14th INTERNATIONAL HERPETOLOGICAL SYMPOSIUM ON CAPTIVE PROPAGATION & HUSBANDRY

DALLAS - FT. WORTH, TEXAS
June 20-23, 1990

EDITED BY
ALAN W. ZULICH

PROCEEDINGS OF THE

14TH INTERNATIONAL HERPETOLOGICAL SYMPOSIUM

on

Captive Propagation

And Husbandry

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ACKNOWLEDGMENTS

The resource data presented within the context of these Proceedings represents an attempt on behalf of the symposium sponsors and participants to develop communications between zoo professionals, scientists, and herpetoculturists at all levels. In retrospect- the opportunities to become acquainted with kindred spirits and to further understand the intrinsic problems related to the dynamics of being considered a herpetologist were developed as a rich experience during the Fourteenth International Herpetological Symposim. It became clear through both formal and more relaxed discussions that most of us share an unusual personality characteristic - the ability to comprehend the plight of creatures that have been indiscriminately harassed for ages. At each symposium, it seems as if we are fulfilled because of our common interest: promoting conservation of herpetofauna.

The success of any symposium is due, to a large extent, to the efforts of the Host Committee Chairperson, who does most of the local leg-work. Tracy Thompson of the Ft. Worth Zoological Park was instrumental in making most of the local arrangements with the help of members of the North Texas Herpetological Society. It was a pleasure working with Tracy, whose dedication to the goals of the symposium surely made the many hours of hard, sometimes frustrating, work, bearable.

The decision to hold the Symposium in the Dallas-Ft. Worth area was an easy one, as it houses two of the most exceptional herpetological collections in the world. Thanks must go to two outstanding curators, James B. Murphy of the Dallas Zoo and David Blody of the Ft. Worth Zoological Park, for their support, the use of their facilities, and the memorable behind-the-scenes tours.

In addition, credit is to be given to Thomas A. Huff, who chaired the Program Committee and was responsible for the quality and variety of the papers presented, and to Alan W. Zulich, who served as editor of the Proceedings and is responsible for the high quality of this publication.

The sponsors are in total agreement that this symposium was well worth the time and energy invested, which was substantial. Our hope is that the investment will continue to pay dividends.

Michael J. Uricheck, Ph.D.
Symposium Coordinator

14th INTERNATIONAL HERPETOLOGICAL SYMPOSIUM
JUNE 20-23, 1990
DALLAS/FORT WORTH, TEXAS

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The following sponsors are gratefully acknowledged for having provided financial assistance toward the 1990 symposium:

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DIVERSITY OF FORMS, MAINTENANCE AND BREEDING OF PALEARCTIC *Vipera, Agkistrodon* AND *Elaphe*

by

NIKOLAI ORLOV AND SERGEI RYABOV

ABSTRACT

A review of the genera *Vipera, Agkistrodon* and *Elaphe* from Eastern Europe, the Middle East and Far East are discussed via a color slide presentation, with emphasis on their maintenance and breeding in captivity. Details of their temperature need are given for winter and summer keeping.

INTRODUCTION

The diversity of the fauna of such "multi-specific genera as *Vipera, Agkistrodon* and *Elaphe* from palearctic Asia makes them vital both for systematic collecting in hobbyists and for formation of pattern collections providing experimental analysis in fundamental zoology, such as the theory of taxonomy, species formation, and comparative embryological research. Also, a number of forms in some areas due to a destructive anthropogenic factor demand creation of a genofund along with the traditional conservation measures.

Taking into account a number of general principles in maintanance and breeding of palearctic *Vipera, Agkistrodon* and *Elaphe*, we consider it relevane to deal with them within the framework of this paper.

Diversity and distribution of the forms

In our experiments with palearctic snakes, we worked with the following species, which occur in various spots within palearctic Asia, namely:

Vipera kaznakowi from the western Caucasus and the Black Sea coast.

Vipera dinniki from a subalpine area of the Great Caucasus

Vipera darevskii from Legli Mount, Armenia

Vipera ursini renardi from a northern slope of the Great Caucasus Ridge

Vipera ursini eriwanensis from the footsteps of the Ara-Iler Mount, Armenia

Vipera transcaucasiana from the Meskhetski and Trialetski Ridges, Georgia

Vipera lebetina obtusa from the eastern Transcaucasiana

Vipera lebetina turanica from mountains and foothills of Middle Asia

Agkistrodon halys halys from Kazakhstan, Kirgizia, Altai, Middle Asia

Agkistrodon halys caraganus from Kazakhstan

Agkistrodon halys caucasicus from

the Talysh Rocks, Azerbaijan, and the Kopetdag Mountains, Turkmenia

Agkistrodon ussuriensis from southern coastal areas adjacent to the Western Pacific known as Primorye, the Far East

Agkistrodon intermedius from Primorye and Khabarovsky Territory, the Soviet Far East

Agkistrodon "mongolicus" from Eastern Mongolia

Agkistrodon "gobiensis" from south Gobi

Elaphe schrenckii from Primorye, the Far East

Elaphe climacophopra from the island of Kunashir, USSR, and the island of Hokkaido, Japan

Elaphe conspicillata from the same area

Elaphe quadrivirgata from the same area

Elaphe japonica from the same area

Elaphe sauromates from the eastern Caucasus, northwest Kazakhstan

Elaphe dinone from the Far East, lower area of the Volga River basin

Elaphe rufodorsata from south Primorye, the Far East

Elaphe longissima from the western Caucasus and western Ukraine

Elaphe hohenackeri from the northern Caucasus and eastern Transcaucasiana

Methods of maintenance and breeding technique

In our work with reptiles, we used terrarium chambers of two types measuring 60 x 60 x 50 cm and 120 x 60 x 60 cm, with automatic temperature and photoperiod regulation. The chambers were transformned into drawers of 4-8 sections, depending upon the size. The internal composition of the "structure of a biotope" was chosen to agree with the biology of the snake.

To prepare palearctic *Elaphe, Vipera* and *Agkistrodon*, the reptiles from the northern and temperate latitudes, it is necessary to remember that within their specific climatic zones, the most stable factor, uninfluenced by fluctuation of the ecological factor, is the photoperiod. The photoperiod yearly alternates strictly conforming to natural laws and regulates many processes of vital functions of animals, snakes in particular, including their reproductive activity. Hence, ecological role of the photoperiod is synchronization of seasonal development adn annual alternation of favorable and unfavorable conditions, i.e. synchronization of yearly cycles of various processes in an organism, differentiation in time of various seasonal states, synchroniztion of sexual cycles and climatic seasons.

Toward that end, it is easier to manage reproductive activity of so-called "northern" snakes compared to tropical reptiles, as the mechanisms initiating

sexual acitvity in tropical snakes are not that apparent and expressed. However, the simplicity in breeding the "northern" snakes is theoretical and superficial. Many complications emerge with regard to the next important climatic factor - temperature. The following two approaches were used in this connection:

1. In the experiments with mentioned reptiles, during the period prior to breeding, the photoperiod was being decreased from 14-16 hours to 6 hours in one month. Then, for two weeks, the snakes were kept at this level. For another two to three weeks, the photoperiod was increased to 16 hours per day. The shortest photoperiod agreed with the lowest temperature, which was gradually dropped to 10-14°C. During the active period, the temperature was maintained at 26-32°C during the day, and 18-22°C at night. Temperature was increased along with the photoperiod. Ultraviolet light was used, and vitamins stimulating sexual activity were added, upt to the general nutritional pattern. Air humidity of 50-60 percent during the short photoperiod was increased to 80-90 percent for the increased phase.

In the prepatory period, the breeders were kept separately. In the period when the temperature was being increased occasionally, the breeders were placed in a communal cage to check their sexual activity. As soon as sexual activity was observed, the breeders were left in the cage. We managed to obtain breeding results in seasons which did not agree with the natural breeding time, but this method had a number of negative consequences.

2. Preparation for the time of reproduction by means of creating real conditions for hibernation.

To ensure this, we also decreased photoperiod and temperature and after that removed snakes to a hibernating cage. But here comes a difficulty in arranaing appropriate temperatures and humidity in a hibernation chamber, as complete information on hibernating sites in the wild is not always available. Normally we used 5-8°C at 80 per cent humidity for most *Elaphe, Vipera* and *Agkistrodon*. And 8-10°C at 50-60 per cent humidity for *Vipera raddei, Vipera lebetina obtusa, Vipera lebetina turanica*. The period of hibernation lasted from 3 weeks to 3 months. The optimal time for hibernation proved to be from 6 to 8 weeks. Cut in the hibernation time diminishes the risk of health disorders caused by deviations from the natural physical factor of environment.

With a preparatory period, mating, egg-laying and incubation being successful, there is one more important item, the creation of adequate conditions for maintenance and feeding of neonates. These conditions often differ from the ones appropriate for adult specimens. It

is very important to correctly estimate a particular inborn feeding stereotype and inborn physiological reactions due to the adjustment of a particular snake specimen to the environment, and their alternation in ontogeny. Owing to this inborn feeding stereotype the offspring often reveal conservatism in diet. Inadequate foodstuff along with mistakes in maintenance may be lethal for a snake. Feeding stereotype may be determined with regard to a form, size, direction or smell of a food item. For instance, *Elaphe rufodorsata, E. quadrivittata, Agkistrodon ussuriensis* react on a specific smell of brown *Rana*. Whereas *Vipera ursini renardi, V. darewskii* respond to jumping movements of Orthoptera. *Elaphe schrenkii, E. dione, E. climacophora. E. sauromates* respond to a particular smell and movements of neonate rodents. The specialization in diet considerably differs even at population level. For instance, *Vipera dinniki* is a highly elevated viper which forms a number of isolated populations. The vipers from one population consume rodents (*Chionomys nivalis*). *V. dinniki* from another population feed on lizards (*Lacerta caucasica*). The ones from the third population feed on Orthoptera as in the latter there are neither lizards nor rodents. and in the former lizards are absent. Normally, the newborn snakes from these populations have distinct feeding stereotypes which in captivity change in ontogeny. But the choice of a starting food item under artificial conditions can be determinant. Inborn physiological "inclinations" of snakes are vital regarding the choice of temperature which also vary at population level. For example. the neonates of *Vipera lebetina turanica* from arid plain populations associated with the area between the rivers Murgab and Tedjen do well at comparatively even temperatures 28-32°C during the day and 25-26 °C in the night. They accept food readily and digest it with no problem. Whereas *V. l. turanica* from montane populations occuring in the Kopetdag and Gissar Ridges at elevations of 1500 to 2000 m demand a temperature drop to 18 to 29°C in the night. *V. kaznakowi, V. dinniki. V. raddei, V. transcaucasiana* also need a drop of temperature to 18°C. Besides all palearctic species of *Elaphe, Aakistrodon* and *Vipera* during a warm period occasionally need a drop in temperature to 17-20°C throughout 5-6 days a month. In this "broken" thermal rhythm the animals feel better. In montane vipers and copperheads maintained without this broken rhythm disorders in health, feeding and growth are most probable. In some species, i.e; *E. climacophora, E. quadrivirgata. V. dinniki*, in order for the neonates to start taking food readily it is necessary to hibernate them at 8-12°C for 5-6 weeks right after the first shedding of skin. It is only after this hibernation that the young begin taking food. In the wild these species obviously produce offspring not long before it gets cold, and probably right after they arrive at hibernation sites.

To sum it up, in order to successfully breed and rear the offspring from palearctic *Elaphe, Agkistrodon* and *Vipera*, one has to provide the following conditions:

1. Adequate temperatures and appropriate hibernation
2. Optimal photoperiod
3. Adequate thermal dynamics in an inactive period
4. Optimal nutritional patterns

Also it is very important to consider specific and population peculiarities in snakes, particularly when you work with the first captive generation F_1.

However, in this paper we discuss secondary items which are also important for maintenance of "terrarium homeostasis", including the structure of a biotope in a cage (shelters, water basins, substrates), regime and ways of offering foodstuff, and other husbandry factors.

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CAPTIVE PROPAGATION OF THE KANSAS GLOSSY SNAKE

Arizona e. elegans

by

ROBERT L. BALL

ABSTRACT

During a three year period three female Kansas glossy snakes laid 115 eggs. Data suggest females ovulate from 12-30 May with oviposition occurring from 15-24 July. Hatchlings emerged from sand incubated eggs some 90 plus days later. Based on feeding behavior the hatchlings were placed into three groups of which only a few individuals from the pink mouse eating group were maintained for extended periods, hatchlings grew slowly with many different methods employed to obtain a faster growth rate failing. Adult female glossy snakes were the easiest to maintain for they readily accepted laboratory mice. Adult males and subadults of both sexes were more difficult to maintain over long periods of time.

INTRODUCTION

I acquired my first glossy snake in 1959. A 917 mm adult female *Arizona elegans occidentalis* was shipped via R.E.A. express to me from California by an uncle. That very docile serpent regularly consumed two laboratory mice per week during an April through October activity period. For a period of nearly six years she endured numerous caretakers during my long periods of absence and died midway through my four year tour of military duty.

Two decades ago I moved to Norman, Oklahoma to attend graduate school at the University of Oklahoma. Dr. Charles C. Carpenter, fellow graduate students, and many unsuccessful field trips piqued my interest in the Kansas glossy snake. In 1983 I accepted a science teaching contract with the Cement Public School District in southeastern Caddo County, Oklahoma.

During the many field trips I had taken to southwestern Oklahoma I had observed a few DOR's of *A. e. elegans* in the Cement area, so Cement seemed a good choice.

However, during three years there, only three live specimens were encountered. Students collected a hatchling in front of the pool hall at 10:15 C.S.T. on 22 October 1983 which was given to me. The hatchling ate a pink mouse the following week and within a few hours was discovered dead. Two adult males 1223 and 1462 mm were

collected on 31 May and 24 June respectively. In early July, I moved to northeastern Kansas taking my reptiles with me. Both glossy snakes refused all food offerings except gerbils. In August both were returned and released at their original capture sites.

In 1985, I moved to the Oklahoma Panhandle and accepted a teaching Contract with The Yarbrough Public School District in far western Texas County. *A. e. elegans* is a locally abundant species and comprises about five percent of the total snake observations in Texas County, Oklahoma (Ball, 1988). Fall observations are invariably of hatchlings, while spring observations are all most equally divided between last season's hatchlings and adults. All of my observations have been made in sandy soiled areas which are not under cultivation. Both Wright and Wright (1957) and Webb (1970) have reported the occurrence of *A. e. elegans* in cultivated areas. Perhaps modern day practice (disc plows, herbicides, pesticides, and ammonia) do not enable glossy snakes to survive now in areas of intense agriculture. By 1989, the Kansas Department of Wildlife and Parks had established *A. e. elegans* as a threatened species in Kansas (Simmons, 1989). Unfortunately, despite this effort all twenty of the specimens of *A. e. elegans* observed in the Cimarron National Grassland Morton County, Kansas had been killed by the oil and gas field workers and ranchers who lease the land.

The low number of mature adult glossy snakes encountered in areas where they are locally abundant and loss of suitable habitat through the activities of man indicate the status of threatened for this species will soon be, albeit unfortunately, to endangered by the state of Kansas. My data suggests it should also be afforded protection in Oklahoma, as well as be a strong candidate for captive propagation programs.

RESULTS

My initial adult specimens were collected between 13 and 16 May 1986. Three females 827, 940, and 986 cm respectively and four males 846, 1127, 1413, and 1473 mm respectively were collected between 9:20 and 11:45 PM C.D.T. The snakes courted and copulated daily for a period of about ten days. However, the smallest male was never observed participating in any sexual behaviors. Without exception the males steadfastly refused laboratory rodents, while the females consumed two every four or five days from their capture date to a period of 24 to 33 days prior to oviposition. Oviposition occurred between 10 and 20 July with clutches numbering 8, 13, and 17. All females resumed feeding on laboratory mice following oviposition and continued to do so every four to six days until the middle of September. In the meantime the males were being fed *Dipodomys ordi*

and *Peroqnathus hispidus*. In October, I placed all specimens in my garage which was used as a hibernaculum where they were gradually cooled into brumation. During my absence in early March, the males died during a cold front. Those males were replaced by two males collected on 22 May 1987 between 9:37 and 10:15 PM C.D.T. Upon returning home that evening I placed the males with the females. My fears that the females had already ovulated were soon dispelled by the courtship and subsequent mating behaviors of the pairs. The pattern was the same as in 1986 (Table 1.) However, I did bring all my snakes out of brumation in March in 1987 and have continued to do so each year. I now allow them to warm slowly under our beds for a period of three or four weeks. Despite early emergence from brumation females continued to ovulate in May suggesting it is a genetically determined or endogenous trait.

Each year, hatchlings emerged following some 90 days of incubation in moist sand at 25-32° C. Females readily accepted laying boxes filled with moist sand. They remained in constant motion appearing to search for suitable laying sites when laying boxes with peat moss or vermiculite were used. All hatchlings were routinely brumated with the adult serpents in separate cages in the garage for a period four months. Following a two to three week warming period the young snakes were offered pink mice and/or thawed lizards.

Hatchlings ranged from 220-286 mm (y=256 mm) in total length and fell into three somewhat equal groups. Group one consisted of those individuals which failed to eat pink mice or lizard scented mice following six weeks of feeding on lizards. Over the three year period they totaled 36. They were all released into the wild near the capture sites of the adults. Group two consisted of those individuals which regularly consumed lizard scented mice. Over half of these eventually started eating pink mice. The remaining 18 were released as above. Group three consisted of those individuals which immediately consumed pink mice. These individuals were subjected to temperature manipulation along with the individuals from group two that started eating unscented pink mice. Individuals do best when kept between 22-28° C. When exposed to temperatures above or below this range regurgitation is a common problem. Numerous attempts to increase food consumption and temperature to obtain a faster rate of growth failed. In all, 20 of the hatchlings were traded for other colubrids. The remaining specimens were released a few at a time as above.

After three years of captive maintenance, one female had grown to 614 mm and a male to 582 mm having consumed 200 and 187 pink mice respectively, for an average growth rate of 171 mm per year (Figure 1.) This

FIGURE 1

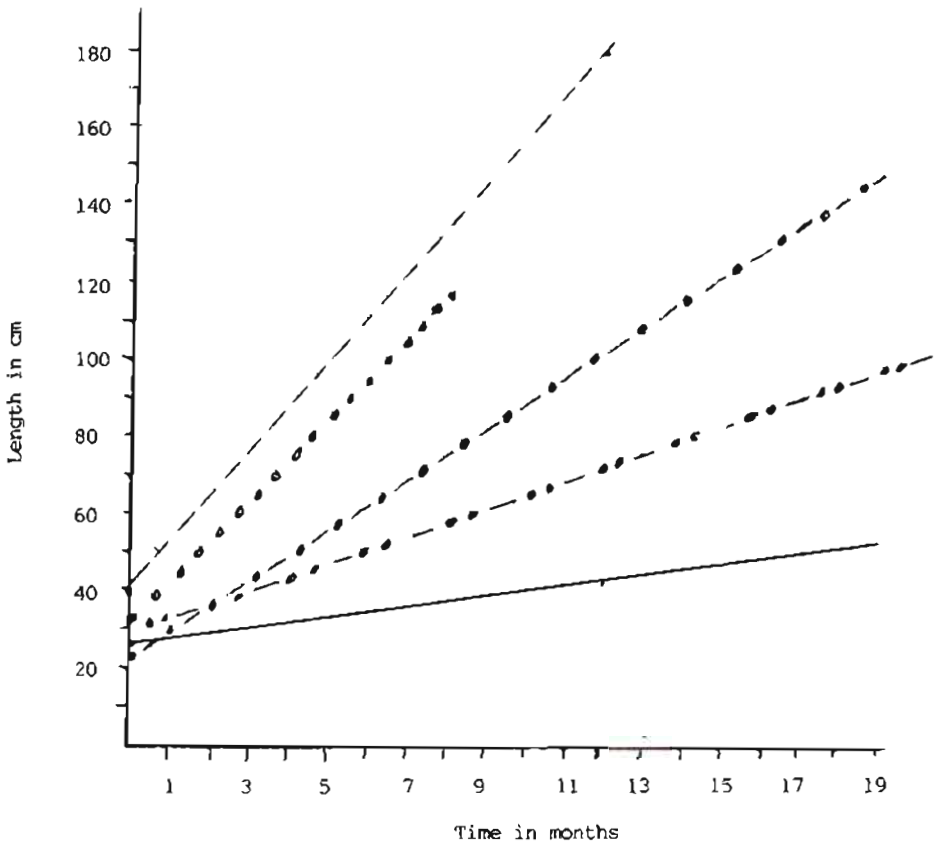

Figure 1. Comparative growth rates for five colubrid sepcies:

_____ Arizona e. elegans

..... Elaphe o. obsoleta

-.-.-.-.-. Elaphe g. guttata

..-..-..-.. Lampropeltis g. getulus

- - - - - - Pituophis. m. melanoleucus

TABLE I
REPRODUCTIVE SUMMARY

SPECIMENS BY LENGTH (CM)	DATE COLLECTED	COPULATION (DAY IN MAY)			OVIPOSITION (JULY)	NUMBER OF EGGS	HATCH DATE OCTOBER	NUMBER OF EGGS HATCHED
		FIRST	LAST	TOTAL				
1986								
FEMALES								
827	5/13	13	20	4	15	8	17-20	8
940	5/13	13	23	7	17	13	18-21	13
986	5/16	15	23	6	20	17	23-25	15
MALES								
1413	5/13	13	20	7				
1127	5/13	22	22	1				
1573	5/14	15	22	7				
846	5/14	15	23	3				
1987								
FEMALES								
827		23	28	3	26	15	27-30	11
940		22	26	2	24	17	26-29	15
986		22	25	3	24	17	25-28	13
MALES								
1224	5/22	22	28	5				
1306	5/22	23	27	3				
1988								
FEMALES								
743	5/12	0	0	0	0			
678	8/31/87	0	0	0	0	13	28-30	11
827		0	0	0	0			
940		20	29	4	27			
986		0	0	0	0			
MALES								
1224		20	26	2				
1306	5/14	21	29	2				
582	5/18	0	0	0				
737		0	0	0				
1989								
FEMALES	NO OTHER DATA RECORDED							
827		15	23	5	All remaining specimens were released 4-14 June 1989 on or near original capture sites			
940		16	28	5				
986		22	27	3				
743		0	0	0				
678		0	0	0				

represented less than one mm of growth per pink mouse. The majority of my specimens required 25-27 months to double the hatching length, while hatchling of other colubrids maintained during the same period time did so at a much faster rate, (Figure 1.) Early last June (1989) I released the adult specimens as close to their original capture sites as my memory would permit. Perhaps some of the hatchling *A. e. elegans* I observed last fall were some of their offspring, as the larger females all appeared gravid.

