7th ANNUAL
REPTILE SYMPOSIUM
on
CAPTIVE PROPAGATION & HUSBANDRY

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7th Reptile Symposium
On Captive Propagation and Husbandry

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From a small one day gathering, the Reptile Symposium on Captive Propagation has grown into an international event. Along with increased attendance has been a higher level of sophistication. Species that were once thought difficult to even keep alive ten years ago are being bred with astonishing regularity. The beauty of an event like the Reptile Breeding Symposium is the fact that this priceless information on reptile reproduction and husbandry is being shared with others. Information relating to reproduction of a rare species was often jealously guarded and not available to the very few people who could have made the most of it. With a new awareness of the precarious existence of many reptiles and amphibians, this attitude has been replaced with a spirit of cooperation which is reflected in the papers presented in this volume.

We were most fortunate that we were able to host this years symposium in the Dallas-Fort Worth area in close proximity to two of the world's most excellent reptile collections. Additionally, the dedicated staffs of the Dallas and Fort Worth Zoos that served on the host committee worked tirelessly to ensure the symposium's great success. Mention must be made of the efforts of David L. Blody, Donal M. Boyer, Richard D. Hudson, Janice Perry and especially to David G. Barker and William E. Lamereaux who acted as host co-chairmen. The Symposium Series Director and the driving force behind the Symposium from the start was Richard A. Hahn. J. Michael Goode pulled the event together as Symposium Coordinator. Thomas A. Huff, Martin J. Rosenberg, and Dr. Richard Ross were invaluable for the effort they put into the program year after year, and Quentin Bloxam as European liason ensured that this symposium was truly an international event. Many thanks for all your help.

Most importantly, we all owe a debt of gratitude to the many contributors that made this event possible. Their willingness to share painfully learned secrets with us all is what made this and the other symposia in our series resounding successes. It was a pleasure working with you all.

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THE SPECIES SURVIVAL PLAN (SSP)

AND IT'S APPLICATION TO REPTILES

Rick Hudson

INTRODUCTION

By the end of the century, about 80% of the earth's people will live in the poorest, least developed countries, where about 80% of the remaining wildlife dwells today. During this period, Africa's population is expected to increase 104% from the base year of 1975, while Latin America's has been projected to increase 96%. Biologists predict that the consequences will be the loss of 15-20% of all living species of plants and animals and the dangerous diminution of many more, primarily as a result of human increase and the conversion of wildlands for man's use (Conway, 1983).

Some of these species can be preserved in zoos and that is the goal of the Species Survival Plan, hereafter referred to as the SSP. The concept was conceived, developed and implemented by the American Association of Zoological Parks and Aquariums (AAZPA), and is specifically defined as "an attempt to develop scientific and cooperative programs to propagate and preserve endangered species in captivity through populational management (Foose, 1981a).

Today, zoos devote increasing priority to propagating endangered animals and making commitments to wildlife preservation with an almost unparalleled spirit of cooperation, as evidenced by the now widespread practice of breeding loan agreements. Although the past few years of cooperation between institutions in matching unmated animals has enhanced breeding results, it has not provided a sound basis for the allocation of zoo space among vanishing animals according to need, responded adequately to the problems of inbreeding or genetic drift, or resulted in agreed upon zoo animal carrying capacities. Neither has it resulted in coordinated scientific study of the problems facing long term wild animal husbandry. It has become clear that cooperation with coordination is insufficient to preserve endangered species in captivity over long periods of time and that captive populations fragmented among many small collections can be preserved only if they are managed scientifically as a whole (or a single biological population) (Conway, 1983).

To coordinate their collective efforts, zoos must first agree upon the species most critically in need of help. It is clear that not every species held in captivity is in need of help. It is also clear that not every species held in captivity is appropriate for inclusion in the SSP, nor can every species now in captivity be saved from extinction. Even with the types of scientific and cooperative management employed by the SSP, the carrying capacity of zoos (space and resources) for populations large enough to be viable for long periods of time is very limited in relation to the growing number of species requiring sanctuary in captivity if they are to survive. Consequently, one of the fundamental objectives for the SSP is to select species for these captive programs, employing criteria that can be summarized under three major categories.

1) Endangerment in the wild - the species continued existence must be in some degree of peril as defined by the IUCN, ICBP, U.S.Fish

and Wildlife Service or reliable field reports.

2) Sufficiency of founder stock - there are enough individuals from the wild gene pool available for captive management to insure a viable population.

3) There must be available an organized group of captive propagation professionals with mastery of the species husbandry and with sufficient support (facilities and other resources) to develop and carry the species program to captive preservation status.

Wild animal species not currently in captivity but meeting SSP inclusion criteria are of particular concern to the SSP if they are:

1) In immediate danger of extinction.

2) The single representative of a taxonomic family or genus (Conway, 1983 and Foose, 1981b).

It is also desirable that a species registry or studbook be available for the species before it is designated for the SSP. Exceptions have been made for reptiles since there are species in immediate need of SSP management and there has never been, up until this time, a studbook compiled for any reptile species.

Some examples of reptile species that were suggested or proposed for SSP inclusion back in the early stages of the program's development, but that fail to meet the established criteria are:

1) Orinoco crocodile, Crocodylus intermedius: insufficient number of founders, with only two contained in one U.S. zoo which have reproduced once.

2) Black caiman, Melanosuchus niger: sufficient number of founders, with only five contained in two U.S. zoos. Never reproduced.

3) Ornate palm viper, Bothrops aurifer: small number of founders contained in three U.S. zoos, which have reproduced only once.

4) Malayan water monitor, Varanus salvator: acceptable number of founders available but have reproduced only once in a U.S. zoo.

5) Gray's monitor: Varanus grayi: small number of founders contained in two U.S. zoos. Reproduction has not occurred to date.

6) Angulated tortoise, Geochelone yniphora: small number of founders (2.4) contained in two U.S. zoos. Never reproduced.

7) Boelen's python, Python boeleni: small number of founders (1.2) in one U.S. zoo. Reproduction has not occured to date.

8) Angolan python, Python anchietae: small number of founders (2.1) in one U.S. zoo. Reproduction has occurred twice.

9) Bismarck ringed python, Liasis boa: small number of founders (6) but reproducing well in one U.S. zoo.

10) Madagascan tree boa, Sanzinia madagascariensis: acceptable number of founders contained in seven U.S. zoos, but reproduction is sporadic, being the exception rather than the rule.

11) Madagascan ground boa, Acrantophis madagascariensis: small, but acceptable number of founders contained in four North American institutions, all of which are in a breeding situation. However, reproduction has not occurred to date.

12) Fiji Island banded iguana, Brachuylophus fasciatus: small number of founders (6.3) contained in four U.S. zoos and in potential breeding situations in only two. Reproduction is sporadic, having occurred in three U.S. zoos but only once recently.

Most of the afore mentioned species are rare and/or endangered, and, providing additional wild caught specimens could be obtained and their reproductive biology ascertained to the extent they could be reproduced reliably, then their inclusion in the SSP may be warranted.

Large species of crocodilians present an additional major management problem in that few zoos have sufficient space or suitable climatic conditions to accommodate breeding size adults, and hence can/will not acquire captive born animals once they become available. Even with the more easily managed small forms such as the West African dwarf crocodile, Osteolaemus tetraspis, which are breeding well in several U.S. zoos , the "saturation point" in terms of institutions willing to acquire this species, is quickly reached and surplus animals are presently a problem.

Once a species is designated for SSP inclusion a multigenerational and population management plan should be developed. This plan should present a genetic and demographic analysis of the population and should provide recommendations for both general strategies and specific tactics in management, which will include:

1) The size and structure of the captive population presently, potentially, and optimally in terms of numbers, ages, and sexes.

2) How many institutions should ideally be accommodating the species in order to determine carrying capacity.

3) Which animals, optimally, should reproduce, how often and with whom.

4) Which animals should, optimally be retained in or removed from the population.

5) What basic standards of husbandry should be emphasized (Conway, 1983 and Foose, 1981c).

Several animals now largely or completely dependent upon zoo propagation are descended from such small groups of founders that inbreeding effects including reduced viability, infertility, and various physical anomalies threaten their future. Already the deleterious effects of inbreeding and genetic drift have been demonstrated in more than 40 wild species of mammals breeding in zoos (Conway, 1983).

We must expect that the deleterious effects of inbreeding will appear with increasing frequency among wild species maintained in captivity, and unless zoos and private collectors recognize the trends while the levels of inbreeding are only one or two generations from the wild, there may be little or no opportunity to correct the problems later (Shoemaker, 1982).

So it is clear that genetic management of many zoo animal populations is necessary to insure their future survival, and we've reached the point where merely breeding a species is not sufficient to guarantee this. There must be a well organized and coordinated management plan to follow, especially with species where additional specimens from the wild are no longer available. Sound captive populations must be established from as large a group of unrelated founders as practical. The history of each genetic line and each animal must be recorded and maintained while each species captive population is maximized and inbreeding managed.

The paramount objective of genetic management is to preserve and maintain the maximum amount of heritable diversity possible (Foose, 1981d). Genetic variation, referred to as heterozygosity, generally implies increased fitness, which refers to the ability of an individual to contribute to the next breeding generation. Inbreeding significantly reduces heterozygosity and fitness. For example, the result of a full sibling or parent-offspring mating is the loss of 25% of genetic diversity in the progeny. (In scientific terms these animals would have an inbreeding coefficient of 0.25. the resulting decrease

in fitness has been well demonstrated in birds and mammals. The results of a sibling mating were tested in several species of domestic birds and it led to a decrease in egg fertility, hatchability and production. In mammals, a decrease in litter size and percentage of young born alive was demonstrated (Frankel and Soule, 1981).

Though the effects of inbreeding have not been tested experimentally and/or documented in reptiles as they have in birds and mammals, there appears to be absolutely no justifiable reason to believe that the same genetic principles that apply to higher vertebrates should not apply to reptiles.

Inbreeding must be minimized because both the fecundity (number of offspring) and viability, which are critical variables, will be depressed at a rate proportional to the amount of inbreeding. Inbreeding was also shown to increase the chances of an unbalanced or skewed sex ratio in litters. This is especially undesirable if one is attempting to establish an effective population. This consists of an equal number of males and females, the adults of which reproduce and contribute equally to the next generation, producing litters having an even sex ratio (Frankel and Soule, 1981). A population with an even (1.1) sex ratio preserves nearly twice as much genetic diversity as a population of similar size with a sex ratio of 1.5 (Flesness, 1977).

An effective population must be established with a minimum of fifty animals if the per generation loss of heterozygosity is not to surpass 1%, which is the maximum tolerable rate of inbreeding. This is the basic rule of conservation genetics (Frankel and Soule, 1981).

One of the most important objectives is to attempt to equalize each founder's genetic contribution to the captive population thus assuring that the maximum amount of heritable diversity is expressed. By equaling the progeny number produced by founding pairs, it is possible to minimize the effects of genetic drift and inbreeding. This may involve promotion of fecundity in less productive pairs or culling of progeny from pairs that are over represented in the population (Frankel and Soule, 1981). This does not necessarily mean killing but refers to removing/surplusing these animals from the collective zoo (SSP) managed population.

Preservation of genetic diversity necessitates maintenance of relatively large populations. In general, the smaller a population, the faster its genetic diversity will decline. The reason is that the rate of inbreeding is inversely proportional to population size. Chronically small population size produced random gene frequency changes and fixation or loss of alleles; such random fluctuations are referred to as genetic drift. Not only will small populations continually "leak alleles" and lose genetic variance, but the beneficial alleles have roughly the same probability of being fixed as do the deleterious ones. In wild populations these deleterious genes are "weeded out" or eliminated before being fixed by the process of natural selection, but this doesn't occur in captivity. Some of these rare alleles that become lost contribute little to genetic variance. Yet rare genes, including perhaps genes for disease resistance may be important in special circumstances, such as during an epidemic (Frankel and Soule, 1981).

Though heterozygosity doesn't suffer as much as loss of alleles in small populations, there is evidence suggesting that the more genetic variation is lost, the more deleterious the losses become. A rapid increase in population size helps alleviate this loss which

means that the population should be expanded to zoo carrying capacity as soon as possible. Depending on the species and the situation, it is estimated that a population of 100-500 animals will be required to preserve an acceptable amount of genetic diversity over a number of generations (Foose, 1981d). Obviously, one or two institutions can't accomodate populations of this magnitude, nor is this desirable. Another immediate objective of the SSP is to assure that the population is well distributed so as to avoid the chance of catastrophic accident.

In addition to genetic management, a major objective of SSP programs will be to develop stable populations at established carrying capacity, which can be achieved through demographic management. Demography is the science of population dynamics and control.

Demographically, a population can be characterized by and hence managed through three basic parameters:

1) The age and sex structure of the population at particular times, i.e., how many animals there are of what ages and sexes in the population.

2) The age and sex specific survivorship, i.e., how long animals live on the average or equivalently what the chances are that an animal will survive to a certain age.

3) The age and sex specific fertilities, i.e., how well animals of various ages can usually be expected to reproduce.

Together, these parameters interact to determine how a population will change in size and structure (Foose, 1981e).

An important principle of demorgraphic management is age distribution. It is not enough to merely regulate numbers. Critical to demographic management of captive populations is stabilization of age structures. Constancy of numbers at a carrying capacity is impossible without stability of the age distribution, unless the population size is being maintained by imports from elsewhere such as the wild. But this kind of demographic subsidization will not be possible or desirable for most endangered species. Simply stated, if the ultimate objective of genetic management is diversity, the ultimate objective of demographic management is stability. The stable age distribution may be as important a concept as inbreeding for management of captive populations (Foose, 1981e).

A stable age distribution is one in which the relative number, i.e., the proportions or percentages of the population, in each class remains the same over time. A necessary trait of a stable age distribution is that each age class must contain an equal or greater number of animals than any older age class. This characteristic confers a recognizable configuration with a broad base of young animals and fewer numbers of older individuals. If an age distribution does not have this kind of configuration, it is not stable. Populations without stable age distributions will behave erratically, often oscillating drastically and detrimentally (Foose, 1981e).

Ultimately the objective of demographic management is to produce a population stable both in total numbers and in age distribution at the established optimal carrying capacity.

Now that the principles and guidelines by which SSP species will be managed have been discussed, it's appropriate to review how these plans will be implemented and by whom. The organizational structures is as follows: SSP species are designated by the Wildlife Conservation & Management Committee (WCMC) of the AAZPA in accordance with the

criteria outlined earlier. Each SSP program will be organized around a Species Coordinator, also designated by the WCMC. He is responsible for coordinating the efforts of the participating institutions in the implementation of SSP plans. The participating institution is an individual, organization, or institution which has committed animals to participation in an SSP program. The Species Coordinator is responsible to a management committee known as the Propagation Group which he convenes and acts as its chairman. It is composed of ten individuals elected by and from participating institutions, plus the species studbook keeper. For SSP programs involving ten or fewer institutions there will be at least one representative from each of the Propagation Group. The Propagation Group will be responsible for the formulation and application of a population masterplan that will provide both strategic guidelines and specific recommendations for the long-term management of their species. Institutions will document their participation in an SSP program by signing a "Memorandum of Participation" which is an agreement to manage their animals in accordance with the SSP masterplan as developed for each species by the Species Coordinator and Propagation Group. This document emphasized that SSP committments are to cooperation in the program, not to a transfer of ownership. SSP animal relocations are between the institutions involved and may entail sales, exchanges, donations or loans at their discretion (Conway, 1983; Foose, 1982).

Initially, there are five reptile species selected for SSP inclusion, representing four taxonomic orders, which were:

1) Chinese alligator, Alligator sinensis
2) Radiated tortoise, Gelchelone radiata
3) Fiji Island banded iguana, Brachylophus fasciatus
4) Indian python, Python m. molurus
5) Aruba Island rattlesnake, Crotalus unicolor

Below is a summary of the reptile species which currently have working SSP programs as well as an explanation for the species that do not.

