turtles Trapped Per Month (n = 252).

	March	April	May	June	July	Aug	Sept	Oct	Nov	Total
Males	4	15	22	16	17	9	16	8	0	107
Females	1	4	28	30	33	26	14	9	0	145

Reported sex rations for *P. scripta* vary from 0.90 to 1.92 males per female (Cagle, 1950; Webb, 1961; Moll & Legler, 1971). The ratio among captured turtles from our pond was 0.74 males per female which is a significant departure from 1:1 ($p < .05$). However males were more abundant than females in the smallest size class while females predominated in the three larger size classes (Fig. 5). Thus among yearling turtles males outnumbered females but in the segment of the population that was over 2 years old there were fewer males than females.

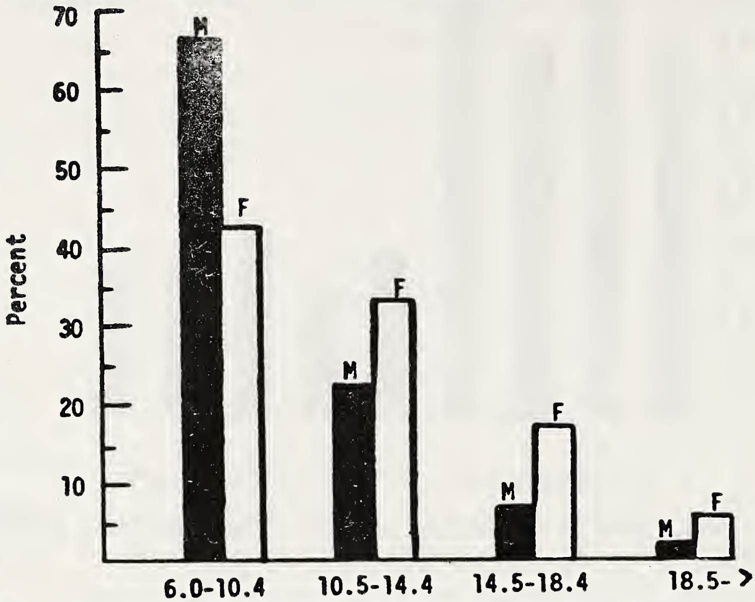

Figure 5. Percent Males and Females (M, F) in Four Size Classes (= plastron lengths, cm).

There was no indication of sexual differences with respect to preferences for particular portions of the pond. Of all shoreline captures, 66 were males and 87 were females. The proportion of the sample male population captured along shorelines was not different from that of females captured at these trap sites ($p > .05$). There was a large number of males captured at center station #1 at the shallow end of the pond. This was the only station at which male captures exceeded female captures (22–20). If this station is considered with shoreline stations (instead of with center stations), there is still no significant difference in the proportion of males captured at shorelines compared with that of females.

The rapid decline of males in the 3 largest size classes compared to females suggests one or more of the following: (1) the capture method becomes selective for females as turtles mature, (2) the mortality rate among yearling males is higher than for females so that the latter tend to predominate in larger size classes, (3) females grow more rapidly than males, and (4) males, compared to females, are more likely to emigrate as they mature.

There was no evidence suggestive of selective captures or of differential mortality. Although females do indeed grow more rapidly than males (Cagle, 1946; Webb, 1961), differential growth cannot account for the skewed sex ratio. It is suggested therefore that these differences are due primarily to a higher emigration rate of young males compared to females. The biological significance of emigration for turtles is twofold: (1) emigrants colonize new habitats that become available and (2) emigrants are vehicles for gene flow between isolated populations. Either gravid females or both sexes must emigrate for successful colonization of new habitats while gene flow can be accomplished soley by emigration of males. Among vertebrate populations emigrants almost always suffer higher mortality rates and aquatic turtles are probably no exception. It is suggested therefore that the skewed adult sex ratio in this pond is due primarily to the emigration of more males than females, that such emigration is a mechanism for gene flow between populations, that mortality among emigrants is probably high, and that successful emigrants may reap fitness benefits.

Population Size & Density

The size of this red-eared turtle population was estimated in a previous study to be 209 (about 70 per acre) (Ingold, et al. 1986). Using the same multiple census technique, the population of this 3-acre pond was estimated to be 207, showing remarkable agreement with the previous estimate.

Few estimates of population size or density for freshwater turtles are available (Spellerberg, 1982). Our estimate of about 70 per acre is similar to the estimate of 77 *P. scripta* per acre for a pond in Panama (Moll & Legler, 1971) and is approximately double the estimate of 35.6 per acre for a freshwater bay in South Carolina (Gibbons, 1970).

Seasonal Growth Rate

Plastron lengths taken on the first capture day and on the last recapture day were used to evaluate growth rates. Of 32 turtles that were recaptured, only 24 showed measurable growth that occurred during the time interval between captures. A weekly growth rate index (growth/week x 100) indicated more rapid growth among young turtles compared to those in larger size classes (Table 4). Cagle (1946) first reported that juvenile females usually grow more rapidly than young males.

Table 4. Growth Rates for Age and Sex Classes Based on Plastron Lengths

Age/Sex Status	Number[a] (n)	Time Between Measurements: Mean Number of Weeks	Growth Rate Index: Mean Growth[b] Per Week x 100
Plastron is 6.0–10.4 cm	12	24.6	2.57
Plastron is 10.5–14.4	8	43.7	1.58
Plastron is longer than 14.5 cm	4	43.1	0.78
All Females	16	34.9	2.02
All Males	8	32.4	1.78

[a] Includes only turtles for which the time interval between captures was great enough to permit measurable growth (n = 28).

[b] Growth indicator was plastron length in cm.

Our data were confirmatory, with a mean weekly growth rate index of 1.78 for males and 2.02 for females.

Movement Within the Pond

Using recapture data for 32 turtles, it was possible to examine the extent and frequency of movements within the pond. For this evaluation the two largest size classes were combined to include all turtles 14.5 cm and larger (for a total of 3 size classes). Those in the intermediate size class (10.5–14.4 cm) were most active and the smallest turtles were least active (Fig. 6).

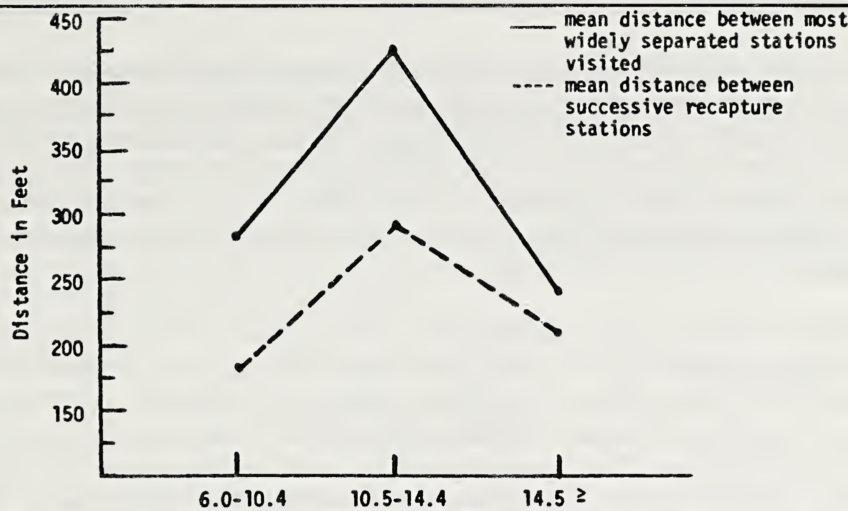

Figure 6. Movement Patterns of Turtles in Three Size Classes (plastron lengths in cm).

Data for 10 turtles captured four or more times revealed preferences of some turtles for particular segments of the pond. Activities of these turtles apparently were confined to certain areas and other parts of the pond were not visited. The mean distance traveled from centers of activity was 230 ft. which was about 33% of the maximum distance that could be traveled without leaving the pond. Whether or not these meager data indicated the existence of home ranges in this small pond is not known.

Food availability, water temperature, and basking sites are the 3 most important factors influencing the distribution pattern of aquatic turtles (Cagle, 1946). Since surface water temperatures were uniform throughout this pond, turtles probably would be expected to concentrate where food and basking sites are available. There was a particularly high capture rate during this study at the south end of the pond where the inlet may have been associated with an allochthonous food supply and where numerous partially submerged logs and stumps provided ideal basking sites. Gradually sloping shorelines also provided basking sites and were places where wind-blown food could accumulate. The population therefore exhibited a clumped pattern of distribution that was probably influenced by the availability of food and basking sites.

Summary & Conclusions

Trapping results indicated that peak activity of this red-eared turtle population occurred in May, June and July, with activity declining markedly from August through October. Males were captured at a higher rate than females in March and April while the female capture rate was higher from

June through August. Capture rates were not closely correlated with changes in water temperatures. Relatively small turtles were rather evenly distributed along the shoreline, while larger turtles were taken at stations in the center of the pond. Rather than being evenly distributed in the center of the pond, most of these turtles were taken at station #1 at the shallow end where there were more basking sites and where food may have been more abundant.

When turtles were divided into 4 size classes, 53% were in the smallest class consisting primarily of yearlings while the next 3 size classes contained 30%, 13% and 4% of the sample population, respectively. This age distribution pattern is similar to those reported for widely varying taxa of vertebrate populations. Even though yearling males outnumbered females, the overall sex ratio for this population was skewed in favor of females. The favored explanation for this disparity was that emigration is a fitness enhancing strategy for males and that males were therefore more inclined to emigrate than females. This explanation would pertain if young males had to compete with larger males for access to females in this pond, while females were assured the opportunity to reproduce without emigrating.

A multiple census population estimation technique applied to this population on successive years indicated that there were about 70 red–eared turtles per acre in this pond. There are too few population estimates available to make comparisons and draw reliable conclusions concerning factors effecting freshwater turtle population size and density. Among interesting speculations that may presently be offered are the following: The ultimate reproductive success of freshwater turtles may be heavily influenced by the amount of suitable shoreline (nursery) habitat for turtles less than 2 years old. Since the ratio of shoreline to pond surface area tends to be inversely related to pond size, population density should be greatest in small ponds. Thus different reported densities may be due in part to pond size and the relative availability of shoreline habitat as well as other factors that effect habitat quality. Since small ponds may be more productive of freshwater turtles, resulting in relatively higher population densities, it is probable that emigration rates from small ponds may also be higher than from larger ponds and lakes. Thus it is proposed that competition among males, especially for mates, intensifies as population density increases, resulting in higher emigration rates for young males, and adult sex ratios skewed in favor of females.

Although tenuous at this point, the argument is extended to suggest that adult sex ratios may in fact be indicators of habitat quality. Where there is a relative abundance of nursery habitat, turtle productivity will be high, population densities will increase, many young males will emigrate, and adult sex ratios will be skewed in favor of females. Where there is a relative paucity of nursery habitat, turtle productivity will be low, eliminating the tendency for emigration by male recruits into the adult population. Under such circumstances, a sex ratio skewed in favor of males in the juvenile population may persist into the adult population. The hypothesis that adult sex ratios of freshwater turtle populations may reflect the relative availability of nursery habitat needs to be tested.

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NEWS AND NOTES:

BOOK REVIEW:

WOMAN IN THE MISTS. By Farley Mowat. Warner Books, Inc., 666 Fifth Avenue, New York, N. Y. 10103. xvii, 380 pp., ill. (color). 1987. $19.95 postpaid.

This book is a moving account of the life of Dian Fossey from its unauspicious beginnings to her brutal murder, at age 53, on December 27, 1985, in her cabin in the Karisoke Research Center that she established September 24, 1967, high (10,000 ft.) on the slopes of Mt. Visoke, one of the three Virunga volcanoes in south-central Africa, for study of the Mountain Gorilla and other organisms.

The Research Center was the culmination of a long-held dream of doing primate research in Africa. It was achieved only by a protracted struggle, and its development and maintenance as an internationally important field station was an even greater struggle. It became her home, despite difficulties with visas in Rwanda, and repeated trips to her origins in the United States and to various parts of the world to gain support through highly successful lectures and conferences. Her book, *Gorillas in the Mist*, (1983) summarized much of her research, although almost from inception of the Center her energies were subverted progressively more and more to the protection of especially the gorillas but also all other animals and the environment in the surrounding parts of the supposedly (but far from actually) inviolate Parc National des Volcans. Between the heroic efforts to finance the Center and to prevent environmental depredations, little time was left for anything else, including exercise of her own scientific talents. Accommodations were developed for many visiting scientists and students, but they often added to her duties and worries as much as they relieved her.

So the story is a somewhat frenetic one, as well as fascinating and tragic. Despite the odds against her, Dr. Fossey (a May, 1976, degree from Cambridge University, on the basis of her gorilla studies) developed a highly respected international reputation, although in that process she alienated many people associated with her through her adamant protective stands.

Mowat's inspired (as always) account gives a classic example of the conflicts—sometimes, as in this case, deadly—that can arise between a dedicated, intelligent, communicatively gifted conservationist (Dian Fossey) and unbridled, highly motivated entrepreneurism, in this case both governmental and scientific.

Fossey does not emerge from this account so much as a scientist as a zoologically (as opposed to anthropologically) empathic person of tremendous drive and total, righteous justification. Scientific ability is there, and was initially very apparent, until the real concern for the very survival of her chosen subjects—primarily the mountain gorilla—rightly took precedence over scientific studies of them.

As usual when not strictly controlled, entrepreneurism prevailed. The book makes evident that scientific entrepreneurism, in the sense of single-minded attention to research and the support thereof, oblivious to the welfare of the subjects and their environment, can be as destructive as overtly commercial entrepreneurism.

It was a sad confrontation, particularly poignant because of (1) the magnitude of the intellectual/moral factor, where usually only moral considerations are at stake, (2) the obvious humanitarian appeal of the subjects, and (3) the poverty and cultural background of the human population involved.

Fossey was a martyr to conservation and intelligent humanitarianism and also to a science that encompasses those considerations. She was no saint, but her faults were far less significant, in the long run, than those of the ones who worked so tenaciously against her. She deserves to be enshrined in the halls of human evolution as one who saw, more clearly than most, the direction in which we are going, and who was trying to the best of her ability to do something about it.

—Hobart M. Smith, *Environmental, Population and Organismic Biology, University of Colorado, Boulder, Colorado, 80309-0334.*

NEWS AND NOTES:

Announcing a New Monograph

STUDIES ON CHINESE SALAMANDERS

ERMI ZHAO • QIXIONG HU • YAOMING JIANG • YUHUA YANG*
*Chengdu Institute of Biology, Academia Sinica, and *Sichuan University, Chengdu*

CHINA possesses one of the largest salamander faunas (34 species in 12 genera and three families: Hynobiidae, Cryptobranchidae, and Salamandridae). Included in this number are the primitive hynobiids which are restricted to eastern Asia and the Chinese giant salamander, largest of all living salamanders. This book is the first review in English of the entire Chinese salamander fauna (both mainland and Taiwan) and includes four sections, three of which were published previously in Chinese and which are here translated, corrected, and updated.

STUDIES ON CHINESE TAILED AMPHIBIANS, by Ermi Zhao and Qixiong Hu. A complete classification of Chinese salamanders with key to families and genera, checklist of species, and distribution maps. Adapted from a book published in Chengdu in 1984. This includes an appendix on the chromosomes of *Batrachuperus* by Yuhua Yang and Ermi Zhao.

TAXONOMY AND DISTRIBUTION OF *BATRACHUPERUS*, by Ermi Zhao and Yaoming Jiang. A detailed review of these hynobiids including a key to species, adapted from *Research on the Qing-Zang Plateau*, published in Kunming, 1983.

TAXONOMY AND EVOLUTION OF HYNOBIIDAE IN WESTERN CHINA, WITH A DESCRIPTION OF A NEW GENUS, by Ermi Zhao and Qixiong Hu. Covers the status of *Ranodon wushanensis, Hynobius* in western China, the evolutionary relationships of Chinese hynobiids, and the new genus *Liua*, adapted from *Acta Herpetologica Sinica*, Chengdu, 1983.

A CHECKLIST OF CHINESE SALAMANDERS, WITH COMMENTS ON RECENTLY-DESCRIBED TAXA, by Ermi Zhao. A completely new section, reviewing in detail all newly-described genera (3) and species (9) since 1982 with full references, plus a checklist of all species.

David B. Wake of the University of California at Berkeley has supervised the translations, performed by Eileen Liching Tang of the same institution. The book consists of 80 pages, with 16 figures, 19 tables, and seven plates including *ten photographs of salamanders and their habitats in full color*. The book is clothbound and measures 7 by 10 inches (18 x 25.5 cm).

PRICES AND ORDERING INSTRUCTIONS

Copies of the book can be obtained from the Publications Secretary, c/o Douglas H. Taylor, Department of Zoology, Miami University, Oxford, Ohio 45056, USA. Please make checks payable to "SSAR"; receipt sent on request only. Prices include shipping charges (book rate) within USA; all overseas orders will be billed only for the *additional* costs in excess of domestic rates. Publications sent at customer's risk; however, packages can be insured at your cost. Overseas customers must make payment in USA funds, by International Money Order, or by MasterCard or VISA (in which case account number and expiration date must be provided).

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SOCIETY • FOR • THE • STUDY • OF • AMPHIBIANS • AND • REPTILES

NEWS AND NOTES:

SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES

Publisher of Journal of Herpetology, Facsimile Reprints in Herpetology, Herpetological Review, Catalogue of American Amphibians and Reptiles, Herpetological Circulars and Contributions to Herpetology

MEMORANDUM

DATE: 15 April 1988

TO: Regional Herpetological Societies

FROM: Stephen Hammack, Chairman SSAR Regional Society Liaison Committee

This year the SSAR Regional Society Liaison Committee is proud to sponsor the 12th Annual Regional Society Workshop, "Exotic Places, Exotic Herps: Volume II" at the 1988 Joint Annual Meeting of The Society for The Study of Amphibians and Reptiles, The Herpetologists' League, The American Elasmobranch Society, The Early Life History Section of the American Fisheries Society, and The American Society of Ichthyologists and Herpetologists. This meeting will take place at The University of Michigan, Ann Arbor, Michigan, 24-29 June 1988. Enclosed is the program for the 12th Annual Regional Society Workshop, from 1-5:15 pm on 25 June 1988.

The registration fee for the 1988 Joint Annual Meeting is $50 regular and $25 student, with a late fee of $20 after 1 June 1988. The registration fee includes the Welcoming Reception on the 24th, the barbeque picnic on the 25th, refreshments at breaks and at the auction, an abstract book, and admittance to all conference activities including the Regional Society Workshop. For a copy of the meeting announcement or for further information contact the local chairman:

Gerald Smith
Museum of Zoology
The University of Michigan
Ann Arbor, Michigan 48109

In addition to the Regional Society Workshop, general information fliers from Regional Societies around the country will be available for distribution. If your organization is interested in having fliers available for distribution, contact me at the address at the bottom of this announcement. Please try and send up to 100 fliers if you are interested.

The SSAR only has one favor to ask of you. Please try and make an announcement about the SSAR 12th Annual Regional Society Workshop at your next meeting and/or put an announcement in your next available newsletter. Thank you for your continued support of SSAR.

Stephen Hammack, Chairman
SSAR Regional Society Liaison Committee
Dallas Zoo
621 E. Clarendon Dr.
Dallas, TX 75203

0307r/gj

Errata:

Bull. Md. Herp. Soc. 24(1):6. The author's address was inadvertently left off the end of the paper "Snakebite in the Lesser Antilles" by K. L. Gosner (March 1988).

Newark Museum, PO Box 540, Newark, N.J. 07101

current address: 203 Longwood Ave.
Chatham, N.J. 07928

Received: 25 November 1987
Accepted: 28 December 1987

NEWS AND NOTES:

"EXOTIC PLACES, EXOTIC HERPS: VOLUME II"
12th Annual Regional Society Workshop
Sponsored by
SSAR Regional Society Liaison Committee
25 June 1988

1-1:30 pm	"The Herpetofauna of a Tropical Wet Forest in NE Costa Rica: La Selva Biological Station"	David L. Hardy, M.D. Tucson Herpetological Society
1:30-2 pm	"Rainforest Fauna of Vaupés, Colombia"	William W. Lamar Adjunct Assistant Professor School of Sciences and Mathematics, University of Texas at Tyler
2-2:30 pm	"Reptiles in Paradise"	Richard Sajdak Aquarium and Reptile Curator Milwaukee County Zoo
2:30-3 pm	"A Texan in Paradise"	Greg Mengden University of Texas Health Science Center San Antonio, Texas
3-3:15 pm	BREAK	
3:15-3:45 pm	"A Visit to the Atacama Desert"	James Dixon Department of Wildlife Sciences Texas A&M University
3:45-4:15 pm	"The Herpetofauna of Stephens Island, Cook Strait, New Zealand"	James Gillingham Department of Biology Central Michigian University
4:15-4:45 pm	"Herping in the High Andes"	John Simmons Collections Manager Division of Herpetology The University of Kansas
4:45-5:15 pm	"Herpetofauna of a Tropical White Sand Rainforest, Camaroon, Africa"	Norman J. Scott, Jr. U.S. Fish and Wildlife Service Museum of Southwestern Biology University of New Mexico

Society Publication

Back issues of the Bulletin of the Maryland Herpetological Society, where available, may be obtained by writing the Executive Editor. A list of available issues will be sent upon request. Individual numbers in stock are $2.00 each, unless otherwise noted.

The Society also publishes a Newsletter on a somewhat irregular basis. These are distributed to the membership free of charge. Also published are Maryland Herpetofauna Leaflets and these are available at $.25/page.

Information for Authors

All correspondence should be addressed to the Executive Editor. Manuscripts being submitted for publication should be typewritten (double spaced) on good quality 8 1/2 by 11 inch paper with adequate margins. Submit original and first carbon, retaining the second carbon. If entered on a word processor, also submit diskette and note word processor and operating system used. Indicate where illustrations or photographs are to appear in text. Cite all literature used at end in alphabetical order by author.

Major papers are those over 5 pages (double spaced, elite type) and must include an abstract. The authors name should be centered under the title, and the address is to follow the Literature Cited. Minor papers are those papers with fewer than 5 pages. Author's name is to be placed at end of paper (see recent issue). For additional information see *Style Manual for Biological Journals* (1964), American Institute of Biological Sciences, 3900 Wisconsin Avenue, N.W., Washington, D.C. 20016.

Reprints are available at $.03 a page and should be ordered when manuscripts are submitted or when proofs are returned. Minimum order is 100 reprints. Either edited manuscript or proof will be returned to author for approval or correction. The author will be responsible for all corrections to proof, and must return proof preferably within 7 days.

The Maryland Herpetological Society
Department of Herpetology
Natural History Society of Maryland, Inc.
2643 North Charles Street
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Herpetological
Society

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BULLETIN OF THE

Maryland Herpetological Society

DEPARTMENT OF HERPETOLOGY

THE NATURAL HISTORY SOCIETY OF MARYLAND, INC.

MdHS............A FOUNDER MEMBER OF THE
EASTERN SEABOARD HERPETOLOGICAL LEAGUE

SEPTEMBER 1988

VOLUME 24 NUMBER 3

BULLETIN OF THE MARYLAND HERPETOLOGICAL SOCIETY

Volume 24 Number 3 September 1988

CONTENTS

The Maryland Herpetological Society
Department of Herpetology
Natural History Society of Maryland, Inc.
2643 North Charles Street
Baltimore, Maryland 21218

BULLETIN OF THE mdhs

Volume 24 Number 3 September 1988

The Maryland Herpetological Society
Department of Herpetology, Natural History Society of Maryland, Inc.

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Membership Rates

Membership in the Maryland Herpetological Society is $16.00 per year. Foreign $20.00/year. Make all checks payable to the Natural History Society of Maryland, Inc.

Meetings

The third Wednesday of each month, 8:15 p.m. at the Natural History Society of Maryland (except May—August, third Saturday of each month, 8:00 a.m.). The Department of Herpetology meets informally on all other Wednesday evenings at the NHSM at 8:00 p.m.

DESCRIPTION OF THE TADPOLE OF *COLOSTETHUS MAYORGAI* (ANURA: DENDROBATIDAE) WITH PRELIMINARY DATA ON THE REPRODUCTIVE BIOLOGY OF THE SPECIES.

Enrique La Marca and Abraham Mijares U.

Colostethus mayorgai Rivero is a dendrobatid frog inhabiting mountain streams along the road Mérida–La Azulita (NW the city of Mérida, Venezuela), from 1700 to 2400 m. The species has been assigned to one of the two only recognized species group in the genus *Colostethus*, namely the *C. alboguttatus* Group (La Marca, 1985b). Of the eight taxa recognized in this monophyletic assemblage, larvae have only been described for *C. haydeeae* Rivero, *C. leopardalis* Rivero, *C. molinarii* La Marca, and *C. orostoma* Rivero. La Marca (1985a) mentioned that the tadpoles described by Rivero (1976) as *C. orostoma* are those to *Hyla platydactyla* Boulenger. The tadpoles described by Rivero (1976) as *C. haydeeae* also seems to belong to this latter hylid frog rather than to a dendrobatid one. No description has been made of the larvae of *C. mayorgai*, the only larval characteristic known for this species being a mentioning of the tooth row formula by Rivero (1978). Since the tooth row formula of *C. mayorgai* does not differentiate the tadpole of this species from other taxa in the group, we provide a more adequate description of the larvae. The examination of metamorphosed specimens allowed us to gather some preliminary data on the reproductive biology of the species. Specimens are deposited in the Colección de Vertebrados de la Universidad de Los Andes, Mérida, Venezuela (CVULA–IV); Museo de Ciencias Naturales de Guanare, Venezuela (MCNG), Museum of Natural History of the University of Kansas (KU), and Universidad de Puerto Rico at Mayaguez (UPR–M).

DESCRIPTION OF THE TADPOLE

Body Morphology

The following description is based on CVULA 4631, 3 back riding tadpoles of *Colostethus mayorgai* in Stage 25 of Gosner (1960).

Body oval in dorsal view, depressed (wider than deep), deepest and widest at about two thirds length of body; body length about 34% of the total length; snout oval in dorsal view; eyes dorsolateral, directed laterally;

nostrils dorsolateral, directed anterolaterally, closer to eyes (about 28.5% distance from eye) than to tip of snout (in CVULA IV–4630, a back riding tadpole raised in Lab from Stage 25 to Stage 36, this distance is about 40%); internostril distance about same than interorbital distance (2/3 of interorbital distance in CVULA IV–4630); chondrocranial elements visible through skin of head; spiracle sinistral, inconspicuous, formed by a short fold (no free tube visible); spiracular opening directed posterolaterally at about midlength of body and about 40% distance from venter to dorsum; cloacal tube constituted by a short (about 1 mm) fold of the ventral fin, opening dextrally; dorsal fin arising at body–tail juncture; caudal fins equal in depth at about three fifths of tail; fins shallower than tail musculature; caudal musculature relatively slender, tapering gradually to point just short of tip of tail; tip of tail rounded (Fig. 1).

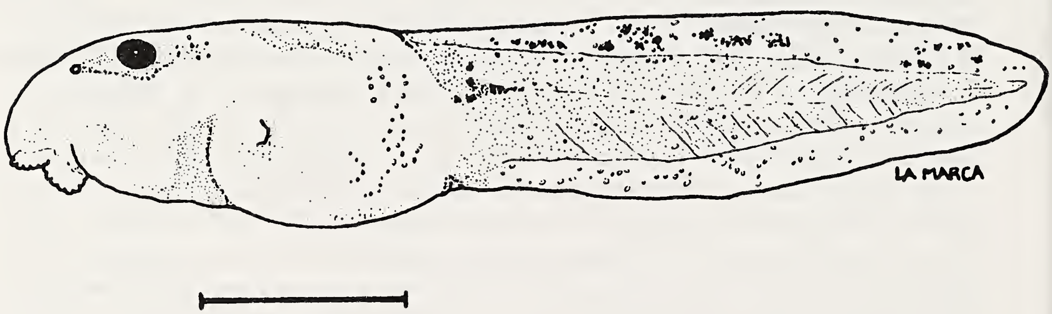

Fig. 1 Lateral view of a free–swimming tadpole in lot KU 167808 in Stage 30. This larva agrees in body and oral morphology with back–riding tadpoles of *Colostethus mayorgai* and tadpole CVULA IV–4630 (back–riding tadpole raised in lab to stage 36). Line = 5mm.

Oral Morphology

The following description is based on CVULA–IV 4630, a back riding tadpole raised in the lab from Stage 25 to Stage 36. We preferred to use this tadpole instead of those in Stage 25 because lower stages of development usually do not have well developed oral structures.

Mouth relatively small (about 28% maximum width of body), ventral, directed anteroventrally; mouth with weak lateral folds; a single row of alternate papillae bordering lips, except on anterior diastema of upper lip; beaks not completely keratinized; upper beak broadly arched, convex in anteromedial part; lower beak broadly V–shaped, with larger serrations than upper beak; blunt serrations on both beaks (serrations inconspicuous in Stage 25); two upper and three lower tooth rows; upper rows of about same length, slightly arched outward medially; A–1 not interrupted; A–2 interrupted medially (medial gap about 1/6 of total row length); rows on posterior labium not interrupted, slightly shorter than those on anterior labium; tooth on P–3 smaller and less keratinized than those of other rows; largest tooth on P–1 (Fig. 2).

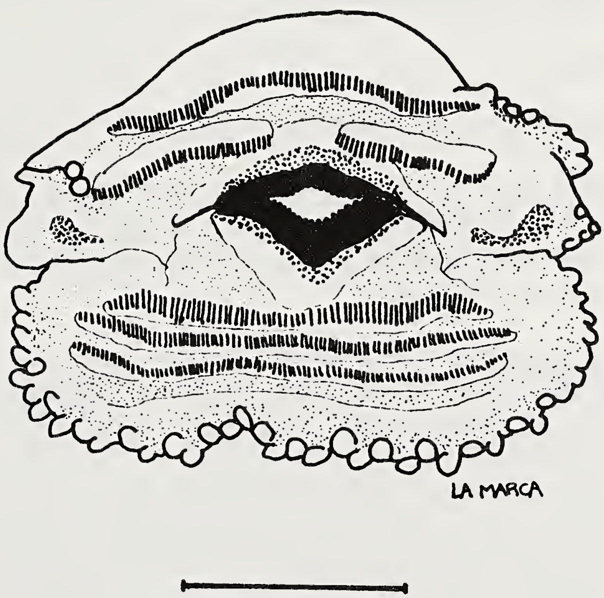

Fig. 2 Mouth of a tadpole in Stage 36 (CVULA IV–4630). This was a back riding tadpole carried by a male *Colostethus mayorgai* (CVULA IV–4628) and posteriorly reared in the lab. Line = 1mm.

Coloration in Life

The coloration in life was recorded from specimen CVULA IV–4630, as follows. Dorsum brown with grayish hues, with numerous small white and yellow stippling; bluish gray hues on flanks; dorsal fin with numerous melanophores; ventral fin with few melanophores albeit with numerous iridophores throughout the fin; caudal musculature with a large concentration of brown mottling on anterior third of tail; brown markings becoming less numerous toward end of tail; venter whitish, semitransparent (heart, intestines and oral musculature, visible).

Coloration in Preservative

The following coloration in preservative was taken from the available larvae in Stage 25 (Appendix I). Body brown above, with anterior part of head paler than dorsum; venter dirty cream, flecked with brown (especially toward flanks); caudal musculature cream, with numerous irregular brown spots; dorsal fin translucent, with brown pale spots; ventral fin translucent, colorless or bearing brown flecks (Fig. 1).

MEASUREMENTS

Table 1 shows some meristic values for tadpoles of *Colostethus mayorgai.*

Table 1. Measurements in mm for selected back riding tadpoles of *Colostethus mayorgai* in different stages of larval development. Values for tadpoles in Stage 25 are means followed by a range given within parentheses.

CHARACTERS	**STAGES**	
	25 (*n*=3)	36 (*n*=1)[1]
Total Length	15.4 (14.2–16.0)	32.0
Body Length	5.1 (5.0–5.1)	11.0
Internarial Distance	1.0	2.0
Interorbital Distance	0.9 (0.8–1.0)	3.0
Eye–naris Distance	0.4 (0.2–0.5)	1.0
Tip of snout–eye Distance	1.4 (1.3–1.5)	2.5
Dorsal Caudal Fin Height	0.5 (0.1–0.9)	1.5
Caudal Musculature Height	1.5	2.5

[1] Back riding tadpole (CVULA IV–4630) raised in lab from Stage 25

REPRODUCTIVE BIOLOGY

Parental care in Colostethus mayorgai consists of transportation of tadpoles by males. Rivero (1978) reported that 10 tadpoles of about 12 mm in total length were carried by the holotype. Although these larvae were not examined, their reported sizes suggest they probably were in Stage 25. We have examine four additional cases in which male *Colostethus mayorgai* carried larvae in Stage 25 on their dorsa: KU 132931, with 11 larvae (KU 139459); MCNG 705 (Fig. 3), carrying 10 tadpoles (MCNG 706); CVULA IV–4628, with 2 tadpoles (CVULA IV–4629 and 4630); and another male, not preserved, transporting three larvae (CVULA 4631). The four males had enlarged testes (from 1.0 to 1.4 mm in diameter), vocal slits, and usually a darkened venter (characters that indicate they were sexually mature). Males carrying tadpoles had SVL's ranging from 21.7 to 27.0 mm. Gonads of 29 specimens (13 males and 16 females) were examined to assess sexual maturity. The data suggest that maturity in males occurs at or near a SVL of 21.7 mm. Female frogs reach sexual maturity (the latter evidenced by presence of deeply convoluted oviducts and/or large ova) at a minimum size of 21.9 mm. These close values for minimum size in mature males and females is not surprising if we take into consideration the mean values for adult frogs [♂♂: $\bar{x}$: 23.6 ± 1.4 mm (1 SD) (range 21.7–27.0 mm; *n*= 11); ♀♀: $\bar{x}$: 25.7 ± 2.0 mm (range: 21.9–28.0 mm; *n*= 13)].

Fig. 3 Male *Colostethus mayorgai* (MCNG 705) carrying 10 tadpoles (MCNG 706) on dorsum. From a color slide by Pascual Soriano.

Clutch size is unknown for the species. An eviscerated female (KU 132928, 28 mm SVL) had some eggs remaining, measuring 2.2 mm in diameter. This size of ova is probably close to the maximum size attained by eggs at the time of deposition. In *Colostethus trinitatis* the egg diameter has been reported to be 3.5 mm (Kenny, 1969), and among other dendrobatids the ovum diameter may be even smaller, e.g., 2.0 mm in *Dendrobates femoralis, D. silverstonei, Phyllobates terribilis*, and *P. vittatus* (Polder, 1976; Myers and Daly, 1979; Myers et al., 1978; Silverstone, 1976).

Territorial behavior has never been studied in *C. mayorgai*. Since only males of this species are known to transport larvae, females, rather than males, may be the ones who perform the task of territorial defense. Wells (1980, 1981) noted that it is unlikely that a frog carrying tadpoles can defend a territory.

COMPARISONS

The tadpole of *Colostethus mayorgai* can be distinguished from the known larvae of other species in the *C. alboguttatus* Group by the spiracular opening directed dorsolaterally (dorsoposteriorly in *C. leopardalis* and *C. molinarii*). Furthermore, it can be distinguished from the tadpole of *C. leopardalis* by the following characteristics (data for *C. leopardalis* taken from Rivero, 1978, and given within parentheses); 1) caudal fins shallower than caudal musculature (caudal fins higher); 2) marginal papillae in a single row (two rows of papillae). The larvae of C. *mayorgai* can further be differentiated from those of *C. molinarii* (character of this later species in parentheses) by 1) nostrils closer to eyes (at about equal distance from eye and tip of snout); 2) spiracular opening consisting of a short fold not forming a tube (forming a short tube); 3) larger and fewer marginal papillae (smaller and numerous papillae); 4) medial gap in denticle row 2A about 1/6 total row length (nearly in touch).

The following key is provided to facilitate identification of known tadpoles of Venezuelan *Colostethus* (data for *C. collaris, C. herminae, C. riveroi* and *C. neblina* taken from La Marca, 1984; data for *C. trinitatis* taken from Kenny, 1969; data for *C. leopardalis* from Rivero, 1976; and that of *C. molinarii* from La Marca, 1985b):

1) a. Caudal fins shallower than caudal musculature 2

b. Caudal fins deeper than caudal musculature ....*leopardalis*

2) a. Spiracular opening directed dorsolaterally 3

b. Spiracular opening directed dorsoposteriorly 5

3) a. Caudal fins arise at body–tail juncture 4

b. Caudal fins arise on tail .... *trinitatis*

4) a. Spiracule forming a short free tube .... *molinarii*

b. Spiracule not forming a short free tube .... *collaris*

5) a. Marginal papillae in a single row 6

b. Marginal papillae in two rows .... *herminae*

6) a. Denticle row P–1 entire 7

b. Denticle row P–1 with a medial gap .... *riveroi*

7) a. Large papillae on lips .... *neblina*

b. Medium–sized papillae on lips .... *mayorgai*

REMARKS

Specimens of *Colostethus mayorgai* were sympatric and syntopic with *C. meridensis* at El Chorotal, Estado Mérida. Tadpoles of this later species have not been collected yet. No other *Colostethus* are known to be syntopic with *C. mayorgai.* The only other herp species we found at El Chorotal was the colubrid snake *Liophis epinephelus opisthotaenia* Boulenger. Although we did not see actual predation, the feeding habits reported by La Marca and García (1987) for this snake suggest that it could be a possible predator of frogs and tadpoles of *C. mayorgai* and *C. meridensis.* Males of *C. mayorgai* carrying tadpoles on dorsa were collected by us in lentic waters with abundant decaying leaves. Other males and females specimens were taken under rocks and along streams at El Chorotal, Bosque de San Eusebio, Quebrada Las González and near El Joque, Estado Mérida.

SPECIMENS EXAMINED

Note: All specimens from Estado Mérida, Venezuela.

Colostethus mayorgai

(Larvae)

KU 139459 (11), 139460 (1 + 3 newly metamorphosed young); 139462 (11), 15–20 Km NW Mérida, on road to La Azulita, about 1700 m.; KU 167808 (7), San Eusebio, 21 Km SE La Azulita, 2100 m.; MCNG 706 (10), La Carbonera, Bosque de San Eusebio, 2400 m.; CVULA IV–4629 (1), 4630 (1) reared in lab from stage 25 to 36, 4631 (3), El Chorotal, 16 Km SE La Azulita, 2100 m.

(Juvenile and Adult Frogs)

CVULA IV–4628, El Chorotal, 16 Km SE La Azulita, 2100 m.; MCNG 702–704, El Chorotal, 16 Km SE La Azulita, 2025 m.; 705, La Carbonera, Bosque de San Eusebio, 2400 m.; KU 132922–132937, 15–20 Km NW Mérida, road to La Azulita, 1700–1900 m.; 132938–132941, 32 km NW Mérida, on road to La Azulita, 2010 m.; 167272, San Eusebio, 21 Km SE La Azulita, 2100 m.; UPR–M 5160, Holotype of *Colostethus mayorgai*, El Chorotal (El Sineral), Carr. Mérida–La Azulita, 1800 m.

ACKNOWLEDGEMENTS

We thank Juan Elías García Pérez, Oscar Alirio Vielma and Toni Enrique Vielma for assistance in the field; and Professor Pascual Soriano for provision of working space at the Universidad de Los Andes. Soriano also generously provided a color slide used in Figure 3. The senior author appreciates the cooperation of Dr. William E. Duellman and Dr. J. T. Collins (KU), and Dr. J. D. Lynch (Univ. Nebraska) for loaning of *Colostethus* material under his care.

ABSTRACT

The tadpole of the Neotropical dendrobatid frog *Colostethus mayorgai* Rivero is described on the basis of larvae carried on top of adult males. The tadpole is distinguished from other members of the *C.*

alboguttatus Group (La Marca, 1985b) by the form and direction of the spiracular opening, position of the nostrils, number of papillae rows, size and quantity of marginal papillae on labia, length of medial gap on denticle row 2A and height of caudal fins. A key is provided to identify known tadpoles of Venezuelan *Colostethus*. Preliminary data on the reproductive biology of *C. mayorgai* is advanced.

RESUMEN

Se describe el renacuajo de la rana *Colostethus mayorgai* sobre la base de larvas transportadas en el dorso de machos adultos de la especie. El renacuajo se distingue de otros miembros del Grupo de *Colostethus alboguttatus* (cf. La Marca, 1985b) por la forma y dirección de la abertura espiracular, la posición de las narinas, el número de hileras de papilas labiales, tamaño y cantidad de papilas marginales, longitud de la diastema central en la fila de denticulos 2A y la altura de las aletas caudales. Se provee una clave para identificar los renacuajos conocidos de especies venezolanas de *Colostethus*. Se reportan datos preliminares sobre la biologia reproductiva de *Colostethus mayorgai*.

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SURVEY OF THE REPTILIAN FAUNA OF THE KINGDOM OF SAUDI ARABIA. II. THE LIZARD AND AMPHISBAENIAN FAUNA OF RIYADH PROVINCE

Mohamed K. AL—Sadoon

Abstract

The lizard and Amphisbaenian fauna inhabiting Riyadh Province of the Kingdom of Saudi Arabia has been investigated through the collection and subsequent identification of 455 specimens from various localities in the province. Twenty six species belonging to five families: Agamidae, Gekkonidae, Lacertidae, Scincidae and Varanidae were recorded. One species of Amphisbaenian belongs to family Trogonophidae was recorded. *Agama stellio brachydactyla, Chalcides ocellatus, Chalcides levitoni, Diplometopon zarudnyi, Mesalina guttulata, Mesalina brevirostris, Pristurus rupestris* and *Stenodactylus slevini* were reported from Riyadh Province for the first time. The geographical distribution of the collected species within this province and in Saudi Arabia was mapped.

Introduction

The kingdom of Saudi Arabia is a vast and an arid country, about the size of Europe. Not only its geographical location but also the extreme variations in climatic conditions within the same season, that range between icy conditions in the northwestern mountains and rainy ones in southwestern mountains, to almost dry weather in the south and southeast and heavily cultivated areas in the northeast make the country a unique one in supporting a rich and diversified fauna. Small collections of reptiles and amphibian have been made by several authors from various regions of Saudi Arabia such as Southern Hijaz (Parker, 1933; 1938). Eastern Region (Mandaville, 1965), Northeastern Region (Mandaville, 1967), Central Region (Schmidt, 1941; El-Wailly and AL-Uthman, 1971) and Riyadh Region (Hussein, 1966). Moreover, some other collections have also been made from different localities by some authors such as Hass (1957, 1961), Hass and Battersby (1959), Gasperetti (1974, 1976, 1977, 1988), Farag and Banaja

(1980) and Al-Sadoon (1988) and recently Arnold (1987) has published an annotated check-list of the lizards and Amphisbaenians of the Arabian Peninsula.

The present study is the second in a series of surveys of the reptilian fauna of Saudi Arabia and deals with the lizards and Amphisbaenians of Riyadh Province.

Materials and Methods

Field trips were carried out to different locations in Riyadh Province between 1983 and 1988. Most of the areas were visited at all seasons in order to sample the fauna under various weather conditions. In general the most favorable time for collection was between March and July, when the environmental conditions were most suitable for the presence of these animals. The collection techniques were generally based on searching the area on foot for these animals. Most of the animals were collected between dawn and mid-morning, or shortly before sunset. Live animals were kept in the Animal Facility of the Zoology Department. All lizards were maintained in large glass cages measuring 100x50x45 cm each of which contained a substratum of sand; vegetation and stones were added to the sand to simulate the animals' natural habitat. Water was provided *ad lib.* and the lizards were fed on insects, mealworm and cat food. Illumination was provided for 9 hrs daily with a 100 W lamp above the cages. Lizards were identified by the author and the identifications were confirmed by Dr. E. N. Arnold, Department of Zoology, British Museum (Natural History) and by Mr. John Gasperetti of the California Academy of Sciences.

Geographical and Climatological Aspects

Riyadh Province occupies the centre of Najd plateau, lying between approximately 18° and 28° 50' N and 41° and 48° 50' E. The altitude is 3500 feet above sea level on the west, degrading to 1500 feet on the east coast. The Sarawat Mountain Range borders the western region and gradual degradation of the altitude passes through rocky mountains and sandy areas including Jabal Kuff, Jabal Burqah and Jabal Dhahlan. In addition to the rocky prairies, there are some oases and cultivated areas. Sand dunes like those of Nufud Al-Sirr extends northwards up to 24th latitude, for 270 kilometers, and a width of 20-25 kilometers. Southwards, Nufud Al-Dahi extends for 300 km parallel to western Tuwaiq. Tuwaiq escarpment is a physical barrier in the study area dividing it into eastern and western section. It extends for 800 km as a curve which is bisected by latitude 24°N. Beyond those rocky areas, there is a prairie landscape which is 1800 feet above sea level and is intersected by many valleys and oases. Al–Dahna sandy prairie is a collection of sand dunes separated by low rocky serials which connect the large northern Nufud with Al–Rub Al–Khali in the south and extends for 1300 km in length and 40–80 km in width (Fig. 1).

Riyadh Province has a continental weather that is extremely hot in summer and cold in winter. The temperature ranges from a maximum of approximately 49°C in mid–summer to below freezing temperatures, in winter. Average rainfall is 25 cm that falls mainly between December and May. The relative humidity ranges from 15% to 20%, but may rise up to 71% during June and February.

Systematic Account

Order Squamata

Sub–order Sauria

Twenty five lizard species, belonging to five families were collected from the various locations sampled in Riyadh Province and their geographical distribution within this province was mapped.

Family Agamidae

This family is represented by eight species:

Agama (Trapelus) blanfordi fieldi (Hass & Werner, 1969)

Ten specimens were collected from rock slopes of Al–Riyadh, Al–Majmaáh, Al–Zilfi, Al–Thimamah, Al–Diriyah, Laila, Thadiq, Al–Kharj and Ushayrah (Fig. 1). The distribution of this striped agama extends throughout Kuwait, Iraq, and Jordan (Arnold, 1987). In Saudi Arabia, it has been reported from the Northern Region.