Hatchlings were housed individually in plastic sweater boxes which had been perforated on both ends and one side for ventilation. The 31.5 x 16.5 x 8.5 cm sweater boxes as well as the 60 x 30 x 30 cm cages were cleaned and disinfected as they were soiled by their occupants. Newsprint was used as a substrate which greatly facilitated cleaning and provided a suitable shelter.

CONCLUSION

In general, my findings on the optimum temperature range of 22-28° C agree with the range of 23-27° C reported by Mehrten (1987). However, my clutch sizes of 8, 13, 17, 15, 15, 17, 17, and 13 ($\bar{y}$=14.4) are higher than those reported by Wright and Wright (1957), Fitch (1970), and Collins (1982) all of whom report a mean of eight. The smallest *A. e. elegans* which participated in sexual activity was the 827 mm female (Table 1.)

The additional specimens were assumed to be subadults as they did not participate in sexual behaviors during this study. Wright and Wright (1957), Conant (1975), Collins (1982) and Tennant (1985) list adult sizes as low as 20 inches (508 mm). I am once again searching on warm evenings for *A. e. elegans* in Oklahoma, as I am certain I can have more success with more effort. I was disappointed when I received my Kansas scientific collecting permit, as they did not approve the collecting of *A. e. elegans*.

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CAPTIVE PROPAGATION AND HUSBANDRY OF ANERYTHRISTIC COLOMBIAN BOA *Boa constrictor imperator*, WITH A BRIEF OVERVIEW OF THE SPECIES

by

GLEN J. CARLZEN A.H.T.

INTRODUCTION

Boa constrictor is a medium to large sized snake whose range extends from Sonora, Mexico to north central Argentina. It inhabits a wide diversity of habitats, from lowland jungles to barren deserts and grasslands. Boas vary in their colors, patterns, and size according to the habitat where they have evolved.

Boa constrictor was first described by Linnaeus in 1758, was later redescribed by Laurenti in 1768, and last described by Forcart in 1960. Presently there are eight recognized subspecies of *Boa constrictor*. They are as follows:

Boa constrictor constrictor: (Linnaeus, 1758) Amazonian South America, Trinidad, and Tobago. The true red-tailed boas such as those being exported from Guyana, Surinam, Peru, and northern Brazil.

Boa constrictor amarali: (Stull, 1932) Southern and southwestern Brazil, and southeastern Bolivia. The Brazilian boa.

Boa constrictor imperator: (Daudin, 1803) Mexico to northwestern South America west of the Andes in Colombia, Ecuador, and Peru. This subspecies includes the Colombian, or common boa and the Central American boa depending on where it was exported from. (Lamar, personal communication)

Boa constrictor nebulosus: (Lazell, 1964) Island of Dominica, Lesser Antilles. The clouded boa or Dominican Island boa.

Boa constrictor occidentalis: (Philippi, 1873) Argentina and Paraguay. The Argentine boa.

Boa constrictor orophias: (Linnaeus, 1758; Lazell, 1964) The island of St. Lucia, Lesser Antilles. The St. Lucia boa.

Boa constrictor ortonii: (Cope, 1877) Northwestern Peru. The Peruvian boa. Possibly not a valid subspecies.

Boa constrictor sabogae: (Barbour, 1906) Taboga Island, Panama. The Taboga Island boa.

Valid or invalid subspecies:

Boa constrictor sigma: (Stull, 1932; Smith, 1943) Tres Marie Island, Mexico. This animal was synonymized with *Boa constrictor imperator*.

Boa constrictor mexicana: (Jan, 1863) Mexico. This animal was synonymized with *Boa constrictor imperator*.

Boa constrictor melanogaster: (Langanhammer, 1983) The black-bellied boa. This animal is thought to be a darker form of *Boa c. constrictor*. Further studies need to be done. There are individual or island populations that serious studies should be considered for subspecies status.

HISTORY

All Colombian common boas were and always have come from the Magdalena River Valley, most being found or shipped from Barranquilla, Colombia. The Magdalena River flows northwards and empties into the Caribbean Sea. The Magdalena River Valley is north and west of the Andes Mountains. This places all the boas taken from this area within the range of *Boa constrictor imperator*, not *Boa c. constrictor*, as most individuals have been led to believe. (Lamar, personal communications and export documentation)

Most baby Colombian boas came from wild caught gravid females who are placed in large holding cages. They are held in cages until they give birth. The adult females are then sacrificed and made into leather products for the leather trade.

During a six month period in 1984, I went through thousands of newly imported baby boas and found thirteen unusually colored boas, unusual in that they were lacking red pigments. These boas were a light grey to an off-white background color with varying degrees of black and brown pigmented patterns, with normal colored eyes .

I tried to figure out what these boas were. I was only familiar with melanism and amelanism and these boas did not fit either description, so I decided to refer to them as white melanistic boas. Several years later, I was told they are anerythristic, meaning lacking the red pigments. I decided these boas were unique and should be kept for attempted breeding, to see if this was a recessive heritable gene.

Nine months after acquiring the first boa, many had died from a severe enteritis condition, and I was left with five baby boas, two males and three females. (Early 1989 I found out one male was actually a female). During 1985, I acquired one more wild imported male boa which brought the total number of wild caught individuals to six.

During 1985 I sold one pair of anerythristic boas to Mr. Steve Evans on a permanent breeding agreement. Mr. Evans was the first person to reproduce the anerythristic boa and successfully produced offspring in 1987, 1988, and 1989. I first reproduced the anerythristic boas in February 1989 between a 1984 female and the 1985 male. Both animals, proved to have a heritable recessive gene.

December 1988 I reacquired ownership of the wild pair of anerythristic boas previously sold to Mr. Evans. I later found the 1984 male I was using for breeding was actually a female. Hence no reproduction in 1987 and 1988.

HOUSING

I worked out a formula for the minimum cage size to house most snakes (Figure 1). First place the snake in a flat circular coil. Measure the diameter of the coiled snake, This measurement would be the minimum width of cage. (Example A) Next double the width of cage, this would be the minimum length. (Example B)

Measure the diameter of the thickest part of snakes body. Triple this measurement, this will give you the minimum height for a snake's cage. (Example C)

All hatchling boas are housed in plastic sweater boxes (16" x 11.5" x 6")(Figure 2). As they grow, they are transferred to plastic storage boxes (23" x 17" x 6")(Figure 3). When they become too large for these cages, they are housed in wooden cages (48" x 24" x 18")(Figure 4), one snake per cage for feeding and health reasons. The only exception is when they are breeding.

Wooden cages are set up with a light in series with a rheostat and thermostat. Heating pads or heat tapes are also set up with rheostats and thermostats. Heat pads or heat tapes are covered with vinyl flooring or sheet metal, which helps disperse the heat over a larger area. The cage doors are constructed out of plywood, glass or lexan, keyed door locks and metal hinges.

FEEDING

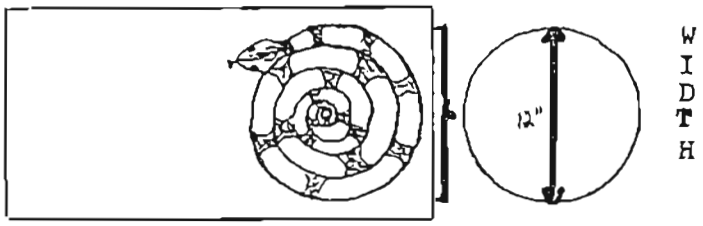
I offer hatchling boas a twelve to fourteen day old mouse for the first four meals and slowly increase the size of the rodents as the snakes grow. Boas under three years of age are fed twice a week. Once they could eat rats, I feed haired and hairless rats. The hairless rats are totally digested. When feeding haired and hairless rats, I get a growth rate equivalent to feeding two rats, but only the feces of feeding one rat. My breeders (three years and older) are fed only once a week as much as they can eat. I keep an eye on their weight to make sure they do not become obese.

PREPARATION FOR BREEDING

The last day I feed my breeders is August 15th in preparation for hibernation or the cooling period. I separate males and females. The males are placed in the coolest as well as the closest cage to the floor. The daytime temperatures are dropped from 84°-86° F to a temperature of 76°-78° F, the nighttime temperatures

FIGURE 1

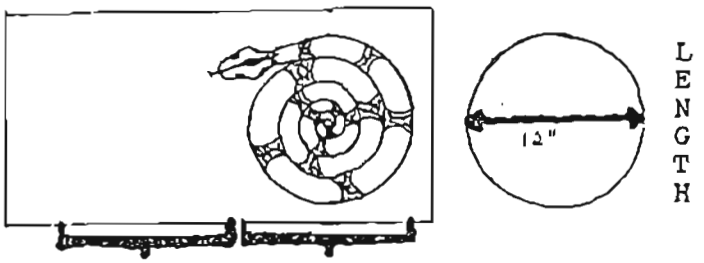
A



Measure the diameter of snake. (12").

Minimum Width.

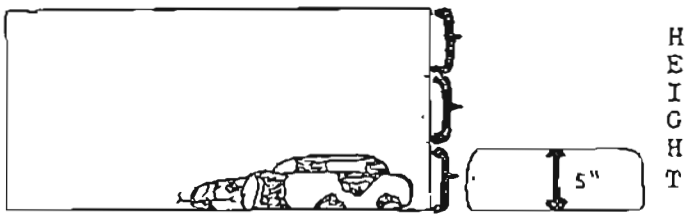
B



Twice the diameter of snake. (12 X 2= 24")

Minimum Length.

C



Measure the diameter of the snake with the greatest thickness(5"). Multiply by Three to get the minimum height.(5x3=15").

to 74°-75° F. I keep the females' cages slightly warmer at night (76° F). I do not feed during the cooling period, All breeder boas are being cooled by August 20th and kept cooled until October l5th. Water bowls are placed in each cage for twenty-four hours once a week. Cage humidity is kept low (40-60%) for most of the cooling period.

BREEDING

I introduce the female into the cage of the male selected for breeding on September 15th. The daytime temperatures are increased from 76°-78° F to 80°-82° F. On or about October 15th, I raise the daytime temperature to 84°-86° F and the nighttime temperatures to 80° F. I then keep a water bowl in each cage continuously, cleaning bowls and changing water frequently.

FIGURE 2
Shoebox set-up for hatchling boas

The males start showing interest in breeding with the change in day and nighttime temperatures instituted on October 15th. Each male pursues the female riding back and forth over her body in an attempt to copulate. I place two males together for several hours to combat in the presence of females. They are then separated and placed in their own cage.

This enables me to selectively breed each female to a specific male. Once breeding starts in earnest, I leave a female in with a male for two days, then remove the female and feed her. I give the female five days to digest food before rebreeding. I alternate three females per male, breeding one at a time. Males only eat during the breeding period when breeding took too much out of them.

When the females ovulate, I notice a large bulging of their bodies. This occurs about two thirds the length of the body. The bulge is noticeable for about three or four days. Then the bulge slowly decreases in width and extends down through the last third of her body.

The female starts showing interest in breeding two to twelve days before the bulge appears. Copulation first occurs three to four days before the bulge appears and continues for up to sixteen days after the appearance of the bulge. I continue breeding until both the males and females were no longer interested in breeding. I combat males at least once a week during the entire breeding season. Breeding stops around the end of February to middle of March.

FIGURE 3
Sweater boxes for yearling boas.

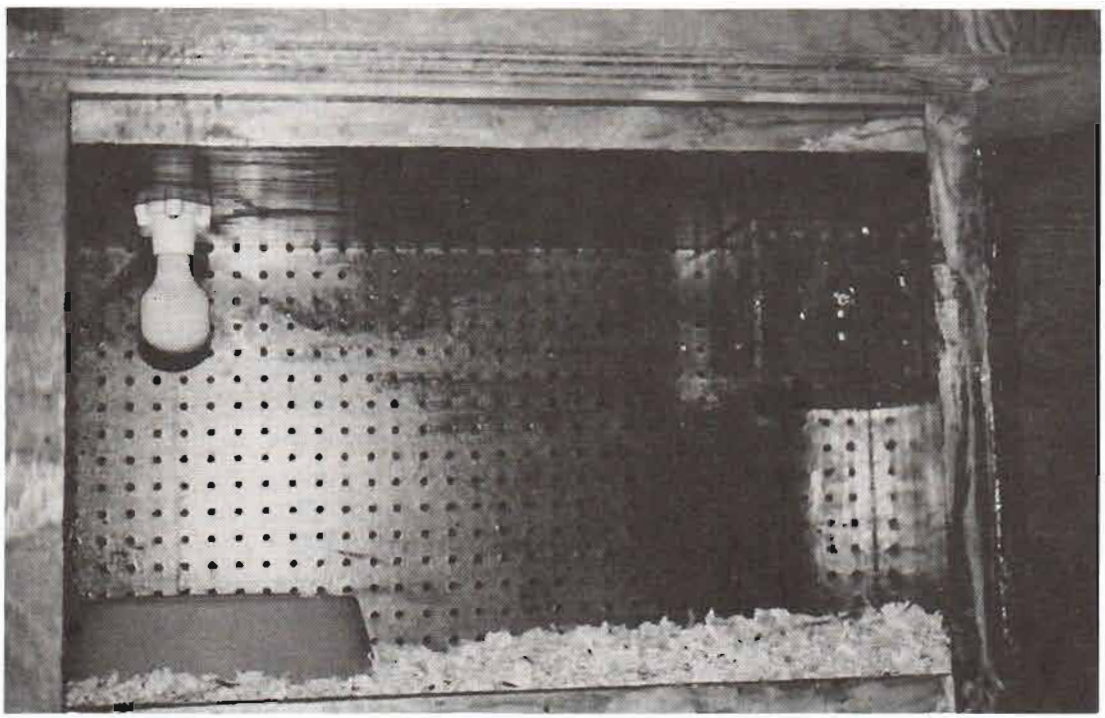


FIGURE 4
Cage set-up for adult boas

GRAVID FEMALE

Female boas start showing they were gravid by the following signs: (1) Accepting only smaller food items. (2) Lack of interest in breeding. (3) Enlargement of last third of body "the deflated tire look". (4) Lying on one side or the other for extended periods. (5) Spending long periods on or near heat sources. (6) Body twitching. (7) Change in temperament.

I separate gravid females and place them in a cage by themselves. Their appetite should increase, provided smaller food items are offered. I also increase feeding from once to twice a week. Gestation lasts between three and a half months to six and a half months. The female becomes restless and aggressive one to two days before giving birth. She becomes very aggressive after giving birth and remains aggressive for up to one week. All female boas shed

ten to fourteen days after giving birth. None would shed before giving birth.

NEWBORNS

When the female boa has finished giving birth, place a towel over her to prevent injury to herself or you. Next, look for any offspring that have not broken through the membrane, and remove it so the baby can breathe.

Remove all offspring from the female's cage. Place the offspring in a cage containing moist paper towels. Young with an umbilical cord still attached to the yolk should be carefully placed in a cage by themselves. This allows them to benefit from the additional nutrients and blood absorbed from the egg yolk.

Offspring will turn opaque within five to seven days of birth. Shedding will occur 7-10 days later.

CONCLUSION

Boa constrictor is a diverse, colorful and impressive species. This is the reason they are quite frequently kept by hobbists, herpetoculturists, and zoological parks alike. In all probability, wild importation will cease in the next five to ten years. Wild habitats will disappear, be burned, developed, or turned into short term profits. Now is the time for captive propagation. The continued future existence of *Boa constrictor* in captivity can only exist with captive reproduction and YOU.

My breeding stock, miscellaneous information pertaining to them, and reproduction to date:

Anerythristic boas

Male # 017 *Boa c. imperator* - Wild import 3-19-84
prime breeding male - sired offspring (1987, 1988, 1989)
Length 89"

Male #033 *Boa c. imperator* - Wild import 4-85
Darkest breeder - sired offspring (1989 with a 1984 female #020)
Length 71"

Female #018 *Boa c. imperator* - Wild import 3-84
Originally thought to be a male during 1986, 1987, 1988. February 1989 was found being copulated by male #017. Presently out of breeding program due to a broken neck vertebra with neurological damage. Euthanized 8-90. Length 85"

Female #019 *Boa c. imperator* - Wild Import 3-84
During the period of 1-2-88 to 10-31-88, Male #033 was placed in to combat with #018, then thought to be a male. On 3-12-89 birth to two stillborm offspring and twenty-one infertile egg masses. Shed on 3-28-89. Copulations observed on

10-8-89, 10-10-89, 11-16-89, 11-18-89 with no offspring produced. Length 102"

Female #020 *Boa c. imperator* - Wild Import 3-84
Observed copulations with male #033 on 10-1-88, 10-6-88, 10-7-88, 10-13-88, 10-14-88. Gave birth to twenty live, one stillborn, fifteen egg masses on 3-12-89. Shed on 3-25-89. Observed copulations on 10-18-89, 11-13-89, 12-20-89, and 1-7-90, with no offspring produced. Length 100"

Female #021 *Boa c. imperator* - Wild Import 3-1984
Observed copulation with Male #017 on 11-l5-86, 11-20-86. Gave birth to sixteen live, four egg masses on 5-16-87. Shed on 5-28-87. Observed copulation with Male #017 on 11-16-87, 11-20-87, Gave birth to eighteen live on 5-12-88. Shed on 5-25-88. Observed copulation with Male #017 on 11-6-88, 11-16-88, 12-27-88. Gave birth to ten live (four deformed), eight egg masses on 6-18-89. Shed on 7-8-89. Observed copulation with Male #033 on 10-7-89, 11-10-89, 12-16-89, 12-28-89, 1-9-90, with no offspring produced. Length 77"

Female #034 F1 *Boa c. imperator* - Captive born (M#0l7/F#020) (1987)
Observed copulation with Male #017 P1 12-16-89, 12-21-89, 12-30-89. Thought to be gravid as of 5-1-90.
Length 78"

Female #035 F1 *Boa c. imperator* - Captive born (M#017/F#021) (1987)
Observed copulation with Male #033 10-17-89, 10-19-89, 12-17-89, 12-19-89, 1-8-90, 1-10-90. Thought to be gravid as of 5-1-90.
Length 69"

ACKNOWLEDGEMENTS

Many thanks to the following individuals for their help, input, photographs, and/or review of my paper: William (Bill) W. Lamar, W. E. Gill, Jr., Bob Searse, Terry L. Vandeventer, Vince Scheidt, Steven T. Osborne, John Ottley, Sandy Veverka, John H. Tashjiun, Tracy Miller, Dave Barker, Lloyd Lemke, Kerry King, John Ruiz

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CAPTIVE REPRODUCTION AND NEONATE HUSBANDRY OF THE OUSTALET'S CHAMELEON, *C. ousatleti* AT THE OKLAHOMA CITY ZOOLOGICAL PARK

by

EILEEN CASTLE

ABSTRACT

This paper presents basic requirements for the successful reproduction of the Oustalet's chameleon, *Chamaeleo oustaleti*, at the Oklahoma City Zoological Park. Courtship and copulation behaviors are described. Egg incubation and neonate rearing are also briefly discussed.

INTRODUCTION

In early 1985, a project was undertaken to exhibit chameleons at the Oklahoma City Zoo. However, available literature was predominantly taxonomic in scope and generally lacked specific information on husbandry requirements. Discussions with colleagues proved to be disappointing. While a number of institutions had worked with chameleons only a few reported any success.

The fundamental goal of the proposed project became to make captive management of chameleons a viable option for the herpetologist, particularly in the zoo environment. The plan that was implemented was "stair step" in design. Acquisitions of new species were made only after specific results with current species were obtained. These included both longevity and successful reproduction within the adult group and successful rearing of the young and their subsequent reproduction.

The flap-necked chameleon, *Chamaeleo dilepis* was selected as the initial program species. Reproduced in 1987, it provided valuable insight into the problems associated with the reproductive behaviors of oviparous chameleons. (Castle, In Press) .

Jackson's chameleons, *C. jacksoni* were incorporated into the project in 1987, enabling the staff to become proficient at maintaining temperature sensitive specimens in Oklahoma's highly variable and often extreme climate. Hatchling sail-finned chameleons *C. montium* provided additional experience in neonate rearing. Oustalet's chameleons *C. oustaleti* were added to the collection in 1988. This paper describes basic parameters for the husbandry, reproduction and neonate care of the Oustalet's chameleon,

TABLE 1
Longevity and mortality data of original breeding group

ANIMAL ID (OKC#)	ACQUIRED	SEX	DATE DIED	CAUSE OF DEATH
4647-01	7-28-88	MALE		
4648-02	7-18-88	MALE	4-15-88	FIBRINONECROTIC PERITONITIS
4649-03	7-18-88	FEMALE	12-26-88	EGG YOLK PERITONITIS
4650-04	7-18-88	FEMALE	6-18-89	EGG YOLK PERITONITIS
4650-05	7-18-88	FEMALE	10-10-88	PARASITISM/BACTERIAL MYOCARDITIS
4652-06	7-18-88	FEMALE	8-20-88	UNDETERMINED

incorporating information derived from the work with previously mentioned species.

During June, 1988, two male (OKC #4647-01, OKC #4648-02) and four female (OKC #4649-03, 4650-04, 4651-06) Oustalet's chameleons were collected near Ambanja and Mahajunga along Madagascar's northwest coast. The group arrived at the Oklahoma City Zoo on July 18, 1988 (Table 1).

