1st ANNUAL
REPTILE SYMPOSIUM
on
CAPTIVE PROPAGATION & HUSBANDRY

SATURDAY, JULY 24, 1976
ROSENSTOCK AUDITORIUM
HOOD COLLEGE
FREDERICK, MARYLAND

CAPTIVE PROPAGATION OF *DRYMARCHON CORAIS*

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1. General Maintenance. Anyone who has kept an exotic subspecies of *Drymarchon* knows that the popular idea of the Indigo or Cribo as a tame, easily maintained animal is a fallacy. Even the phlegmatic *Drymarchon corais couperi* can be extremely difficult to care for in captivity. We have had experience with five subspecies of *Drymarchon corais* and have developed certain standardized methods of coping with the various problems presented by these snakes. We hope these methods will help other keepers to keep and breed *Drymarchon* successfully.

A newly imported Indigo usually has already rubbed off his rostral scale and sometimes has destroyed the underlying bone as well. Apply an antibiotic ointment to the sore until it begins to heal. Indigos have amazing recuperative powers when it comes to wounds, and after a couple of sheds the nose will look almost normal. Another frequent problem with new Indigos is body rot, which can usually be cured by daily applications of Zephiran chloride solution (1:750). One problem you will always have is eyecaps, which some specimens seem never to shed. Check for them after each shed.

A hiding box is essential for all newly acquired Cribos and for most long-term captives. Many of our specimens will not feed unless provided with a box. Cages should not contain any screen or mesh, since even long-term captives will suddenly decide to indulge in nose-rubbing. Pegboard or decorative filler panels can be used for ventilation.

Indigos subdue their prey with their jaws, and they have extremely powerful jaw muscles. Since they bite and chew instead of merely striking, you are well advised to avoid the bite of a large specimen. Wrestling with an Indigo who has a good grip on you hand results in damage to both of you; your best bet is to blow on the snake's face or to hold his head under a water tap. By careful practice you can learn to handle an evil-tempered Cribo without being bitten. Holding them by the neck is difficult, since they are usually strong enough to get out of the hold, and such a hold always inspires them to bite.

2. Feeding. Irrespective of subspecies, some *Drymarchon* will eat right away in captivity and others will fast stubbornly. The best way to induce them to feed is to offer a wide variety of food items, both live and dead. All subspecies are relatively omnivorous, and if your animal turns down rodents you can try baby chicks, frogs, fish, lizards, or snakes. Once you learn your specimen's preferences, you can use your ingenuity to persuade him to accept dead rodents. Tying a rodent to a dead chick is one way to introduce rodents to the diet. For one of our adult *Drymarchon corais couperi*, we rubbed garter snake musk on dead rodents, put the garter snake in a glass jar in the Indigo cage, and piled the rodents around the jar. The combination of sight and smell of garter snake stimulated our specimen to feed. Other specimens have accepted rodents with fish or frog slime rubbed on them.

We use dead juvenile rats as a standard diet, with occasional additions of vitamins to the food animals. (Only the most enormous Cribos can eat adult rats, since their necks have less ability to stretch than do those of most snakes.) Chicks provide a welcome treat but are not really adequate as a steady diet. Fish is a cheap food and is often relished, but you should be cognizant of the danger of thiamine deficiency

Brown Cribo (*D. c. unicolor*) - brown with black spots, sometimes with black head and tail.

Mexican Indigo (*D. c. rubidus*) - black, red and white mixed colors; belly may be salmon, yellow, or off-black; body color may be reddish, brown and black, or all black.

Texas Indigo (*D. c. erebennus*) - gray-black with salmon-colored interstitial markings.

Florida Indigo (*D. c. couperi*) - black, sometimes with red chin and red under neck.

7. Research. Our work is done in cooperation with Terry Whitecar's *Drymarchon* Research Center. We would like to hear from anyone with new ideas about the breeding of Indigos, and we welcome any questions or information sent by Indigo fanciers.

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TABLE 4

TEST SPECIES BEING FED HERP DIET

Test Animal	Months on Diet
Prairie Kingsnakes	6
Surinam Toad	18
Amphiuma	18
Mexican Axolotls	10
Bull Frog	10
Tiger Salamander	3
American Crocodile	2
Golden Monitor	9
Aldabra Tortoises	18*
Snakes (see list)	12
Turtles (see list)	18*
Tropical fish (Pacu)	18
Blombergs Toad	18
Rhino Iguana	12*
Green Iguana	4*

*Herp Diet only part of diet.

TABLE 5

WEIGHTS (g) OF RED RAT SNAKES FED HERP DIET OR NATURAL DIET

	Dec. 1975	Mar. 1976	June 1976
Herp Diet #2	5.0	Died	-
5	7.2	Died	-
6	8.0	13.0	25.5
7	7.9	Died	-
10	8.0	10.0	18.5
13	5.8	Died	-
14	8.0	11.0	26.5
15	6.5	9.0	31.5
	7.0	10.7	25.5
Mice #4	7.3	10.0	20.5
8	7.7	8.5	19.0
9	7.0	Died	-
12	8.2	11.0	20.0
	7.5	9.8	19.8

No statistically significant difference between means

TABLE 6

WEIGHTS (g) OF RED EARED AND SNAPPING TURTLES FED THREE DIFFERENT DIETS

	Aug. 1975	June 1976
Herp Diet		
Red eared	8.6 ± 0.1	*16.3 ± 6.0
Snapping	11.3 ± 0.8	82.0 ± 20.5**
Natural (Mice and fish)		
Red eared	9.1 ± 0.6	12.6 ± 4.7
Snapping	11.7 ± 0.5	*49.0 ± 5.5**
Bird of Prey Diet		
Red eared	9.6 ± 0.8	*14.0 ± 2.5
Snapping	11.6 ± 0.4	40.4 ± 7.5**

Each value is the average of four turtles (± range)

*One turtle died in each of these groups

** ($p < .01$)

if first duped by holding the food in a container that had held rat feces.[4] Other animals besides snakes were tried, most all with success. Table 4 shows the species being fed Herp Diet.

The results in snakes are shown in Table 5. The 50% mortality seen in the snakes fed Herp Diet, as compared to 25% observed in the snakes fed mice, is not attributed to diet, inasmuch as the group on Herp Diet weighed more than those fed mice, and high mortality is expected in young snakes. The weight of snakes eating Herp Diet was equal to, or better than, controls (full siblings) on mice.

In turtles similar results were seen (Table 6). Turtles fed Herp Diet were larger (both by weight, as well as length, and width dimensions) than their littermates fed Bird of Prey Diet, or natural diet. These results were observed in both snapping turtles and red-eared turtles. In the snapping turtles, the length x width product averaged 3,535 sq. mm. for those fed Herp Diet, while those fed Bird of Prey Diet and natural diet averaged 2,131 and 2,383 sq. mm., respectively. This would tend to support the conclusion that the greater weight of the animals fed Herp Diet is real growth and not storage. The differences in weight as well as size were statistically significant ($p < .01$).

In conclusion, it is felt that a diet is available to assist in overcoming some of the problems of reptile and amphibian husbandry. One of these problems may well be the sub-optimum nutrition of natural diets. More importantly, the first steps have been taken toward a greater understanding of nutrition of these creatures. The next step is to begin to quantify the contribution and importance of each single nutrient.