1. Chinese alligator, Alligator sinensis: This was the first reptile to be designated for the SSP. John Behler, Curator of Herpetology at the Bronx Zoo, was named Species Coordinator as well as International Studbook Keeper.

This species satisfies basically all three of the criteria needed for SSP inclusion:

1) They are critically endangered and in imminent danger of extinction in the wild, and listed on Appendix I of CITES.

2) They have reproduced successfully at the Rockefeller Wildlife Refuge in Louisiana in 1977, 1979 and 1980 as a result of a cooperative breeding program between the Bronx and National Zoos. The number of young has increased each year with a total of 22 hatched in 1980 (J. Behler, Pers. Comm). Currently there are 17 captive born juveniles in two U.S. zoos.

3) The number of founders is fairly low with 2.4 at Rockefeller and another pair at the Bronx which recently arrived from China. Worldwide, however, there are 9.15.71 contained in 34 collections (International Zoo Yearbook) so the prospect of acquiring additional founders from foreign zoos is good.

The Chinese alligator, due to its small size and ability to over winter or hibernate outside, can be more easily managed than the larger forms of crocodilians. Hence more institutions should be able

to accommodate them, making this species an excellent choice for SSP inclusion.

II. Malagasy ground boa, Acrantophis dumerili: This was the first snake species which the WCMC received a proposal on regarding its captive status, breeding history and future management, hence it was selected for SSP inclusion. The Indian python is still on the primary list of SSP reptile candidates, but to date, no input has been received other than nominations, and a program has yet to be initiated. Hopefully the A. dumerili program will serve as a model for future snake species.

The Species Coordinator is John McLain of the Herpetology Department at the Houston Zoo and I, Rick Hudson, am in the final stages of compiling a regional studbook, which will include all animals contained in North American collections.

The Malagasy ground boa lends itself well to captive management and meets all the criteria for SSP inclusion.

1) They are listed on Appendix I of CITES and accorded Endangered Status by the IUCN Red Data Book.

2) They are well represented with 16 North American collections holding approximately 125 specimens, the majority of which are captive bred. Reproductive success has been impressive. Since 1972 seven institutions and at least four private breeders have produced numerous litters, and five of these facilities continue to do so on a regular basis. While the number of captive born animals continues to increase significantly, little attention is being paid to the lineages of breeding pairs and there is an alarmingly high incidence of inbreeding occurring, mainly among the private sector. A high percentage of offspring born in North America are the progeny of sibling parents (from the 1973 San Diego Zoo litter), or worse, progeny of siblings from sibling parents.

3) There are currently 17 founders that entered the U.S. in the early 1970's, several of which have never reproduced, or are not being maintained in breeding situations, thus representing a possible loss of valuable genetic material. Also, several of these founders are currently paired with inbred or related specimens.

John McLain and I have completed the initial evaluation of the A. dumerili population in North America and have made some basic recommendations to the Propagation Group for their approval. Primarily, these include relocating the unpaired founders to zoos holding other founders, which have experienced breeding success in the past.

III. Aruba Island Rattlesnake, Crotalus unicolor: This was one of the primary five species designated for SSP inclusion and just recently, a program has been initiated for its captive management.

Gary Carl of the Department of Herpetology at the Fort Worth Zoo has been designated Species Coordinator and Karl Peterson of the Houston Zoo Herpetology Department has been named regional studbook keeper.

This species satisfies most of the criteria for SSP inclusion;

1) Listed as "Rare" by the IUCN Red Data Book and was recently given "threatened" (T) status by the U.S. Fish and Wildlife Service, despite opposition by several zoo biologists concerned with their preservation. It is feared that "T" status will hamper zoo propagation efforts by making it exceedingly difficult or impossible to procure additional founders from Aruba Island.

2) They are breeding on a regular basis in three U.S. zoos;

however, two of these institutions maintain the same bloodline and are breeding related animals

3) The founder stock is small, consisting of six or seven animals, (several of which have never reproduced) which are contained in only two U.S. zoos.

The rarity of Crotalus unicolor is due to human encroachment (oil company, tourist industry) as well as habitat destruction by the native goat population. It has never been a common species and has been found only at the southern end of the island where their home range has been reduced to only seven square miles of undisturbed habitat. An attempt to have the Aruban government declare the remaining habitat a national park and begin a goat eradication program has been undertaken (K. Peterson, pers. comm).

Karl Peterson of the Houston Zoo Reptile Department traveled to Aruba in July and December 1982 to ascertain their status in the wild. He was unable to locate a single specimen and conversations with local people revealed that very few had been seen in the last three or so year.

If, indeed, Crotalus unicolor still exists on Aruba Island, then the population is undoubtedly very small. Considering the small number of founders in captivity today, it is imperative that increased collecting attempts be made in order to secure additional wild specimens for captive propagation.

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The U.S. Fish and Wildlife Service

Endangered Species Recovery Program

Peter G. Poulos

Introduction

The U.S. Fish and Wildlife Service (FWS) is required to develop plans for all listed Endangered and Threatened species. Current policy is to concentrate Service efforts on listed native species and not expend Endangered Species Program resources on exotic listings. Recovery plans are prepared by recovery teams, species experts, or FWS personnel. Initially recovery teams were the primary means of plan preparation for species with high visibility and wide distribution. Most remaining recovery plans are for species with limited, endemic distribution. This has led to the use of individual species experts and FWS personnel to develop recovery plans. Plans are used in the FWS to identify management and budget needs. There is inadequate funding available to fund all recovery activities. The Service, therefore, must make decisions in determining high priority needs and allocate funding resources accordingly. Captive propagation has generally not been considered a high priority recovery activity. At the present time there are nine recovery plans for reptiles.

Recovery Plans

The Endangered Species Act of 1973 (Pub. L. 93-205), as amended by the Endangered Species Act Amendments of 1982 (Pub. L. 97-304), directs the Secretary of the Interior and the Secretary of Commerce to develop and implement recovery plans for the conservation and survival of species of fish, wildlife, and plants listed as Endangered or Threatened in accordance with Section 4 of the Act. Section 4 (f) was amended to read as follows:

"(1) Recovery Plans - The Secretary shall develop and implement plans (hereinafter in this subsection referred to as 'recovery plans') for the conservation and survival of endangered species and threatened species listed pursuant to this section; unless he finds that such a plan will not promote the conservation of the species. The Secretary, in developing and implementing recovery plans (1) shall, to the maximum extent practicable, give priority to those endangered species or threatened species most likely to benefit from such plans, particularly those species that are, or may be in conflict with construction or other developmental projects or other forms of economic activity, and (2) may procure the services of appropriate public and private agencies and institutions, and other qualified persons. Recovery teams appointed pursuant to this subsection shall not be subject to the Federal Advisory Commission Act."

Recovery plans are used by many agencies and organizations responsible for conservation efforts under the Act to help eliminate

duplicative efforts and omissions. Recovery plans provide a means to combine the varied programs of the FWS and other cooperating organizations into effective,efficient, concentrated efforts, which will ultimately lead to the reclassification of listed species to non-endangered status. Non-endangered status is always the ultimate goal. In many cases, however, the immediate objective of a recovery plan may be to maintain present numbers and/or prevent extinction.

While plans are a planning tool used to identify and accomplish specific recovery objectives, recovery planning efforts are dictated by species priorities. This requires a consideration of the biological needs of a species, the threats to its survival, anticipated benefits, and interagency coordination and cooperation. Plans, therefore, are not an end in themselves, but serve as a catalyst to initiate recovery activities and then to maintain FWS objectives in all long term recovery efforts.

Recovery efforts are terminated once plan objectives have been accomplished. It is anticipated that implementation of all recovery tasks identified in a recovery plan will result in the removal of a species from the Endangered and Threatened species list (delisting). When this occurs, the FWS still retains management responsibility, but this responsibility shifts from the Office of Endangered Species to some other appropriate Service program such as the Office of Migratory Birds. Delisting may also result because of the discovery of new populations or a reassessment of current taxomonic status. Of course, delisting will follow if a species is determined to be extinct, such as recently occcurred with the Blue Pike Stizostedion vitreum glaucum.

The basic approach for a recovery plan as a management tool, then, is one of identifying individual recovery tasks and describing how these tasks are to be accomplished. All tasks identified in a recovery plan are presented in priority sequence, given an estimated duration, an estimated cost, and then assigned to an agency, organization, or individual participating in the plan's implementation. Each plan must be sufficiently dynamic to continually incorporate new facts, techniques, objectives and accomplishments, In this regard, there will never be a final version of a recovery plan until its primary objective (delisting) has been accomplished.

When originally conceived, it was determined that each listed species would have a recovery plan. It has since been shown, however, that species which share common or similar ecosytems are more logically combined into a recovery plan which addresses the recovery of the ecosystem. By the same token, wide ranging species, such as the bald eagle, require more than one recovery plan to accomodate its wide geographical distribution and divergent habitat needs.

The length and complexity of each recovery plan will vary in accordance with the complexity of problems facing the species, its geographical distribution, and number of agencies, organization, or individuals involved. A brief plan may be all that is necessary to identify simple actions such as removal of a threat or protection of a tract of land by acquisition. On the other hand, a complex and lengthy plan may be necessary for a widespread species or group of species whose status or habitat has deteriorated badly through a combination of factors and whose recovery will entail numerous actions by many organizations. The FWS has established a general format to be followed for all recovery plans.This consists of:

Part I entitled "Introduction" - It contains background material

on habitat requirements, population limiting factors, past and current distribution, status, and conservation efforts. Lengthy taxomonic discussions are not considered relevant, except in unusual circumstances.

Part II entitled "Recovery" - This section states the primary objective (delisting) of the plan in as quantitative terms as possible. This is followed by an outline which gives the steps considered necessary to meet the stated objective. This is called the Step-down Outline and should include every item/task the author/authors feel is required to attain the plan's objective. The Step-down Outline is revised as new information becomes available.

Part III entitled "Implementation Schedule" - This is the day to day "working" portion of the recovery plan. It takes the tasks identified in the Step-down Outline; identifies the responsible agency, organization, or individual; gives the task priority; estimated cost; and the estimated task duration. The Implementation Schedule is utilized by the Service to develop budgets and in assessing funding/grant proposals submitted from out side sources.

Plan Preparation

Recovery plans can be prepared in several ways;

1. By the use of a volunteer recovery team
2. By a State agency, Federal agency, institution, or conservation organization.
3. By a knowledgeable individual on a voluntary or contractural basis.
4. By the Fish and Wildlife Service.

The method used in development may depend on such factors as:

1. Range of the species (limited vs. extensive)
2. Complexity of recovery actions contemplated.
3. Number of organizations responsible.
4. Expertise of personnel available.

The FWS has been developing recovery plans since 1975. These first plans dealt with the more visible, widely distributed species and were developed almost exclusively by the recovery teams. As more and more plans were developed (there are presently 91 approved recovery plans), the method of plan development has evolved from the traditional recovery team to contracting with individual species experts.

It is the intention of the Service to have plans prepared as quickly and efficiently as possible. Currently, the development of a plan requires an average of one year from initial planning to approval by the director of the FWS (a Regional Director may approve certain recovery plans). The Service subjects draft recovery plans to three separate reviews which include the biological aspects of the plan, the administering of plan implementation, the adherance to Service policy. After aproval, the plan becomes a Service planning tool.

There are presently approved recovery plans for the following reptiles: American Crocodile Crocodylus acutus, Blunt-nosed Leopard LIzard Gambelia (=Crotaphytus) silus, Eastern Indigo Snake Drymarchon corais couperi, Culebra Giant Anole Anolis roosevelti, Virgin Island population of the Leatherback Turtle Dermochelys coriacea, and the

Plymouth Red-bellied Turtle Pseudemys (=Chrysemys) rubriventris bangsi. Three plans are in draft, pending approval. They include: Coachella Valley Fringe-toed Lizard Uma inornata, Mona Boa Epicrates monensis monensis, and the Mona Ground Iguana Cyclura stejnegeri.

Beginning in 1975, the Service concentrated its efforts in developing recovery plans for native species (including Puerto Rico, Virgin Islands). This was due primarily to the belief that any recovery plans developed by the FWS for non-native species would have no impact on the internal conservation efforts or other countries. Recovery efforts for exotic species, therefore, have been limited to import/export restrictions as imposed through the Convention on International Trade in Endangered species. No effort to develop recovery plans for exotic species is anticipated in the near future.

Captive Propagation

Captive propagation has been identified as a high priority recovery effort for only a few native species. These include the Red Wolf Canis rufus, the California Condor Gymnogyps californianus, the Houston Toad Bufo houstonensis, and several of the endangered Southwest desert fish. The captive propagation programs for the wolf, condor and toad are all administered by zoological parks while the desert fish program is administered by the Service. Captive propagation generally has never been considered a high priority recovery activity, principally because the Service has always been much more habitat protection/management oriented. This is because producing large numbers of individual organisms is not helpful if there is no habitat available in .pawhich to establish them as self-sustaining wild populations.

With the species mentioned above, the Service determined that present habitat was underutilized and wild populations needed to be augmented or reestablished. It is impossible to predict how often this may occur in the future considering the pressures exerted on our wild lands.

With the continued wide-range destruction of wildlife habitat, the Service may be forced to modify its traditional position and reconsider the importance of captive propagation in overall species recovery. Additionally, the whole concept of "recovery" may need to be reexamined in those circumstances where captive populations are all that remain and species habitat is no longer available.

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MANAGING A LARGE, PRIVATE SNAKE COLLECTION

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INTRODUCTION

The last half decade has witnessed a remarkable change in the way private snake enthusiasts in the United States establish and manage their collections. Until just a few years ago, most hobbyists maintained a hodgepodge menagerie, acquiring single specimens on a one-of-this, one-of-that basis. Little thought was given to serious breeding efforts, as few hobbyists cared to deal with the problems associated with hatching and raising young specimens. Collectors generally strived to assemble a complete series of animals, often based on color patterns or taxonomic relationships.

As wildlife conservation laws became more and more restrictive with regards to the removal of reptiles from the wild, so too did we rapidly become more proficient at propagating our captives. These factors diminished to a certain extent the need for uncontrolled removal of specimens from the wild. Peer pressure quickly influenced hobbyists to actively try to breed their captives rather than simply strive to have the best series of individuals available. This, coupled with the fact that gradually fewer wild collected specimens were legally obtainable and more and more captively produced stock was available, has led most collectors to put a much greater emphasis on assembling at least pairs, if not trios or even larger breeding groups of a few species, rather than attempting to match diversity of forms to numbers.

There have certainly been economic incentives to propagate one's captives as well. Reptile prices have escalated markedly over the last few years, and it appears that the days of seven dollar baby Boa constrictor and ten dollar California kingsnakes are long gone. Surplus hatchlings now produced are quickly consumed, either through trade or outright purchase, by a seemingly ever growing "pet" market, and a few dozen select breeder snakes can easily generate tens of thousands of dollars annually. As a result, a number of hobbyists have "gone professional" and are presently devoting a full time effort to the commercial propagation of their captives.

Collection sizes have grown recently as well; while the average private snake collection in the U.S. probably numbers between 25 and 75 specimens, a number of ambitious individuals now manage several hundred snakes single-handedly. Generated by this dramatic increase in specimens per keeper has been a number of resource management problems, such as providing functional caging facilities, an adequate and balanced food supply, and others. This discussion will analyze the problems confronting the large scale hobbyist/professional who is generally limited in space, money and most importantly, time. While few zoos would admit that their specimen/keeper ratio exceeds 500 to

1, a number of hobbyists are fast approaching this figure. The enormous time expenditure associated with maintaining this many specimens appears to be a critical difference between the private hobbyist and institutionally-associated professional zoo keepers. Not only do these private individuals generally have to manage the specimens by themselves, but to do so effectively, they must exercise conscious control of five major resource groups: food, water/humidity, caging/shelter, temperature control and data. Much of the successful methodology these persons employ today has been the result of trial-and-error techniques, expanded upon from the "standard" of established practices of years past.