The larger of the two males, (#-01) and the four females were housed in a walk-in enclosure, 4.01 x 1.65 x 4.95 m. Several dry tree branches were interspersed with live trees, providing a varied arboreal habitat. A tempered water stream flowed across the front half of the exhibit. Cypress mulch was used as a substrate in the rear half. Two skylights and six 40-watt Sylvania 350 ultraviolet fluorescent lamps provided illumination and local photoperiod. Basking sites 35°C were provided throughout the cage by nine 250 watt infrared heat lamps. A sliding window

and a thermostatically-controlled fan mounted outside an air duct provided fresh outside air to the exhibit. Cage temperatures ranged from 31°C to 35°C daytime highs to 22°C to 28°C nighttime lows.

A sliding door on the back wall of the exhibit accessed a 1.8 x 0.6 x 1.2 m outdoor welded metal/wire cage. Propped in the same manner as the main enclosure, it provided unfiltered sunlight and rainfall. A greenhouse shade cloth and a moderate growth of ivy provided shade and some temperature control.

Four overhead misters inside the exhibit and an oscillating sprinkler beneath the outdoor enclosure were operated 15-30 minutes every other day to supply drinking water. In addition each animal was misted daily with a hand held spray to ensure that it was drinking.

The remaining male (#-02) was housed outdoors in a 1.25 x 1.18 X 2.13 m wood frame/wire screen cage. Live trees and appropriate sized branches supplied necessary drinking, perching and hiding surfaces. To moderate Oklahoma summer temperatures, greenhouse shade cloth was attached to the east-facing side of the cage. The screen was raised and lowered to help maintain desired temperatures. A garden soaker hose coiled on top of the cage provided both additional temperature control and dripping water for drinking.

When outdoor temperatures dropped consistently below 16°C, male (#-02) was moved to a similar enclosure in the herpetarium's greenhouse.

Food was offered one to two times a day. Grey crickets, large mealworms and waxmoth larvae were eagerly accepted. All insects were lightly dusted with an equal mix of Nekton-Rep, a multi-vitamin powder and either D-Cal-Fos, a calcium diphosphate supplement or Osteoform, a calcium, Vitamin D_2 supplement. One to four day old mice and one to seven day old rat pinks were also offered and occasionally accepted.

Although these animals had been wormed prior to transport with TBZ (Thiabendazole), routine exams identified heavy loads of ascarids and nematodes. Oral doses of Ivermectin and Telmin (Mebendazole) were prescribed.

Toward the end of September, 1988, male (#-01) began to develop two air filled sac-like structures between his two front legs, just below the gular region. Two of the females (#-03 and #- 04) developed similar structures.

Multiple copulations were observed between male (#-01) and females (#-03 and #-04) throughout October. One additional copulation was observed between male (#-01) and female (#-03) on 9 November.

Courtship appeared to be initiated by the male. At the onset of courtship the male took on a white and maroon mottled coloration. A yellow stripe which ran from his chin to his tail became very bright, almost fluorescent in color. The male approached the female head on usually several feet above or below her. Once spotted by the female, he would shake his head vigorously from side to side. This was followed by a back and forth rocking motion and another series of head shakes. The sequence was repeated until the male had passed the female, and then turned to approach her from the rear. The female remained unresponsive throughout this exchange. No color change was noted. The male then mounted the female, firmly grasping either her forearms or head. After 30 seconds to 1 minute, the male would either crawl off the female or the female would crawl out from under him, advancing about a foot or so down the branch. The male would resume head shakes and rocking and again mounted the female. The sequence would be repeated until the female lifted her tail. Actual copulation times average 20 minutes in duration.

Within a week of their last observed copulation a distinct color change was observed in both females. Regardless of their previous coloration, both females took on a red to reddish brown ground color with dark brown bars. The sac-like structures disappeared at this time. Female (#-03) also developed bright red bars on her face.

In order to provide a large nest area, the stream was shut off. Once the bed was dry it was filled with an even mix of potting soil and moist sphagnum peat to a depth of 13 cm. A number of short plants were added to provide low level cover.

About the first week of November female's (#-04) appetite tapered off significantly. On November 9, she was observed in the low level cover near the ground. During a routine morning check the female appeared extremely deflated. The stream bed was excavated and thirty-four eggs were found 15 cm from the front of the exhibit at a depth of 13 cm. The eggs averaged 1.05 cm in diameter, 1.45 cm in length and 0.9 grams in weight. The eggs were laid in rows of five to eight against a pile of pea gravel that covered the stream drain.

Female (#-03) was first observed on the ground December 6, 1988. By December 12 all food was refused. Throughout the next several days she remained on or near the ground. Digging was first observed on December 15. For the next eleven days she continued to dig, usually abandoning nest sites after a few hours. On December 26, the female was found dead. Twenty-nine eggs were surgically removed. Necropsy revealed the cause of death as egg yolk peritonitis.

On December 26, 1988, copulation was observed between male (#- 01) and female (#-04). On January 19, 1989, a second clutch of thirty-four eggs was laid in approximately the same location as the original clutch.

In order to allow the female (#-04) adequate time to recover from oviposition, she was separated from the group and moved to a reserve enclosure in the herpetarium greenhouse. Although she remained separated from the males, she produced a total of three additional clutches. She died June 6, 1989 of egg yolk peritonitis.

Each clutch of eggs was placed in 3.8 liter glass jars which contained approximately 5 cm of damp vermiculite (vermiculite: water ratio 1:1 by weight). Each jar was covered with clear plastic wrap. Egg incubation temperatures could not be determined from available literature. Communication with colleagues encouraged the selection of cooler incubation temperature to reduce potential birth defects (Ferguson, personal communication). Recommended temperatures (22-23°C) were maintained by placing the jars in a water bath regulated with a 200 watt submersible aquarium heater.

After 268 days of incubation twenty-seven of the eggs in the November 11 clutch had doubled in size and weight and appeared firm and white in color. When candled no development was apparent. The eggs were opened July 20, 1989. Each contained a thick, opaque pale-yellow fluid. No blood spots were noted and the clutch was discarded.

The remaining clutches were candled July 30, 1989. Veins and shadows were observed in four of the eggs removed from female (#- 03). No other development was discerned in any of the remaining eggs. After considering the possibility that incubation temperatures were inadequate, the remaining clutches were slowly warmed to 26-27°C.

Four eggs from female (#-03) hatched August 28-31, 1989, following a 245 to 248 day incubation. The young (OKC #5084-10, 5084-11, 5084-12, 5084-13) averaged 9 grams in weight, 3.3 cm snout/vent, and 6.76 cm total body length.

No further development was seen in the four remaining clutches until December 10, 1989. Following a four day cooling to 22°C and a subsequent rewarming, pink spots, approximately 0.5 cm in diameter were observed in several eggs in each clutch. By the end of the first week in January, 1990, ninety-one of the remaining eggs were solid pink in color when candled. Veins were noted in fifteen eggs on January 11. By the end of March, veins were observed in twenty-three of the eggs.

On May 1, several eggs were slightly

dented and one egg from (#-04) January clutch had ruptured. The ruptured egg was opened. The neonate was alive but appeared to be about one to two weeks from term. It died within eight hours.

The clutches were lightly misted to simulate the coming of the rains. The condition of eggs in all clutches began to deteriorate. The number of sweating or dented eggs increased daily. The neonates in dented eggs were dead but nearly full term when opened. The neonates in sweating eggs were alive if opened within a few hours. However the young were small and weak and most did not survive beyond 48 hours. The remaining eggs were opened at this time. All clutches regardless of oviposition date were at the same point of development. Most were stillborn and approximately 15% had umbilical hernias. A large amount of uric acid and fecal material was also noted. Four hatchlings from different clutches survived for five to eleven days.

Neonate Rearing

Unlike *C. dilepis*, who are active immediately following hatching, *C. oustaleti* hatchlings were extremely lethargic. Very little movement was noted during the first twenty-four hours, although their color darkened rapidly when they were disturbed. Within 48 hours movement had increased. Approximately ten to fifteen minutes of activity was followed by 30-45 minutes of complete inactivity. At 72 hours, activity was equal to that of hatchling *C. dilepis* or *C. jacksoni*.

For the first week the young were housed together in a 40 gallon aquarium. The top and front were aluminum framed screen. Once they became relatively active they were divided into pairs and placed in aluminum screen enclosures 61 x 61 x 61 cm in the herpetarium greenhouse. The environment consisted of appropriate and varied dry tree branches and live potted plants. The natural illumination and photoperiod was supplemented with one 40 watt Duro-test Power Twist Vita Lite Florescent lamp and one 40 watt Sylvania 3500 ultraviolet florescent lamp. Each animal was sprayed several times throughout the day to ensure each one was drinking. On a number of occasions, they were observed shooting water droplets with their tongues.

Compared to other neonates, their appetites were enormous. Food was offered one to two times each day. The young readily accepted one week old crickets and were eating two week old crickets fourteen days after hatching. At three months of age, they were eating adult crickets, mealworms and waxmoth larvae dusted with standard vitamin/mineral supplement.

The young grew rapidly (Table 2). Cage mate aggression began to surface about 5 months of age. No secondary

TABLE 2
Comparative neonate rearing data

ANIMAL ID (OKC #)	5084-10	5084-11	5084-12	5084-13
8-29-89	0.9 g 3.34 cm svl 6.78 cm tl	0.8 g 13.32 cm svl 6.79 cm tl	0.9 g 3.23 cm svl 6.53 cm tl	1.0 g 3.45 cm svl 7.08 cm tl
11-15-89	6.0 g	4.3 g	5.l g	7.3 g
12-27-89	13.6 g	7.5 g	10.3 g	15.5 g
1-14-90	20.01 g	8.6 g	15.1 g	22.1 g
l-29-90	32.1 g	11.0 g	22.4 g	33.2 g
2-19-90	56.8 g	19.0 g	40.9 g	57.4 g
4-5-90	94.3 g	42.0 g	92.2 g	104.6 g
5-15-90	150.4 g	127.6 g	142.7 g	168.0 g
6-18-90	226.6 g 17.5 cm svl 42.5 cm tl	172.6 g 16.2 cm svl 33.7 cm tl	2Ol.0 g 18.0 cm svl 40.0 cm tl	212.0 g 21.5 cm svl 45.5 cm tl

sexual characteristics were observed and most of the aggression occurred during feeding periods.

On January 22, 1990, when the young reached five months of age they were separated into individual enclosures. Hemipenal bulges became apparent during the first week of May, 1990. All four young were sexed as males.

On May 22, 1990, the largest male (#-13) was introduced to a recently acquired female (OKC #5193-14). Courtship and copulation were observed four hours after introduction.

DISCUSSION

Oustalet's chameleons can be successfully maintained and reproduced

if proper environment, social and medical conditions are met, they tolerate a broad range of temperatures. Daytime highs of 27-30°C with a 32°C basking site and nighttime lows around 22°C seem to be preferred.

The presence of a fluid air mass seems to be critical. When surrounded by a stagnant air mass, like those often associated with Oklahoma's indoor winter environment, chameleons often become lethargic and anorexic.

Although Oustalet's chameleons come from a seasonal wet/dry environment water should be offered daily. Thirsty animals will often refuse food (Bustard, 1963).

Parasites associated with wild caught animals must be isolated and treated immediately. Parasite loads, particularly ascarids were heavy and often required four to six treatments.

Social grouping is another important consideration. Little hierarchy as noted in the female group. Aggression was infrequent and occurred mainly at meal times and just prior to oviposition. Males, however, did not seem to co-habitat well together. Although threat posturing (puffing up with air, head bobbing and gular extension) were noted violent confrontations were not observed. A decrease in appetite and general rise in anxiety, usually in the smaller animals occurred after several hours.

Reproductive complications appear to be the leading cause of death in females. Females who could not find suitable nesting areas would not lay. What was suitable for one female was considered unacceptable to another. To complicate the process females produced large clutches of eggs (in excess of 30) which fill the body cavity. Experience has shown the use of hormonal stimulation, like Oxytocin, occasionally produces contractions strong enough to rupture unlaid eggs. Egg yolk peritonitis has been determined as the cause of death in three females.

Egg incubation techniques are still being investigated. It appears that eggs can undergo a period of diapause influenced, most likely, by environmental factors. Future clutches of eggs will receive various controlled thermal treatments in an effort to understand and control this phenomenon.

Neonates were sluggish the first 48-72 hours after hatching (Arnett, pers. comm.). Once this period has passed, they become extremely active and perpetually hungry. The young should be fed at least once a day and a variety of food items given as soon as possible.

SUMMARY

The information presented in this paper can be applied to most of the available chameleon species. It is important to remember that these are not

low maintenance animals. Changes in behavior are often minute and health problems can intensify rapidly.

Chameleons require time.

ACKNOWLEDGEMENTS

A special thanks to Debbie Mercer for typing this manuscript.

Products Mentioned in the Text

D-Cal-Fos: A bone ash, vitamin D_3 supplement, Fort Dodge Laboratories, Inc., Fort Dodge, IA 50501

Power-Twist Vita-Lite: A 40-watt fluorescent lamp manufactured by Duro-Test Corp. , 2321 Kennedy Blvd., North Bergen, NJ 07047

Ivermectin: A wormer manufactured by MSD Agvet a Division of Merck and Company, Inc., P.O. Box 2000, Rahway, NJ 07065

Neckton-Rep: A vitamin, amino acids, and trace element supplement manufactured by Nekton-USA, Inc., 1917 Tyrone Blvd., St. Petersburg, FL 33710

Osteoform: A calcium-phosphorus powder, manufactured by Vet-A-Mix, Inc., Shenandoah, IA 51601

Oxytocin: A labor-inducing hormone manufactured by Wyeth Laboratories, P.O. Box 8299, Philadelphia, PA 19101.

Sylvania 350: A 40-watt ultraviolet fluorescent lamp manufactured by GTE-Sylvania, 100 Endicott Street, Danvers, MA 01923

Telmin: Mebendazole manufactured by Pittman-Moore, Inc., P.O. Box 344, Washington Crossing, NJ 08560

TBZ: Thiabendazole manufactured by MSD Agvet, a Divison of Merck and Company, Inc., P.O. Box 2000, Rahway, NJ 07065

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ADDITIONAL NOTES ON THE CAPTIVE REPRODUCTION OF THE SPINY-TAIL AGAMA *Uramastix acanthinurus* AT THE OKLAHOMA CITY ZOO

by

SCOTT WHEELER

ABSTRACT

This paper briefly describes the courtship and copulation behavior of a group of *Uromastyx acanthinurus* at the Oklahoma City Zoological Park. Also discussed are the husbandry techniques and behavior of hatchling *U. acanthinurus*

INTRODUCTION

In 1982, the Oklahoma City Zoo committed to work with *Uromastix*. To initiate the program, *U. acanthinurus* was chosen, due to its availability. In 1986, the zoo was successful at propagating this species (Grow, 1988; Wheeler, 1988). This paper presents data on additional breeding of *U. acanthinurus*, with updated husbandry techniques for neonates. Specifically addressed is agonistic behavior observed in juveniles, and possible pair bonding in adults.

MATERIALS AND METHODS

The Oklahoma City Zoo currently maintains five adult *U. acanthinurus*. (Table 1) .

A detailed account of the husbandry was described by Wheeler (1988). One pair of *U. acanthinurus* was maintained on exhibit. In April surplus males were routinely introduced in the exhibit to stimulate the pair. (Table 2).

For incubation, the eggs were placed in a container of 1:1 water to vermiculite, by weight, at 29°C. In 1987, a clutch of 12 eggs was incubated at 32°C. Only two hatched. This high temperature may have contributed to the failure. (See Table II for egg data).

Hatchlings were housed in groups of no more than five. Each group was housed in ten gallon aquaria, with 5 cm of a sand-clay mix for substrate. Each tank had a 250 watt sunlamp for illumination, and basking. Daytime temperatures ranged from 49°C to 26°C. Nighttime temperatures ranged from 26°C to 24°C.

Diet was not changed from previous reports (Wheeler, 1988). It consisted of

TABLE 1
Weights and measurements of adult *U. acanthinurus*

ID (OKC #)	SEX	DATE	WEIGHT	SVL	TOTAL
2768-03	male	11-30-82	290 g	20.9 cm	33.4 cm
4102-14	male	4-29-87	320 g	aprx 20 cm	aprx 35 cm
4104-16	male	4-29-87	360 g	aprx 20 cm	aprx 33 cm
4629-20	female	6-29-88	331 g	20.3 cm	31.7 cm
4882-21	female	3-30-89	295 g	19 cm	30.5 cm

mixed greens, waxmoth larvae, small crickets, and occasional flowers. Standing water was provided daily.

Adults and juveniles were hibernated at 12°C, December through February, according to techniques described by Wheeler (1988).

RESULTS

Combat, breeding and egg laying appeared consistent with earlier observations (Wheeler, 1988). The breeding females exhibited aggression toward subordinate, non-breeding males, introduced into the exhibit. Female attacks on other females were not observed. Four weeks after hatching, juveniles exhibited agonistic behavior. An individual would display either "push ups", or "head bobbing." Dominant animals would mount submissive individuals, neck biting, and embracing, similar to adult courtship behavior.

Because of space restrictions the zoo was unable to house juveniles individually as recommended by Wheeler (1988). To compensate for aggression, the most dominant and the most submissive individuals were removed from the

TABLE 2
Egg and breeding data of *U. acanthinurus*

FEMALE ID	EGG LAYING DATES	NUMBER OF EGGS	NUMBER HATCHED	DATE HATCHED	AVERAGE INCUBATION TIME
OKC #2	6-1-86	11	8	8-2-86	93 days
deceased	6-13-87	12	2	8-4-87	83 days
OKC #16	5-8-89	18	17	8-11-89	93 days
	4-20-90	21	currently incubating		

groups. This method failed because a new hierarchy would be established. To correct this problem of a new hierarchy, individuals were frequently moved to different groups. This method of displacement of group members appeared to be the most effective means to reduce aggression.

DISCUSSION

The present husbandry techniques (Wheeler, 1988) utilized at the Oklahoma City Zoo for *U. acanthinurus*, appeared to be adequate for long term support and successful reproduction.

Attacks on subordinate non-breeding males by the breeding females may be an indication of pair bonding. The only time females have been observed to attack males was while housed with a dominant male. Subordinate males were typically attacked by a female first, followed by attacks from the dominant male. This aggressive behavior by females was very interesting, and merits further investigation.

Due to aggression of juveniles, individual housing is strongly recommended. Since this cannot always be accomplished, frequent disruption by rotating group members, appeared to lower the stress of subordinate individuals. Future investigations of neonate dispersal is planned.

ACKNOWLEDGEMENTS

I am indebted to Richard Lockwood for reviewing the original manuscript. Debbie Mercer is thanked for typing the manuscript.

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FRESHWATER TURTLES OF URUGUAY

by

DAVID FABIUS

ABSTRACT

Five turtle species are found in Uruguay; one Cryptodiran, *Trachemys dorbignyi*, and four Pleurodirans, *Hydromedusa tectifera, Phrynops hilari, Phrynops williamsi* and *Platemys spixi*. Information obtained mostly in field studies regarding morphology, color, habitats and habits is included.

INTRODUCTION

Five freshwater turtle species are found in Uruguay. While morphological descriptions have been published (Ernst & Barbour, Vaz Ferreirra y Sierra de Soriano, among others), information is in other aspects scanty, and sometimes differs from my field observations in Uruguay.

Uruguay is a temperate country, therefore various degrees of hibernation occur in the herpetofauna. The land is mostly a rolling prairie, with low hills and many watercourses. The turtle fauna has adapted to different habitat types, ranging from the very specific ones of *Phrynops williamsi* and *Platemys spixi* to the other, widely distributed species.

The only Cryptodiran species, *Trachemys dorbignyi*, would seem out of place in a predominantly Pleurodiran area. Nevertheless, it ranges widely and is common in many areas.

The beautiful carapace and plastron pattern is lost in males, when black blotches cover the surface on a yellowish or greenish background color.

I have not seen any males with elongated foreclaws, and there is no plastron concavity, but the tail is thicker and longer than in the female. Collections in local zoos generally show females to be more abundant than males, although it would be interesting to know if there is a bias in the collecting methods employed.

This basking turtle may be found in a variety of water bodies, including small ponds, streams and lagoons situated alongside rivers, but probably not in the rivers themselves.

The eggs are leathery and elliptical, although Gambarotta (pers. comm.) reported to me about spherical brittle-shelled oviducal eggs. I have seen a female in early December digging a nest at mid-morning, where she laid nine

eggs. Thereinafter, she walked about 100 meters to return to water, the overflowed border of a lake.

This turtle opens its mouth to bite when first caught, and is believed by country people to be highly poisonous, but in Montevideo, hatchlings are sold as pets.

Hydromedusa tectifera is a widespread species. The very long neck makes it impossible to mistake for another one. Younger specimens have three keels, one median and two lateral, composed of rough tubercles, which in the newly hatched are bent flat against the carapace, straightening in a few hours. The tubercles disappear with growth and very large individuals have a deep median groove. In Uruguay, large individuals are those over 22 cm in length, and those over 25 cm can show an elongation of the flat forepart of the carapace up to the base of the neck, and posteriorly, the bulging sides create the aforementioned deep groove.

Males have a deep plastral concavity and longer, thicker tails. Thus, a male can be identified from above, as the carapace over the tail is pointed to cover the extra bulge of the tail, whereas that of the female is more rounded. I cannot say if one sex is larger than the other, but females may be higher of carapace.

Some of the adult individuals show a few orange or red dots around the tail or on the legs. I have not seen this in younger turtles, even in the offspring of such colored adults. Medium-sized or larger turtles about to shed laminae show a silvery-gray color.