4. Patrick Birchfield, personal communication

at the same time seeking shelter. It is therefore of great importance to provide hiding places for their well being and as an aid to feeding, since most individuals will not accept the offered crickets or mealworms in the open. It is best to immobilize the insects and place them under a piece of bark. The young geckos usually begin to feed 8 to 10 days after hatching. At first only insects are accepted but substitute food such as raw very lean strips of beef and hard boiled egg can be introduced thereafter. The meat and egg, as well as the insects, should be supplemented with vitamins in powder form since these geckos refuse moist food. A liquid multi-vitamin can only be used in the drinking water but this is rather inefficient because the Spotted Desert Geckos do not drink much. For the past four years, I have been using Paltone Powder - (Pitman-Moore Inc.) a Vitamin-Mineral Tonic. This odorless powder adheres well to the food offered, the lizards taking it without hesitation. Prior to the use of this vitamin powder the young geckos did not appear healthy and some showed signs of malformation of the limbs. The above suggested diet should be offered generously. It is amazing to see a 75 mm long hatchling, three or four weeks old, devouring a full grown cricket (*Grillus domesticus*) with ease in a few seconds time. For the first 8 to 10 months feeding should take place every third day. A well nourished Desert Gecko with a total length of 180 mm should have a tail of at least 15 mm width at its widest point. The tail, building up fatty tissue as a reserve of nutrition for the lean periods (hibernation or aestivation) acts as a condition indicator for the keeper.

Growth progress of *Eublepharis macularius* hatched in captivity

	WEIGHT	LENGTH (incl. tail)
at hatching	3.5 gram	71 mm
2 months	5.9 gram	92 mm
4 months	7.1 gram	125 mm
8 months	10.7 gram	137 mm
12 months	17.8 gram	155 mm
15 months	23.1 gram	167 mm

These averages are derived from records of 12 individuals. The four specimens, three females and one male, which the author imported in 1966, are still in excellent condition at the time of this writing, although reproduction declined sharply after the sixth year in captivity. This group produced a total of 36 fertile eggs. All hatchlings were reared under the above described conditions.

This first generation in captivity, offspring became sexually mature at an average of 15 months. Some individuals matured at an age of 8 months. Females are dominating in this offspring at a proportion of 12 to 1. During the breeding seasons of 1974 and 1975, nine females and one male produced 16 eggs of which 13 young hatched. None of the specimens of the second generation offspring has matured yet (summer 1976). The delayed maturing is most likely caused by a complete hibernation period from mid November to end of April. This "hibernation" was induced to further simulate natural conditions, in order to gain growth and reproduction data values closer to those taken under natural conditions. Although animal behavior in capitivity is influenced considerably by the unnatural conditions prevailing in captivity, countless facts have been revealed and contributed to science. It is hoped collectors will venture for more elaborate simulation in vivarium setups for their captives. Keeping the more delicate forms of reptiles is a great challenge, getting them to reproduce in a strange environment requires a great deal of effort and hardship, but is a very rewarding enterprise.

OP

1st Annual Reptile Symposium

ON CAPTIVE PROPAGATION AND HUSBANDRY

c/o Box 126, Rt. #3 Thurmont, Md. 21788 Tele: 301-271-7488

Fellow Herpetologists:

It gives me a great deal of pride to be able to introduce this publication of the Proceedings on the 1st Annual Reptile Symposium on Captive Propagation and Husbandry. For many years, much of the information contained in these manuscripts was considered private, privileged information unavailable to the general herpetologists at large. Those speakers whose papers are contained therein recognized the responsibility that they had and the importance of disseminating the information that they had acquired through hundreds, perhaps thousands, of hours of study and work with reptile husbandry. If it were not for these unselfish individuals' contributions, no symposium nor proceedings would have been possible. Because of them, their work may be utilized and expanded by you the reader and many others worldwide augmenting the herpeteculturists' knowledge and ultimately contributing directly to the continuation of reptilian species on this planet.

A great deal of the credit for this landmark publication must go the Symposium committee: Barbara Divers, Veterinarian, Baltimore Zoo; Frank Groves, Curator of Reptiles, Baltimore Zoo; Clyde Peeling, Owner/Director, Reptiland; and the zoological sponsors: Baltimore Zoological Society, Catoctin Mountain Zoological Park, Philadelphia Zoological Society, and Clyde Peeling's Reptiland. Special thanks are due to Brenda Manahan Sears and Mary Anne Hahn for many hours of volunteer work before, during, and after the meeting. Finally, Tom Huff and Rhoda Moore of the Reptile Breeding Foundation, Picton, Ontario without whose contribution this publication might still not be a reality.

Sincerely yours,

Richard A. Hahn
Executive Director
Catoctin Mtn. Zoological Park

NOTES ON PHOTOBIOLOGY, HIBERNATION, AND REPRODUCTION OF SNAKES

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The majority of snakes living under subtropical and temperate climate respond to increasing daylength after hibernation. This response occurs either immediately or within a two-month period after hibernation, depending on species. In general, the daylength needs to be gradually increased beyond the twelve to fourteen, or even better, sixteen hours daily. While hibernation is essential for some, it occurs in nature for all except the equatorial rain forest species. In captivity many species wil reproduce without the hibernation phase. Such species are: *Elaphe guttata* and subspecies, *Elaphe subocularis*, *Lampropeltis getulus* and subspecies, *Lampropeltis triangulum* and subspecies, *Lampropeltis mexicana* and subspecies, *Eublepharis macularius*, and others. These species should be kept at the lowest of their activity temperature ranges while exposed to darkness and light for gonadal growth. Exposure to dark prior to light is preferable.

The following temperatures are recommended as the lowest activity temperature limits: *Lampropeltis getulus* and subspecies at 24.5°C (76°F), *Elaphe guttata* and subspecies at 24.5°C (76°F), *Elaphe subocularis* at 18°C (65°F). Most *Lampropeltis triangulum* subspecies (of lowlands) 22°C (72°F), for the highland forms such as *arcifera*, *pyromelana* and *zonata*: 20°C (68°F). The minimum time for keeping the species in the dark is at least a two-month period. During this period no food should be offered--only water. The same procedure should be followed during exposure to lights. The overall condition of the snake should be excellent (slightly fat), so that it might survive the fasting and mating period in good condition. *Heloderma* should be hibernated prior to light exposure.[1]

Hibernation temperatures for the temperate climate species should be at 4°C (39°F). For the subtropical species (which are distributed between the average monthly isothermal January and July lines of 7°C and 18°C [45°F and 65°F]), temperatures should be at 10°C-13°C (50°-55°F). For high mountain forms, such as the Mexican Plateau, rattlesnakes of the Tierra Templada and Tierra Fria zones, the lowest temperatures could fall to 4°C (39°F). During hibernation moisture must be present to prevent desiccation and death.

For light exposure, the desired intensity falls between 2,000-5,000 footcandles in nature, averaging 3,500 footcandles power. In captivity, lower than 2,000 footcandles still could work. The problem is that raising the number of footcandles also raises the undesirable heat level, thus air-conditioning is essential. Even so, higher footcandles are more desirable to define the boundaries of dark and light.

Recommended artificial light sources are: large window light, full-spectrum and continuous-spectrum fluorescent and incandescent light sources with higher color correction and chromatic index number at least 88-91 CRI and 5500K°. Also, Vita-Lite fluorescent lamps, Superwhite incandescent plant lights and Fluomeric Deluxe White.[2]

1. Wagner, Ernie Seattle, Washington Reptile Department
2. Duro-Test Corporation, North Bergen, New Jersey 07047

CAPTIVE MAINTENANCE OF LIZARDS

Ernst G. Hofmann
South Orange, New Jersey

I have kept over 250 species of lizards over the years, and currently maintain third-generation animals representing 14 species. I have found that a simulated natural setting is most successful in maintaining these animals.

The temperature and illumination in my cages are controlled by time clocks set according to the length of the day, varying from eight hours in winter to 12 hours in summer. Heat sources are thermostatically controlled spotlights of 75 to 250 watts, depending upon the size of the cage. Daylight fluorescent bulbs or Vita-Lite bulbs are used for illumination.