Agama (Trapelus) flavimaculata (Ruppell, 1835)

Three specimens were collected from shrubs in the desert area of Al-Thimamah, Al-Birk and Al-Diriyah (Fig. 1). The largest was about 24.7 cm in length. This yellow spotted agama has a range of distribution extending throughout Egypt and western Arabia (Pasteur & Bons, 1960). In Saudi Arabia it has been reported from Ummluj, Yanbu and Al-Biar (Farag & Banaja, 1980).

Agama (Stellio) stellio brachydactyla (Hass, 1951)

Three specimens were collected for the first time from escarpment places near Al-Majmaáh and Al-Ghat (Fig. 1). The largest was about 27 cm in length. This agama has a range of distribution extending from Palestine to Egypt (Arnold, 1987). In Saudi Arabia, it has been recorded from Hail (Al-Sadoon, unpublished data) and from Mount Arafat in Hejaz (Anderson, 1896).

Agama (Pseduotrapelus) sinaita (Heyden, 1827)

Ten specimens were collected from rocky wadies and escarpment places in Al-Riyadh, Al-Diriyah, Al-Majmaáh, Sadus, Al-Hawtah, Al-Quwayiyah, Al-Hair and Al-Birk (Fig. 1). The largest specimen was about 22.4 cm in length. This desert rock agama is distributed throughout northeast Africa, Jordan, Palestine and Syria (Werner, 1971). It is widespread in Arabia but is absent from Rub-al-Khali (Arnold, 1987). In Saudi Arabia, it has been reported from Al-Taif and Baljarshi (Farag & Banaja, 1980).

Agama (Trapelus) pallida hassi (Werner, 1971)

Three specimens were collected from Sadus and 50 km east of Al-Riyadh (Fig. 1). It was found in open habitat in desert area with scattered bushes. The largest specimen was about 19 cm in length. This pale agama extends throughout Jordan, Iraq and Kuwait (Arnold, 1987). It has been reported from northern Saudi Arabia (Arnold, 1987) and from Buraydah (Al-Sadoon, unpublished data).

Phymocephalus arabicus (Anderson, 1894)

Thirty specimens were collected from sand dunes in Al-Zilfi, Al-Thimamah, Al-Muzahimiyah, Nufud Qunayfidhah, Nafud Al-Sirr, Al-Hawtah and Nafud Al-Dahi (Fig. 1). The largest was about 12.8 cm in length. This Toad–headed agama is widely distributed throughout Arabia, except in the Western Region (Arnold, 1987).

Phrynocephalus maculatus (Anderson, 1872)

Two specimens were collected from the steppes of the elevation of Al–Jubaylah and Shaqra (Fig. 1). The largest specimen was about 12 cm in length. It is found in Syria, Iran, Iraq, Afghanistan and Pakistan (Clark *et al.* 1969). It is also widespread in Arabia (Arnold, 1987).

Uromastyx aegyptius microlepsis (Blanford, 1874)

Forty specimens were collected from the arid regions of Al–Artawiyah, Al–Zilfi, Al–Muzahimiyah, Shagra, Al–Dawadimi, Al–Majmaáh Al–Kharj, Jalajil, Al–Quwayiyah, Laila, Thadiq, Ushayrah and Durma (Fig. 1). The largest specimen was about 68 cm in length. Widely distributed in Arabia, Iraq and Jordan (Arnold, 1987). This spiny–tailed lizard is the commonest lizard in the Central Region.

Family Gekkonidae

This family is represented by seven species.

Bunopus tuberculatus (Blanford, 1874)

Twenty two specimens were collected from Sandy habitats hiding by day under stones, metal sheets and old automobile tyres. In Riyadh Province it was found in Al–Majmaáh, Al–Dawadimi, Al–Hawtah, Ushayrah, Al–Riyadh, Al–Quwayiyah, Al–Muzahimiyah, Rumah, Al–Thimamah, Al–Zilfi, Al–Kharj, Tumair, Khurais, Laila and Al–Diriyah (Fig. 2). The largest specimen was about 9.8 cm in length. This tuberculated sand gecko is widespread in Arabia, Jordan, Palestine, Iraq, Iran, Afghanistan, and Pakistan (Arnold, 1987).

Cyrtodactylus scaber (Heyden, 1827)

Six specimens were collected from sandy ground beneath rocks and on walls or near old buildings from Al–Riyadh, Al–Zilfi, Laila, Al–Kharj and Al–Diriyah (Fig. 2). The largest specimen was about 9.2 cm in length. This keeled rock gecko extends around the Arabian Gulf, North Oman and Aden, Egypt, Sudan, Iraq, Ethiopia, Southern Iran, Afghanistan and Pakistan

(Arnold, 1987). In Saudi Arabia, it has been reported from Madinah, Jiddah, Hadda and Makkah (Farag & Banaja, 1980).

Ptyodactylus hasselquistii hasselquistii (Donndorff, 1798)

Thirty specimens were collected from old buildings, walls, caves, rocky wadi and deserted houses of Laila, Al–Hawtah, Al–Riyadh, Al–Kharj, Al–Quwayiyah, Al–Dawadmi, Sadus, Al–Jubaylah, Rumah, Al–Thimamah, Ushayrah, Al–Majmaáh, Al–Zilfi, Shagra, Al–Hair and Al–Diriyah (Fig. 2). The largest specimen was about 17.5 cm in length. This fan–footed gecko is widespread in Arabia, North Africa, Jordan, Palestine, Syria, Iraq and southwestern Iran (Arnold, 1987). In Saudi Arabia, it has been recorded from Jiddah, Al–Taif and Wadi Fatimah (Farag & Banaja, 1980).

Pristurus rupestris (Blanford, 1874)

Three specimens were collected from mountain areas near Al–Jubaylah and Al–Hawtah (Fig. 2). The largest specimen was about 9.5 cm in length. This semaphore rock gecko is widespread throughout southern Arabia and islands of the Arabian Gulf (Hass & Werner, 1969). The present records are the first reports of this lizard from Riyadh Province.

Stenodactylus slevini (Hass, 1957)

Seven specimens were collected from scrub desert and dunes of Al–Zilfi, Al–Dawadmi, Al–Quwayiyah, Rumah and Al–Kharj (Fig. 2). The largest specimen was about 7.8 cm in length. The slevin's gecko is distributed through North and western Saudi Arabia, Kuwait, southern Iraq, Bahrain, Qatar, Hadhramout and western United Arab Emirates (Arnold, 1987). The present records are the first reports from this province.

Stenodactylus arabicus (Hass, 1957)

Three specimens were collected from sand dunes of Nafud Al–Dahi, Al–Dahna and Al–Zilfi (Fig. 2). The largest specimen was about 7.5 cm in length. This web–footed sand gecko is distributed throughout southern Arabia, southern and central Oman, United Arab Emirates and Hadhramout (Arnold, 1987). In Saudi Arabia, it has been reported from Dhahran and Riyadh area (Arnold, 1987).

Hemidactylus turcicus (Linnaeus, 1758)

Two specimens were collected under stones from Sadus and Al-Zilfi (Fig. 2). The largest specimen was about 6.8 in length. The disc-fringed gecko is found throughout western Saudi Arabia, North and south Yemen, Oman, eastern United Arab Emirates, Iran, Pakistan and the western coast of Red Sea from Egypt to Somalia (Arnold, 1987). In Saudi Arabia, it has been reported from Al-Riyadh (Arnold, 1987).

Family Lacertidae

This family is represented by five species:

Acanthodactylus boskianus (Daudin, 1802)

Forty five specimens were collected from valleys with low shrubs and sparse vegetation of various localities from Al-Zilfi, Al-Artawiyah, Al-Majmaáh, Al-Hawtah, Ushayrah, Thadig, Al-Riyadh, Sadus, Huraymila, Al-Qasab, Al-Dawadmi, Al-Quwayiyah, Al-Rawdah, Al-Kharj, Al-Hariq, Al-Birk, Laila, Al-Thimamah, Rumah, Khurais, Al-Hair and Marah (Fig. 3). The largest specimen was about 27.5 cm in length. The fringed toed lizard is widely distributed in Arabia, North Africa, Jordan, Syria, Iraq, Palestine and Turkey (Arnold, 1987). In Saudi Arabia, it has been recorded from Jiddah and Makkah (Farag & Banaja, 1980), Al-Riyadh, Najran and between Al-Gaisumah and Turaif (El-Waily & Al-Uthman, 1971).

Acanthodactylus schmidti (Hass, 1957)

Sixty five specimens were collected from sand dunes after digging the burrows around low shrubs. In the present study, it was reported from Laila, Al-Sayh, Al-Rawdah, Al-Kharj, Al-Salamiyah, Najan, Al-Thimamah, Rumah, Al-Quwayiyah, Rwayghib, Thadiq, Malham, Al-Tuwaym, Al-Hair, Jalajil, Al-Zilfi, Al-Artawiyah, Ushayrah, Tumair, Shagra, Al-Ruwaydah, Al-Muzahimiyah, Al-Hariq and Sajir (Fig. 3). The largest specimen was about 25.5 cm in length. Widely distributed throughout Arabia, Jordan and southwest Iran (Arnold, 1987). Records of this species are widely distributed throughout Saudi Arabia including Dhahran, Abqaiq, Qatif, North of Tebuk, Wadi Fatimah and the outskirt of Makkah (Farag & Banaja, 1980).

Acanthodactylus opheodurus (Arnold, 1980)

Twenty six specimens were collected from open desert rocky terrain and valleys with low shrubs of different localities of Laila, Al-Birk, Al-Kharj, Al-Riyadh, Al-Thimamah, Al-Dawadmi, Al-Hair, Al-Quwayiyah, Durma, Al-Muzahimiyah, Sadus, Khurais, Tumair, Al-Majmaáh, Rwayghib, Rumah, Al-Zilfi, Ushayrah, Shaqra, Sajir, Al-Artawiyah and Al-Hawtah (Fig. 3).

The largest specimen was about 20.4 cm in length. This striped fringed toed lizard extends throughout Arabia, Jordan, Palestine, and Iraq (Arnold, 1987).

Mesalina guttulata (Lichtenstein, 1823)

The present collections represent the first report of this lizard from Riyadh Province. Ten specimens were collected from semi-arid regions with shrubs and under rocks near Laila, Al-Thimamah, Al-Quwayiyah, Al-Zilfi and Ushayrah (Fig. 3). The largest specimen was about 17.2 cm in length. This short-nosed lizard has been known from North Yemen, western and South Yemen, North Africa, Palestine, Jordan, Iraq and northern and western Saudi Arabia (Arnold, 1987). In Saudi Arabia, it has been reported from Wadi Baish and near Jizan (Farag & Banaja, 1980).

Mesalina brevirostris (Blanford, 1874)

The present specimens are the first report of this lizard from Riyadh Province. Four specimens were collected from vegetated and gravel plains of Al-Zilfi, Al-Quwayiyah, Al-Kharj and Laila (Fig. 3). The largest specimen was about 13.2 cm in length. It is distributed throughout northern Saudi Arabia, Bahrain, Qatar, United Arab Emirates, Kuwait, Iraq, Pakistan and Iran (Arnold, 1987). In Saudi Arabia, it has been reported from Al-Wajh (Farag & Banaja, 1980).

Family Scincidae

This family is represent by five species.

Chalcides ocellatus (Forskal, 1775)

The present record from Al-Zilfi, Al-Riyadh, Al-Kharj, Al-Hawtah, Ushayrah, Al-Diriyah, Laila and Al-Hair are the first ever from this region (Fig. 4). Twenty specimens were collected from cultivated areas, among dead leaves. The largest specimen was about 17.8 cm in length. The ocellated skink is distributed throughout the Mediterranean area: Sicily, Crete, Cyprus, Greece and Sardinia and eastward through Turkey and southwest Asia to Pakistan and southward to North Africa (Welch, 1983). In the Arabian Peninsula, it has been reported from western Saudi Arabia, North Yemen, South Yemen, Oman eastern United Arab Emirates (Arnold, 1987) and Kuwait (Eissa & El-Assy, 1975). In Saudi Arabia, it has previously been reported from Jiddah, Yanbu al Bahr, Rabigh and Abha (Farag & Banaja, 1980) as well as from Unaiyzah (Arnold, 1987).

Chalcides levitoni (Pasteur, 1978)

The present record from Al–Kharj, is the first from Riyadh Province (Fig. 4). Five specimens were found under leaves in a cultivated area. The largest specimen was about 15 cm in length. It differed from the previous skink by its smaller head and limbs and by the ocelli that have been replaced by dull scales (Pasteur, 1978). In Saudi Arabia it has been recorded only from Khasawijah near Jizan, on the southwest coast.

Mabuya brevicollis (Wiegmann, 1837)

Twenty five specimens were collected from irrigated cultivations at Al–Zilfi, Al–Muzahimiyah, Al–Quwayiyah, Al–Hawtah, Al–Riyadh, Al–Hair and Laila (Fig. 4). The largest specimen was about 30.5 cm in length. This red–throated skink extends throughout southwest Arabia and eastern Africa (Welsh, 1983). In Saudi Arabia, it has been reported from Taif to Asir, Buraydah and Al–Riyadh (Arnold, 1987).

Scincus mitranus mitranus (Anderson, 1871)

Thirty two specimens were collected around the slopes of sand dunes of Al–Riyadh, Al–Zilfi, Al–Muzahimiyah, Nufud Al–Dahi, Al–Dahna, Nufud Qunayfidah, Irq Ban Ban and Nufud Al–Sirr (Fig. 4). The largest specimen was about 17.2 cm in length. The Sandfish is widely distributed throughout south and East Arabia (Welch, 1983). In Saudi Arabia, it has been reported from Unayzah, Al–Hassa and northern Saudi Arabia (Arnold, 1987).

Scincus scincus conirostris (Blanford, 1881)

Nine specimen were collected from sand dunes of Al–Thimamah, Nufud Al–Sirr, Nufud Qunayfidah, Al–Zilfi and Nufud Al–Dahi (Fig. 4). The largest specimen was about 16.3 in length. Known throughout southern and eastern Saudi Arabia, Bahrain, Kuwait, eastern United Arab Emirates, South Yemen, south west Iran and Iraq (Arnold, 1987).

Family Varanidae

This family is represented by a single species.

Varanus griseus griseus (Daudin, 1802)

Twenty specimens were collected from hard soils in Al-Zilfi, Rumah, Al-Thimamah, Al-Dawadimi, Al-Artawiyah, Al-Majmaáh, Ushayrah, Al-Riyadh, Al-Quwayiyah, Laila, Sadus, Nufud Qunayfidah and Al-Kharj (Fig. 5). The largest specimen was about 80 cm in length. In Saudi Arabia, it has been reported from Wadi Fatimah (Farag & Banaja, 1980). The desert monitor is widely distributed throughout Arabia, Syria, Lebanon, Palestine, Iraq, Jordan and extends westward to North Africa (Welch, 1983).

Sub-order: Amphisbaenia

One species belongs to one family was recorded in Riyadh Province.

Family Trogonophidae

This family is represented by a single species.

Diplometopon Zarudnyi (Nikolski, 1907)

The present records are the first authentic reports from Riyadh Province. Twenty five specimens of an average length of 21.5 cm were collected from damp soil in date palm gardens from Al-Riyadh, Al-Kharj, Al-Zilfi, Nufud Qunayfidah and Al-Thimamah (Fig. 6). This worm lizard is known to be distributed along the coasts of the Arabian Gulf (Arnold, 1987).

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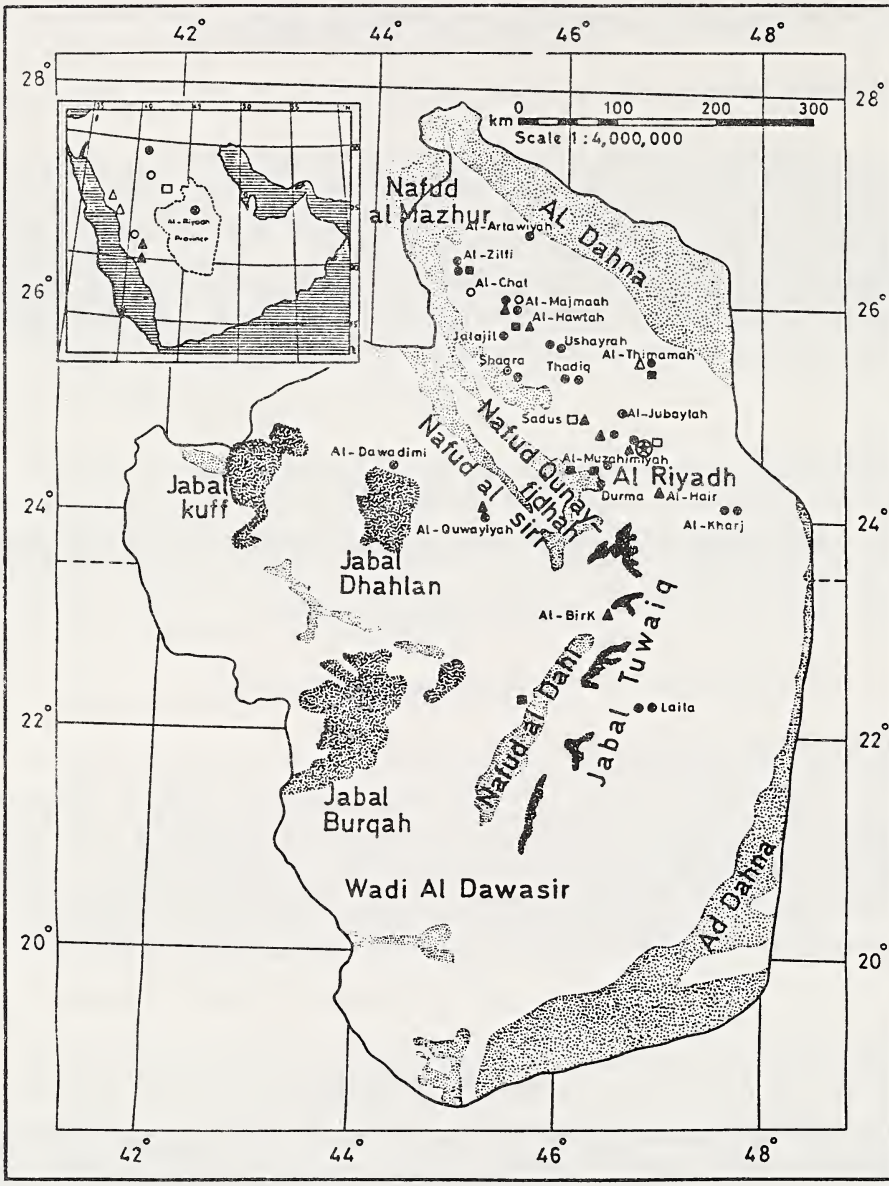

Fig. 1. Map of Riyadh Province showing the distribution of: (•) *A. blanfordi*; (Δ) *A. flavimaculata*; (O) *A. stellio*; (▲) *A. sinaita*; (❑) *A. pallida*; (■) *P. arabicus*; (⊖) *P. maculatus*; (⊗) *U. aegyptius*, including also the records in Saudi Arabia.

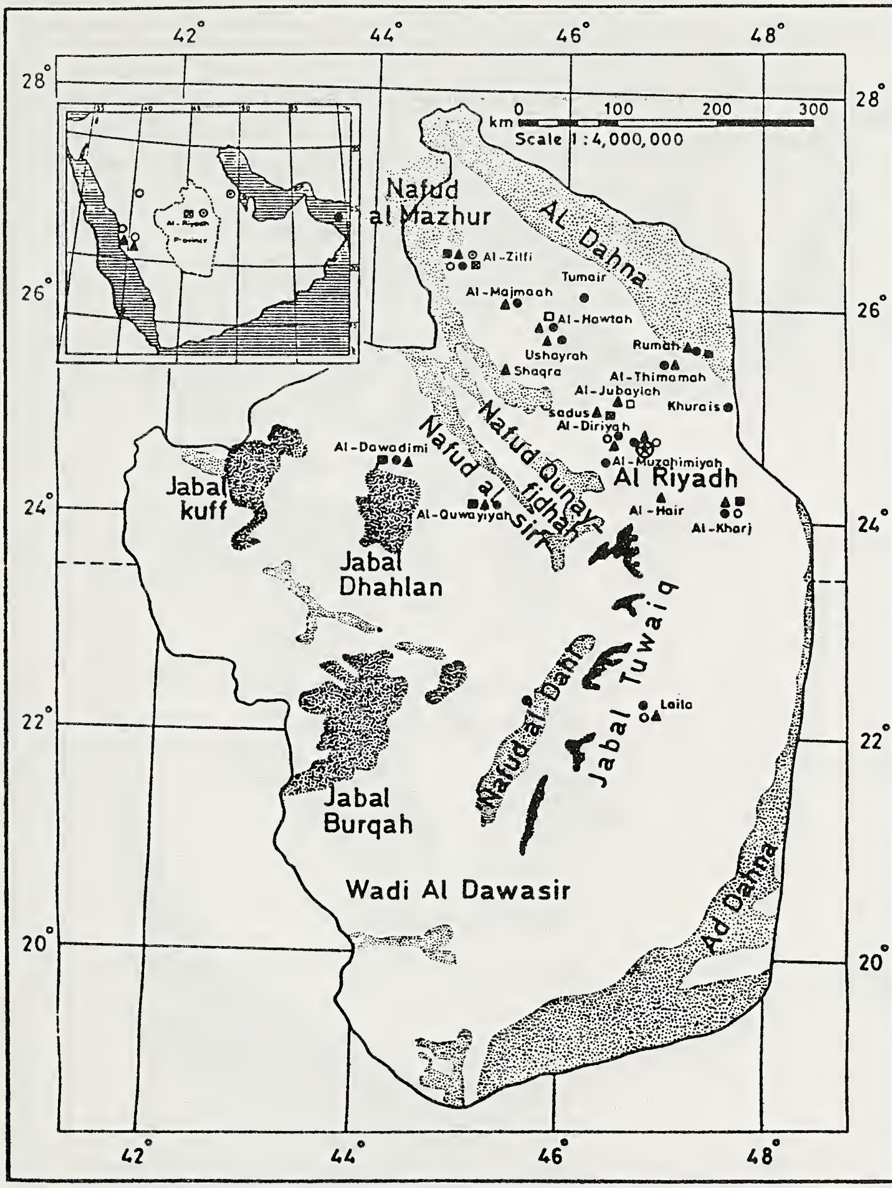

Fig. 2 Map of Riyadh Province showing the distribution of: (•) *B. tuberculatus*; (O) *C. scaber*; (▲) *P. hasselquistii*; (□) *P. rupestris*; (■) *S. slevini*; (ʘ) *S. arabicus*; (☒) *H. turcicus*, including also the records in Saudi Arabia.

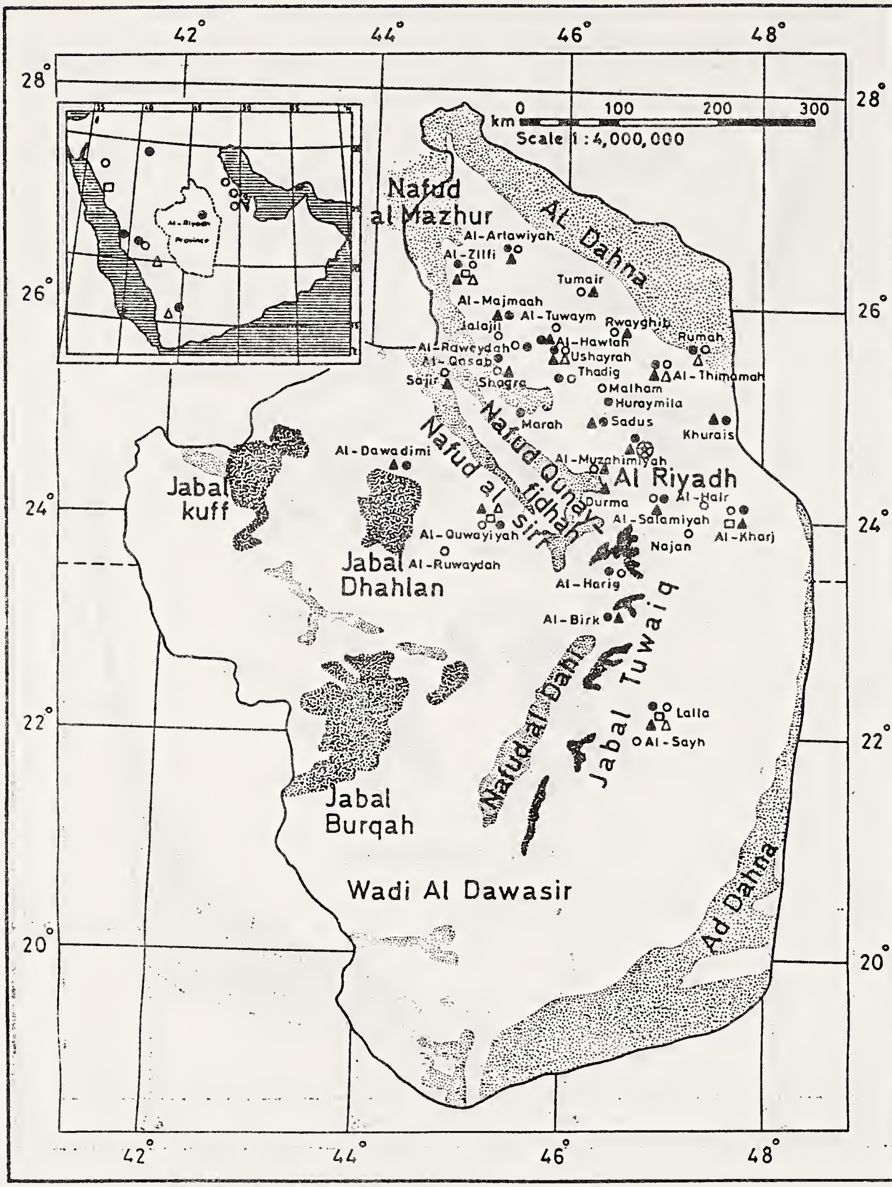

Fig. 3 Map of Riyadh Province showing the distribution of: (•) *A. boskianus*; (O) *A. schmidti*; (▲) *A. opheodurus*; (Δ) *M. guttulata*; (❑) *M. brevirostris*, including also the records in Saudi Arabia.

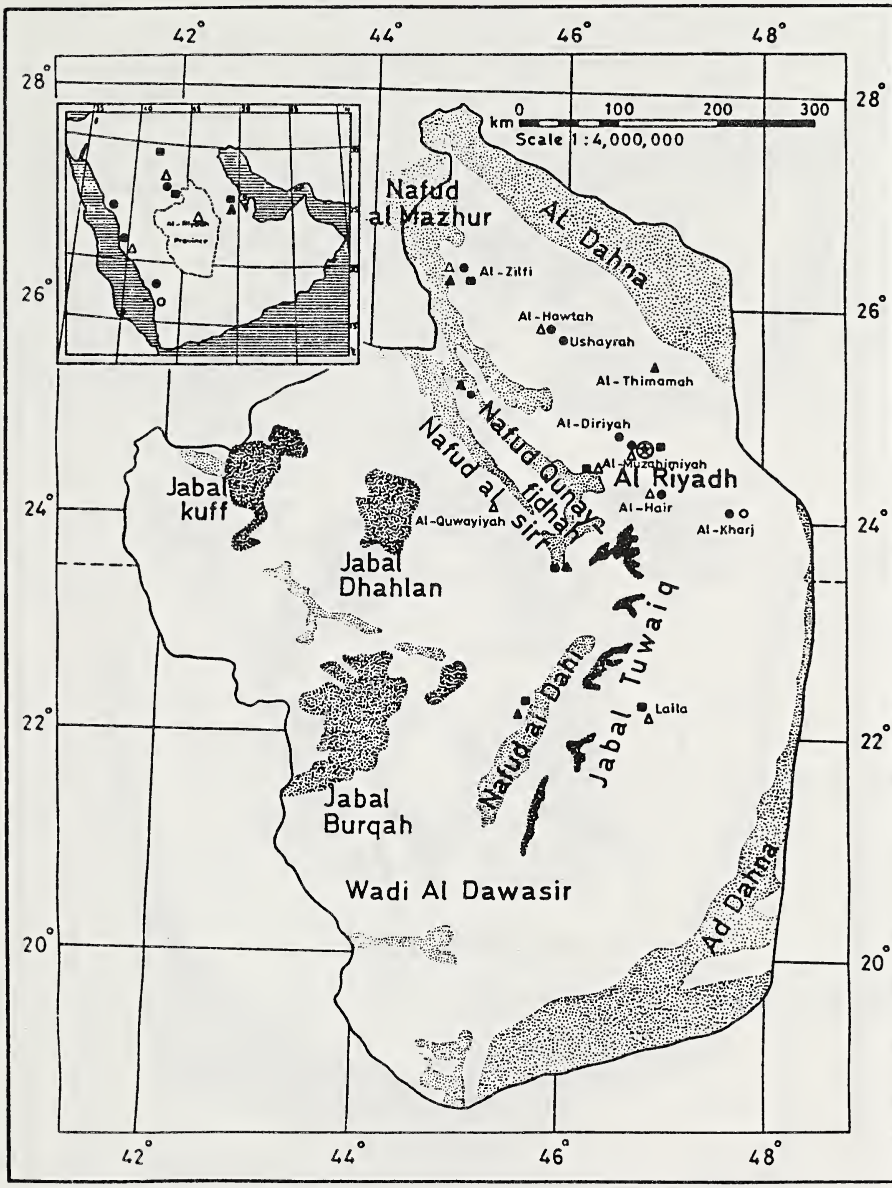

Fig. 4 Map of Riyadh Province showing the distribution of: (•) *C. ocellatus*; (O) *C. levitoni*; (Δ) *M. brevicollis*; (■) *S. S. mitranus*; (▲) *S. S. conirostris* including also the records in Saudi Arabia.

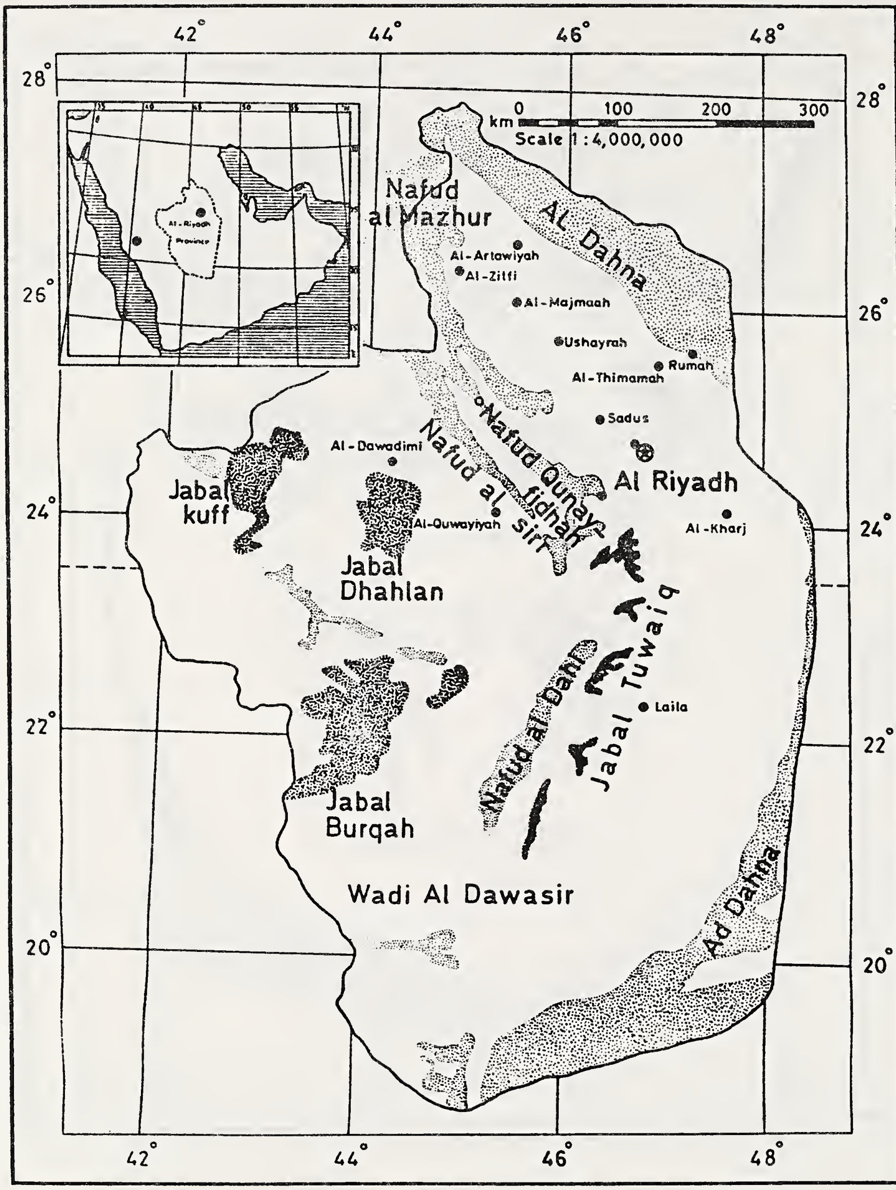

Fig. 5 Map of Riyadh Province showing the distribution of: (•) *V. griseus*, including also the records in Saudi Arabia.

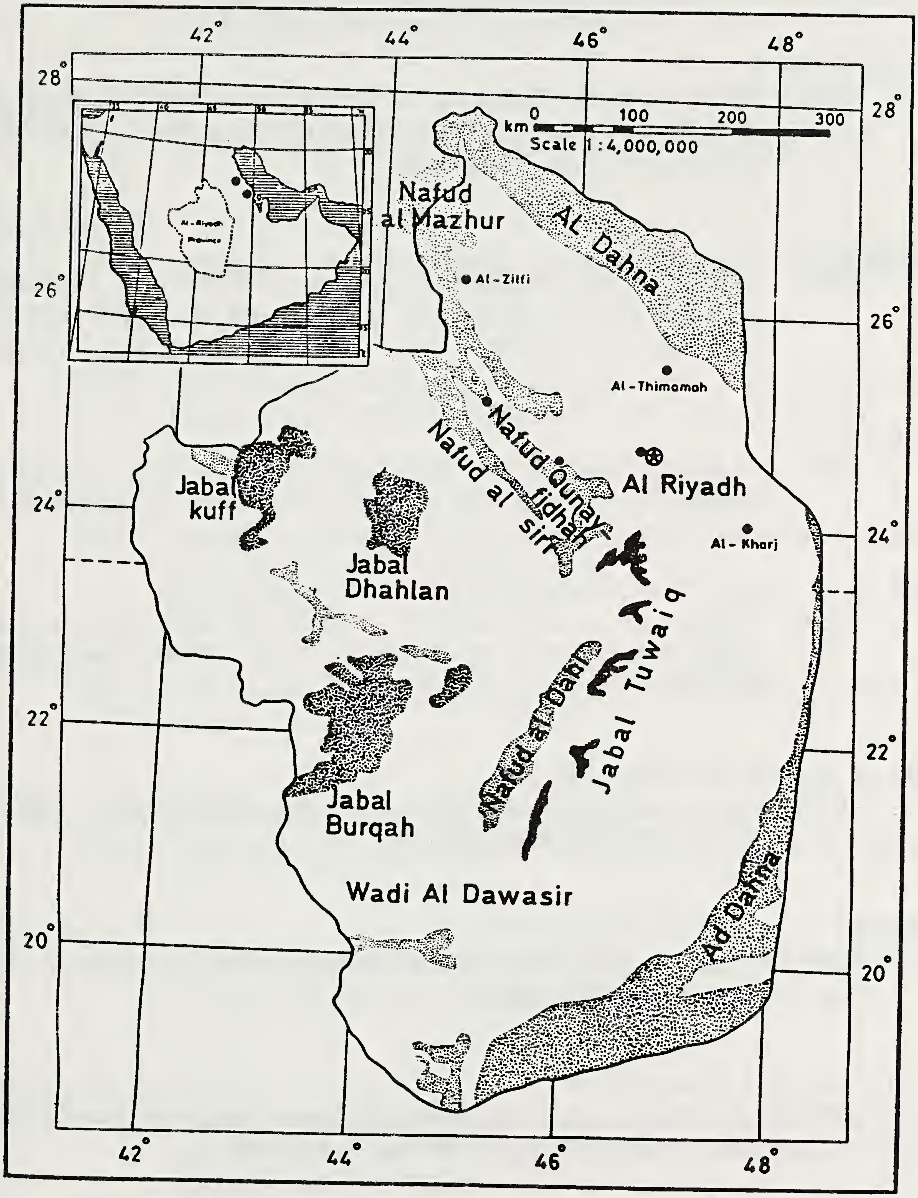

Fig. 6 Map of Riyadh Province showing the distribution of: (•) *D. Zarudnyi*, including also the records in Saudi Arabia.

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THE ROZELLA SMITH FELLOWSHIP FUND

Rozella Pearl Blood Smith, a well known figure among herpetologists, died 15 December 1987, after a protracted illness.

Diversely talented, Rozella Smith was an outstanding expert in many fields of thought and endeavor—she was a most catholic scholar with many skills. Her quick wit, articulate expression, energy and vivacity made memorable every association with her. In every way she was a very special person.

Rozella Smith's manual dexterity and logical, mathematical mind were phenomenal, and were applied in many ways. Although her direct and indirect contributions to knowledge were many, through numerous associates, certainly her greatest impact was upon herpetology, in which field she contributed some 72 articles and books (see the Great Basin Naturalist, 1988, 48: 180–187); others are in press or in final stages of preparation.

Dr. Smith (she received an honorary D.Sc. degree from the University of Colorado in 1982) developed probably the most effective data-retrieval system ever utilized in herpetology or related fields, and applied it with great originality, enthusiasm, and energy to the massive files accumulated by her husband on the herpetofauna of Mexico. Only through her diligent and innovative manipulation of some 150,000 basic index cards derived from about 11,000–12,000 works were the six volumes of the Synopsis of the Herpetofauna of Mexico produced from 1971–1980. In that process she prepared literally millions of punch cards; many analyses were never published or used. Her system was applied in a few other contexts, but its full potential was never realized because her deteriorating health coincided with the demise of punch cards, which were the primary vehicle for her system.

Rozella was probably handicapped during her life, in realization of and recognition for her capabilities, through the same social structure that limits many talented women. Therefore, a unique and perpetual academic memorial to Rozella Smith has been established at the University of Colorado. This memorial, which consists of a named graduate fellowship, will be administered by the University of Colorado. In harmony with Rozella Smith's own principles and achievements, this Fellowship will be dedicated to academic excellence. Commitment of institutional and private funds has already been substantial, and promises to make the Rozella Smith Fund the largest and most prestigious of endowments in environmental biology at the University of Colorado.

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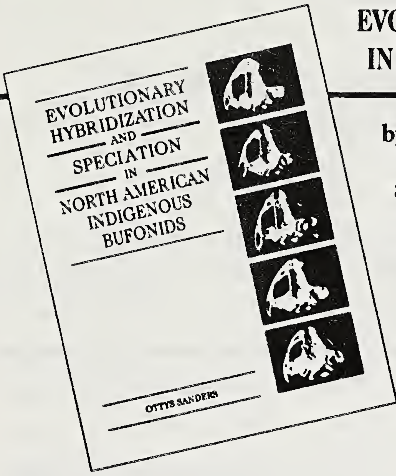

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by Ottys Sanders

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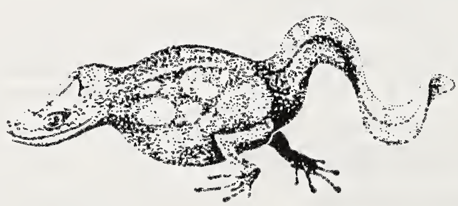

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Richard S. Funk, D.V.M., of the College of Veterinary Medicine, University of Tennessee.

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The registration fee is $20. This includes admission to a Friday evening ice-breaker and to the Saturday conference. Please use the attached form and mail in your registration as soon as possible. Although we are not charging extra for late registration, we need to know how many are coming and we need the money to cover deposits.

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Registration will begin at 5:00 P.M. on Friday evening and will continue throughout the ice-breaker, which will begin at 6:00 P.M. Registration will also be possible starting at 8:00 A.M. Saturday. The conference proper will run from 9:00 A.M. through 5:00 P.M. Saturday. You will be on your own for lunch Saturday.

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DEPARTMENT OF HERPETOLOGY

THE NATURAL HISTORY SOCIETY OF MARYLAND, INC.

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DECEMBER 1988

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Volume 24 Number 4 December 1988

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A COMPARATIVE STUDY ON THE METABOLIC RATES OF FIVE SPECIES OF LIZARDS BELONGING TO THREE DIFFERENT FAMILIES

M. K. Al-Sadoon & N. M. Abdo

The metabolic rate–temperature curves of various lizards belonging to three families: Agamidae; Scincidae and Chamaeleonidae were examined in relation to ambient temperatures. A double chamber volumetric closed system was used to measure the resting oxygen consumption of the lizards.

A direct correlation between the M–T curves, the method of thermoregulation and the behavior of the lizards in their specific habitats were observed and discussed.

Introduction

Terminologies classifying reptiles according to their methods of thermoregulation has been debated by many workers (Al-Sadoon and Spellerberg, 1985; Campbell, 1985). Several studies have been undertaken to determine the physiological responses of lizards to temperature (Dawson and Templeton, 1963; Licht *et al.*, 1966 and Al-Sadoon, 1986). The rate of oxygen consumption in most ectothermic animals increases with increasing temperature, in a manner according to the Vant Hoof's generalization (Gordon *et al.*, 1982). However, the relationship between the oxygen consumption rate and temperature may not always be of a linear nature (Al-Sadoon and Spellerberg, 1985). Recent research suggests that some species of reptiles have some control over their oxygen consumption within their voluntary body temperature range, (Al-Sadoon, 1983; Al-Sadoon and Spellerberg, 1985 and Al-Sadoon, 1986). A close relationship has also been determined between the characteristics of the acute metabolic rate–temperature curves, the method of thermoregulation and the ecology of some desert species of lizards (Al-Sadoon 1983, 1986, 1988). The aim of the present study is to examine the M–T curves of various species of lizards belonging to three different families from two climatic regions of Saudi Arabia in order to assess the ecological implications of the various characteristics of these curves.

Materials and Methods

The lizards used in the present study were three species of the family Agamidae and a single species each of the families Scincidae and Chamaeleonidae. The Agamidae species were the toad-headed agama, *Phrynocephalus arabicus* (mean body weight, $\bar{x}$ W = 5.2 g) collected from sand dunes around the city of Riyadh, the rock agama, *Agama sinaita* ($\bar{x}$ W = 13.2 g) collected from rocky wadies (= Valleys) and mountainous escarpments around Riyadh and the stripped agama, *Agama blandfordi* ($\bar{x}$ W = 29.7) collected from rocky slopes around Riyadh. All of these lizards are diurnal, typically posturing heliotherms that feed on insects and worms.

The red-throated skink, *Mabuya brevicollis* ($\bar{x}$ W = 32.8 g) was the representative of the family Scincidae and was collected from cultivated areas around Riyadh. This is a diurnal, surface-dwelling as well as a burrowing and a both heliothermic and thigmothermic lizard that feeds on insects and worms. The representative of the Chamaeleonidae was *Chamaeleo chamaeleon* ($\bar{x}$ W = 35.6 g) that was collected from the high mountainous (3000 metres above sea level), temperate area around the city of Abha, Asir Province south-western Saudi Arabia. This is a diurnal basker that feeds on insects.

The lizards were kept in the Animal Facility of the Zoology Department, College of Science, King Saud University which is centrally cooled and with an independently controlled temperature of about 24°C and a daily photoperiod cycle of 8-9 hours. They were maintained in large glass tanks, 100 x 50 x 45 cm with wire-netting sliding tops and substrata of sand containing vegetation and stones to simulate the lizards' natural habitat.

Each lizard species was fed its suitable diet up to a few days prior to experimentation, but water was provided *ad lib.*

The system described by Al-Sadoon and Spellerberg (1985, 1987) was used to measure the resting oxygen consumption rates at the temperatures 10°C, 15°C, 20°C, 25°C, 30°C, 35°C and 40°C. The resting oxygen consumption values obtained in the experiments for different lizards were expressed as ml oxygen consumed per gram body weight per hour. All experiments were made at a time when the lizards would normally be active. Statistical analysis of differences between the mean values of oxygen consumption at each temperature in various groups of lizards were performed using two-tailed t-tests. Differences were considered to be statistically significant when $P<0.05$.

Results

Resting oxygen consumption:

It is observed from Table 1 that the mean resting oxygen consumption values measured at the temperatures (20°C, 30°C, 35°C) increase with increasing temperature for all lizards species. Comparison of these data with those calculated using regression equations derived by Bennett and Dawson (1976) and Bennett (1982) showed that the most similar observed and predicted results were at the 35°C category, followed by 30°C category and least similar were at the 20°C category. Observed values deviation from predicted ones was of the same degree for the three families, though there were highly deviating values for single lizard species, like *P. arabicus* at 20°C and *C. chamaeleon* at 35°C. *P. arabicus* and *A. sinaita* are small-sized animals and it is well noted that their O/P ratios are most different from the heavier species. This could be compared with those of the heavy and large species used by Bennett and Dawson (1976) which have a marked effect on the weight specific resting metabolic rate relationship in lizards.

Table 1. The observed and predicted mean resting oxygen consumption values (O_2 ml g^{-1} h^{-1}) for the species of the three saurian families at three temperatures. The predicted values were calculated using regression equations derived by Bennett and Dawson (1976) and Bennett (1982).