This turtle occurs in a wide variety of habitats, including man-made ponds and highly-polluted streams, where breeding occurs normally. They are sometimes washed ashore in the Rio de la Plata estuary beaches coming from small rivers, and it may yet be demonstrated that they tolerate brackish water. This turtle is rarely seen basking, and a growth of algae is present on some specimens. Also, it is more of a bottom walker than a swimmer. Courtship is quite violent, the male climbing over the female and biting the neck skin, even stretching it away but not biting into it. The eggs are brittle-shelled, elongated, and are usually laid in late November and early December, with hatching taking place early March to April. When incubated in excessively humid conditions, the outer shell may crack, giving way to an enlargement of the egg, with normal hatchlings at the end of the incubation period. I had a case involving the hatching of twins in such conditions, but this may not be caused by the humidity. In this case, one specimen was a normal hatchling, whereas the other was a dead, underdeveloped fetus (Fabius, Meueghel & Brum, in press). When feeding, this turtle sometimes uses the same method as *Chelus fimbriatus*, whereby the long neck is violently

expended, a lunge is made, and food is sucked into the mouth. This turtle never bites, although captives may harmlessly bite at the keeper's fingers when looking for food.

Phrynops hilari is the largest of the Uruguayan turtles, adult specimens usually being around 30 cm in length or more. Young specimens have a median keel, which is lost with adulthood, even turning to a wide, shallow groove in large specimens. The longer, thicker tail in males can be seen even in younger specimens, but the concavity of the shell shows only in the larger adults.

This turtle has been called the lagoon turtle (*tortuga de laguna*), but is also found in larger rivers. As is the case with the preceding species, they may breed in the heavily polluted streams. This is a basking turtle and an active swimmer. Caution must be exercised when handling newly-caught specimens, as the sharp jaws can deal painful wounds with amazing speed.

I have seen specimens in the wild taking hooks baited with whole monk parakeets. Wild females are found to contain eggs almost the year round, but more so in February and March, when most eggs are probably laid. I have found areas of high density nesting on the slopes of a hill overlooking a small stream.

Incubation in captivity at room temperature may take about one year, but I have incubated one egg lain in July with a heat source, and it hatched in February. The size of the spherical egg is quite variable, and I've had in captivity clutches ranging from 11 to 19 eggs.

Phrynops williamsi is much rarer than *Phrynops hilari*. The carapace is reddish brown, with black vermiculations. This makes it very hard to find the turtles among stones of the same color, and the red earth that forms the floor of the streams near Rio Yaguaron, Departmento de Cerro Largo. The plastron in adults is a very light yellow, but juveniles have a whiter plastron with a well-defined, but faded pattern of gray spots. The color of the dorsal surface of the head is black-striped on reddish-brown, to a subdued red; the ventral surface is black-striped on white. Males have longer tails than females.

This turtle likes to bask on top of rocks in its habitat, the rock-bottomed streams of the north and western part of the country. I have found it both in narrow streams and a large river. Feces of newly caught specimens contained insect remains.

The habitat of this species is periodically subjected to rushing floods, as water collected on the nearby hills from heavy rains moves downward. Intraspecific predation is high in captivity, the main points of attack being the sides of the head.

Platemys spixi is almost wholly black as adults, newly hatched specimens have orange-red spots on the rim of the carapace, the ventral surface of head and neck, the extremities and plastron. This color fades to yellow with age, until it fades completely when the turtle is over 10 cm in length.

Males have longer, thicker tails than females, and there is a very slight concavity to the plastron. Females have a slightly convex plastron, making comparison with males easier.

Although found in many places, concentrations of the species are found in the southeastern swamp areas, where very shallow and small bodies of water may harbor many turtles. The area is subject to drought periods in the summer, and the turtles walk long distances to find water. They have probably been saved by manmade ponds. In winter, the heavy rains flood large areas, and the turtles may be passively transported by the overflowing of the ponds.

Of the eleven turtles found in June, only one was collected with a baited trap, which may catch good numbers in the summer. The rest were located by sight, and although some would not move, one tried to escape when seeing me, while the water temperature was 10°C. It is also possible to find similar situations in winter with *Phrynops hilari* and *Hydromedusa tectifera*.

I have seen courting in November, with the male making sideways head movements. Females are usually found gravid in the wild in January, and it is very possible that gravid females prefer the deeper, cooler waters than the males, although more sightings would help confirm this hypothesis.

In November, the feces of newly caught specimens contained many elitra, indicating a beetle diet.

Regarding habitat, I have found living sympatrically *Hydromedusa tectifera* with *Phrynops hilari* and *Trachemys dorbignyi* in mud-bottomed bodies of water. *Phrynops williamsi* were found with lesser numbers of *Trachemys dorbignyi* and *Hydromedusa tectifera* in rock-bottomed streams (*Hydromedusa tectifera* and *Trachemys dorbignyi* were found in still water nearby). In only two cases were *Hydromedusa tectifera* living in the shallow waters inhabited by *Platemys spixi*.

Summing up, three species do not deeply hibernate, with some individuals even feeding or showing flight response. Some species have a particular habitat preference, this seemingly precluding other species from using it intensively.

ACKNOWLEDGEMENTS

Most information not otherwise referred in the bibliography or text comes from the author's own observations, both

in the field and in captivity. Part of the information has been obtained with co-worker Melitta Meneghel. To her, my gratefulness for agreeing on its public use, well before the completion of the work.

To the Director of the Museo de Historica Natural de Enseñanza Secundaria, Prof. Dr. Luis A. Torres de la Llosa, my indebtedness for his years' long encouragement, and the opportunity to develop my concepts through teaching at the Museo.

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SOME OBSERVATIONS CONCERNING SHELL GROWTH IN CAPTIVE MADAGASCAN RADIATED TORTOISES

by

COLETTE HAIRSTON

ABSTRACT

Shell growth in young captive Radiated Tortoises can reveal a great deal about their rearing history. Some degree of scute pyramiding may be normal. Extremely irregular scutes, stacked scutes, or the marked absence of growth rings may be indicative of one, or a combination of factors. Some of these influencing factors include injury, illness, poor diet, insufficient space, inadequate lighting and/or heat. We have encountered less illness and more normal shell growth in our captive Radiated Tortoises because our rearing protocol gradually has evolved to mimic conditions most likely to be encountered by these tortoises in the wild.

INTRODUCTION

The Gladys Porter Zoo became involved with the captive management of the Madagascan radiated tortoise, *Geochelone radiata* in 1971. Young have been produced for the last 16 consecutive years, yielding a total of 138 babies. Presently, 55 of these captive progeny reside in our collection.

Nearly every age and size of radiated tortoise is well represented in this group. We have made the observation that much of their rearing history is reflected in the growth of their shells. Some degree of scute pyramiding may be normal for some animals, however, extremely irregular scutes, stacked scutes, or the absence of growth rings may be indicative of one, or a combination of variables. Some of these influencing factors include injury, illness, insufficient available space, poor diet, incubation technique (Lynn & Ullrich, 1950), inadequate light and/or heat. This paper will share some of the observations we have made after encountering these variables while attempting to raise healthy radiated tortoises.

NORMAL SHELL MORPHS

In order to determine normalcy in shell growth, we first addressed the different shell morphs which exist in our founder stock. Our breeding group currently consists of 6.7 wild caught adult radiated tortoises. Among the females

there are four distinctly different carapace shapes. From the lateral view, some are highly domed and helmet shaped. Others are similarly domed, but the rear marginals flare out. Two of our larger females are fairly elongated. One female, our original breeder, is domed in the anterior aspect of the carapace, and elongated in the posterior.

None of our males are even remotely domed in appearance. They are moderately more dorso-ventrally flattened than the females and are elongated in the same fashion as are our largest females. A noteworthy characteristic that is shared to some degree by the elongated males and females alike is the presence of a protruding fifth central scute. For lack of a better term, we call it a "shelf." This "shelf" may possibly serve a purpose in the males during copulation. The bottom half of this scute is usually well worn in sexually active males and we have observed them resting back on it when mounting large females. It seems to prevent them from toppling over backwards during copulation.

One noteworthy animal is the male on loan to our institution from the San Diego Zoo. His carapace is extremely smooth and totally devoid of growth rings. At one time we considered him old and attributed the smoothness of his carapace to mechanical wear and weathering. It is of interest to note that many of his offspring lack distinctive growth rings as well.

Another male, which is no longer in our collection, came to us on breeding loan from a private individual. This tortoise appeared more closely related to a flattened *Psammobates tentorius* than a radiated tortoise. His carapace was more dorso-ventrally flattened than any we had ever seen. His scutes were dramatically pyramided. We had little history on the animal and assumed that his misshapen shell was due to some illness or dietary deficiency he had encountered early on. Again, it was interesting that the only two young he sired at our facility grew to look exactly as he did.

INJURY

All of the peculiarities we have seen in shell growth of captive radiated tortoises certainly cannot be attributed to heredity. There are several animals in our collection with marked growth defects caused by mechanical injury. The most remarkable of these is one sub-adult which was placed in an open yard for public viewing. This animal was evidently hit by rocks thrown by vandals. In several instances, the point of impact of the rocks was the sensitive growth ring or growth plate area of the scutes. As time passed, additional growth rings produced at these sites were of jagged configuration. However, the overall appearance of the animal is unaffected.

On two separate occasions involving two specimens, we have seen alteration in normal shell growth due to damage to the beak of the premaxillary region of the lower mandible. The inability to properly bite off sections of food items often hampered their ability to feed properly and growth temporarily slowed or stopped. In both cases, the broken lower beak was discovered only after a deviation in shell growth was noticed. It was estimated that the damage was done to the beak several weeks before it was noticed. We do not know whether the beaks cracked due to some metabolic or dietary deficiency or if another tortoise broke it while feeding. In any case, once the beaks were repaired the tortoises began to feed normally and shell growth resumed.

The beak injury occurred very early in development for one of these tortoises. It was less than two years old. Following the repair and eventual regrowth of the damaged beak; though the animal appeared well, his shell never grew normally. There was not a tremendous amount of pyramiding in the scutes, but there was much more than we would have expected. The second tortoise was almost six years of age when his beak was broken, and once he began feeding again, his shell growth continued without pyramiding. This is consistent with what we normally see when growth inhibiting factors are encountered in these tortoises. The older the animal in which the shell growth is interrupted, the greater the chances are that normal growth will resume after the problem is resolved.

In both instances, the history of the broken beaks can be detected within the old growth rings of these animals.

ILLNESS

Some of our most disfigured radiated tortoise youngsters are those that contracted health disorders early in life, went off feed, and remained off feed for an extended period of time. Once again, we can cite cases of two separate animals, years apart, whose shell growth seemed seriously damaged by an illness. One animal was a hatchling that was a chronic poor-doer since emergence with a history of low vitality and slow feeding response. He had a poorly calcified shell; which at one point would dent easily if it was depressed with a finger. Diagnostic testing revealed nothing about the nature of this tortoises' problem. Eventually, simple nursing practices brought him back to health and his shell finally hardened. However, he never grew properly. Because of the seriousness of his illness and the early age of the tortoise when it occurred: we were not surprised to see how poorly he grew.

In another case, several of our two to four year old radiated tortoises became lethargic, their shell became soft and pliable to the touch and they began

passing mucous and bits of sloughed intestinal tissue with their stools. Fecal examinations revealed multitudes of flagellated protozoans. Treatment was initiated immediately but unfortunately, only one survived. After a six month period of medication followed by slow recuperation, shell growth resumed, but it was dramatically altered. Prior to his illness, this radiated tortoise was growing very well and appeared normal. Now it has probably the most grotesque appearing carapace of any radiate in our collection.

AVAILABLE SPACE/LIGHT/HEAT

When we speak of available space in reference to tortoise husbandry, we do not mean the amount of ground space the animals have access to for exercise purposes, although doubtless that factor figures as an important one as well. Nor do we mean air space, as in the height of an enclosure. What this terminology refers to is the availability of, and easy access to basking sites and cool refuges, as well as the lack of pressure from overcrowding and competition for food, comfort or security. With our young, we must do this indoors. We have experienced problems with biting ants, rats and other predacious creatures that make it risky to put the young radiated tortoises outdoors before they reach the age of six years or so. At our Zoo, freshly emerged hatchlings are removed from the incubator shortly after they begin to feed, and are reared for a period of time in a twenty gallon aquarium without a lid. Heat and light are provided by an incandescent 75-watt light bulb directed at one end of the aquarium. Because the aquarium is small and easily overheated, care is taken not to get the light too close to the hatchlings. The available space is uniformly warm - 29° C. - and this seems to work very well with extremely young tortoises. Additionally, it is easy to keep track of their feeding responses and to monitor the fecal material they pass. Individuals that begin to grow rapidly, however, seem to need a larger space in a very short period of time. Left in the aquarium, it has been our observation that their scutes begin to pyramid and their growth is adversely affected from the onset. The best illustration we have to this effect is a pair of siblings that were originally placed in the aquarium within weeks of one another. A surge of new hatchlings prompted us to move a few of the more robust animals to the larger area designated for aquarium graduates. This area measures 150cm X 75cm (approximately 5' X 2.5') and has alfalfa above corrugated cardboard as a substrate. Lighting is provided by a four foot hanging double bulb fixture containing one 40 watt Duro Test Vita-Lite and one 40 watt G. E. Black Light F40BL. The fixture is suspended 28cm above the substrate. Hot spots are provided by two incandescent bulbs in reflector shields suspended 24cm

above the substrate at opposite ends of the enclosure. One of the bulbs is a simple 100 watt incandescent. The other is a 75 watt DuroTest Reflector super white. One of the siblings was moved to this larger area four months before the other. Eight months after both had been in the large enclosure together, the tortoise given more available space from early on was at least one-third larger than his sibling. Additionally, the larger animal exhibits better scute formation than the smaller one.

We have attempted taking hatchlings directly from the incubator and placing them immediately into the larger quarters with plenty of hot spots, cool corners and substrate in which to hide, but the results were poor. The freshly hatched radiated tortoises were extremely seclusive when offered such a large space and they would seldom, if ever, come out to bask. When rousted from hiding at feeding time, they would run right over the food and go back into seclusion without eating.

The availability of space, complete with adequate heat, good light and substrate are essential in rearing healthy radiated tortoises at any stage.

These things are just as critical to proper shell formation as any other factor in good tortoise husbandry. Radiates we have raised on good, low protein, low fat, high fiber diets, have exhibited pyramiding in the scutes when we failed to provide essential elements such as heat, light and space.

DIET

Perhaps the most challenging aspect of rearing tortoises under artificial conditions was the dilemma of selecting a diet that would be simple, readily available and would mimic the nutritional levels of the food they consume in the wild. Radiated tortoises are herbivorous, and the micro-organisms that reside in their digestive tracks are capable of breaking down large volumes of plant material into the essential elements required for their metabolism (Stevens, 1982). In the wild, they probably spend a large amount of their time feeding or looking for food. The food they consume doubtless has little resemblance to the high protein dog chow we once fed our radiated tortoises in relatively high volumes. We also fed random produce and Opuntia cactus. The dog chow we fed in a prepared diet once weekly had 27g protein on a dry matter basis, 4% fiber and 10% fat. It seems miraculous that these tortoises fared as well as they did. Those animals still residing in our collection that consumed this diet on a regular basis have stacked and crowded scutes in varying degrees. Additionally, for the first six years of their lives, they were raised under florescent lighting with no available hot spots for thermo-regulation.

About six years ago, we launched a

campaign to eliminate the problems we were seeing in our captive radiated tortoises. We began with their diet, eliminating gradually the dog food in their rations and replacing it with commercial rabbit pellets. Research was done on the calcium-phosphorus ratios of the produce we fed the tortoises and it was found to be drastically incorrect. Calculations were made and the produce mixture was altered radically (Table 1). After some time, Purina Horse Chow #200 took the place of the rabbit pellets. Shell growth was improving, however more work had to be done. Varying degrees of shell pyramiding existed in the scutes of the animals reared on the new diet. Black lights and hot spots were made available and more space was designated for rearing the young. Two years ago, the Purina Horse Chow #200 was replaced by Purina Pure Pride #100 because of the lower protein and higher fiber it offered. As recently as a year ago, most of the fruit was eliminated from our prepared diet and replaced with more vegetable matter. The prepared diet was then fed twice weekly instead of once (Table 2). Finally, eight months ago, the produce (such as kale, spinach, Romaine lettuce and broccoli) we had offered as browse to the young tortoises almost daily was changed almost entirely to native edible plants and grasses.

However, the freeze our area suffered in late 1989 forced us to return to produce as browse for a period of time.

The prepared diet we feed today has no apparent drawbacks, but a recent laboratory analysis revealed unnecessarily high copper and selenium levels which could cumulatively cause problems in our radiated tortoises. We intend to reduce these levels by changing our vitamin supplement and using a commercially prepared diet similar to the Pure Pride #100, but containing lower copper levels. We are currently looking at the Mazuri Bovine Grazer Maintenance Diet 5651 as a possible replacement.

CONCLUSION

Because there are so many variables involved in raising radiated tortoises with normal shell growth; we find it difficult to point to any one factor such as diet or lighting and assign relative importance in the pyramiding of the scutes. In some instances, siblings raised side by side under identical conditions develop dissimilar shell growth for reasons we cannot explain. What we can say is, the closer our rearing protocol mimics those conditions most likely to be encountered by these tortoises in the wild, the healthier they appear to be.

TABLE 1
Dry matter analysis
Gladys Porter Zoo reptile herbivore diet

% crude protein	10.19
% Crude fat	1.20
% Neutral detergent fiber	27.97
% Acid detergent fiber	9.77
% Crude fiber	2.76
% Ash	7.45
% Calcium	0.84
% Phosphorus	0.46
IU/KG Retinol	5746.00
ppm Carotene	104.98
IU/KG Vitamin E	74.39
IU/KG Vitamin D	1437.00

CALCIUM:PHOSPHORUS = 1.82:1

ANALYSIS
Prepared by Allen and Baer Associates, Inc. Zoo Animal Nutritionists/Silver Spring; MD.

TABLE 2
Prepared diet fed twice weekly

FEED NAME AND PORTION USED	WEIGHT IN GRAMS
5 lbs. Purina Pure Pride #100	2270
12 cups of water	2724
10 lbs. carrots	4540
3 heads of celery	043
2 bananas (peeled)	284
2 heads broccoli	1249
1 orange (peeled)	170
7 apples (with skins)	795
4 tbsp. Vita Plex SeE	40

All items processed in a Hobart Food Chopper to the consistency of softened Grape-Nuts Cereal.

Water is added to Horse Chow to moisten it before chopping.

The Vita Plex SeE is added only once weekly to the prepared diet.

ACKNOWLEDGEMENTS

Special thanks to Mary E. Allen, Ph.D. and Dr. Duane E. Ullrey for their timely assistance with the analysis of our prepared herbivore diet. Gratitude must also be extended to Pat Burchfield and Dr. Tom Alvarado for their endless enthusiasm and support.

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NATURAL HISTORY AND CAPTIVE BREEDING
IN *Paramesotriton deloustali*

by

IVAN REHÁK

ABSTRACT

Paramesotriton deloustali is an extremely rare salamander, known only from its type locality, Tam Dao in North Vietnam. During field research in 1987, the total number of specimens was estimated - only about one hundred specimens. Various data on natural history and variability of *P. deloustali* are given, and problems associated with the protection of the species are discussed. Notes on the type locality and local herpetofauna are added. Apparently, only one captive breeding colony of *P. deloustali* exist. A summary is given of ten years experience with successful breeding of the species, including breeding the captive-born generation.

INTRODUCTION

The salamandrid genus *Paramesotriton* (Chang, 1935) includes six species, *P. chinensis* (Gray, 1859), from the Chinese provinces Chekiang and Anhwei, *P. deloustali* (Bourret), *P. hongkongensis* (Myers & Leviton, 1962), from Hong Kong, *P. (Allomesotriton sensu* Freytag, 1983) *caudopunctatus* (Liu & Hu, 1973), from the Chinese province Kweichow, *P. guangxiensis* (Huang, Tang & Tang, 1983), known only from the type locality and *P. fuzhongensis* (Wen, 1989), from the north-east Guangxi. Of these, more complex data on bionomics and reproduction are available for *P. hongkongensis*. There is either none or incomplete knowledge of the way of the life, the reproduction and the ontogenetic development in *P. chinensis, P. caudopunctatus, P. guangxiensis* and *P. fuzhongensis* (Romer, 1951; Freytag, 1963; Rimp, 1978; Sparreboom, 1981, 1983, 1984; Wen, 1989).

P. deloustali is the biggest form of the genus, and with regard to the geographic distribution it is the southern-most species of tailed amphibians of the eastern hemisphere. It is known only from the species' type locality. Fundamental data on the character of this locality, complemented with ecological and ethological notes, were given by several authors (Bourret, 1934, Freytag & Petzold 1961, Freytag, 1963; Přívora, 1963; Dao van Tien, 1965; Felix, 1975; Jiroušek, 1981; Vít & Těšík, 1981). Adult specimens were found exclusively in water, in calm sites of a mountain

brook in the primeval forest at Tam Dao and in man made basins fed by stream in altitude about 950 m. Freytag and Petzold (1961, 1978), and Freytag (1962, 1963) gave a detailed descriptions of the morphology of adults. No data were published on either eggs, larvae and juveniles of the species from the nature.

The first successful import of living *P. deloustali* to Europe was realized more than twenty years after the discovery of the species. Czech physician Dr. O. Brož imported, after the finishing of his work in Vietnam in 1957-58, the first three living specimens (another seven specimens died during the transport) to Prague. After fifteen years other successful imports of limited numbers of specimens, again to Prague, were realized repeatedly by I. Kubát from the Zoological Garden, Prague. These imports were consequently followed by several other imports of some specimens of *P. deloustali* to Czechoslovakia through naturalists having visited Tam Dao. Unfortunately, most of the imported animals died sooner or later in the collection of Zoo Prague and in some private collections. Several imported specimens were exported to East Germany, west Europe and USA. Observations on the adult *P. deloustali* in captivity were made by Přívora (1963), Felix (1975), Freytag and Petzold (1978), Tuma (1980), Herper (1981) and Jiroušek (1981). However, no successful captive breeding was reported.