An excellent method of providing natural sunlight is to combine an indoor cage with an outdoor solarium by building the cage around a window. On the outdoor side of the cage, plastic sheets should be used instead of glass plates, so that ultraviolet rays will not be filtered out.

Sand and pine bark mulch make a good substrate since they absorb moisture. To provide a place for digging, a mixture of topsoil and sand can be enclosed among firmly anchored rocks. Lizards can use this area to lay their eggs or to burrow for shelter.

Many lizards need extremely high humidity, which is difficult to provide indoors. A cold mist vaporizer is the best method to simulate environs of high humidity.

Lizards need more "props" than snakes. Rocks and branches are useful for basking, and potted plants are particularly appreciated. Plants give the added advantage of simplifying cage-cleaning problems by washing the feces down into the soil, where they are absorbed as fertilizer.

Some species of lizards will drink from a dish, but for others, water supply can be a problem. Certain species, such as chameleons, need running water, which can be supplied by a drip bottle or an atomizer. Lizards are sometimes attracted by moving water, and a small waterfall or a water container with an aerator in it will encourage them to drink.

Some carnivorous lizards will thrive well on chicken gizzards, which offer excellent nutrition. Natural foods are best, and most species insist upon live prey. Crickets are the food of choice, since they can be readily obtained from cricket dealers and bait shops. Crickets removed from the holding container can be placed in a feeding container with a wire mesh bottom to allow the small crickets to return into the holding container. By use of graduate mesh sizes the crickets can be sorted. Placing the feeding container in a refrigerator overnight immobilizes the crickets for easier feeding.

To catch flies for food, a fly trap can be made by forming a screen funnel and inserting it in a glass jar baited with fish or meat scraps. Grasshoppers and other insects can be gathered by sweeping a butterfly net through tall grass and then shaking the contents into a bottle; the bottle can then simply be emptied into the lizard cage.

Vitamin supplements can be critically important, especially for delicate species. I use Paltone vitamin powder, which can be sprinkled on the food items and can also be easily applied to crickets, earthworms and mealworms prior to feeding.

With the above described methods of lizard care I have achieved considerable records of longevity ranging from 5 to 12 years especially with some delicate small species.

to have two pairs for a breeding group. There is also an increased chance that a compatible pair or group can be established from a larger number of animals. When selecting animals for a breeding group, those of similar size should be chosen to minimize intraspecific harassment and possible injury or death (Honegger, 1971). To realize the potential of the group as soon as possible, mature animals should be chosen. This may be difficult in some species, as life history information, including the size and age at which sexual maturity is attained, is often lacking. The age of sexual maturity may vary with the species and is perhaps affected by the conditions of captivity. Yangprapakorn (1971) reports that Siamese crocodiles, *Crocodylus siamensis*, mature at 10 to 12 years while estuarine crocodiles, *Crocodylus porosus*, mature at 12 to 15 years.

The enclosure must fulfill certain needs. There must be a pool, for crocodilians are amphibious and need water in which to breed. Pool depth may be an important factor in breeding crocodilians; larger species may need deeper water in which to copulate (King and Dobbs, 1975). The land area of the enclosure should provide a dry basking site and, for nesting females, a secluded area provided with appropriate nesting materials (Bustard, 1975). The Samut Prakan Crocodile Farm provides 4 x 4 m nesting stalls which can easily be defended by female Siamese crocodiles and by female estuarine crocodiles; dried grasses are provided as nesting material (Yangprapakorn, 1971). The main crocodile exhibit at the Philadelphia Zoological Garden has an off-exhibit nesting chamber with a sand pit as well as a sand-filled nest box in the exhibit. Their female Nile crocodile, *Crocodylus niloticus*, has access to both during the breeding season. Plants can be effectively used to create secluded nesting areas, shade, refuges for crocodilians seeking to escape their aggressors, and hiding place for shyer species. Plants also make exhibits more appealing to the public.

Temperature is important to crocodilians. With the exception of the Chinese alligator, *Alligator sinensis*, and perhaps the American alligator, *Alligator mississippiensis*, they should be maintained at temperatures no lower than 25° C (Bustard, 1975), and higher temperatures are preferrable. The Bronx Zoo uses subsurface heating to warm basking sites to approximately 32° C and warm water of about 26° C to 27° C is used to fill the pools (Dowling and Brazaitis, 1966). The Atlanta Zoo keeps the temperature in their enclosures at about 32° C (Hunt, 1973). The greenhouse effect in their solaria contributes to temperature maintenance. At the National Zoological Park, a simple thermal gradient is provided for the Cuban crocodiles. During the winter months, steam-heated, subsurface coils warm specific land areas to approximately 30° C while during the summer months, sunlight through the glass roof warms parts of the land. To cool off in the winter, the crocodiles can move from the steam-heated areas to unheated areas or to the pool. To cool off in the summer, they can move from sunlit areas to the shade or to the pool. Heated water is used to fill the pools in winter months.

Seasonal variations in temperature, humidity, and photoperiod may play an important role in inducing crocodilians to breed. These parameters have not been well investigated. However, it should be noted that most crocodilian breeding takes place in outdoor enclosures at zoos exhibiting species endemic to their area (Honegger, 1971).

Proper diet is very important. Adult individuals can be maintained for long periods on a diet that is deficient in elements essential to good nutrition; young crocodiles and potential breeders should be fed a balanced diet (Honegger, 1971). No minimum daily requirement has been

established for crocodilians, so it is best to feed them a varied diet of whole animals. Hatchlings and young can be fed insects, crustaceans, small fish, frogs, chicks and chopped or whole mice and small rats. Larger specimens can be fed larger animals such as fish, chickens, rats and rabbits. If a variety of whole animals is used as food, and there is access to direct sunlight, vitamin supplementation should not be necessary. Crocodilians housed without exposure to direct sunlight may need vitamin D supplementation for proper metabolism of calcium (King and Dobbs, 1975). As excessive amounts of vitamin D can have deleterious effects on animals, and the dose for crocodilians has not been determined, it should be used with caution. Where meat is substituted for whole animals, many zoos add vitamin and mineral supplements.

Medical problems should be minimal if crocodilians are provided with adequate diets and housing. Pooley (1971) lists various crocodilian ailments and their causes. Inadequate pool hygiene can cause dermatitis and tongue lesions as well as contribute to the spread of infectious diseases. Smooth pool surfaces can help prevent abrasions, worn nails and bleeding toes, as well as make cleaning easier. Exposure to cold leaves crocodilians more susceptible to respiratory and eye infections, gout, hypoglycemic shock, decreased appetite and subsequent decline in condition (King and Dobbs, 1975; Pooley, 1971). Sudden exposure to cold can cause thermal shock and possibly death. Low temperatures or improper diet or a combination of these can result in abnormal growth (Dowling and Brazaitis, 1966). Also associated with improper diet are decalcification of the skeleton which may result in permanent deformities, irregular tooth formation, and weakened musculature. Caution must be exercised when feeding whole fish, as many contain fatty acids which can precipitate a disease called "steatitis". Vitamin E, because of its antioxidant properties, is reported to prevent this disease (Frye, 1973). The Atlanta Zoo has altogether eliminated whole fish from the diets of its adult, breeding crocodilians (Hunt, 1973). This was done after egg clutches showed a low fertility rate and hatchling autopsies showed organ damage possibly symptomatic of steatitis. This is contradicted by the fact that the Samut Prakan Crocodile Farm feeds their breeding stock a diet of salt water trash fish and an occasional duck (Yangprapakorn, 1971). This may be explained by the difference in oil content of the fish fed in these two places. High oil content has been linked to steatitis (Frye, 1973).