Species	20°C			30°C			35°C		
	Observed	Predicted	Ratio (o/P)	Observed	Predicted	Ratio (o/P)	Observed	Predicted	Ratio (o/P)
P. arabicus	0.146	0.070	2.09	0.315	0.182	1.73	0.310	0.316	0.98
A. sinaita	0.097	0.057	1.70	0.208	0.155	1.34	0.233	0.256	0.91
A. blandfordi	0.057	0.049	1.16	0.158	0.134	1.18	0.174	0.213	0.82
M. brevicollis	0.066	0.048	1.38	0.098	0.133	0.74	0.151	0.209	0.72
C. chamaeleon	0.060	0.074	1.28	0.096	0.131	0.73	0.121	0.205	0.59

Metabolic rate–temperature curves:

The data obtained for resting oxygen consumption values at the seven experimental temperatures from 10°C to 40°C were presented and plotted in the form of M–T curves in Figures 1—3. The general resting oxygen consumption values for all the species increased with the increasing test temperatures, though it decreased in the case of *P. arabicus* only once between 30°C and 35°C. Inspite of the numerous interspecific differences of the oxygen consumption levels and the rates of change in the M–T curves over the test temperatures, there seems to be a generally similar pattern for the species of the same family. This is quite evident in the case of the three species of the Agamidae. The other two families reflected independent M–T curve patterns.

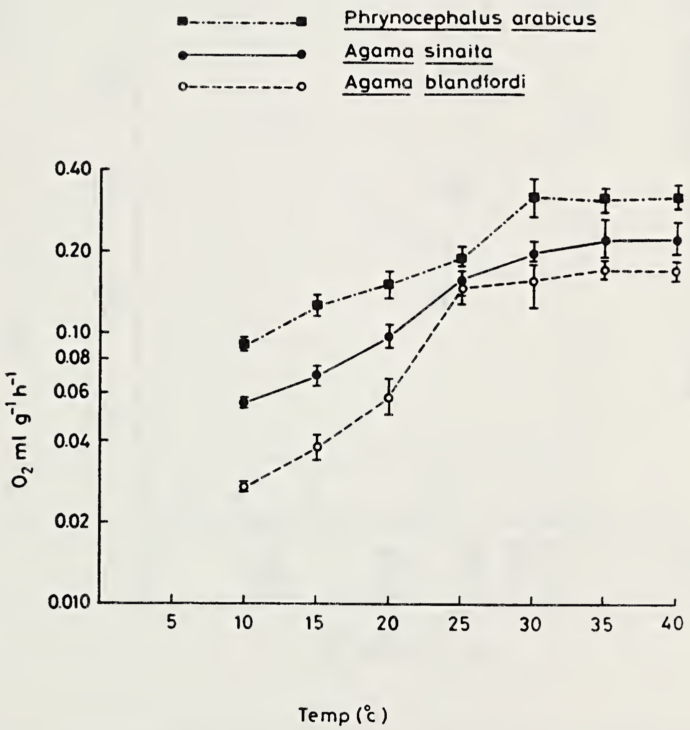

Fig. 1 Relationship between oxygen consumption rate and experimental temperature for three agamid species.

P. arabicus (■ —· — —· —· —■); *A sinaita* (● ———————●) and *A. blandfordi* (O - - - - - - - - O). Each point represents the mean of different individual lizards. Vertical lines represent ± standard errors.

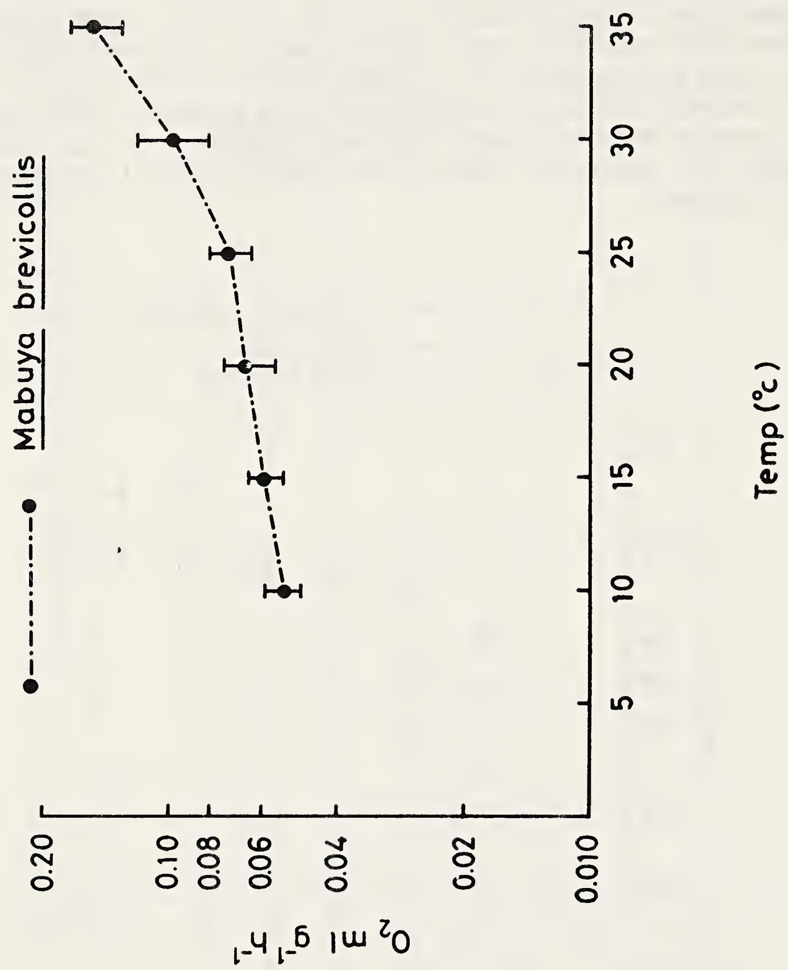

Fig. 2 Relationship between oxygen consumption rate and experimental temperature for *M. brevicollis* (● —· —· —· — ●). Each point represents the mean of different individual lizards. Vertical lines represent ± standard errors.

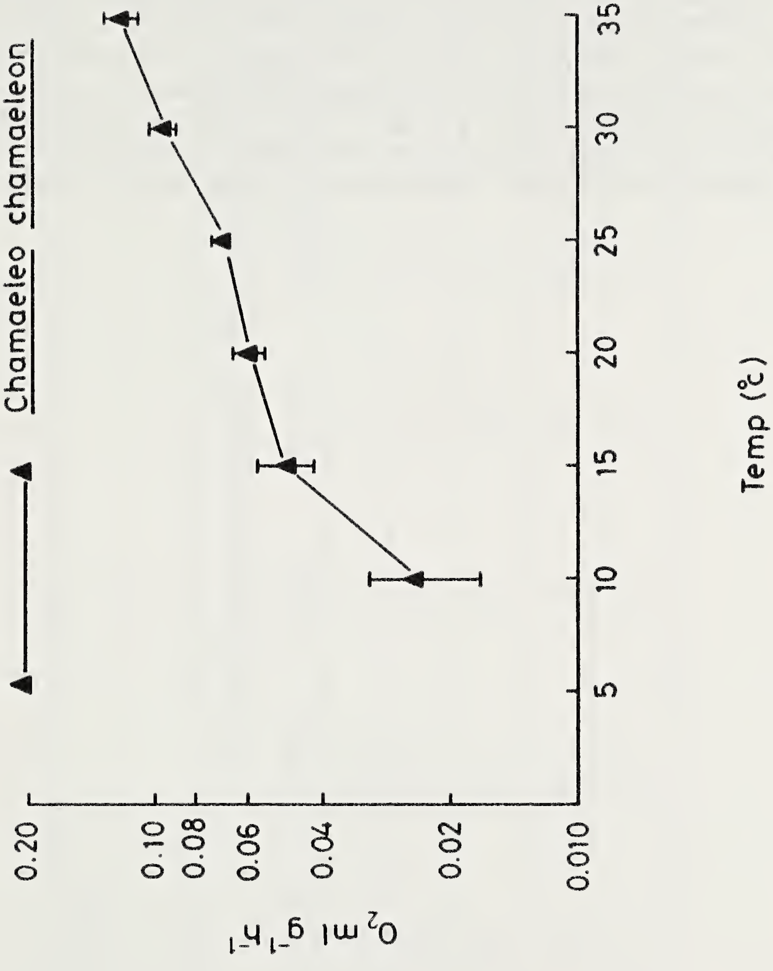

Fig. 3 Relationship between oxygen consumption rate and experimental temperature for *C. chamaeleon* (▲——▲). Each point represents the mean of different individual lizards. Vertical lines represent ± errors.

Q_{10} values:

The Q_{10} values for the resting oxygen consumption levels were presented in Table 2. The pattern of increasing Q_{10} values were variable both at low and high temperatures. All Q_{10} values were positive apart from the single negative case of *P. arabicus* between 30°C and 35°C. *M. brevicollis* gave the lowest "overall" Q_{10} value (1.51), while *C. chamaeleon* gave the highest "overall" Q_{10} value (1.91). The closest Q_{10} values to unity were those obtained for *A. blandfordi* (1.11 at 35°C to 40°C) and *M. brevicollis* (1.19 at 20°C to 25°C). The highest Q_{10} values obtained were those for *A. blandfordi* (6.65 at 20°C to 25°C) and *C. chamaeleon* (4.17 at 10°C to 15°C).

Table 2. The Q_{10} values of resting oxygen consumption for the species of the three saurian families.

	Q_{10} values of oxygen consumption for the indicated range of temperature						
	10–15°C	15–20°C	20–25°C	25–30°C	30–35°C	35–40°C	Overall Q_{10}
P. arabicus	1.99	1.32	1.71	2.72	0.97	1.15	1.57
A. sinaita	1.62	1.92	2.46	1.87	1.26	1.22	1.73
A. blandfordi	2.03	2.25	6.65	1.16	1.21	1.11	1.86
M. brevicollis	1.24	1.21	1.19	1.85	2.37	—	1.51
C. chamaeleon	4.17	1.50	1.36	1.88	1.59	—	1.91

Discussion

The M–T curves obtained for the three lizard families in the present study revealed that they were different with respect to both shape and magnitude (Figs. 1—3). It is interesting to note interspecific resemblance of these M–T curves within the Agamidae (Fig. 1). The shape of the M–T curves for these species is fairly consistent. The first part of their M–T curves (10°C—30°C) represents an increase in the oxygen consumption rates followed by a flattened part of the M–T curves over the temperature range 30°C—40°C. This may indicate that their PBT might fall between 30°C and 40°C. This is understandable as it was observed that all of the three agamid species are strict diurnal heliotherms that maintain high (38°C) activity temperatures (Spellerberg, 1977; Avery, 1982 and Philips, 1986). *P. arabicus* has a PBT of 39.31°C (Arnold, 1984). It is also interesting to note that these species in their desert habitats and rockslopes spend considerable time basking in midday, when temperature is extremely high, in almost motionless postures but when disturbed they have a rapid form of locomotion that needs a considerable rate of aerobic metabolism to supply enough energy for such a sudden burst of activity. Times of activity, ways of hunting and methods of thermoregulation have also been reported in some of these agamids (Arnold, 1984).

Inspection of the M–T curve of *M. brevicollis* reveals some evidence between the shape of this curve and the behavior of this species (Fig. 2). The M–T curve of this species is linear and semi–horizontal between 10°C and 30°C (Q_{10} = 1.35), then is followed by a sudden rise in Q_{10} to 2.37 at 30—35°C which might show a greater activity at this high temperature. The overall Q_{10} (1.51) for *M. brevicollis*, the lowest value in all the test animals, might reflect another aspect of the M–T curve and the thermoregulation of this species in relation to its habitat. Although the ecology of this species has not been studied, but it is noticeable that *M. brevicollis* is a diurnal thigmotherm that exhibits heliothermic behavior. It lives in cultivated areas and often remains hidden below green leaves and loose earth. It may well be that this type of behavior does not expose the animal to a great threat of predation, therefore it does not require high oxygen consumption. It appears that such environmental conditions might have a strong impact on the outcome of the thermoregulatory patterns of this skink. However, other species of skinks from hot and arid environments were shown to have high activity temperatures (Warburg, 1965; Pianka, 1969; Curry–Lindahl, 1979; Avery, 1982).

The chameleons which are represented by *C. chamaeleon*, are the least studied of the lizards tested. The Q_{10} (4.17) at 10°C—15°C is the next highest and might reflect a sharp rise in metabolism at this low temperature, however, Q_{10} values between 15°C and 35°C stayed within low range

(1.36–1.91), which might indicate a combination of activity and thermoregulation and may also reflect that the PBT might vary within this wide range of body temperature (PBT of this species ranges between 16°C and 32°C, Al–Sadoon, unpublished data). This regulation of body temperature in *M. brevicollis* and *C. chamaeleon* over a wide range and their tendency to consume less oxygen within this PBT range is in line with previous results (Al–Sadoon, 1986; Al–Sadoon and Spellerberg, 1985 and Davies, 1979). Other studies have shown that the arboreal chameleon, *Chamaeleo pumilus* might be active at a wide range of weather conditions and its mean body temperature might rise from 22.4°C to the highest temperature of 37°C (Burrage, 1973). While the iguanid lizard, *Liolaemus multiformis* that lives at high mountainous terrains could heat its body up to 31°C by absorbing solar rays when the shade temperature was 0°C (Pearson, 1954).

Though the general shape of the M–T curves of the tested animals are different, it is quite evident that all occupied positions in a relatively regular pattern. The lightest species, *P. arabicus* had the highest M–T curve level, the heaviest species, *C. chamaeleon* had the lowest M–T curve level and the other species (*A. sinaita*, *A. blandfordi* and *M. brevicollis*) had M–T curves that occupied levels inversely proportional to their body weights. These metabolic rate values were valid for interspecific and interfamilial levels independent of the limitations imposed by climatic variations. This situation could be interpreted through the metabolic rate weight–specific relationships.

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ANALYSIS OF THE BEHAVIORAL SEQUENCE EMITTED BY RATTLESNAKES DURING FEEDING EPISODES III.

STRIKE–INDUCED CHEMOSENSORY SEARCHING AND LOCATION OF RODENT CARCASSES

David Chiszar, Paul Nelson, and Hobart M. Smith

Abstract

Twelve rattlesnakes of the genus *Crotalus* were observed after striking rodent prey and after seeing, smelling, and detecting thermal cues arising from rodent prey. Mouse carcasses concealed in the snakes' home cages were usually discovered and ingested if a predatory strike had been delivered prior to the tests. If no strike had been delivered, then snakes usually did not locate or ingest the carcasses within the 20 min test periods. A path analysis suggested that rate of tongue flicking should be conceptualized as the proximal determinant of carcass location, and that striking should probably be conceptualized as a more distal factor which exerts its influence on carcass location largely through its mediating effect on rate of tongue flicking. Hence, factors (other than striking prey) which increase rate of tongue flicking should also increase the efficiency with which rattlesnakes locate dead prey.

Predation by rattlesnakes involves a number of complex behavioral events such as migration from hibernacula to feeding grounds, location of rodent colonies, and closing with prey (usually involving an envenomating strike, followed by release of the wounded rodent and subsequent trail following; Dullemeijer, 1961; Duvall *et al.*, 1985; Kardong, 1986; Klauber, 1956). Each of these events exhibits variation, probably associated with variation in macro– and microhabitats. Indeed, part of the job of researchers is to quantify behavioral variation and to discover its causes and consequences, although it is often useful to begin by studying behavioral processes under controlled (constant) conditions to obtain an initial view of their componential features, including the sequential relationships among the components. In a series of such studies on rattlesnake predation we have shown that the delivery of a predatory strike initiates a chain of events involving: (1) a high rate of tongue flicking (RTF), (2) location of prey trails, (3) trail following, (4) carcass location and (5) ingestion (Chiszar *et al.*, 1982a,b; Golan *et al.*, 1982; see Burghardt, 1970, and Halpern & Kubie, 1980, for discussions of the relationship between tongue flicking and chemoreception). Mostly we have concentrated on the first two components, together called strike-induced chemosensory searching, and the third one; and we have established that a dichotomous variable (no-strike, NS vs. strike, S, presentations of prey) accounts for about 60% of the variance in post-presentation RTF (Chiszar *et al.*, 1982a). That is, rattlesnakes exhibit much higher RTF after striking than after detecting a prey item just outside of striking range. Not surprisingly, trailing behavior was far more reliable and effective after S than after NS presentations of rodents (Chiszar *et al.*, 1983a; Golan *et al.*, 1982). Consequently, we expect high correlations to exist between (1) NS vs. S presentations and RTF, and (2) RTF and latency to discover carcasses; furthermore, a high correlation should also exist between (3) NS vs. S and latency to discover carcasses. In fact, if NS vs. S is the major determinant of RTF and if RTF is the major determinant of the latency to discover carcasses, then correlations 2 and 3 ought to be equal. Such precise quantitative predictions have not previously been tested, and this is the purpose of the present study (see Grice, 1966, and Lindquist, 1953, for discussions of this approach to the study of empirical relationships).

Method

Subjects and maintenance conditions. Twelve adult, long-term captive rattlesnakes were observed in the experiment (2 *Crotalus viridis*, 2 *C. horridus*, 4 *C. triseriatus*, 2 *C. adamanteus*, 1 *C. lepidus*, 1 *C. durissus*). All specimens had been in captivity for at least two years prior to the study, living in individual glass terraria, (50 x 22.5 x 30 cm). Temperature was 26° ± 1° C during photophase (0700-1900 h) and 23° ± 1° C during scotophase. One live mouse (*Mus musculus*, 15-20 g) was offered to each snake weekly, and these prey were readily accepted.

The use of multiple taxa confounds individual variation with variation associated with taxa. However, differences between taxa have generally been small in studies of strike-induced chemosensory searching (Chiszar *et al.*, 1977, 1983a; but see Chiszar *et al.*, 1986 and Cruz *et al.*, 1987). Consequently, we believe that variation among our 12 snakes primarily reflects individual rather than species differences.

Procedure. Each snake was observed four times, and observations always occurred prior to a regularly scheduled weekly feeding session. A dead mouse was always placed behind a clean brick inside the snake's home cage, about 20 cm from the snake's resting position. Prior to placing carcasses into cages, a plywood partition was inserted between the snake and the brick. Hence, snakes did not see carcasses as they were introduced. Then, the partition was removed and a live stimulus mouse was suspended via forceps into the cage and held just out of striking range for 3 sec. On NS trials the mouse was simply removed, the snake's cage was closed, and all tongue flicks were recorded (via hand-held counters) for the next 20 min or until the snake located and began ingesting the dead mouse. Each snake was observed in condition NS twice. Condition S was exactly like NS except that the snake was allowed to strike the live (stimulus) mouse after the initial 3-sec. presentation. After the stimulus mouse was released by the snake, it was removed and tongue flicks were recorded as described above. Each snake was observed in condition S twice. The NS and S observations were made in a random order at the rate of one per week.

Dependent variables were RTF and latency to contact the mouse carcass behind the brick. Since stimulus mice were always suspended into cages via forceps, these mice never touched cage floors or walls during presentation. Therefore, deposition of odors was minimized and was probably equal in NS and S conditions. Importantly, no odor trails were made between the snakes' resting positions and the spot where dead mice were located. Accordingly, this experiment does not involve trailing behavior (Dullemeijer, 1961, Golan *et al.*, 1982; see Burghardt, 1970, for a review); instead it involves searching behavior which could be either randomly directed or guided only by airbourne cues arising from the hidden, dead prey (Gillingham & Baker, 1981).

Finally, if a snake failed to discover the dead prey within 20 min, a latency score of 1200 sec was assigned, and the hidden carcass was moved (with forceps) to the snake. In all such cases snakes eventually ingested the carcass. Hence, all snakes on all trials were hungry and ready to accept prey.

Results

Means on each dependent variable are shown in Table 1 for NS and S trials, together with outcomes of repeated-measures analyses of variance showing that all measures differed significantly between the two types of trials. Notice that 6 NS trials resulted in discoveries of hidden carcasses within 1200 sec. The mean RTF on these trials was 35.1, a value that did not differ significantly from the mean RTF on strike trials. Hence, NS vs. S was not the sole determinant of RTF. Yet, there was an apparent correlation between RTF and discovery of carcasses in that whenever the latter event occurred the snakes exhibited high RTF, and whenever carcases were not discovered the RTF was low.

Table 1. Mean RTF and latency to discover hidden carcasses in NS and S conditions. The bottom row shows number and percent of carcasses discovered within 24 NS and S sessions. The right column presents statistical tests.

	Condition		
Dependent Variable	NS	S	F (df = 1,11)
RTF	10.0	42.3	71.34 **
Latency	1032.2	479.5	43.64 **
Number (%) Carcasses Found within 1200 Sec	6 (25.0)	23 (95.8)	38.30 **

** P < 0.01

Table 2 explores this point more systematically by presenting correlation coefficients among NS vs. S, RTF and latency to discover hidden carcasses. All of these correlations are significant, with NS vs. S

Table 2. Correlation matrix for the three variables of primary interest. Numbers above the diagonal are correlation coefficients, those below the diagonal are coefficients of determination showing the proportion of variance accounted for by each correlation.

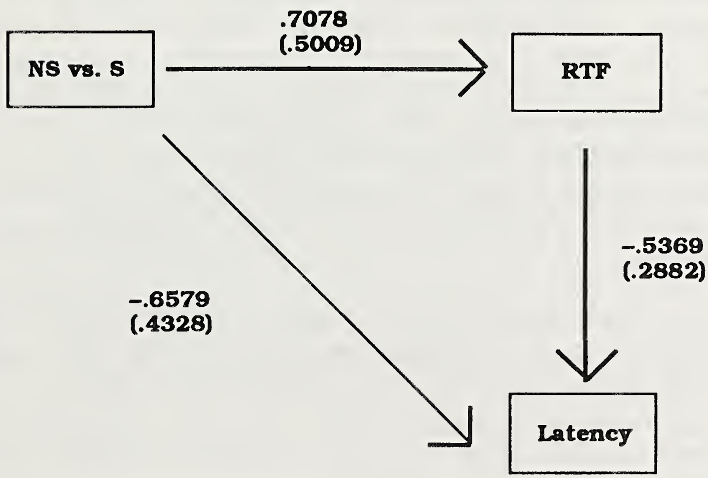
	NS vs. S	RTF	Latency
NS vs. S	---	.7078**	-.6579**
RTF	.5009	---	-.8450 **
Latency	.4328	.7140	---

** P < 0.01

showing its typically large influence on RTF, and RTF being strongly related to latency. As implied above, however, NS vs. S was not the sole determinant of RTF. This can be seen by comparing the two correlations involving latency. Although both are substantial and inverse, they differ significantly ($t = 3.10$, $df = 45$, $p < .05$; Ferguson, 1976) with RTF more strongly associated with latency than was NS vs. S. The main implication of this finding is that RTF predicts the effectiveness of searching better than does NS vs. S. As in previous studies, NS vs. S must be viewed as a determinant of RTF, but it is not the exclusive determinant (if such had been the case, the two correlations in question would have been equal). Other factors such as interactions between motivational state and detection of prey outside of striking range appear to influence RTF, thereby bringing about effective searching.

These ideas can be expressed in terms of a path analysis treating RTF as a mediating variable (Table 3). The path coefficient between RTF and latency was −.5369, and this value was independent of the relationship between NS vs. S latency. Hence, when latency was predicted from the two paths shown in Table 3, we were able to account for abut 72% of the variance in latency scores by incorporating RTF, whereas only about 43% of the variance in latency scores was explained on the basis of NS vs. S alone.[1]

Table 3. Path structure based on the correlation matrix shown in Table 2. Numbers not in parentheses are path coefficients, and numbers within parentheses represent proportion of variance accounted for by each path or segment thereof. RTF explained 28.8% of the variance in latency, independently of the 43.2% that was explained by NS vs. S



Discussion

Since striking prey caused a large elevation of RTF in rattlesnakes (see Chiszar & Scudder, 1980, and Chiszar *et al.*, 1983a, for reviews), it was hypothesized that striking facilitates discovery of carcasses by causing snakes to make searching movements and by increasing sensitivity to chemical cues. Because the present study shows RTF to be a better predictor of latency to discover the mouse carcass than was NS vs. S (see Table 2), it seems probable that any factor that results in elevated RTF will also predispose snakes to discover carcasses (Chiszar *et al.*, 1981; Gillingham & Baker, 1981; Radcliffe *et al.*, 1986). Inasmuch as six NS trials resulted in both high RTF and successful discovery of mouse carcass, it can be inferred that these snakes were stimulated to emit strong chemosensory searching by visual, thermal, and/or chemical cues arising from the NS presentation (see also Chiszar *et al.*, 1981; Cowles & Phelan, 1958; Gillingham & Clark, 1981). In other words, the critical variable in determining location of carcasses under present conditions was whether or not chemosensory searching had been initiated, not NS vs. S. The importance of NS vs. S lies in its ability to trigger high RTF.

Our earlier papers placed too much emphasis upon NS vs. S, and gave too little emphasis to flexibilities imparted by the RTF pathway in Table 3. Gillingham and Clark (1981) were the first to point toward these flexibilities, and we conceptualize the present analysis as providing a quantitative confirmation of their argument (see also Chiszar *et al.*, 1981; Gillingham & Baker, 1981).

Some writers believe that rodent-feeding rattlesnakes are primarily ambush predators (i.e., sit-and-wait predators; Chiszar *et al.*, 1982a,b; 1983b; Klauber, 1956) whereas others have suggested that rattlesnakes may engage in active hunting and/or carrion feeding more frequently than would be expected on the basis of only opportunistic exploitation of such predatory modes (Duvall *et al.*, 1985; Gillingham & Baker, 1981; Hennessy & Owings, 1988 ; Greene, 1982). It is here suggested that analyses of the sort shown in Table 3 might be useful in settling this issue. For example, ambush predators would be expected to exhibit very high correlations between NS vs. S and RTF and between NS vs. S and latency to discover the carcass. On the other hand, foragers and carrion feeders should be stimulated to emit high RTF by a variety of factors besides NS vs. S, leading to lower correlations between NS vs. S and RTF, and Ns vs. S and latency. Since no comparative data are currently available, Table 3 cannot be said to illustrate either the ambushing or the foraging path structure. However, a decision of this sort should become possible when data from a sufficient number of taxa have been submitted to this kind of analysis.

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Footnote

[1] It might be argued from Table 2 that the simple correlation between RTF and latency accounts for about as much of the variance in latency as the two paths shown in Table 3, so why bother with the more complex path analysis? The latter procedure, however, explicitly quantifies the variance in latency that is attributable to RTF over and above the effect on latency that derives from NS vs. S. That RTF has such an association with latency is of vital importance because this tells us unequivocally that (1) NS vs. S is not the whole story, (2) any attempt to treat NS vs. S as such will be able to explain only about half as much variance in searching effectiveness as can explained, and (3) RTF must be viewed as process determined by multiple factors, not simply by NS vs. S and experimental error (i.e., measurement error and unreliable or chance variation).

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NEWS & NOTES:

SMITHSONIAN RESEARCH FELLOWSHIPS IN HISTORY, ART, AND SCIENCE

The Smithsonian Institution announces its research fellowships for 1989-1990 in the fields of History of Science and Technology, Social and Cultural History, History of Art, Anthropology, Biological Sciences, Earth Sciences, and Materials Analysis.

Smithsonian Fellowships are awarded to support independent research in residence at the Smithsonian in association with the research staff and using the Institution's resources. Predoctoral and postdoctoral fellowship appointments for six to twelve months, and graduate student appointments for ten weeks are awarded. Proposals for research in the following areas may be made:

History of Science and Technology: History of computers, communication, and society; history of agriculture; air and space; electrical technology; engineering; industrial archaeology; mathematics; medicine and pharmacy; natural history; physical sciences; social dimensions of science and technology; and transportation.

Social and Cultural History: American political, military, social, and cultural history; American business history; American folklore; history of money and medallic art; history of music and musical instruments; and materials aspects of American everyday life.

History of Art: African art; American art of the 18th, 19th, and 20th centuries; decorative arts; modern art; Asian and Near Eastern art; and twentieth-century American crafts.

Anthropology: Archaeology; cultural anthropology; folklife; linguistics; and physical anthropology.

Biological Sciences: Animal behavior and pathology; ecology; environmental studies; evolutionary biology; marine biology; natural history; paleobiology; systematics; and tropical biology.

Earth Sciences: Meteoritics; mineralogy; paleobiology; petrology; planetary geology; sedimentology; and volcanology.

Materials Analysis: Archaeometry and conservation science.

NEWS & NOTES:

Applications are due January 15, 1989. Stipends supporting these awards are: $25,000 per year plus allowances for senior postdoctoral fellows; $20,000 per year plus allowances for postdoctoral fellows; $12,500 per year plus allowances for predoctoral fellows; and $3,000 for graduate students for the ten-week tenure period. Pre-, post-, and senior postdoctoral stipends are prorated on a monthly basis for periods less than one year.

Awards are based on merit. Smithsonian fellowships are open to all qualified individuals without reference to race, color, religion, sex, national origin, age, or condition of handicap of any applicant. For more information and application forms, please write: Smithsonian Institution, Office of Fellowships and Grants, 7300 L'Enfant Plaza, Washington, D.C. 20560. Please indicate the particular area in which you propose to conduct research and give the dates of degrees received or expected.

4th August 1988

Dear Fellow Herps,

Greetings! We are happy to inform you that we have built a new research station in Central Trinidad and have name it Victoria Regia.

We welcome all, whether students, scientists, collectors, nature lovers or bird watchers. The main building stands on a hill and is surrounded by mixed habitats including forests. Research facilities available include ponds, concrete tanks, workshed, cages and aquaria.

Our rates are U. S. $25./day/person, which includes breakfast, U. S. $35. for those wanting all meals. We have included rates for groups of five or more and for individuals staying for one month or longer. We will also cater for large groups and institutions interested in holding seminars or meetings.

We thank you and look forward to hearing from you and for any suggestions you may have to offer.

Sincerely,

Jack & Caroline Price

Please write:
Victoria Regia Research Station
La Gloria Road,
Talparo, Mundo Nuevo,
Trinidad, W. I.

NOTE TO HERPETOLOGISTS:

The island of Trinidad possesses a herpetofauna characterized by South American species in a readily accessible setting. There are 65 reptiles and 25 amphibians. The snakes include 4 poisonous species: bushmaster, Fer–de–Lance and 2 species of coral snakes. Many reptiles and frogs can be found on the premises and indeed inside the main building.

Tobago has a smaller herpetofauna, but presents two lizards and a frog not found in Trinidad. Access to Tobago is by shuttle flight or by ferry, and the island is part of the same country so no formalities are required.

We are planning seminars for the summer of 1989, including herpetology. Anyone interested should write us as early as possible for further details.

NEWS & NOTES:

A Preliminary Announcement and Call for Papers

The Northern California Herpetological Society

presents a fourth

Conference on the Captive Propagation and Husbandry of Reptiles and Amphibians

All professional and amateur herpetologists are invited to submit for consideration the titles of papers they wish to present at the 1989 NCHS Conference on the Captive Propagation and Husbandry of Reptiles and Amphibians. Paper lengths should range from 20-45 minutes. A brief abstract of the presentation should be submitted by October 15, 1988.

February 11 - 13, 1989 -- President's Day Weekend
University of California, Davis, Room MS-170

Submit papers to:
1989 Conference Program Committee
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NEWS & NOTES:

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Harold Heatwole

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Elizabeth Tootill is a former research botanist who now writes and edits reference books. Recently, she coedited *he Biographical Encyclopedia of Scientists.*

THE FACTS ON FILE DICTIONARY OF BIOLOGY, edited by Elizabeth Tootill
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ISBN# 0-8160-1865-0; 320 pages; 6 x 9

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NEWS & NOTES:

displacement activity A type of behaviour that appears irrelevant to the situation in which it is performed. It occurs when an animal is torn between equal and opposing tendencies, such as threat and escape, and often consists of comfort actions, e.g. grooming, eating, or scratching. For example, fighting cocks may stop and peck at the ground as if feeding, and fighting herring gulls may stop and pluck at nest material for a few moments. Displacement activity occurs when there is conflict between antagonistic drives in animals fighting at a boundary between their territories, where the drive to escape and the fighting drive are both aroused. It may also occur when the animal has a strong urge that cannot be fulfilled.

display behaviour Activities such as movements, postures, sounds, etc., that are used by an animal to communicate specific information to another, especially one of the same species. Display behaviour is most frequently seen in courtship and aggression; for example, a male bird may puff out its feathers, bow or turn its head, and sing to attract a female during the breeding season.

distal Denoting the part of an organ, limb, etc., that is furthest from the origin or point of attachment. *Compare* proximal.

distely Having two steles, e.g. the stem of *Selaginella kraussiana*. The steles are joined only at branches. *See also* polystely.

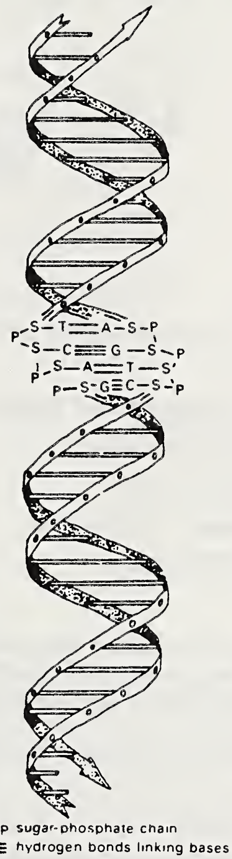
diurnal rhythm *See* circadian rhythm.

diverticulum A blind tubular or saclike outgrowth from a tube or cavity. For instance, the appendix and caecum of a rabbit form a diverticulum. The primitive chordate animal, *Amphioxus*, has such an outgrowth at the point where the oesophagus meets the intestine. It projects forwards beside the pharynx and may be homologous with the liver of vertebrates.

division names end in *phyta* (e.g. Chlorophyta and Bryophyta), with the exception of the fungal divisions, which end in *mycota*. Divisions may be divided into subdivisions.

dizygotic twins *See* fraternal twins.

DNA (deoxyribonucleic acid) A nucleic



The double helix of the DNA molecule

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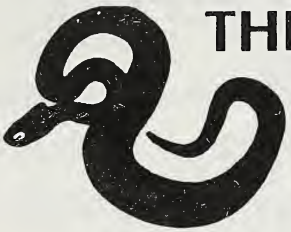

SNAKES OF THE ORIENT, A Checklist

by Kenneth R.G. Welch
Orig. Ed. 1988 192 pp. $22.50
ISBN 0-89464-203-0

Summary

The orient has for many years been greatly neglected by herpetologists, compared to the rest of the world. Presented in this book is a list of the snakes of the area to be used as an encouragement for further study.

In this work an attempt is made to list the snake fauna of the Orient as a whole (Pakistan, east of China, south through Asia, to include Japan, Philippine Islands, Indonesia and Papua New Guinea.) The list includes present names, original names and references, type locality, distribution and any recent taxonomic references.

Contents

HANDBOOK ON THE MAINTENANCE OF REPTILES IN CAPTIVITY

by Kenneth R.G. Welch
Orig. Ed. 1987 162 pp. $17.50
ISBN 0-89874-830-5

The aim of this text is not to tell the reader how to keep reptiles, but to act as a guide, a base for the beginner to start from, and at least in part, a handbook for the more experienced reptile keeper. The text is divided into four parts. The first is an introduction to the maintenance of reptiles in captivity; the second is supplementary notes to the introduction; the third, specific accounts on the keeping of a selection of reptiles in captivity; and finally, there is a list of species, with references on their maintenance in captivity, breeding results, behavior, ecology, and other subjects considered necessary knowledge to aid in the keeping of those species in captivity.

NEWS & NOTES:

BIOMEDICAL AND SURGICAL ASPECTS OF CAPTIVE REPTILE HUSBANDRY

by Fredric L. Frye

Orig. Ed. 1981 468 pp. $62.50
ISBN 0-935078-01-0

Summary

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Society Publication

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The Society also publishes a Newsletter on a somewhat irregular basis. These are distributed to the membership free of charge. Also published are Maryland Herpetofauna Leaflets and these are available at $.25/page.

Information for Authors

All correspondence should be addressed to the Executive Editor. Manuscripts being submitted for publication should be typewritten (double spaced) on good quality 8 1/2 by 11 inch paper with adequate margins. Submit original and first carbon, retaining the second carbon. If entered on a word processor, also submit diskette and note word processor and operating system used. Indicate where illustrations or photographs are to appear in text. Cite all literature used at end in alphabetical order by author.

Major papers are those over 5 pages (double spaced, elite type) and must include an abstract. The authors name should be centered under the title, and the address is to follow the Literature Cited. Minor papers are those papers with fewer than 5 pages. Author's name is to be placed at end of paper (see recent issue). For additional information see *Style Manual for Biological Journals* (1964), American Institute of Biological Sciences, 3900 Wisconsin Avenue, N.W., Washington, D.C. 20016.

Reprints are available at $.03 a page and should be ordered when manuscripts are submitted or when proofs are returned. Minimum order is 100 reprints. Either edited manuscript or proof will be returned to author for approval or correction. The author will be responsible for all corrections to proof, and must return proof preferably within 7 days.

The Maryland Herpetological Society
Department of Herpetology
Natural History Society of Maryland, Inc.
2643 North Charles Street
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BULLETIN OF THE

US ISSN: 0025-4231

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DEPARTMENT OF HERPETOLOGY

THE NATURAL HISTORY SOCIETY OF MARYLAND, INC.

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MARCH 1989

VOLUME 25 NUMBER 1

BULLETIN OF THE MARYLAND HERPETOLOGICAL SOCIETY

Volume 25 Number 1 March 1989

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The third Wednesday of each month, 8:15 p.m. at the Natural History Society of Maryland (except May—August, third Saturday of each month, 8:00 a.m.). The Department of Herpetology meets informally on all other Wednesday evenings at the NHSM at 8:00 p.m.

NOTES ON THE NATURAL HISTORY AND STATUS OF THE TIGER SALAMANDER, *AMBYSTOMA TIGRINUM*, IN DELAWARE

Rudolf G. Arndt

Abstract

A total of 173 ponds in Delaware sampled in May 1983 and from June 1986 through January 1987 for breeding tiger salamander, *Ambystoma tigrinum*, yielded 12 ponds with egg clusters, larvae, or breeding adults. Including records from the literature and personal communications, this salamander is now known from 20 Delaware localities. Reproduction occurred in relatively large natural ponds (Carolina bays) and small man-made ponds; all were completely surrounded, or partly bordered, by mature deciduous or mixed forest. Submerged and emergent aquatic vegetation was abundant in some ponds, and absent in others. Pond substrate ranged from firm sandy loam to heavy organic mud to sand and clay. Pond water pH ranged from 5.5 to 7.8. No fish occurred in ponds with reproducing *A. tigrinum*. In the drought year of 1986 only three ponds, all man-made, are believed to have produced metamorphs. During a more normal and wetter year than 1986, successful breeding probably occurs in more ponds than noted in this survey.

Larvae collected in the wild and then held captive metamorphosed from late June through late July. Metamorphosis in the wild occurred from 14 June through late August. Larvae total length (TL) at metamorphosis was 99 mm to 118 mm. Captives reached adult size at an age of approximately 12 months. Wild-caught adult males averaged 229 mm TL, and females 200 mm TL. Males preceded females to breeding ponds. Breeding adults were found in ponds from 6 December to 4 January. Egg clusters were found attached to underwater branches or grasses on 6 and 26 December and 4 January. Newly hatched larvae were found on 4 January. Summer food of larvae consisted predominantly of insects and crustaceans and varied between ponds.

Extensive land development in Delaware suggests that the status of this species be monitored. Management steps are recommended.

Introduction

As a result of extensive habitat alteration by man, the tiger salamander, *Ambystoma tigrinum*, is now a species of concern in all states in the northeastern extreme of its range, including Delaware. While the biology of this widely distributed species is generally well-known (for example, Gehlbach 1967) and its distribution and ecology in the adjacent state of Maryland have been delineated (Conant 1945, Stine 1953, Stine et al. 1954, Musick 1972, Cooper et al. 1973, Harris 1975, Miller 1980, Stine 1984), there are few published data available for Delaware. I herein summarize literature and personal communication data on *A. tigrinum* in Delaware, and augment these with the results of an intensive field survey designed to locate all breeding localities in Delaware and to add to our knowledge of its biology. I relate my data to other Delaware data but not to the voluminous literature on this species from elsewhere in its huge range.

Materials and Methods

Breeding ponds were identified by the presence of larvae, adults, or eggs. Considered potentially suitable were ponds that lack a stream inflow and outflow, and thus less likely to contain fishes, many of which prey on larval *A. tigrinum* (Cochran 1961; R. G. Arndt, personal observations), and that were at least partly bordered by mature forest. Ponds in which fish were noted were not sampled. Fishes were identified in these ponds (usually possible without catching them), and in those ponds where they were found after seining them. Ponds located in active agricultural fields and a minimum of some 100–150 m from woods, and in developed areas, were deemed unsuitable and were not investigated.

Field sampling dates were 6 May 1983; 6, 7, 8, 14, 15, 18, 19, 20, 28, 29, and 30 June; 5, 6, 12, and 27 July; 7, 8, 17, and 30 August; 6, 7, and 26 December 1986; and 3 and 4 January 1987. Ponds were visited as often as possible on an irregular schedule, and with the goal of allowing me to describe major parameters of *A. tigrinum* life history. Some field work continued into 1987, and it consisted of occasional monitoring of selected ponds. Based on this limited sampling, results were similar to those of 1986, and only some highlights are included here.

Ponds were located on United States Department of the Interior Geological Survey (U.S.G. S.) 7.5 minutes series topographic maps. Several ponds not on these maps were also found and sampled.

The year 1986 was one of drought conditions in southern Delaware, with annual precipitation 21 cm below normal, and an annual temperature 0.61 C above normal (Anonymous 1987). Drought greatly facilitated this survey: many ponds were dry or almost dry by early June 1986 and thus sampling for larvae was not possible or could be done quickly because of the low water and small pond area. This allowed me to sample a larger number of ponds in a shorter period of time than would normally have been possible, and it provided the opportunity of allowing me to determine a minimum number of ponds that support larvae to metamorphosis.

Ponds were sampled with a 3 m x 1.2 m nylon straight seine with a 3.2 mm mesh, a 6 m x 1.2 m nylon bag seine with a 3.2 mm mesh, and a dip net. Noted or estimated for each pond were: adjacent habitat (forest, farm fields, houses, etc.); whether the pond was natural or man–made; whether it was vernal or permanent; whether fishes occurred and which species; and whether or not farm animals, particularly ducks and geese, occurred. Most ponds could readily be identified as natural or man–made, but the origin of several was questionable.

For each pond with A. *tigrinum* were recorded pond dimensions, water depth, water temperature, air temperature (at ground level, in shade, and out of wind), pH (with a Hach pH kit), water color (visual estimation), pond substrate, conspicuous aquatic plant species, conspicuous plant species near the pond, and amphibian and reptile species associates.

All of Delaware north to the Chesapeake and Delaware Canal was surveyed, as well as three sites just north of the Canal. Not surveyed were the Piedmont and the Fall Line areas. There are no records of *A. tigrinum* from these northern portions of Delaware, nor is there a record of any existing population in Pennsylvania (McCoy 1982). A chronological summary of all available Delaware *A. tigrinum* data is included herein. For the sake of completeness, even anecdotal records are included.

Selected subsamples of larvae and adults of A. *tigrinum* from most ponds were preserved in 10% buffered formalin and later washed in water and transferred to 40% 2–propanol. Snout–vent length to the posterior angle of the vent (SVL) and total length (TL) to the nearest mm and weight (nearest 0.1 g) were obtained from most preserved specimens, and from some live adults which were then released. Newly hatched larvae were measured to the nearest 0.1 mm with a binocular microscope, and weighed to the nearest 0.001 g on a Sartorius analytical balance. Stomachs of 77 larvae were removed, and all food organisms identified to the lowest taxon possible and counted.

Data on growth and dates of metamorphosis were obtained from larvae kept in 40 liter (l) tanks provided with aerators and filters and bricks for shelter and fed sliced beef liver every two or three days. Metamorphosed larvae were moved into individual 40 l terraria with 6 cm of soil, tree bark for shelter, and a container of water, and fed meal worms, *Tenebrio molitor*, and new-born mice, *Mus musculus*, every several days. All foods provided were eaten readily.

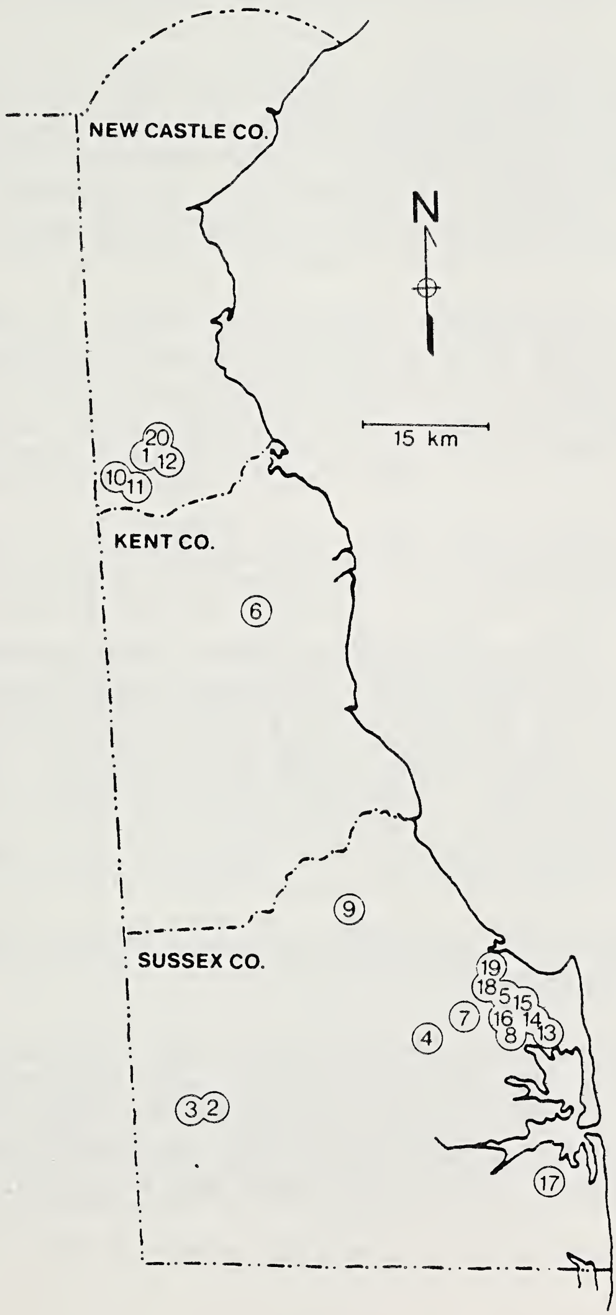
Breeding pond localities have been provided to the Delaware Division of Fish and Wildlife. A total of 134 voucher specimens have been deposited in the Section of Amphibians and Reptiles, the Carnegie Museum of Natural History (CM 115336–115443). Museum numbers refer to individual specimens or to a series.