This author has received live specimens of *P. deloustali* by courtesy of I. Kubát. During the study of bionomics of the species in captivity he succeeded in reproducing and rearing *P. deloustali* in captivity. Detailed descriptions of individual developmental stages, their bionomics, ontogenetic changes and growth were given in Rehák (1981, 1984, 1986).

During the Prague European Herpetological Meeting in 1985, the possibility of the including *P. deloustali* among species listed in Red Data Book IUCN were evaluated with the authorized specialist IUCN Dr. B. Groombridge. The proposition was accepted, and consequently basic information on the species status in nature and captivity has been delivered. The incomplete image about real abundance of the species in the nature resulted in including of the field-study of wild population of *P. deloustali* in the program of zoological expedition in Vietnam in 1987 in which took part the present author.

In the present paper, knowledge is summarized of methods of captive breeding of *P. deloustali* based on repeated successful breeding of the species during 1980-90, including breeding of captive born generation. Notes are added on natural history of *P. deloustali* based on observations made during field research of the species in Tam Dao.

WILD POPULATIONS

Type locality

As far as is known, *P. deloustali* occurs only on the species' type locality, Tam Dao (northeast of Viet Tri), Vinh Phu province, north Vietnam, altitude about 950 m, montane locality in the complex of large montane primeval forests. Local distribution of *P. deloustali* is associated with man-made basin, approximately 50 m long and 40 m wide, collecting waters from the slopes surrounding basin except its south side, and small stream originating in the basin and following more or less southwestern orientation in accordance with drained montane valley opened to the southwest. The stream has calm sites changing with parts of rapid current. There are several small basins fed by the stream alongside. The stream is interrupted by higher waterfalls after approximately half kilometer. The banks of the upper basin and the stream are mostly covered by dense vegetation, rarely are bare. Bottom of the stream is very heterogenous, including empty places, covers of dense vegetation (especially *Limnophila* sp.): accumulations of old leaves and branches and stony places.

The stream is flowing through a small montane village. Subtropical climate of Tam Dao, much more pleasant that in neighboring lowland, is reason why some effort is done to use Tam Dao as the tourist area. In similar way it was used already by French colonizers. Through Bourret's studies made at Tam Dao, this became the type locality of several species described among local rich herpetofauna by this herpetologist. At the end of November and start of December, we have recorded declining temperatures every day. However, the water temperatures are more constant that air temperatures, e.g. the declining of water temperatures measured at evenings was from 19°C to 14°C in four days, while air temperatures measured at the same time declined from 16°C to 7°C. Local air temperatures fluctuate highly during the day according to momental weather. According to Freytag and Petzold (1961), Dao van Tien (1965), Felix (1975) and Jiroušek (1981) the water temperatures are about 11°C during the cool season, during the summer 21.5°C-24.5°C, winter air temperatures are about 8°C (with a minimum of 1°C), and summer air temperatures rise up to 30°C.

Population abundance and dispersion:

The annual life cycle of *P. deloustali* in nature has not been yet elucidated entirely. On the basis of mosaic field observations complemented by knowledge of life cycle of captive *P. deloustali* it can be stated, that juveniles after the metamorphosis are terrestrial; and adults are amphibiotic with marked tendency to the prolonged period of aquatic life or, apparently especially in

big specimens, to entirely aquatic mode of life. It is supported also by ontogenetic differences in the hind limb structures described by Darevsky and Salomatina (1989). Only on very rare occasions during non-reproductive periods, adults were found several hundreds meters away from the stream. It should be pointed out that Tam Dao is very humid locality. The end of November seems to be period just prior mating season. It could be expected, with regard to apparently annual reproduction of the species, that all adults are present in the water at this time. It allowed to estimate total number of adult *P. deloustali* inhabiting type locality. We use Schnabel's method in three steps during November 27-30, 1987.

The total number of 63 adult specimens was estimated. The 95% confidence limits, determined with regard to binomial distribution of marked individuals, given by small number of all specimens and high proportion of recaptured salamanders, by the Clopper-Pearson graphic method (Holčík & Hensel, 1972), showed the range of 55-123 specimens. Totally, we captured, with extreme effort and good equipment, 52 adults. Of these, seven specimens were collected after finishing the estimation. All specimens were released. The reliability of the estimation could be evaluated by Schnabel's method. In every case, the correlation was good.

Most of the salamanders (34 specimens) were collected in the upper basin. The sex ratio was 2.5 times in favor of males. Individual recaptures of salamanders, released at the places of capturing, showed that adults are very stationary. Only on one occasion the migration of 250 m between the upper basin and the stream was recorded in one male. *P. deloustali*, at least males, are highly territorial. The population dispersion and density is then influenced distinctly by aggressive behavior. Only on rare occasions two males were found at the distance under one meter. However, big differences occur among population densities in individual parts of the stream and basin, apparently according to local conditions. Calm sites with many hiding places are especially favored.

Description of adults

A total of 52 live specimens were examined, Snout-vent length (L), tail length (Lcd), weight (m), coloration and abnormal development of toes has been recorded. Sexual dimorphism is well marked. Compared with females, males are slightly smaller, they have relatively shorter tail and a loaf-shaped cloacal lump. Following measures and weight have been recorded in individual sexes: males (n = 37) - total length (L + Lcd) = 131 (162) 195 mm, s = 16 mm, m = 15 (28) 43 g, s = 7 g, L/Lcd = 1.09 (1.21) 1.57, s = 0.09; females (n = 15) - total length = 157 (186) 216 mm, s = 19 mm,

m = 26 (43) 60 g, s = 13 g, L/Lcd = 0.95 (1.08) 1.18, s= 0.06. Many males had wounded tail tips, apparently by the consequence of aggressive territorial attacks.

Coloration of dorsal side fluctuated from almost black to reddish brown (Figure 1). The ventral side has aposematic coloration - spots in a bright yellowish orange to reddish color on a dark background (Figure 2). Specimens kept in captivity for a prolonged period, about one year or more, display less bright and intensive ventral coloration, The spots are usually large and full, rarely, the ventral side is almost purely orange. This type of coloration was recorded in 36 (97%) males and 11 (73%) females. Ventral coloration of 1 (3%) male and 4 (27%) females was of a slightly different type characterized by larger areas of dark background and smaller spots, frequently with a dark center. All males displayed nuptial coloration characterized by a bright, turquoise, wide stripes running through the middle of the lateral sides of the male's tail.

Eight (21%) males and no females had developed polydactylia and/or syndactylia. For example, it has been recorded syndactylia of 1st and 2nd, 1st, 2nd and 3rd or 3rd and 4th toes of forelimb, and similarly of 1st and 2nd, 2nd and 3rd or 3rd and 4th toes of hindlimb. One specimen had left forelimb with combined polydactylía (5 toes) and syndactylia (of 4th and 5th toes). Other male had left hindlimb with syndactylia of the toes 1st and 2nd, and toes 3rd and 4th. Oligodactylia in the form of only three toes on left hindlimb, accompanied by deformations of development of toes on remaining limbs, has been recorded, too. Anomalous development of toes seems to be a consequence of aggressive attacks and sometimes combat for food. Males with mentioned deformations were collected mostly at one place with the highest observed density of salamanders. Apparently males preferred to inhabit convenient place although with many conspecific competitors than to move to other place.

Food

The content of stomachs was analyzed, using washing out method. In 15 males and 3 females collected Nov 30, results were following: males - no remnants of food (3 sp.), remnants of swallowed exuvia (2 sp.), Odonata - larva (2 sp.), Odonata - larva and small gastropod (1 sp.), small gastropods (1 sp.), no determined remnants of food accompanied with fragments of aquatic plants (4 sp.), no determined remnantS of food; females - Odonata - 4 larvae (1 sp.), no determined remnants (2 sp,). The relative quantity of food in stomachs of males was very low if compared with

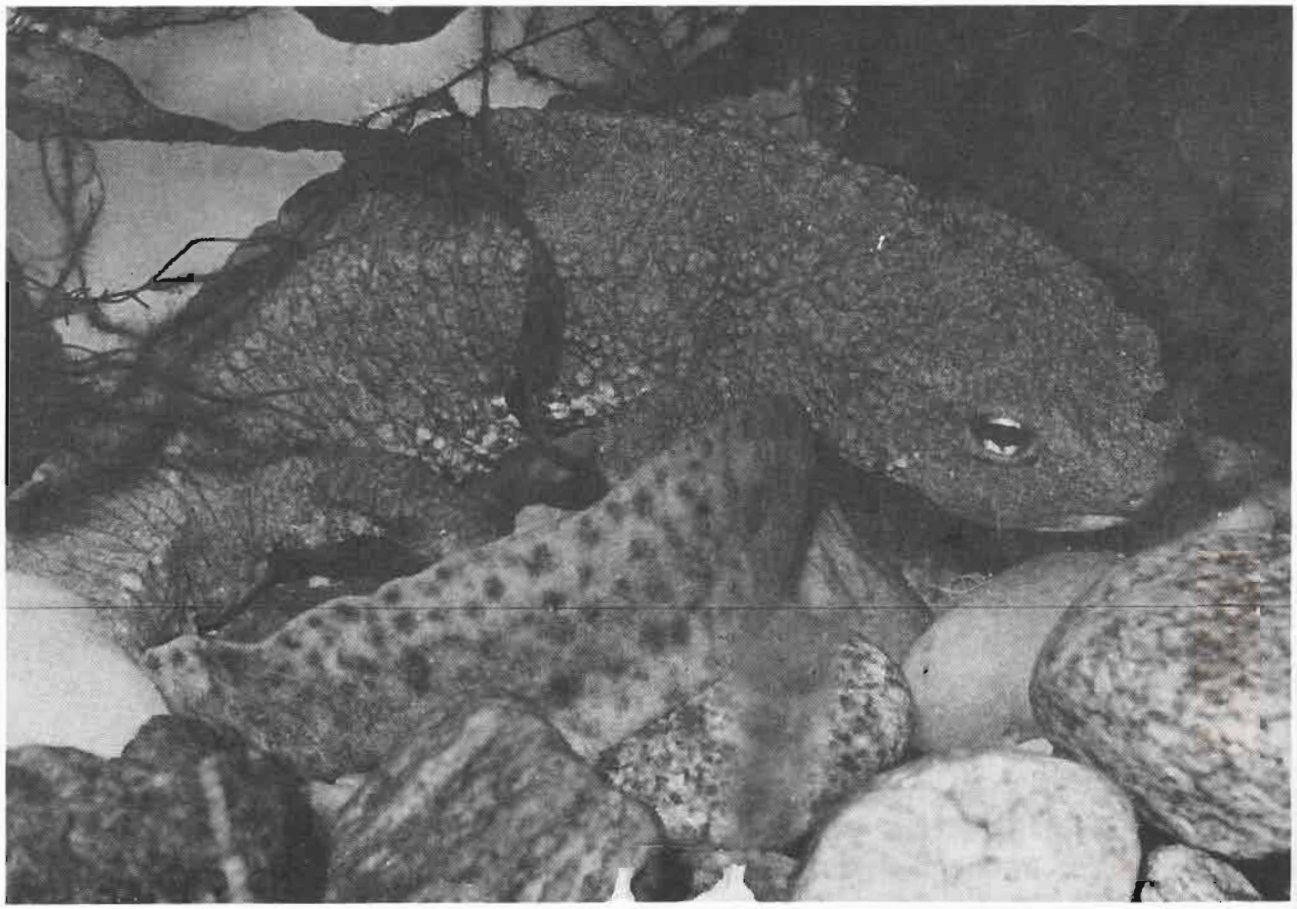

FIGURE 1
Adult female *P. deloustali*

females. Limited uptake of food observed in males is apparently associated with the start of breeding activity. It is supported also by data given by Dao van Tien (1965).

Ethological notes

P. deloustali exhibited night activity. Males were found frequently during the night sitting on higher stones and

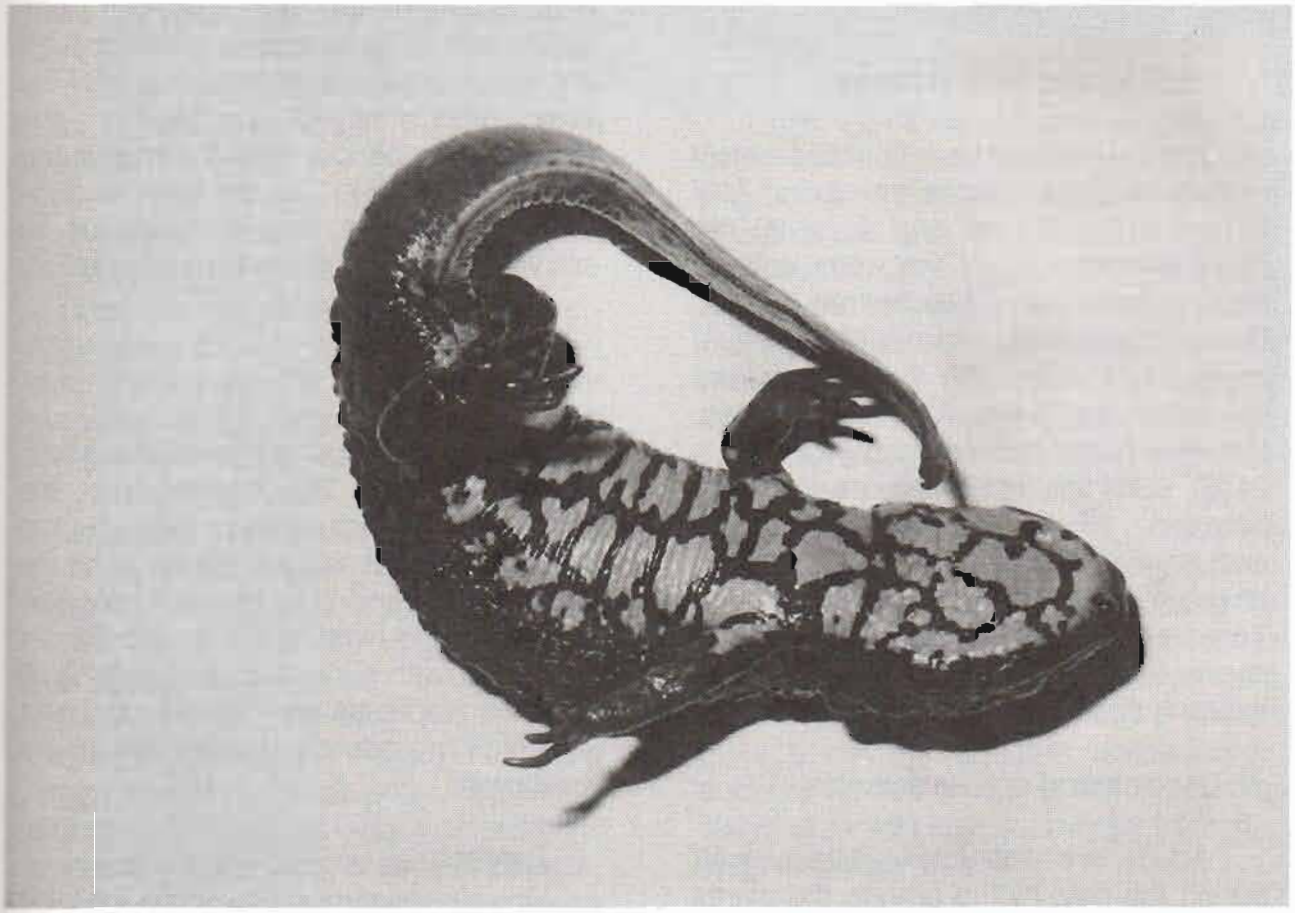

FIGURE 2
Ventral side of adult male *P. deloustali*

guarding their territories. During daytime salamanders escaped usually in hiding places. Sometimes individual specimens were observed apparently basking, in shallow water or on the top of the cover of aquatic vegetation. When disturbed, the animals withdraw rapidly and hide. When handled, salamanders become inert, close their eyes and release a sticky substance smelling of parsley root.

CAPTIVE CARE

Adults

Housing and temperatures

The salamanders are kept separately or in pairs in glass tanks measuring 71 x 24 cm, 51 x 30 cm and 41 x 20 cm respectively height of the water column from 20 to 40 cm. The bottom is bare. Dense stand of fern *Microsorium pteropus*, and broken flower pots are placed in the tanks for hiding places. Summer temperatures range from 20 - 24°C. Winter temperatures fluctuate between 15 - 20°C. Adults are exclusively water-bound. No possibility is given to leave aquatic environment. Tanks are covered by glass. Ventilation is only through minor openings between the tank and glass cover.

Daytime and annual activities

Adults are nocturnal. Mostly inert during the day, hiding among the plants or under the fragments of flower pots. In November, nuptial coloration appears in males. Courtship and oviposition occur in winter, usually at night.

Feeding

Earthworms are given twice a week to the salamanders. They also fed on gastropods (*Planorbis*) which they pulled out of their shells. Salamanders immediately locate the earthworms crawling through the tank, attack them quickly and devour them ravenously. If two salamanders got hold of one earthworm, they started to rotate around the longitudinal axis of the body until the prey was halved. During the reproduction period, both the males and the females stop or at least reduce feeding, and the females continue to starve usually until the end of oviposition.

Molting

The skin, rupturing first on the head, is pushed over the forelimbs to the hindlimbs by squeezing through the water plants and rubbing the body on the bottom. As soon as the skin dangles down from the hindlimbs, the salamander catches it with his mouth and pulls it off over the hindlimbs and the tail. Usually, except of reproduction period, the skin is swallowed.

Defense

When handled or attacked by a rival, the salamanders exhibit a thanatosis as described above.

Courtship

Courtship behavior has been observed in December, January and February. Behavioral repertoire of courtship has number of elements occurring during the courtship of the species of salamandrid genera *Triturus* and *Cynops* (for details see Rehák,

1984). After the courtship period, the male lost quickly its courtship coloration. During the breeding season, the course of mating is stimulated by a decrease in the temperature to 16-18°C from 19-20°C.

Aggressiveness

The sexually active male is extremely aggressive toward other males, rarely against a female. He attacks the intruder by biting his tail, legs and body (Figure 3). Sometimes, the male holds the leg of his rival and both animals become entangled in a ball and remain motionless in this position for a long period. Repeated aggressive attacks can result in rival's death. That is why, a sexually non-receptive female should be separated from sexually active male, because courting without female's response can change into aggressive attacks. The male's aggressiveness is lowered outside the breeding season. Attacks associated with territorial defense continue against other males, females are tolerated.

Oviposition

It occurs from January to April. The eggs are deposited usually singly on the leaves and roots of the fern *Microsorium pteropus*. Female bends the leaves to form a bed for the egg with her hindlimbs. Fertility depends on female's body size. While bigger females deposited up to 256 eggs, smaller ones gave only about 30 eggs per season.

Eggs

Eggs with their mucose sheaths are ovoid and measure from 7-8 x 5-6 mm (Figure 4). Without the sheaths, the egg is spherical and measures 3 mm in diameter. Laid eggs with ferns are collected in intervals of several days, and placed in glass enclosures, similar to that used for adults. The rate of mortality of eggs is low generally not more than 10%. The development of the eggs is completed within 28-48 days at a temperature of about 23°C fluctuating occasionally within the range from 17-27°C (Figure 5). The difference in the span of time which the egg needs to complete its development is dependent on two factors: the temperature (larvae emerge earlier in a higher temperature), and on the fact that the developmental stage at which larvae emerge from the eggs is greatly different.

Larvae

Housing

Larvae are kept in glass tanks, similar to that used for adults (Figure 6). There are about 30 larvae in one tank. Temperatures fluctuate from 20-24°C. In higher water temperatures from 25-30°C, the larvae need longer to complete their development.

FIGURE 3
The male biting the female

Feeding: Larvae are fed *ad libitum* by *Tubifex*, larval *Chaoborus* and *Chironomus*. They feed ravenously.

Bionomics

Larvae are diurnal. Most of the day they hide inert among the plants. From time to time, they creep slowly through

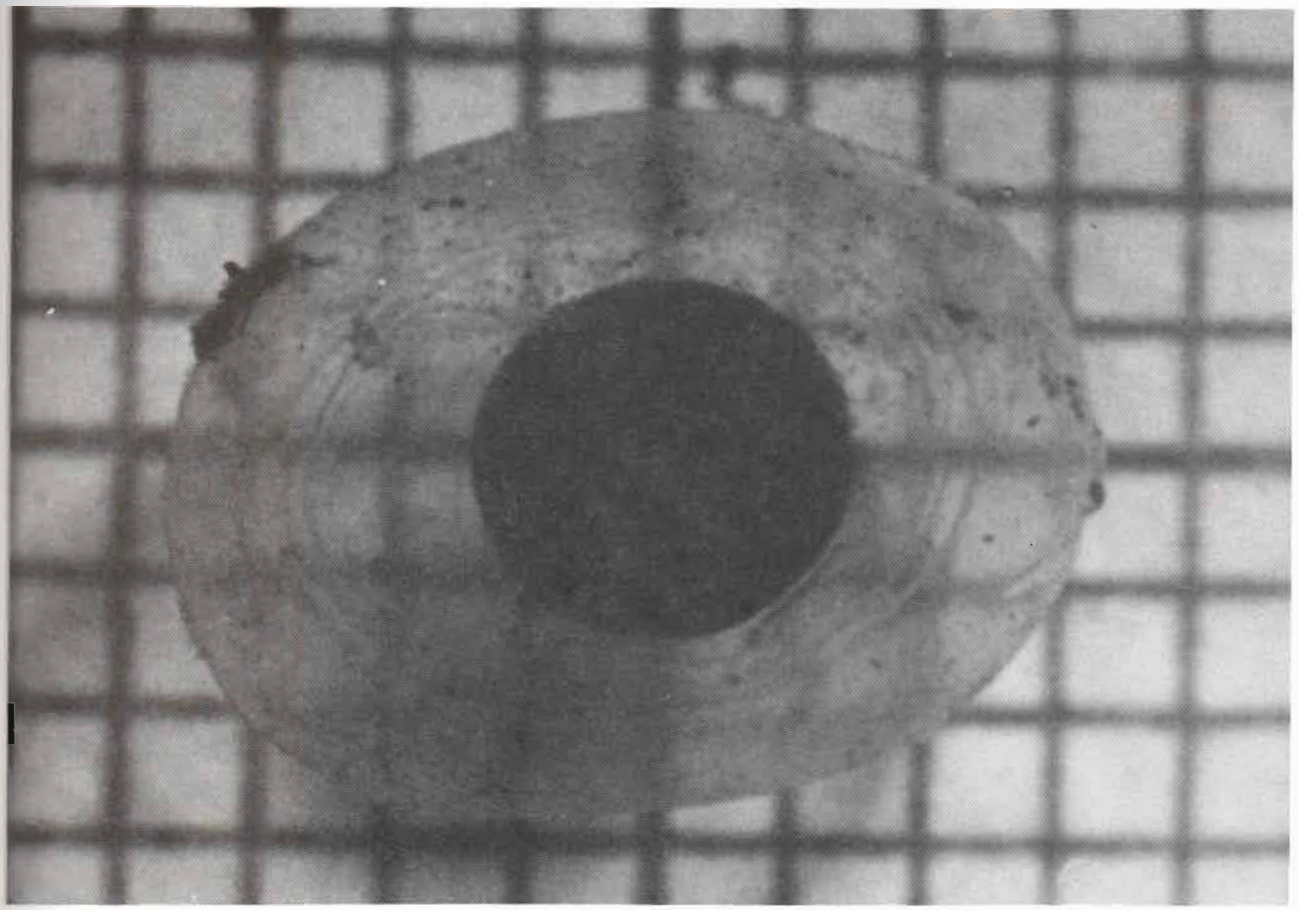

FIGURE 4
The egg immediately after oviposition

the tangle of ferns or along the bottom. They swim exceptionally, mostly when disturbed.