Many zoos are becoming interested in breeding crocodilians. In these zoos a reduction in the number of crocodilian species is occurring as efforts are made to pair up singleton specimens to establish potential breeding groups. The basis for developing a breeding program involves species selection based on available facilities and formation of a monospecific group with specimens of appropriate sex, size and age. Good husbandry practices must be followed to realize the breeding potential of the group. Proper diet and environment must be provided. Medical problems are minimal when these animals are maintained under good conditions. If the basic requirements are met, chances are good that efforts to propagate crocodilians in captivity will be successful.

TORTOISE HUSBANDRY

Dick Goergen
Alden, N. Y.

A. INTRODUCTION

1. 55 tortoises of 16 species ----- All kept in basically same environment
2. Size range: 8 oz. - 27 3/4", 126 lbs.

B. ENVIRONMENT

1. Reptile collection is housed in total basement area of raised ranch house.
   a. Consists of 1050 sq. ft.
   b. Tortoise collection is housed in 2 rooms
      1. Lg. Tortoise Room 12' x 13'
      2. Small Tortoise Room 12' x 18'
   c. Total 372 sq. ft.
   d. The balance of 678 sq. ft. is for:
      1. Snake Room
      2. Incubator and Equipment Room
      3. Rat/Mouse Room
      4. Medical Room
      5. Kitchen
2. Basement is:
   a. Insulated
   b. Paneled
   c. Windows are sealed with plastic
3. Heating:
   a. Basement has separate thermostat from rest of house
   b. Thermostat is set at 78° F.
   c. Type of heat is hot water baseboard heat
4. Lighting:
   a. Incandescent 75 watt reflector flood lights are used
   b. Vita-Lights (8' long bulbs) are controlled with timers
5. Humidity - is also an important factor which is necessary for healthy environment.
   a. I had a humidifier installed and gauge is kept set at 45%, which I found to be the most desirable for the tortoises.

C. HOUSING

1. All housing except for large tortoise area are constructed with plywood, coated with fiberglass resin, and paneled on outside.
2. Each plywood pen (total 6) was built with sliding partitions to separate according to size or species.
   a. Also these partitions can increase or decrease the size of a particular area.
3. The 3 large tortoises are kept on cement floor, which is epoxy painted, sawdust as bedding and heat lamps.

D. FEEDING

1. General Weekly Feeding Schedule is:
   a. 4 days/week - dog food and greens
   b. 2 days/week - fruit
   c. 1 day/week - greens

   However, this varies somewhat according to the seasons.
2. Vitamins are supplemented
   a. Perivinal powdered multi-vitamin

MAINTENANCE OF SNAKES IN CAPTIVITY WITH SPECIAL REFERENCE TO THE GENERA *CROTALUS* AND *SISTRURUS*

Herbert S. Harris, Jr.

I will start by saying that I am a scientist, not an individual interested in the husbandry of snakes in captivity. During the course of my research interest in *Crotalus* and *Sistrurus* it became necessary to maintain as many individuals of all species and subspecies alive as was possible. In part, my research interest, taxonomy of the rattlesnakes, requires using all available techniques to define various parameters in serum, plasma, venom, scent secretions. Adult maximum size has to be determined in various populations as well as detailed notes on behavior. In all, many questions arise that cannot be answered when working with preserved rattlesnakes alone.

In keeping these snakes alive, I have taken all precautions that I determined necessary for their survival. What I am about to discuss is what has worked for me. It may be frowned upon by some. It may not be the best method, but for me, it works.

I. Facilities
   A. Laboratory
      1. Escape-proof room
         a. All ventilation areas covered with screen
      2. Services
         a. Temperature
            (1) Day time - gradual rise
            (2) Night time - gradual drop
         b. Humidity
            (1) Maintained at about 50%...This can be controlled by using a humidifier during the winter months (heat on) and a dehumidifier during the summer.
         c. Light
            (1) Maintaining a photoperiod of short days during winter and long ones during summer with gradual changes respectively.
         d. Ventilation
            (1) Air sterilized via ultraviolet radiation
   B. Cages
      1. Custom made, aquariums, jars
         a. Floor coverings (formica, contact paper, towels)
         b. Dishes - culture type - heavy base

II. Techniques
   A. New arrivals
      1. Antibiotic treatment - keep from water for ca. 4 days then provide dish containing oxy-tetracycline
   B. Transfer vessels and tubing methods
   C. Utensils
   D. Cleanser - VGS (Iodine compound)

III. Food
   A. Mammals
      1. Mice - White laboratory type (*Mus musculus*)
      2. Rats - White laboratory type (*Rattus norvegicus*)
   B. Birds
      1. Quail (*Coturnix japonicus*)
      2. Chickens - White Mountain Cockerels (*Gallus domesticus*)
   C. Reptiles
      1. Lizards - *Uta* and *Anolis*, *Sceloporus*

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         b. Dishes - culture type - heavy base

II. Techniques
   A. New arrivals
      1. Antibiotic treatment - keep from water for ca. 4 days then provide dish containing oxy-tetracycline
   B. Transfer vessels and tubing methods
   C. Utensils
   D. Cleanser - VGS (Iodine compound)

III. Food
   A. Mammals
      1. Mice - White laboratory type (*Mus musculus*)
      2. Rats - White laboratory type (*Rattus norvegicus*)
   B. Birds
      1. Quail (*Coturnix japonicus*)
      2. Chickens - White Mountain Cockerels (*Gallus domesticus*)
   C. Reptiles
      1. Lizards - *Uta* and *Anolis*, *Sceloporus*

7. The smooth surface of the plexiglass module eliminates nose rubbing problems.

Reserve specimens at the Knoxville Zoological Park's Reptile Complex are housed in fiberglass units produced by Ranger Automotive Company.[3]

Venomous species are kept in units which are bright red, non-venomous species in blue units. Plexiglass is used for the fronts of these cages, which slide to the left or right on runners. The locking device is simply a bolt placed through a drilled hole which is capped by a wing-nut. A concrete sink was especially built for the disinfecting of these cages. We simply fill the sink with a chlorine bleach or a betadine solution and emerse the cages.

Seven stainless steel tanks (3½' l. x 3½' w. x 3½' h.) are used for small aquatic reptiles. These tanks are all on four rubber wheels, which can be locked into place. The top is comprised of stainless steel mesh and also is fitted with a bolt-latch locking device. Another tank has the same physical features but is larger (12' l. x 5' w. x 4' h.).

Crocodilians and aquatic turtles are housed together in a structure that is 300 feet in circumference. A center aisle divides the structure into equal parts. The roof and walls of this enclosure is also plexiglass, which is attached to steel beams. During our warm season, this is, frontally, an open-air exhibit. During the winter months, the front is covered by a tight-fitting canvas canopy in order to maintain optimum ambient air temperatures. In summer this is an open-air exhibit; in winter it becomes a solarium.

Giant tortoises are provided with a large, landscaped yard 250 feet in circumference. This enclosure is made up of used railroad ties, which were donated to the zoo by the Southern Railroad. In winter, these tortoises are brought inside.

A large colony (40) of Eastern Box turtles, *Terrapene c. carolina*, are housed in a landscaped yard that is 100 feet in circumference. This exhibit is walled by stockade poles. These turtles are allowed to hibernate, during the winter months, inside the enclosure.

Four other landscaped outside enclosures are used for various species of turtles, tortoises, and lizards. These enclosures are fronted with plexiglass placed at an angle.

These outside enclosures are very important in terms of providing fresh air and solar rays to those species, such as iguanids, that really benefit from being kept in such a manner, for seven months of a year.