While the comments and ideas presented are directed primarily at the large-scale private snake collector, they are, in many instances, applicable to both hobbyists and working zoo personnel who maintain other forms as well.

Caging/Shelter Management: Europeans have long maintained the "terrarium", normally a large, aesthetic and naturalistic cage environment filled with rocks, logs, live plants and occasionally even running water and deep pools. That these units are not only beautiful, but provide appropriate habitat for captive reptiles is testified to by early successes some European hobbyists have had at breeding even the more difficult to maintain species. American collectors, on the other hand, have generally shied away from these elaborate cage facilities, preferring the more mundane, although easier to clean and control, cage set-up. The standard in this country for smaller captives has been the aquarium or glass fronted wooden box equipped with a simple substrate such as newspaper or carpeting, a hide box shelter, and a heavy based water dish. Both heat and light are provided to the captive through the use of incandescent bulbs either within or adjacent to the cage. The serious large scale hobbyist has moved away from this standard in recent years. Although appropriate, perhaps even ideal for maintaining just a few captives, this type of basic cage facility is hardly suitable for use by the hobbyists managing several hundred captives.

The management of functional caging/shelter facilities actually involves two separate areas of endeavor: 1) the management and maintenance of containment facilities (cages), and 2) factors determining the selection of refugia for use within the cage.

Although , as mentioned, simplicity in the way of an aquarium or glass fronted box has been the standard cage in use in the U.S. for many years, a large number of maintenance problems associated with these units have made them unacceptable to most serious large scale hobbyists. Wooden cages are difficult to clean, and virtually impossible to sterilize. This may be their major drawback, as pathogenic organisms associated with dirty cages must be removed quickly and effectively from the rest of the specimens in a collection. In addition, wooden cages tend to be heavy, awkward to move, and relatively fragile. They must also be custom made, and can be relatively expensive. While aquariums are superior to wooden box-type cages in a number of ways, they never the less retain certain disadvantages, particularly their extreme fagility and the fact that they are difficult to clean thoroughly.

The most common caging unit currently in use by most large scale hobbyists nationwide is an inexpensive product which was never intended to hold reptiles: the plastic shoe and sweater box. Literally

thousands are in use in southern California alone, and more and more hobbyists are switching over from their expensive and awkward cages to these cheap and simple units. They hold a number of distinct advantages over anything else currently available: first, and possibly of the greatest significance to the large scale collector, they are extremely inexpensive. Molded of crystal clear polystyrene plastic, they can be purchased readily at most discount and department stores, retailing for between one and five dollars, or purchased in quantity through distributors for even greater savings. Secondly, they are easy to clean and effectively sterilize with chlorine bleach or other disinfectants. Thirdly, they can easily be glued if broken (although because they cost so little it is often easier to simply discard them outright). They are completely translucent, allowing easy inspection of the captive from any angle. Because they are relatively thin-walled, they heat and cool quickly, allowing temperature adjustments to be made easily. As they are normally smooth cornered, there is a reduced chance of specimen injury - rostral scraping is minimized. Finally, they are lightweight, stackable for storage when not in use, and not nearly as fragile as glass or wooden containers.

There are certain disadvantages to using shoe and sweater boxes as caging units. Like any small cage, they will obviously limit the mobility of captives and in addition only small to medium sized specimens may be maintained in them. Some would say that they are not at all aesthetic, although this is certainly a matter of opinion, as a well arranged display of individual units, in my opinion, has a certain functional beauty to it. Finally, the friction fit lids must be secured with tape, rubber bands, or blocks, as they are light enough to be easily lifted off by the captives, allowing escape.

A hide shelter placed within the containment unit,although not required by all specimens, can be of siginificant benefit to many captives. Some animals refuse to feed well without a refugium into which they can retreat; indeed, some specimens will feed only inside of one of these shelters.

Following the same basic dictates as the cage unit itself, hide-shelters should be simple and functional. While a piece of curved bark or small hollowed log may be aesthetic, these items are normally difficult to clean effectively, because the bare wood will tend to soak up any liquid component of the feces. A small blackened box with smooth corners seems to be the ideal unit in this situation, although no single satisfactory product appears to be available at this time.

Substrate selection for use within the cage is a topic of some debate. The two primary substrates used by most hobbyist/professionals are wood shavings of coarse sawdust, and either newsprint or other paper. Each of these has its own merits and faults. Paper soils quickly and requires frequent changing, while wood shavings may emit harmful fumes when wet, and are frequently ingested when the snake feeds. In addition, shavings containing walnut byproducts or certain other hardwood components must be rigorously avoided, as they can be toxic to captives.

A variety of other substrate materials have been tried, some with limited success. None, however, appear to be the substance of choice (i.e. preferred by the majority of hobbyists). These include sand and gravel, dirt or potting soil, carpeting, crushed and dried corncob, straw, vermiculite, sphagnum moss, pearlite and others.

Temperature Control Management: As previously mentioned, the old standard method of heating a cage was with incandescent lamps. That these are unsatisfactory for the large scale collector should be obvious; cost alone precludes their use, as the conversion of energy from light to heat is inefficient at best. In addition, incandescent bulbs burn out frequently, are relatively fragile, can severely burn specimens, and can affect natural light-dark cycling. The use of direct heating elements is clearly a superior method of controlling cage temperatures. A single bulb heating only one cage can consume 25 - 100 watts of energy. This same amount of energy can easily heat 30 or more separate cage units if used judiciously.

No serious large scale collectors use incandescent bulbs as their primary source of heat. A few occasionally will employ them for supplementary heating or to provide illumination, but direct heating elements, particularly heat tapes, seem to be universally the principal source of cage heating. Heat tapes are devices designed to be wrapped around pipes to prevent them from freezing in areas where winter temperatures fall below freezing. As a consequence they can be difficult to obtain in some areas.

Some hobbyists prefer to use space heating to control the temperature of their captives, employing devices such as electrical or kerosene heaters rather than direct heating elements. Using this system, all of the individual cages are assembled in a single room, and the room air temperature is maintained thermostatically at the desired temperature (usually 27 to 30 C degrees.) There appears to be several drawbacks to this practice. First, space heating is inefficient. A heating element placed directly under or adjacent to a specimen's cage allows an almost direct transfer of heat to the animal without significant radiant loss to the surrounding air. Space heaters must heat a huge volume of air which in turn heats the captives to achieve the same effects. The loss of heat through the roof and walls of a facility under this system can be significant. Secondly, space heaters allow only limited cage to cage variation. The most energetically efficient facilities will indeed allow the least variation. This can be a distinct disadvantage, as different forms certainly have different optimal thermal requirements. Third, a well heated room can be uncomfortable for the hobbyist to work in for any extended period. Although our captives may require it, few persons enjoy prolonged exposure to temperatures in excess of 30 C. Finally, and perhaps most significantly, space heating allows virtually no intracage variation in temperature. By heating the entire cage, specimens are forced to remain no cooler or warmer than the surrounding air. Rather than allowing a specimen to select its preferred temperature for conducting any particular activity (such as feeding, breeding, digestion, etc.), we virtually eliminate thermoregulatory choice. Nature has directed the evolution of thermoregulatory behaviors so as to best provide for the needs of physiological processes. And captive specimens will certainly select gradients in temperature which will most effectively and efficiently accommodate these processes.

As previously mentioned, direct heating elements (particularly heat tapes) appear to be the units of choice. On a smaller scale the so-called "hot rock" will serve adequately, even common heating pads will suffice. These have the drawback of generally producing too much heat, however, and can, like incandescent bulbs, burn specimens.

The simplest, most energy efficient, and to date most effective method of heating specimens with a direct heating element such as a heat tape is to simply place the containment unit (sweater box, aquarium, etc) directly upon the extended length of tape. By placing cages side by side, numerous units will be able to be heated with this single inexpensive heater. Through the installation of a rheostatic dimmer switch between the primary leads, the temperature of the heating device itself, and hence, the cages which sit upon it, can be controlled precisely. And finally the installation of an in-line thermostat to measure cage or heater temperatures will prevent overheating on even the hottest days. Rather than heating the entire containment unit, these types of direct heaters will generally heat only a limited area of the substrate. By adjusting the position of the cages over the heater, the keeper can "finetune" his enclosure temperatures. Most choose to place the tape or pad beneath the back third of the cage thus producing a warm area at the rear of the enclosure and a relatively cool area at the front.

Cooling is a topic few keepers are particularly concerned with. Unless one lives in areas of extreme desert heat, this is rarely an important issue, Never the less, thermostatically controlled air conditioners or other space coolers may be desirable in places where indoor temperatures can exceed 95 degrees F.

Finally, the ultimate threat to any large snake collection is fire. The extensive use of lights, heaters, and other electrical devices greatly increases the likelihood of devasting situations. Extreme care must be taken to ensure that appliances are sufficiently grounded and that all electrical cords are shielded. Heat tapes have been known to short circuit as well as overheat and catch fire. (There have been two incidences of near disaster in San Diego in the last two years). The best insurance against such problems seems to be careful attention and an orderly and well controlled facility. A sprinkler system to extinguish any potential flames might be in order as well, although no private facilities that I am aware of use one.

Food resource Management: The management of a steady, nutritionally balanced, and relatively inexpensive food supply for one's captives is generally not only the least satisfying aspect of reptile husbandry, but it can also be the most taxing, draining finances and often leading to petty frustration. This is unfortunate, as managing an adequate food supply really requires no particular amount of creativity or imagination. It is simply a matter of sufficient foresight and persistent attention.

Rodents are the primary food items offered to captive snakes. Some hobbyists use hatchling chickens as a supplement, or, in some cases, as the primary food source. The limited hobbyist, one arbitrarily defined herein to be a collector with only 20 or so captives, can afford to purchase these rodents, assuming he or she has a steady source, at regular retail prices (from pet shops, etc.), as needed.

There are three major reasons why this is impractical for the large scale hobbyist. The primary reason is cost. Normal retail prices for domestic pet shop mice range between $.75 and $1.25 each. Assuming that the hobbyist is able to buy in bulk at a discount price of $.40 per mouse, he or she still must spend between 25 and 35 dollars per specimen per year. Multiplying this figure by 200 or 300, we see that costs quickly become unreasonable. In addition to facing prohibitively

high costs, the hobbyist with several hundred captives, who is often maintaining specimens of a wide variety of sizes, must have available all sizes of rodents from the neonatal pinky to adult mice to large rats. Pet shops normally sell only one size of rodent: weaned adults. Purchasing directly from the rodent breeder can alleviate this problem. The final problem associated with the purchase of mice is time availability. The active hobbyist needs to have available on a round-the-clock basis any size and quantity of food item. Time management, as previously stated, is probably the most critical issue facing the hobbyist. He or she needs to be ale to attend to the collection at any time of day or night. While few would choose to feed their captives at 4:00AM, it may be necessary in certain instances. As a consequence, most hobbyists breed their own rodents. Not only are costs kept to a minimum in this way, but size and time availability problems are ideally controlled as well.

The successful management of a rodent breeding colony is a complex subject well beyond the scope of this discussion. A few comments, however, are appropriate. Professional and high quality equipment, while not an absolute necessity, certainly can save time, money, and a great deal of frustration. Although not inexpensive, (each set-up, including water bottle with stopper, base box, and stainless steel lid, retails at between twelve and twenty-five dollars), the investment is certainly worthwhile, as well-cared for equipment will last for years, producing thousands of mice or rats which otherwise would have to be purchased outright. Used equipment can frequently be purchased from lab supply houses or professional rodent breeders at a substantial savings.

Some hobbyists rely heavily on frozen mice and rats to feed their captives, as these items require virtually no attention, and must only be thawed prior to being offered to the specimen. But there are problems associated with a diet of mainly frozen foods, the most obvious being the inevitable loss of vitamins as a result of the food being kept frozen for long periods of time. In addition, the frozen good item continues to decay while frozen (bacteria levels increase relatively slowly in frozen tissue, however), and there is some question as to how long an item may remain frozen and still be safely used. I personally have know of hobbyists using mice that have been frozen for several years, although most hobbyists now discard an item if it remains unused for six months to one year. While feeding long frozen items may not result in acute illnesses, a continued diet of such foods is certainly nutritionally depleted, and may result in chronic and or difficult to diagnose problems.

Artificial diets have been tried in various zoos with apparently good success. These basically consist of a commercially prepared carnivore or feline diet mixture, occasionally supplemented with vitamins, and encased in pork or sheep gut sausage casings. The "sausage" may either be used immediately, or frozen for later use. While many specimens eagerly accept this diet outright, others will only take sausages that have been scented with the snake's principal prey item or regular prey offering. These artificial diets may hold great promise for the future; however, they are still experimental in nature, somewhat awkward to use, and must be prepared on a custom basis. For the time being, therefore, most hobbyists will continue to rely on whole animal food sources.

The adage "you are what you eat" applies not only to humans, but

to captive animals as well. For this reason, it is important to feed specimens healthy and well fed rodents. Prey gut contents are often an important source of certain vitamins for reptiles, and the constant use of starved or sickly mice could result in vitamin deficiencies. On the other hand, a diet of primarily obese rodents can cause complications, possibly resulting in not only obese but malnourished captives as well.

Water/humidity Management Providing: an adequate water supply to captive snakes seems a simple enough task on the surface. Simply place a heavy based water dish in the specimen's cage and fill it up. But as we all know, water quality varies greatly from area to area, and this may be of significance to our captives.

In 1978 The EPA reported the results of a survey of municipal water qualities in 113 major U.S. cities. One pollutant they tested for was trihalomethane, a cholorination by-product. Prior tests had established 100 ppb to be a level safe for human consumption. My hometown, San Diego, California, slid under the rope at 97ppb. The worst area tested was the city of Melborne, Florida, with a measured level of 550ppb. Another city in California, Fresno, maintained an exemplary level of only .37ppb. Because of statistics like these, a number of serious hobbyists rely on bottled, distilled or well water, rather than depending on municipal water qualities for both themselves and their captives.

Most hobbyists provide drinking water to their captives on a constant basis, enabling the snakes to drink whenever water is desired. Others prefer to offer drinking water on an occasional basis only. Both groups have arguments in their favor. The pros and cons of each system are discussed in Table 1.

TABLE 1

Constant Water Supply Available to Captives	Water Offered Only Occasionally to Captives
ADVANTAGES	
Water constantly available for drinking, soaking, etc.	Forces regular attention to herps
Humidity within cage easy to keep relatively high if desired	H_2O always clean
DISADVANTAGES	
Dish invariably knocked over soaking substrate	Forces regular attention to herps
Soiled H_2O may foster pathogenic organisms	May result in dehydrated captives
Captives may drink soiled H_2O	Very time consuming
Captives may sit in H_2O too long	High humidity levels harder to maintain

Maintaining a controlled humidity level within a captive's enclosure is a practice frequently ignored by the casual or inexperienced collector. In my opinion,however, it can be a significant factor in the management of young specimens in particular. Empirical evidence suggests that relatively high humidity levels can predispose hatchling snakes to feed more actively and aggressively. Dampening a heated area of the substrate with paper towels will elevate levels significantly, particularly in a relatively closed cage environment. Obviously, this dictates that particular attention be paid to the cage substrate, as a warm and humid environment will clearly stimulate the eventual growth and development of pathogenic organisms.

Data Management: The final topic of this discussion involves information management. This subject actually warrants much greater depth than presented here; however, a few major points are in order.

There are two general categories of data kept by collectors: The first is immediate or temporary information. This generally involves some record of the current state of a specimen or its current activities. Included in this category are such things as contents of the cage (besides the captive; particularly, quantity and type of food items being offered), health conditions of the captive, and other states, such as gravidity period, in preecdysis, and so forth. Although some hobbyists feel that they know their captives so well that recording this data is unimportant, most will have to admit that

a rotting or regurgitated mouse can be difficult to locate when there has been no record of which specimens were offered food and which were not. Most collectors employ a cage-tagging system of some sort to identify the animals that have been offered food, are gravid, are opaque , etc. The presence of some form of removable tag allows the hobbyist to know at a glance the current state of any particular captive without having to open the cage and examine the specimen closely. In addition, it allows him or her to remove offered food items should they remain uneaten.