Description and growth

Emerging larvae measure from 12-16 mm, whereby the larvae emerge at a different developmental stage. Larvae have three well-developed pairs of cluster-like gills. The larval body is black. In darkness the black color of larva changes to grayish; in this case small larvae become partly transparent. First light ventral spots appear at the age of two months. For detailed descriptions

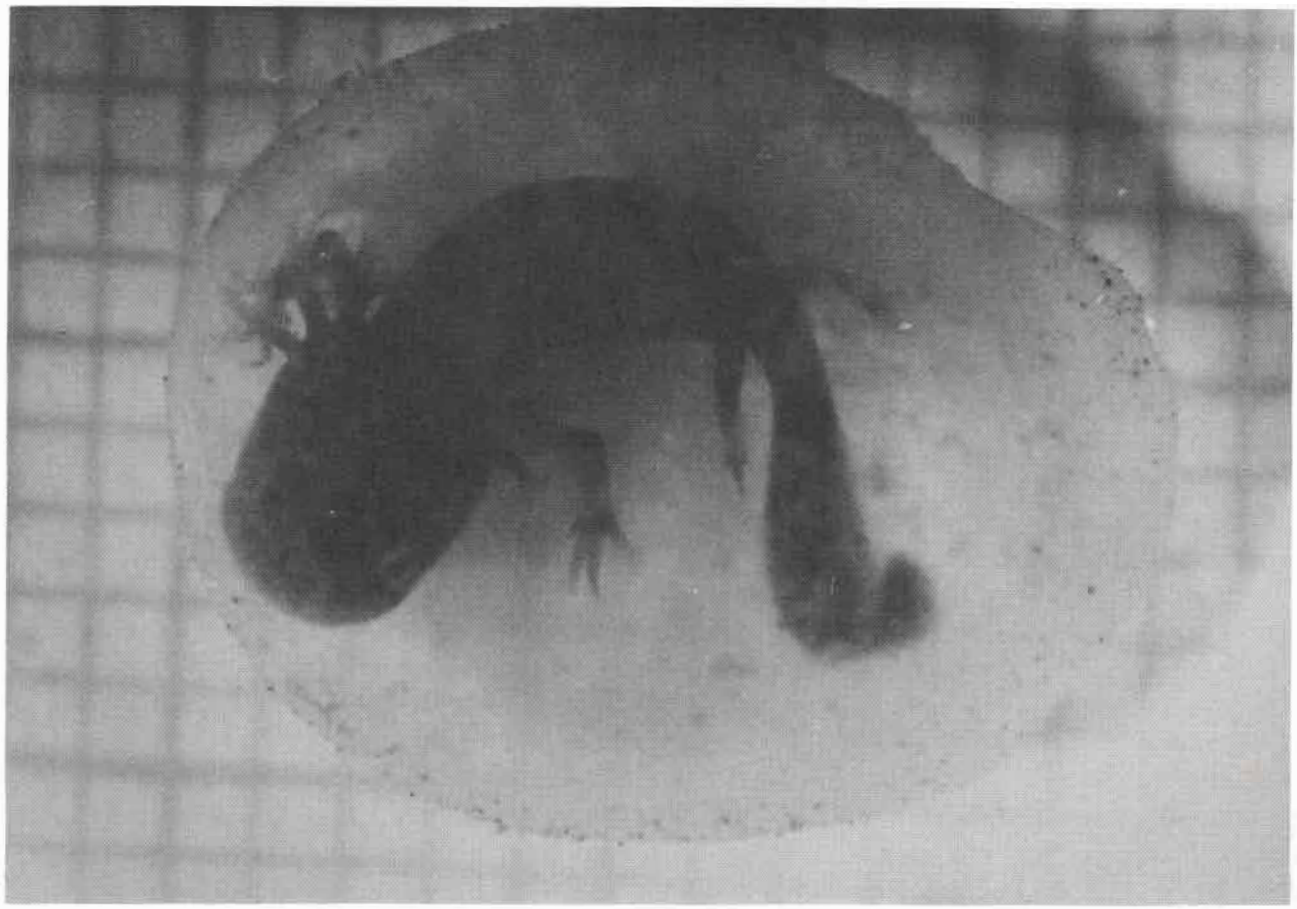

FIGURE 5
The egg 42 days after oviposition

see Rehák (1984, 1986). Metamorphosis starts within 4-12 months of age, at a size of about 50 mm. First, they lose their clusterlike gills, and usually leave the aquatic environment before the loss is complete. In tanks with a reduced water column, larvae start to crawl onto floating slabs of polystyrene. The viability of larvae is considerably high during their development, and mortality is practically nil. However, the period of metamorphosis is critical. Up to half of specimens can die through high mortality during the metamorphosis and immediately upon leaving the water.

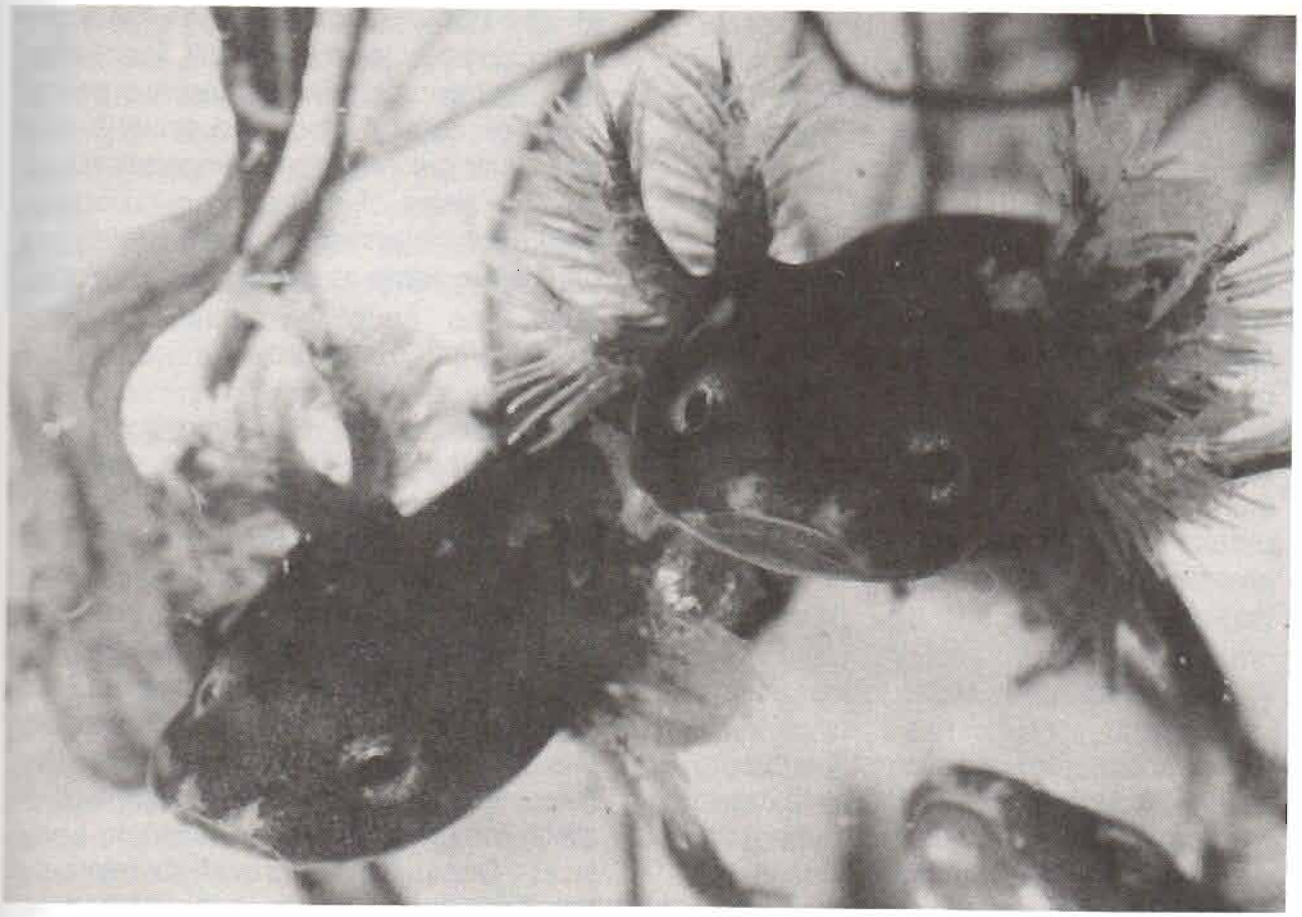

FIGURE 6
The larvae, three months old

Juveniles

Housing

Land-bound juveniles are kept in glass tanks, arranged as paludarium, on a peat substrate intermixed with bits of bark, with a dense stand of various mesophilous plants (e.g. *Scindapsus, Tradescantia*). A dish filled with water is added to each tank, and a high humidity is retained in order to give the substrate a marshy character. Winter temperature range from 18-20°C, summer temperature from 20-25°C.

Feeding

The food consists first of *Tubifex* and *Enchytraeus*, later of small earthworms. Some juveniles do not start to eat a prolonged period after the metamorphosis, and they have to be force fed as long as necessary. Some juveniles refuse to catch prey during the day, but they eat well at night. Generally, by contrast to adults and larvae, the uptake of food on the part of juveniles is problematic. To avoid mortality through starvation, it is necessary to control the uptake of food individually in each juvenile. No feeding problems occur in larger juveniles.

Bionomics

Juveniles are nocturnal, creeping slowly through the tank and climbing in tangles of plants, and sleep during the day, hiding either under bark or in the plants. The first ecdysis starts soon after the metamorphosis. Molting is similar as described above in adults, realized on the land or in the water. Handled juveniles exhibit the thanatosis. No social interactions, except combats for food, when prey is accepted at once by two juveniles, have been observed among juveniles. Growing juveniles became continually more and more aquatic and enter the water frequently, remaining there often for several days. At this time, they should be kept in enclosures with larger aquatic areas. Juveniles start to return to the water for prolonged period at a body length of 90-100 mm approximately one and half year after their metamorphosis. During this period juveniles can be placed to aquaria with low water column, dense vegetation and floating slabs of polystyrene. Usually, they became entirely aquatic. Following care is the same as described for adults.

Description and growth

Soon after the metamorphosis, the body of the juvenile is plump, the skin relatively smooth. At the age of one to two months, the dorso-lateral and the dorsal ridges gain in prominence, the skin coarsens and becomes verrucose on the dorsal side, ventral area occupied by the yellowish spots increases, and the juvenile starts to resemble the adult. Juveniles immediately after the metamorphosis do not increase in size or there may even be a reduction in body size. Generally the growth is relatively constant in juveniles. In individual, specimens, great irregularities in growth can occur. In average, juveniles measure about 70 mm at the age of one year, and about 110 mm at the age of four years. The biggest juveniles measure about 150 mm at this age (for details see Rehak, 1984, 1986).

At the age of four years, and at a length above 120 mm, sexual dimorphism starts to be similar to the adults. However, full sexual maturity is attained later. Salamanders of the captive born generations reproduced for

the first in their sixth or seventh year of life, and at a length of 125-140 mm. The age in which the maturity is attained, seems to correlate more with individual development of specimen than with the sex. The growth of young mature salamanders continues relatively quickly and becomes very slow when usual adult size is attained. Young and small females were observed to be very weak after their first reproduction, and some of them died some time after successful oviposition. To avoid the damage of female's health or her death it is recommended that she not be allowed to reproduce until a bigger size is attained. Mortality of bigger juveniles is minimal. Adults have a considerable viability. They can die especially through overheating of their enclosure (e.g. by exposition to sunlight and in the consequence of uncontrolled aggressive encounters. Potential longevity can be estimated to be considerably high. A male, collected in nature as adult, died through unhappy reason after 12 years. He was sexually active and fertile. His real age can be estimated at least about 20 years.

DISCUSSION

There are no confirmed records on the distribution of *P. deloustali* outside of species' type locality. If future faunistical research will discover another locality of paramesotritons in north Vietnam, it should be verified whether they are not a new species what is probable for relict salamandrid populations inhabiting the southern borders of the family distribution. In the case that *P. deloustali* lives really only at the type locality, this species is among the rarest of the world's amphibians.

Estimated number of adults is extremely low. Moreover, the sex ratio is considerably in favor of males. Species biotic potential depends highly on prolonged longevity of adults. New born generations needs a long period to attain maturity.

The survival of the species is associated with the existence of very short water system of a single stream. The impact of native village to the locality has not been very dangerous. Traditional mode of life of natives wastes the stream minimally. However, elements of the "modern life" could represent potential danger. Natives know *P. deloustali* well: and call him Cá Cóc (fish-frog). Perhaps they used occasionally some specimens for the purposes of traditional medicine. In last years Tam Dao has been included to tourist routes of some groups of foreign visitors of Vietnam. Unfortunately, some persons are interested in receiving wild *P. deloustali*, and mostly buy them from native collectors. The negative influence of such foreign visitors is growing at present, in parallel with their growing number and inconsideration. If this practice is not stopped, it can be expected detrimental effect on the

survival of *P. deloustali*.

No information is available on the appearance of the locality before it has been changed by man. Although it is apparent that density of adults is limited by their aggressiveness, it is not possible to estimate well balanced natural abundance of the species under given ecological conditions. In every case, the building of new basins in Tam Dao valley could be advantageous for the controlled protection of *P. deloustali* in the future.

Captive care, following methods described above, can result in successful captive breeding of *P. deloustali*. It is associated with some problems, especially very slow growth and development of juveniles and larvae until the maturity is attained. At present apparently only one captive breeding nucleus of *P. deloustali* exist. With regard to the critical situation of single known wild population wider interests in captive breeding of the species, using captive born or already captured specimens, could be an important part of the effort to save *P. deloustali* the future.

ACKNOWLEDGEMENTS

My thanks are due to my mother for the long-time help with captive *P. deloustali*, and to Dr. J. Horavec and Dr. F. Poier for their field assistance.

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HUSBANDRY OF CAPTIVE CAECILIANS

by

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ABSTRACT

This paper deals with the care and maintenance of two species of caecilians, the yellow-striped caecilian and the Brazilian siphonops. Included are notes of observations, cage requirements, lighting, heating, feeding and feeding times, as well as notes on the "typical caecilian day". In short, this paper was written to aid the keeper in an area where little knowledge is to be found, and to help provide information on these little-studied amphibians.

INTRODUCTION

In 1735, Seba wrote of and described a new species of snake. In 1754, Linnaeus wrote of this new family in his classifications. Then, in 1811, caecilians were correctly classified as amphibians, though there weere still some who believed the order Gymnophiona to be reptile. In 1908, however, its classification came to rest where it is today, a separate family of amphibia known as Caeciliidae.

Caecilians can best be described as legless amphibians with long, cylindrical bodies ranging in length from anywhere between seven inches and four feet. Presumably, there are 75 existing species and all live in the warmer tropics, Mexico south to northern Argentina, southern Asia eastward toward the coast, and in the Seychelles as well as several isolated regions of Africa.

A caecilian's skin is smooth and slimy but the major dermatological difference between it and other amphibians is the presence of tiny, nearly invisible scales. The eyes are small and located toward the sides of the head. Usually,m they are covered by skin, rendering them useless.

The next physiological difference is one of the great mysteries of the Gymnophiona order. Located just below the eye sockets and running to the tip of the snout is a "tract". This tract is lubricated by a mucous type liquid, which allows for the protrusion of a tentacle. There has been some speculation as to its function and all seem to have valid proof. The tentaclke is protruded and recalled while it meanders its burrow, and can be seen when the animal surfvaces atop the peat moss. Sopme have raised the point of its aid of the sense of touch. However, it also protrudes when the

animal senses food and, this is what the caecilian hunts by, smell. More than once I have seen a *Siphonops* chase an earthworm to the bottom of its cage, and the worm is definitely out of tentacle range. With the caecilian far behind but still on its trail and the earthworm at the bottom of the swampy mess, it would seem more likely that the tentacle s\has a more smell-oriented purpose than one of touch.

Keeping the burrowing form of the caecilian is not difficult at all if the animal is comfortable and warm. The aquatic forms do not follow this suit, and this work does not involve them, as one was impossible to acquire.

CAGE REQUIREMENTS

Because acquiring a caecilian is hard enough, the animals are kept isolated from each other, one to a cage, including same species. This eliminates the possibility of spread of disease and the like.

The cage that has been used for animals under a foot in length is an 8.5 x 15 clear, plastic shoebox. It has many advantages over other types of cages in that it is light, plastic and therefore easily washable, and its lid can be drilled to allow for air. Lrger cages of this type are available for larger specimens.

The major disadvantage of a cage of this type is its height. Due to caecilians burrowing nature, it needs at least 3-4 inches of peat to burrow in. The cage can hold that amount, it's just that the animal has only one inch of space to move in when it surfaces.

Another type of cage is higher (6.5"), but shorter (6"), and the top is made of plastic which has been molded with a space on top of the lid and slits all about its sides. Except for the fact that it is two inches shorter, this cahge works perfectly.

The next important note in this section is the substrate. Since these are burrowing animals, the medium must be easy for the animal to move through. Loose top or potting soil would work when moistened, but since it must constantyly be damp, it would become mud, which would be somewhat unattractive and annoying to clean. A preferable method would be the use of peat or sphagnum moss. Of all the substrates, sphagnum works best.

The medium should be dampened and placed abouth the cage so that there are no bare spots. It should be at least four inches deep and the bottom 1.5 inches should be entirely submerged. The moss must be wet at all times and be changed at least once a week, for the water becomes acidic when expesed to the moss.

Heat is also an imporatant factor in

keeping caecilians. As no amphibian should be kept in direct sunlight, the possibility of natural heating is almost non-existent. The heater used by tropical fish hobbyists can be used. If the heater is polaced under the soil nearly horizontally, the medium and the animal will be kept warm. When this method is used, teh water level must be slightly raised to accomodate teh glass covering of the heater. If the heater is left exposed, the glass will crack.

FEEDING

The staple for any caecilian (aquatic forms excluded) is earthworms. The caecilian can and will attack any size earthworm and no matter how much of a struggle occurs, the mighty caecilian will twist and writhe and keep a grip on its porey. The caecilian is equipped with small, sharp teeth that latch onto the worm and prevent it from writhing away. Three large earthworms a week, one every other day, will keep a specimen active and healthy.

After this fact, not much is known about their eating habits, It has been said that some will eat termites, but this can be risky to the owner if the caecilian doesn't eat them or the insect's housing isn't escape proof.

The best way to find out what a certain animal will take is by trial and error. By holding a minnow in a pair of forceps and dangling it before the caecilian, it was found that they would be accepted as food. This allowed for two things. First was variety in that he might make up for missing, but necessary vitamins, and second, the minnows were much easier to acquire in the winter than earthworms.

On one occasion, I had a leftover pinkie mouse that a hatchling corn snake refused and, on a whim, I tried it on a Brazilian *Siphonops*. Surprisingly, he accepted it and ate it quite greedily. The sad thing about it was that no one believed me. However, mine eyes have seen the truth.

Caecilians are by far, one of the easiest herps to care for and are not at all demanding. Cage requirements are simple, feeding is clean and not at all time consuming, and caecilians are not all too common so they make for excellent conversation. The most difficult step in this procedure is the caecilian's acquisition.

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HERPETOLOGY AND HERPETOCULTURE IN CZECHOSLOVAKIA

by

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ABSTRACT

An overview of the history and the present of herpetology and herpetoculture in Czeckoslovakia is given. Notes on herpetology and herpetoculture in other "eastern countries" are added. Herpetology in Czech countries and Slovakia developed originally within the framework of herpetology in the Austro-Hungarian Empire. First herpetological studies uritten by Czech authors dealing with the native herpetofauna, appeared two hundreds years ago. Herpetoculture has relatively long tradition in Czechoslovakia. The first organization of the herpetoculturists (together with aquarium keepers) was started in 1899. In 1910, the first Czech journal dealing with captive keeping and breeding of amphibians, reptiles and tropical fishes was started. The herpetoculture in Czechoslovakia is explosively developing at present, and is demonstrated with relatively big and quickly growing number of herptile keepers and breeders, and more and more frequent breeding successes, especially in private collections. Relatively frequent in Czechoslovak collections are herps originating from Vietnam, Balkans, Cuba, Soviet Union, and other countries. Successful breedings cover a number species of amphibians, snakes, lizards, some chelonians and crocodiles.