Because of the importance of keeping reptiles in a clean environment as free of pathogenic organisms as possible, we of the Knoxville Zoological Park's Reptile Complex are pleased with our caging. Our Isometric Reptile Module and other caging have been used for almost two years now. They are proving to be both easy to maintain and durable. We recommend their use to future zoological reptile facilities in either their present or a modified form.

3. Ranger Automotive Co., Inc. Cage Division Clinton, Massachusettes 01510 (617) 368-8831

was maintained. The light system lasted ten weeks.

The results were astonishing. One pair of *Vipera x. xanthina* mated just after the third week; a pair of *Cerastes cerastes* mated after the fifth week and again after the eighth week of light exposure. A pair of *Vipera x. xanthina* mated after the seventh week. In general, the texture of the skin of both sexes changed physiologically. The bodies of the snakes were swollen and greasy in appearance. The males' tails were swollen and much thicker. The males approached the females with a jerking motion while the females twitched and lifted their tails nervously. The *Cerastes cerastes* did not exhibit much jerking or twitching movements.

Most species of *Lampropeltis, Elaphe, Natrix, Pituophis*, and Geckos: *Eublepharis, Phelsuma* do not require any cooling prior to daylength extention. *Lampropeltis t. sinaloae, polyzona, mexican alterna* and *getulus* subspecies, *Eublepharis macularius, Phelsuma madagascariensis* and other *Phelsuma* species were reproduced without cooling prior to extended daylengths. However, *Heloderma* species do require cooling first and extended daylengths for successful reproduction.

The method of cooling first and extending the daylength second works well with subtropical and temperate reptiles. Besides snakes; lizards, turtles, tortoises, and alligators work well with this procedure. It is not known with alligators if the mating mechanism is triggered by the process of warming them up or extending their daylengths. Species from temperate climates should be hibernated at lower temperatures, 4°C (39°F), and for a longer period of time (little longer than 3½ months minimum).

In the case of increasing daylength type reptiles, the light projects can be carried out with low light intensities (50 - 100 FC power), the results seem far better and more pronounced.

Most tropical snakes, chelonians, crocodilians, and the tuatara have similar reproductive patterns to their subtropical and temperate cousins. But the tropical ones' mating mechanism is triggered not so much by the light, but by the cooling period first (little over two months minimum and never lower than 18°C [65°F]). They should then be warmed up slowly to the desired average year round temperature (above the lowest digestion point). Mating occurs shortly after the emergence and warming up period on most occasions in the end of February and March (in the northern hemisphere and the end of August and September in the southern hemisphere). Such animals are species of the genera: *Bothrops, Trimeresurus, Bitis, Naja*, tropical *Agkistrodon* and many other tropical species. Also many species of Anurans under temperate, subtropical and tropical climates which are evidently not effected by extended daylengths. All species of the genus Varanus seem to have this type of reproductive pattern. In some other cases, the beginning of the rainy season triggers the mating. Some Anurans and the Aldabra tortoises are an example. Probably most species of the subfamily Pythoninae and Boinae, (pythons, boas) and the Indigo snakes (*Drymarchon*) however have still another kind of reproductive pattern. Some other species are suspected of having the same pattern. These snakes mate during the winter months in captivity, during the coldest part of the dry season (mostly in December, January and February in the northern hemisphere; in June, July and August in the southern Hemisphere). *Epicrates* in the West Indies are known to mate as late as March and early April. All of these species are decreasing daylength types.

Decreasing daylengths are always associated in the same time with some lowering of temperatures in nature. Decreasing daylength

captivity could be induced to mate, not by chance, but by a definite choice. Using photobiology for the purpose of planned reptilian reproduction is a promising new tool for the herpetological keeper and is believed to be a giant step forward toward reptilian reproduction in captivity.

The writer wishes to express his most sincere thanks to Mr. Louis R. DiSabato, Director, San Antonio Zoological Gardens, for providing and installing the cooler and the unusual light equipment, which was the first time used in any zoo. Also I wish to thank Alan Kardon, my assistant for typing and preparing this manuscript to its present form.

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Stock No. 010-1410
Ranco Division
Columbus, Ohio

Vita-Lite
Duro Test Corporation
North Bergen, N. J.

NOTES ON PHOTOBIOLOGY, HIBERNATION, AND REPRODUCTION OF SNAKES

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San Antonio, Texas 78212

The majority of snakes living under subtropical and temperate climate respond to increasing daylength after hibernation. This response occurs either immediately or within a two-month period after hibernation, depending on species. In general, the daylength needs to be gradually increased beyond the twelve to fourteen, or even better, sixteen hours daily. While hibernation is essential for some, it occurs in nature for all except the equatorial rain forest species. In captivity many species wil reproduce without the hibernation phase. Such species are: *Elaphe guttata* and subspecies, *Elaphe subocularis*, *Lampropeltis getulus* and subspecies, *Lampropeltis triangulum* and subspecies, *Lampropeltis mexicana* and subspecies, *Eublepharis macularius*, and others. These species should be kept at the lowest of their activity temperature ranges while exposed to darkness and light for gonadal growth. Exposure to dark prior to light is preferable.

The following temperatures are recommended as the lowest activity temperature limits: *Lampropeltis getulus* and subspecies at 24.5°C (76°F), *Elaphe guttata* and subspecies at 24.5°C (76°F), *Elaphe subocularis* at 18°C (65°F). Most *Lampropeltis triangulum* subspecies (of lowlands) 22°C (72°F), for the highland forms such as *arcifera*, *pyromelana* and *zonata*: 20°C (68°F). The minimum time for keeping the species in the dark is at least a two-month period. During this period no food should be offered--only water. The same procedure should be followed during exposure to lights. The overall condition of the snake should be excellent (slightly fat), so that it might survive the fasting and mating period in good condition. *Heloderma* should be hibernated prior to light exposure.[1]

Hibernation temperatures for the temperate climate species should be at 4°C (39°F). For the subtropical species (which are distributed between the average monthly isothermal January and July lines of 7°C and 18°C [45°F and 65°F]), temperatures should be at 10°C-13°C (50°-55°F). For high mountain forms, such as the Mexican Plateau, rattlesnakes of the Tierra Templada and Tierra Fria zones, the lowest temperatures could fall to 4°C (39°F). During hibernation moisture must be present to prevent desiccation and death.

For light exposure, the desired intensity falls between 2,000-5,000 footcandles in nature, averaging 3,500 footcandles power. In captivity, lower than 2,000 footcandles still could work. The problem is that raising the number of footcandles also raises the undesirable heat level, thus air-conditioning is essential. Even so, higher footcandles are more desirable to define the boundaries of dark and light.

Recommended artificial light sources are: large window light, full-spectrum and continuous-spectrum fluorescent and incandescent light sources with higher color correction and chromatic index number at least 88-91 CRI and 5500K°. Also, Vita-Lite fluorescent lamps, Superwhite incandescent plant lights and Fluomeric Deluxe White.[2]

1. Wagner, Ernie Seattle, Washington Reptile Department
2. Duro-Test Corporation, North Bergen, New Jersey 07047

Reproductive maturity is governed not so much by age, but by bodily development. In nature this maturity usually does not manifest itself until the reptile is from three to five years of age, but in captivity it is possible for successful mating to take place as young as eight months.

One successful, but limited mating technique that works well with some snakes (mainly lowland warm forms) is keeping the males and females separated at all times then introducing them to each other immediately after the female sheds her skin. The female should always be introduced to the male. The smell of the moist, freshly shed female skin rubbed on the back of the female often excites the male and occasionally induces him to mate.[6] To increase the chances of mating, it is advisable to introduce several individuals to maintain a small colony. The desirable ratio is a few females to a greater number of males. Repeated separation and reintroduction of the opposite sexes during certain intervals proves helpful in stimulating and enhancing mating.