The second category of data recorded is permanent information about each specimen within the collection. This may include such things as origin and ownership of the animal, a brief physical description of the specimen, and any notable or unusual behavioral characteristic displayed by the captive. In addition, food preferences, genealogy, and other aspects of captive history, including feeding, shedding and breeding events are normally recorded.

Most serious hobbyists record this permanent data on a data card or form, often custom designed or modified from a zoo specimen record sheet. Others employ a log-book style format, with daily entries recorded on a single page. A few advanced collectors have begun to computerize their data. The flexibility and expansion capabilities of computer application to this area are limited only by the imagination. Not only can one maintain an accessible inventory and individual specimen history, but many other related subjects such as expense records and annual breeding patterns can be analyzed. It seems evident that as computers become more and more a part of our lives, so too will they be used in the management of large private animal collections to a greater and greater degree.

Conclusion: The analytical examination of reptile collection management should be an effort that all hobbyists make, functionality must constantly be strived for in order to minimize the expenditure of time and money, and to maximize the enjoyment of the captives themselves. The five separate areas of management presented here cover the major issues of concern: Although other topics, such as veterinary care and breeding techniques, are beyond the scope of this discussion, they nevertheless form additional aspects of collection management, and thus should be examined. Only through the efficient control of all of these aspects of reptile maintenance will the serious hobbyist achieve successful long term collection management.

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PREVENTION AND TREATMENT OF DYSTOCIA IN REPTILES

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This presentation will deal with some of the treatments of dystocia in reptiles, particularly in snakes. In each of the methods, the advantages and disadvantages of the procedure will be reviewed.

Obviously, the best treatment for dystocia is prevention. Most dystocias are probably caused by improper husbandry. Certainly, one should acquire as much knowledge as possible about the care of the animals under them. If the proper conditions cannot be met adequately, it would be better not to breed until they can be met. Unfortunately, in many cases nobody really knows the best way to care for herps. So sometimes we must try to do our best, use common sense, and the knowledge available.

Some of the factors to consider in prevention of dystocia are:

1) Proper nutrition for that particular species. Never assume if good for one species, it's good for another.
2) Adjust cycling, cooling, and seasonal changes for the breeding regime.
3) Have correct temperature and humidity at all times.
4) Have good substrate, nesting materials, etc.
5) Have correct photoperiod if necessary.
6) Allow the animals to reach adequate age and size before breeding.
7) Have hiding areas, seclusion and avoid undue stress and disturbance.

All the next factors should be diligently studied and hopefully met (Collins and Murphy, 1980). Know when parturition should occur. The guidelines include:

1) Knowing when copulation occurs and the average gestation period.
2) Usually colubrids lay eggs shortly after a pre-laying shed, about 7-14 days; This is more variable in boas and pythons.
3) Note restlessness, and nesting behavior (be sure nesting sites are available) should be evident.
4) Changes in weight distribution and overall appearance of the female.
5) Positioning of the young or eggs, especially of moving down towards the vent, "dropping".
6) Female makes attempts at parturition, or has uterine contractions.
7) Some of eggs laid and others are retained.
8) Nesting behavior, uterine contractions, etc. and then all stops with nothing produced.

Close observation and knowing the animals is essential to ascertain when parturition should occur. If the latter few observations have occurred and no eggs or young have been produced, dystocia is probably present. Don't treat early or premature abortion may be induced (Collins and Murphy, 1980, Wagner, 1983).

Assuming all husbandry and environmental conditions have been met and there are still retained eggs or young after delivery should have occurred, the keeper has several options available. If the female is healthy, of good weight, and feeding, she may be just left alone and observed closely for any developing problems. The other options can be

divided into three categories: drug or hormonal, physical manipulations, and surgery.

There are several drugs which may help in correcting dystocia. Almost all of them are used to stimulate uterine contractions. It is best to use them very close to normal parturition to synchronize with the female's own hormone levels and time table. The principal advantages are ease of treatment and the relatively high degree of safety. The disadvantage is they give only fair results at best, and are usually unsuccessful. This method seems to work best in turtles. Generally they should be the first option chosen and used as close to normal parturition date as possible (Frye, 1981; Wagner 1983).

The most popular is oxytocin (Pitocin - Parke-Davis), a posterior pituitary hormone that induces uterine contractions. Dosage is 1 to 4 units/100 grams of body weight in small turtles and lizards and .5 to 1.0 units/100 grams in larger animals. Give intramuscular (IM) or subcutaneous (SQ), and if no results occur, repeat in two to four hours at the same or half the original dose. A calcium product such as calcium lactate at .5 to 5.0 ml. given IM 30 minutes prior to oxytocin may sensitize the uterus to the oxytocin. This has not been proven definitively in reptiles, but it has worked well in dogs by the IV (intravenous) route of 5 to 10 ml. (Bush, 1980; Frye, 1981; Roberts, 1971).

There are other drugs that may have possibilities, but these should be researched prior to dosage. Dexamethasone, 1-5 mg. IM, is a glucocorticoid which is actually quite similar to the sex hormones. It is sometimes used to abort cattle.

Arginine vasotocin, (AVT) a nuerohypophysial hormone, is experimental and difficult to acquire. It induces oviductal and uterine contractions. Intraperitoneal injections of 2.0 micrograms of AVT worked very well in small lizards. It has worked well in turtles and colubrid snakes and may hold much promise (Jones and Guillette, 1982).

Prostaglandins are substances that occur in nearly all tissues, at least in mammals and have numerous chemical and biological activities. They probably cause changes in the uterine wall and may aid the action of oxytocin. Those products have other activities and probably should not be used until much more research is done on them. The same applies to PMS (pregnant mare serum) (Collins and Murphy, 1980).

Estrogens,like the glucocorticoids, can induce abortion. .1 to 1 mg. of ECP (estradiol cyclopentylate) would be a maximum dosage (Roberts, 1971).

Most of the drugs offer some potential and should be safe at the correct dosages. Oxytocin, especially in conjunction with a calcium product such as calcium lactate, is probably the safest, has fair efficacy, and would usually be a high choice to use. The reptilian neurohypophysis contains mesotocin, arginine vasotocin, and oxytocin. Since mesotocin and AVT are probably the major hormones involved in parturition, AVT may very likely be the future drug of choice.Some experiments have found it to be ten times more effective than oxytocin (Collins and Murphy 1980).

Physical manipulations have sometimes proved successful. They should be done within a week or two after normal parturition to minimize adhesions between eggs and the reproductive tract. Severe damage or even death can occur in the process of removing eggs or young after adhesions have formed. The advantages are: usually safe if done very gently; often successful especially if only one or two obstructing

eggs; no female hormonal changes as with drugs. the disadvantages are: difficult to internally see what is being done; may easily injure the female; permanently damage the reproductive tract and therefore any future reproduction. There are several methods.

Aspiration of egg contents through the belly wall with a 14-23 gauge needle can reduce egg size and ease delivery. The introduced contamination, possible internal damage, pain, and inability to see internally, would generally make this a poor technique to use. It could have merit when collapsing one egg that is blocking the vent and when done via the open vent. Therefore, there would be no damage to female, no pain, no contamination, and one can see what is being done.

A better technique is to lubricate the vent thoroughly, insert a probe, and lubricate round the egg in the oviduct. The oviduct opening is immediately inside the vent and up on the roof of the cloaca. Use a good sterile lubricant such as K-Y Jelly (Wagner, 1983).

Be gentle. If eggs cannot be massaged out easily, don't force them. Tissues can be torn, or eggs ruptured and left to decompose in the oviducts. This could result in infection, toxemia, and eventual death. Sometimes an obstetric forceps can be inserted into cloacoa and used to gently grasp the egg and remove it. Gentle stretching of the vent and soft massage may also aid laying (Wagner, 1983).

If relaxation is needed, anesthesia may be used if available. Halothane gas may be given via an endotraceal tube or a saturated cotton ball may be placed in a syringe cover, funnel or small jar and animal left to breathe into them. Never do this without close monitoring of anesthesia depth. It is better to keep patients on the light side with some movement, voluntary self-breathing, even tongue movement, etc. rather than a comatose patient that may succumb to anesthesia overdose. Thus, never do this alone and make sure someone is always measuring the depth of anesthesia.

Ketamine (Ketaset*-Bristol) can be given IM at a dosage of 20-60 mg/kg/ Generally it is very safe. Some research should be done before using any of these anesthetics. Always try to become knowledgeable about any drug that you use (Frye, 1981).

If previous methods fail, and the animal's condition is deteriorating, then a caesarian may be indicated. If she is feeding and acting normally, some keepers have elected to forego treatment. Some reptiles have deposited eggs several months later, but this is usually the exception. Invariably all retained eggs or young are non-viable in a dystocia. As viable eggs would be very rare in this situation, saving the female should be the top priority.

If a caesarian is decided upon, the incision site is scrubbed and prepped for surgery and the patient is anesthetized with a general or a local anesthetic. The author has found that 2-10 cc of lidocaine hydrochloride, a local anesthetic, injected along the incision site usually allows the surgery to be performed without general anesthesia and the associated risks. Moreover, one person can usually hold the animal easily as pain and subsequent struggle are minimal.

The integument is cut through at the ventral midline or just below the ventral part of the ribs along the edge of the belly scales. Incise over one of the more caudal eggs but cranial to vent and cloacal tissues.

After the oviduct is exposed, it is incised and all the contents are massaged to and removed from the one site. Don't allow any of the contents to leak out into the coelomic cavity and risk contamination.

Pack with gauze sponges around the opening or bring the oviduct out of the body if possible and them remove the eggs or young (Frye, 1981).

When finished, close the oviducts with two layers of continuous inverting sutures. If contamination is suspected, an antibiotic such as nitrofurazone (Furacin-Eaton) may be placed in the coelomic cavity. The belly wall is then sutured closed. Make sure that the coelomic membrane, musculature, and integument are properly apposed to each other. Since the scales tend to invert markedly, they must be everted before tightening the sutures. Absorbable sutures are usually left in for 2-3 weeks (Frye, 1981).

Post-op, gentamycin sulfate (Gentocin-Schering), at 2.5 mg/kg may be given every 72 hours for 3-5 injections if it is felt antibiotics are needed. If antibiotics are used, make sure the type and dosage are safe for that particular species. The above dosage has proved nephrotoxic in some species of pythons. Most animals recover nicely from ceasarians and have been known to reproduce successfully in future breeding attempts (Bush, 1980).

On Chelonian caesarians refer to an article on the detailed procedure of this operation (Frye 1981). It would be better yet to take the animal to a veterinarian who has had previous success with this procedure. The advantages of caesarian are complete removal of eggs or young, and complete visualization of the reproductive tract and any problems that may then hopefully be corrected. The disadvantages are the surgical risk; introduced contamination; tissue damage to the female; and probable higher expense. Overall, the success rate should be high.

DISCUSSION

In summary, try to know as much before breeding as possible. Do everything to prevent dystocia before it occurs. Try drugs and/or manipulations as soon as possible to: coincide with animal's natural parturition process and hormonal levels; prevent adhesions from forming and to avoid developing toxemia from possible decomposing embryos or eggs.

Much needs to be known, and these should be used as guidelines only. Insight, common sense, and the pursuit and sharing of knowledge by all will go a long way to increasing success in the treatment and prevention of dystocia.

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NEUROLOGICAL SYNDROMES IN SNAKES

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Damage to the neurological system is one of the major undesirable effects secondary to the use of drugs, chemicals, or other therapeutic modalities in captive reptile husbandry. Whereas animals with legs can demonstrate a variety of neurological disturbances, snakes, lacking limbs, are limited in their ability to manifest nerve damage secondary to any of the therapeutic or maintenance procedures that we may use. In fact, the only manner in which nerve damage is manifested is by disturbance in serpentoid movement, feeding behaviour, or posture. We have observed such disturbances in several snakes during the last few years which seem similar in physical nature, but which appear to be due to unrelated causes. Four separate and neurologically similar but distinguishable disorders have occurred in specimens under our care.

The first, and perhaps most well known neurological syndrome is that caused by viral encephalitis, a disease which has appeared intermittently in collections in localized epidemics since about 1972. The infection itself has been described in detail at this Symposium in 1982 by Dr. Elliot Jacobson. Briefly, it is a viral infection of the brain, an acute infection which like a number of human viral diseases, leaves the infected animal with a relatively permanent syndrome of neurological damage. Several facts should be emphasized about this disease. First, although it is difficult to prove this point, one infection probably confers life-long immunity. In mammals, one infection by viral organisms causes the immune system to generate antibodies which are life-long. It is because of this that it is only possible to get chicken pox, measles, and similar diseases once during each persons lifetime. Second, and again difficult to prove, an acute infection by this organism probably only produces paralytic disease, or nerve damage, in a limited percentage of infected animals. In 1974, we submitted a specimen with this disorder to the Stanford University experimental veterinary laboratory. Electron microscope studies of the brain demonstrated lesions very similar to that of poliomyelitis, or polio, in humans. In human polio, paralytic disease occurs in about 5% of affected individuals. Similarly, nerve damage probably occurs in some limited percentage of snakes, rather than in all infected specimens. This probably accounts for the phenomenon of only a limited number of snakes developing the physical signs of the disease as it spreads through a collection. During our experience with this disease, we noted that in some cases only one specimen in a cage with three or four specimens actually developed the neurological syndrome. Two other factors about this disease should be mentioned here: (1) it is untreatable, and (2) it is incurable. We have frequently spoken with collectors and even veterinarians who have treated specimens afflicted with this disease with a variety of different drugs and treatments, including antibiotics, steroids, high oxygen concentration, etc. Without exception, the residual damage of this infection is not treatable. This is not to say that it is completely permanent: we have seen an occasional specimen mildly afflicted with neurological damage from this infection recover spontaneously after some months. However, this is an inherent aspect of the disease in that if the damage is mild, it may not be totally irreversible. How-

ever, there is no treatment for the condition per se: if recovery is to take place, it will do so spontaneously. Since it is a viral disease, it is essentially incurable, as there are no drugs that are effective for viral diseases except for experimental drugs not yet released for general usage.

This syndrome is manifested by a loss of coordination of the anterior segment of the body, such that the head is held in unusual positions, sometimes turned backwards at the neck, sometimes inverted upwards and backwards over the body during attempts to crawl. There is no loss of ability to drink, strike, constrict, and eat. Specimens mildly affected may eat if dead food is placed in the mouth, and may drink if the head is placed in water, but may actually be unable to withdraw the head from the water vessel. One specimen in our collection, a Burmese python, had mild neurological damage from this disorder, and was kept alive in the above manner for several years, during which time he successfully bred with a female.

If this disease appears in a collection, the standard precautions of isolation should be initiated, e.g., keeping affected specimens, as well as specimens in direct contact with affected specimens, separate from other specimens. The acute phase of the disease is certainly self-limiting, but there is no way to know exactly at what point afflicted specimens are no longer contagious. Several months would certainly be adequate.

The second neurological syndrome is similar to the first, in that it is characterized by a loss of coordination, but distinctly different in that the area affected is not the anterior portion of the body, but the posterior. Earlier, I described a method of treating respiratory infections by "thermotherapy", or using high temperature over an extended period of time. In one specimen that this treatment was used for, at about 6 or 7 days of treatment, some ataxia, or loss of coordination was observed. The snake was able to strike quite effectively, and was also able to constrict, kill, and eat. However, when excited, the middle and posterior part of the body would become twisted and contorted in purposeless movements. When quiet, the snake appeared normal; when it attempted to crawl, tha ataxia and loss of coordination became apparent. Over a several week period, the symptoms gradually disappeared, the tail end returning to normal at last. After about four weeks, the snake was entirely normal. Presumably, this effect was caused by prolonged exposure to high temperature. We have seen this disorder in a snake that was exposed to excessively cold temperatures, and in this specimen the effects were permanent; we also know of two specimens that developed this disorder after attempts at artificial hibernation at 60 degrees. These snakes were pythons: both died shortly after the neurological abnormalities appeared, this being several days after the termination of the hibernation period. The syndrome is clearly different from the post-encephalitis syndrome in that the latter is not reversible and different areas of the body were affected.