Results and Discussion

Locality Records and General Ecology

The eastern tiger salamander is now known from 20 sites in Delaware, and from all three counties (Fig. 1). Stine et al. (1954) recorded it from Sussex County, but gave no additional information. Arndt (1983) reported on two young specimens (CM 92895–92896) found on the night of 1 August 1973 during a rain on highway in a wooded area 3.7 km SSW Townsend, New Castle County (Site 1, Fig. 1). Roger Conant (pers. comm., 1983) has provided several Sussex County records, now in the collection of the University of New Mexico (UNM), from: Seaford (UNM 28159); 1.6 km W Seaford (UNM 28160); 11.3 km N Millsboro (not preserved); and Belltown (UNM 28158) (Sites 2–5, respectively, Fig. 1). The Seaford specimen is an adult female of approximately 107 mm SVL and 210 mm TL (it was difficult to measure because of a curved body due to preservation) collected in autumn 1946 by Robert Tiegle; UNM 28160 is an adult female of 108 mm SVL and 190 mm TL collected on 3 November 1952 by T. W. Rugg; and UNM 28158 is a male of 79 mm SVL and 152 mm TL and which, on the basis of a well-developed cloaca, appears to be an adult; it was collected on 22 September 1953 by Bill Maloney. No additional data are available for the specimen from N Millsboro. Conant in the same communication recalls "a teacher from Dover once wrote to me about finding 10 or 15 specimens in an area that had recently been disturbed somewhere near the capital". Although this locality, the only one from Kent County, is not documented by specimens, suitable habitat is present throughout and the tiger salamander has been taken nearby to the north and the south, so the record is

Figure 1. Delaware localities for the tiger salamander, *Ambystoma tigrinum*. Site numbers correspond to those in text.



considered to be entirely plausible. It is plotted as Dover, Site 6, Fig. 1.

On 6 May 1983, Mary C. Brosnan, George H. Fenwick, Arnold W. Norden, and I visited two natural ponds in SE Sussex County in mature mixed forest and known to them to be breeding sites for *A. tigrinum.* Pond diameters were approximately 245 m and 230 m. These ponds have characteristics of Carolina bays (see Abercrombie 1985, Fairbridge 1968, Gary et al. 1972), namely an interior drainage, elliptical to near circular outline, and a saucer–shaped profile with a gentle slope, and are hereafter referred to as bays. Several sweeps with a dip net in the first bay (Site 7, Fig. 1) captured one larva, and several hauls with a 3 m seine at the nearby bay (Site 8, Fig. 1) yielded eight larvae (five specimens preserved, CM 115336). Numbers of larvae estimated present in each of these bays were in the thousands, based on the large catch per small effort and the large size of the bays. Observations made in subsequent years in other ponds support these estimates. For example, in 1986 numerous large larvae were collected and released and a total of 68 preserved from two other Sussex County ponds (considered later). The surface areas of these two ponds ranged from a minimum of 0.4% to a maximum of 1.1% of the surface area of the two bays sampled in 1983. Many other larvae were collected and released and approximately 275 were preserved in 1987 from a third Sussex County pond with a maximum surface area only 10.6% of that of Site 7 (Fig. 1).

On 15 June 1986, in a drought year, Sites 7 and 8 were both almost dry. Seining in both was almost impossible because of dense vegetation, and no larvae were captured. Both bays were dry and covered by dense grasses and other plants in July and August 1986. By 26 December 1986 most vegetation had died and late autumn rains had created spongy conditions in the bay centers similar to those present on 15 June. No seining was attempted in the shallow water and dense vegetation, and no salamander was seen. Winter rains filled Site 7 to a depth of about 90 cm and to within 25 m of its maximum diameter by 20 January 1987 (George N. Porter, pers. comm., 1987). Such water regime patterns were noted in other bays and in man–made ponds in Delaware.

Several post–metamorphic specimens of *A. tigrinum* from Site 7 were reported to me by Porter: one of about 25 cm TL plowed up in his garden in April 1984, a dead specimen found under a log on the bay edge in September 1985, and one of approximately 22 cm TL found alive after dark 30 m from the bay high water mark in late October 1986, after a day of rain.

One post–metamorphic specimen (CM 115337) of 106 mm SVL and

233 mm TL was collected in calm and misty weather after dark by George E. Jester (pers. comm., 1986) at his home on 21 October 1985. Mature mixed forest surrounds the house located 7.1 km S Milford, Sussex County (Site 9, Fig. 1). No potential breeding site was found in a subsequent search of this area.

James F. White (pers. comm., 1987) found one or two recently transformed specimens per occasional visit, for a total of 11 specimens, in the months March through August from 1983 through 1986 in a window–well and basement of a house in deciduous forest in SW New Castle County (Site 10, Fig. 1). A bay 60 m distant was a likely breeding pond, and another bay 200 m distant yielded larvae on 8 June 1986 (Site 11, Fig. 1).

William A. Dunson (pers. comm., 1986) found an adult female *A. tigrinum* clasped around the neck by an adult male wood frog, *Rana sylvatica*, on 15 March 1986 in a bay in mature deciduous forest in SW New Castle County (Site 12, Fig. 1). According to Dunson, it contained a full complement of eggs. The female was released where captured. Larvae of *A. tigrinum* were found here on 7 June 1986.

I attempted to sample a total of 186 ponds, of which 41 were in New Castle County, 33 in Kent County, and 112 in Sussex County (Table 1). Of the 173 ponds located (the remaining 13 ponds could not be found), 12 (6.9%) contained larvae or adults in 1983, 1986, or 1987 (Sites 7, 8, 11–20, Fig. 1; Table 1). Woods surrounded or partly bordered most (87.3%) ponds (Table 1). Twenty–two (12.7%) ponds were located in active agricultural fields (corn, soy bean, pasture) often 100 m or more from woods, and in developed areas. Approximately 110 (63.6%) of the 173 ponds are considered to be man–made and 63 (36.4%) natural (Table 1). Ninety–seven (56.0%) of the 173 ponds are considered to be permanent, and 76 (44.0%) vernal (Table 1). These last numbers no doubt vary annually with rainfall and temperature.

Eighty–nine (51.4%) of the 173 ponds contained no fish (Table 1). Fish were absent from all vernal ponds sampled, and are no doubt absent from all ponds considered vernal. Sixty–two (35.8%) ponds contained fishes, typically largemouth bass, *Micropterus salmoides*; bluegill, *Lepomis macrochirus*; and pumpkinseed, *L. gibbosus*, and these had usually been stocked. A total of 12 additional fish species common in Delaware and the eastern United States were noted in some other of theses 62 ponds. The presence or absence of fish in another 22 ponds in agricultural fields and developed areas was not determined. No pond with fish contained larvae of *A. tigrinum*.

Table 1. Data on Delaware ponds surveyed in 1983, 1986, 1987, by county and by counties combined, for actual and potential use by breeding *Ambystoma tigrinum*. Ponds were located on U. S. Geological Survey topographic maps.

	New Castle County	Kent County	Sussex County	All Counties Combined
Number Ponds Located	38	28	107	173
With at Least Some Woods To Pond Edge	34	24	93	151
Lacking Woods on Pond Edge	4	4	14	22
Ponds Considered Man-Made	10	14	86	110
Ponds Considered Natural	28	14	21	63
Ponds Considered Permanent	11	15	71	97
Ponds Considered Vernal	27	13	36	76
Ponds with No Fish	29	13	47	89
Ponds Containing Fish	6	9	47	62
Presence of Fish in Ponds Not Known	3	6	13	22
Ponds Used by Breeding Tiger Salamander	3	0	9	12
Ponds Believed Not Suitable for Breeding by Tiger Salamander	12	13	61	86
Suitability of Ponds for Breeding by Tiger Salamander Not Known	23	15	37	75

Only one pond with fish contained any life-history stage of *A. tigrinum.* I found no larvae or fish in this pond when it was sampled in summer 1986. This puzzled me as the pond appeared highly suitable for *A. tigrinum.* On 6 December 1986 I found numerous adult salamanders and two eggs here, as well as one adult largemouth bass. I hypothesize that this fish was stocked in this small pond, that it was present but not caught in summer 1986, and that it did not prey on *A. tigrinum* eggs or adults but that it fed and grew large on salamander larvae produced here in spring and summer 1986 (and perhaps earlier years).

Of the 12 breeding ponds found, 10 contained larvae and six contained adults, and two of the ponds with adults also contained egg clusters (Table 2).

One pond (Site 17) had been vandalized. On 4 January 1987 the clear water in this partially-filled pond (surface area of approximately 30 m^2) was only to 11.5 cm deep. The pond contained 42 adult salamanders, dozens of newly hatched larvae, and approximately 60 egg clusters attached to grasses in the pond center. All but two of the adults had been shot and killed. The two live adults were measured and released, those relatively intact were measured, and six vouchers were saved (CM 115435-15440).

Seven of the 12 breeding ponds are man-made, and five are natural (Table 3). All man-made ponds are located in borrow pits situated in 1) inactive pits in still-active sand extraction operations, and 2) in now abandoned operations. All borrow ponds are in upland areas, except for one in lowland forest. Owners of two borrow ponds informed me that they were excavated in 1951 and 1968. This indicates that the salamanders moved into them relatively recently, and from distances of hundreds of meters, as there are no other *A. tigrinum* breeding ponds in the vicinity. All natural breeding ponds are bays.

All of the natural and three of the seven borrow pit breeding ponds dried between late spring and late summer 1986 (Table 3). No larvae were found in two of four ponds (all man-made) that retained water through summer of 1986, in one case no doubt because of the presence of a fish predator, and in the other for an unknown reason. Thus, in 1986 only three ponds (two permanent and one that dried in late summer) apparently supported larvae to metamorphosis. However, in a more typical and wetter year additional vernal ponds probably retain water until salamander metamorphosis.

Table 2. Dates and total numbers of egg clusters, larvae, and adults of *Ambystoma tigrinum* observed (o) and those collected (c) in May 1983 and from June 1986 to January 1987 in 12 ponds in Delaware. Voucher specimens were saved from all ponds except numbers 7 and 16.

Site No.	Dates Eggs Were Found	Dates Larvae Were Found	Dates Adults Were Found
7	—	6 May 1o, 0c	—
8	—	6 May 8o,5c	—
11	—	8 Jun 4o, 4c	—
12	—	7 Jun 3o, 3c	—
13	—	15 Jun 1o, 1c	—
14	—	15 Jun 18o, 18c; 29 Jun 8o, 8c; 12 Jul 6o, 6c; 27 Jul 1o, 1c	26 Dec 7o, 3c
15	6 Dec 2o, 1c; 26 Dec 2o, 1c	—	6 Dec 14o, 4c; 26 Dec 7o, 0c
16	—	—	26 Dec 3o, 0c
17	4 Jan 60+/-o,0c	15 Jun 6o, 6c; 4 Jan 75+/-o, 23 c	4 Jan 42o, 40c (those kept had been shot by vandals)
18	—	14 Jun 14o, 11c; 30 Jun 4o, 4c; 12 Jul 9o, 9c; 27 Jul 11o, 4c; 7 Aug 4+o, 4c; 17 Aug 7o, 3c	6 Dec 3o, 2c; 26 Dec 1o, 0c
19	—	30 Jun 1o, 1c	7 Dec 1o, 1c
20	—	7 Jun 6o, 6c	—

Table 3. Data on ecology of 12 Delaware ponds known to contain one or more life–history stages of *Ambystoma tigrinum* in 1983, 1986, and 1987.

Pond No.	Man–Made (MM) or Natural (N)	Permanent (P) or Vernal (V)	Estimated Maximum Surface–Area When Filled (Hectares)	Estimated Maximum Depth (m)	Observed Near–Surface Water Temperatures (C)	Observed pH Values
7	N	V	4.7	1.3	17.0	5.5
8	N	V	3.6	1.3	23.0	6.0
11	N	V	1.05	1.0	3.3–41.1	6.0–6.1
12	N	V	0.26	1.0	1.1–24.4	5.9–6.1
13	N	V	0.80	1.2	29.0	6.7
14	MM	V	0.02	1.2	6.7–34.4	6.4–7.7
15	MM	P	0.02	1.3	5.6–7.2	6.2–6.3
16	MM	P	0.003	0.6	7.2	6.2–6.5
17	MM	V	0.50	1.2	7.2–35.0	6.1–6.8
18	MM	P	0.04	1.6	6.1–32.2	6.9–7.8
19	MM	P	0.09	1.3	5.0–30.5	6.2–6.8
20	MM	V	0.07	0.7	0.6–27.7	6.0–6.3

Physical Characteristics of Breeding Ponds

Pond maximum surface areas and depths are listed in Table 3. Man–made ponds were small, and the bays relatively large. Natural ponds had a large surface–area to volume ratio and a gently sloping bottom, and thus decreased greatly in surface area in warm weather. Borrow ponds had a smaller surface–area to volume ratio and steep sides, and in summer decreased in area much less than bays. In 1986, larvae metamorphosed only in the longer–persisting man–made ponds.

Water temperatures recorded within three or four inches of the water surface in breeding ponds are given in Table 3. Water temperature range when larvae were present was 7.2 C—35.0 C; larvae no doubt occur at lower temperatures. Larvae collected during July and August 1986 in one pond were taken in deeper and more shaded waters that were 2.2 C cooler than in near–surface and shore water, while earlier in the summer (June) larvae here were found in near–surface and in shore waters. Adults were taken at water temperatures ranging from 5.0 C—7.8 C, and from some ponds partly covered by ice. Eggs were taken at water temperatures of 5.6 C—7.2 C. Air temperatures at which any life–history stage of A. *tigrinum* was found ranged from 1.1 C—36.1 C.

The pH value range for all ponds with *A. tigrinum* was 5.5 to 7.8 (Table 3). Larvae were taken over this entire range. Bays were usually more acidic than man–made ponds. Alkaline waters were noted only in two man–made ponds. The largest and most robust larvae were taken in a generally alkaline pond with a pH range of 6.9 to 7.8, but large size probably resulted from more optimal water temperatures and food rather than higher pH.

Water color in breeding ponds ranged from brown (tannins) and clear to strongly turbid. Clear water was noted usually but not exclusively in bays, and turbid water was noted occasionally in man–made ponds, particularly after rains and where pond edges lacked plant cover. Algal blooms probably accounted for the occasional green tint in waters of some bays and man–made ponds.

Substrate in breeding bays ranged from firm sandy loam with dead plant stems to heavily organic and deep mud. In man–made breeding ponds, substrates ranged from firm mud–sand with much organic material to deep soft mud to bare soft deep clay and sand.

Biotic Characteristics of Breeding Ponds

All bays contained abundant submerged or flooded wetland vegetation and included pondweed, *Potamogeton* sp.; duckweed, *Lemna* sp.; tearthumb, *Polygonum* sp.; meadow beauty, *Rhexia virginica* and *R. mariana*; rice cut-grass, *Leersia oryzoides*; burreed, *Sparganium* sp.; and others. Man-made ponds ranged from lacking any vascular plants (two ponds) to containing abundant unidentified aquatics and various emergents such as foxtail, *Phragmites communis*; cattail, *Typha* sp.; sedge, *Scirpus* sp.; meadow beauty, and pondweed. Buttonbush, *Cephalanthus occidentalis*, occurred in all bays and some man-made ponds. It varied from poorly developed and occasional in some ponds, to over 2 m high and abundant in some bays.

Seven breeding ponds (five bays, two man-made ponds) were surrounded by mature mixed forest, and the remainder were partly bordered by forest. Common were American holly, *Ilex opaca*; loblolly pine, *Pinus taeda*; red cedar, *Juniperus virginiana*; dogwood, *Cornus florida*; tulip tree, *Liriodendron tulipifera*; sassafras, *Sassafras albidum*; red maple, *Acer rubrum*; sweet gum, *Liquidambar styraciflua*; swamp magnolia, *Magnolia virginiana*; wild cherry, *Prunus* sp.; six species of oaks, *Quercus*; and others. Common shrubs were lowbush blueberry, *Vaccinium* sp.; catbriers, *Smilax* spp,; poison ivy, *Rhus toxicodendron*; bayberry, *Myrica* sp.; Virginia creeper, *Parthenocissus quinquefolia*; Japanese honeysuckle, *Lonicera japonica*; and others. All but one borrow pond were located in high sandy areas where the deep pits tapped the water table. Xeric habitat around some borrow ponds supported camphorweed, *Heterotheca subaxillaris*; winged sumac, *Rhus copallina*; bear oak, *Quercus ilicifolia*; and other species.

All bays and one borrow pond contained prolonged standing surface water, as indicated by water-stained trunks of trees and shrub bases on the pond perimeters. Plants present here included bald cypress, *Taxodium distichum*; black tupelo, *Nyssa sylvatica*; black willow, *Salix nigra*; common persimmon, *Diospyros virginiana*; highbush blueberry, *Vaccinium corymbosum*; false pepperbush, *Clethra alnifolia*; wild grape, *Vitis* sp.; viburnum, *Viburnum* sp.; and ferns.

A total of 10 species of amphibians was observed in breeding ponds, and included spotted salamander, *Ambystoma maculatum*; newt, *Notophthalmus viridescens*; Fowler's toad, *Bufo woodhousei fowleri*; cricket frog, *Acris crepitans*; chorus frog, *Pseudacris triseriata*; bullfrog, *Rana catesbeiana*; green frog, *Rana clamitans melanota*; pickerel frog, *Rana palustris*; wood frog, *R. sylvatica*, and southern leopard frog, *R. utricularia*. Reptiles noted in ponds were snapping turtle, *Chelydra serpentina*; mud turtle, *Kinosternon subrubrum*; painted turtle, *Chrysemys picta*; water snake, *Nerodia sipedon*; and five-lined skink, *Eumeces fasciatus* (pond dry). Noted in adjacent woods were red-backed salamander, *Plethodon cinereus;* box turtle, *Terrapene carolina;* and ring-necked snake, *Diadophis punctatus.*

Tiger Salamander Life History

Seventy-eight breeding adults were found in six ponds from 6 December 1986 to 4 January 1987 (Table 2). One to 42 adults were found per pond. Adults were not present in six unfilled ponds.

Based on data for live and preserved adults from all ponds combined, the SVL of 29 adult males ranged from 95 mm—120 mm (x = 109.3 mm) and is about equal to SVL of 25 adult females (range 90 mm—124 mm, x = 108.1 mm). The TL of males (range 199 mm—264 mm, x = 228.6 mm) exceeded that of females (range 175 mm—244 mm, x = 200.3 mm). Ten live adult males each weighed from 23.2 g—58.6 g (x = 37.1 g), and two live adult females weighed 21.0 g and 33.0 g.

For all ponds combined, the ratio of adult males/females collected on 6 and 7 December was 17/1, on 26 December it was 13/5, and on 4 January it was 14/20 (sex of eight other specimens on the last date could not be determined because of gunshot damage). These data indicate that males preceded females to ponds. All females were gravid, although eggs in two ponds indicated that at least some of these, or other, females had begun oviposition.

Four egg clusters were found attached to tree branches in one pond on 6 and 26 December. The clusters were incomplete, perhaps damaged by seining. Approximately 60 intact clusters were attached to grasses in shallow water in another pond on 4 January. One intact cluster contained 107 eggs; cluster dimensions were 90 mm by 55 mm by 37 mm, and its volume was 100 ml.

Twenty-three newly hatched larvae from Site 17 on 4 January measured from 9.6 mm—12.8 mm SVL (x = 10.3 mm), and from 17.0 mm—23.1 mm TL (x = 18.5 mm); larval weight ranged from 0.037 g—0.099 g (x = 0.050 g).

Ranges in length and weight, by month, of 82 older larvae from seven ponds combined were: May (n = 5) 29 mm—33 mm SVL (52 mm—60 mm TL) 1.0 g—1.8 g; June (n =50) 33 mm—67 mm SVL (53 mm—122 mm TL) 1.6 g—15.9 g; July (n =20) 41 mm—78 mm SVL (70 mm—149 mm TL) 2.9 g—

23.7 g; August (n = 7) 75 mm—82 mm SVL (137 mm—152 mm TL) 18.6 g—26.2 g.

Larval size differed markedly between ponds. Mean larval weight in two ponds differed almost by a factor of two (4.3 g versus 7.7 g) in mid-June samples (n = 26), and by a factor of three (4.9 g versus 14.7 g) in mid-July samples (n = 15). Corresponding TL differed by 19% (82.4 mm versus 101.5 mm) and by 30% (86.0 mm versus 123.3 mm) in the same samples, respectively. Larval age and food availability likely influenced size.

Larvae were found in one pond until 27 July, when one specimen was taken, and several larvae were found in another pond until 17 August. Larvae presumably metamorphosed and then migrated out of both ponds.

Captive larvae in 1986 metamorphosed (resorbed their gills, swam erratically in aquaria in apparent efforts to leave the water, and no longer fed while in water) between 20 June and 30 July. Captive metamorphosed larvae (n = 5) ranged in weight from 6.5 g—10.3 g (x = 7.5 g), and in length from 56 mm—72 mm SVL (x = 62.0 mm) and 99 mm—118 mm TL (x = 105.6 mm).

One of 11 larvae collected at Site 18 on 14 June 1986 was metamorphosing. It measured 115 mm TL, and was similar in size to associated unmetamorphosed larvae. Unmetamorphosed larvae up to 152 mm TL were collected at this site in mid-August. Recently transformed specimens of 105 mm and 107 mm TL were found crossing a highway on 1 August (Arndt, 1983).

Three larvae collected at three ponds in June were kept in captivity until post-metamorphosis. From total lengths ranging from 82 mm to 106 mm and weights from 4.3 g to 10.1 g at capture, one reached 145 mm TL and a weight of 14.7 g by 8 December 1986, and the other two reached 176 mm TL and 177 mm TL and weights of 21.8 g and 25.1 g, respectively, by 25 December 1986. These sizes are comparable to those of reproductive adults in the wild.

Stomach contents of 50 larvae collected in June, 20 larvae collected in July, and seven collected in August (larval size range 33 mm—82 mm SVL) yielded seven (9.1%) empty stomachs and a total of 2609 individual food items in the remainder. Foods were primarily in five classes and 15 orders in the phyla Arthropoda and Mollusca (Table 4).

Insects were found in 95.7% of stomachs with food, Crustacea in 52.9%, and mollusks in 35.7%. Important foods (% occurrence) for all

Table 4. Percent frequency of occurrence (%) and mean number ($\bar{x}$) of food items by month, and for all months combined, in stomachs of larvae of *Ambystoma tigrinum* from Delaware in 1986 for six sites combined. Percents and means based on numbers of stomachs that contained foods.

FOOD	JUNE		JULY		AUGUST		TOTAL	
	%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$
Arachnida								
Hydracarina	2.2	.02					1.4	.01
Crustacea								
Cladocera								
Daphnidae	33.3	12.71	42.1	23.15			32.8	14.45
Chydoridae	6.7	7.33					4.3	4.71
Unidentified	2.2	1.11					1.4	.71
Ostracoda	42.2	11.80	15.8	5.26			31.4	9.01
Copepoda								
Cyclopoida	24.4	.91					15.7	.58
Malacostraca								
Isopoda	6.7	.17					4.3	.11
Amphipoda	2.2	.02					1.4	.01
Insecta								
Ephemeroptera	6.7	.13					4.3	.08
Odonata								
Anisoptera	44.4	.62	52.6	.53	100	1.50	51.4	.67
Zygoptera	28.9	.51	21.0	.18	83.3	2.16	31.4	.63
Unidentified	13.3	.95	15.5	.67			18.6	1.04
Hemiptera								
Notonecta	8.8	.09	5.3	.05	16.7	.33	8.6	.10
Corixidae	17.8	.18			16.7	.17	12.8	.13
Trichoptera	13.3	.29					8.6	.18
Coleoptera								
Dytiscidae	17.8	.29					11.4	.18
Unidentified	6.7	.09					4.3	.06
Diptera								
Culicidae	2.2	.07					1.4	.04
Chironomidae	13.3	1.50	26.3	1.63			15.7	1.38
Unidentified	31.1	.80	5.3	.05			21.4	.53
Unidentified Insecta	11.1	.31	26.3	.31			14.3	.40
Gastropoda								
Lymnaea	2.2	.15					1.4	.10
Unidentified	48.8	2.71	5.3	.21			32.8	1.80
Bivalvia	2.2	.07					1.4	.04
Unidentified remains in above taxa	17.8	—	10.5	—			14.3	—
Filamentous algae	4.4	—	5.3	—			4.3	—
Plant seed	2.2	.02					1.4	.01
Miscellaneous (sand grains, unidentified plant remains)	6.7	—	5.3	—			5.7	—
Number stomachs empty	5		1		1		7	
Number stomachs examined	50		20		7		77	

months combined were Anisoptera (51.4%), Daphnidae (32.8%), Zygoptera (31.4%), Ostracoda (31.4%), unidentified Diptera (21.4%), Chironomidae (15.7%), Cyclopoida (15.7%), and Corixidae (12.8%) (Table 4). Filamentous algae were found in 4.3% of stomachs.

Particularly important as measured by mean number of food items per stomach were Daphnidae (mean number of 14.45 items), Ostracoda (9.01), Chydoridae (4.71), unidentified Gastropoda (1.80), Chironomidae (1.38), and unidentified Odonata (1.04) (Table 4). Surprisingly, not found were any remains of vertebrates, such as tadpoles, which were common in all breeding ponds that contained *A. tigrinum* larvae, or any sign of cannibalism.

Variation in diet between populations at different ponds was pronounced. Insects comprised the great majority of food of larvae from Sites 14 and 18 (the sites that yielded the most larvae), but there were pronounced inter–pond differences in the insect orders ingested and their percentage occurrence. Percentage of stomachs with insects at Sites 14 and 18 (in parentheses) compared was: Odonata, 53.6% (100%); Ephemeroptera 10.7% (0%); Trichoptera, 10.7% (6.7%); Coleoptera 28.6% (0%); and Diptera 42.9% (23.3%). Gastropods were found in 82.1% of larvae from Site 18, but were absent in larvae from Site 14. Odonata and Hemiptera were the only foods found in August samples, based on examination of seven larvae from one pond.

Status and Conservation

The tiger salamander is now known from most of Delaware. It no doubt breeds in more ponds than those enumberated in this survey since 1) some ponds present in Delaware were probably not located in this survey, 2) in a wetter year than 1986 recruitment probably occurs from more vernal ponds than noted herein, and 3) larger numbers of larvae are most likely produced per breeding pond in a more normal and wetter year than in 1986. Pronounced variation in annual survival rates of larvae is probably normal (Semlitsch, 1983), and the long–lived adults no doubt carry populations through periods of low reproductive success.

Population size of Delaware *A. tigrinum* is estimated to be large based on 1) its distribution through almost the entire state, 2) the relatively large numbers of adults found at several ponds, 3) the large numbers of larvae noted in some ponds, and 4) the greater numbers of larvae estimated to be present in some bays. However, rapid development of portions of Delaware, with potential adverse impact on suitable habitat, suggests that this species be monitored.

Ambystoma tigrinum in Delaware occurs over a wide range of ecological conditions. It appears to require only permanent or long-lasting vernal ponds free of fish and with adjacent mature mesic or mixed forest for successful reproduction. Such habitat is still common. The number of potential breeding ponds, a likely limiting factor for the species, can be augmented by eliminating fish in otherwise suitable ponds and by new pond construction. This would be particularly effective on lands secure from major habitat alteration, such as logging or development for construction.

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THE STATUS OF THE LIZARD *COLEONYX FASCIATUS* AND THE BIOLOGICAL SPECIES CONCEPT

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Abstract. Although most recent authors have regarded Boulenger's *Eublepharis fasciatus* as a subspecies of *Coleonyx variegatus*, Grismer has argued that it is specifically distinct. His conclusion is here accepted, but arguments quoted that the biological species concept supports conspecificity is untenable. The criterion of biological species is reproductive incompatibility; it says nothing about the status of populations that are reproductively compatible. The concept is incontrovertibly valid for organisms reproducing exclusively bisexually, hence virtually all tetrapods; it is not valid for most organisms reproducing otherwise, hence is not applicable universally, nor is that now claimed, although attacked frequently under that supposition.

Grismer (1988) has presented an excellent review of eublepharid geckos, mostly at the species and higher levels. Most of his conclusions concerning names for and ranks of Mexican taxa have appeared in his earlier publications, although his phylogenetic conclusions are to a certain extent new. The only taxonomic change introduced for Mexican taxa in the new account is the elevation of Boulenger's *Eublepharis fasciatus* from the subspecific rank in *Coleonyx variegatus* it has held in most works since 1965 (Conant, 1965; Dixon, 1970; Kluge, 1975; DeLisle, 1980; Webb, 1984; Smith, 1987) to specific rank.

In so doing, Grismer (1988:433) pointed out that previous authors, in accepting subspecific rank for *fasciatus* because of evidence of occasional interbreeding between *fasciatus* and *C. v. sonoriensis*, had been guided by the biological species concept, "which of late has come under heavy criticism." Those criticisms were directed, however (e.g. Mishler and Donoghue, 1982), at the inadequacy of the biological species concept in the role of universality: a "unified field species concept," and were based largely on phenomena occurring widely among plants and parthenogenetic animals.

There can be no controversy on the limited validity of the biological species concept; it may well not be valid even for the majority of species. It is, however, fully confirmed as valid for virtually all tetrapod species, and for these it is an objective reality. It is definitely not a concept on the verge of abandonment; instead distributional limitations are simply being more clearly defined. Certainly the concept is completely valid for *Coleonyx* species as well as most other tetrapods.

Assumption that the biological species concept requires distinct taxa that interbreed to be regarded as subspecies is erroneous. Reproductive *incompatibility* does indeed denote specific rank, but reproductive compatibility by no means denotes subspecific rank; many well recognized, related species evolving in isolation from each other fail to evolve intrinsic isolating mechanisms, simply because there is no selection pressure to do so. In these cases a degree of difference consistent with that between related taxa that *are* reproductively incompatible is the only standard available.

Since Grismer (1988) has shown that occurrence of intermediates between *fasciatus* and *C. v. sonoriensis* is both exceptional and erratic, without regularity, and that the morphological differences between *C. variegatus* and *fasciatus* are equal in magnitude to those distinguishing other well-accepted species of the genus, the biological species concept is no argument to consider the taxa as subspecies. His conclusion that they are of specific rank is fully consistent with the concept, and correct on the basis of information at present available.

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EASTERN HOGNOSE SNAKE EATS SPOTTED SALAMANDER

The primary prey of the eastern hognose snake, *Heterodon platyrhinos*, are various anurans, especially toads and hylid frogs, but occasionally salamanders are also eaten (Wright and Wright, 1957; Platt, 1969; Ernst and Barbour, 1989). In most cases where salamanders have been listed as prey no species have been given. The spotted salamander, *Ambystoma maculatum*, has only once been reported as prey of *H. platyrhinos* (Trauth, 1982), and this episode occurred in Arkansas.

At 1018 hr, 27 April 1988, an approximately 55 cm male *H. platyrhinos* was discovered basking in a pile of brush next to an old field at the Mason Neck National Wildlife Refuge, Fairfax County, Virginia. When placed on open ground, the snake performed the typical stereotyic threat, convulsions, and death feigning behavior of the species. During the convulsions, it disgorged the complete head and partially digested body of an adult *Ambystoma maculatum*. Both the snake and salamander are common at Mason Neck, and many adult *A. maculatum* breed in March in a shallow cement pool approximately 300 meters from where the snake was caught. Only toads had been previously recorded as *Heterodon* food items at the refuge.

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The Catalogue of American Amphibians and Reptiles

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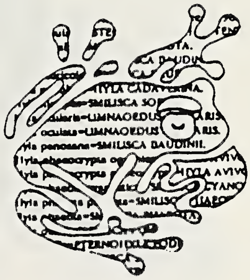

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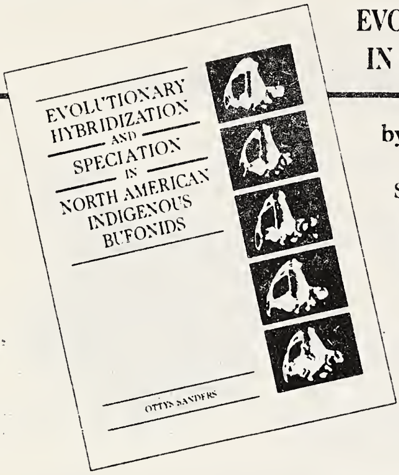

EVOLUTIONARY HYBRIDIZATION AND SPECIATION IN NORTH AMERICAN INDIGENOUS BUFONIDS

by Ottys Sanders

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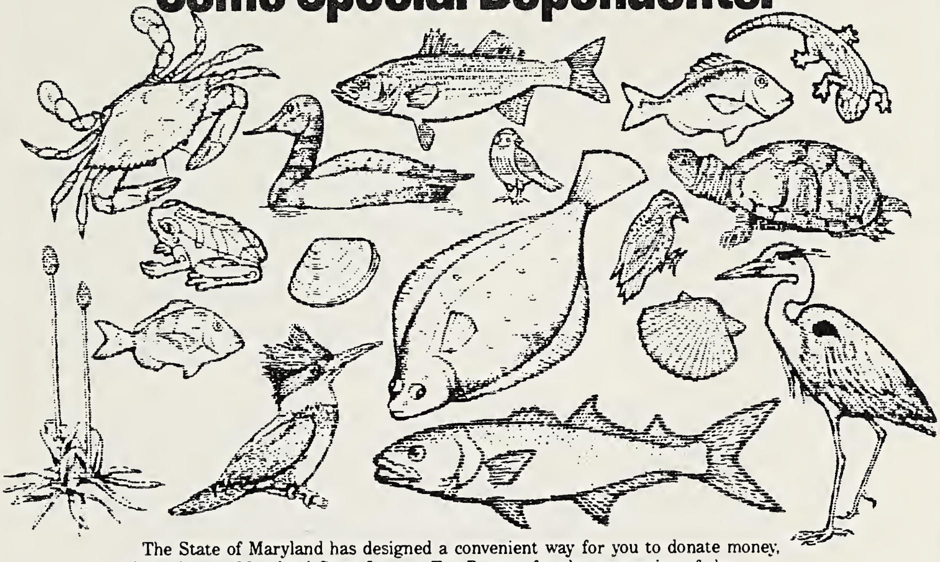

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DEPARTMENT OF HERPETOLOGY

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JUNE 1989

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Volume 25 Number 2 June 1989

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MAP AND SOFTSHELL TURTLES FROM VERMONT

Terry Graham

Aside from old literature records of map and softshell turtles from Vermont (Thompson, 1842, 1853; Babbitt, 1936), there is no recent published information on the distribution of these two species in Lake Champlain. Babbitt (1936) felt that the eastern spiny softshell, *Trionyx spiniferus spiniferus* (LeSueur), was scarce or rare, while Babcock (1919) indicated that the few Lake Champlain softshells in museum collections were all taken from the vicinity of the Winooski River near Burlington. He also mentioned that one other Vermont specimen taken from the White River (no other data) was in the collection of the Boston Society of Natural History (BSNH). In reference to the common map turtle, *Graptemys geographica*, Babcock (1919) cited Thompson (1842, 1853) who reported them as common all along the eastern shore of Lake Champlain, but nowhere else in the state.

Examination of the old BSNH reptile catalogue shows that prior to 1940 *Graptemys* were found along Champlain's eastern shore from Swanton south as far as Shelburne. The same catalogue shows that *Trionyx* occurred from Alburg south only as far as the Winooski River at Burlington. It is regrettable that the bulk of the BSNH material has been discarded or destroyed. From 1983 to the present the following field sightings of basking *Graptemys* have been recorded (DesMeules, unpubl.): 1) West Haven near the mouth of the Poultney River, Rutland Co.; 2) Benson at Red Rock Bay, Rutland Co.; 3) Colchester on the lake side of Colchester Bog, Chittenden Co.; 4) East Alburg near the west end of the Rte. 78 bridge, Grand Isle Co.; 5) Highgate at Big Metcalf Island on Mississiquoi Bay, Franklin Co.; 6) Shelburne Bay, Shelburne, near the mouth of the LaPlatte River, Chittenden Co. In the future additional field work will be necessary to determine if *Trionyx* occurs south of Franklin and Chittenden Counties.

In an effort to satisfy my curiosity about the possible occurrence of Blanding's turtle (*Emydoidea blandingi*) in Vermont, I undertook a collecting trip in July of 1988. On the assurance of a commercial snapping turtle trapper I headed for St. Albans Bay, Franklin Co., with two fyke nets and ten conventional nylon mesh turtle traps to find *Emydoidea*. What I found instead was an apparent plethora of *Graptemys*, which I assume were the probable basis for the *Emydoidea* rumor. I managed to catch five *Graptemys* and one *Trionyx* over a two day period. The collection site was a marshy expanse which includes the confluence of Jewett and Stevens Brooks just north of St. Albans Bay State Park (44°48'30"N and 73°08'45"W).

Before launching my canoe and setting traps I carefully scanned the area with a 60X spotting scope and immediately saw about eight adult *Graptemys* basking on a cut off stump in the middle of the open water. I subsequently saw many more map turtles sunning in dense aggregations on limbs, stumps, and floating debris throughout the marsh. At no time did I see any *Trionyx*. The single softshell collected was taken on canned sardines in soybean oil. This specimen, an adult male, was subsequently donated to the Museum of Comparative Zoology at Harvard University (MCZ 174022). Its dimensions were as follows: carapace length (CL) = 157.3 mm, plastron length (PL) = 85.9 mm, and greatest carapace width (GCW) = 142.6 mm. Of the five map turtles captured, the two juveniles (Table 1) were taken by dipnet while basking inshore. A hatchling *Graptemys* was spotted near the canoe launch site, but it was not netted. All young map turtles basked at or very close to shore (Pluto and Bellis, 1986), and the fact that they did bask contradicts the suggestion of Gordon and MacCulloch (1980) that juvenile *G. geographica* do not bask. Basking adult *Graptemys* were exceptionally wary and retreated from their basking perches whenever I got within 50 m in the canoe. The single adult male (Table 1) was found dead in a baited trap, the apparent victim of a lethal bite to the head by a very large male snapping turtle (*Chelydra serpentina*). The two females (Table 1) were taken in baited traps which did not contain snappers and it occurred to me that they may actually avoid traps containing snappers.

Chelydra was the most frequently taken turtle and several times two or three large adults were caught in the same trap. The other turtle commonly caught on bait was the painted turtle, *Chrysemys picta*. No turtles except a few painteds and a small snapper or two were taken in the fyke nets. A probable cause of this was the rather extensive net damage caused by entrapped muskrats. Many holes chewed in the nets at water level by these rodents provided exits for turtles. However, these nets did capture large numbers of carp (*Cyprinus carpio*) and a few bowfin (*Amia calva*). Water depth above the soft ooze-like sediments in the marsh was less than 1 m in most places. The sediments were almost 1 m deep in many places, but were underlaid by a firm substrate. Nonetheless, it was very difficult wading around while setting the nets.

Contrary to the findings of Pluto and Bellis (1986) that only *Graptemys* in their first season of growth are not sexable, I was not able to sex either of my juveniles which were in their second season of growth. Of the four live *Graptemys* returned to my lab, one died 8–28–88 (MCZ 174020) and the others were sacrificed on 9–1–88 and subsequently donated to the MCZ. I can confirm the claim that map turtles are hyperactive and difficult to maintain in captivity (Carr, 1952). They refused to eat for me and continually swam against the walls of their tanks until they abraded the skin on their legs from repeated contact with the underside of the carapace. The reluctance of map turtles to feed in captivity is well known (Newman, 1906; Pope, 1939).

Table 1. Museum number (MCZ), carapace length (CL), plastron length (PL), greatest carapace width (GCW), greatest shell height (SH), and weight (WT) of five *Graptemys* from St. Albans Bay, Vermont.

MCZ	CL_{mm}	PL_{mm}	GCW_{mm}	SH_{mm}	WT_{g}	SEX
174017	230.2	205.9	181.3	81.2	1670.1	F
174018	237.3	207.8	186.4	85.3	1740.1	F
174019	132.8	115.5	101.8	48.1	251.4	M
174020	77.3	68.4	67.6	28.4	51.8	J
174021	85.4	78.8	71.8	31.9	66.9	J

Plastron size at hatching and after one year of growth for the two juvenile *Graptemys* was estimated by the summation of medial border lengths of the plastral annuli (Graham, 1979). For MCZ 174020 the estimates are, hatching = 31.3 mm, and 1 yr = 55.0 mm; for MCZ 174021 hatching size = 29.9 mm and 1 yr = 55.9 mm. These data yield 75.7% and 100.3% annual increments, respectively. Such growth rates are extremely high for New England turtles; spotted turtles increased 43% their first year (Graham, 1970), redbellies grew 63% their first year (Graham, 1971), and snapping turtles grew 73.9% their first year (Graham and Perkins, 1976). I was told that the marsh site at St. Albans Bay receives treated sewage effluent via Stevens Brook. This nutrient source has undoubtedly contributed to the enhanced growth rates of juvenile *Graptemys* in the marsh, in much the same way that effluent enrichment probably stimulated the growth of *Chelydra* at the Great Meadows in Massachusetts (Graham and Perkins, 1976). It would be interesting to examine growth rates for *Chrysemys* and *Chelydra* from St. Albans Bay to see if their early growth is accelerated as well.

Acknowledgment

I am grateful to Marc Desmeules for the use of his unpublished field records and both he and Chris Fichtel helped with net checks. Without the able assistance of Doug Nesbitt with canoe, nets, and traps, this project would have been extremely difficult, if not impossible. And thanks, Doug, for dipnetting the young map turtles. The use of fyke nets and baited traps was authorized under a scientific collecting permit granted by the Vermont Department of Fish and Wildlife.

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STRUCTURE AND COMPOSITION OF TWO LIZARD COMMUNITIES OF THE CAPE REGION, BAJA CALIFORNIA SUR, MEXICO

Sergio Alvarez, Patricia Galina and Alfredo Ortega–Rubio

Abstract

The composition of two lizard communities from the Cape Region, Baja California Sur was studied. Structural data, such as diversity, density, dominance and biomass of these assemblages are provided and discussed, with special emphasis on endemic species.

The Cape Region, located at the meridional tip of the Baja California Peninsula, is an interesting location for the study of flora and fauna, due to its long time isolation (León de la Luz *et al.*, 1988; Murphy, 1983). The species of the Cape Region differ remarkably from those of the northern and central parts of the peninsula and from those of the Sierra Madre Occidental. The amphibian and reptile species of the Cape Region are for the most part endemic and are related, in a primitive way, to species from the Sierra Madre Occidental and other parts of the peninsula (Murphy, 1983; Stebbins, 1985).

Biological and ecological studies about endemic species are important. Most studies on lizard species of the Cape Region were focused on the taxonomic aspects (Van Denburgh, 1920; Schmidt, 1922; Hall and Smith, 1979; Ottley and Murphy, 1983; Scudder *et al.*, 1983) and more recently on biogeographic aspects (Savage, 1960; Seib, 1980; Murphy, 1983). Works concerning the biology and ecology of the endemic lizards of the Cape Region are few (Asplund, 1967; Leviton and Banta, 1964; Papenfuss, 1982; Karasov and Anderson, 1984; Ortega *et al.*, 1987).

In this work we studied the structure and composition of two lizard communities at the Cape Region, analyzing their diversity, density, species dominance and biomass. The results obtained represent a contribution to the knowledge of these little studied lizard species.

Study Sites

Our observations concerned two localities: "El Comitán" and "El Mogote." Both study sites are located in the northern part of the Cape Region (Fig. 1) in the state of Baja California Sur, Mexico. "El Comitán" is located 17 km north of La Paz City, and is a coastal lowland with mud–sandy soils. Its predominant floristic–physiognomical unity is the xerophitic–scrub (León de la Luz and Troyo, 1985), composed mainly of the cacti *Pachycereus pringlei, Machrocereus gumosus* and the shrubs *Jatropha cinerea* and *Fouqueria digueti*. "El Mogote" is located over the bar that limits the Ensenada of La Paz, 19 km NW La Paz City. Its substratum is mainly sand dunes and the principal plant species are the shrubs *Cyrtocarpa edulis, Condalia* sp. and *Lycium* sp. (León de la Luz and Troyo, 1985). The average annual temperature in both zones is 23.9°C, with a mean annual precipitation of 62 mm concentrated mostly in the summer (August–September). The weather is BW(h')hw(e) (Hanstings and Humprey, 1969).

Methods

We marked a 10,000 m² square in each study site. At the end of July 1986 we collected for four consecutive days. Individuals were secured using .22 caliber dust shot, rubber bands or by hand. All the animals were weighed, sexed, preserved, and deposited in the herpetological collection of the Centro de Investigaciones Biológicas.

The diversity was calculated by the Simpson's Index (Levins, 1968) which considers the number of species and the individuals per species: $D = (p_i^2)^{-1}$.