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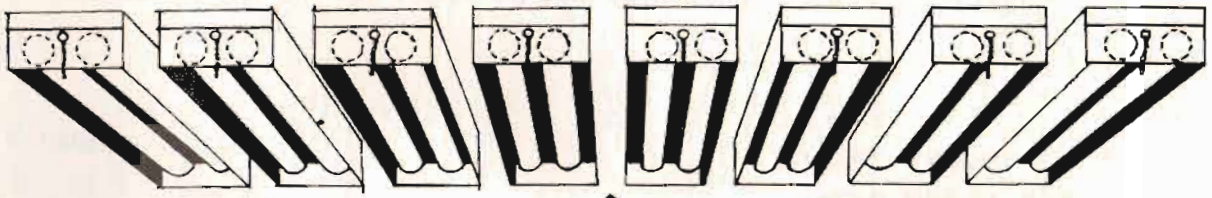
The writer wishes to express his sincere thanks to Alan Dardon, Reptile Keeper, for helping secure many of the important references used in this vital project.

6. Logan, Tommy, Curator, Reptiles, Houston Zoological Gardens

UNIT AND REPTILES NEED TO BE AIR-CONDITIONED BETWEEN 25°-12°c (77°-54°F) DEPENDING ON APPLICATIONS.



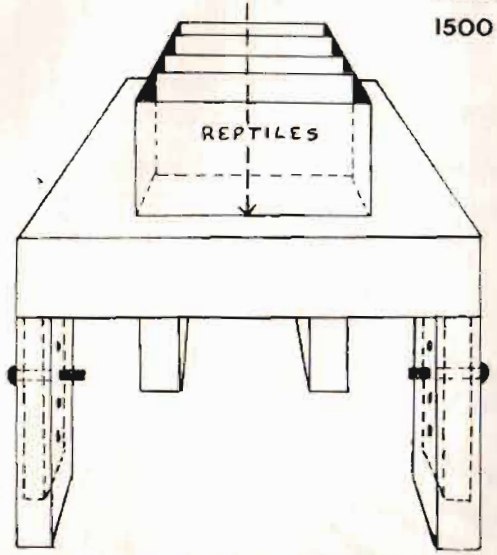
MINIMUM OF 1½" BETWEEN LIGHT FIXTURES- THIS SPACE IS IMPORTANT FOR LESS HEAT BUILD-UP.

3'o"

TOTAL OF 16 LIGHTS - 8 FIXTURES.

215w, 96" TH. 17 U.H.O. FLUORESCEN 1500 M.A. POWER TWIST.

EVERY DOUBLE FIXTURE HAS AN INDIVIDUAL ON & OFF SWITCH.



ADJUSTABLE HEIGHT TABLE.

PROPOSED PLAN FOR 1975-77 REPTILIAN PHOTO-BIOLOGIC REPRODUCTIVE STUDIES AT SAN ANTONIO ZOOLOGICAL GARDENS - REPTILE DEPARTMENT.

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Exposure to the photoperiod is a vital factor in captive snake breeding. Its effect on tropical species is uncertain but it definitely evokes a positive response in sub-tropical and temperate-zone forms. Fortunately, our Reptile House has a spacious room with a glass ceiling admitting natural daylight. Here, specimens that are kept apart for most of the year are brought together for breeding in the early spring. Additionally, 12 large habitat exhibits are partially lighted through windows set behind and slightly above them so that their occupants have at least a dim perception of the photoperiod. Prospective mates are kept together in these cages throughout the year.

Eggs are taken from the mother as soon as possible after laying. Our incubators are one-gallon glass jars with screw-on lids. The jars contain four inches of sterilized pea gravel and two inches of water. The eggs are placed on top of the gravel and the lids are left ajar until shortly before hatching time when they are screwed on loosely to prevent possible escape of hatchlings. The incubators are kept in well-lit areas but out of direct sunlight. Each jar holds about 12 eggs; large clutches may be divided between two or more jars. Using this method, we have had an 85 - 90% hatch.

Hatchlings are removed from the incubator as soon as they are out of the eggs. This is done to protect unhatched eggs. On at least two occasions, the first hatchlings accidentally slit other eggs with their egg-teeth, apparently causing death of the embryos in the prematurely opened eggs.

3 Turtles:

Terrapene c. carolina
Graptemys nigrinoda
Pseudemys s. scripta

6 Lizards:

Anolis c. carolinensis
Sceloporus u. undulatus
Phrynosoma cornutum
Coleonyx variegatus
Eumeces fasciatus
E. inexpectatus

16 Snakes:

Heterodon platyrhinos
Diadophis punctatus
Coluber constrictor
Opheodrys aestivus
Drymarchon c. erebonnus
Elaphe g. guttata
E. o. spiloides
Pituophis m. sayi
Lampropeltis g. getulus
L. g. floridana
L. g. niger
L. g. californiae
L. g. doliata
L. mexicana blari
L. c. rhombomaculata
Cemophora coccinea

You will notice that the same technique works with snakes, turtles, and lizards. We have never had any crocodilian eggs to try, but I suspect it would work with them also.

Experienced herp people will probably note the basic similarities between this method and that reported by Charles Hoessle of the St. Louis Zoo in the International Zoo Yearbook Vol. 9 (pp. 13-14). The basic differences being the use of a box rather than plastic bags and Vermiculite instead of peat moss. We feel that the advantages offered by the strength of the box and the relative cleanliness of Vermiculite are significant improvements; also he had trouble with turtle eggs which we have not experienced.

I should mention that, quite by coincidence, both Mr. Pate and I place our eggs under Gro-lux fluorescent lights. We do not know if this is significant, but it surely has not been detrimental to hatching success.

I do not have the facilities to experiment with many different variables, nor does our small reptile collection provide an abundance of eggs to hatch. However, I do have a few speculations to offer as to why this method works so well. As I mentioned earlier the mica material is heat-treated for softness, this treatment is of sufficient duration and temperature to destroy most mold and bacteria spores, as you know, most egg failures for which a cause is known are due to mold. Vermiculite is soft and non-abrasive, any hatching medium which includes sand must scratch the eggs, providing a point of attack for mold. The use of paper towels has enjoyed fairly good success, but, even so, paper itself is subject to attack by various fungi and provides a nutrient source for mold not associated with Vermiculite. The spongy texture of Vermiculite also allows free circulation of air around the egg and cushions the developing embryos from external shock. Last of all the newly hatched reptiles can safely crawl around on or burrow into the Vermiculite in the event the hatching is not immediately discovered.

2. Cage size and specimens housed:
   a. 4' x 8' x 4' - 2 Burmese (females)
   b. 3' x 6' x 2' - 1 Indian (female)
   c. 3' x 6' x 2' - 1 Indian (female)
   d. 3' x 3' x 2' - 1 Indian (female)
   e. 4' x 6' x 4' - 2 Burmese (males)
   - 2 Indian (males)
   - Cage is partitioned in center with 4 males separated according to sub-species.

3. This caging system (1 per cage with Indians) is very space consuming. However, the feed and breeding is very well controlled.

4. Bedding used: San-I-Cel (ground corn cobs)

E. BREEDING

1. Breeding season
   a. Is December, January and February
   b. At this time male is placed in cage with female I wish to mate him with
   c. Scent - given off by adult females plays an important role to stimulate male.
   d. After copulation, male is removed until I wish to use him again. I found much better results to occur by removing male and re-introducing him rather than leaving him in continuously.
   e. Copulation usually lasts from 1 - 4 hours.