The third syndrome involves the entire body of the snake, thus differentiating it from the other two. We have one specimen that twenty-four hours after treatment with a full size Vapona-type insecticide strip, had developed a generalized ataxia affecting the entire body. It is most pronounced when the snake is excited, least noticeable when the snake is crawling slowly, and sometimes causes the snake to rest in unusual positions as well. At rest, it often appears

normal. The snake is able to strike, and also constrict, and can drink. This snake has maintained these symptoms for nearly one year without any sign of improvement. It was acquired as a freshly imported specimen, and developed the syndrome several months after acquisition, making it unlikely that it was caused by heat damage, and also unlikely to be caused by encephalitis, since it was normal for several months before the symptoms became apparent, and no other specimen in the collection developed the disorder. Although it is difficult to prove, we feel this disorder developed from the Vapona strip: whereas these devices are used widely, there are occasional reports of death from their use, and in this case, an entire new strip was placed in the cage.

The last syndrome is that caused by aminoglycoside neurotoxicity. It is well known that the aminoglycoside drugs, such as gentamycin, or gentocin, cause renal damage. They can also cause nerve damage when given in mildly toxic doses. This can be manifested in several ways. The least severe is loss of the righting reflex: snakes with this disorder lie with segments of their body inverted or twisted, sometimes totally upside down. With more severe damage, loss of coordination during feeding seems to occur. We have had several specimens that have been treated successfully with these drugs, but subsequently had great difficulty in feeding. They become very aggressive and excited when food is placed in the cage, but seem unable to locate it, and strike or attack in all directions. Alternatively, they may demonstrate a tremor-like movement when poising to strike. The prey may be killed by being constricted by a random coil from the midsection of the body, or by pressing it against the side of the cage. Sometimes, when the food is placed directly in front of the snake, even touching the nose, the snake seems unable to recognize it, but if the prey is grasped while randomly striking about, it is readily killed: however, it is not uncommon for the snake to have extreme difficulty in locating the prey after having killed it; if killed food is left in the cage, the snake rarely finds it. Once having killed the prey, the affected snake may search for hours, even among its own coils with the prey totally constricted repeatedly passing over the food animal and eventually abandonning the search. Part of this abnormal behaviour may be caused by olfactory nerve damage, perhaps to Jacobson's organ, making it difficult for the snake to locate or identify prey; other components of the pattern are possibly caused by cerebellar damage. Ataxia such as occurs in the previous syndromes does not occur, except that constricting is often rather sloppy and uncoordinated. Thus this syndrome is easily differentiated from the others, in that during excitation or crawling, there is no ataxia or loss of coordination. The primary problem occurs with feeding, and loss of righting reflex.

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NOTES ON A BREEDING OF THE RED - EYED TREE FROG, *Agalychnie calliorvas*

Tracy J. Miller

INTRODUCTION

The red eyed tree frog, *Agalychnis callidryas*, is a moderate sized species that ranges throughout Mexico, Honduras, Costa Rica, and Panama. It inhabits forested regions where it breeds in temporary and permanent ponds during the rainy season (Duellman, 1970). Duellman (1970) described and illustrated personal observations regarding the red-eyed tree frogs, and the reader is referred to this book for the descriptive diagnosis, natural history, and distribution of the species.

MATERIALS AND METHODS

Three male (x length 48mm) and one female (55mm)(Fig.3c) were housed in a standard exhibit unit at the Buffalo Zoo (Fig.1). Cherry et. al. (1983) described this exhibit design, and the reader is referred to this paper for the description and its application to succesful reproduction and maintenance of amphibian species at the Buffalo Zoo.

The red-eyed tree frogs, as well as other species maintained in the collection, were kept in relatively dry environments. The frogs were kept in a dry cycle prior to the breeding period and misted only lightly one or two times per week. In the prebreeding period, light, daily mistings were done at 8:00 and 16:00. Each frog was carefully lifted from its resting position and lightly misted with warm water.

The frogs were maintained on two week old crickets heavily dusted with bonemeal and Vionate powder two to three times per week. Small and moderate sized species such as the red-eyed tree frogs are fed smaller sized food items in greater quantities (Miller 1983a).

A daily individual inspection of the frogs kept a continual update on health, feeding activity, and position preference in the exhibit. Understanding activity levels, territorial relationships, feeding mechanisms, and environmental conditioning is thought to be of prime importance for the successful maintenance and reproduction of any amphibian species.

REPRODUCTION

Observations in the wild of *Agalychnis callidryas* at Encinal, indicate breeding activity during the months of June, July, and August (Pyburn, 1963). Data from a captive breeding at Minnesota Zoo indicated a breeding period of October through January. Egg deposition occurred twice during this time, but no tadpoles were successfully metamorphosed (Lewis, 1981).

Based on information from the Minnesota Zoo that a breeding had occurred in October, it was decided to try to environmentally cycle the red-eyed tree frogs in the Buffalo Zoo collection to encourage a breeding at the same time. Misting schedules were altered in the first week of September, 1982, until the frogs were exposed to one

shower 15-30 minutes in duration between 16:00 and 16:30 daily.

Frogs were observed in amplexus for the first time on September 24, 1982. The single female was seen in amplexus with all three males during the breeding period. The female was quite active and carried a male on her back continuously until egg deposition on October 17, 1982. The males rarely opened their eyes even if the female would leap across the exhibit. Similar behavior has been observed in the wild (Pyburn, 1963).

The female's abdominal area appeared to become enlarged although eggs could not be seen. Conversely, the males after being in amplexus for days on end appeared very thin. Fighting between the three males to remain in amplexus with the female or gain a position on the female was not observed (Pyburn, 1970), but it is felt that there was a distinct possibilty that confrontations between the males did occur. The physical condition of the males seemed to deteriorate during the breeding period, and several times when checked in the morning the frogs and the exhibit were noted to have a much dirtier appearance than normal.

The female with a male on her back was observed on a leaf surface overhanging the pool below many times. Amplexus was also observed on the glass front of the exhibit over the water. The female appeared so large by October 16, 1982, and amplexus was observed so frequently that it was decided to increase the daily 30 minute shower to a late afternoon-all night shower. It was hoped that this stimulation of a long rain would initiate egg deposition.

A fine mist of hot water entering the exhibit from a hose installed in the rear vent (Fig. 1), was turned on at 15:00 the afternoon of the 16. On the morning of October 17, it was discovered that four clutches of eggs had been deposited by the female (Fig. 2).

RESULTS

CARE OF EGGS AND EGG DEVELOPMENT

Three egg clutches were laid on one side panel of the exhibit. A plastic shoe box filled one inch deep with dechlorinated water was secured underneath the clutches. A fourth clutch was laid on the surface of a Pathos leaf directly above the water. The leaf was carefully removed and carried off to the exhibit area. A glass gallon jar was filled with one inch of dechlorinated water and used to "incubate" the eggs in. A string was tied to the stem of the leaf and the leaf was suspended in the jar several inches above the water. A top was made from a shallow side of a plastic culture dish and secured with tape to the jar. Holes were drilled in the top for ventilation.

The number of clutches, size of clutches, and number of eggs per clutch was consistent with the literature (Pyburn, 1963, 1970). The eggs were all uniformly light turquoise in color. Pyburn's (1963) description of the egg mass, "The eggs are fairly evenly spaced near the surface of the clear jelly. At first the surface of the mass is relatively even, but as development proceeds the exposed surface of the jelly around each egg becomes rounded, giving the entire clutch the globular appearance of a miniature bunch of grapes" is a perfect one. The transition of the shape of the egg clutch during the five days from deposition to hatching is a fascinating one to watch.

The following day the eggs were observed to be in two distinctly different states. The majority of the eggs were now green on the

bottom and white on the top. Unfertilized eggs of P. callidryas contain a large quantity of green yolk, capped by pale cream cytoplasm at the animal pole (Pyburn, 1963). The remaining eggs were determined to be fertile.

Embryos could be seen developing on 10/19/82, and were observed drifting from side to side in the jelly envelopes. The gel masses changed in their configuration at this time. On 10/20/82 the first external gill filaments were observed and muscular contractions started. The embryos developed steadily and on the morning 10/22/82 were found hatched. Tadpoles were found swimming in the bottom of the gallon jar and the plastic shoe box.

CARE AND DEVELOPMENT OF THE TADPOLES

A total of 23 tadpoles with an average length of 10mm hatched. Two of these did not appear normal and died shortly after hatching. The remaining 21 tadpoles were set up in standard 15 gallon aquariums, 5 tadpoles per tank.

Each tank was filled with two gallons of dechlorinated water. Complete water changes were made every 48 hours. Tanks were cleaned with tap water, and no detergents were ever used. Tanks were aerated.

To maintain temperature and prevent water evaporation plexiglass tops were cut to fit over the tanks. Two inches of air space was left uncovered. Heat was provided by heat cables run underneath the tanks. Water temperatures ranged daily from 76-86F.

Light was provided by Chroma 50 and black light lamps suspended in fixtures above the tanks. Lights were on from 8:00-16:30 daily.

The diet for the tadpoles was Tetra-min Basic diet. Food was offered three times daily at 8:00, 12:00, and 16:00. Bone meal and Vionate powder was finely ground and offered at the 16:00 feeding starting day 31 post hatching. The addition of bone meal and Vionate coincided with the legs of the tadpoles approaching one third of the way out. Tremper (1982, pers. comm.) recommended this to me after being told of deformities in captive hatched, newly metamorphosed Litoria caerulea. The true benefit of adding bonemeal and Vionate is unknown. I have used the Tetra-min flaked food diet with the addition of the calcium and mineral supplements for Agalychnis callidryas, Bombina orientalis, Bufo lemur, and Litoria caerulea. In the nearly 750 frogs that have metamorphosed, not one has exhibited a deformity.

The tadpoles were often observed in a stationary position at a 45 degree angle while rapidly propelling the tips of their tails. Their behavior was similar to that observed in Dendrobates auratus tadpoles. The tadpoles were measured weekly and grew from post hatching size of 10mm to premetamorphosis size of 50mm (Fig. 3a). The first fecal strands were observed five days after hatching. Color change was dramatic toward the end of development. The green color that had come in by 11/12/82, suddenly turned to pink on 11/24/82. Nemarus (1982, pers. comm.) observed newly metamorphosed individuals of red-eyed tree frogs in the wild in Panama that were red. On 11/29/82, white spots that were raised above the skin surface appeared on many of the tadpoles. These same spots are often observed on adult red-eyed tree frogs.

On 12/1/82, 40 days post hatching two tadpoles had their arms out. Two transparent spots on the white ventral surface of the tadpole are where the arms emerge from. Large finger tips could be seen

protruding from the ventral surface. The arms slowly emerge at the same time. At this time, the mouths had changed and they were no longer feeding.

CARE OF NEWLY METAMORPHOSED FROGS

Two newly metamorphosed red-eyed tree frogs were found 12/2/82, 41 days post hatching. As they emerged from the water, the frogs climbed up the side of the tank. While their tails were being absorbed, they remained on the glass so that the end of the tail remained in the water.

A fundamental error was made during this state of transition. The frogs remained on the sides of the aquarium until their tails were absorbed. No surface areas were provided for them to climb upon. The frogs were misted several times a day for the fear that they would become dehydrated. The exact opposite occurred and the frogs took on a bloated appearance as fluids accumulated in their abdominal area. Maintaining the frogs in an environment which was too humid was thought to contribute to this condition. The frogs were transferred to a less humid environment with live plants, branches, and gravel.The bloated appearance subsided and an alternative method of transition was later found.

A second species of tree frog, Litoria caerulea, was transitioned very successfully. A glass pie plate was placed upside down into the water with a potted plant on top. All of the frogs climbed up into the plants and absorbed their tails while perched on the branches and leaves. No bloating was observed in the 275 newly metemorphosed tree frogs (Miller, 1983b).

The newly metamorphosed frogs were in two distinct color phases; red and green. Many times the babies would be red during the day and green during the night, or the reverse. No set pattern could be observed as to when or why the colors would change at this time. As weeks went by the red color phase was observed less frequently until no babies were observed in the red phase during the day time. At night, most individuals were observed to be in the red phase. On many occasions, the young frogs were observed in the daytime in a blue color phase. Red-eyed tree frogs, White's tree frogs. and Phyllomedusa hypochondriallis have all been observed in green/brown-red/blue color phases throughout the day.

The tadpoles of red-eyed tree frogs have round pupils. As the frogs metamorphosed and were absorbing their tails the pupils were observed to have gone from a round to an elliptical shape. As observed by Pyburn (1963) and others, the color of the eyes at metamorphosis was a straw yellow which did not start to change to bright red until more than two weeks post metamorphosis.

The maintainence of the young frogs was exactly the same as the adults. Each specimen was checked visually at 8:00 and 16:00 daily. The frogs were lightly misted at this time. The frogs were fed two week old crickets dusted heavily with bone meal and Vionate powder two times per week at 16:30.

DISCUSSION

The hatching of the red-eyed tree frog tadpoles and their metamorphosis represents the first successful captive breeding and raising

for this species in a United States zoo. Though this species is maintained in many collections, scant data is available detailing captive management or reproductive efforts.

Information regarding breeding behavior, egg development, tadpole development and metamorphosis is consistent with and supports the existing literature. Rate of metamorphosis was considerably shorter than published by Pyburn (1963) with an average of 43 days versus 79 days. This was probably due to optimal environmental conditions and a high protein diet. Growth and development of the frogs has been constant (Fig. 3b) and it is expected that they could reproduce by one year of age.

Five of the frogs have been loaned to the San Diego Zoo, where they are being cared for by Susan Schafer. They have adapted well to their new environment and records are being kept of their growth and development. Future plans include establishing a group of red-eyed tree frogs that will reproduce with predictability. Emphasis will be on getting a better understanding of reproductive behaviors, tadpole behavior, and color change mechanisms.