INTRODUCTION

During the period before the independence of Czechoslovakia, herpetology in Czech countries and Slovakia developed originally at the frame of herpetology of the ancient Austrian, resp. Austrian-Hungarian monarchy. The first herpetological studies written by native authors has appeared among studies published by The Royal Czech Society of Sciences at Prague. Descriptions of *Coluber bohemicus* (*Natrix natrix*) by Schmidt (1788) and *Coluber hydrophilus* (*Natrix tessellata*) by Lindacker (1791), and first scientific lists of Bohemian herpetofauna (Lindacker, 1790; Schmidt, 1795). Following scientific list of Bohemian herpetofauna has been published by Glückselig (1851). The issue of Presl's (1821) Czech zoological nomenclature was of the great importance for the formal herpetological terminology and expression in the Czech language. Many Czech names proposed by Presl for both, native and exotic

herpetofauna, has been accepted, and they are functional until the present time. Public, not scientific names of amphibians and reptiles existed only before the Presl's terminological effort in Czech language. Descriptions of all known species of native herpetofauna were published by Prach (1861).

During the following period, prominent naturalist A. Frič was author of herpetological studies, including those based on the comparative anatomy. In 1872 he published a new list of Czech herpetofauna. He has drawn attention to the fossil species. His major paleoherpetological study (1883-1901), based on rich Bohemian fossil fauna of stegocephals from fossiliferous coal, has been of great importance for the world paleobatrachology. He described a number of fossil amphibians, e.g. Dolichosoma, Keraterpeton, Microbrachis. Other paleoherpetological studies were written by another authors, e.g. Reuss (1855), Počta (1905). The most famous Czech herpetologist of his times, F. Bayer developed Czech herpetology by number of studies, dealing with anatomy and organogenesis of amphibians and reptiles, with paleoherpetology, and moreover he completed Czech herpetological nomenclature (1880, 1894). An overview of the zoogeography of reptiles and amphibians was given in, several studies by Palacký (1890) and Thon (1907). Pražák (1898) was the author of doubtful list of Czech herpetofauna. This study was critized as the mystification later (Štěpánek, 1949). Histology and anatomy of amphibians and reptiles were studied by physician Schoebel (1882). Physiologist E. Babák (1905) dealt with physiology of amphibians and reptiles.

A faunistical research in Moravia and Silesia was developed by number of authors, (Smyčka, 1899; Laus, 1902). Notes on herpetofauna of Czechoslovak territory appeared in studies by Jeitteles (1862), Moisisovics (1888), Kammerer (1899), Wolterstorff (1890, 1907), Werner (1897), Bolkay (1907), Féjérváry-Langh (1917) and others.

After the establishment of independent Czechoslovakia various herpetological studies - anatomy, descriptions, sexual behaviour, zoogeography were published by private herpetologist R. M. Boušek (1923, 1928). In 1934 he summarizied knowledge on the history of herpetology in Czech countries. In his private herpetological laboratory over 2,000 micro- and macropreparats, the collection of original aquarels of exotic herpetofauna, and maps of the world distribution of amphibians and reptiles were accumulated. Unfortunatelly, only a small part of Boušek's collections have been saved for the town museum in Tabor after his death. Moreover, Boušek was publisher herpetological journal "Herpetologica". Distribution of native herpetofauna in Bohemia, Moravia, Silesia, Slovabia and Transcarpathian

Ukraine was studied intensively (Frankenberger, 1920,; Zbořil, 1920; Adolph, 1921, 1922; Záleský, 1922a, 1922b, 1925a, 1925b). New stegocephals have been described by Stehlík (1924).

During the following period the development of Czechoslovak herpetology influenced especially O. Štěpánek, herpetologist of National Museum at Prague. He was author of number of special studies dealing with herpetofauna of Central Europe and Balkans (1937, 1938), and of the monograph on amphibians and reptiles of Czech countries (1949). After World War II, prominent Slovak herpetologist J. Lác started to study intensively Slovak herpetofauna (1956, 1957, 1959, 1967, 1969, 1970). He also published a monograph on Slovak herpetofauna (1968). The development of native paleo-herpetology continued especially in extensive studies made by Špinar (1951, 1972). Z. Burian, painter closely cooperating with paleontologists J. Augusta and Z. Špinar, was author of a number of reconstructions of fossil animals, including a number of amphibians and reptiles, which became world known. His illustrations appeared in number of books, (1984). The key for determination of Czechoslovak amphibians and reptiles was published by Hrabé et al. (1973). Opatrný (1978, 1979) summarizied results of questionnary action taking aim at distribution of Czechoslovak herpetofauna. Detailed summary of recent knowledge on native herpetofauna will be given in two volumes of the edition Fauna of Czechoslovakia - *Amphibians* and *Reptiles* (Baruš et Oliva, eds.), being in press now. Snake venoms are Studied by Kornalik (1967).

Now herpetology belongs to the relatively quickly developing branches of vertebratology in Czechoslovakia, but it is represented by a very few professionals only if compared with ichthyology, theriology and ornithology. On the other hand, number of amateur herpetologists exist in Czechoslovakia. Herpetological section of Czechoslovak Zoological Society of Czechoslovak Academy of Sciences was based for the better coordination of herpetological activities in the country in 1973. Herpetological master school thesis appear regularly at present. The European Herpetological meeting, Prague, 1985 has influenced positively herpetology in Czechoslovakia.

At present the occurence of 19 native amphibian species (plus 1 hybridogenetic klepton) and 12 reptile species are known from Czechoslovakia. Most of them are protected by Czech and Slovak laws of 1965. New laws, covering practically all native herpetofauna, are just prior to acceptance. Specialized organisations for the protection of native herpetofauna exist at the frames of both, Czech and Slovak, national organizations for nature protection.

Herpetoculture in Czechoslovakia

The fact is of interest that the cult of snake - household- god existed among ancient Slavik people, in some areas of Czechoslovakia. Snakes, naturally acumulated around the buildings due to many hiding-places, source of food, rodents, dunghills with the micro-climate of great importance, especially for the favorite species for the function of household-god, the Aesculapian Snake, *Elaphe longissima*, living here on the northern border of the species distribution, and using dunghills for the incubation of eggs and overwintering, were considered protectors of the building and family. They were offered ritually with meals and drinks.

The captive keeping and breeding of amphibians and reptiles has a long time lasting tradition in Czechoslovakia, The development of captive care about both native and exotic, herptiles started already in last century. Primarily, it was associated with scientific work of some zoologist, and with professional interests of some naturalists, frequently especially among teachers of natural history. However, captive keeping of herptiles became quickly accepted also by hobbyists, especially at greater cities. Herpetoculture was traditionally associated with the activities of aquarium hobbyists. In 1899, the first "Society of Friends of Aquaria and Terraria" was based at Prague. It consisted of both amateurs and professionals. Among them, E. Babak was prominent, and he established a journal "Akvaristicky obzor" (Aquarist horizon). He directed the journal, together with B. Žežula, in the period 1910-1914. Number of papers dealing with captive keeping and breedins of herptiles (e.g. *Chalcides ocellatus*) was published in it.

In 1921, after the interruption caused by the 1st World War, another journal, "Akvaristické listy" (Aquarisstic leafs) followed mentioned traditions. This journal, directed by Babák's assistant 0. V. Hykeš, was issued until the year 1952. The journal fell in the consequence of some changes in laws, including statut of publisher. However, in 1958 the new journal "Akvárium terárium" has been established under the guidance of O. Oliva. It was issued originally once in two months, now it is issued monthly. A number of articles by Czechoslovak herpetoculturists are regularly published in the journal. Similar papers appear occasionally in other journals of Czechoslovak naturalists, especially "Živa".

Herpetoculture has also found a place in several book publications (Král & Olexa, 1969; Štraub & Neidl, 1971; Vergner & Vergnerová, 1986). Especially, Z. Vogel drew attention to exotic herptiles by his books (1967, 1973). Moreover, he influenced the development of modern native herpetoculture by imports of many exotic herptiles.

Captive breeding of amphibians and reptiles is developing extraordinally quickly in Czechoslovabia at present. It is true for herptile collections of zoological gardens and some similar organizations but especially for private collections. The number of herpetoculturists is relatively high in Czechoslovakia, and it is increasing rapidly at present. Many of them are members of organizations, with long-lasting traditions of annual meetings. The level of captive care on herptiles in private collections can be illustrated by the number of breeding succeses in recent years, e.g. *Kaloula pulchra, Osteopilus septentrionalis, Peltaphryne peltocephalus, Agrionemys horsfieldi, Chelydra serpentina, Geomyda spengleri, Ocadia sinensis, Crocodylus niloticus, Caiman crocodilus, Eublepharus macularis, Hemitheconyx caudicinctus, Paroedura picta, Phelsuma madagascariensis, Rhacodactylus auriculatus, Teratoscincus scincus, "Agama" caucasia, "A." lehmanni, Amphibolurus vitticeps, Uromastix acanthinurus, Chamaeleo calyptratus, C. chameleon, Anolis bartschi, A. vermicularis, Basiliscus plumifrons, Chamaellis barbatus, Cyclura nubila, Iguana iguana, Sceloporus poinsetti, Cordylus warreni, Egernia depressa, Eumeces schneideri, Tiliqua gigas, Acrantophis dumerili, Charina bottae, Corallus enydris, Epicrates angulifer, E. chrysogaster, E. inornatus, E. striatus, Eunectes notaeus, Eryx jaculus, E. milliaris, Chondropython viridis, Liasis childreni, Morelia spilota, python regius, Tropidophis melanurus, Hydrodynastes gigas, Elaphe bimaculata, E. climacophora, E. dione, E. helena, E. situla, E. subocularis, Gonyosoma oxycephalum, Heterodon nasicus, Lampropeltis triangulum, L. mexicana, Spalerosophis diadema, Bioga dendrophila, Bitis arietans, Bothrops atrox, Crotalus durissus, Trimeresurus albolabris, T. monticola, Vipera kasnakowi, V. lebetina*. Species such as *Paramesotriton deloustali* and *Tropidophis feicki* apparently has not been bred outside Czechoslovakia. Among interesting captive breeding successes, reached in zoo collections, belong breeding of *Osteolaemus tetraspis* at Zoo Jihlava, *Varanus bengalensis* at Zoo Dvur Kralove, and several generatons of *Naja naja* at Zoo Prague.

The herpetoculture, if compared among former "communist countries" is most developed in Czechoslovakia and East Germany. The herpetoculture in Hungary, Poland and Soviet Union is less developed with regard to relative abundance of herpetoculturists, contents of collections and captive breedings. However, the top keepers and zoological gardens can show some excellent results and quality collections. The captive breeding and keeping of herptiles by hobbyists does not exist practically in remaining "communist countries". However, a crocodile farming under seminatural conditions exist in Cuba (*Crocodylus rhombifer, C. acutus*) and in

Vietnam (*Crocodylus porosus, C. siamensis*). The snake farming is traditionally developed in Vietnam (*Python molurus, P. reticulatus, Bungarus fasciatus, Naja naja, Ophiophagus hannah*), including house-keeping, for the economic purposes (food, medicine, skins). Several toxin producting snake farms occur in Soviet Union.

The rich herpetofauna of Balkans, Cuba, Soviet Union and Vietnam has been traditionally important source of exotic herptiles for captive collections in Czechoslovakia. Czechoslovakia, Cuba and Vietnam are not members of CITES. The flow of exotic herptiles has been rather limited from the "west countries" to Czechoslovakia. A growing interest of Czechoslovak herpetoculturists about cooperation with the "west" herpetoculturists can be expected at present. In parallel, some legislative changes influencing similar cooperation are prepared, to avoid a negative impact on the protection of herpetofauna.

ACKNOWLEDGEMENTS

My thanks are due to Prof. Dr. Ota Oliva, C.Sc. for the information about history associated with journal "Akvárium terárium" and previous journals dealing with herpetoculture.

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OCULAR DISEASE IN CAPTIVE REPTILES AND AMPHIBIANS

by

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ABSTRACT

Diseases of the eyes of reptiles and amphibians are frequently seen in veterinary practice. Although many of the ocular diseases are similar to those occurring in domestic species, variations in ocular anatomy as well as the predisposition of these animals to systemic diseases rarely seen in mamnals results in several unique ocular conditions. These will be presented and their management through improved husbandry practices and specific therapy will be discussed.

INTRODUCTION

The anatomy of the eye in the lower vertebrate classes shows considerable evolutionary diversity. This is especially true in reptiles where differences are seen in gross structure in all five orders. The saurian eye is considered the most typically reptilian, although much variation is found even among living species in ocular structure and histology.(Walls, 1942; Duke & Elder, 1958)

Most reptiles have well developed eyelids except certain lizards (geckos) and all snakes. Most species have a third eyelid. Crocodilians have a well-developed bony plate in the upper lid, which makes it difficult to open the crocodilian lids to examine the eye. The lids of chameleons are constricted around the cornea to provide a small circular aperature for the eyes, which are treh most mobile of all reptiles. Some lacertid, teiid lizards and skinks have a transparent window in the lower lid to allow the animal to see with the eyelids closed, an adaptation to burrowing in sandy environments, or as a filter against bright sunlight. The extreme situation is found in geckos and snakes, in that the upper and lower eyelids are fused to form the spectacle, separated from the cornea by a subspectacular space. The spectacle, although transparent like the cornea, does contain very fine blood vessels. The anterior layers of the spectacle are shed with the skin at each normal ecdysis in snakes and lizards with spectacles. The spectacle becomes a cloudy or blue color due to thickening of and breakdown of some of the skin

layers with accumulation of a fluid lubricating layer between the old outer and new inner layers of skin during the shedding cycle. The spectacle becomes transparent again immediately before the skin is shed (Maderson, 1965; Jacobson, 1977). The spectacle is largely impervious to medications which can hinder treatment of diseases affecting the eyeball.

The lacrimal glands vary in size in different species, and are especially large in chelonians. In marine chelonians they function as organs for salt-secretion. The nasolacrimal duct in species which possess one (chelonians lack this duct) drains from the conjunctival sac or subspectacular space to the roof of the mouth near the base of the vomeronasal (Jacobson's) organ.

The eyeball is similar in structure to that of mammals, although the outer fibrous coat contains variable amounts of cartilage. The muscles of the iris are voluntary or skeletal in type, unlike the involuntary smooth muscle in mammals. Drugs which affect the iris sphincter muscle in mammals, therefore have no effect on the reptile eye. It is therefore, more difficult to dilate the pupil to examine the posterior parts of the eye in reptiles.

The retina of the eye in crocodilians has a modification of its outer layer which gives the highly reflective eye-shine seen in these species when caught in a flashlight beam at night. Congenital abnormalities (by definition present at birth) are relatively common in captive bred animals. The eye may be smaller than usual or completely absent. In severe cases the entire head may be abnormally developed with only one eye developed in the central portion of the head (cyclopia) (Millichamp et al., 1983).

Skin diseases often involve the eyelids in reptiles. These include herpesvirus infection (gray-patch disease) in mariculture-raised green-sea turtles (Rebell et al., 1975), and a pox-like virus in caimen (Jacobson et al., 1979). The latter often occurs in recently imported and stressed animals. Fungal infections of the skin may involve the spectacle in snakes. If untreated fungal infections may result in loss of the eye (Zwart et al., 1973). Bacterial infections of the orbit may result in massive distension of the eyelids in lizards. The inspissated nature of pus involved in many such lesions renders therapy difficult.

The spectacle in snakes may be retained during shedding. This usually occurs in dehydrated or debilitated animals or those kept in very dry conditions. Several layers of the spectacle can be retained at subsequent ecdyses. Infestation with mites appears to predispose snakes to this problem. Although the retained spectacles can be removed carefully with forceps, it is equally reasonable to leave the spectacle until the next shedding cycle, correct

cage humidity, and treat the snake for any ectoparasites. Often the spectacle will be easier to remove at that time. Application of olive oil to the spectacle before shedding may help soften retained layers and aid shedding.

The subspectacular space is a common site of infection and abscessation in snakes and geckos. Infections may reach this site by retrograde extension along the nasolacrimal duct from necrotic stomatitis in the mouth, traumatic perforation of the spectacle or systemic infections. Bacterial isolates may include *Pseudomonas spp.* and other Gram-negative organisms. In many cases of necrotic stomatitis, the opening of the lacrimal duct becomes plugged by exudate in the mouth. Tear secretions accumulate and distend the spectacle. Debridement of the crusted material in the roof of the mouth may be sufficient to unblock the duct. If the problem is untreated, the bacterial infection will eventually ascend to the sub-spectacular space (Millichamp et al., 1983; Miller, 1986). Infections of the subspectacular space are treated by excising a portion of the spectacle to drain the abscess, and after culturing the discharge, using appIropriate topical and systemic antibacterial agents.

Conjunctivitis and blepharitis (inflammation respectively of the conjunctiva and eyelids) may accompany septicemia in lizards, bacterial respiratory system infections (for instance pasteurellosis in desert tortoises) or be associated with deficiencies of vitamin A in the diet. This may be seen as a problem in chelonians emerging from hibernation with ocular discharge as the presenting sign. Topical application of antibiotics, increased temperatures and resumed feeding, supplemented with vitamin preparations is usua.lly sufficient to control the ocular problem. Vitamin A deficiency is often seen in aquatic turtles fed an all meat or insect diet. Affected animals have swollen eyelids and discharge from the eyes. Gradually the affected animals refuse food and eventually succumb to to effects of the deficiency on internal organ systems or infections (Elkan & Zwart, 1967). Parenteral administration of vitamin A, and improvement of the diet, with supplementation with cod-liver oil, will reverse the disease in early cases.

Corneal injuries may be seen in recently imported animals - corneal ulcers heal rapidly in most cases - topical antibacterial agents may prevent secondary infection and promote healing. Severe corneal injuries with corneal perforation require surgical attention soon as possible, and topical antibacterial therapy. Removal of the eye may be necessary.

Inflammation within the eye (uveitis) may accompany systemic infectious diseases - especially those where the reptile develops bacteremia. The dense

capillary networks of the intraocular vasculature traps bacteria, setting up a focus of infection within the eye. Diagnosis of the underlying systemic disease (for instance necrotic stomatitis, pneumonia, gastroenteritis) is essential for any attempt to be made at therapy of the eye disease. Effective treatment of the underlying disease may resolve the ocular inflammation. In severe cases surgical enucleation (removal) of the eye may be the only practical therapy (Millichamp et al., 1983; Bonney et al., 1978; Tomson et al., 1976; Lambiris, 1976).

Cataracts occur sporadically in reptiles, associated with old age, ocular inflammation, hibernation in temperate species in captivity, and possibly (although this has never been proven) with nutritional factors. Therapy has never been described in reptiles (Millichamp et al., 1983).

Retinal degeneration may occasionally be seen in reptiles, although it is not a significant clinical problem. Although difficult to diagnose, retinal inflammation is the most likely cause.

In amphibians few ocular diseases bave been described. Intraocular inflammation (uveitis, panophthalmitis) associated with bacterial septicemia may occur in stressed groups of animals (due to the stress of importation, temperature extremes, or overcrowding). Bacteria involved include *Aeromonas spp*. By the time ocular signs are seen, the disease is often advanced with a poor prognosis, although systemic antibacterial drugs may be effective in some cases (Brooks et al., 1983).

We have recently seen several frogs including Cuban treefrogs and White's treefrogs with lipid keratopathy, or deposits of lipids in the cornea. Affected animals present early in the disease with faint gray opacities in one or both corneas. These progress asymmetrically to form dense white corneal opacities, severely limiting the animals' vision. The disease appears to occur most frequently in females, which also have considerable deposits of lipid in the liver and occasionally in other organs. The affected female frogs were undergoing vitellogenesis. This is a metabolic disease where lipid becomes abnormally distributed in body tissues (including the cornea). The etiology is unknown, and to what extent environmental or dietary factors are involved is unknown at present (Carpenter et al., 1986; Millichamp et al., 1990).

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INFERTILITY AND FECUNDITY DISORDERS OF REPTILES

by

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Infertility is defined as a failure to conceive; fecundity is a relative measure of reproductive capacity, and is determined by the numbers of liveborn normal young produced, compared to what would be normal or average for a given taxon. For example, if a full-grown boa constrictor produces a litter of only two or three young, or a litter which produces many infertile ova, dead or deformed young, this represents poor fecundity. However, if she fails to conceive, she is infertile.

Infertility and disorders of fecundity are related problems. Both can be caused by specific events or factors occurring at many different points during the reproductive cycle of both males and females. In order to evaluate and identify causes of infertility or poor fecundity, it is first necessary to understand the reproductive cycle in both sexes.

Unlike mammals, female snakes continually manufacture new ova. In mammals, all ova are present at birth, and no new ova are produced during the female mammal's lifetime. In female snakes, the process of formation and release of gametes, or reproductive cells, is slow.

Although the time required for gamete formation is not specifically known for most reptile taxa, it is known to take as long as three years in some snakes. The earliest stage of ova production is the formation within the ovary of oocytes, which begin as microscopic cells. Gradually, the oocytes grow in size, and at a certain point in their development, the deposition of yolk begins. The resulting ovum develops within a structure in the ovary known as the follicle. The egg, or ovum, is contained within the follicle, and the gamete rests on the surface of the yolk.

The gradual growth of the oocyte plus yolk is known as the follicular maturation cycle; the deposition of yolk is known as vitellogenesis. When the ovarian follicle has completely matured, it releases its yolked ovum, which then enters the oviduct to be fertilized.