2. Specifics
   a. Burmese - males are alternated in cage but never introduced together.
   b. Indian - 1st male was bred with 2 females of similar color
   2nd male was bred with female of similar color

   RESULT:
   **This year I was able to offer for sale unrelated offspring, which I never have heard of being offered before.

3. Past Breeding Results:
   a. 1973-74 Bred - 2 Burmese
   b. 1974-75 Bred - 2 Burmese
   1 Indian
   c. 1975-76 Bred - 2 Burmese
   3 Indian

NOTE: The number of females listed above for each breeding season were the only ones tried for that particular season. They were bred and produced fertile clutches, contributing to the 100% breeding success up to the present.

4. Feeding During Breeding
   a. Males - once males refuse food for the first time during the breeding season they are never offered food again until the end of the season. This way they concentrate entirely on breeding instead of digestion. They usually refuse at the beginning of the season.
   b. Females are also offered food until they stop which is usually half way through the season.

2. Breeding Records
   a. Name of breeders
   b. Approximate times of copulation

3. Laying Records
   a. Name of female
   b. Weight of each egg
   c. Weight of female after laying
   d. Average egg weight
   e. % egg clutch is of total body weight of female

4. Hatching records
   a. Name of female
   b. Dates of hatching
   c. Number hatched on that date

J. FUTURE GOALS

1. To breed Peruvian Red-Tail boas, which I will be trying for the second season, working with 2/2 adults.
2. To set up several other pairs of adult boas or pythons for breeding.
3. To raise my highest of 86% hatchability to a constand 90% - 100%.
4. Continue to produce quality
   a. *Python molurus bivittatus*
   b. *Python molurus molurus* - hopefully continue in the future as this year producing unrelated offspring to help and encourage other collectors to also set up breeding programs in order to continue this "Endangered Species."

ventral surface. The follicles develop rather rapidly; it is possible to palpate a snake one week and feel nothing and then find fully developed follicles the following week. From the time of development of her follicles, the female has approximately twenty-one days to locate a male and mate before they will be reabasorbed. Mating should optimally occur within the first two weeks. Matings which occur past 15 or 16 days of follicle development often result in low fertility or the follicles being reabsorbed anyway. After copulation the follicles become larger and non-palpable as embryogenesis and development occurs. During the following month additional changes occur in the female, including her going off feed and the absorption of the adipose tissue along the vertebrae, giving her a ridge backed, pear-shaped, appearance if viewed in cross section. Basking under a heat source may frequently occur during this period if one is available. Prior to egg laying a shed will occur which will give you a very accurate timing mechanism for calculating the day the eggs will be laid. In 145 clutches of corn snakes in Dr. Slemmer's lab he observed the range for this pre-egg laying shed to be 9 to 12 days, with an average of 10 days. In Blair's kings they shed 6 to 8 days prior to laying. Arizona mountain kings shed 10 days prior, Sinaloa milks, 12 days, Emorys rats 14 days and Burmese pythons 10 days prior to egg laying. After the eggs are laid, there follows another shed, the postlaying shed, which like the first shed occurs on a very predictable cycle usually 9 to 13 days after the eggs are laid, depending on species.

All of these behavioral mechanisms are very useful in determining what is occurring with your animals and they point out the advantage of a private collection over a public one such as a zoo. In zoos the snakes and lizards can be given some cover but need to remain on display. In private collections with the use of the hidebox many of these mechanisms become quite obvious. If you come into the collection in the middle of the day and all of the snakes are hidden out of sight, everything's normal. If a snake is out and restless it could mean illness, an impending shed, mite infestation or possibly a reproductive state, especially if other animals of the same species are active at the same time. At any rate it is a sure signal that something is going on with that particular animal and some attention should be paid to find out what it is. In many ways, a hidebox is the most useful tool a collection can utilize.

With several species of snakes including corn snakes, Blair's kings, Florida kings, California kings and Emory's rats, we have observed recycling after the first clutch has been laid, with the development of follicles again and the production of a second clutch of eggs within the same season. This appears to be a trait which is passed on from one generation to another. I have heard a lot of discussion in visiting various zoos about the usefulness of separating and re-introducing the sexes to induce breeding. The sudden introduction of the opposite sex may induce copulatory behavior, especially on the part of the male, but if environmental conditions have not induced follicle formation in the female at that particular time, nothing will come of it. We house our snakes together year round at the zoo and get good reproduction. Often many of the behavioral signals are missed by the keepers because the snakes are forced out in the open all the time, or the signals are occuring in the evening when no one is present to see them. It is also effective to house your snakes separately and watch for follicular development in the females and then introduce the animals together, especially if you are breeding large numbers of animals for specific

it on a prophylactic tetracycline regimen in the drinking water until the respiratory wheezing clears up. The clean environment is much more important in dealing effectively with this problem than the tetracycline. Dr. Slemmer has written a detailed description of the etiology of this syndrome and its effect on system, which will be published at a later date. Any questions on this will be forwarded to him. The most important thing to remember is to keep your cages clean and catch any problems at an early stage when they can be treated easily.

As already mentioned earlier, it is best to keep each species at its own optimum temperature. Variation too far above or below the optimum can be very damaging over the long run as it can cause a shutdown of the immune response mechanism and interfere with the snake's ability to produce antibodies, making your snakes susceptible to infectious processes which would normally be easily controlled by the body. It can also interfere with correct kidney function, causing a visceral gout condition with urate deposits throughout the gut.

Day-to-night variations in temperature do not seem to be important in maintaining and reproducing most reptiles; but in some species, such as some of the *Thamnophis* and *Heloderma*, a winter cooling period is a required precurser to reproduction.

The type of light cycle used to stimulate breeding has already been discussed, but there is often uncertainty about which lights are effective and the required intensity. Incandescent lights are a full spectrum light and they have proven effective at both the zoo and at home. Of the fluorescent type lights, we have shown that the cool white is probably not an effective light for inducing reproduction, but the vita-light probably is. Relatively low intensities appear to be effective, for example the 25 watt incandescent light which I use at home.

Age of reproduction is another consideration, and I believe that it is not the age of a snake or lizard which matters, but its size. If a hatchling is kept under optimum conditions and given large amounts of food and adequate vitamin supplement, it can reach reproductive size at a very early age. Dr. Slemmer has had 30% of his corn snakes reproduce at 9 to 11 months of age and can get 100% reproduction by 20 months of age. Leopard geckos will easily grow to a reproductive size within one year of hatching.

Sexing snakes is a relatively simple process with most species. Most adults can be sexed by external observation of a thicker, longer tail in the males, especially if it is a species you are familiar with. Probing is the most certain method and is a very safe procedure if done correctly. A blunt-ended probe of the appropriate size should be inserted into the hemipenal opening with gentle pressure and the probe should be rolled between the fingers as it is inserted. Any size snake can be effectively probed, including newly hatched babies, and we have never injured a snake during this procedure. King snakes are the most difficult to sex, and there are times that even probing may be confusing with some members of this genus. Lizards can be sexed in a variety of ways, from external features such as the presence of enlarged preanal pores in males of some species, to probing in others such as the monitors.

Vitamin D3 supplement is one of the less obvious factors which has a direct effect on reproduction in many species. Obviously adequate levels of D3 are needed for proper utilization of available calcium during growth. Therefore it is important to supplement juveniles at adequate levels, and those animals which are undergoing a very rapid period of growth have a much higher requirement than those who are growing slowly. Beyond this

go moldy or spoil within a couple of weeks. This is probably caused by low sperm count in the male at the time of copulation. This is relatively easy to check if copulation is observed. When the male withdraws, a large amount of sperm is deposited on the substrate and it is quite simple to check for viable sperm with a microscope at this time. Sperm can also be obtained from a cloacal smear taken from the female any time within a week after mating.