Diurnal lizard density per hectare for each species was estimated using the regression line (Delany, 1974) (a standard minimum method originally used on rodents, but in this case applied to lizard populations). Biomass was calculated using the number of individuals collected of each species and lizard body mass. The biomass dominance percentage was estimated with the relative percentage of biomass corresponding to each species population in the sampled area (Cox, 1976).

Results

A total of 11 lizard species was collected at the "El Comitán" study site. At "El Mogote" we collected 7 species, all represented in the "El Comitán" collection (Table 1). Table 1 show that, at "El Comitán", not only is the species diversity greater, but also the number of individuals. The most abundant at this study site, having the highest number of individuals are: *Cnemidophorus hyperythrus, Urosaurus nigricaudus, Uta stansburiana* and *Dipsosaurus dorsalis*; the former two are Baja endemics or autochthons. At "El Mogote" the more abundant species are *Uta stansburiana, Callisaurus draconoides* and *Dipsosaurus dorsalis.*

If we consider not only the number of individual lizards but their body mass (Table 2), we see that at "El Comitán" *Dipsosaurus dorsalis* and *Ctenosaura hemilopha* represent 63% of the lizard community biomass, where as at "El Mogote" *Dipsosaurus dorsalis* alone, represents 67% of the total lizard biomass in this community. At "El Comitán" *Cnemidophorus hyperythrus* and at "El Mogote" *Callisaurus draconoides* show respectively a biomass percentage greater than 10%,

Discussion

When we take into account a parameter different from the number of individuals, such as biomass, the relative importance of each species is shown. For example, two of the most common lizards at "El Comitán", *Uta stansburiana* and *Urosaurus nigricaudus* together, represent only 6.7 on the total biomass of that community. At "El Mogote", *Uta stansburiana* is the main species as characterized by the number of individuals, but represents only 6.7% of the total biomass.

The biomass results support one of the main conclusions obtained from the data on the number of individuals: the community diversity is greater where the substrata are more diverse and where habitat structure is more complex.

Several authors have stated that these lizards are closely dependent on the microhabitat spatial features such as structure, and mainly on the optimal substratum availability (Barbault et al., 1985: Ortega et al., 1982). Our results support this idea and also give additional information concerning ecological aspects such as community diversity and relative abundance of these little known species of the Cape Region.

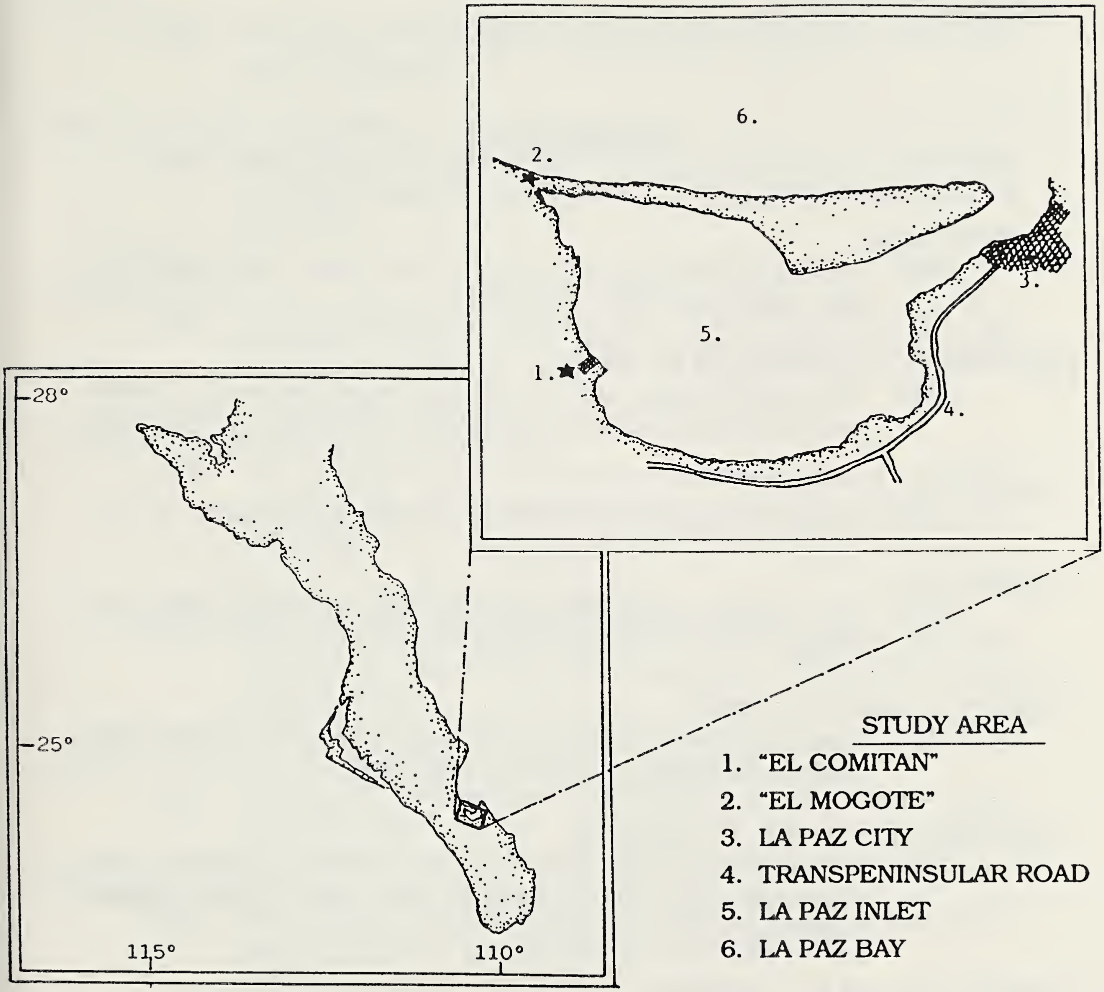
Table 1. Species diversity. Numbers of Individual Lizards collected by species at each study site. (E = Baja California endemics or autochthons).

	"EL COMITAN"	"EL MOGOTE"
GEKKONIDAE		
Coleonyx variegatus	1	1
Phyllodactylus unctus (E)	2	–
IGUANIDAE		
Dipsosaurus dorsalis	9	11
Callisaurus draconoides	3	32
Sceloporus monserratensis (E)	2	–
Sceloporus zosteromus (E)	3	1
Uta stansburiana	13	43
Urosaurus nigricaudus (E)	40	–
Ctenosaura hemilopha	2	–
Phrynosoma coronatum	2	1
TEIIDAE		
Cnemidophorus hyperythrus (E)	42	2
TOTALS		
Number of species	11	7
Number of individuals	141	96
Diversity	5.45	3.07

Table 2. Biomass (grams/hectare) and its relative percentage in the communities of lizard populations found at both study sites.

	"EL COMITAN"		"EL MOGOTE"	
	Biomass g/ha	Dominance % biomass	Biomass g/ha	Dominance % biomass
Coleonyx variegatus	2.50	.18	2.8	.24
Phyllodactylus unctus	4.18	.30	—	—
Dipsosaurus dorsalis	508.22	36.90	637.71	67.4
Callisaurus draconoides	16.82	1.22	152.90	16.1
Sceloporus monserratensis	25.50	1.85	—	—
Sceloporus zosteromus	114.20	8.30	40.03	4.2
Uta stansburiana	29.89	2.17	63.42	6.7
Urosaurus nigricaudus	62.19	4.50	—	—
Ctenosaura hemilopha	362.91	26.40	—	—
Phrynosoma coronatum	70.71	5.10	36.50	3.8
Cnemidophorus hyperythrus	189.20	13.71	12.20	1.2
TOTALS	1375.8	100.0	945.5	100.0

Fig.1: The study sites.



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NOTES ON EVAPORATIVE WATER LOSS IN TERRESTRIAL CHELONIANS

R. Earl Olson

In two recent articles I have discussed evaporative water loss in *Gopherus berlandieri* (Olson, 1976, 1987). During those studies, data were gathered on several other species of varying taxa and habitat preferences. The purposes of the present article are to describe the measured body weight loss (BWL) under ambient temperature and humidity regimes and to present comparative data.

Studies of *Gopherus berlandieri* indicated that members of that genus are notably conservative in evaporative water loss (EWL). Such a conclusion was not solely a comparative one. In addition, it was observed that individuals of that species have the capacity—as relates to EWL—of remaining dormant for much greater periods of time than habitat climatic cycles demand.

Experimentation was carried out with *Emydoidea blandingi, Geochelone carbonaria, Geochelone denticulata, Geochelone pardalis, Kinixys belliana, Rhinoclemys pulcherrima, Testudo graeca, Terrapene carolina carolina, Terrapene carolina triunguis*, and *Terrapene ornata*. Numbers of subjects totalled 205, involving 1700 subject-days. These observations were conducted along with those of *Gopherus berlandieri* and under similar conditions. Subjects were observed both during activity and dormancy seasons.

Observations reveal two factors: 1) that activity and dormancy season BWL differ one from the other, and 2) that *Emydoidea* and *Terrapene* differ markedly from the other species studied in BWL conservancy (Tables 1–4).

Three factors were borne in mind: 1) habitat, 2) behavior, and 3) apparent degree of development of physiological mechanisms to allow freedom from drinking water. For instance, *Emydoidea blandingi* is known to be "semi-aquatic" and to drink water, a habit of *Terrapene* as well. Retreat burrows, of whatever moisture content or degree of cover, are utilized by all species concerned. The problem under investigation was the degree of ability of these chelonians to conserve body water in ambient temperatures and humidity without benefit of cover.

SPECIES ACCOUNTS

Emydoidea blandingi: These turtles are "semi–aquatic". In Illinois (Olson, 1956), Wisconsin, and Minnesota I have often found them either swimming in sloughs or about bogs or swamp edge. During cool late May and June days and again in mid–autumn in Minnesota they are commonly terrestrial. Body water loss in this species is very rapid: 1.2 (1.1–1.3)% BW/day during the activity cycle in three individuals. Compared with more terrestrial species of large size this figure is staggering (see Figs. 1 & 2).

Geochelone carbonaria: Two weight classes were sampled during activity period: 75–120g, and 650–800g. The 75–120g group showed g/d loss averaging 2.91 representing 2.70% BWL, while the larger tortoises (650–800g) were more conservative with 2.08 g/d, 0.23% BWL.

Geochelone denticulata: Subjects of this species were in the 900g class. Results were similar to those seen in *G. carbonaria*: 2.08 g/d, 0.23% BWL.

Geochelone pardalis: Turtles of this species are inhabitants of lightly forested areas and savannah. Although in dormancy the water loss was quite as conservative as in *Gopherus berlandieri* of comparable size (0.38 g/d; 0.06% BWL), at activity temperatures there was more marked loss (3.27 g/d; 0.46% BWL).

Kinixys belliana: Observations of the 250g sample during activity showed 1.2 g/d; 0.49% BWL. These tortoises inhabit savannah and grassland habitats.

Rhinoclemys pulcherrima: An inhabitant of forested slopes and lowland savannah, members of this species nevertheless revealed surprising water conservancy: 1.6 g/d; 0.63% BWL at the 250g weight level during activity.

Testudo graeca: A 300g subject was quite conservative during 18 subject days, with 1.54 g/d loss, representing 0.51% BWL. Populations of *Testudo graeca* occur in semi–desert habitat.

Testudo sulcata: (Data from Cloudsley–Thompson, 1970).

33.5± 1°C	–	101.9–90.3g/6 days	=	1.9% BWL/24 hrs
33.5± 1°C	–	116–101g/18 days	=	0.72% BWL/24 hrs
28.0± 1°C	–	44.5–39.0g/18 days	=	0.69% BWL/24 hrs

Terrapene carolina carolina: Living in the relatively moist deciduous forests of eastern North America, these turtles exhibited non-conservative water retention compared with tortoises. During the activity cycle they lost an average of 2.3 g/d in both 180–280g and 300–450g weight groups, with 0.93 and 0.76% BWL respectively for those two classes. During dormancy at 5°C, the averages for 180g animals were 0.39 g/d and 0.2% BWL; for the larger animals, 0.47 g/d and 0.16% BWL.

Terrapene carolina triunguis: This subspecies inhabits long–grass prairie and open woodland. Even so, it is equally non–conservative as is the above race.

Terrapene ornata: As inhabitants of both long–grass and short–grass prairies, as well as semi–desert conditions, these turtles are relatively non–conservative regarding water loss. During activity temperatures of 33°C, the larger animals (200–400g) showed BWL of 1.1 g/d = 0.30 to 0.47% BWL.

The conservative nature of EWL in tortoise species of the various genera is not shared with members of any of the taxa exhibiting semi–aquatic or water–drinking behavior. Data indicate that even the most precipitous loss of body water in any of the tortoises approximate only 50% that of either *Terrapene* or *Emydoidea* samples studied.

Without water replenishment, and retreat to moist situations, it is doubtful that members of either *Terrapene* or *Emydoidea* could survive a summer of activity. Whereas most of the tortoises would fare quite well for considerable periods. Observations indicate that, when the BWL approaches 50% in an animal, the animal lapses into a lethargic state, during which food and water are refused, and for recovery to occur, special treatment is required.

Fig. 1: % BWL/24 hr. averages for four species of tortoises in the 250–300 gram weight range, during activity temperatures.

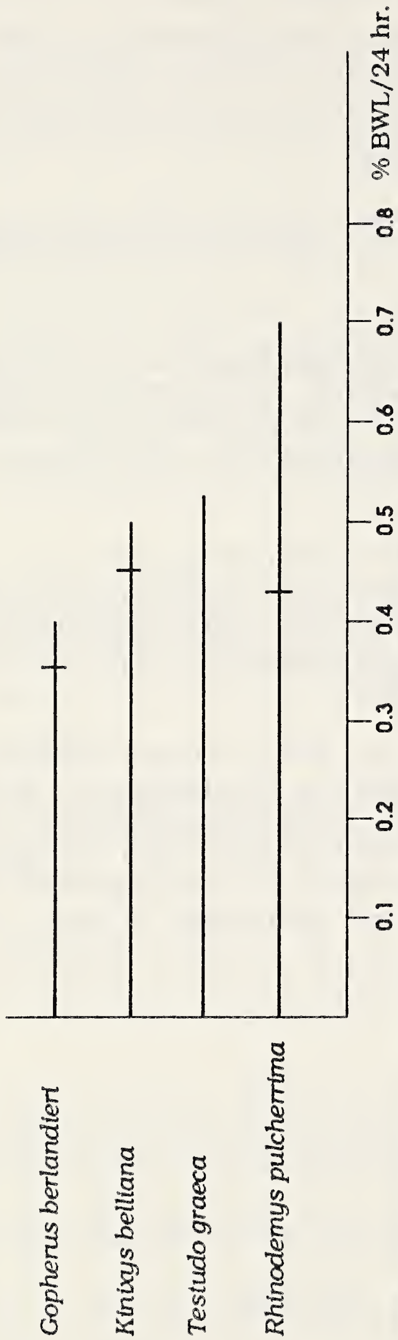

Fig. 2: % BWL/24 hr. averages for four species of tortoises in the 700–800 gram weight range, during activity temperatures.

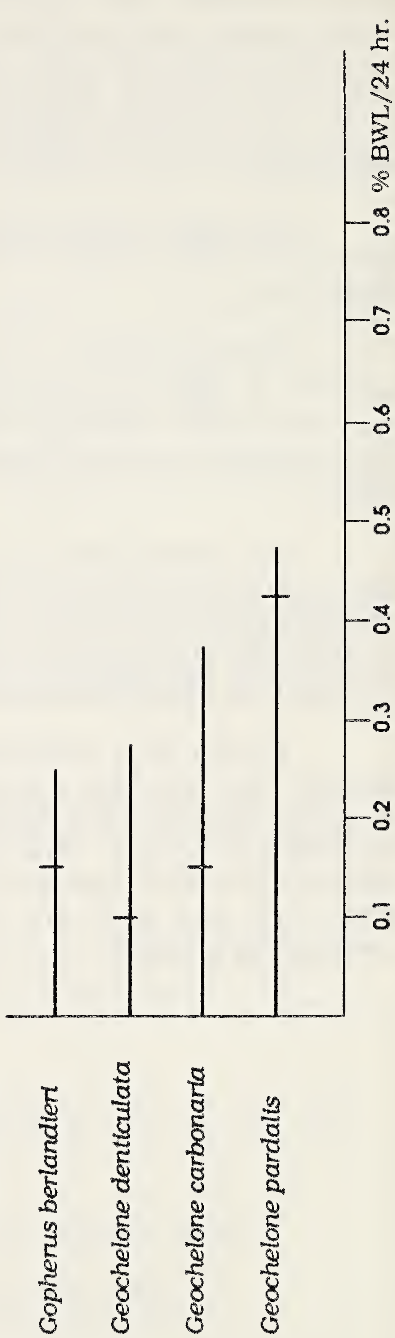

Table 1: % BW loss/24 hr in species of land turtles under summer activity temperatures (unless otherwise indicated) @ 32°C ± 1°

		% BWL	g/d	Subject days
Geochelone denticulata				
900 g		0.23 (0.07–0.41) 7	2.08 (0.6–4.0) 7	59
Geochelone carbonaria				
650–800		0.37 (0.12–0.65)	2.71 (0.1–5.1)	56
75–120		2.72	2.71 (0.9–4.0)	25
Geochelone pardalis				
700–775 grams				
	35°C	0.46 (0.42–0.49)	3.27 (3.0–3.5)	7
	25°C	0.19 (0.14–0.30)	1.37 (1.0–2.1)	26
	15°C	0.06 (0.04–0.10)	0.38 (0.2–0.7)	14
Rhinoclemmys pulcherrima				
250		0.63 (0.4–0.8)	1.6 (1.5–2.0)	4
Kinixys belliana				
250		0.49 (0.43–0.54)	1.2 (1.1–1.3)	35
Testudo graeca graeca				
300		0.51	1.54	18
Emydoidea blandingi				
1800–2000		1.2	24.36 (14.6–29.7)	19

Table 2: Body weight loss data for *Terrapene carolina carolina* subjects.

	Subj. No.	ACTIVITY CYCLE Temp.	g/d loss	%BWL	DORMANCY CYCLE Temp.	g/d loss	%BWL
to 100g.							
75g	158	32°C		1.1			
100–200g.							
200–300g.							
280g	146	32°C	2.15	0.7			
210g	156	32°C	2.45	1.1			
220g	162	32°C	2.23	1.0			
180g	169	32°C			5°C	0.39	0.217
			$\bar{x} = 2.28$	$\bar{x} = 0.93$			
300–450g.							
310g	155	32°C	2.25	0.88			
400g	157	32°C		0.8			
390g	163	32°C	2.33	0.61			
315g	166	32°C			5°C	0.474	0.16
			$\bar{x} = 2.29$	$\bar{x} = 0.76$			
450+g.							
480 g	167	32°C			5°C	0.215	0.0478

Table 3: Body weight loss data for *Terrapene carolina triunguis.*

		ACTIVITY CYCLE			DORMANCY CYCLE		
	Subj. No.	Temp.	g/d loss	%BWL	Temp.	g/d loss	%BWL
to 100g.							
90g	104	32°C	0.82	0.91			
70g	154	32°C	0.10	0.18	5C	0.33–0.41	0.090, 0.060
100–200g.							
120g	108				5C	0.19	0.13, 0.13, 0.14
130g	175						
200–300g.							
220g	125	32°C	1.2, 1.3	0.54, 0.6	20C	1.0, 1.1	0.48, 0.5
					5C	0.28, 0.1	0.14, 0.05
250g	164	32°C	1.13	0.452	5C	0.07	0.031
				$\bar{x} = 0.53$			
300–450g.							
320g	165	32°C	1.88	0.607	5C	0.173	0.058
320g	147	32°C	2.43	0.748			
370g	160			1.15			
				$\bar{x} = 0.84$			
450+g.							
480 g	126	32°C	1.9, 1.8	0.4, 0.38	20C	1.5, 1.5	0.32, 0.32
					5°C	0.15, 0.35	0.08, 0.03
			$\bar{x} = 2.0$				

Table 4: Body weight loss data for *Terrapene ornata*.

TERRAPENE ORNATA

Weight Regime Data

	Subj. No.	ACTIVITY CYCLE Temp.	g/d loss	%BWL	DORMANCY CYCLE Temp.	g/d loss	%BWL
to 100g.							
40g	170				5C	0.013	0.033
100–200g.							
130g	103	32°C	1.2	0.80			
130g	109	32°C			5C	2.2, 3.2, 4.8	0.10, 0.06, 0.10
190g	110				5C	3.4, 3.9, 5.0, 5.6	0.06, 0.07, 0.07, 0.09
170g	127	32°C	1.1, 1.0	0.59, 0.6	20C	0.75, 0.75	0.47, 0.47
105g	129	32°C	0.3, 0.45	0.3, 0.44	5C	0.1, 0.07, 0.07	0.1, 0.07, 0.07
					20C	0.41, 0.31	0.42, 0.31
200g	171	32°C	1.90 $\bar{x} = 1.0$	0.958 $\bar{x} = 0.62$	5C	0.122	0.0642
200–300g.							
200g	128	32°C	0.4, 0.6	0.36, 0.21	20C	0.5, 0.58	0.34, 0.36
					5C	0.13, 0.11	0.09, 0.08
	202	32°C	1.8, 1.4 $\bar{x} = 1.1$	0.825 $\bar{x} = 0.47$			
300–450g.							
400g	102	32°C	0.69	0.21	5C	0.11, 0.65	0.05, 0.11, 0.027, 0.007
		32°C	1.5 $\bar{x} = 1.1$	0.38 $\bar{x} = 0.30$	5C	0.45, 0.86 0.07	0.1, 0.2 0.021
330g	102				5C	0.52 $\bar{x} = 0.49$	0.17 $\bar{x} = 0.86$

Parts of this work were aided by students, especially Robert Hruska and Glennice Campbell. The extensive literature references were presented earlier (1987a).

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A *TERRAPENE CAROLINA TRIUNGUIS* FROM MARYLAND

On the morning of 17 August 1988, a driver, traveling north on Maryland route 45 in Hunt Valley, stopped to retrieve a box turtle crossing the road. This specimen is the only *T. c. triunguis* recorded from the state of Maryland.

The specimen, a female, measures 12.4 cm in length and 9.2 cm at her widest point (This being 6 cm from the front, at the 7th marginal adjacent to the scuteal seam between 2nd and 3rd costal scutes). Weight is not available for the time of capture, since I did not receive the specimen until January 12, 1989. The *T. c. triunguis* is now recovering from a respiratory infection and does appear to be doing well at this time. It will be deposited in the collection of the NHSM.

Single records on non–native species of turtles are not uncommon in Maryland. Such chelonia as *Kinosternon bauri* (Miller, 1988), *Graptemys khoni* (Schwartz, 1967), *Emydoidae blandingi* (McCauley, 1945), and *T. c. major*, have all been recorded from Maryland. With the exception of the lone *T. c. major* found in Beltsville in the summer of 1986, however, none had any reproductive potential. What makes this record of such concern is the fact that while the *T. c. major* was a male, it was found in a highly urbanized area, thus limiting reproductive potential with our native *T. c. carolina*. The *T. c. triunguis*, on the other hand, was a female. Since female *T. carolina* can retain sperm for at least four years, there is a chance that offspring of various ages, fathered by males of both *T. c. triunguis* from this female's natural range and *T. c. carolina* local to the area, may be living in the proximity of the capture.

Assuming that there may be offspring in the area of capture may be premature, but the possibilities concern me, especially with the knowledge that thousands of *T. c. triunguis* are sold in the pet shops and department stores of neighboring states. Unfortunately, many of these animals are sold to inexperienced consumers who may, for a multitude of reasons, release them outside of their natural range. With that in mind, I urge all herpetologists, both amateur and professional, to stress the consequences of such actions in their literature (especially popular literature aimed at such collectors, as well as any and all regional newsletters).

I ask anyone with knowledge of other such incidents in Maryland, or any other state, to please contact me at this address (Photographs are desired).

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1945. *The Reptiles of Maryland and the District of Columbia.* Published by the author, Hagerstown, vi + 194 pp, 46 figs., 48 pls.

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—K. Peter Polley, *71 North Main Street, Stewartstown, PA, 17363*

Received: 18 January 1989
Accepted: 20 January 1989

MANTIS PREYS ON SALAMANDER

At 1100 hours on 28 September 1988, while performing a rare herptile study for the Nongame and Endangered Species Program of the New Jersey Department of Environmental Protection at the Earle Naval Weapons Station, Colts Neck Township, Monmouth County, New Jersey, I noted motion among the leaves and stems of a meter–high milkweed from which I then saw a large insect fall to the ground. Upon immediate examination I found it to be an adult praying mantis that had tumbled to the sandy road surface while grasping a small salamander in the spines of its forelegs. The amphibian was an immature red–backed salamander, *Plethodon cinereus*, approximately 35mm. long, with sand grains adhering to it from its contact with the road. The 50mm. insect, recognized as *Mantis religiosa* by the single black–ringed spots near the bases of its front coxae, held the nearly–motionless salamander behind the eyes and near the base of the tail. An injured area three to four mm. long in the central portion of the salamander's back indicated the mantis had been feeding upon it prior to its fall. Because mantids usually devour their prey at the sites of capture, and this mantis would have had particular difficulty moving about with its heavy load, evidence suggested that the salamander had been captured in the milkweed, an unusual morning location for a nocturnal, ground–dwelling amphibian. I took a photograph and observed the pair for approximately 15 minutes, during which time the mantis continued to feed. Rechecking the site at 1400 hours, no signs of mantis, salamander, or remains were found.

Although popular literature has occasionally mentioned small vertebrates being eaten by mantids, and Prescott (1968) reported a large mantis—possibly *Tenodera sinensis*—feeding on a bird that had been trapped in a mist net, I know of no other records of mantids preying on salamanders.

Literature Cited

Prescott, K. W.
1968. Preying Mantis Feeds on Netted Brown Creeper, Bird Banding 39:59.

—Raymond J. Stein, *Biostar Associates, RFD Box 165, Far Hills, New Jersey 07931*

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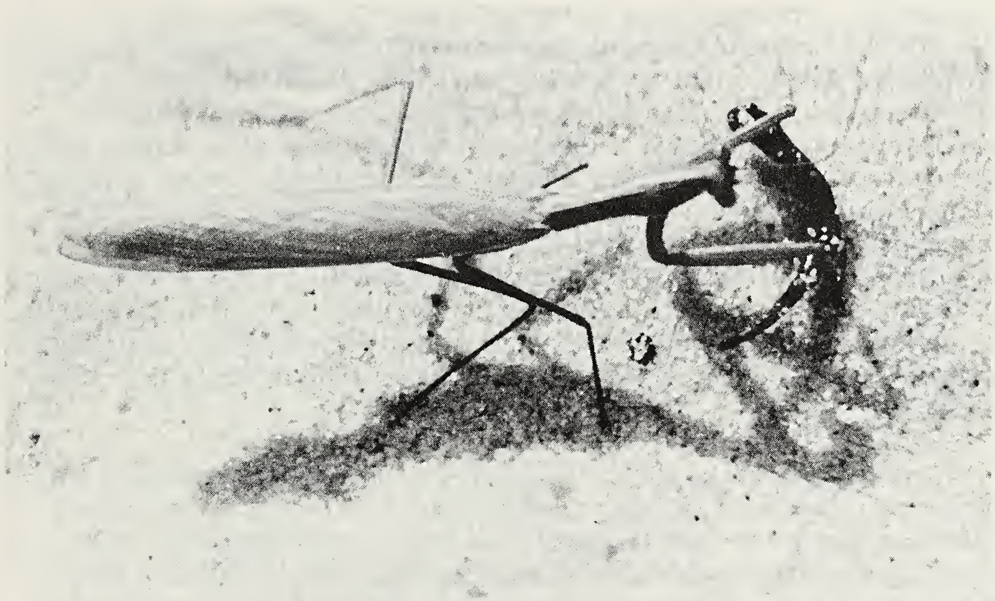

Fig. 1: A *Mantis religiosa* feeding on a *Plethodon cinereus.*

BOOK REVIEW

MIDDLE AMERICAN HERPETOLOGY: A BIBLIOGRAPHIC CHECKLIST.

By Jaime Villa, Larry David Wilson, and Jerry D. Johnson. University of Missouri Press, 200 Lewis Hall, Columbia, Missouri 65211. xxxvi, 132 pp., frontis., 91 color figs., map, 21 b–w figs. Nov. 22, 1988. $35.00, hardbound, with dust jacket, typeset, printed on glossy paper, 25.5x17.5 cm.

No reviewer can be comfortable reviewing a book dedicated as effusively as this to his wife and himself. In the relativity context at least of the unheralded contributions of those on whose achievements we all stand, encomiums are never deserved. Whatever the merit in this case, it is an outstanding honor to receive such a dedication. That honor properly belongs to the distaff side, solely responsible for production, and so often taken wrongly for granted.

Middle American Herpetology, produced by three of the most important living specialists on the herpetofauna of Middle America (defined as the area between the middle of the Isthmus of Tehuantepec and South America), the book is a major landmark in refinement of knowledge of its subject. As stated in the Foreword by Henry S. Fitch, the formidably diverse species treated (782) in this work constitute "the world's richest herpetofauna." With its enormous and scattered literature (850 cited works), increased exponentially in the last two decades, it has become very difficult for non–specialists to deal with. This book greatly simplifies the problem, and will no doubt be the catalyst for an even greater rate of growth in knowledge of the field it covers. Its utility is further enhanced by being essentially bilingual (Spanish and English).

The purpose of the work is to provide a catalog of all species of the herpetofauna of the area (subspecies are not dealt with), to state their existence in any of the seven complete countries and two areas of Mexico (Yucatán, southeastern Mexico), with references to documentation of distribution in each area, to provide references to the most recent important literature on each species, and to cite the location of selected illustrations. Important in the latter context are the 91 color figures and 21 b–w figures included in the book; most illustrate species particularly in need of depiction. A complete index of scientific names is appended.

The book is thus a tremendous boon for anyone, specialist or not, as a ready source of information on any segment of the Middle American herpetofauna. As stated in the introduction, it is intended as the first of a series of editions, each augmented and up-dated from its predecessor. Therefore users are urged to participate in making future editions accurate, complete and up-to-date.

The authors must be commended for undertaking such a major project, designed, as it is, primarily for the benefit of other workers, and for their plan to maintain it, expanded and up-dated, in the future. All workers having to deal with herpetofauna of Middle America can be grateful.

The University of Missouri Press has also made this a very attractive book, with very few typographical errors. It is well worth its price.

—Hobart M. Smith, *Department of Environmental, Population and Organismic Biology, University of Colorado, Boulder, 80309-0334.*

Received: 9 January 1989

NEWS & NOTES:

ORNATE BOX TURTLE
OFFICIAL STATE REPTILE OF KANSAS

The ornate box turtle became the official state reptile of Kansas on Monday, 14 April 1986 when Kansas Governor John Carlin signed a bill that had been passed by both the Kansas House the Kansas Senate. Governor Carlin signed the bill in front of several hundred people at the school in Caldwell, Kansas in what the Governor stated was the largest bill signing ceremony ever held during his terms as Governor of Kansas.

The idea of having this unique animal named the state reptile was that of the 17 students in the 1985-86 Caldwell, Kansas sixth grade class. They started their campaign during October of 1985, and by early 1986 they had gained the support of thousands of students and other interested people all across Kansas, and even a number of other states.

Caldwell is proud to have been a part of Kansas history. Several stores, in the small town located about 50 miles southwest of Wichita, are now selling such items as ornate box turtle t-shirts, belt buckles, bumper stickers, and post cards. Caldwell has even been declaired the "ORNATE BOX TURTLE CAPITAL OF THE WORLD" by city officials.

Requests for more information about the "ORNATE BOX TURTLE CAPITAL OF THE WORLD" and what is available in Caldwell, Kansas should be mailed to the address given below.

CALDWELL CHAMBER OF COMMERCE
"THE ORNATE BOX TURTLE CAPITAL OF THE WORLD"
P.O. BOX #42
CALDWELL, KANSAS 67022

NEW BOOKS

PEREZ-SANTOS, Carlos and Ana G. MORENO

Ofidios de Colombia. 1988. (Mongrafia VI, Mus., Reg. di Scienze Naturali, Torino). 87 colour photographs. 121 black & white figures. 28 distrib. maps. 517 p. gr8vo. Cloth. In Spanish, with bilingual (Spanish/ English) keys. DM 160; Approx. US$89

The main goal of this book is to give a clear summary of the actual knowledge of the snakes of Colombia. For further information we add a copy of the table of contents to this letter.

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TURTLES AND TORTOISES COMPREHENSIVELY DETAILED AND VIVIDLY DEPICTED IN LATEST ADDITION TO ACCLAIMED SERIES

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Chelonians -- the family of reptiles known as turtles, tortoises and terrapins -- have had a unique relationship with human beings throughout history. Highly regarded by the ancient Egyptians, kept as pets in many households, considered delicacies by gourmets, and slaughtered for their highly prized shells, turtles have been alternately revered and hunted by man.

TURTLES AND TORTOISES OF THE WORLD, by David Alderton (Publication date|: January 18, 1989; Price: $24.95, hardbound), is a complete guide to the evolution, physiology, habitat and characteristics distinctive to these resourceful creatures. The latest in Facts On File's acclaimed Natural History Series, the book features all the latest chelonian research as well as previously unpublished data.

Complemented by color and black and white photographs throughout and written in an accessible style, the text details the various species of turtles and tortoises so the reader will learn such things as:

* *While the group of reptiles variously known as tortoises, turtles and terrapins are instantly recognizable because of their distinctive shells, the actual terms used to describe the creatures are not that clear. "Tortoise" tends to be applied to those species which are primarily terrestrial; "turtles" are predominantly aquatic, and certain members of this group are known as "terrapins."*

* *Chelonians are able to store water within their bodies. In tortoises, the bladder itself is a particularly valuable site for the storage of water, a fact appreciated by sailors visiting the Galapagos who found giant tortoises there.*

NEWS & NOTES:

** The stinkpot turtle, one of the most widely distributed species, can be found as far north as Canada and as far south as Texas, possibly Mexico. These turtles exude an unpleasant scent whenever they feel threatened, and handling one in the wild will inevitably provoke this response.*

TURTLES AND TORTOISES OF THE WORLD provides a wealth of information and insight into these creatures' diversity of form, adaptability for survival, and their long lifestpan. The author draws attention to the danger of extinction threatening many of the species and discusses the artificial methods naturalists are using to try to preserve them.

DAVID ALDERTON is a noted naturalist and animal expert who has been active in wildlife conservation and legislation. Since studying veterinary science at Cambridge University, he has established himself as a leading author on pets and wildlife.

TURTLES AND TORTOISES OF THE WORLD
By David Alderton, photographs by Tony Tilford
Publication date: January 18, 1989; Price: $24.95, hardbound.
ISBN# 0-8160-1733-6.
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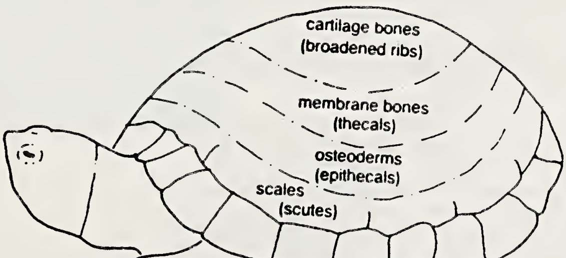

Fig. 1 The chelonian's shell comprises several layers, which increase its overall structural strength, although, in some cases, these layers may be reduced or absent. The scutes form the outer layer.

NEWS & NOTES:

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Carl H. Ernst and Roger W. Barbour

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Dr. Carl H. Ernst has been involved in research on the ecology and taxonomy of turtles for over 30 years. His previous book Turtles of the United States (also with Dr. Roger W. Barbour) won the Wildlife Society's prestigious "Wildlife Publication of the Year" award in 1973. Dr. Ernst is currently a professor of biology and director of the doctoral program in Environmental Biology/Public Policy at George Mason University. He received his Ph.D. in Zoology from the University of Kentucky. Dr. Roger W. Barbouris a professor emeritus at the University of Kentucky, where he retired in 1984. He has published several books, including *Bats of America* (University Press of Kentucky). Dr. Barbour received his Ph.D. from Cornell University.

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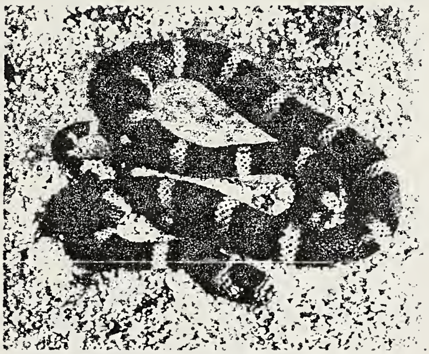

Lampropeltis triangulum andesiana.

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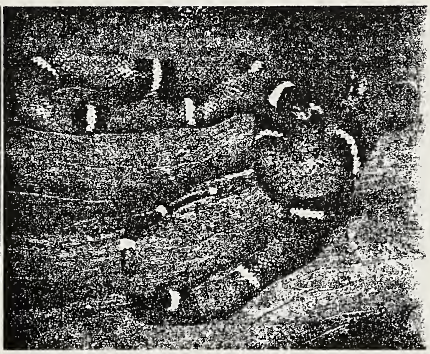

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DEPARTMENT OF HERPETOLOGY

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MdHS............A FOUNDER MEMBER OF THE
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SEPTEMBER 1989

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THE DISTRIBUTION OF *LEPTOPHIS DIPLOTROPIS* (SERPENTES: COLUBRIDAE)

Gonzalo Pérez–Higareda and Hobart M. Smith

Abstract

A new locality for the state of México, near its western border, at La Palma, near Temascaltepec, is the second for the state, and extends the known range of the species into another tributary valley of the Río Balsas, 80 km W of the other known locality, Chalma. Occurrence in other deep valleys cut into the western slopes of the central Mexican plateau is likely, making it probable that the species occurs marginally in three or four other inland states where it is not now known, to wit Durango, Zacatecas, Puebla and Aguascalientes.

The endemic Mexican snake species *Leptophis diplotropis* (Günther) was recorded in the latest review of the species (Oliver, 1948: 207–211, fig. 9, map) from the Pacific slopes of six states, from Sonora and Chihuahua in the north to the Isthmus of Tehuantepec in Oaxaca (Chihuahua, Guerrero, Michoacán, Nayarit, Oaxaca, Sonora). An earlier, acceptable record existed, however, for Sinaloa (Van Denburgh, 1898:464, Mazatlán), and an inacceptable one (Dugès, 1896:480) for Veracruz (Motzorongo, very likely referable to *L. m. mexicanus*). Although Smith and Taylor (1945:91) stated that records existed for Jalisco, none was published until 1958 (Smith and Grant, 1958:18), for Puerto Vallarta, Jalisco. Subsequently Morelos (Davis and Smith, 1953:133, 138–139; Progreso), Chiapas (Alvarez del Toro and Smith, 1956:13; Parque Madero) and Colima (Telford, 1964:40; Colima), all more or less to be expected within the range of the species, were added to the list. In addition, confirmation of occurrence in the Tres Marias Islands was later published (Zweifel, 1960:107, Maria Madre; McDiarmid et al., 1976:3, Maria Magdalena), as well as numerous substantiating records for mainland areas of several states.

Leptophis diplotropis is a lowland species whose distribution "coincides for the most part with the areas of tropical scrub forest" (Oliver, 1948:211). Its habitat requirements do, however, extend far up the deep canyons of many of the Pacific coast rivers, as is exemplified by the records from Chihuahua and Morelos. McCranie and Wilson (1987:16) place the species in both the Pacific Coast Tropical Area and the Cordillera Volcánica Montane Woodland Area, although certainly its occurrence in the latter zone is marginal. They regard it as a member of the Pacific Lowland Subhumid Assemblage.

It is to be expected, therefore, that the range of *Leptophis diplotropis* extends into a number of inland states in addition to Morelos and Chihuahua, as well as in the coastal states, from all of which it is now known. In that context, Camarillo's report (1983:43) for Chalma, state of México, is of special interest since that locality is on the Río Chalma, a tributary of the Río Balsas, and lies barely within the eastern boundary of the state with Morelos. We here report a second locality near the western border of the state of México, on the Río Temascaltepec, also a tributary of the Río Balsas, where one female *L. diplotropis* (first author's field no. GPH 88–70, in the UNAM herpetological collection) was found at La Palma, 1800 m, near Temascaltepec, in oak woodlands some 80 km W Chalma.

These reports, clearly near the extreme distributional limits of *L. diplotropis*, make it apparent that the species very likely penetrates other inland states, following the deep canyons cut into the western slopes of the central Mexican plateau. It may be expected as a part of the herpetofauna of Durango, Zacatecas, Puebla and possibly even Aguascalientes.

Acknowledgement

We are much indebted to Ing. Jorge Pérez Higareda, owner of Rancho La Palma, Temascaltepec, for his hospitality and aid in collection of herpetological material there.

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THE SIGNIFICANCE OF TOOTH CROWN MODIFICATION IN LIZARDS

Hobart M. Smith and David Chiszar

Abstract

Numerous dental crown types occur in lizards: haplodont, cuspidate, cristate, striate, denticulate, canaliculate, molariform. Their distribution, evolution, and comparative functional relationships remain to be elucidated.

The well–documented evolution of mammalian teeth through elaborations on a primitive multituberculate type (Peyer, 1968: 178–189), and familiarity with somewhat similar multicuspid types derived from the laterally compressed crown in many lizards (e.g. Iguanidae; Olson et al., 1986, 1987; Sumida and Murphy, 1987) has led to adoption of much the same terminology throughout for specializations, of that general type, in structure of the crown in lizards.

Tooth specializations in lizards are highly varied, and not limited to essentially a single theme such as that at least of extant taxa of mammals. Examples include the grooved, venom–conducting teeth of helodermatids (Peyer, 1968: pl. 66b), the nearly flat, crushing teeth of some macroteiids (Peyer, 1968: 157), the fused teeth of some agamids (Estes et al., 1988: 192), and the denticulate teeth of some moniters (Estes et al., 1988: 163). Many groups have simple conical teeth in part of the jaws (usually the anterior part), or throughout; that haplodont (or conodont) condition is primitive in some, no doubt a secondary simplification in others as is true in marine mammals (Peyer, 1968: 186). An ontogenetic change occurs in some, such as *Tupinambis* (Peyer, 1968; 155), with a complex juvenile structure (tricuspid) replaced in adults with simple conical teeth.

In most lizards, however, the crown modifications take the form of either (1) three or more cusps at the apex of a laterally compressed tooth, as shown by Olson et al. (1986) for most iguanids, or (2) one or more curved ridges, medially pointed, as is characteristic of gekkonids (Sumida and Murphy, 1987). These two types of specialization are not variations on one theme, but are of completely different character. We suggest that the second type be designated the cristate (Latin, crista, cristata, ridge or crest, ridged or crested) type, the first the cuspidate (Latin, cuspis, point) type.

The cuspidate type occurs widely in the Iguanidae and Teiidae, the cristate type in the Gekkonidae, Pygopodidae (Sumida and Murphy, 1987: 2891), Eublepharidae (Grismer, 1988: 387) and Scincidae (Sumida and Murphy, 1987; Olson et al., 1986). The highly modified, acrodont and sometimes fused teeth of the Chameleontidae and Agamidae are presumably derived from the cuspidate type (Sumida and Murphy, 1987; 2891; Estes et al., 1988: 193, 195), evident in parts of their jaws. So also is the molariform type in some teiids. The teeth of the Helodermatidae are also highly specialized, presumably derived from a primitive, simple, conodont type. However, the teeth of other Anguimorpha, insofar as described in detail, are "striate" – a condition seemingly independent of either cristate or cuspidate types, although possibly derived from the latter. The striate condition apparently has led to bizarre denticulate types as in *Varanus* (Estes et al., 1988: 163, fig. 10 D), and to the canaliculate type of *Heloderma*.

Although no thorough survey of crown modifications of lizard teeth has ever been made, it seems certain that the cristate type has arisen independently at least twice, in the Gekkota and the Scincoidea (classification of Estes et al., 1988: 140, fig. 6). The cuspidate type may well also have evolved at least twice, in the Iguania and Lacertiformes.

In any event, a thorough comparative study of tooth crown modifications–haplodont (conodont), cuspidate, cristate, striate, denticulate, canaliculate, molariform–throughout lizards promises to be fruitful of phylogenetic and functional insights. Only Sumida and Murphy (1987: 2887, 2889–2890) have so far dealt with comparative functional considerations, which remain to be explored in detail.

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COMMENTS ON THE NAME *AMPHIUMA TRIDACTYLUM* CUVIER (AMPHIBIA: CAUDATA) AND A CAUTION TO SYSTEMATISTS

Harold A. Dundee

Abstract

An earlier name, *Syren quadrupeda*, was proposed by Custis (1806) for *Amphiuma tridactylum*, but has been erroneously credited to Barton (1808). The history of the errors is discussed and reason to suppress *quadrupeda* as a specific epithet is given.

Salthe (1973) gave credit for the name *Amphiuma tridactylum* to Cuvier, 1827. The second entry in the synonymy presented gave "*Siren quadrupeda* Barton, 1808; Gray, 1850: 55. Not seen." If indeed the name *Siren quadrupeda* was given by Barton, it would have priority and the animal should have been called *Amphiuma quadrupeda* (Barton), a format that shows a transfer of genus for the species described. Strange that Salthe did not offer this latter name or a reason for its rejection. In actuality, Gray (p. 55) showed under *Muraenopsis tridactyla* the following: "? Four-footed Siren, Siren quadrupeda Barton on Siren lacertina."

I have an electrostatic copy of the original Barton article and nowhere in it do I find the name *Siren quadrupeda*. But on p. 28 Barton mentioned a "large four-footed Siren" from South Carolina and "that a species (probably the very same), with four feet also has been seen and examined by one of my pupils in the neighborhood of the Red-river..." The footnote identifies the pupil as Dr. Peter Custis of Virginia.