The process of vitellogenesis requires a great deal of stored energy, in the form of fat. As a protective mechanism, if ovulation does not occur, the follicle atrophies, or shrinks, and the yolk is reabsorbed. This prevents the loss of the yolk, which was stored fat taken from the female's body and deposited in the ovum to nourish the growing embryo.

Once released or ovulated, however, the egg enters the oviduct and cannot be reabsorbed. The type of tissue which lines the oviduct and uterus is incapable of absorption - this is not the purpose of these tissues. Once an ovum is released and has entered the oviduct or uterus, it must be eventually passed out of the oviduct, even if it has never been fertilized. This is the origin of "slugs" or infertile ova, which are passed with eggs or young at the time of delivery. If ovulation occurs but fertilization has not taken place, an entire clutch of infertile ova will be passed.

The formation of sperm, or spermatogenesis, occurs more rapidly than oogenesis. Although it is not known precisely how long this process takes place in most reptile taxa, it is known to take about a month in some lizards. Sperm contain no stored energy other than that required for survival and motility necessary to achieve fertilization. Since there is no yolk on sperm, there is little energy lost. There is no process of reabsorption. However, sperm are only released during copulation.

The follicular maturation cycle, and to a lesser extent, spermatogenesis, are dependent of three factors:

1. General health and nutrition of the animal
2. Environmental factors (weather/temperature patterns, photoperiod, etc.)
3. Ethological or behavioral factors

Health Factors

Female reptiles that are in less than optimal health are less likely to be fertile. The primary reason for this is that adequate fat stores are essential for successful follicular maturation. Stored fat is utilized to produce the yolk during maturation of ovarian follicles. Without adequate fat stores, follicular maturation may fail to occur entirely, or may be incomplete. This may result in one of several outcomes:

1) reduced number of ova caused by inadequate amount of fat yolk and all mature ova

2) reduced viability of ova caused by inadequate fat stores necessary to nourish ova during development prior to and subsequent to fertilization

3) complete failure of follicular maturation, and therefore functional sterility

Thus, reptiles in less than optimal health may be infertile. Alternatively, ovulation may occur, but the number or viability of ova may be reduced, resulting in poor fecundity. It is not known whether a well nourished reptile that is sick can successfully complete follicular maturation. However, it is likely that once the process of ovulation begins, it

will continue in spite of an illness that develops.

Sperm formation appears to be less dependent upon nutrition than ova formation. However, malnourished may be less likely to produce a normal number of functional sperm.

Environmental Factors

Environmental factors necessary for fertility and good fecundity vary with the climate in the natural habitat of the reptile. Although not entirely correct, for purposes of discussion it is convenient to divide reptiles into two groups, temperate and non-temperate.

Among temperate taxa, variations in photoperiod, rainfall and temperature may all contribute to fertility and fecundity. Sperm formation and possibly ova formation and release are likely to be dependent on seasonal changes, including photoperiod, rainfall and temperature. The changing seasons trigger the events necessary for fertility and mating. Failure to provide these exogenous or climatological variations can result in failure to induce spermatogenesis or ovulation, as well as failure to trigger copulation.

In tropical reptiles, it is generally the case that temperature is the primary factor related to fertility nd mating. Photoperiod has little relevance to the reproductive cycle. A fluctuation in temperature has been shown both experimentally and experientially to be essential for reproduction in many tropical species of reptiles. Failure to provide the necessary environmental stimuli as well as the correct environmental conditions, may result in infertility or poor fecundity. Courtship, copulation, as well as spermatogenesis, follicular maturation and ovulation appear to be dependent to a greater or lesser degree on a cyclic fluctuation in temperature.

For example, if an adequate period of cooling (or hibernation in temperate taxa) is not provided, no sperm may be produced or ovulation may not occur. However, if tropical reptiles are exposed to excessively cold temperatures, or kept cold without a diurnal period of warming, sperm or ova may be killed or damaged. If fertilization has already occurred, developing embryos also may be killed or damaged.

Also included under environmental factors are exposure to toxins, x-rays, drugs or any other stimuli which may be harmful to ova, sperm or developing embryos.

It is important to remember that most environmental toxins can cause infertility if exposure occurs prior to copulation or conception, and can also cause poor fecundity if developing embryos are exposed.

Ethological or behavioral factors

Courtship and male combat, probably the most obvious and intriguing *manifestations of reproductive behavior,* have long been considered no more than curiosities. It is now apparent that these behaviors often play an essential role in reptile reproduction. Failure to allow for these forms of interaction may be an overlooked cause of breeding failure. Here are a few examples:

Studies in Cuban boas by Tolson revealed that females exposed to male/male combat had higher levels of estrogen than females that were not. The latter group failed to ovulate.

Blackheaded pythons are much more likely to mate if several males are present and allowed to combat. Single pairs may fail to copulate until an additional male is added. The same phenomenon may be observed in carpet pythons and many species of insular *Epicrates*. This latter phenomenon is referred to as "multiple males". Multiple males are frequently helpful, if not essential in achieving copulation in many taxa.

Fertility and fecundity are also affected by other health factors in female snakes. These may be complications arising from previous pregnancies or ovulatory cycles, such as retained or unfertilized ova, retained embryos or retained shelled eggs. In these cases, x-rays may be necessary for evaluation of the problem. Surgical correction may be necessary to restore fertility.

Finally, an often overlooked cause of *infertility,a nd especially of poor fecundity* is excessive breeding. It is incorrect to assume that female reptiles reproduce every year in the wild. In oviparous reptiles with long gestation periods, such as many boa taxa, complete depletion of fat stores may occur. In order to become fertile again within a one year time period, excessive feeding is necessary. This practice is unhealthy and stressful to the animal. Eventually, decreasing fecundity will develop.

Other similar phenomena also play a role in infertility. Dominance, hierarchy formation, mate preference and inappropriate cage design can all contribute to breeding failures.

Dominance and Hierarchy Formation:
This phenomenon occurs when one specimen dominates one or more other specimens within a breeding group. Subordinate specimens generally fail to be reproductively active. However, the dominant specimen also may be sexually inactive, and no breeding takes place.

Mate Preference

Many breeders have observed that some specimens will reject potential mates, giving the appearance of being reproductively inactive or unreceptive, but

when offered an alternate mate, will copulate readily. Mate preference is a potential explanation for breeding failures among otherwise healthy specimens.

Cage Design

Cage design can be critical. Failure to provide adequate thermal gradients may prevent specimens from selecting the necessary microhabitats required for fertility. Cages that are too small may prevent specimens from executing necessary courtship routines. Inappropriate cage design or cage contents should be considered when healthy specimens fail to reproduce.

This is a basic approach to evaluating infertility and poor fecundity within breeding groups of reptiles. Once specimens have become acclimated, reproduction should eventually be achieved. If reproduction is not forthcoming, the herpetologist must analyze every aspect of the breeding group to determine the cause or causes of breeding failures. We must assume that there are no insurmountable obstacles to captive breeding; therefor the cause should always be sought.

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AN OVERVIEW OF AMPHIBIAN AND REPTILE REPRODUCTION AT THE ST. LOUIS ZOOLOGICAL PARK

by

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ABSTRACT

Originally opened in September, 1927, the St. Louis Zoo reptile house was completely renovated and reopened as a modern herpetarium in July 1978. Since the renovation, the goal of herpetarium staff has been to exhibit a diversified collection of amphibians and reptiles in naturalistic surroundings as well as to promote reproduction in selected species whenever possible. Fifty species representing 15 families have successfully bred and produced young during the past twelve years. The current breeding program involves 42 taxa of amphibians and reptiles. A general discussion on the herpetarium will be included in the manuscript. This discussion will include information on temperature, photoperiod and humidity cycles used in the four biome sections of the building,

THE HERPETARIUM

Facility

The St. Louis Zoo reptile house was opened in September of 1927. Fifty-one years later, in July 1978, the building was renovated and renamed the herpetarium. This facility is approximately 25,000 square feet, making it one of the largest structures used for the exhibition of amphibianS and reptiles. The combination of the original bas-relief reptile sculptures, which adorn the entrances to the herpetarium as well as the interior columnar supports, and the modern naturalistic exhibits enhances the beauty and uniqueness of the building. The facility follows a biome theme (cloud forest, temperate forest, tropical rain forest and desert) and is composed of 125 indoor exhibits and three outside crocodilian/tortoise enclosures.

Collection

The St. Louis Zoo's herpetological collection is composed of 30 species of

amphibians and 161 species of reptiles, representing a total of 37 families. There are currently 660 specimens in the collection.

Exhibit Cages and Aquaria

The exhibit cages and aquaria used at the St. Louis Zoo herpetarium are constructed of fiberglass and ABS material, respectively, with the exception of 18 large exhibits which are made of concrete. The fiberglass cages are of three sizes (Table 1) and are mounted on a Unistrut support system. The versatility of this system allows the cages to be arranged in several combinations: 4 small cages, 2 small cages and a medium cage, 2 medium cages, or one large cage. All of the cages have dual access, and a re equipped with a two inch drain. In addition to the fiberglass cages, the herpetarium is outfitted with sixteen two-sided glass/ABS aquaria. These aquaria will hold 55 gallons of water and are used primarily for aquatic amphibians and turtles. Like the fiberglass cages, the aquaria also have access from two sides and built-in drains.

TABLE 1
Dimensions of Fiberglass Cages and ABS Aquaria

CAGE/AQUARIUM	DIMENSIONS (cm)
SMALL FIBERGLASS CAGE	44.4 X 45.7 X 48.3
MEDIUM FIBERGLASS CAGE	87.6 X 45.7 X 55.8
LARGE FIBERGLASS CAGE	87.6 X 121.9 X 109.2
GLASS/ABS AQUARIA	84.4 x 84.4 x IO4.1

Reserve Space

In addition to the specimens on exhibit, each of the biome sections has a reserve area for housing breeding stock and offspring. A 8.8 x 5.6 x 2.8 m quarantine reserve room, located in the basement of the herpetarium, is used to isolate all new arrivals from the established collection. Specimens are quarantined for a minimum of 30 days while fecal analysis, blood work, etc. are conducted. Once an animal is shown to be free of disease and parasites and is

feeding regularly, it is moved to the reserve area of the proper biome.

Hibernaculum

In order to elicit reproductive behavior in selected temperate zone species, an off exhibit hibernaculum was constructed to provide the neccessary cool, dark dormancy period. Besides serving as a hibernation chamber, the hibernaculum also doubles as a cool room for housing montane viperid snakes, i.e., *Vipera bornmuelleri* and *V. wagneri*. This 2.6 x 2.5 x 2.8 m hibernaculum/cool room has insulated walls and is equipped with a programable thermostat and timer, which herpetarium staff to program seasonal temperature and photoperiod cycles.

Tuatarium

The St. Louis Zoo has had an interest in the tuatara, *Sphenodon punctatus*, since the late 1960's when they recieved their first specimen. After years of working with the tuatara a concerted effort was made in 1979 to establish a captive breeding program for this species at the St. Zouis Zoo. In 1980, an off exhibit 7.4 x 3.5 x 2.8 m tuatarium was constructed in the basement of the herpetarium. This climatically controlled refrigeration unit has programable timers for setting temperature, photoperiod and humidity. The tuatarium's seasonal cycles are based on climatological data from Stephens Island located off the coast of New Zealand. The current breeding group consists of 3.2 specimens. In addition to 1.1 belonging to the St. Louis Zoo, 1.1 are on breeding loan from the Philadelphia Zoo and an immature 1.0 is on breeding loan from Dr. Carl Gans of the University of Michigan.

THE BREEDING PROGRAM

The purpose of our program is to elicit reproductive behavior through simulation of the phenological cues a species experiences in its natural habitat. Therefore, each of the herpetarium's biome sections follow a particular climatic cycle (Tables 2 and 3). The program is based on captive breeding methods and phenological data from the literature (Crews & Garrick, 1980; Jones, 1978; Laszlo, 1979; Regal, 1980).

Photoperiod

Cage lighting is provided by 20, 30 and 40 watt Vita-Lites. Ultraviolet light is supplemented for chelonians and saurians by using blacklight (Phillips, F20T12/CW or F40BL) tubes in combination with the Vita-Lites. Skylights provide natural photoperiod for the St. Louis, MO area. Photoperiods are controlled by timers located in each of the biome sections.

TABLE 2

Temperature, Photoperiod and Misting Cycles for the Temperate Forest and Cloud Forest Biomes

MONTH	TEMPERATURE (°F)		DAY LENGTH (HOURS)	MISTINGS PER WEEK
	DAY	NIGHT		
JAN	55 (65)	55 (60)	-- (12)	- (1)
FEB	55 (65)	55 (60)	-- (12)	- (2)
MAR	65 (70)	60 (65)	12 (12)	3 (3)
APR	70 (70)	65 (65)	13 (12)	3 (5)
MAY	75 (70)	65 (65)	14 (12)	3 (6)
JUN	80 (75)	70 (65)	15 (12)	4 (7)
JUL	85 (75)	75 (65)	14 (12)	4 (7)
AUG	85 (75)	75 (65)	13 (12)	3 (7)
SEPT	80 (75)	70 (65)	12 (12)	3 (6)
OCT	75 (70)	65 (65)	10 (12)	1 (5)
NOV	65 (70)	60 (65)	10 (12)	1 (3)
DEC	55 (65)	55 (60)	-- (12)	- (2)

Note: The hibernation period is denoted by (-) during the months of December, January and February. The temperature, photoperiod and misting cycles for the cloud forest biome are listed in parentheses.

TABLE 3

Temperature, Photoperiod and Misting Cycles for the Tropical Rain Forest and Desert Biomes

MONTH	TEMPERATURE (°F)		DAY LENGTH HOURS	MISTINGS* PER WEEK
	DAY	NIGHT		
JAN	85	70	12	5
FEB	85	70	12	6
MAR	80	68	12	7
APR	80	68	12	7
MAY	85	70	12	7
JUN	85	70	12	6
JUL	87	74	12	5
AUG	87	74	12	3
SEPT	85	72	12	2
OCT	85	72	12	1
NOV	85	70	12	2
DEC	85	70	12	5

Note: The mistings are omitted for the desert biome. Desert reptiles which require a cool dormancy period are moved to the hibernaculum during the winter.

Temperature

The herpetarium is heated by forced-air furnaces, with individual thermostats located in each section of the building. Basking spots are created by using 50, 75 and 150 watt Plant-Gro bulbs over one corner of the exhibit. The cloud forest biome is the only section which is currently air conditioned.

Humidity

Humidity cycles are an integral part of captive amphibian and reptile reproduction programs. The inclusion of live plants and waterfalls in many of the exhibits as well as regular mistings help maintain required humidity levels. For tropical species from habitats with defined wet/dry seasons, a misting nozzle mounted over the exhibit can be used to simulate rain showers. During the rainy season these rain showers are provided on a daily basis for several hours at a time. *Atheris nitschei, Bitis gabonica, Corallus caninus* and *Chondropython viridis* will drink the droplets of water off their bodies while being misted. Many lethargic species defecate with regularity after being "rained" on.

Species

Herpetarium staff are very selective of the species in which they try to promote breeding. Most of the efforts are directed to rare and endangered species or species which have never been bred in captivity. The current breeding program involves 42 species of amphibians and reptiles (Table 4).

TABLE 4

The Amphibian and Reptile Species in the Current Breeding Program

Class Amphibia

Order Caudata - Salamanders
Family Cryptobranchidae
Eastern Hellbender (*Cryptobranchus a. allegainiensis*)

Order Salientia - Toads and Frogs
Family Dendrobatidae
Green and Black Arrow Poison Frog (*Dendrobates auratus*)
Blue Arrow Poison Frog (*Dendrobates azureus*)
Yellow-banded Arrow Poison Frog (*Dendrobates leucomelas*)

Family Leptodactylidae
Surinam Horned Frog (*Ceratophrys cornuta*)
Smoky Jungle Frog (*Leptodactylus pentadactylus*)

Class Reptilia
Subclass Anapsida

Order Testudines - Turtles and Tortoises
Family Chelydridae
Alligator Snapping Turtle (*Macroclemys temminckii*)

Family Testudinidae
Speckled Cape Tortoise (*Homopus signatus*)

Family Pelomedusidae
Yellow-spotted Side-necked Turtle (*Podocnemis unifilis*)

Order Crocodylia - Alligators and Crocodiles
Family Crocodylidae
Chinese Alligator (*Alligator sinensis*)

Order Rhyncocephalia - Tuatara
Family Sphenodontidae
Tuatara (*Sphenodon punctatus*)

Order Squamata - Lizards and Snakes
Suborder Sauria - Lizards
Family Agamidae
Philippine Sail-finned Lizard (*Hydrosaurus pustulatus*)

Family Anguidae
Haitian Giant Galliwasp (*Diploglossus warreni*)

Family Gekkonidae
Leopard Gecko (*Eublepharis macularius*)
African Fat-tailed Gecko (*Hemitheconyx caudicinctus*)
Madagascar Velvet Gecko (*Homopholis antongilensis*)
Madagascar Giant Day Gecko (*Phelsuma m.grandis*)

Family Helodermatidae
Mexican Beaded Lizard (*Heloderma h. horridum*)

Family Scincidae
Prehensile-tailed Skink (*Corucia zebrata*)

Family Teiidae
Red Tegu (*Tupinambis rufescens*)

Family Varanidae
Mangrove Monitor (*Varanus indicus*)

Suborder Serpentes - Snakes

Family Boidae
Dumeril's Ground Boa (*Acrantophis dumerili*)
Emerald Tree Boa (*Corallus caninus*)
Brazilian Rainbow Boa (*Epicrates c. cenchria*)
Jamaican Boa (*Epicrates subflavus*)
Desert Rosy Boa (*Lichanura t. gracia*)
Green Tree Python (*Chondropython viridis*)

Children's Python (*Liasis childreni*)
Carpet Python (*Morelia s. variegata*)
Blood Python (*Python curtus*)
Ball Python (*Python regius*)

Family Colubridae
Eastern Indigo Snake (*Drymarchon c. couperi*)
Gray-banded Kingsnake (*Lampropeltis alterna*)
Pueblan Milksnake (*Lamproreltis t. campbelli*)
Central American Milksnake (*Lampropeltis t. polyzona*)

Family Viperidae
Taylor's Cantil (*Agkistrodon b. taylori*)
Amelanistic Osage Copperhead (*Agkistrodon c. phaeogaster*)
Eyelash Viper (*Bothriechis schlegelii*)
Aruba Island Rattlesnake (Crotalus d. unicolor)
Black and Green Bush Viper (*Atheris nitschei*)
Hermon Mountain Viper (*Vipera bornmuelleri*)
Wagner's Viper (*Vipera wagneri*)

ACKNOWLEDGMENTS

I would like to thank Ron Goellner and Ann Day for reviewing the manuscript and for their help and encouragement during the course of this project.

PRODUCTS MENTIONED IN TEXT

Vita-Lite - full spectrum fluorescent tube made by Duro-Test Co., Fairfield, NJ 07001.

Blacklight (F20T12/CW and F40BL) fluorescent tubes and Plant-Gro bulbs made by Philips Lighting Co., Somerset, NJ 08873.

Unistrut support system made bu Unistrut Service Co of St. Louis, 2722 Mercantile Dr., St. Louis, MO.

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THE EFFECT OF CALCIUM/PHOSPHATE AND VITAMIN D_3 SUPPLEMENTATION ON GROWTH RATES IN HATCHLING RAT SNAKES

by

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In recent years, there have been several articles in the lay herpetological press and much discussion regarding the dietary supplementation of hatchling colubrids. This supplementation usually takes the form of calcium carbonate (i.e., ground cuttlebone) and vitamin D_3, usually as part of a multivitamin/mineral preparation such as Linatone or Reptivite.

To assess the effect(s) of calcium/phosphate/vitamin D_3 supplementation on growth rate in colubrids, a single clutch of 18 *Elaphe o. obsoleta* hatchlings were entered into a randomized, double-blind, crossover dietary study lasting a period of 13 months. The study was divided into three phases; a one month "pre-entry" phase, and two sequential six month study phases, Phases I and II.

In the pre-entry phase, all 18 hatchlings were sexed (8.10), allowed their post-hatching shed, and begun on live mouse pinkies. The hatchlings were then switched over to frozen-thawed pinkies. Fourteen animals, (6.8) were well established feeders on thawed pinkies by the end of this phase. The animals were then divided into two groups of 3.3 animals.

For Phase I, the animals were randomly assigned numbers (88-1 through 88-12) by a disinterested party (my wife) and had a bag of pinkies (1-3 g) and fuzzies (4-8 g) labelled with their assigned numbers. The pinkies and fuzzies had been previously prepared by CO_2 gassing and injection with either 0.9% saline (controls) or a $CaCl_2/NaH_2PO_4/D_3$ solution (experimentals). The animals body weights, snout-vent length (SVL), and total length (TL) were recorded once weekly, and the animals were then fed pinkies *ad libitum* from their respective labeled bags. The total weight of the food consumed was then recorded.

In six months the animals were then entered into Phase II, in which three animals from each group were randomly selected to cross over into the opposite study group. The labels on the bags of food animals were subsequently altered to reflect these changes. Measurements of body weight, SVL, TL, and amount of food consumed were recorded for each animal as in Phase I. At the end of Phase II, the animals were removed from the study, and three animals from each group were sacrificed and frozen in preparation for bone densitometry studies.

Analysis of the results demonstrated that there were no significant differences in the rates of weight gain or linear growth rates between the two groups. Further, there was no difference between the bone densitiometries of the two groups. I therefore conclude that dietary calcium, phosphate and vitamin D_3 supplementation has no effect on growth rates in hatchling rat snakes throughout the first year of life.

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PHOTO CREDITS

Front Cover: Neonate Burmese Pythons: *(Phython Molurus Bivittatus)*
photo by George Lewis

Back Cover: TOP: Eye of Tokay Gecko: *(Gekko Gecko)*
photo by Dr. Michael J. Uricheck

BOTTOM: Red-Tailed Rat Snake: *(Gonyosoma Oxycephala)*
photo by Dr. Michael J. Uricheck