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Products Mentioned in Text

G.E. Chroma 50	General Electric Co. General Offices Nela Park Cleveland, Ohio 44122
Lawler Series 9200 Exposed Photographic Mixing Valve	Lawler ITT 453 North Mac Queston Pkwy. Mount Vernon, New York 10552
Sylvania F40-BL Blacklight	Sylvania One Stanford Form Stanford, Conn. 06904
Tetra-Min Flaked Fish Food	Tetra Werke Dr. Rev. Nat. Ulrich West Germany
Vionate Vitamin-Mineral Powder	E.R. Squibb & Sons, Inc. Prineton, N.J. 08540

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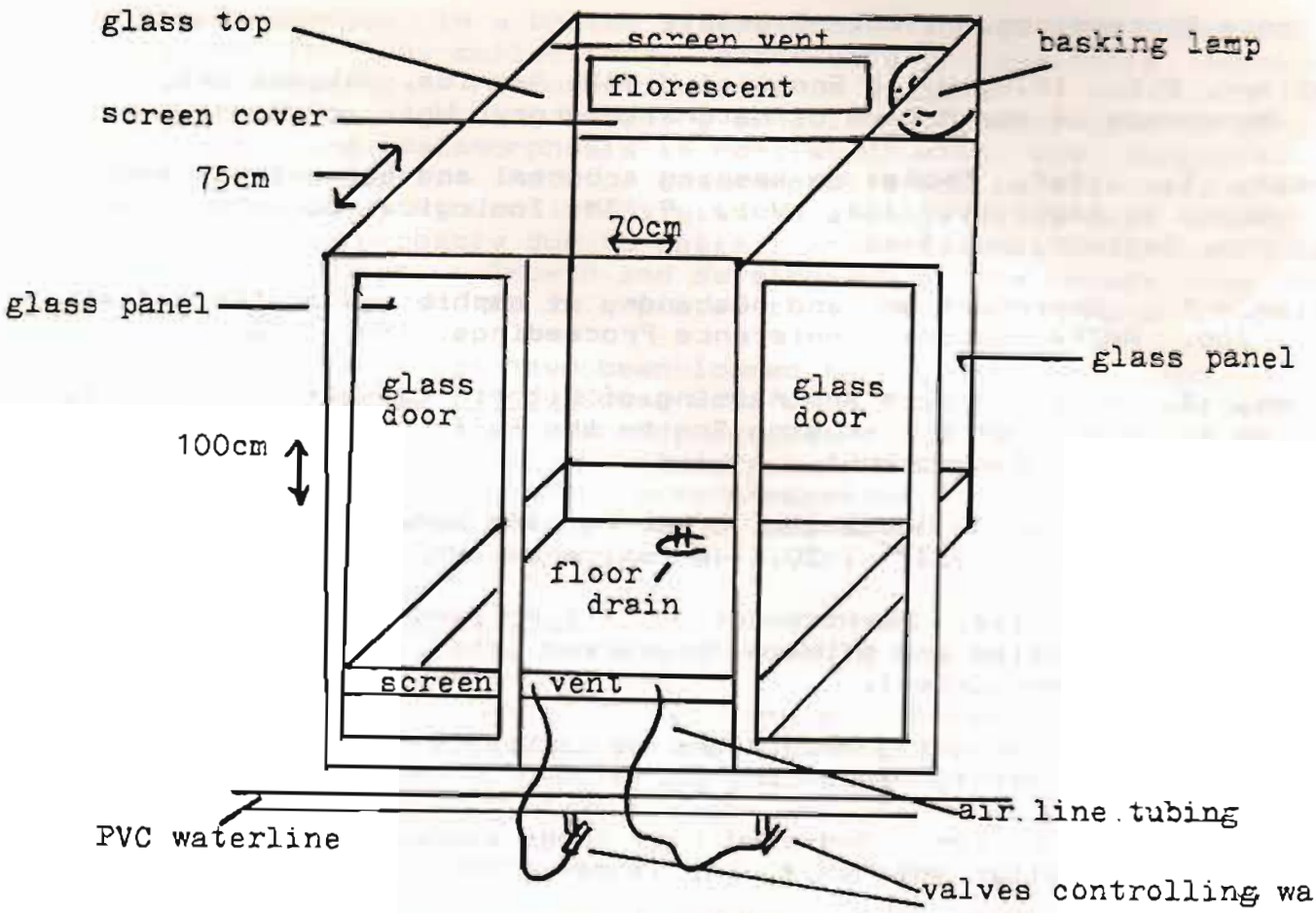

Figure 1. Exhibit unit for amphibians at the Buffalo Zoo.

	Number of eggs in clutch	Width of clutch	Length of clutch	Height above water
#1	65	40mm	55mm	91cm
#2	40	30mm	35mm	66cm
#3	38	25mm	40mm	91cm
#4	20	20mm	25mm	83cm

Figure 2. Data on egg clutches deposited 10/17/82 by female Red-eyed tree frog.

Fig. 3a
n=21

DATE	SIZE	NOTES
10/22/82	10mm	Tadpoles hatched.
10/27/82		First fecal strands observed.
10/29/82	18-20mm	
10/30/82		Leg buds observed for first time.
11/ 5/82	25-30mm	
11/12/82	35-40mm	Green color coming in on bodies.
11/19/82	40-45mm	Ventral surface turning white.
11/24/82		Body color turning pink.
11/26/82	50mm+	
11/29/82		Arms seen moving. White spots observed on dorsal surface.
12/ 1/82		Arms on two tadpoles are out.
12/02/82		Mouths changing, not feeding.
12/03/82		5 frogs out of water.
12/04/82		3 frogs out of water.
12/05/82		7 frogs out of water.
12/06/82		5 frogs out of water.
12/07/82		1 frog out of water.

Fig. 3b
n=7

12/1 - 12/7	20mm S-V	21 frogs out of water.
12/21/82		Red coloration in eyes coming in.
1/03/82	23-25mm	
2/03/82	28-30mm	
3/03/82	32-38mm	Possible sex differentiation in growth rate observed.
4/03/82	40-45mm	
5/20/82	42-52mm 6.1-10.0g. $\bar{x}$ 7.5g.	

Fig. 3c
n=4

ADULT FROGS

1.0 #1: 48mm S-V
1.0 #2: 50mm
1.0 #3: 48mm
0.1 #1: 55mm

Figures 3a- Growth rate and development of Agalychnis callidryas tadpoles (21), hatched 10/22/82.

3b- Growth rate of newly metamorphosed Agalychnis callidryas (7), metamorphosed 12/1/82 - 12/7/82.

3c- Measurements of breeding group of Agalychnis callidryas (4).

	Red-eyed tree frog *Agalychnis callidryas* +	Fire-bellied toad *Bombina orientalis*	Puerto Rican Crested toad *Bufo lemur* ++	Poison Arrow frog *Dendrobates auratus*	White's tree frog *Litoria caerulea*
Number of eggs that female deposited	100+	100-200+	300+	4-13	1,000+
Time from egg deposition to hatching	5days	48hrs.	24hrs.	6-9days	24hrs.
Size of tadpole at hatching	10mm	10mm	5mm	10mm	10mm*
Size of tadpole prior to metamorphosis	50mm+	45mm	35mm	28mm+	70mm+
Leg buds apparent	8days	7days	7days	30days	7days
Arms out	40days	21days+	17days+	44days+	16days
Metamorphosis	41-47days	23-39days	20-30days	54-61days	19-27days
Size of frog/toad at metamorphosis	20mm	10mm	10mm	10mm+	20mm
Number metamorphosed	21	400+	180	15	275

* Tadpoles observed one day post hatching.

+ First captive breeding and raising of this species in a United States Zoo.

++ First second generation captive breeding for this species.

+++ First captive breeding by Houston Zoo for this species in a United States Zoo. Transferred to Buffalo Zoo one day after tadpoles hatched.

Figure 4. Comparitive chart of egg deposition, tadpole growth, and number of frogs/toads metamorphosed between Red-eyed tree frogs and four other species metamorphosed at Buffalo Zoological Gardens.

HORMONALLY INDUCED BREEDING AND REARING OF WHITE'S TREEFROG, *Litoria caerula* (Anura: PELODRYADIDAE)

R. Andrew Odum
John M. McClain, and
Thomas C. Shely

INTRODUCTION

White's treefrog, *Litoria caerulea*, is a moderate to large species (maximum S-V length >100 mm) of treefrog found in northern and eastern Australia as well as southern New Guinea. It is found in a wide variety of habitats from semi-arid brush to tropical forests and breeds in temporarily flooded grassy marshes. This species commonly enters human dwellings where it appears to be attracted to any open water (i.e. toilets, water tanks) (Cogger, 1975).

In captivity, we have found *L. caerulea* to be a hardy species that can be maintained for years on a diet of crickets and small mice. They can be housed in a variety of types of enclosures, including plastic shoeboxes, aquaria, concrete display cages, and wooden cages. These anurans are fairly tolerant of dry cage conditions and temperatures ranging from 20-32C degrees.

The following is an account of the first known captive breeding of White's treefrogs in North America, with the only other known breeding occurring in England in 1982 (Ronald Tremper, pers. comm.). This paper will describe the conditions of this breeding and will discuss several methods used to rear the larvae at two institutions (The Buffalo Zoological Gardens, BZG; and the Houston Zoological Gardens, HZG). A short discussion of water quality and its effects on amphibian larvae is included.

MATERIALS AND METHODS

Breeding

Our first attempt to reproduce *Litoria caerulea* occurred when seven individuals of undetermined sex were placed outside in a *ca.* 1.2 x 1.2 x 1.2 m wood and screen enclosure on 14 March 1982. A shallow pool (*ca.* 65 cm.) was provided as a breeding site and several logs were available for climbing and hiding. The substrate was composed of leaf litter on dirt. It was hoped that the natural rains and temperature fluctuations would promote breeding. No reproductive activity other than males calling during rain was observed and the frogs were returned to their indoor enclosure on 5 June 1982.

The second attempt to reproduce *L. caerulea* was made using the synthetically manufactured hormone, GnRH (Gonadotropin releasing hormone, D-alanine, 6-des-gly-10-ethylamide) (Bachem, Inc. Torrence, Ca.) on 17 October 1982 as described for *Ceratophrys ornata* by E. Wagner (Pers. comm. 1982). The GnRH was prepared by dissolving 1.0 mg in 10.0cc of sterile isotonic saline (NaCl=0.9%). Four males and two females were weighed on a triple beam balance and injected with GnRH subcutaneously (at the dosage of 1.0cc/Kg body weight) in the posterior half of the venter. The actual dose was 0.1 mg/kg (GnRH to body weight). The specimens were placed in a 56.8 l (61 cm x 32 cm x

32 cm) glass aquarium containing water at a depth of ca. 10 cm. A dry area was provided by a ca. 25 cm. hemispheric rock, and several plastic plants were scattered throughout the water to aid in egg separation. At 0730h on 18 October, one pair of frogs was observed in amplexus but no oviposition had occurred. The frogs remained in amplexus until ca. 1030h.

The third reproductive attempt began on 17 November 1982. A hibernation enclosure was prepared using a standard 56.1 glass aquarium. The aquarium was filled to ca. 15 cm. with sphagnum moss that had been thoroughly soaked in water and wrung by hand. The aquarium was covered by 6.35mm thick pegboard (6.35mm holes every 25.4mm). Four males and two females were placed in this enclosure and the temperature was dropped from 26.6C degrees to 17.8C degrees over a period of several hours. The relative humidity (measured with a wet and dry blub thermometer) outside of this enclosure was 75-80 percent. During this initial phase of hibernation, the frogs readily accepted 2-3 week old mice which were offered once a week. These conditions were maintained until 13 December when the temperature was allowed to rise to 26.6C degrees. On 18 December the temperature was dropped slowly over a five day period until 23 December when a constant low of 12.5C degrees was established. During this period of hibernation the relative humidity was 75-80% and the frogs were not disturbed.

On 16 January 1983, the specimens were removed from hibernation and examined. Three males and two females were found alive but very thin. One male was found dead and was almost completely desiccated.

The five remaining frogs were then placed in a breeding enclosure that consisted of a standard 56.8 l glass aquarium with a clear plastic lid. The bottom of the aquarium was covered by an undergravel filter plate and 50mm of a dolomite and #3 aquarium gravel mixture. Two air lift tubes were used to establish flow through the gravel. In the center of the tank, a large (ca. 20cm x 36 cm x 20 cm) limestone rock was placed to provide a land mass. Water was added to a depth of 80 mm. Showering with water was accomplished by recirculation through an Eheim (#2013)(U.S. Distributor - Hawiaiian Marine Import, Inc. Houston, Tx.) power filter containing polyester filter floss and activated carbon. A temperature of 27.9C degrees was maintained for both the water and the air by a 100 watt Jager submersible heater (Ebo-Jager Manufacturing, W. Germany.

Within one hour of being placed in this enclosure, all the frogs appeared to return to their prehibernation, robust appearance. Within two weeks all frogs were taking 2-3 week old mice.

On 2 February two males and one female were injected with GnRH as previously described at approximately 1400h. More than 1,500 eggs were observed in the enclosure at 0730h the following day, the larvae had hatched and infertile eggs were removed. Due to the nature and color of the gravel substrate and the small size of the tadpoles, an accurate count of the animals was not attempted.

Between 0730h-1600h on 3 and 4 February, observations during embryonic development were made using a binocular disecting microscope following standardized staging developed by Gosner (1960).

On 5 February approximately 375 tadpoles were sent to the BZG. Information concerning the rearing of these larvae will be presented later in this paper.

Rearing

On 4 February approximately 230 larvae were removed from the breeding enclosure described above (hereafter called Tank A) and distributed into three 20.8 l (41 cm x 21 cm x 21 cm) glass aquaria (designated as Tanks B, C, and D) each housing 60, 85, and 85 animals respectively. Tank A was maintained at 27.8C degrees, Tanks B and D at 26.7C degrees and Tank C at 29.4C degrees. Each aquarium was heated with a 100 watt Jager submersible tank heater and filtration was provided by an air powered sponge filter. Each tank was illuminated with Vita-lites (Duro Test Corp., Grand Prarie, Tx.). Tank A was covered with a solid plexi-glass covered with metal window screening to prevent the escape of metamorphosing specimens and were filled to within 2 cm of the top with water.

On 13 February (when extreme overcrowding became evident by the fouling of the water in Tank A), a fifth enclosure (Tank E) was established utilizing an open flowthrough system (See Diagram 1). The system consisted of two 56.8 l aquaria connected by an overflow siphon. One tank was used to house the larvae, while the other was used to dechlorinate the incoming city water supply. Each tank contained approximately 25 liters of water. Dechlorination was accomplished in two stages using activated carbon. The first stage was an initial flow through filter that contained ca. 0.5 kg of activated carbon. This primary stage removed over 90% of the chlorine in the water (determined by spectrophotometric analysis).The second stage of dechlorination utilized an Eheim power filter (#2013) that recirculated the water in the dechlorinating tank. The city water influent was maintained at ca. 0.05 l/min allowing approximately 10 complete passes through the Eheim filter before the water entered the tank containing the larvae. Tank E was covered with solid plexi-glass and no direct Vita-lite was provided. Between 13-17 February approximately 250 larvae were transferred into Tank E. Chlorine, ammonia/ammonium and nitrite concentrations as well as pH were monitored in all tanks using a Hach spectrometer (dr/2). Chlorine (as chloramines) is present in

On 9 March 1983 when high levels of ammonia were present in Tank A, the direction of flow was reversed through the biological filter (undergravel) in an attempt to increase efficiency. Utilizing and Ehiem 2013 filter as a primary mechanical and activated carbon filter, water was pumped beneath the undergravel filterplate, establishing an upward flow through the substrate. To facilitate gas exchange at the water surface, aeration was provided with an air-stone.

All tadpoles were fed a diet of freeze-dried tubifex worms and Spirulina 20 algae flakes (Aquatrol, Inc., Anaheim, Ca.), two to three times daily. Quantities for each feeding were increased corresponding to tadpole growth so that food remained in each Tank for ca. two hours after each feeding. After ten days, when no growth difference was observed corresponding to tank temperature, the temperature in Tanks C and D was allowed to drop to ca 25.60C. Approximately 50% of the water was changed in Tanks A,B,C and D daily and the visible fecal material removed by siphoning or filtering.

Metamorphosing individuals (determined by appearance of front legs) were removed from each tank and placed in three separate cages. These cages were well ventilated screen and plywood enclosures 398cm X 218cm X 76.5cm and contained ca 1.5cm of water in a plastic shoebox at one end. A 60watt light bulb used to provide a thermocline was placed at the opposite end of the cage from the plastic shoe box. Paper towels were used as a substrate. The substrate was moistened each day and allowed to dry overnight. The 60 watt lightbulb was turned on daily at ca 0730h and turned off at 1600h providing a diurnal thermocline of ca 25.60C-32.20C. No food was offered until metamorphosis was complete (tails completely absorbed).

When complete metamorphosis had occurred, individuals were transferred into a display cage ca 1.4m X 1.11m X 1.2m. Three large plastic ferns and several plastic short-leafed pine branches were provided as cover and a large tree trunk was positioned diagonally for the frogs to climb. A thermocline was established using a 250 watt heat lamp that remained on constantly, and a 150 watt floodlight that was directed toward the top of the tree trunk. The white flood light was turned on between 0730h-1600h. The thermocline was measured from 21.10C-43.30C with a digital type probe thermometer (H-B Instrument Co., Philadelphis, Pa.). For the first week, water was provided ad libidum, and the enclosure was washed daily with tap water. After the first week water was provided only during the ca 15 minute washing period and for ca a 45 minute period afterward as the cage slowly drained. The cage became completely dry between washings.