The American Philosophical Society kindly provided me with a copy of Custis' 1806 letter to Barton. On page 3 the following appears:

> "Twenty one miles below Natchitoches I saw an animal which was caught in a pond near the River that resembles in every respect, except the number of its legs, the Syren Lacertina.—It was furnished with four legs. Two were placed after the manner of the Lacertina's, the other two were placed about six inches from the end of its tail.—It measured three feet in length & 6 inches in circumference.—I have

> called it Syren quadrupeda until we know more of it.—Had it not been in a very advanced state of putrefaction I should have preserved and sent it on."

From the foregoing description we could feel fairly certain that the animal, based on appearance and geography, was what we know as *Amphiuma tridactylum.* Custis had likely seen *Siren lacertina* in Barton's laboratory because Barton had a live specimen and was preparing an account of it that appeared in 1808. To account for Custis' saying that the animal resembled *Siren lacertina*, except, for the legs, thus implying that gills were present, I can only suggest that his recall was somewhat blurred or that the decaying animal had damage in the pharyngeal region that either caused some loose tissue to resemble gills, or to make Custis think the gills had decayed away.

A published description in Freeman and Custis (1807, p. 60) reads as follows:

> "Twenty one miles below Natchitoches, Mr. Custis saw an animal which had been caught in a pond near the river, resembling in every respect, except the number of its legs, the *Syren lacertina* of Linn.: the *Lacertina* has two legs, it has four, the two hindermost of which are about six inches from the end of its tail. It measured three feet in length and six inches in circumference. Mr C names it the *Syren quadrupeda.*"

From the text the collection site was about 11 miles above the junction of Little and Cane rivers, thus about four miles north of Melrose, Natchitoches Parish, Louisiana. The above description constitutes an acceptable description of the species, but rather than the credit going to Barton, it belongs to Peter Custis.

Further exploration of the possibility of Barton having supplied a name is in order. Did Barton actually us the name *Siren quadrupeda* as implied by Gray (1850)? Barton (1806a) published part of Custis' letter, but left out the account of *Syren quadrupeda.* Barton (1807, p. 23) said that Custis "has observed near the Red–river, a new and singular species of Proteus, which resembles the Proteus anguinus, and some other European species, in being furnished with *four* legs." The Barton 1808 paper, referred to by Gray (1850), was republished in 1821 and it is the same paper as my copy of the 1808 paper. Flores (1984, p. 227) said that in 1808 "in his article, 'Some accounts of the *Siren lacertina* and other species of the same genus,' Philadelphia Medical and Physical Journal Supplement (1808), p. 69, Barton proceeded to describe a new, four–legged *Siren* using a slight variation of the name Custis had proposed: *Siren quadrupedes*, for which Barton has received credit in the literature." I have examined the University Microfilms copy of the Philadelphia Medical and Physical Journal series (1806–1809), as well as the originals of that journal, and found no 1808 supplement. Three supplements are included: 1806, 1807, 1809. In the 1806 supplement, no. 1, section second (Barton 1806b) a specimen of *Siren lacertina* is mentioned on p. 69, but clearly nothing pertaining to a Red River animal that could be *Amphiuma*. Flores (pers. comm.) indicated that he also cannot locate the Barton 1808 paper in the Philadelphia Medical and Physical Journal microfilm to which he had access. Barton himself (1812) referred to the 1808 paper in such a way that the privately printed version that I have seen is the only version.

At this time the best guess is that Gray (1850) and Flores (1984) may have gotten their notes scrambled and gave credit to Barton where such was not deserved. Except for Gray (1850), no use of *Syren quadrupeda* or variant seems to exist, other than in Custis' original description. I will therefore ask the International Commission on Zoological Nomenclature to apply Article 23 b and Article 79 c of the International Code of Zoological Nomenclature to suppress the specific epithets "*quadrupeda*" and "*quadrupedes*" as pertaining to *Amphiuma* because the senior epithet has not been used as a valid name for the past 50 years and its use would threaten nomenclatural stability of the name *Amphiuma tridactylum*.

An important moral should be gained from the story of *Syren quadrupeda*–never cite a paper without reading the original for one's self. I have seen various incorrect citations of my own writings and of other articles that I have checked. With regard to the Barton (1808) title, I myself have misquoted it as "Some accounts of the *Siren lacertina* and other species of the same genus" before I got a copy of the paper. That is the same title given by Salthe (1973), Flores (1984), and Nickerson and Mays (1973). Schmidt (1953) under *Cryptobranchus*, incorrectly gave "Some account of the *Siren lacertina*..." But in fact the actual title has the word "account" and did not use italics for *Siren lacertina*. Barton's text style used italics, but not for complete scientific names. He did give "*horrida*", immediately followed by "Salamandra horrida". The actual title is more extensive than usually cited (see Lit. Cited). If an author does cite something he has not seen, he should at least quote his source, e.g., Barton (1808) (fide H. Dundee, 1989).

Acknowledgments

I am indebted to Beth Carroll–Horrocks and Roy Goodman of the American Philosophical Society Library for supplying me with documents from the Benjamin S. Barton Collection, and to Dr. Joseph Ewan of the

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AMPHIBIANS AND REPTILES OF A COASTAL PERIURBAN ECOSYSTEM (SOLYMAR, URUGUAY): LIST, PRELIMINARY ANALYSIS OF COMMUNITY STRUCTURE, AND CONSERVATION.

Eduardo Gudynas

Abstract

The amphibians and reptiles of Solymar, Dpto. Canelones, Uruguay, were studied between 1977 and 1984 (46 field trips). The herpetofauna was found to be composed of 29 species (14 amphibians and 15 reptiles). The present day physiognomy of the site has resulted, in part, from human activities due to physical restructuring and introduction of exotic trees and shrubs. These species were found in seven of the eight recognized habitats (Beach; Open Formations; Marshes; Isolated Trees; Synanthropic; Channels and Debris). Highest species richness was found in Marshes, dominated by amphibians. The man-made Artificial Woodlands habitat presented zero species. Reptiles were dominant in the Open Formation habitat. Species composition for environmental components resulted in the highest richness for the terrestrial component (dominated by reptiles) immediately followed by aquatic and aquatic-margin components (dominated by amphibians). These habitats present a low number of shared species, signaling a low success in colonization of new habitats, particularly Artificial Woodlands and Isolated Trees. Reproductive strategies were analyzed. The community structure may be divided in two main species group: colubrids, transient species, found from the terrestrial to aquatic components; and a second heterogeneous group, including anurans and a turtle and lizard associated with microlimnotopes, lizards associated with the terrestrial component, while *E. bicolor* could not be classified. This composition seems to be the result of an historical and ecological process. The conservation status for the coastal area of Uruguay and southern Brazil is reviewed.

Introduction

Coastal localities of southern Uruguay at the Río de la Plata and Atlantic Ocean are characterized by their sand dunes, with rocky points, gorges, and river and stream mouths. These areas support an increasing human impact due to urbanization, industrial and recreative facilities, ports, etc. Today these coastal ecosystems are quickly and permanently modified, unfortunately in an almost total absence of information on the characteristics of the natural ecosystems, at the level both of basic species inventory and of analysis of community structure.

A basic knowledge of the community is of great importance for Latin American temperate ecosystems, not only to provide an insight on their structure and function, but also to evaluate the consequences of human modifications, giving information that may be of potential value for a conservation effort. In other words, Latin American countries will not try to protect those environments they do not know they are losing. There are almost no data on vertebrate communities at temperate southern regions of South America. In the cases of amphibians and reptiles communities, there are only the works of Barrio (1962) and Gallardo (1970, 1976, 1980) in Argentina.

The objective of this study is to analyze the herpetofauna in a periurban satellite ecosystem, adjacent to the city of Montevideo, complementing a similar work for another coastal site by Gudynas & Rudolf (1987). First, an annotated list of all species at the site is presented, followed by a preliminary analysis of its structure, including an evaluation of human impact. Lastly, a conservation perspective for this site and other coastal areas of Uruguay and adjacent southern Brazil is presented.

Materials and Methods

This study was carried out at Médanos de Solymar and Lomas de Solymar sites, Department of Canelones, Uruguay (approximate coordinates Long. 55°55' W, Lat. 34°47' S). Between 1977 and 1984, 46 field trips were taken to these sites by one to six persons. I participated in 28 of them comprising a total of 207 man-hours of field work, considered separately for some analyses. Each trip followed a similar route at the site (Fig. 1) and data on species presence, occupied habitats and all other biological information were recorded. Representative series of all species were obtained (except for a chelid turtle) and were deposited in the collections of the Dpto. Zoología Vertebrados, Facultad de Humanidades y Ciencias; Dpto. Zoología, Centro de Estudios de Ciencias Naturales; and Dpto. Biología, Centro Educativo Don Orione (Montevideo).

Ecological data were grouped following Eisenberg (1981) as follows:

A) Habitat: beach; open formations; marshes, artificial woodlands; isolate trees; synanthropic; channels; and debris.

B) Activity patterns: diurnal (Dr), crepuscular (Cr) and nocturnal (Nr).

C) Environment components: terrestrial, aquatic, aquatic–margin, vertical–low, vertical–high, semifossorial, and fossorial.

D) Reproductive strategies: D.1. Amphibians: 1, eggs and larvae free; 2, eggs in a foam nest and free larvae; 3, eggs in a constructed cavity and free larvae; 4, eggs and larvae in a constructed cavity. D.2. Reptiles: 5, oviparous; 6, oviparous, but laying in *Acromyrmex* ant–hills; 7, viviparous. D.3. Amphibians and Reptiles: 8, parental guarding behavior of the clutch or neonates. The categories for amphibians were inspired by Crump (1974). Egg laying in leaf cutting *Acromyrmex* ant–hills was considered alternative to oviparity, and listed as a distinct category.

E) Feeding: 1, invertebrates; 2, fishes and tadpoles; 3, adult amphibians; 4, reptiles; 5, birds and mammals. The data for these categories were obtained from examination of stomach contents, literature survey and field observations, at this locality and the Pajas Blancas site.

Terminology in this paper follows Udvardy (1959), Crump (1971), Whittaker (1972) and Duellman (1978). Community: any set of related organisms, near each other and interacting. Biotope: a major area, artificially delimited but with subjective uniformity in relation to physical parameters (as weather and soil types) and vegetation physiognomy, and supportive of a particular community. Habitat: that portion of the biotope occupied by the species, where it carries out its life processes. Refuge or microhabitat: a subdivision of the habitat that corresponds to the precise occurrence of the species (as example, under rocks).

These ecological categories were binary coded, and all possible pairwise comparisons were made, with the computation of the association ecological coefficient of Sorenson. Cluster analyses were then carried out by weighted pair–group method using arithmetic averages (WPGMA) methodology, and polar ordination (Sneath & Sokal, 1973; Poole, 1974). Species composition for each habitat was calculated as the community coefficient (Whittaker, 1972).

Description of the Study Site

Solymar is located on the coastal plains bordering the Río de la Plata (Fig. 1) Weather is temperate humid (Cfa in Koppen's classification; Rocha–Espinosa, 1981), with a mean annual temperature of 16.5°C, mean annual rainfall of 1000 mm (Fig. 2) and predominant winds from the south (García & Sánchez, 1969). Solymar is part of the coastal sandy biotope, as defined by Gudynas (1980), characterized by recent quartzitic sands, of fine to medium granulation.

The coastal area of the Department of Canelones, between the Arroyo Carrasco and Arroyo Pando streams, includes the study site, and is adjacent to the city of Montevideo, Department of Montevideo (Fig. 2), and now part of its metropolitan area. The original landscape was described by Legrand (1960) as a series of sandy dunes bordering the coast line, with scarce psammophytic vegetation (dominated by a Chlorideae, *Spartina coarctata*), backed by litoral sand bars with an association of *Panicum racemosum* – *Androtrichum trigynum* (Peniceae–Andropogoneae), bordered landward by an extensive depression. Among the litoral dunes there were many marsh enclaves with dense hydrophytic vegetation. Eskuche (1973) studied the present vegetation of the coastal dunes of Uruguay, complementing Legrand's (1960) information.

This area, including the study site, has been modified by human activities since 1910, beginning with the introduction of exotic trees. Since the 1950s the effects became intensified by urbanization. Exotic trees introduced on the interior dunes included *Pinus* spp and *Eucalyptus* spp, with the following consequences: (i) levelling and (ii) fixation of the dunes; (iii) lowering the water table; and (iv) reduction of the marshes. The native "junco de copo" (*Androtrichum trigynum*) participated in this transformation.

Today, the area presents a habitat gradient from little altered (as marshes and dunes) to others produced by human activities (as introduced artificial woodlands). This environment is part of a periurban satellite ecosystem as defined by Morello (1983), derived from urbanization, with an extensive area and low house–population density. Houses are dispersed widely, surrounded by the different habitats, while dunes persist bordering the beach (Fig. 1).

I have recognized the following habitats at the site (Fig. 3):

1. Beach (B) habitat between the Río de la Plata water and the base of the first dunes; without vegetation.

2. Open formations (OF): sandy dunes, with partial vegetation coverage, dominated by psammohalophytic grasses and herbs (*Panicum, Senecio, Spartina, Hydrocotile*) and small native (*Dodonea*) or exotic (*Acacia*) shrubs. This habitat is particularly extensive bordering the beach in a band of about 200 m, and is also present as enclaves between the other habitats (Figs. 5, 7).

3. Marshes (M): temporal microlimnotopes, homeothermic, depressed, with low water flow, fed by rains, superficial sheet flows and ground water movements (Goselink & Turner, 1978). The vegetation is hydrophytic, dense, including floating species, a stratum of low herbs dominated by Ciperaceas, including the umbelifer (*Eryngium*), graminaes (*Cortaderia*), juncus (*Junco*) and triticeaes (*Typha*) that overreach this stratum (Figs. 6, 8).

4. Artificial woodlands (AW): plantations of *Pinus* spp and *Eucalyptus* spp.

5. Isolated trees (IT): isolated *Pinus* trees (usually of low to medium height), live or fallen in other habitats (Fig. 6).

6. Synanthropic (S): human houses and their surroundings.

7. Channels (C): these small channels (approximate depth 0.5 m) are found beside streets and gardens, draining rain water. Their borders present a dense hydrophytic vegetation that resembles the marshes habitat.

8. Debris (D): diverse kinds of material, from rocks to human litter. This habitat, a product of human activities, may be found within any of the other habitats.

Commented Systematic List

Some variants of determination or nomenclature from the recent list of Uruguayan amphibians (Langguth, 1976) were advanced by Gudynas (1983), and additional comments may be found in Gudynas & Rudolf (1987). For each species information is included on habitat, activity periods (abbreviated as in Materials and Methods) and relative abundance (common, uncommon and rare –one to five specimens observed or collected–).

Those species mentioned by Legrand (1960) are so noted.

CLASS AMPHIBIA

ORDER ANURA

Family Leptodactylidae

1. *Odontophrynus americanus* (Dumeril & Bibron, 1841)

   C. Cr and Nr. Rare.

2. *Physalaemus gracilis* (Boulenger, 1883)

   M and D. Dr, Cr and Nr. Common.

3. *Pseudopaludicola falcipes* (Hensel, 1867)

   M. Dr and Cr. Common. Legrand (1960).

4. *Leptodactylus gracilis* (Dumeril & Bibron, 1841)

   M, C and D. Dr and Cr. Common

5. *Leptodactylus latinasus* Jimenez de la Espada, 1875

   M, C, and D. Dr. Common. Legrand (1960).

6. *Leptodactylus mystacinus* (Burmeister, 1861)

   M, C and D. Dr and Cr. Common Legrand (1960).

7. *Leptodactylus ocellatus* (Linnaeus, 1758)

   C, M, and D. Dr, Cr and Nr. Common. Legrand (1960).

Family Bufonidae

8. *Bufo arenarum* Hensel, 1867

   M, S and OF. Common. Legrand (1960)

9. *Bufo fernandezae* Gallardo, 1957

M, S, OF and C. Dr, Cr, and Nr. Common. Legrand (1960)

Family Pseudidae

10. *Lysapsus mantidactylus* (Cope, 1862)

M. Dr, Cr and Nr. Common. Legrand (1960)

Family Hylidae

11. *Hyla pulchella pulchella* Dumeril & Bibron, 1841

M and C. Dr and Nr. Common. Legrand (1960)

12. *Ololygon eringiophila* (Gallardo, 1961)

S, IT and M. Cr and Nr. Common.

13. *Ololygon squalirostris* (Lutz, 1925)

M. Cr and Nr. Common.

Family Microhylidae

14. *Elachistocleis bicolor* (Valenciennes, 1838)

Only one specimen was collected at the Debris habitat semiburrowed in the sand. Not observed in activity. Rare. Legrand (1960).

CLASS REPTILIA

ORDER CHELONIA

Family Cheliidae

15. *Hydromedusa tectifera* Cope, 1869

One specimen was observed in a marsh on September 10, 1978; it was identified and returned to its habitat. M. Rare.

ORDER SQUAMATA

Suborder Lacertilia

Family Iguanidae

16. *Liolaemus wiegmannii* (Dumeril & Bibron, 1837)

OF and S. Dr. Common. Legrand (1960).

Family Teiidae

17. *Teius oculatus* (d'Orbigny & Bibron, 1837)

OF and S. Dr. Common. Legrand (1960). Notes on its behavior and ecology at this site were provided by Gudynas (1979) and Gudynas et al (1981).

18. *Pantodactylus schreibersii schreibersii* (Wiegmann, 1834)

OF and IT. Dr. Common.

Family Scincidae

19. *Mabuya dorsivittata* Cope, 1862

M and IT. Dr. Common. Ecological and behavioral notes on this species at this site were provide by Gudynas (1980).

Family Anguidae

20. *Ophiodes vertebralis* Bocourt, 1881

B. Dr. Rare. Legrand (1960).

Suborder Amphisbaenia

Family Amphisbaenidae

21. *Amphisbaena darwinii darwinii* Dumeril & Bibron, 1839

OF. Rare. Not observed in activity.

22. *Anops kingii* Bell, 1833

D. Rare. Not observed in activity. One specimen was found in the stomach content of a *L. ocellatus*.

Suborder Serpentes

Family Colubridae

23. *Liophis jaegeri jaegeri* (Gunther, 1858)

FA y D. Dr. Rare. As was stated by Gudynas & Rudolf (1987), this species have been considered a rare colubrid in Uruguay. This record, and those from Pajas Blancas confirms its presence in Uruguay. At Solymar we recorded four individuals. Scutellation and measurement for two preserved individuals (CEDO–R 105 and 105) are as follows: total length 345 and 375 mm; tail length 205 and 100 mm; dorsal scale rows 17–17–17; ventrals 162 and 162; subcaudals 61 and 54; anal plate divided.

24. *Liophis obtusus* (Cope, 1863)

M. Dr. Rare. Legrand (1960).

25. *Thamnodynastes strigilis* (Thunberg, 1787)

OF and M. Dr. Rare.

26. *Lystrophis dorbignyi* (Dumeril, Bibron & Dumeril, 1854)

OF. Dr. Legrand (1960).

27. *Clelia rustica* (Cope, 1878)

IT. Dr. Rare.

28 *Philodryas patagoniensis* (Girard, 1857)

OF and S. Dr. Uncommon.

29. *Philodryas aestivus subcarinatus* (Boulenger, 1902)

M. Dr. Rare.

Results

1. Sampling success

The number of observed or collected species at Solymar against the actual and unknown number at the site was evaluated by the cumulative number of new species and collecting effort. Fig. 8 shows the result of sampling success for the field trips with the participation of the author. In the first trips, a high proportion of species were registered, reaching the 50% level for the first 17 man–hours of field work. For half the field work (103.5 hours), 26 species were recorded (96.3%). The total number of species that I recorded was 27. On the other 18 field trips made by other persons of the research group, two additional species were found, both Reptiles (a chelid turtle and the colubrid snake *C. rustica*).

2. Analysis of species richness

The number of species (α diversity; Whittaker, 1972) at Solymar was 29 (14 amphibians and 15 reptiles). Of the eight recognized habitats, seven presented herpetofauna whereas in the Artificial Woodlands no species were recorded (Fig. 9). Marshes presented the highest species richness; the lowest, other than Artificial Woodlands, was for Isolated Trees. Most of the remaining habitats were more or less equal to each other in richness. The herpetofaunal composition for each habitat was different: anurans were dominant in the Marshes (11 anurans spp and 5 reptiles spp), and also in the Synanthropic, Channels and Debris. Reptiles found in the Marshes included a turtle, a scincid lizard and three colubrid snakes (*T. strigilis*, *L. obtusus* and *P. a. subcarinatus*). These colubrids are transient species that reach the Marshes while searching for food. On the other hand, reptiles were dominant at the Open Formations and Isolated Trees habitats. Most species in these habitats were lizards and snakes, although a bufonid toad (*B. arenarum*) was also recorded.

3. Comparisons between habitats

The change between habitat richness (β diversity; Whittaker, 1972) was measured by the Community Coefficient. A total of 28 pairwise comparisons were made between habitats, of which 11 presented zero shared species (7 against the Artificial Woodlands habitat; the others were D x IT, B x IT, C x IT and D x B). These results agree with the absence of herpetofauna at the Artificial Woodlands habitat and the low richness at the Isolated Trees habitat.

Community coefficients were utilized for a cluster analysis

(Fig. 10) revealing low relationships between habitats. Two groups were formed: one included Marshes, Channels and Debris habitats, and the other Open Formations, Synanthropic and Beach, while Isolated Trees and Artificial Woodlands were isolated with a very low or zero number of shared species.

4. Analysis of the species in the environmental components

The highest species number was recorded in the terrestrial environmental component (Fig. 11). It was closely followed by the aquatic–margin and aquatic components, while the vertical–low, semi–fossorial and fossorial components presented from three to one species respectively. The vertical–high component presented zero species. Of the two first components, the dominances were different: reptiles (66.7%) dominated the terrestrial one, and anurans (78.6%) the aquatic–margin. The water–ground interface of the marsh is utilized by many anurans species (Fig. 13), whereas only three species were present at the aquatic, aquatic–margin and vertical–low components, taking advantage of the vegetation (*H. p. pulchella*, *O. eringiophila* and *O. squalirostris*).

Reptiles that were dominant at the terrestrial component were also transients (particularly ophidians), and only some amphibians were also present. Only one lizard, *M. dorsivittata* was collected in the terrestrial, aquatic and aquatic–margin components. *E. bicolor* was the only semifossorial species and the two amphisbaenians (*A. d. darwinii* and *A. kingii*) were the only fossorial species.

5. Reproductive strategies

Reproductive strategies for Solymar species are listed at Table 1, following Crump (1971), although the codes I utilized for cluster analysis were different (see Material and Methods). Of the total of 14 anuran species, nine (64.3%) presented the generalized strategy of free eggs and larvae. Alternative strategies, all for leptodactylid species, were eggs deposited in a burrow for three species (21.4%) and a foam nest in two species (11.3%). Eggs of *L. latinasus*, *L. gracilis* and *L. mystacinus* are laid in burrows in the ground and may reach the marshes after rains or floodings, where the larvae complete their development. *L. ocellatus* and *P. gracilis* construct foam nests, although they are different. The nests of *L. ocellatus* are always at the margins of the marsh, made of mucus and foam, extremely adherent, elevated, and guarded by the female. *P. gracilis* foam nests are of lower consistency, not elevated, may be found in any place within the marsh, are not so adherent, and are not guarded by parents. Although I did not conduct field experiments to evaluate reproductive success of these two species at

Solymar, some observations are noteworthy. *L. ocellatus* foam nests adhere to the vegetation and do not follow ascents or descents of water level in the marsh. On the other hand, *P. gracilis* nests were not adherent, or not firmly so, and they follow water–level fluctuations. Fig. 12 shows evolution of 18 *L. ocellatus* foam nests in a marsh during an eight days period, as an example. Similar results were obtained for seven other marshes. At the end of this period, of a total of 13 potentially viable nests, 10 did not follow descent of the marsh water surface level, hence the nests dried and the eggs and larvae died. Females guarding nests were observed at the center of the nests or its surroundings. The percentage of guarded nests was low at Solymar: 12%.

Among reptiles, reproductive strategies were also variable: viviparous species (20%) were the colubrid T. *strigilis*, the anguid *O. vertebralis*, and the lizard *M. dorsivittata*; all other species were egg–laying (80%). Among these last, *T. oculatus*, *P. patagoniensis*, *L. j. jaegeri* and *L. obtusus* lay their eggs in leaf–cutting *Acromyrmex* ant hills.

6. Cluster and ordination analysis

Cluster and ordination analysis permits a graphic representation of all species for all the ecological variables that were recorded. It must be pointed out that these data come from first level inventory information, and that ecological categories are rigid.

Two analyses were carried out for amphibian species: one included only data recorded during breeding, and the other, all data available. Fig. 14 shows the result for the amphibians with data recorded at breeding. Two groups were detected: each one included a high–similarity nucleus (*L. gracilis–L. mystacinus* and *B. fernandezae–H. p. pulchella*).

Clustering analysis for all amphibian and reptile species is presented in Fig. 15. Data for amphibians include all information available. Two main groups were observed. Polar ordination (Fig. 16) for the same data presented a similar picture. The first one (group A, Fig. 15) is large and heterogeneous, and comprised of three main subgroups clustered at similar coefficient values. All anurans (except *B. arenarum* and *E. bicolor*) were clustered with two reptiles (*M. dorsivittata* and *O. vertebralis*). All these species, except *O. vertebralis*, were associated with the Marshes habitat, Channels or Debris, and were found at the aquatic and aquatic–margin components.

The second subgroup included all other lizards and amphisbaenids, found in the terrestrial component. The third one is a highly heterogeneous one, including the chelid turtle, a lizard and a bufonid toad. The frog, E. *bicolor* remained isolated at low similarity values within the group, registered on only one occasion in the Debris habitat and of fossorial behavior.

In polar ordination (Fig. 16) a large group from medium to high dissimilarity values included all anurans (except *E. bicolor*), the chelid turtle, lizards and amphisbaenians, closely resembling cluster A.

Thus cluster A and the corresponding group in polar ordination, included a heterogeneous set of species with ecological characters ranging from those associated with the microlimnotopes to those of the terrestrial environment.

The second cluster (B, Fig. 15) included all of the seven colubrid snakes of Solymar. Also, in polar ordination (Fig. 16) all snakes were found associated with high values of dissimilarity. They were found in the Open Formations, Marshes, Isolated Trees or Debris and the terrestrial and aquatic-margin components. The first five species (*L. j. jaegeri, P. patagoniensis, L. obtusus, C. rustica* and *L. dorbignyi*) were characteristic transients that may enter several habitats from the terrestrial components. On the other hand, *T. strigilis* and *P. a. subcarinatus* were found in the aquatic-margin component and Marshes habitat, although *T. strigilis* may use shrubs occupying the vertical low components.

Discussion

The few ecological studies (Barrio, 1962; Gallardo, 1970, 1972, 1980) on the amphibians and reptiles communities of the temperate areas of South America have been recently pointed out by Gudynas & Rudolf (1987).

The 29 species registered for Solymar were found in all the recognized habitats, except Artificial Woodlands. I consider this number very close to the real number of species inhabiting the site. Nevertheless, human presence during many years probably altered the composition of the herpetofauna. Legrand (1960) cited for the Carrasco area 12 species of anurans, of which the following were not found at Solymar: *Melanophryniscus stelzneri, Physalaemus biligonigerus* and *Pleurodema bibroni.* These species, except *P. biligonigerus*, still occur in the Carrasco area, and are not considered rare or secretive. Thus, their absence from Solymar is considered real. Therefore, it is concluded that the anuran sample is very close to, if not, the actual species number at the site. The gymnophionan *Chthonerpeton indistinctum* has been recorded west of Solymar at Carrasco, and eastward at Arroyo Tropas Viejas. Its absence from samples to date be due to its fossorial and aquatic habits.

The situation with reptiles, particularly snakes, is different. Legrand (1960) cited for the Carrasco area five species, of which *Liophis poecilogyrus*, *L. anomalus* and *L. miliaris* were not recorded in our area. I can not conclude that they are absent there, as collecting chance and human persecution affect particularly colubrid populations. Our collecting efforts occurred while these populations were reduced due to these factors. Furthermore, those field trips not included in the sampling analysis added two reptiles new to the area.

Legrand (1960) presented a list of 13 amphibians and 8 reptiles for Carrasco. Compared with these results, at Solymar, 4 amphibians and 10 reptiles not recorded previously by Legrand (1960) were found.

Anurans were predominant at the Channel and Marshes habitat, but were also present at the remaining habitats, except Artificial Woodlands. Nevertheless, three sets of amphibians may be recognized: (i) breeding species; (ii) species not at their breeding period; and (iii) species in their larval stage. This distinction follows Crump's (1982) proposal of distinguishing breeding from non–breeding populations. At Solymar, anurans start their breeding season with the increase of temperature and rainfall in August–September. Of the 10 reproductive strategies recognized by Crump (1974) for an anuran community in Ecuador, only three (Table 1) were found at Solymar. Crump (1982) related the diversity of reproductive strategies with the number of available habitats. This trend may be also found at Solymar, where the absence of a native vertical–high habitat of trees correlated with the absence of frogs utilizing a reproductive strategy for that habitat.

As at Pajas Blancas, *H. p. pulchella* was found breeding in temporal marshes (Gudynas & Rudolf, 1987), contrary to Gallardo (1961). I observed males calling at levels from the water surface to the vertical–low component, in vegetation, as Barrio (1962) reported for Punta Lara. During the breeding period most species were found at, or near, the margin of marshes. Only *L. mantidactylus* was a strictly aquatic frog, and as pointed out by Gallardo (1964) never do they come out of water voluntarily. Other anurans may be found in the shallow marshes (as *B. fernandezae*). The tree hylids at Solymar are found in a variety of situations in the marshes, almost identical to those reported by Gudynas & Rudolf (1987). *O. squalirostris* is noteworthy, as seemingly restricted to *Eryngium* umbelifers, as reported by Lutz (1973).

L. ocellatus is unique among the leptodactylids at the site as it protects the nest and tadpoles. This behavior has been considered of adaptive value, as it increase tadpole survivorship probabilities (Vaz–Ferreira & Gehrau, 1975), compared to other leptodactylids that do not construct nests or guard them. The observations at Solymar contrast with that idea, because the *L. ocellatus* nests adhere to the vegetation and thus may result in the loss of the offspring, contrary to the feeble foam nests of *P. gracilis*. Gorzula (1976) reported that *P. enesefae* from Venezuela prepared nests that disintegrated within 3 days of being laid. It is possible that *L. ocellatus* may be more effective in other kinds of microlimnotopes lacking drastic level changes. High mortality rates agree with the high number of eggs in *L. ocellatus* despite the nest guarding behavior if compared, for examples, with the former "cavicola" species group, as reported by Heyer (1969).

The terrestrial environment is dominated by reptiles. Lizards restricted to the terrestrial component were *L. wiegmannii*, *P. s. schreibersii* and *T. oculatus* (although the latter may enter marsh borders). *L. wiegmannii* is a strictly psammophytic species, a sit–and–wait predator, and may take refuge burrowing in the sand. On the other hand, *P. s. schreibersii* is found in a variety of situations in the open formations habitat and is an active predator. *M. dorsvittata* is unique among Solymar lizards because of its aquatic habits. Gudynas' (1980) notes may be complemented by Solymar individuals recorded in the terrestrial, aquatic–margin and aquatic components in the Marsh habitat; during winter the skink was found in the Open Formation and Isolated Trees habitats (where it was collected under tree bark).

Few amphibians were found in the terrestrial component (*B. fernandezae*, *B. arenarum*, *L. mystacinus*, *O. americanus* and *P. falcipes*), although they enter the aquatic and aquatic–margin components at their breeding period.

Colubrids constitute a group of diverse strategies. *L. dorbingnyi* was restricted to the Open Formation habitat and the terrestrial component, whereas the Liophis species were transients that entered marshes; *T. strigilis* and *P. s. subcarinatus* also were transients and also entered the vertical–low components in the shrubs. *L. dorbignyi* is unique because of its well–known fossorial behavior (Gudynas, 1979).

The number of colubrid specimens recorded during the study period diminished in time: five specimens were recorded in 1977; 11 in 1978; 3 in 1979; 2 in 1980, and zero between 1981 and 1984. The diminishing frequency may be related to the increase in human population, especially since 1980, through either persecution or road kills. Particularly susceptible is *L. dorbignyi* which at the beginning of the study was a common species in the area, but exhibited a defensive behavior with a tail display, without fleeing, that would promote human persecution.

The presence of two amphisbaenians at the study site is also noteworthy. *A. d. darwinii* was found in sympatry with *A. kingi*, a small amphisbaenian reported to occur in harder soils than *A. d. darwinii*. Gans & Rhodes (1964) also found *A. kingi* in sandy soils.

These observations provide data on species occurrence in habitats created by human activities. Fig. 10 shows that Debris and Channels habitats shared more species with Marshes. Channels presented clear structural similarities to Marshes, including the presence of water and hydrophytic vegetation. On the other hand, Debris seems to be an effective refuge for many anurans (or at least increases the probabilities of collecting them). In the other group, the Sinanthropic habitat shared more species with Open Formations and Beach habitats. Nevertheless, the low values obtained for the community coefficient must be pointed out, reflected by the few species that have been able successfully to utilize these new habitats.

Conservation

There are many studies on the wildlife and conservation management of coastal areas all around the world. Nevertheless, this kind of study is extremely scarce for South American coastal areas, and the little literature available is descriptive and not analytical (West, 1977).

The data presented on Solymar permits some considerations on conservation management for this coastal area. Although Solymar was urbanized since the 1950s by a medium economic social class, seeking a week-end at the beach, in the last 15 years the area converted to permanent residence. Population in the coastal area adjacent to Montevideo, between Arroyo Carrasco and Arroyo Pando, is estimated in 43,723 by the 1985 "Censo de Población y Vivienda".

I have identified two main modification on the original ecosystem: 1) massive forestry with exotic species, and 2) drastic reduction of number and surface of marshes. The balance between these two modification has determined the present shape of the Open Formation habitat, which has also been altered by exotic shrubs. These alterations are equivalent to the physical restructuring and introduction of exotics that Rapport et al (1985) defined as stress modifications. Thus, Solymar is an ecosystem under stress, where I have been able to identify at least two symptoms: alterations in species diversity and retrogression. Changes in species richness are shown by the zero value of the artificial woodlands. A similar picture, although not quantified, is known for marsh-dwelling birds that have lost sites for breeding, rearing and alimentation. The value of wetlands has been repeatedly pointed out, as they are indispensable for abiotic processes, the normal development of many plants and animals, and in maintaining endangered wildlife (Baaijems & Molenanr, 1980; Williams & Dood, 1978).

Furthermore, ecosystem under stress tend to eliminate large and long-lived species while favoring short-lived, opportunistic species (Rapport et al., 1985). For example, the gradual disappearance of *T. oculatus* (the largest lizard in the area, and at the K extreme of the r-K continuom, sensu Pianka, 1974), if compared with the small, short-lived *L. wiegmannii*, may be also considered as a stress symptom.

The absence of lizards from Artificial Woodlands certainly is related to vegetation modification. Lizards were found only in open areas, or areas with isolated or juvenile trees, where they receive direct solar radiation. Changes in lizard populations after vegetation modification were also reported by Busack & Bury (1974). Opdam et al. (1983) provided a report on a similar situation for coastal areas in The Netherlands, where lizards have to adapt to a dynamic system: juvenile lizards must search for young forests or its borders.

Other remodelling activities in this ecosystem, at several sites adjacent to Solymar, were sand surface mining, resulting in creation of medium-sized lagoons, whose consequences are still unknown.

A recent review by Arana (1983) of environmental problems in the coastal areas of Uruguay clearly reveals the consequences of the absence of basic information. Arana (1983) stated that on the coast, and in general terms, forestry was a positive fact that contributed to enrichment of a naturally poor ecosystem. This statement lacks a scientific basis. Actually, those habitats not or little altered are very rich in herpetofauna. Artificial woodlands do not present herps, and their presence have lowered species richness of the ecosystem. The native herpetofauna has been unable to colonize these new habitats.

A similar situation to that found at Solymar is developing at several coastal localities at southern Uruguay and Río Grande do Sul state, Brasil. There is an increasing pressure for these coastal areas to be urbanized for recreational and turistic purposes. As stated by Hooker & van Hulst (1979), these situations generate socioeconomic problem and improperly conceive or ignores the holistic values of ecosystems. Under this "market paradimg" any planning design will be only a palliative measure. On the other hand, Lombardi (1982) stated that forestry in the eastern coasts was carried out in the absence of alternative utilization of these poor soils. Nevertheless, research for alternative uses of the area were never attempted. There is an urgent need therfore for natural reserved and other protected areas along these coastal areas. At the Río de la Plata coasts of Uruguay, a good conservation measure will be to protect sand dunes adjacent to the beach.

Conclusions

The herpetofauna of Solymar was found to be composed of 29 species. This represents an important proportion of 31% of the known amphibians and reptiles of Uruguay (excluding sea turtles). Of this total, there were 14 amphibians (48.2%) and 15 reptiles (51.8%). The analysis of sampling success revealed a close approach to the real number of species for amphibians, and in a lower level of accuracy for reptiles due to collecting chance and population modifications, particularly in colubrid snakes. These species were found in seven of the eight recognized habitats; no species were recorded in the Artificial Woodland habitat. The highest species richness was found in Marshes and the lowest in Isolated Trees (except for Artificial Woodlands). The species composition for each environmental component was not taxonomically determined, although there were clear dominances. The highest number of species was recorded in the terrestrial component, immediately followed by the aquatic and aquatic–margin. Detected dominances were reptiles in the terrestrial component and anurans in the aquatic and aquatic–margin. Similar dominances were found for habitats. Reptiles were dominant in the Open Formation habitat and amphibians in Marshes and Channels.

For amphibian species three different reproductive strategies were detected. L. *ocellatus* is unique among anurans at it constructs a nest, and parents guard the foam nest and tadpoles. Although this behavior is commonly considered an advantage, *L. ocellatus* nests at Solymar adhere to vegetation and do not follow water level oscillations, resulting in less reproductive success. Among reptiles, most species are oviparous, and only two viviparous; four species lay their eggs in leaf cutting ant–hills.

Community structure may be divided in two main species groups: colubrids, transient species, that were found from the terrestrial to the aquatic components; and a second group, heterogeneous, with three subgroups: those associated with microlimnotopes, those associated with the terrestrial component, and an uncorrelated group including a bufonid, a turtle and lizard, while *E. bicolor* could not be assignable. Furthermore, species distribution in polar ordination (Fig. 16) suggest a gradient from species closely related to the Marsh habitat and/or riparian situations to transient colubrid species. *E. bicolor* was found uncorrelated.

Comparisons of herpetofauna composition between habitats resulted in a low number of shared species. Comparing little altered habitats against heavily altered habitats, Marshes appeared more similar to Channels and Debris, and on the other hand, Open Formation and Beach appeared more similar to Sinanthropic. Although some habitats produced by human actions, as Channels, presented structural similarities with other little modified habitats, as Marshes, they are inhabited by a low number of species, signaling a low success in colonization of these new habitats.

It seems that the present day composition of the Solymar community is the result of two processes: an historical process that accounts for the taxonomic groups at the area; and an ecological process, where limiting factors (as soils and climate) determine the present species integration. As pointed out for Pajas Blancas (Gudynas & Rudolf, 1987), Solymar is at the southern limit of several species. Most species seem to have arrived at the area by simple dispersal.

The present day physiognomy of the area has resulted, in part, from human activities. The ecosystem is considered under stress, particularly due to physical restructuring and introduction of exotic species. The symptoms of retrogression, and particularly, changes in species richness, were detected. Forestry, in creating the new habitat of Artificial Woodland, has eliminated all herpetofauna. Similar modifications are under way at other coastal localities of Uruguay and southern Brasil, where intensive forestry may result in the loss of an important segment fo the temperate herpetofauna.

Acknowledgments

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Table 1. Reproductive strategies of the amphibian community at Solymar. Species are ordered by families or subfamilies (number of species between brackets). Reproductive strategies follow Crump (1974); a category for parent guarding behavior is added.

Reproductive strategies	Telmatobiinae (1)	Leptodactylinae (6)	Bufonidae (2)	Hylidae (3)	Pseudidae (1)	Microhylidae (1)
I. Eggs and larvaes in water						
1. eggs and larvae free	1	1	2	3	1	1
3. constructed nest	-	3	-	-	-	-
II. Eggs out of water, larvae develop in water						
5. eggs in foam nest, larvae in water	-	2	-	-	-	-
Maternal guarding behavior	-	1	-	-	-	-

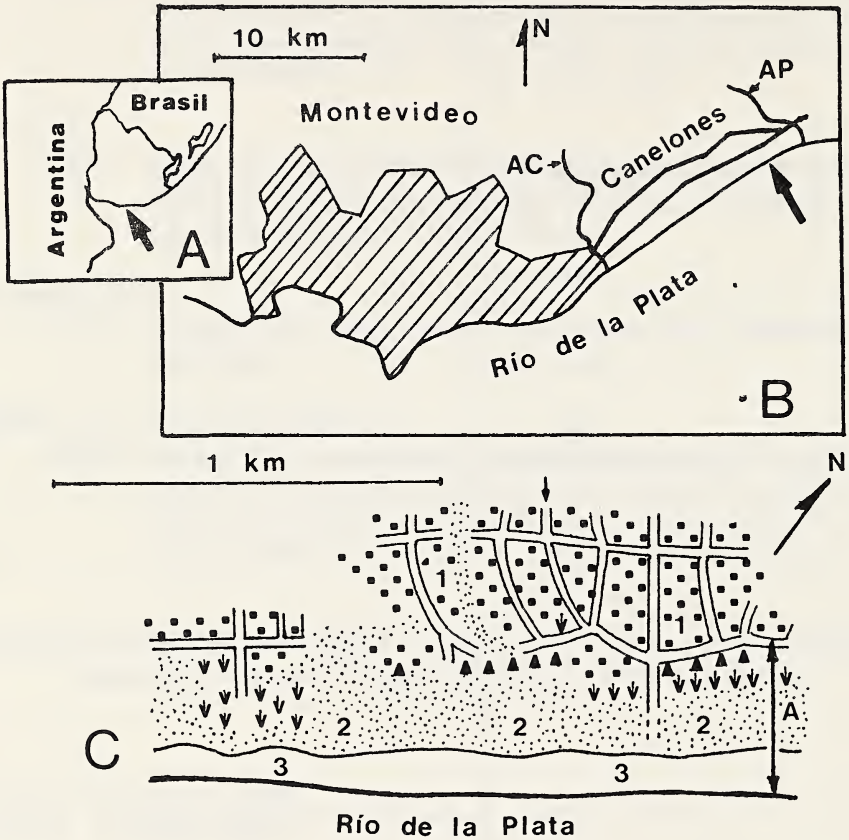

Figure 1. A, situation of Uruguay; arrow shows Solymar site. B, situation of Lomas and Médanos de Solymar site (arrow), Dpto. Canelones; AC shows Arroyo Carrasco stream; the striped area is the urbanized regions at the Dpto. Montevideo. C, study site, redrawn and modified from aerial photograph at 1980. Arrow shows the beginning point of surveys in a street; 1, blocks with isolated houses and dominated by artificial woodlands are shown (black squares); and adjacent to the coast are found areas with dominance of artificial woodlands, without houses (black triangles), dominance of marshes (three point symbol), and dominance of open formations habitats, with isolated trees and marshes enclaves (stippling, 2); beach (5). The figure is diagrammatic and does not show complex habitat relationships. Figure 3 was based on line A transect.

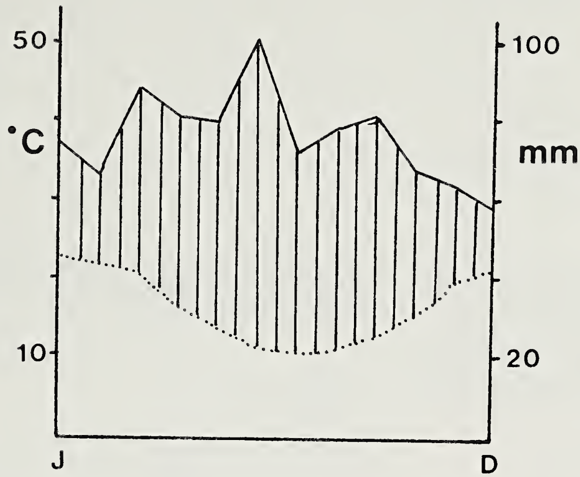

Figure 2. Climatic diagram for Montevideo (data from the Dirección Nacional de Meteorología del Uruguay). Continuous line: mean monthly rains (mm) (1906–1970 period); broken line: mean monthly temperature (°C) (1946–1970 period).

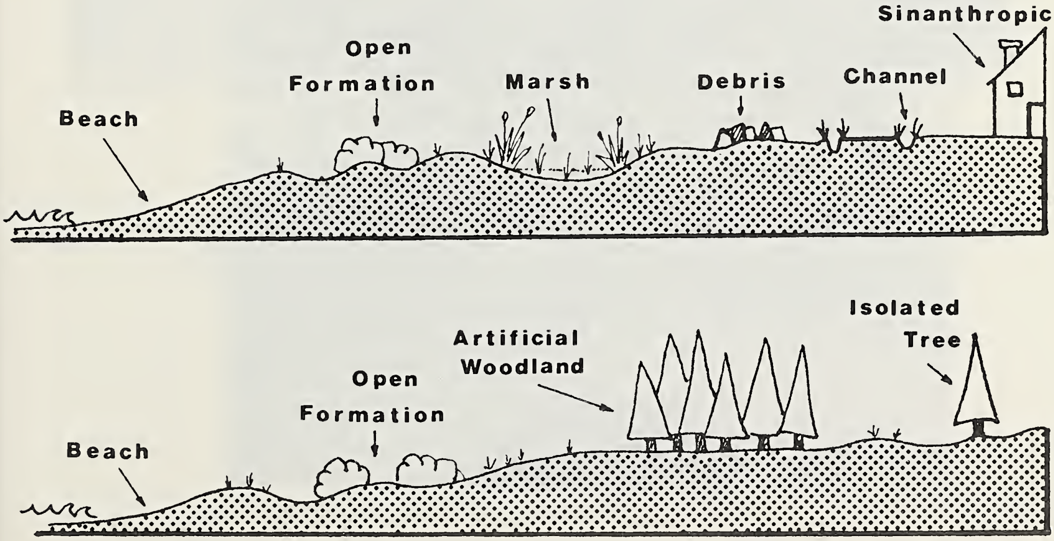

Figure 3. Diagram of the eight recognized habitats at Solymar.