Most of the processes which I have described here are applicable to many of the temperate and subtemperate species of reptiles; but what about tropical forms? Many tropical forms don't see a greatly changing light cycle, yet they are often seasonal in reproduction, such as the boas and pythons. These animals may be cycled by changes in humidity indicating wet or dry seasons, or they may be very sensitive to minor changes in seasonal temperatures, or they may simply have built in (circadian type) mechanisms which time their reproductive periods. We have not been able to palpate follicles in female boas or pythons prior to copulation. On three boas from separate collections which were examined during copulation this spring, none had palpable follicles at the time of copulation. About two weeks later, they all went into a shed and all had palpable follicles at that time. This may be a different type of mechanism at work where, during the correct seasons of the year, if the opportunity to copulate arises, the snakes will do so and possibly the act of copulation or the presence of sperm may then cause follicle formation in the female. Not enough information is available on this group of animals at this time to do more than speculate.

The main thing I would like to leave you with is that there is a large amount of information remaining to be worked out in this field, and it should be approached in a logical, rational fashion. Much of the information we are looking for will be given to us through the behavior of the reptiles themselves; and in the course of a busy day's routine of cage cleaning and feeding, it pays to take the time to observe behavior and try to interpret its meaning.

place them in a dark place and do not interrupt them with motion and light for a few days. When the eggs are valuable to me I frequently hatch them in several groups, perhaps using both methods. In reference to this it is probably of significance that in at least one clutch in which I incubated half of the clutch on nylon netting and the other half in vermiculite the eggs in vermiculite hatched four days before the other group, indicating that the vermiculite holds more heat.

I mentioned this before, but this symposium, if it proves to be an annual affair, would prove an exceptionally good place to bring our results together and find out if any one of a number of methods are equally good, or if, indeed, there is one best method for snake eggs or perhaps one best method for various genera.

SOME PARAMETERS FOR BREEDING REPTILES IN CAPTIVITY

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So far this year at Woodland Park Zoo we have bred the following species: *Eublepharis macularius, Hemitheconyx caudicinctus, Heloderma suspectum, Lampropeltis getulus californiae, L. g. floridana, L. zonata, L. melanoleucus alterna* (Blair's phase), *Elaphe guttata, Pituophis m. catenifer, Agkistrodon mokasen, A. bilineatus, Chameleo jacksoni* and *Dendrobates auratus*. In addition between our combined facilities we have bred over the past four to five years: *L. pyromelana, L. triangulum sinaloae, L. t. annulata, L. g. splendida, L. g. yumensis, Elaphe g. emoryi, Elaphe g. rosacea, Elaphe obsoleta quadrivittata, Pituophis m. affinis, Python m. molurus, Python m. bivittatus and Boa constrictor.* Some of these species have been bred to the third and fourth generation by us. During this period of time Dr. Slemmer has produced over 1000 corn snakes and the zoo has produced over 250 leopard geckos.

I will begin with a brief description of the three facilities used for housing and reproduction and then discuss some of the problems involved. Woodland Park Zoo has a fairly new reptile house which, like most zoos, is built for the display of a variety of reptiles to the general public. There are 30 fiberglass cages approximately four feet square with cast-in pools. There are four large walk-in cages for housing pythons, boas, monitor and gila monsters and there are seven grotto displays including a large natural swamp about 20 feet square which houses a trio of bog turtles and sundry other swamp animals. The reptile collection is typical of what you would expect to find in any good municipal zoo. The heating is forced air, with a background temperature of 75° to 78°F in the daytime, dropping to 72° to 74°F in the evenings. Lighting is provided by incandescent lamps and our animals have bred under these for several years. We are adding vita-lights to the exhibits but still retaining one incandescent light over most of the cages. The wattage is varied depending on how warm we want that particular cage. The substrate for most cages is dry sand or pea gravel and driftwood and plastic plants are used freely in the exhibits.

My breeding room at home is in the basement and has a background temperature of 70°F in the evening, 75°F during the day except in the winter when the temperature falls to 60°F at night and 65°F in the daytime. I use 25 watt incandescent lights over the cages and for heat there is a double heat tape attached to the back wall of the aquarium racks. All the cages are pushed up against this tape so the snakes can select their own temperatures, warm at one end of the cage or cool at the other. The heat tapes are attached to a rheostat and turned down as low as they will go. All my own cages are aquariums with a substrate of dry fir wood shavings and every cage has two plastic hideboxes. One of these is on the heated end of the cage and the other is on the cool end, allowing the snakes to hide but not be forced into unwanted temperatures when they do so. Light cycle is varied from 8 hours in the winter to 16 hours in the summer, the same as in the zoo collection. In addition to this area I have an environmental chamber about two feet square and four

compared with that of other snakes. Once adapted to captivity, a *Spilotes* will feed twice a week. When your specimen has established acceptable feeding habits, it is generally a good idea to administer a mild vermifuge, since almost every wild-caught specimen has endoparasites. If the animal has been under severe stress, you may also wish to inject vitamins and a broad-spectrum antibiotic. Calculate all dosages by weight, not by body length.

After as much as a year of privacy and regular feeding, you may be able to display your *Spilotes*. It is much more likely, however, that the animal will at once go off feed and get neurotic again. Our suggestion is that you keep adult *Spilotes* behind the scenes and breed them, since properly raised baby *Spilotes* make wonderful display snakes and have none of the problems common to specimens captured as adults. By allowing your breeders total privacy, you can produce enough *Spilotes* to ensure a permanent supply of display specimens.

3. Breeding. If you are fortunate enough to acquire a gravid *Spilotes*, don't wait until she lays her eggs before you begin your attemps to feed her. Because of the lightning metabolism of this slender snake, the female continues to feed throughout the gestation period.

Mating seasons vary with the native (and captive) latitude of whatever subspecies you are working with, and it is possible for a female to lay more than one clutch of eggs in a year. Use your own preferred methods of breeding regarding ultraviolet, vitamin D, temperature variation, and photoperiodicity. Once your adults are healthy and have adjusted to their new environment, introduce the male and female. Keep them together for a few days, and repeat the procedure once a month until copulation is observed or until the female is obviously gravid. Provide her with a box of moist sphagnum and give her a small water dish, or you may have the heartbreaking experience of finding an entire clutch of eggs drowned in the water bowl. The female may be ready to mate again two or three months after laying her eggs.

Gestation lasts about two and a half months, and the eggs take about three months to hatch. A good-sized female will produce four to nine smooth, elongate eggs. Standard incubation procedures for snake eggs should be used; sterile sphagnum works particularly well.

4. Hatchlings. The babies will be about 18" long and pencil-thin. It is vitally important that they begin feeding as soon as possible. Begin offering live pinkie mice immediately after the postnatal shed. Our own method of feeding hatchling *Spilotes* involves a radical departure from the normal feeding practices of adults, but it produces snakes that are well adapted to display purposes, with aggressive (and diurnal) feeding habits.

Provide each baby with its own small cage and a tiny wooden hiding box. A small branch for climbing can be included in the cage. When your hatchlings have shed, take the hiding box out of the cage and toss in a pinkie mouse. It is important that you feed hatchlings only during the day, and that you stay by the cage during the whole procedure to accustom the baby snake to your presence at feeding time. If the hatchling shows no interest in the baby mouse, pick it up and tease him with it. Baby *Spilotes* are just as irascible as their parents, and after several strikes at your hand the hatchling is likely to grab the pinkie by accident and begin to investigate it or even to swallow it right away. If he abandons it, pick it up and tap his nose with it again. If he hasn't eaten after 15 minutes, give up your efforts and try again the next day. You may leave the pinkie in the cage, and if it is eaten later, try to make sure that you are present during future meals. Some hatchlings are picky