The newly metamorphosed frogs readily accepted two week old crickets. The size and quantity of the crickets were increased as the frogs grew. Within three weeks, many individuals accepted newborn mice. Crickets were dusted every week to 10 days with Pervinal (St. Aubrey/Division of 8 in 1 Pet Products, Inc., New York, N.Y.) dog vitamin supplement. Before being fed to the frogs, the crickets were fed moistened Zupreem Primate diet (Hill's Pet Products, Inc., Topeka, Ks.) biscuits to increase their nutritional value.

Approximately 325 larvae arrived alive at the BZG on 5 February 1983. These tadpoles were separated into 12 56.8 l aquaria, each containing ca 7.8 l of water and eight 37.9 l aqaria, each containins ca 5.7 liters of water. Groups of 20 tadpoles were placed in each of eight 56.8 l aquaria, groups of 15 tadpoles were placed in each of four 56.8 l aquaria, and groups of 12 tadpoles were placed in each 37.9 l aquaria. Water temperature ranged from 24.40C-300C, and light was provided for eight and half hours each day with General Electric C-50 Chroma 50 lamps and Sylvania Lifeline F-40 Black lights. Complete water changes were made every 48h using dechlorinated municipal water. Larvae were fed three times daily a mixed diet of Tetra-min fish foods including: Staple Food, Growth diet, FD brine Shrimp, FD Mosquito Larvae and FD Tubifex worms. Vionate vitamins and bone meal powder

were offered during the last stages of larval development. (T. Miller, pers.com.).

RESULTS

Eggs and Larvae

Within two weeks after being transferred into the breeding enclosure (Tank A), the two female frogs swelled considerably more that the males and ova became clearly visible through the lining of the abdomen. During this period the males were also observed calling on several occasions.

Group 1, Tank A.

Initial water quality measurements made on 3 February for Tank A (breeding enclosure) were as follows: pH=7.8, Total nitrogen as NH34+=0.25 mg/l, nitrogen as NH3=0.011 mg/l, NO2-=3.0 mg/l, NOPv3Pv-=1.5mg/l. The pH throughout the development of the larvae varied between 7.3 and 8.3 while the pollutants steadily rose through 9 March when they reached their maximum values (total nitrogen as3/NH4+=20.6mg/l, nitrogen as NH3=0.45mg/l,NO2-=0.055, NO3-=3.0 mg/l) (note that the reduced nitrates, NOPv3Pv- were from daily water changes and within the tank). The day after the initiation of the reverse flow system with prefiltration, a ca 75% water change, and stirring of the filter bed, the values for the pollutants were greatly reduced, total nitrogen as NH3/NH4+=1.0 mg/;, nitrogen as NH3=0.017 mg/l,NO2-=0.195 mg/l, NO3-=2.5 mg/l. Utilizing the reverse flow system, the total nitrogen NH3/NH4+ was maintained below 8.5 mg/l, nitrogen as NH3 below 0.01 mg/l, with NO2- at tolerable levels.

Approximately 400 hundred tadpoles remained in tank A After the initial removal and distribution of animals to other aquaria on 4 February. Between 13-15 February, 250 more larvae were moved to Tank E, leaving ca 150 larvae in Tank A. Metamorphosis started on 2 March 1983 and continued through the second week of April with ca 100 individuals successfully transforming into frogs. It should be noted that for several days prior to, and including 9 March, an increase in larval mortality was observed. This suggests possible lethal concentrations of pollutants for L. caerulea.

Approximately 1500 eggs were laid the night of 2-3 February, of which 1000 were fertile (infertile eggs=ca 500-600). After the shipment of ca 375 animals, ca 625 remained at the HZG. On 11 March 1983, 50 newly metamorphosed frogs were shipped to both the St. Louis Zoological Park and the Cincinnati Zoo. Both institutions reported that they had successfully reared the majority of these animals to adult or subadult status. By early June, 1983, 198 of the remaining Litoria caerules were successfully reared to subadult or adult status at the HZP.

In order to best report the results of the different aquatic systems to house the larvae at both the Houston and Buffalo Zoos, we will discuss these in four groups: 1) Tank A; 2) Tanks B,C,D; 3) Tank E; 4) Animals raised at the BZG. Physical data and notes on several observations for animals that were raised at the HZG will be presented after the discussion of Group 3. Table 1. It should be noted that the metabolically produced pollutants that are most toxic to vertebrates (as established for fish) are un-ionized ammonia (NH_3) and the nit-

of nitrates (NO3-) and ionied ammonium (NH4+) are much more toxic *(U.S. Environmental Protection Agency, 1977). The toxicity of those* pollutants will be evaluated in the discussion section of this paper.

Group 2, Tanks B,C,& D.

Water quality varied in Tanks B,C, and D on a daily basis, dependent upon the food quality offered (this increased as the larvae grew), number of animals left in the enclosure, and cleanliness of the sponge filter. Maximum water quality valued recorded were: total nitrogen as NH3/NH4+=13.0 mg/l, nitrogen as NH3=0.8 mg/l, nitrites NO2-=1.42 mg/l, nitrates NO3-=8.8 mg/l. Approximately 80-90% of the animals in these enclosures metamorphosed successfully between 1 March 1983 and the first two weeks in April.

Group 3. Tank E

Even though there was a greater density of animals in Tank E than any other aquaria, the concentration of pollutants was maintained considerably lower. The pH ranged between 7.3 and 8.1 while the maximum values of pollutants recorded were: total nitrogen as NH3/NH4+=1.3, nitrogen as NH3-=1.2 mg/l. Chlorine was below measurable levels on the spectrophotometer (CL2(0.01mg/l). Metamorphosing individuals were first observed on 2 March and transformations continued until the second week in April. Approximately 100 animals successfully metamorphosed in Tank E.

Animal Data For Animals Raised At HZGS

The female frog that laid the eggs weighed 58g and the two males were 43 and 50g prior to injection with GnRH on 2 February. It was not determined if one or both males were involved in the fertilization of the eggs. On 3 February, the female was again weighed and measured (weight=50g, S-V length=78.5mm). The female lost 18g during oviposition. The males were not weighed or measured after 2 February.

Eggs were measured on the morning of February and appeared uniform in size, ca 1.5mm. A group of tadpoles was measured from Tank C on 5 February (total length X=8.1mm range=7.2-10.3mm, n=10). A comparison physical data of larvae and newly metamorphosed frogs from the HZG and BZG as well as time to metamorphosis is presented in Table 1. After the specimens were transferred to the large exhibit no further growth data were taken because the individual frogs could not be identified.

Physical abnormalities were observed in specimens from all enclosures and occurred with the greatest frequency in Tank E. These abnormalities consisted of either short or malformed limbs (usually hind). Although no dissections were performed on these specimens, the nature of the deformities would be consistent with problems in osteological and nuscular development. Deformed animals were euthanized.

Results From Animals Raised At BZG

Two hundred and seventy-five Litoria caerules were successfully metamorphosed at the BZG between 23 February and 3 March, 1983. Forty-one died previous to metamorphosis; the majority from ruptured stomachs caused by over eating. A sample of the first 100 frogs to metamorphose (23-24 February) was measured on 3 March and the range

for S-V length was 23-30mm. A group of 12 frogs that metamorphosed on 3 March was weighed and measured on 5 May 1983 (weight X=21.0g,range-=17-25g; length X=63.7mm, Range=60-70mm) (see Table 1 for larvae and newly metamorphosed specimen data). (T. Miller, pers. com.).

Rearing The Frogs At The HZG

Over 95% of the animals showing no outward medical problems that were transferred to metamorphosing cages completed metamorphosis and were moved to the exhibit cage described earlier. During the last portion of metamorphosis, the transforming frogs were observed to frequent the warmer areas of the enclosure (maximum temperature=32.20C.)

Approximately 285 frogs were moved from the three metamorphosing enclosures to the display cage, while the remainder were shipped to other zoos (as previously described) on 11 March. Many specimens were observed to frequent the areas in the cage with higher temperatures for basking (maximum recorded temperature for prolonged basking (time) 2.5h) was 42.20C).

During basking and sleeping the frogs reduced their exposed surface area by tightly tucking forearms and hindlegs, pressing venter to substrate and closing their eyes. Generally, when left undisturbed, the frogs spent most of the day immobile in this posture and were active only during cleanings, feedings or at night. Several mortalities occurred during this period of rearing due to trauma or drownings. On many occasions, especially during feeding, large animals seized smaller individuals in their mouths for several seconds then released them. Thirty to 50 frogs could not be located in early June and were presumed to have been cannibalized. Although cannabalism was never actually seen, the frequent seizing behavior suggests that it probably occurred.

DISCUSSION

Five species of anurans (*Litoria caerulea*, *Ceratophrys ornata*, *Bufo houstonensis*, *Bufo valiceps*, and *Phrynomerus bifaciatus*) have been reproduced at the HZG through the use of synthetic hormone, GnRH. Preconditioning of the animals prior to injection of the hormone (i.e. drying and/or cooling) was used in all species except *Ceratophys ornata* and *Bufo valiceps*. The importance of preconditioning for some species was established in this study by the initial failure of our attempts to induce oviposition in *L. caerulea* before the animals were hibernated. GnRH should be considered a tool that will initiate reproductive activity and oviposition in animals that are in a reproductive state (the time in a reproductive cycle that the females and males are ready to reproduce). It will not cause oviposition in animals that are not in a reproductive state. In considering the use of this hormone on any anuran, a careful study of the animal's life cycle in the wild should be made to establish what type of preconditioning is needed, as it is felt proper preconditioning can greatly increase the probability of successful reproduction in some species.

Several observations of the embryological development of *L. caerulea* were made on 3 February. The embryos had reached stage 17 (tail bud present) (Gosner, 1960) by 1225h. Muscular response (Stage 18) was first observed at 1430h the same day. During late stage 17 and stage

18, a pattern of circulation of the fluids within the egg membrane was clearly visible flowing in two separate circles on each side (laterally) of the head. The flow was most rapid near the area of the gills and flowed independently on each side of the head in a posterior direction. This circulation has been described by Pyburn (1963) for Agalychnis callidryas. By 0730h, 4 February, the embryos had reached stages 22-23 and had hatched. Most of the larvae were positioned in a vertical orientation, heads facing upwards, on, next to, or under a solid object (i.e. rocks, plastic plants, substrate).

A greater variation in the amount of time from hatching to metamorphosis (25-69 days) was encountered in the animals raised at the HZG as compared to the animals raised at the BZG (20-28 days). There were no reports of deformities in the animals raised at the Buffalo Zoo as was noted in the HZG specimens. the BZG experienced approximately 8% mortality of the animals that arrived alive, compared to 33% mortality for the same period of development (hatching through metamorphosis) at Houston. Although the animals at the BZG did metamorphose more rapidly and had a lower mortality rate, the frogs at the HZG averaged larger (S-V length; X=20BZG, X=24.4 HZG) upon completion of metamorphisis.

In comparing the differences in techniques used at the two zoos, we can establish several possibilities for the different success rates. The Buffalo Zoo diet was more diverse, consisting of five food items, as compared with two at Houston. A vitamin supplement, Vionate, and powdered bone meal were offered just prior to metamorphosis at Buffalo, while no dietary supplementation was offered at Houston.

The animals at Buffalo were fed larger meals (the most signigicant cause of death of larvae was stomach rupturing caused by over eating).

The maximum density of tadpoles was 2.5/l of water at BZG compared to 11.0/l at HZG.

All larvae at Buffalo were exposed to long-wave ultraviolet radiation as well as a broad spectrum fluorescent light. At Houston, only part of the group was exposed directly to a broad spectrum light source (Tanks A,B,C,D). There was no supplemental ultraviolet radiation exposure. The general nature of the deformities at Houston were osteological abnormalities of the limbs upon metamorphosis. These abnormalities occurred in greater percentages in Tank E which had no direct broad spectrum light. These types of abnormalities can be associated with the lack of vitamin D used in calcium metablolism (Frye, 1973) which is produced by animals exposed to certain frequencies of light.

It is our opinion that the diverse diet, quantity of food and presence of ultraviolet radiation were the most important factors for improving the success rate in rearing larval L. caerulea. Density of animals per liter of water may also be a direct factor, although we could not establish any direct relationships. It was difficult to judge proper meal size when there was a high density of larvae present in the rearing tanks. For this reason and our reluctance to overfeed and foul the water, the larvae at the HZG were probably underfed. Other evidence to suggest this possibility was observed in two types of feeding behavior, coprophagy and cannibalism of any sick, injured or dead animals. These behaviors were most prominent in the Tanks A and E which had the highest animal densities. Indications that the animals at Buffalo were probably overfed was evidenced by stomach

rupturing. The correct meal size and frequency are believed to be somewhat between Houston's and Buffalo's procedures.

The results for the experiments of different aquatic systems for rearing amphibian larvae can be used as a basis for future designs. The use of biological and mechanical filtration can greatly improve the quality of the environment for the larvae and can reduce, if not completely eliminate, the need for frequent water changes. The sponge typ biological filter appears very efficient for small systems with a limited number of larvae. The filter should be removed and rinsed in clean dechlorinated water daily to prevent clogging.

If undergravel filters are to be used for biological filtration, we recommend reverse flow system with mechanical pre-filtration. Because of the large quantities of food consumed by rapidly growing larvae, direct flow under gravel systems have a tendency to become clogged with feces and food, causing filter inefficiency and ultimately leading to water fouling. this occurred on 9 March in Tank A, when the water pollutants were extremely high, just prior to changing the direction of flow through the filterbed. By 10 March, with a reverse flow system, these pollutants (mainly NH3/NH4+) were reduced some twenty fold (from 20.8 mg/l to 1/0 mg/l). The Eheim filters are ideal for use as a pre-mechanical filter with the added benefit of large capacities for activated carbon. Another possibly helpful addition to this type of closed system is the installation of a UV sterilizer in the filter discharge line. This will reduce the numbers of colliform and other bacteria in the environment.

The open system of Tank E maintained the cleanest environment for the larvae of any of the systems used. The only maintenance required was changing the activated carbon in the filters once every 2-3 weeks. The system, as designed, is adequate for about 150 specimens. Problems were encountered in adequately feeding the 250 larvae in Tank E. Competition between individual larva appeared high and judging the correct amount of food for each feeding was difficult. It is our opinion that these two problems, as well as the lack of any direct broad spectrum light, probably caused the high degree of mortality and abnormalities encountered in Tank E. Ideally, open systems like Tank E have many advantages over closed and semi-open systems. The continual flow through the system maintains a clean environment for the larvae and thus reduced the numbers of both pathogenic and non-pathogenic bacteria, a distinct advantage for reducing both disease caused by chemical pollution and pathogens.

There is very little literature available examining the tolerances of amphibian larvae to nitrogenous waste products. Exstensive studies have been done on fish for un-ionized ammonia (NH3), nitrites (NO2-), and nitrates (NO3-) (U.S. Environmental Protection Agency, 1977). Ammonia/ammonium is a metabolic waste product of aquatic organisms. Nitrites and nitrates are produced through the organic oxidation of ammonia/ammonium by certain genera of bacteria (Spoote, 1970). All the above mentioned molecules and ions are toxic to aquatic vertebrates (to varying degrees) and are considered as pollutants (U.S. Environmental Protection Agency). Although no controlled experimentation was performed to determine the effects of certain aspects of water quality on L caerulea larva, our observations may prove helpful to future workers. The pollutant that we encountered in the highest concentrations was unionzed ammonia.

Un-ionized ammonia (NH3) and ionized ammonium (NH4+) are in

equilibrium in aqueous solution.