Figure 4. Open formation habitat at Solymar, showing clump of *Panicum* grasses and *Acacia* longifolia shrubs.

Figure 5. Isolated trees (*Pinus* spp) adjacent to a marsh (dense vegetation is evident, with a large *Cladium* clump).

Figure 6. Open formation habitat showing dunes with scarce psammophytic vegetation.

Figure 7. Marshes habitat showing large *Cortaderia* clumps emerging from the water. Behind the marsh is shown the first dune with dominance of *A. longifolia* shrubs.

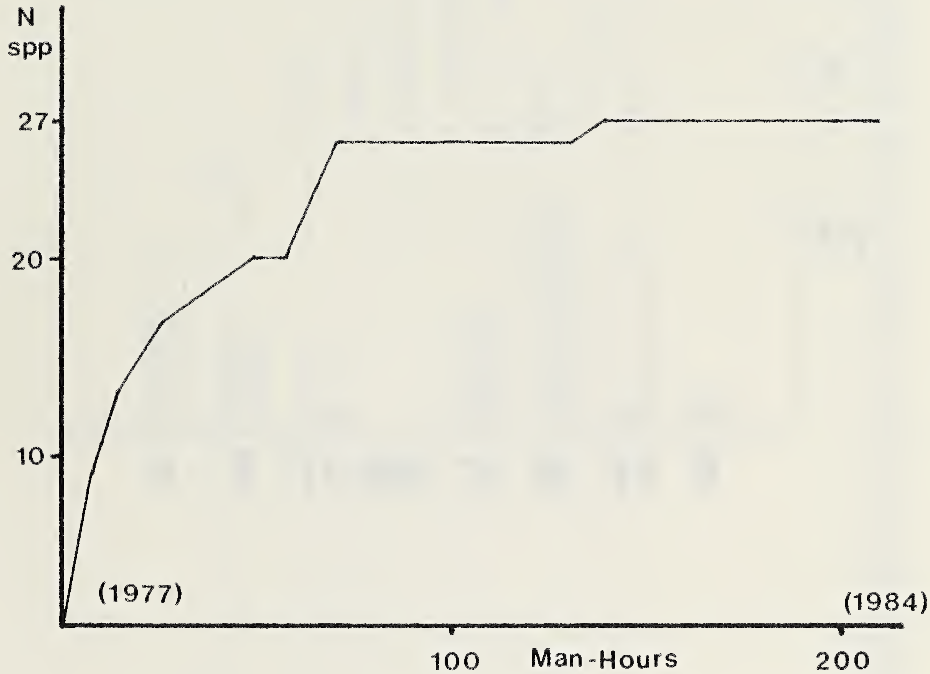

Figure 8. Graphic representation of accumulative man–hours of field work (total 207 man–hours) for 28 field trips against the cumulative number of new species recorded at Solymar. The number of newly recorded species would become constant as the actual total number of species at the locality is approached. These results show a curve stabilizing at high values of man–hours of collecting effort.

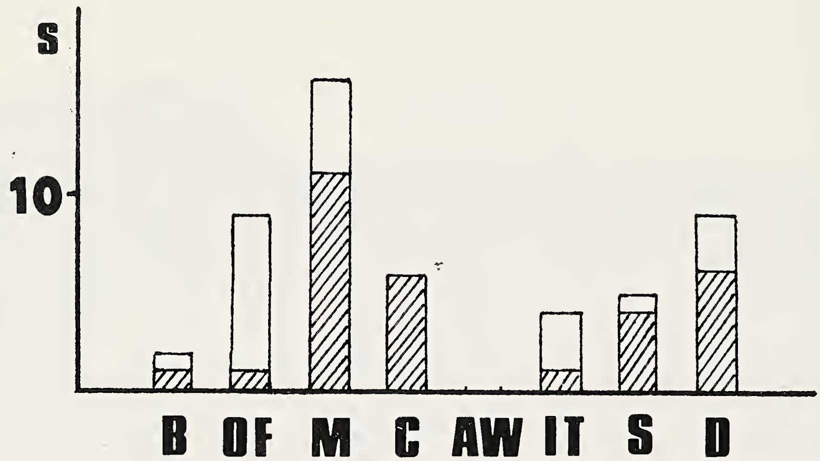

Figure 9. Species richness (S) of reptiles (open) and amphibians (striped) for Solymar habitats. No species were observed in the Artificial Woodlands habitat. Abbreviations as in text.

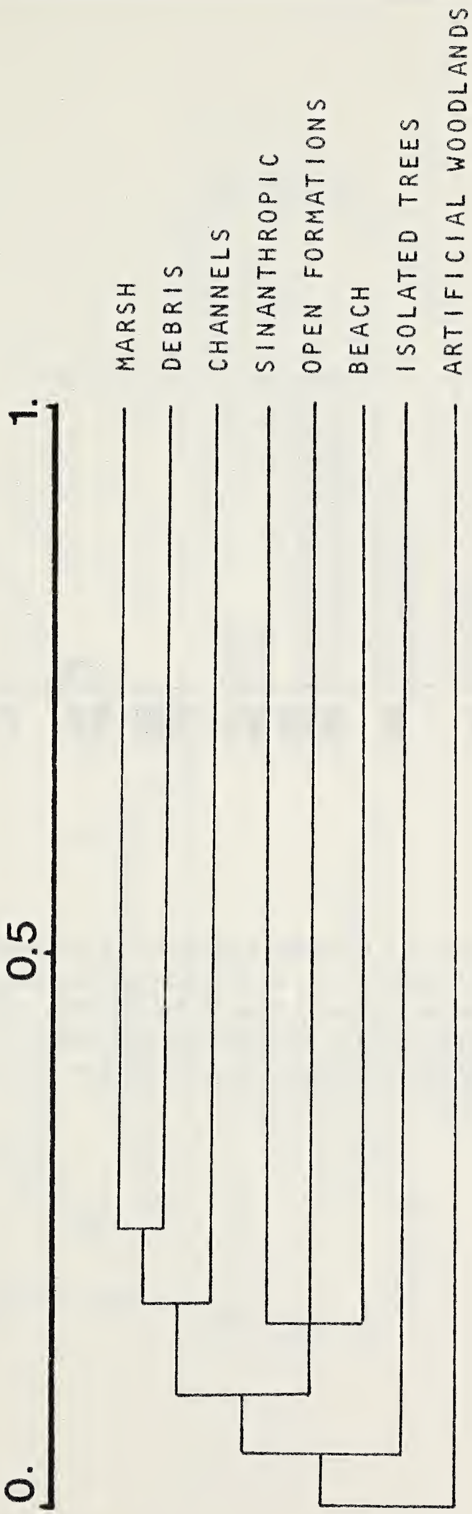

Figure 10. Cluster analysis showing relation between habitats at Solymar as determined by shared species. Similarity was measured by the Community Coefficient, WPGMA. See text for further comments.

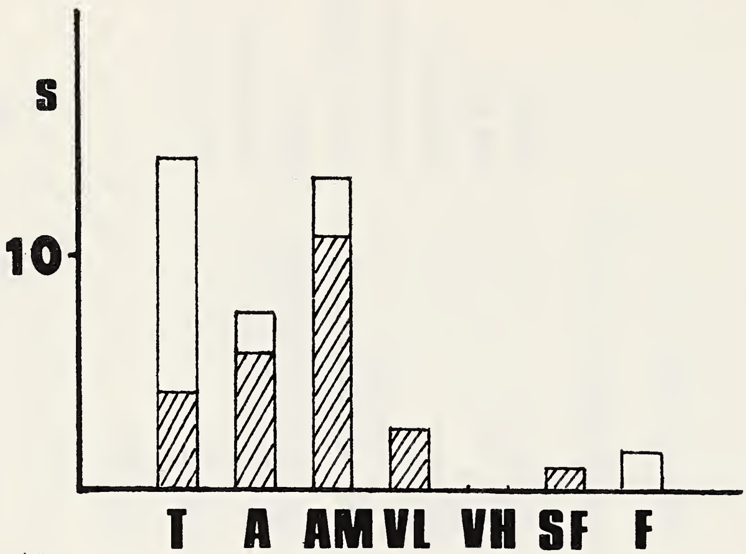

Figure 11. Species richness (S) of reptiles (open) and amphibians (striped) for environmental components at Solymar. Three anuran species were found to occur at the same time in the aquatic, aquatic–margin and vertical–low components. Abbreviations as follows: T, terrestrial; A, aquatic; AM, aquatic–margin; VL, vertical–low; VH, vertical–high; SF, semi–fossorial; and F, fossorial.

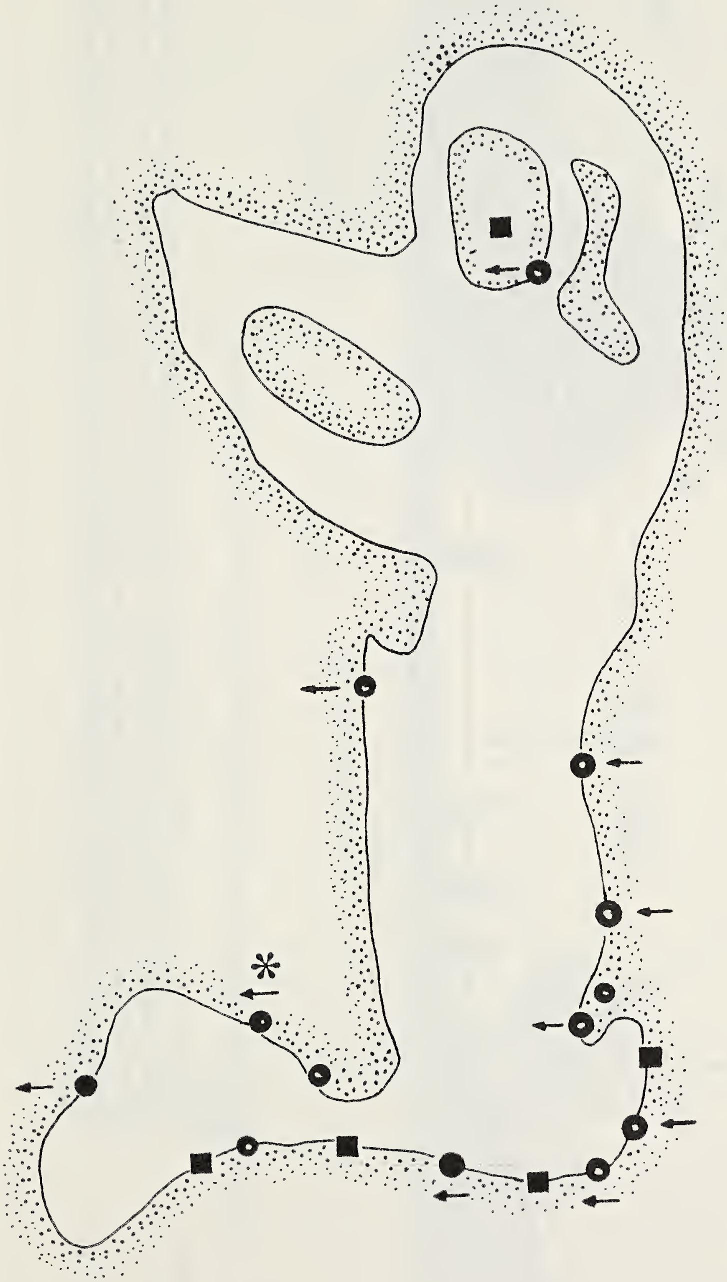

Figure 12. Diagram of the situation and evolution of *L. ocellatus* nests during a eight day interval. Nests are shown as circles, with diameter proportional to size. Squares shows debris from other nests. Nests guarded by parent are shown by *. Arrows show those nests that did not follow the water level descent and dried after the eight day interval.

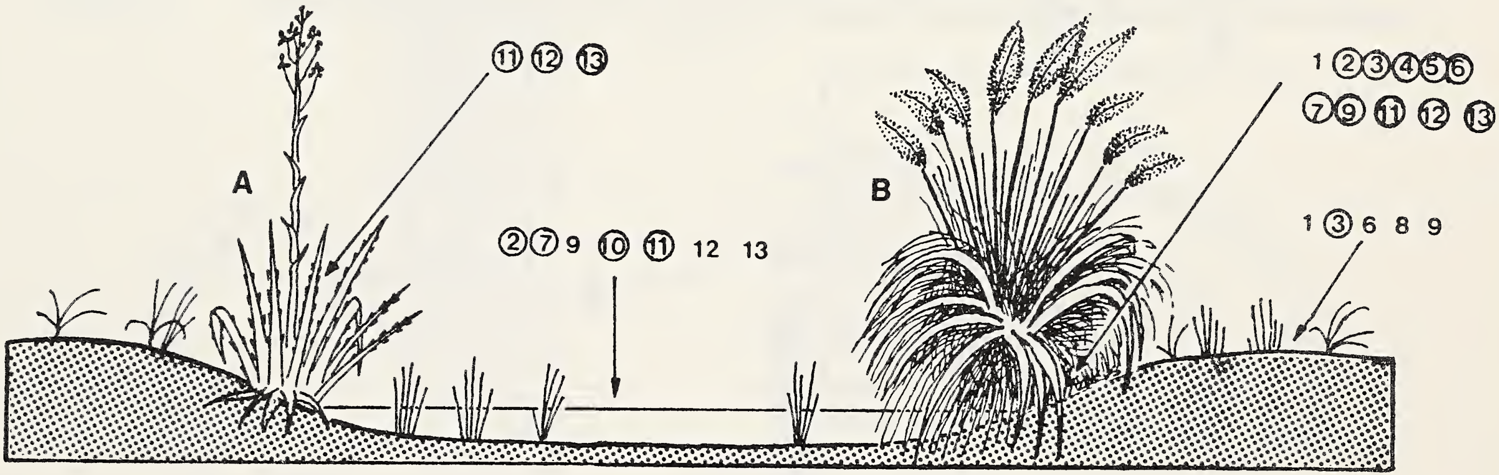

Figure 13. Diagram of the marsh habitat representing component situation of anuran species (terrestrial, aquatic, aquatic–margin, and vertical–low), numbered as in the systematic list. Circled species shows location during breeding period. Three hylid frogs occur at the vertical–low component, particularly the umbelifer *Eryngium* (A). On right side a clump of the arundineae *Cortaderia* (B) is shown.

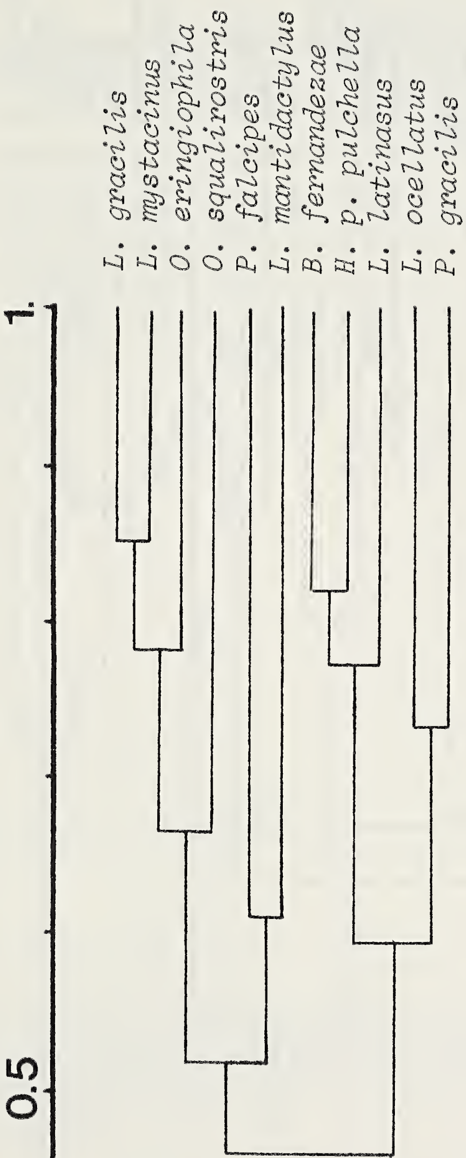

Figure 14. Cluster analysis for amphibian species with data recorded at their breeding period. The following categories were recorded: habitat, environmental component, size, activity period and reproductive strategies, as in Material and Methods. Similarity coefficient: Sorenson association coefficient; WPGMA.

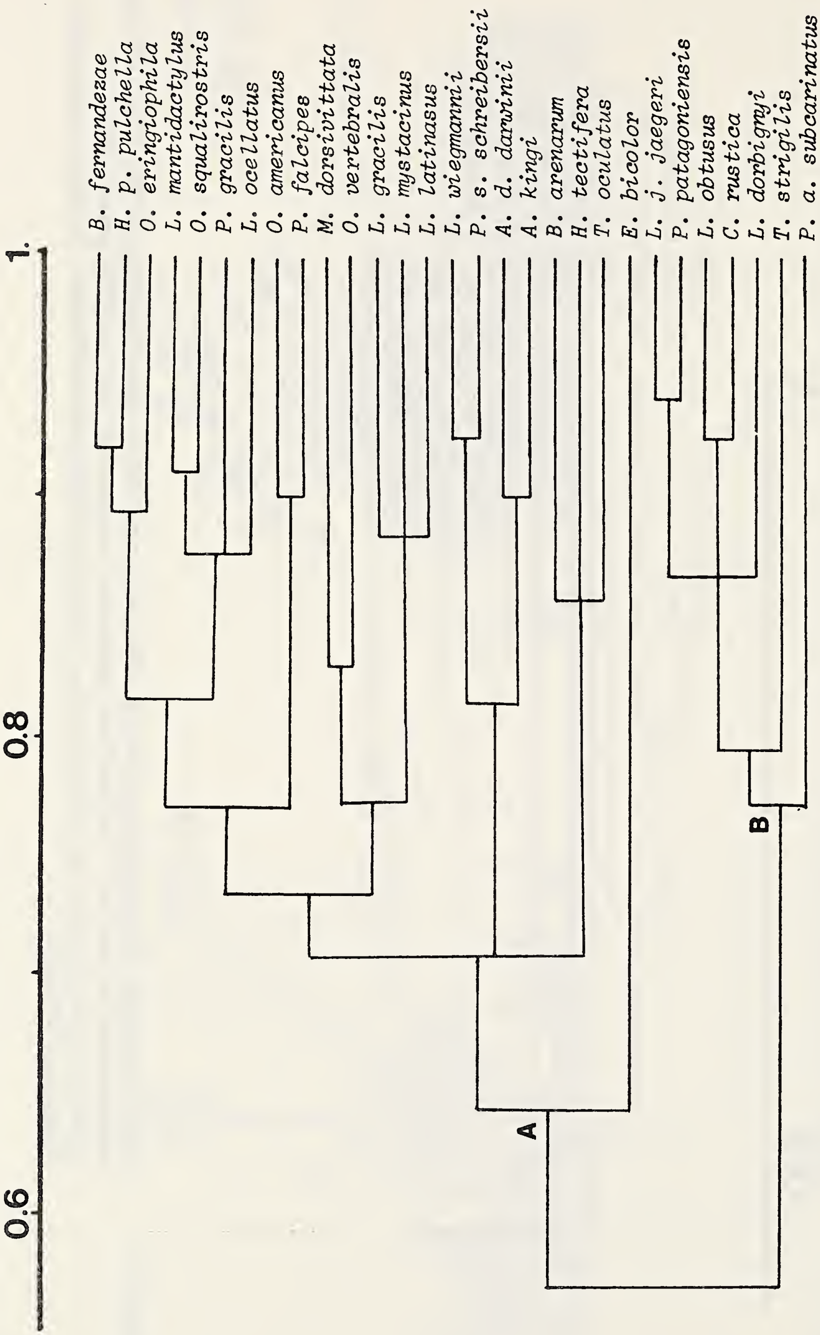

Figure 15. Cluster analysis for all amphibian and reptile species at Solymar. All categories were recorded: coefficient and method as in Fig. 14.

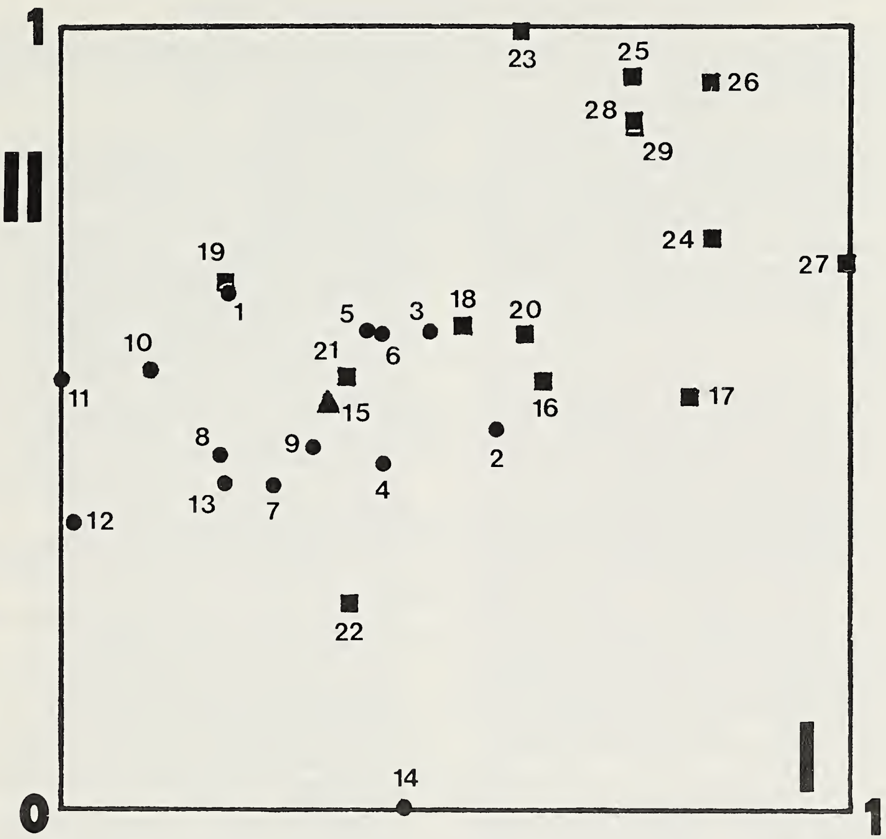

Figure 16. Polar ordination of amphibians (circles) and reptiles (turtle, triangle; squamates, squares) species at Solymar. Species numbered as in the systematic list. All categories were recorded. Axis I and II are dissimilarity coefficients.

NEW BOOKS: The Society for the Study of Amphibians and Reptiles Announces Two New Books To Be Published in Fall 1989 to Commemorate the First World Congress of Herpetology

SNAKES OF THE *AGKISTRODON* COMPLEX

by the late Howard K. Gloyd and Roger Conant

THIS LONG-AWAITED WORK is the first monographic treatment of the poisonous snakes originally included in the genus *Agkistrodon* but now placed in four genera: *Agkistrodon* of Asia and America, *Calloselasma* of Southeast Asia and Java, *Deinagkistrodon* of China, and *Hypnale* of India and Sri Lanka. In all, 33 taxa are covered. For each taxon there is a chresonymy, followed by sections entitled Type Locality, Vernacular Names, Definition and Diagnosis, Scutellation, Hemipenis, Coloration and Pattern, Form and Size, Distribution, Specimens Examined, Natural History and Ecology.

The book is extensively illustrated, with a color frontispiece (from a watercolor by David M. Dennis), **32 color plates** (247 separate photographs of animals and their habitats), 20 black and white plates (of skin patterns, heads, and entire animals), 60 text figures, and 28 maps showing distribution. There are also 14 tables and 6 charts.

The authors of the main text have been two of America's most respected authorities on snakes for over half a century. The late Dr. Gloyd, former Director of the Chicago Academy of Sciences, was the author of "The Rattlesnakes, Genera *Sistrurus* and *Crotalus*," one of the landmark books in American herpetology. Dr. Conant, former Director of the Philadelphia Zoo, is the author of the best-selling "Field Guide to Reptiles and Amphibians of Eastern and Central North America," in the Peterson series.

The authors began their project to monograph the genus *Agkistrodon* in 1929 and since that time have published numerous papers on these snakes. This book represents the culmination of decades of detailed study of more than 6200 specimens, field work by the authors in many parts of the range of these snakes, and the synthesis of everything that is known about their systematics and natural history. Their text includes a comprehensive bibliography of nearly 2000 titles.

This book is also packed with **discussions of general interest**, including the following:

• The Cantil, *Agkistrodon bilineatus*, which survives through a severe annual season of drought by aestivating, and should not be called the Mexican "water" moccasin. On the opposite side of the world the Malayan Pit Viper, *Calloselasma rhodostoma*, endures a similar quiescent period, and occurs only in regions that have an annual dry season of a month or more.

• Vipers, esteemed as "medicine" in the Orient, are believed to cure a variety of ailments ranging from impotence to serious diseases. A favorite way to obtain the greatest benefit is to kill a snake, remove the gall bladder, and swallow it at once with a glass of rice wine.

• The Himalayan Pit Viper, *Agkistrodon himalayanus*, has been reported from 16,000 feet (4877 m), probably the highest elevation ever recorded for a snake.

• A full dozen taxa of pit vipers, including subspecies, was swept for decades into a taxonomic "wastebasket," labelled *Agkistrodon halys*. The Asian snakes of the genus *Agkistrodon* are much smaller, in both length and bulk, than the American copperhead, *Agkistrodon contortrix*.

• Special essays included are "The Mamushi Industry in Japan" by Richard C. Goris and "American Copperhead in History, Folklore, and Religion" by Roger Conant.

Supplementing this main text are **nine ancillary chapters**, each written by the leading specialists on various topics of relevance:

• Ritualized Behavior in *Agkistrodon* and Allied Genera, by Charles C. Carpenter and James C. Gillingham

• Chromosomes of *Agkistrodon* and Other Viperid Snakes, by Charles J. Cole

• The Fossil History of the Genus *Agkistrodon* in North America, by Roger Conant

• The Palearctic Species of *Agkistrodon*, by the late Howard K. Gloyd

• An Updating of the Literature on Venoms and Envenomation in *Agkistrodon* and Its Allies, by David L. Hardy

• General Skull, Bone, and Muscle Variation in *Agkistrodon* and Related Genera, by Kenneth V. Kardong

• A Review and Comparison of Hemipenial Structure in the Genus *Agkistrodon (sensu lato)*, by Edmond V. Malnate

• Immunologic Relationships in *Agkistrodon* and Related Genera, by Sherman A. Minton

• Pleistocene Forests and Copperheads in the Eastern United States, and the Historical Biogeography of New World *Agkistrodon*, by Thomas R. Van Devender and Roger Conant

The book is about 550 pages (8.5 x 11 inches or 21.5 x 28 cm) and is bound in library-grade buckram cloth. A complete list of the book's contents and a specimen color plate are given in the March 1989 issue of *Herpetological Review*; copies of that ad are available on request from the Publications Secretary. There is an order blank on the next page.

SOCIETY • FOR • THE • STUDY • OF • AMPHIBIANS • AND • REPTILES

NEW BOOKS:

CONTRIBUTIONS TO THE HISTORY OF HERPETOLOGY

by Kraig Adler, John S. Applegarth, and Ronald Altig

THIS BOOK consists of three separate sections, each of them worldwide in coverage and including herpetologists of both past and present. **The first and longest section, by Kraig Adler,** is a series of detailed biographies of the leading contributors to herpetology—each complete with a portrait, signature, and references to other biographical information—followed by an extensive bibliography of historical works in herpetology. These biographies feature 150 persons, but also include information about their colleagues and students, so that the effective coverage is more than 500 individuals. A wide range of persons is included, from gifted amateurs sometimes having no formal education at all to the most distinguished and influential people of their day. Biographies are arranged chronologically so that the development of the field of herpetology can be visualized. There is a comprehensive index.

The 150 biographies include these 100 persons:

• Leading herpetologists such as Boulenger, Cope, Daudin, the Dumérils, Fitzinger, Merrem, Mertens, Noble, Wilhelm Peters, Schlegel, Schmidt, Stejneger, Strauch, Wagler, and Werner.

• Great naturalists who dabbled in herpetology: Agassiz, Cuvier, Gessner, and Linnaeus.

• The explorers Espada, Maximilian zu Wied, Spix, and Tschudi.

• Collection builders Baird, Barbour, Boettger, Gray, Günther, Logier, Seba, and Van Denburgh.

• The popularizers Ditmars, Kauffeld, and Vogel, the terrarist Klingelhöffer, and serious amateurs Klauber and Malcolm Smith.

• Authors of herpetological textbooks (Goin, Terentjev), prominent teachers (Boring, Gaige, Myers, Ruthven, Wright), anatomists (Baur, Bojanus, Camp, Haas, Alfred S. Romer), and ecologists (Blair, Cowles, Tinkle).

• The artists Roesel von Rosenhof and Sordelli.

The coverage is comprehensive, including:

• Geographic areas such as the USA (Cochran, Garman, Girard, Harlan, Holbrook, James Peters, Pope, Rafinesque, Say, Edward Taylor), Australia (Glauert, Kinghorn, Krefft, Mitchell, Waite), and Africa (Anderson, Bocage, Vivian FitzSimons, Hewitt, Loveridge, Pitman, Andrew Smith, Villiers).

• Experts on taxonomic groups such as frogs (Liu, Miranda Ribeiro, Okada), salamanders (Bishop, Dunn, Sato), turtles (Carr, Deraniyagala, Medem, Schöpf, Siebenrock), and snakes (do Amaral, Blanchard, Gloyd, Hoge, Jan, Maki, Oshima, Russell, Wall).

The second section, by John S. Applegarth, is an index of over 2400 authors in taxonomic herpetology, an unique reference for researchers, librarians, and historians. Included is everyone who has ever proposed a new taxon within the living families of amphibians and reptiles, as well as persons who were honored by such taxa *and* who authored at least one contribution to herpetology. Authors are identified by their full names, exact dates of birth (and, if applicable, death), countries of residence, and the taxonomic orders in which they proposed new names.

The third section, by Ronald Altig, is a listing of herpetologists giving the names of their university and major professor, and the date of their doctoral degree. The information is arranged in such a manner that the academic lineages of herpetologists can be followed from generation to generation. 1300 names are included and indexed.

The book is about 200 pages long (8.5 x 11 inches or 21.5 x 28 cm) and is bound in library-grade buckram cloth. There is a color frontispiece and 150 photographs. A sample account is printed in the March 1989 issue of *Herpetological Review*; copies are available on request from the Publications Secretary.

PRICES & ORDERING INSTRUCTIONS. Books can be obtained from the Publications Secretary, Robert D. Aldridge, Department of Biology, St. Louis University, St. Louis, Missouri 63103, USA. Make check payable to "SSAR"; receipt sent on request. Prices include shipping charges (book rate) within USA; overseas orders will be billed only for the *additional* costs in excess of domestic rates. Publications sent at customer's risk; however, packages can be insured at cost. Overseas customers must make payment in USA funds, by International Money Order, or by MasterCard or VISA (give account number and expiration date).

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Both books will be published in Fall, 1989. The Society for the Study of Amphibians and Reptiles publishes *Journal of Herpetology, Herpetological Review, Facsimile Reprints in Herpetology, Herpetological Circulars, Contributions to Herpetology* (monographs), and *Catalogue of American Amphibians and Reptiles*. Pricelist of publications and information on Society membership are available on request from Dr. Aldridge.

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GENERAL INTEREST

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Dundee and Rossman provide a brief history of herpetology in Louisiana, and offer useful information on caring for amphibians and reptiles in captivity as well as on collecting and preserving specimens. In response to an area of continuing popular concern, they include a discussion of snakebite and treatment. Pointing to the declining populations of some species, the authors emphasize the need for conservation. They also analyze the zoogeography of the herpetofauna.

With its many illustrations, identification keys, and clear descriptions, *The Amphibians and Reptiles of Louisiana* will prove useful and informative for professional and amateur herpetologists and students.

Harold A. Dundee is curator of amphibians and reptiles and professor emeritus of biology at Tulane University.

Douglas A. Rossman is curator of reptiles at the LSU Museum of Natural Science and adjunct professor of zoology at Louisiana State University.

Eugene C. Beckham was formerly a senior research biologist at the Louisiana Department of Wildlife and Fisheries.

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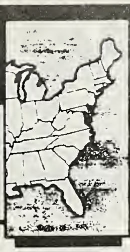

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Carl H. Ernst and Roger W. Barbour

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Table of Contents: Preface; Introduction; Identification of Snakes; Typhlopidae: Blind Snakes; Colubridae: Colubrid Snakes; Glossary of Scientific Names; Bibliography; Index.

About the Authors

Carl H. Ernst is Professor of Biology at George Mason University and author of *Turtles of the United States* (1972). **Roger W. Barbour** is Distinguished Professor Emeritus at the Morgan School of Biological Sciences, University of Kentucky. The authors bring to this volume more than 60 years of teaching and field study of snakes.

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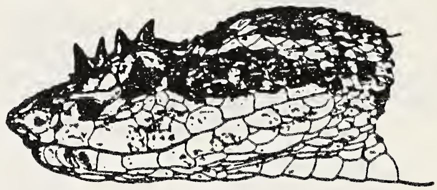

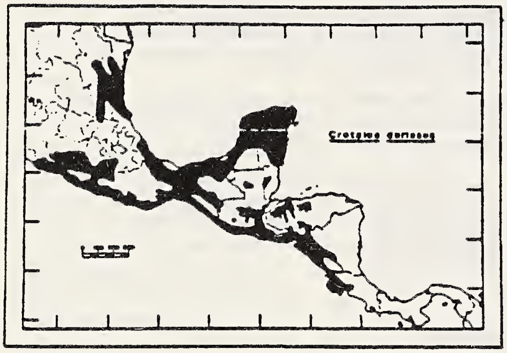

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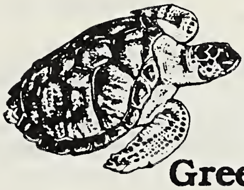

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NEWS & NOTES:

April 6, 1989

Dear HL Member:

As you may know, the **HERPETOLOGISTS' LEAGUE** has greatly expanded its services to the herpetological community over the past several years. In addition to publishing our excellent journal, **Herpetologica**, we have initiated several other projects and expanded our participation at the annual meetings through joint sponsorship with other societies. To continue these activities and keep our dues low, we need to boost our membership. We are asking for your help to increase the numbers of student and regular members in the society.

All professionals should be involved in their societies. We want to encourage fellow herpetologists, especially students, to join in the expanded activities of the **HERPETOLOGISTS' LEAGUE**. As an incentive to join, new members will be able to purchase an exceptional new book on venomous reptiles of Latin America at a greatly reduced price (see enclosed announcement). This bargain is available to all current **HL** members **and** to new members who join now.

We also encourage you to subscribe to **Herpetological Monographs**; No. 3 is scheduled for publication this year and contains some exciting and important papers. Please use the order form on the enclosed flyer to order the book and subscribe to **Herpetological Monographs** if you currently do not have a subscription. The membership application form can be used to encourage a colleague or student to join the **Herpetologists' League**.

HERPETOLOGISTS' LEAGUE -- ACTIVITIES & BENEFITS:

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The quarterly journal **Herpetologica** has published new research findings on the biology of amphibians and reptiles since 1936. Research reports are of 20 printed pages or fewer. The journal is free to all **HL** members.

The **Herpetological Monographs** series began publication in its current format in 1988 and consists of large research reports (>20 pages) on the ecology, systematics, and other biological aspects of amphibians and reptiles. A single volume of one to four research monographs and a color frontispiece is published each year. **Herpetological Monographs** has become an important publication outlet for major herpetological papers. The subscription price to **HL** members is only $9.00.

NEWS & NOTES:

ANNUAL MEETINGS

The **Herpetologists' League** holds annual meetings, usually with another herpetological society and sponsors activities for its members in attendance.

The League recognizes student achievements in herpetological research by giving awards at the annual meetings for the best paper and the best poster. The League sponsors the Distinguished Herpetologists Lecture Series at the annual meetings.

SPECIAL SPONSORED BOOKS

The **Herpetologists' League** recently embarked on a program to support the publication of books of interest to its members. This effort encourages the publication of top quality herpetological research and simultaneously increases the availability of the resulting book to the herpetological community by offering substantial discounts to members. The first book in this series is detailed on the attached flyer.

SERVICE

The **Herpetologists' League** is involved in conservation efforts in behalf of reptiles and amphibians and gives all members opportunity to participate in society activities involving particular projects of current national and international interest.

The **HERPETOLOGISTS' LEAGUE** can best continue to increase its service and contribution to the herpetological community by having all herpetologists involved in the society. Encourage your friends and colleagues to join **HL** and support our expanded programs and activities.

NOTES:

NOTES:

Society Publication

Back issues of the Bulletin of the Maryland Herpetological Society, where available, may be obtained by writing the Executive Editor. A list of available issues will be sent upon request. Individual numbers in stock are $2.00 each, unless otherwise noted.

The Society also publishes a Newsletter on a somewhat irregular basis. These are distributed to the membership free of charge. Also published are Maryland Herpetofauna Leaflets and these are available at $.25/page.

Information for Authors

All correspondence should be addressed to the Executive Editor. Manuscripts being submitted for publication should be typewritten (double spaced) on good quality 8 1/2 by 11 inch paper with adequate margins. Submit original and first carbon, retaining the second carbon. If entered on a word processor, also submit diskette and note word processor and operating system used. Indicate where illustrations or photographs are to appear in text. Cite all literature used at end in alphabetical order by author.

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The Maryland Herpetological Society
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Natural History Society of Maryland, Inc.
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DECEMBER 1989 VOLUME 25 NUMBER 4

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Volume 25 Number 4 December 1989

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The Maryland Herpetological Society
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BULLETIN OF THE

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Volume 25 Number 4 December 1989

The Maryland Herpetological Society
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Meetings

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PRELIMINARY REPORT ON ENHANCED GROWTH AND EARLY MATURITY IN A MARYLAND POPULATION OF PAINTED TURTLES, *CHRYSEMYS PICTA*

Carl H. Ernst and Billy S. McDonald, Jr.

Abstract

An enriched diet and longer annual activity period in nutrient rich habitat (sewage lagoons) produced an enhanced growth rate in both sexes of painted turtle, *Chrysemys picta*. Males grew to the normal size of maturity in two years instead of the four years needed to reach this length in a nearby population living under natural conditions. Females, although experiencing faster growth, were not sexually mature at lengths greater than those normally shown by mature individuals.

In most species of North American turtles, the attainment of sexual maturity is generally related to attainment of some minimum shell length (or possibly body mass) rather than a certain age (Cagle, 1944, 1948, 1950, 1954; Legler, 1960; Gibbons, 1968; Ernst, 1971a; Ernst and Barbour, 1972; Moll, 1979; MacCulloch and Secoy, 1983). The only North American turtle living under natural conditions known to vary from this concept is *Sternotherus odoratus*, whose males apparently mature at various shell lengths but at approximately the same age throughout its range (Tinkle, 1961). However, some *Trachemys scripta* living in thermally impacted environments mature at larger sizes than others from nearby naturally heated ponds (Gibbons et al., 1981; Thornhill, 1982).

Turtle populations at various latitudes may differ in body size and age of maturity. *Sternotherus odoratus* (Tinkle, 1961; Gibbons, 1970a) and *Chrysemys picta* (Christiansen and Moll, 1973; Moll, 1973) from southern latitudes in United States mature at an earlier age and at shorter shell lengths than from more northern states. *Trachemys scripta* from natural waterbodies vary little in size at maturity in North America (Cagle, 1950), but this species matures at greater shell lengths in the tropics (Moll and Legler, 1971).

However, is the apparent correlation of sexual maturity and shell length true? Data seem lacking to substantiate this in most species. In fact, Gibbons et al. (1981) reported that at the U.S. Department of Energy's Savannah River site in South Carolina, female *Trachemys scripta* matured at a larger size (approximately 20 cm plastron length) but at about the same age (8 years) at PAR Pond than did females from nearby Ellenton Bay (approximately 16 cm plastron length, 8 years). Water temperatures and food quality were more optimal at PAR Pond, which received heated effluent from a nuclear reactor (Gibbons, 1970b; Parmeter, 1980), than at the more natural Ellenton Bay. Similarly, Thornhill (1982) found that female *T. scripta* from an Illinois lake artificially heated by thermal effluent from a coal-fired power plant were younger (3 years) and larger (186 mm) at maturation than females (4 years, 180 mm) from a natural lake less than two kilometers distant. Growth was enhanced in the *T. scripta* from the South Carolina and Illinois impoundments (Gibbons, 1970b; Christy et al., 1974; Thornhill, 1982), so if the correlation of plastron length with maturity exists (Cagle, 1950), these females should have matured at a younger age but at about the same length as those from impoundments that experienced a natural growth rate.

Will an accelerated growth rate bring on maturity earlier in *Chrysemys picta*, or will a larger size be required for maturity as seen in female *Trachemys scripta* from South Carolina and Illinois (Gibbons et al., 1981; Thornhill, 1982)? Also, do *C. picta* from different populations at the same latitude mature at the same plastron lengths? To answer these questions, we examined attainment of maturity in two populations of *C. picta* from Charles County, Maryland, where McDonald had conducted population studies for several years. The first population was from the St. Charles Community Sewage Disposal Lagoons at Waldorf. Painted turtles from this site experienced rapid growth due to an enhanced diet of insect larvae and algae living in the enriched bottom substrate of the lagoon, and a longer annual activity period due to the warmer water temperatures resulting from oxidation of the muck (McDonald, pers. observ.). The second population was located at the nearby Myrtle Grove Wildlife Management Area, where conditions were natural and the turtles showed a normal growth rate comparable to that reported for painted turtles from southeastern Pennsylvania (Ernst, 1971b).

Male *Chrysemys picta* from both southeastern Pennsylvania and central Virginia mature at plastron lengths of 71 mm in their fourth year (Ernst, 1971a,b; Mitchell, 1988). Females from these same areas attain maturity at plastron lengths of about 100–110 mm at ages of 5–8 years (Ernst, 1971a,b; Mitchell, 1988). Using these size data, turtles of known age with plastron lengths greater than the minimum for mature individuals of both sexes were collected from each site (Table 1). Sample sizes were kept small so as not to adversely affect McDonald's ongoing studies of population dynamics, and no females were taken from Myrtle Grove due to nesting studies there. All males exhibited the sexually dimorphic characters of elongated foreclaws and precloacal tail lengths associated with sexual maturity (Ernst, 1971a).

Males were sacrificed on 11 and 16 March, a period when mature sperm are found in the epididymides, and females on 8 May, when ovarian follicles are at maximum diameter prior to ovulation (Ernst, 1971a). Both reproductive tracts were dissected from each turtle, fixed in 10 percent formalin and after two weeks transferred to 80 percent ethyl alcohol for storage. The bodies of the turtles were placed in the vertebrate collection of George Mason University (GMU 398–410). Later the testes and epididymides were embedded in paraffin, sectioned, and stained with hemotoxylin and eosin. The greatest diameters of the ovarian follicles from the preserved reproductive tracts were measured with dial calipers accurate to 0.1 mm, and compared to the classification scheme developed by Mitchell (1985) for Virginia *C. picta*. He assigned follicles to three size classes: Class I, < 6 mm in diameter; Class II, 6–11 mm; and Class III, > 11 mm. His criterion for determination of female maturity was the presence of Class III follicles. Ernst (1971a) used a follicle diameter of 15 mm for determination of sexual maturity in female *C. picta* from southeastern Pennsylvania.

Table 1 presents data on the state of maturity of all painted turtles examined. Age and length data indicated that turtles from the Sewage Lagoons grew much faster than those from Myrtle Grove. All Myrtle Grove sacrificed males were larger than 71 mm plastron length, and had mature sperm in either the seminiferous tubules or epididymides. Both males from the Sewage Lagoons were also mature, but had grown to mature lengths in two years rather than the four years taken by the males from Myrtle Grove. This may indicate that male *C. picta* become sexually mature within a certain size range, and that enhanced growth may bring on maturity earlier.

Data for females is more interesting. All four from the Sewage Lagoons showed accelerated growth to 127–139 mm in three years, whereas three and four year old females from southeastern Pennsylvania only grew to 70–90 mm (Ernst, 1971b), and were much larger than the 100–110 mm minimum plastron lengths reported for mature females from Pennsylvania and Virginia (Ernst, 1971a; Mitchell, 1988). However, using the criterion of the presence of Class III (> 11 mm) ovarian follicles only the largest two were mature, and if a criterion of 15 mm is applied (Ernst, 1971a) none were mature. None contained corpora lutea or oviducal eggs. These female *C. picta* showed the same pattern of maturity at a larger size (with enhanced growth) that was reported for female *Trachemys scripta* from thermally impacted environments by Gibbons et al. (1981) and Thornhill (1982).

Halliday and Verrell (1988) reported that the growth rate prior to the age of maturity in amphibians and reptiles is a much more significant source of variation in body size than age. This is evident for both the *C. picta* from Maryland and the *T. scripta* from South Carolina (Christy, et al., 1974; Gibbons et al., 1981), and Illinois (Thornhill, 1982) living under artificial conditions. Stearns and Crandall (1984) reviewed the relationship of environmental stress on size and age of maturity in fish that also pertains to similar situations in reptiles. An organism encountering unavoidable stress resulting in an abnormal growth rate should alter its age and size at maturity along a trajectory that minimizes any reduction in fitness caused by this growth rate. This trajectory along which age and size at maturity change as stress increases is called a plastic trajectory (Stearns, 1983). It is this trajectory, and neither a specific age nor size at maturity taken separately, that may be considered the character under selection. Stearns and Crandall constructed a life history model to predict such a trajectory for fish.

Although the data presented on *C. picta* are scanty, and this report must be considered only a preliminary notice, two points seem apparent. First, under artificial conditions favoring a richer diet and longer annual period of activity, both sexes of *C. picta* will experience more rapid growth. Second, this enhanced growth rate may bring on maturity earlier in males, but possibly retard maturity until a longer than normal shell length is attained in females. A more complete study of these relationships in *C. picta* is needed.

Acknowledgement

J. Whitfield Gibbons and Jeffrey E. Lovich read an early draft of the manuscript and offered many helpful suggestions for its improvement. Dr. John C. Harshbarger prepared the testes slides. Thanks are also given to the managers of the Waldorf Sewage Disposal Lagoons and the Myrtle Grove Wildlife Management Area for permission to study and to remove turtles from these sites.

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Table 1. State of sexual maturity in painted turtles, *Chrysemys picta*, from two populations in Charles County, Maryland. All measurements are presented in millimeters.

Specimen	Sex	Age (Yrs)	Plastron length	Mature Sperm	Follicle Classes I	II	III	Greatest Follicle Diameter	Sexually Mature
				Waldorf Sewage Lagoons					
398	M	3	119.3	+	–	–	–	–	Yes
399	M	2	87.1	+	–	–	–	–	Yes
400	F	3	132.0	–	+	+	+	12.0	?
401	F	3	139.0	–	+	+	+	13.3	?
402	F	3	129.0	–	+	–	–	3.8	No
403	F	3	127.0	–	+	+	–	10.0	No
				Myrtle Grove Management Areas					
404	M	4	81.8	+	–	–	–	–	Yes
405	M	4	98.5	+	–	–	–	–	Yes
406	M	4	95.8	+	–	–	–	–	Yes
407	M	4	86.1	+	–	–	–	–	Yes
408	M	5	105.0	+	–	–	–	–	Yes
409	M	4	89.5	+	–	–	–	–	Yes
410	M	4	93.7	+	–	–	–	–	Yes

THE SUBSPECIFIC IDENTITY OF THE POPULATION OF *SCELOPORUS UNDULATUS* SYMPATRIC WITH *S. OCCIDENTALIS*

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Abstract

Three scale characters (number of dorsals, head to base of tail; number of femoral pores; number of "interfemoral" scales between the two series of femoral pores), and one of pattern (barred vs. striped) differentiate *Sceloporus undulatus elongatus* and *S. u. tristichus*, as shown by 63 specimens of the former, 72 of the latter, from Arizona, Colorado, New Mexico and Utah. The population that occurs in southeastern Utah in sympatry with *S. occidentalis biseriatus* represents intergrades between *S. u. elongatus* and *S. u. tristichus*, agreeing completely with the former in pattern, and being closer to the latter in number of dorsals, intermediate in number of interfemoral scales, and closer to *S. u. elongatus* in number of femoral pores.

In a seminal study of lizards of the *Sceloporus undulatus* complex in the Pine Valley Mts. of southwestern Utah, Cole (1983) conclusively demonstrated that two taxonomically distinct populations coexist there in sympatry, and are accordingly allospecific in the context of the biological species concept. One he regarded as *S. occidentalis biseriatus*, the other as *S. undulatus elongatus*. However, the dorsal scale counts given by Cole (1983) for the latter population in the Pine Valley Mts. are low for that subspecies occurring in adjacent parts of Arizona fide Smith (1938). Indeed, on that basis Smith (1938) included extreme southwestern Utah within the range of *S. u. tristichus* in spite of resemblance of that population to *S. u. elongatus* in pattern. Unfortunately, Smith (1938) included what is now regarded as a distinct subspecies, *S. u. erythrocheilus*, in his composite concept of *S. u. elongatus*, hence his comparisons of that subspecies, as now understood, and *S. u. tristichus* are meaningless. We here evaluate the distinctions of *S. u. elongatus* and *S. u. tristichus* in an attempt to determine the taxonomic status of the population of *S. undulatus* that occurs sympatrically with *S. occidentalis* in the Pine Valley Mts. of southwestern Utah.

Confining our study to characters shown by previous studies to be useful in distinguishing these subspecies of *S. undulatus*, we recorded three scale character states for all specimens studied: (1) dorsal scales, counted in as direct a line as possible from occiput to a line even with the rear margins of the thighs as held at right angles to the body; (2) number of femoral pores on each side; and (3) number of "interfemoral" scales in contact with each other on as direct a line as possible between the two pore series. Since sex and size have not been shown by previous studies to differ in these three respects, results were pooled for males and females, juveniles and adults. The data are summarized in Table 1.

Samples studied were selected from scattered localities throughout much of the range of each subspecies, drawing upon the collections of the University of Colorado Museum (UCM). Of *S. u. elongatus*, 63 specimens were studied, and of *S. u. tristichus*, 72; 15 additional specimens studied were ultimately regarded as intergrades (10 from Washington Co., Utah, and 5 from San Juan Co., Utah). The localities represented are plotted on the accompanying map (Fig. 1) and listed in the Appendix.

As indicated in Table 2, an 80% separation or better of the two subspecies is obtained with any of the three scale characters studied. The intergrades (see Appendix) are intermediate between the means in all three characters differing between the two subspecies. The two groups of intergrades were compared by Analysis of Variance (ANOVA) for each of the three scale characters, keeping the family-wise error rate less than 0.05 (Keppel, 1973). All three comparisons proved insignificant, so these two samples were pooled for comparison with *S. u. elongatus* and *S. u. tristichus*. The latter comparisons are summarized in Table 1.

Multiple comparisons (Newman-Keuls, also with family-wise error rate less than 0.05) revealed that the intergrades were significantly different from both *S. u. elongatus* and *S. u. tristichus* in all three characters. The intergrades thus were higher than the latter and lower than the former by each measure of scutellation (see Fig. 2).

The data given by Cole (1982) on variation of scutellation in his series of *S. u. undulatus* from the Pine Valley Mts. of southwestern Utah conform almost perfectly with the data from our series from the same locality, and support our allocation of them to intergrade status. His series from the Virgin Mts., Mohave Co., Arizona have data so similar to the Pine Valley Mts. population that it too should be regarded as representative of an intergrade population.

Interestingly, the more northern locality in San Juan Co., Utah (Devil's Canyon, ±85 km N of the Mexican Hat locality where the intergrades were taken; see Appendix), is represented by more or less typical *S. u. elongatus*, agreeing with that subspecies in all scale characters (49–50 dorsals, N7, 86% agreement; 15–21 femoral pores, N14, 64%; 6–8 interfemoral scales, N7, 70%), as well as having the typical barred pattern.

The intergrades from both San Juan and Washington counties, Utah, have a barred pattern as in *S. u. elongatus*, but that pattern also occurs in some of the more northern samples from New Mexico (Taos Co.) that we have here assigned to *S. u. tristichus* on the basis of conformity with that subspecies in all scale characters. As noted by Smith (1938), transition in pattern between the two subspecies – barred in *S. u. elongatus*, striped in *S. u. tristichus* – does not coincide in location with transition in scale characters, all of which are linked. The *S. u. elongatus* pattern invariably encroaches upon the *S. u. tristichus* scale character states; the reverse seemingly does not occur. Because of the preponderance of the scale differences, and their objectivity of appraisal, we continue to recommend, as did Smith (1938), that they be given precedence over the much more subjective character of color pattern in assignment of intergrade populations to subspecies, and that intergradation determination exclude color pattern.

On the basis of the information here summarized, we conclude that *S. occidentalis biseriatus* is sympatric in Washington Co., Utah, with *S. u. elongatus* x *S. u. tristichus*, and that the western species probably is not sympatric with either *S. undulatus* subspecies in non–intergrade territory.

Acknowledgments. We are much indebted to Drs. Carl and Jane Bock for the opportunity for one of us (HMS) to visit the area of sympatry in southwestern Utah. Dr. Shi–Kuei Wu kindly provided facilities for study of material in the University of Colorado Museum, and assured care of new material.

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Appendix

Data were taken from the following specimens (all numbers are for UCM). *Sceloporus undulatus elongatus*. ARIZONA. *Coconino Co.*: 4.5 mi SE Page, Hy 189 (17434). COLORADO. *Mesa Co.:* Colorado National Monument (CNM) (3179, 9439, 10464, 10485, 10488, 10490, 10493, 24048); Pollock Canyon, CNM (21708, 24054, 24056–7, 24061, 24068, 24070, 24073, 24077, 24087–8); Headquarters, CNM (18134); mouth Canyon East, CNM (18130); 3 mi SSW Fruita (2731, 2733, 24060, 24067, 24078, 24082, 24095, 24097); 10 mi S Fruita (24046); 8 mi Grand Junction (24098–9); 10 mi N Grand Junction (23943); 9.8 mi W Grand Valley (10788). UTAH. *Grand Co.*: Little Dolores River, 20 mi WSW Glade Park, Mesa Co., CO (6026). *Piute Co.*: 2 mi E Kingston (13829–31). *San Juan Co.*: Devil's Canyon, 12 mi S Monticello (6612–9). *Sevier Co.*: 5 mi E Salina (13832–42). *Uintah Co.*: Dinosaur National Monument (DNM) (14114–5); Harper's Corner, DNM (5469–70); Headquarters, DNM (2678, 6013).

Sceloporus undulatus tristichus. ARIZONA. *Maricopa Co.*: Sycamore Creek Campground nr Sunflower (44030). *Pinal Co.*: Oak Flat Campground, 4 mi E Superior (46054–5). *Yavapai Co.*: 1 mi NW Yarnell (13302–11). NEW MEXICO. *Bernalillo Co.*: 15 mi E Albuquerque, Hy 40 (44005); 2 mi N Isleta Pueblo (6242–4, 6246–50, 6252–3); 4 mi N Isleta Pueblo (6239–41). *Catron Co.*: nr Old Horse Springs (34142); 1 mi W Old Horse Springs (2 specimens, no no.); 6 mi WSW Old Horse Springs (6257, 6259–60, 6262, 6270, 6275–6, 6278); 7 mi WSW Old Horse Springs (6256). *Rio Arriba Co.*: 2 mi W Regina (7356–9). *Taos Co.*; 3 mi W Arroyo Hondo, Rio Grande (7012, 7014, 7019–21, 7024, 7026, 7029); 16 mi S CO line, Hy 285 (14692–3, 14695); 3.3 mi E Ojo Caliente (43948–50); Questa (6227); 2.5 mi E Taos (7032–7, 7039–42, 7046–9).

S. u. elongatus – tristichus intergrades. UTAH. *San Juan Co.*: 10 mi NW Mexican Hat (17437–40, 17457); *Washington Co.*: Oak Grove Campground Rd., 4.2–7.2 mi NW Leeds (56059–65); 25 mi NE St. George (13863–5).

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Table 1. Scutellation+ of *Sceloporus undulatus* Samples (see Appendix)

Subspecies	Dorsals	Femoral Pores	Scales Between Pore Series
S. u. elongatus	48.6 ± 0.27 (44–54) 62	18.6 ± 0.12 (15–22) 123	8.0 ± 0.14 (6–11) 62
S. u. tristichus	41.8 ± 0.31 (37–49) 70	16.0 ± 0.13 (12–19) 142	5.8 ± 0.13 (4–8) 71
Intergrades	44.1 ± 0.45 (42–49) 15	17.9 ± 0.21 (16–19) 28	6.6 ± 0.20 (6–8) 14
F ratios from ANOVAs comparing the three samples (all Ps < 0.01)	139.98	106.19	73.99

+ Figures (rows 1–3) are the mean ± 1 SE, in the top line; parenthetically, the range, followed by the number (N) of counts.

Table 2. Percentage Separation of *Sceloporus undulatus* Samples

Subspecies	Dorsals	Femoral Pores	Scales Between Pore Series
S. u. elongatus	4.8% 44–45 95.2 % 46–54	20.3% 15–17 79.7% 18–22	8.1% 6 91.9% 7–11
S. u. tristichus	91.4% 38–45 8.6% 46–49	82.4% 12–17 17.6% 18–19	81.7% 4–6 18.3% 7–8

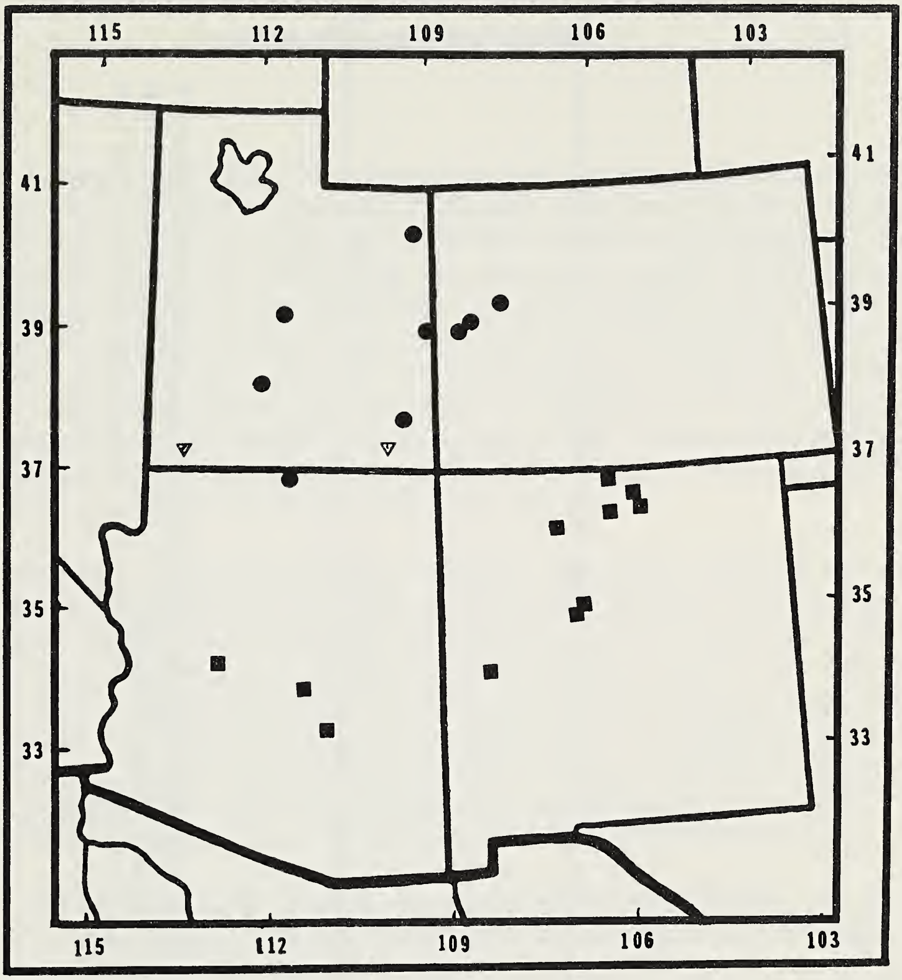

Fig. 1. Map showing the location of sample sites of *Sceloporus undulatus*. Dots, *S. u. elongatus*; squares, *S. u. tristichus*; triangles, intergrade populations.

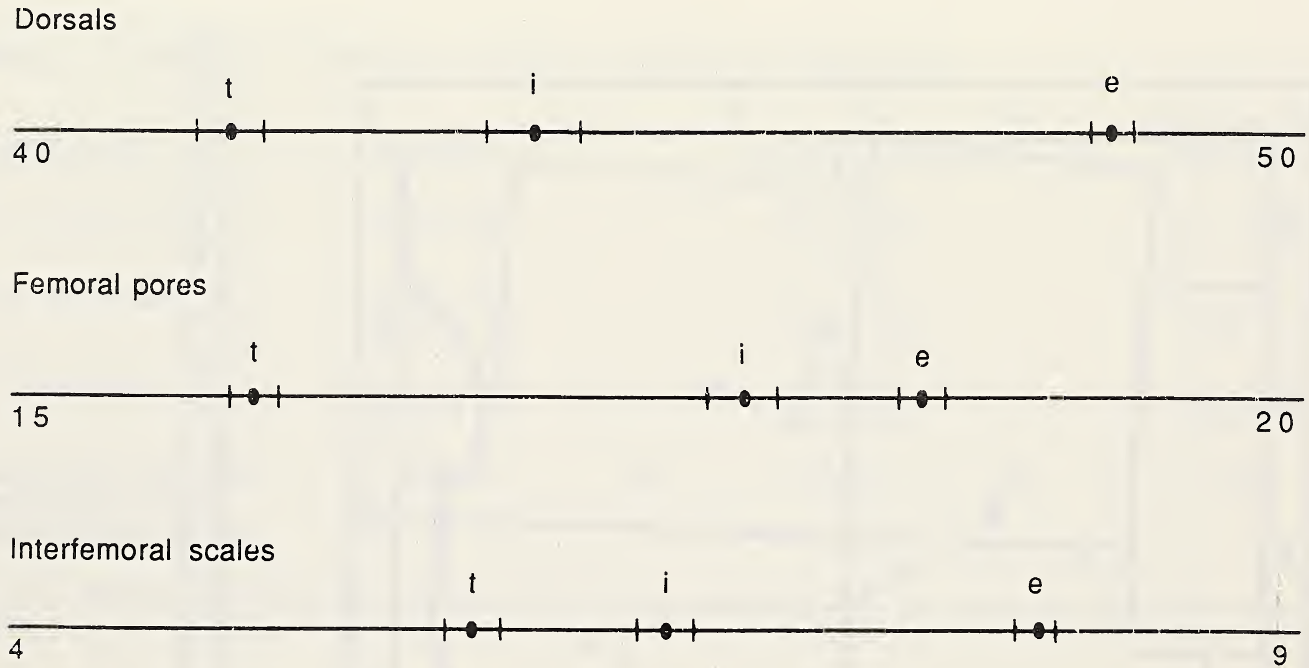

Fig. 2. Relation of scale characters in the *S. u. elongatus* x *S. u. tristichus* intergrades to those of their parent subspecies. Mean ± 1 SE is plotted along the pertinent range of each character; e, *S. u. elongatus*; i, intergrades between the two subspecies; t, *S. u. tristichus*.

AN AMELANISTIC MOLE KINGSNAKE (*Lampropeltis calligaster rhombomaculata*), FROM EAST TENNESSEE

A significant amount of information has become available concerning color variations and aberrancies in snakes. Albinism appears to be one of the most frequently encountered mutations and has been described for a number of species as evidenced by the reviews of Hensley (1959), Gilboa and Dowling (1974) and Dyrkacz (1981). Earlier accounts classified many specimens as albinos based only upon the lack of melanistic pigment normally present in the skin eyes, but more recently, attempts have been made to standardize the definitions of albinistic types according to colors which may be present (Bechtel, 1978; Dyrkacz, 1981). Those snakes which lack melanin but contain some color, primarily yellows or reds, are considered to be amelanistic (Bechtel, 1978; pers. comm.).

Though a number of color mutations have been reported for the kingsnakes, genus *Lampropeltis*, few of these have included reference to *L. calligaster*. "Albino" specimens of *L. c. calligaster* have been found in Dallas County (J. B. Murphy, pers. comm, in Dyrkacz, 1981) and Harris County (Tryon, 1984, in part), Texas that were utilized in zoo breeding programs. The single report of an aberrancy in the mole kingsnake, *L. calligaster rhombomaculata* appears to be that of Collins (1960) which was described as "pure albino in appearance." Because of this, it seems desirable to report on an amelanistic specimen of *L. c. rhombomaculata* from east Tennessee.

The snake (Fig. 1), a male, was collected at about 1600 h, 14 July 1989 on a road through a residential neighborhood within the city limits of Knoxville, Knox County, Tennessee. Based on size (386 mm snout–vent length, 438 mm total length, weight 23.8 g) it was estimated to be two years of age at the time of capture. General appearance seems to be that of a light pink snake with red markings, but closer inspection reveals a white ground color in which most scales are flecked with varying amounts of red pigment, thus giving the overall pinkish cast. There are 36 red dorsal rhombs (37 if one broken is counted as two) on the body and 11 (12 if one broken is counted as two) on the tail. Typical alternating lateral markings of red are also present. There is a red "Y" shaped marking on the top of the head extending onto the neck which is flanked on both sides by one red circular dot. A red postocular stripe is present and the eyes and tongue are red. Ventral and caudal pattern is a diffused light reddish–orange checkerboard. Scutellation appears normal for the subspecies. Scale formula is 21–21–18, and there are 205 ventrals and 43 subcaudal scales. Supralabials number 7–7, and infralabials are 8–6.

Bechtel (1978) pointed out that the chromatophores of snakes are limited to a few basic colors, black, red, yellow and the reflected hues of iridophores. In the absence of black, the patterns of most amelanistic specimens are yellow (xanthic) or red (erythristic). *L. calligaster* presents an interesting situation in that most known "albino" specimens of *L. c. calligaster* exhibit the yellow ground coloration (those in Tryon, 1984), while the above *L. c. rhombomaculata* is erythristic, probably based on the presence or absence and degree of these pigments in normally colored snakes. It is not known if this is always the case, but it would be of interest to discover an aberrantly colored specimen from an area where these subspecies may intergrade to see which, if either of these colors predominate.

Tryon and Carl (1980) remarked on the reduced (sometimes absent) overall body pattern on some older male specimens of *L. c. rhombomaculata* and speculated that this tendency toward a faded pattern or one masked by darker pigment may be dimorphic from certain parts of its range. In view of this, the specimen described by Collins (1960) is of further interest since it too was a large (31 1/2 inches) adult male with barely present faint red dorsal blotches. If the pattern in these snakes is masked with pigment as aging occurs, then the pattern would be retained throughout the life of an amelanistic specimen. If however, these patterns do fade, then this may have been the case with this specimen, resulting in an almost patternless, white snake. If so, Collins' specimen may have appeared similar to the one described here at a younger age, and thus at one time may have been properly described as amelanistic. This may be more fully explained in *L. c. rhombomaculata* from observation of the present specimen as aging occurs.

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I am indebted to Michael Schaffer, the collector, and his family for the donation of this snake to the Knoxville Zoo. I thank H.B. Bechtel for his comments and thoughts on the manuscript and specimen described. Color slides of this snake have been deposited in the North Carolina State Museum of Natural History.

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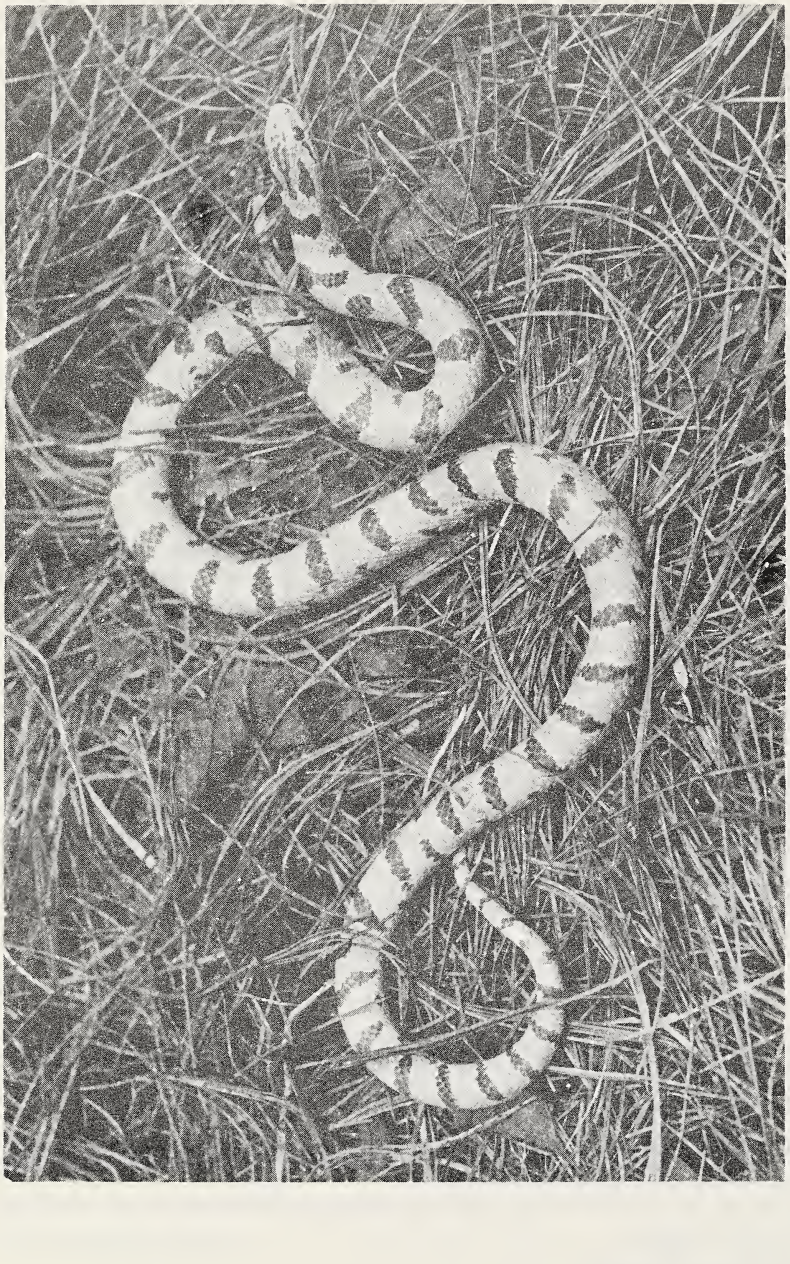

Fig. 1. Amelanistic *Lampropeltis calligaster rhombomaculata* from Knox County, Tennessee.

UNIQUE FEEDING HABIT OF A CAPTIVE BLACK RAT SNAKE, *Elaphe o. obsoleta*

While at the Pennsylvania State University, 1948–1950, I kept a captive black rat snake *Elaphe o. obsoleta*, which fed readily upon dead rats, dead English sparrows, and dead starlings. It consistently refused green frogs (*Rana clamitans melanota*), leopard frogs (*Rana pipiens*), and northern dusky salamanders (*Desmognathus f. fuscus*). This is typical for this species, which feeds primarily on birds, small rodents, and bird eggs. The snake was captured in the forest in western Union Co., Pa., was quite docile, and coiled snugly around my wrist on the hike back to the Boy Scout Camp, Camp Karoondinha. The snake's left eye was missing, and this might be related to the behavior and the feeding habits described below.

A large number of live adult white mice were available from other laboratories. The mice were sometimes taken readily, and sometimes refused. The best procedure seemed to be to dangle the live mouse in front of the snake, which usually resulted in grasping, constriction, and ingestion. The time between grasping and release from the snake's coils is called "constriction time", and the time between onset of swallowing to disappearance of the body and legs is called "swallowing time". Time for disappearance of the entire tail is not included in swallowing time.

Of nineteen mice swallowed, eleven were taken head first, and nine tail first. From these nineteen feedings, the average constriction time was 3.57 minutes, with extremes of one and five and one–half minutes. The average swallowing time was 3.10 minutes, with extremes of two, and four and one–half minutes. There was no significant difference in whether the mice were swallowed head first or tail first.

The snake would usually take from four to six mice successively. However, if a time interval of about one hour or more intervened between the offering of the last and a successive mouse, no amount of teasing, or shaking the live mouse in front of the snake would induce grasping. After about two or more days, the snake would again accept mice. Snakes are vulnerable to attack upon swallowing large prey, since in this state they cannot move readily. This snake, however, was not hindered at all by a small meal of four to six mice, but it still refused more mice, until digestion had presumably begun upon the previous meal. On one occasion it took twelve dead mice, but would take no more until several days later.

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Carpenter, Charles C. and James J. Krupa. Oklahoma herpetology: an annotated bibliography. Univ. Oklahoma Press, Norman. vii, 258 pp., frontis., cover ill. Hardbound, $21.95 (University of Oklahoma Press, 1005 Asp Ave., Norman, OK 73019).

Monographers of state herpetofaunae dream of inclusion in their monographs of the exhaustive literature analyses that are incumbent upon a competently thorough study. Rarely is that dream materialized. The present work is an exception, not only in embracing a literature analysis for Oklahoma but doing so independent of a faunistic monograph. It is a bibliographer's triumph, rarely achieved.

What makes that analysis especially worthwhile is not merely the list of publications pertinent to Oklahoma herpetology, although there are an impressive 1536 numbered items, arranged alphabetically and spanning a 165-year period, 1823–1987; it is the genus and keyword indices to the content of those publications that makes the work an indispensable reference for any investigation on Oklahoma herpetology or on the 133 species occurring in Oklahoma.

The content is indicated genus by genus (86 pp.) following the bibliography (146 pp.), listing the pertinent bibliographic item numbers under each of 23 key words (archeology, behavior, bibliography, development, distribution, ecology, economics, evolution, general reference, genetics, health, historical, husbandry, lore, management, morphology, natural history, paleontology, parasitology, physiology, popular, taxonomy, techniques) for each genus. The book terminates with a six-page index of English common names, referring each to the appropriate entry in the Genus and Key Word Index.

A vital 5-page checklist of extant amphibian and reptilian species of Oklahoma precedes the bibliography, providing the only means for determining to which species the entries in the generic-key word index might apply. Each bibliographic entry is accompanied by a list of the key words and genera pertinent to that entry.

The bibliography is exhaustive, accounting for not only journal articles and separately published works (popular and scientific, paleontological and archaeological, taxonomic and distributional), but also dissertations from the University of Oklahoma, Oklahoma State University and a few other universities. Even some unpublished manuscripts are included, according to the Introduction. The propriety of inclusion of unpublished material, such as dissertations, may be seriously questioned, although increasingly customary; it places a stigma of undue obligation on researchers who have hard enough a time encompassing published material. It is extremely useful, nevertheless, to have unpublished material made known; its use is then optional, but no more than optional. In that sense the book performs another rare service, for seldom are unpublished works included in such bibliographies.

The book is reproduced from beautifully prepared, camera-ready copy, with very few typographical errors.

Although the focus is Oklahoma, it would be a mistake to interpret this book as useful only in Oklahoma herpetology; it is an important reference also for research on any of the 133 species of amphibians and reptiles of the state, making it a useful part of the library of a wide spectrum of vertebrate zoologists and ecologists.

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NEWS & NOTES:

CONCERN OVER PUBLISHING LOCALITY DATA

Concern over the problems of publishing exact locality data, which may lead to increased exploitation of wild populations, has recently been expressed to the Society for the Study of Amphibians and Reptiles (SSAR) by the Wisconsin Herptile Working Group (WHWG). Readers have an opportunity to express their opinions on the issue before it is discussed at the SSAR board meeting in September 1989. In a letter drafted by WHWG to Alvin L. Braswell, editor of the Geographic Distribution Section of the SSAR's Herpetological Review (HR), WHWG noted that herp exploitation is becoming increasingly significant due to continuing habitat destruction and degradation and consequent fragmentation of populations. Exploitation can include outright killing for fun, hate, or profit; commercial collecting for skins or live animals, and removal of protected animals from sites so as to avoid permit requirements for development. Publishing locality data often provides exploiters with road maps to collection sites, examples given were recent exploitation of *Cryptobranchus* in Missouri, *Thamnophis* and *Crotalus* in Canada, and *Clemmys* in Wisconsin. While clear cut correlations between publishing locality data and subsequent exploitation are not always evident, common sense dictates that specific localities of exploitable species be kept as confidential as possible. The WHWG asked that the SSAR consider a more sensitive editorial policy towards this concern, noting that reporting of locality data must be balanced between exploitation concerns on one hand, and availability of data for conservation and research concerns on the other hand. It was suggested that for localities within the United States the county could be used as a standard locality description (half counties for very large western counties), and that voucher specimen numbers be given so that more specific locality data may be requested from the depository institution. WHWG felt that few researchers required more specificity in locality data. Faunal surveys compiling occurrence data for cryptic species like most herptiles are best approached by amassing regional data rather than limiting a record search of the few acres in question. Thus data available to county specificity would still show up in searches for regions. Little extra burden on museum personnel was anticipated, as requests for locality data would be for specific specimen numbers (easily found in the museum catalog). WHWG pointed out that specimen data is not public information, and institutions have every right to withhold specific locality data unless valid reasons are given for needing this information, especially for protected species. WHWG also pointed out that a judgement on which species or populations are vulnerable to exploitation is subjective and can change with time due the vagaries of the animal markets and habitat changes. They suggested that a policy of publishing to county only for all species would be better than attempting to make a judgement on how specific the locality should be in each submission. A similar system for localities outside of the U.S. may be impractical, due to political and institutional instability in many Third World countries. The letter was cosigned by 26 persons from 20 major zoos, museums, universities and herp societies who agreed that the problem warranted serious discussion, but were indeterminate on a specific solution. Cosigners were: David Blode, Fort Worth Zoo; James H. Harding, MSU Museum; F. William Zeigler, Miami Metrozoo; Laurie J. Vitt, Univ. Calif.–Los Angelos; Richard A. Sajdak & David Sorensen, Milwaukee County Zoo; Ray Pawley, Brookfield Zoo; Herbert S. Harris, Jr., Natural History Soc. of Maryland; Tom Taylor, Arizona Herp. Assn.; R. Howard Hunt & Dennis W. Herman, Zoo Atlanta; Wayne G. Homan, Phoenix Zoo; Tom R. Johnson, Missouri Dept. Conservation; Ronald F. Nicotera, Director Bur. Endangered Resources Wisc. DNR; Harvey M. Fischer, Los Angleos Zoo; Terry J. Cullen, The Cullen Vivarium; Max Nickerson, Richard Spieler, Robert Henderson & Gary Casper, Milwaukee Public Museum; Millicent S. Ficken, Univ. Wisc.–Milwaukee; Stanley A. Temple, The Nature Conservancy Wisc. Chapter; Robert W. Hay, Wisc. Herp. Soc.; Theodore Garland, Jr., Univ. Wisc.–Madison; Patrick M. Burchfield, Gladys Porter Zoo; & Ron Humbert, Chicago Herp. Soc.

A response to WHWG's letter was made by Dr. Braswell to Hugh R. Quinn, then President of SSAR, rather than to WHWG. Dr. Braswell believed current editorial policy was adequate and no change was warranted. He felt that most localities published in the Geographic Distribution Section of HR, at least, were range peripheries and extensions, where populations are thin and not usually commercially exploitable, and they do not represent research sites where population studies are conducted. Dr. Braswell believed information used to exploit herps was gathered from other sources, that supplying locality data to county was not sufficient to warrant publication, and that resource management communities are best served by providing the most accurate locality data possible. He noted that there can be problems with obtaining data from understaffed and underfunded institutions maintaining research collections, and that under WHWG's proposal an extra level of effort would be added to obtain information from collection managers. Dr. Braswell noted that publicizing locations of habitats and animals can also serve to educate people and secure support to protect resources, and that limiting locality data might send the wrong message to other disciplines and government agencies who need to be convinced of the need for precise data and voucher specimens. Current SSAR President Henri C. Seibert responded to WHWG, saying little more than the issue will be discussed at the next SSAR Board meeting, which takes place in London in September 1989.

The principle question to be asked is: Is there more to be gained or lost by continuing the current course? Dr. Braswell feels there is more to be gained. WHWG feels the system can be modified to reduce the negative aspects while preserving the benefits.

Concerned readers should ask themselves if they feel publishing exact localities for rare species, research or den sites makes it easier to exploit these animals, and express their opinions as soon as possible to SSAR President Henri C. Seibert, Dept. Zoological & Biomedical Sciences, Ohio University, Athens, Ohio 45701. Please send copies to Dave Ross, Chair, WHWG, Wisconsin River Power Co., PO Box 8050, Wisconsin Rapids, WI 54495–8050; Martin J. Rosenberg, Editor, Herp. Rev., Dept. Biology, Case Western Reserve University, Cleveland, Ohio 44106; Richard H. Rosenblatt, President, ASIH, Scripps Institute of Oceanography, University of California, La Jolla, CA 92903; James R. Dixon, President, HL, Dept. Wildlife & Fisheries Sciences, Texas A & M University, College Station, TX 77843; and Samuel S. Sweet, Editor, J. Herpetology, Dept. Biological Sciences, University of California, Santa Barbara, CA 93106.

Received: 26 July 1989

NEW BOOKS:

NEWS/FACTS ON FILE

BIRDS AND AMPHIBIANS AND REPTILES EXPLORED IN YOUNG PEOPLE'S SERIES, ENDORSED BY NATIONAL WILDLIFE FEDERATION

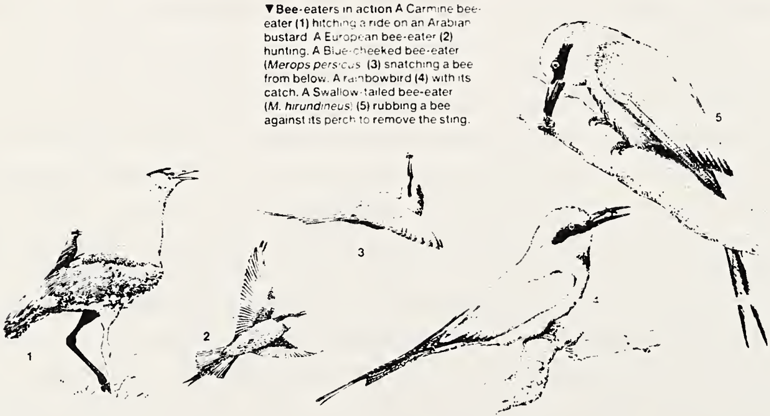
"Practically anyone of any age will find likely new knowledge within (these) books. And traveling wildlife aficionados will applaud the encyclopedia's able assistance in learning or indentifying animals seen, or to be seen, on a journey."

<u>Houston Chronicle</u>

Three volumes on birds -- **WATER BIRDS, THE PLANT AND SEED-EATERS** and **AERIAL HUNTERS** -- and the fourth on **AMPHIBIANS AND REPTILES** (Publication Date: October 10, 1989; Price: $17.95 each volume), have been added to **ENCYCLOPEDIA OF THE ANIMAL WORLD**, by Linda Losito, Christopher O'Toole, Robin Kerrod and John Stidworthy, a young adult series for ages 9 to 14, endorsed by the National Wildlife Federation.

An enthralling learning tool filled with captivating color photos and fascinating facts, **ENCYCLOPEDIA OF THE ANIMAL WORLD** will eventually comprise a total of 12 volumes, each covering a particular animal or animal group. The series was launched with four installments on **MAMMALS -- THE HUNTERS, LARGE PLANT EATERS, SMALL PLANT EATERS,** and **PRIMATES, INSECTS AND BALEEN WHALES.** Upcoming titles will cover fish, insects and spiders, pets and farm animals, and simple animals, such as jellyfish, barnacles and octopi.

▼Bee-eaters in action A Carmine bee-eater (1) hitching a ride on an Arabian bustard A European bee-eater (2) hunting. A Blue-cheeked bee-eater (*Merops persicus* (3) snatching a bee from below. A rainbowbird (4) with its catch. A Swallow-tailed bee-eater (*M. hirundineus*) (5) rubbing a bee against its perch to remove the sting.



NEW BOOKS:

Each work in the collection is alive with over 200 color illustrations, original artwork, maps and charts. Each chapter's text offers clear, concise and captivating descriptions of each creature's breeding habits, eating patterns, social behavior, self-defense, ecology, communication skills and more. And each volume includes a preface from the National Wildlife Federation.

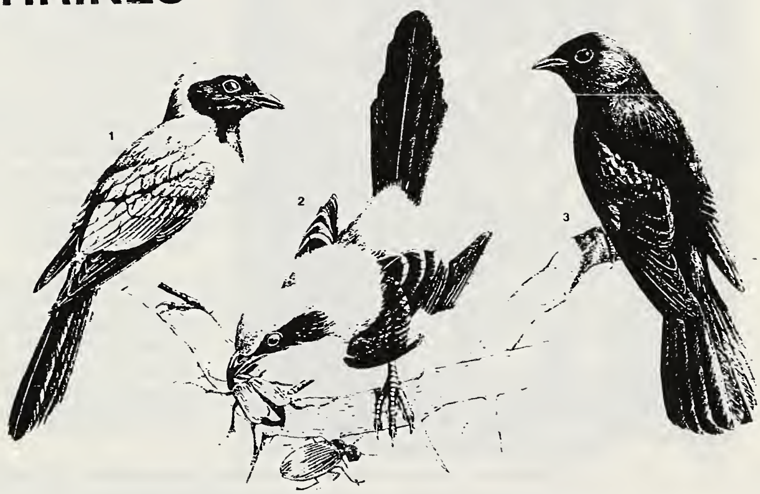
BIRDS: WATER BIRDS covers the many varieties of birds that are equally at home in two environments -- the air and water. Among the aquatic birds featured are: loons, geese, swans, pelicans, storks, gulls and penguins.

BIRDS: THE PLANT-AND SEED-EATERS explores the creatures that are among nature's most talented music makers. This volume gives youngsters an understanding and appreciation of their singing abilities.

BIRDS: AERIAL HUNTERS introduces readers to some of the most intriguing birds -- the predators and the flightless birds. Herein are the hunting methods of such predators as hawks, owls and woodpeckers, as well as the habits of such flightless birds as parrots, kiwis and ostriches.

AMPHIBIANS AND REPTILES is devoted to a broad range of species that include chameleons, who change color to match their environment, and pythons, among the world's longest animals.

SHRIKES



BIRDS: WATER BIRDS, ISBN 0-8160-1962-2
BIRDS: THE PLANT-AND SEED-EATERS, ISBN 0-8160-1964-9
BIRDS: AERIAL HUNTERS, ISBN 0-8160-1963-0
AMPHIBIANS AND REPTILES, ISBN 0-8160-1965-7.

Price: $17.95 each volume (In Canada: $21.95)
96 pages each; 8-3/4 X 10-3/4;
200 full-color illustrations, photos, maps, charts, line drawings.
Glossary. Index.

Perched on a fence-post on a New England farm, a Great gray shrike scans the ground for prey. A movement in the grass catches the bird's eye, and like a miniature hawk it pounces. Returning to its perch with a large beetle in its bill, the bird moves out along the fence wire and with a brisk movement of its head impales the beetle on one of the sharp steel barbs.

NEWS & NOTES

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SMITHSONIAN RESEARCH FELLOWSHIPS IN HISTORY, ART, AND SCIENCE

The Smithsonian Institution announces its research fellowships for 1990-1991 in the fields of History of Science and Technology, Social and Cultural History, History of Art, Anthropology, Biological Sciences, Earth Sciences, and Materials Analysis.

Smithsonian Fellowships are awarded to support independent research in residence at the Smithsonian in association with the research staff and using the Institution's resources. Predoctoral and postdoctoral fellowship appointments for six to twelve months, and graduate student appointments for ten weeks are awarded. Proposals for research in the following areas may be made:

History of Science and Technology: History of computers, communication, and society; history of agriculture; air and space; electrical technology; engineering; industrial archaeology; mathematics; medicine and pharmacy; natural history; physical sciences; social dimensions of science and technology; and transportation.

Social and Cultural History: American political, military, social, and cultural history; American business history; American folklore; history of money and medallic art; history of music and musical instruments; and material aspects of American everyday life.

History of Art: African art; American art of the 18th, 19th, and 20th centuries; decorative arts; modern art; Asian and Near Eastern art; and twentieth-century American crafts.

Anthropology: Archaeology; cultural anthropology; folklife; linguistics; and physical anthropology.

Biological Sciences: Animal behavior and pathology; ecology; environmental studies; evolutionary biology; marine biology; natural history; paleobiology; systematics; and tropical biology.

Earth Sciences: Meteoritics; mineralogy; paleobiology; petrology; planetary geology; sedimentology; and volcanology.

Materials Analysis: Archaeometry and conservation science.

NEWS & NOTES:

Applications are due January 15, 1990. Stipends supporting these awards are: $25,000 per year plus allowances for senior postdoctoral fellows; $20,000 per year plus allowances for postdoctoral fellows; $12,500 per year plus allowances for predoctoral fellows; and $3,000 for graduate students for the ten-week tenure period. Pre-, post-, and senior postdoctoral stipends are prorated on a monthly basis for periods less than one year.

Awards are based on merit. Smithsonian fellowships are open to all qualified individuals without reference to race, color, religion, sex, national origin, age, or condition of handicap of any applicant. For more information and application forms, please write: Smithsonian Institution, Office of Fellowships and Grants, 7300 L'Enfant Plaza, Washington, D.C. 20560. Please indicate the particular area in which you propose to conduct research and give the dates of degrees received or expected.

NEWS & NOTES:

NOTES:

Society Publication

Back issues of the Bulletin of the Maryland Herpetological Society, where available, may be obtained by writing the Executive Editor. A list of available issues will be sent upon request. Individual numbers in stock are $2.00 each, unless otherwise noted.

The Society also publishes a Newsletter on a somewhat irregular basis. These are distributed to the membership free of charge. Also published are Maryland Herpetofauna Leaflets and these are available at $.25/page.

Information for Authors

All correspondence should be addressed to the Executive Editor. Manuscripts being submitted for publication should be typewritten (double spaced) on good quality 8 1/2 by 11 inch paper with adequate margins. Submit original and first carbon, retaining the second carbon. If entered on a word processor, also submit diskette and note word processor and operating system used. Indicate where illustrations or photographs are to appear in text. Cite all literature used at end in alphabetical order by author.

Major papers are those over 5 pages (double spaced, elite type) and must include an abstract. The authors name should be centered under the title, and the address is to follow the Literature Cited. Minor papers are those papers with fewer than 5 pages. Author's name is to be placed at end of paper (see recent issue). For additional information see *Style Manual for Biological Journals* (1964), American Institute of Biological Sciences, 3900 Wisconsin Avenue, N.W., Washington, D.C. 20016.

Reprints are available at $.03 a page and should be ordered when manuscripts are submitted or when proofs are returned. Minimum order is 100 reprints. Either edited manuscript or proof will be returned to author for approval or correction. The author will be responsible for all corrections to proof, and must return proof preferably within 7 days.

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Natural History Society of Maryland, Inc.
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