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$$

This equilibrium is both temperature and pH dependent, with higher temperatures and pH's favoring the left side of the equation and the increased concentration of NH3 (Spotte, 1970). Un-ionized ammonia is extremely toxic to aquatic life forms as compared to its ionized counterpart NH4+, which is considered 1/50 as toxic (Tabata, 1962). Many studies have been done on fish regarding the toxicity of NH3 for rainbow trout fry, Salmo sairdneri. This was reported as 0.2 mg/l by Liebman (1960). Fromm (1970) found that LC50 (lethal concentration that kills 50% of the test group) for trout in a 24h period was 8mg/l, although concentrations this high should yield 100% mortality in a longer period of time. The United States Environmental Protection Agency has set its maximum NH 3 levels for environmentally safe water at 0.02 mg/l (U.S. Environmental Protection Agency, 1977).

In our study we did not encounter what we felt were any water quality related deaths until NH3 = 0.45mg/l and total nitrogen as NH3/NH4+ = 20.6 mg/. This suggests that L. caerulea larvae may be more tolerant to NH3 pollution than many fish tested. The development of lungs early in the larval stage, and the protective skin secretions might aid this amphibian in tolerating conditions in which fish could not survive. This seems a likely adaptation for a temporary pool breeder like L. caerulea.

Few institutions are equipped to raise large numbers of amphibian larvae. With increased knowledge of amphibian biology and tools like GnRH, captive amphibian reproduction is becoming more common. In highly productive species, offspring are produced in the thousands, and rearing is problematical. At any given institution, a maximum number of animals that can be successfully reared with the available resources should be established and followed. When possible, the remainder of the offspring should be transferred to other institutions for rearing (as was done with a group from this breeding) or perhaps euthanized as a last resort. Failure to follow this established maximum can result in a drop in the overall success rate of any breeding and may cause health problems in the surviving specimens.

In the past, breedings of captive anurans were uncommon (International Zoo Yearbook, 1972-1981). With the advent of several new techniques in recent years, successful breedings are becoming frequent for some species. Today, several once rare captive anuran species are being produced by the thousands in commercial ventures.

Another aspect of amphibian reproduction that will need future consideration is the radical change of the genetic composition of the entire captive population that can result from a single breeding. Unfortunately, euthanasia of a large percentage of the progeny of any one breeding may be needed with certain species in order to maintain genetic diversity in a captive population. This may be especially true of captive propagation programs for endangered species, where genetic management is so important.

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TABLE I

NEONATE DATA COMPARISON OF HZG AND BZG SPECIMENS

	HZG	BZG
Time from hatching to metamorphosis	25-69 days	20-28 days
Larva size weights at begining of metamorphosis	Total length X=67.2mm, range= 53-73mm Weight X=2.3g, Range= 1.3-2.7 n=8	Total length ca70mm Weight na
Sepcimen size and weight after metamorphosis	S-V length X=24.4mm, range 21.5 - 26.5 n=10 Weight X=1.2g, Range 0.7=1.8 n=10	S-V length X=20mm n=na Weight na

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SOME SPECIAL ASPECTS OF THE HUSBANDRY OF SOFT-SHELL TURTLES (REPTILIA, TESTUDINES, TRIONCHIDAE) AT THE MOSCOW ZOO

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INTRODUCTION

The Soft-shell turtles are not very rare in terrarium collections. However, one can hardly tell that they are easy to keep. In our opinion that can be explained by the unsuccessful solution of three problems.

The first problem is skin disease, common for all the freshwater turtles, but for the Trionychidae in particular.

The second problem is metabolic disturbances and suppression of the growth process of turtles by their own metabolites.

The third problem is an unbalanced high in calories and low in micro-elements feeding.

Ulcerative Shell Disease In Soft-Shell Turtles And Its Course Under Traditional Husbandry Conditions

It is well known that the soft-shell turtles are the turtles which are usually subject to ulcerative shell disease (Wallach, 1975 a). Attempts at treatment with chloramphenicol and it's analogous doses reccommended by Bush and co-authors (Bush et al., 1980) practically always failed (Frye. 1974; Wallach, 1975 b). The disease was suppressed, and temporary improvement was reached, but no complete elimination of the disease occurred, and at the first oppurtunity it reocurred in a more severe form. In our opinion it can be referred to the fact that the indicated drugs affect the causitive agent of the secondary infection only. The recurring and exhausting disease can result in an animal's death, which was caused, in our opinion, not only by the causitive agent itself, but by the side effect of the drugs and of physiotherapeutical procedures. Thus the drugs often suppress the protective ability of the organism, and the procedures, (which destroy the normal skin structure), promote the secondary development of the causitive agent in the skin.

Most often the disease occurs in Trionyx kept on sand, or, which is worse, on gravel. As burrowing seems to fulfill an ecological need, the turtles injure the shell skin stratum of the carapace under these conditions, and areas with even minor wounds show foci of infection, which spread quickly to all remaining skin surface.

In turtles kept on hard substratum, such as concrete, lesions appear first on the front part of the plastron, and not on the carapace; in all the rest of the infection the course of the disease is similar to that of the first example with only slight differences. In carapace infections the symptoms are manifested in appearance of whitish mould-like blots, distinctly visible on the generally darker background of the carapace. When these are removed with cotton wool,

erosions and superficial ulcers become visible. In the case of plastron injury, ulcers are revealed at a later stage by their reddish colour. These are deeper and more numerous. This can be attributed to the fact that on a lighter background primary foci are less visible, and the animals injure them furthur by brushing them constantly against the bottom of the tank.

Without treatment, the foci of lesions enlarge and increase in number greatly, covering previously unaffected areas and perforating the cutis and resulting in the death of the animal.

After Walach (Wallach, 1975b), Candida albicans should be considered the primary causitive agent, and Beneckea chitinovora the secondary causitive agent. Those bacteria can affect other animals, besides turtles, as well (Rosen, 1970; Campbell, 1974). According to our supposition, the severity of the disease and the fatal outcome is caused not only by the primary fungal affection, but to a larger extent by the secondary bacterial infection.

The disease can also develop under conditions where everything seems to be done in order to prevent it, like providing clear water, making sure of the absence of injuring factors, isolation, yet after three to four months, nidi may still appear on the carapace, and a conclusion was made that avoiding carapace injuries alone does not lead to success, and some other preventative measures are necessary which should be directed mainly against fungal infection.

MATERIALS AND METHODS

We proceeded from the supposition that since they inhabit silty reservoirs, in the process of evolution the Trionychidae must have developed complex relations with the microflora of acid silts, which might perform a sanitary function for the cutis. That is why when being deprived of their biological complement, silt, in captivity they appear to be absolutely unprotected against external fungal infections.

Proceeding from all the aforesaid, a supposition was made that biologically active silt can become the needed universal solution to ulcerative skin disease in soft-shell turtles.

This supposition was tested on the five specimens of Trionyx available - one Trionyx spiniferus and four Trionyx ferox. The Trionyx spiniferus had been kept in captivity for three years. It had several relapses of the disease which had been suppressed with the help of ultraviolet irradiation and antimicotic drug, but treatment did not prevent the disease from recurring in three to four months. The other four turtles arrived at the Zoo quite young, not long before the experiment started. The adult Trionyx was kept in a 150 litre aquarium. Another aquarium of the same size held the group of young turtles. First the symptoms of the disease appeared in three young turtles during the second month in captivity. Treatment was not successful in that case either, though the process was suppressed for some time. Under those conditions the new method was used. About 10 litres of silt from a climax pond was introduced in each aquarium.

Considering the hopelessness of all the treatment methods previously used, we stopped any interfering in the course of disease and stuck to controlling cage conditions only.

RESULTS

During the first two weeks after the experiment started, the nidi in turtles did not increase in size, and no nidi appeared in the fourth animal. In two more weeks the nidi disappeared from the least affected animal and were reduced considerably in the rest. In two months all the manifestations of disease disappeared completely. Thus, treatment with biologically active silt appeared to be much more effective than treatment with the drugs previously used. Especially important was the absence of negative side effects of any kind.

After a year of keeping in captivity, as a result of too frequent changing of water the silt was almost completely removed from the aquarium of the adult Trionyx, and the sand fraction was clearly distinguished on the bottom. The result was prompt. First foci of lesions appeared on the carapace. Immediately after that tha aquarium was washed and filled with fresh silt. Soon the first signs of healing appeared, and in six weeks the animal recovered. In young Trionyx no relapses were observed at all, though after a fight one of them had the hind edge of the carapace slightly bitten. In spite of the fact that no deliberate medical interference in the healing process took place, the wound healed soon. Later on, injuries caused by biting were observed in Trionyx several more times, and all of them healed successfully by themselves.

DISCUSSION

Summing up the experiment, it might be said that keeping Trionychidae in captivity one might be sure of success by placing biologically active silt into the aquarium in such an amount that the animal could bury itself in it completely. This provides protection against the fungal and bacterial infection, which is indispensible for the health of the turtles.

Oblique Effects of Biologically Active Silt

1. In turtles kept in small reservoirs, like aquariums, metabolic disturbances and suppression of the growth process by their own metabolites can hardly be avoided. This problem is usually solved by changing the water as frequently as possible. However, inactivation of metabolic by-products by the biological agents of silt seems much more beneficial, as it demands considerably less work about the aquarium, reducing it to changing the silt every three months, which in turn diminishes the stress factor for the animals. The basic criterion of frequency of changing of water is appearance of perpetual turbidity, which signifies the exhaustion of the biologically active components of silt.

2. A serious problem for keeping groups of turtles in captivity represents the group hierarchy, which causes the oppression of animals occupying the lower hierarchical position. One of the aggravating factors in this respect is the constant presence in the mutual field of vision of both the dominant and submissive animals. In that case as well, the presence of silt in the aquarium appears to be extremely beneficial: during bouts of agression, silt is stirred up from the bottom, clouding the water, and the animals lose each other from sight

and calm down. Thus the hierarchy is preserved, but stress is reduced to a minimum. This could hardly be possible under different husbandry conditions.

3. The possibility of hiding itself is indispensible for the animal during its acclimatization, in particular for those coming from the wild. Not being used to new stimuli such as moving of people behind the glass, or bright light from all directions, the animal tries to find a hiding place, and not finding it in the aquarium, remains in a stressed state, does not feed well and becomes more sensitive to disease. Under these circumstances the benefit of silt as a place where the animals can bury themselves is evident.

4. While introducing silt into the auarium, introducing of a certain amount of crustaceans is unavoidable (mostly Daphnia and Diaptomus). However, the absence of relapses of the disease testifies to the fact that those organisms do not cause the disease, even assuming the possibility of their harbouring the causitive agent, (described for higher crustaceans by Rosen, 1970).

5. The safety of contacts between Trionyx and lower crustaceans makes it possible to use the latter not as a sporadic food supplement, butalso as the basic component of the diet. This seems to us to be extremely important for young turtles, as it provides the possibility of solving the third of the basic husbandry problems, a partially balanced diet at last.

Drawbacks

In our opinion, the only drawback of the silt containing system is a considerable reduction of exhibit value, especially when the turtles are kept in a group, but until this is tolerated because of the important advantages of the system.

Supplement

By the end of its second year in captivity the biggest Trionyx ferox reached a lenth of 180 mm. The rest measured 150m, 140mm, and 130mm, accordingly. Proceeding from repeated manifestations of sexual behavior and from the fact that some Trionyx, even as large as Trionyx sinensis, of the same size, took part in the breeding already (Thieme, 1979), or were capable of it (Buldovsky, 1936), conclusions were able to be made about the successful rearing of Trionyx from new-born to mature specimens.

All the aforesaid enables us to regard optimistically the furthur prospects of keeping and breeding Trionyx species in captivity.

P.S. The described method of keeping turtles was also successfully used for treating the Twist-neck turtle (Platemys platycephala) for superficial micosis.

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CAPTIVE REPRODUCTION IN THE PYGMY MULGA MONITOR *VARANUS GILLENI* AT THE DALLAS ZOO

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INTRODUCTION

Little is known about the pygmy mulga monitor, a small arboreal monitor inhabiting the central part of the great Victorian Desert, (Cogger 1962). Habitat selection was discussed by Pianka (1969), and ritualized male-male combat behavior was described in detail by Murphy and Mitchell (1974) and Carpenter et al. (1976). Information dealing with reproduction was presented by Horn (1978). This paper describes husbandry and reproductive behavior in *Varanus gilleni*.

MATERIALS AND METHODS

Although arboreal, these lizards were kept in a terrestrial enclosure measuring 150cm x 60cm x 36cm in height. The top was made of window screen. Substrate consisted of fine sand, filled to a depth of 75mm. A water bowl was always present. Cork bark slabs, a large rock, and bricks were used to provide security.

Lighting was provided by a 50watt heat lamp. The large rock and bricks were placed beneath the heat lamp for a basking site (lizards basked frequently on them). Photoperiod varied through the year. In the summer a maximum day length of 12 hours was reached. During the winter day length was gradually decreased to 9 hours. Temperature fluctuated from 27C degrees to 20C degrees on a daily basis.

Cleaning the enclosure was simple. The enamel sides of the cage were easily cleaned by wiping with disinfectant. Sand was cleaned as needed by sifting through window screen.

DIET

The lizards were fed twice per week: small newborn laboratory mice and one dozen adult crickets *Gryllus domestica*. Crickets were dusted with bonemeal. As *Varanus gilleni* preys upon other small lizards (Cogger 1975) and occasional *Anolis* or *Uta* were offered.

RESULTS

COURTSHIP BEHAVIOR

Once courtship was observed an additional adult male was placed in the enclosure to initiate male-male combat. The adult female was present during combat bouts. The males were frequently introduced to each other for combat. Once it was apparent which male was dominant in the combat bout the subordinate male was removed. During combat one lizard would suddenly break away and flee or assume a passive role (Murphy and Mitchell 1974). This is the subordinate male in a combat bout. The courtship behavior that will be described is fairly typical

of the other courtship sequences seen.

On 2 February 1978, an adult male was placed with a female. The male quickly encountered the adult female. He approached her from the rear and mounted her from the rear. Once his snout was near her head and neck area he began to bob his head in a vertical plane. His tongue flicking rate became much more rapid: 8 flicks/5 seconds. During the head bobbing, the male nudged the female's gular area with his snout. The male's hind legs were rotated in a circular motion over the female's vent region; the male's claws lightly scratched the female's vent region.

BREEDING

On 24 January 1978 an adult male was discovered in copulo with the female on the bricks under the heat lamp. The male was on the female's right side. The cloacae were in apposition, his tail was under hers and his left leg was over her pelvic area. His left hemipene was inserted and periodic dorso-ventral flexures of his trunk were seen. If the female began to move the male would bite her neck. They remained in coitus from 0830-0950h. When the female was held up in front of an artificial light source, the eggs could be seen through her ventral surface.

The sand at one end of the enclosure was kept damp with a large flat piece of flagstone (slightly elevated) placed over the dampened area. Although the female was seen frequently investigating this area two weeks before oviposition, she laid three eggs on the surface of the sand at the dry end of the cage near a large rock used for basking. A short time before the eggs were discovered, the female was rubbing her cloacal region in the sand from side to side. Oviposition occurred for approximately five hours. When oviposition began the male was removed.

The female's condition deteriorated during the last week prior to oviposition. She appeared emaciated and the pelvic bones became more visible. This had been seen in other female lizards prior to oviposition. After the egg laying, the female appeared depleted; recovery encompasses three weeks. The procedure used included separation from the male, heavy feeding of vitamin enriched crickets, and an anole offered weekly. Fresh water was present to prevent further dehydration.

EGGS AND INCUBATION

On 12 February 1978, the eggs were removed as they were laid. After being weighed and measured, eggs were placed together in a one gallon jar with vermiculite and water in a 1:1 ratio, by weight. Incubation temperatures ranged from 27C degrees to 30C degrees. Occasionally the lid was opened to allow fresh air into the jar.

On 17 May 1978 at 0910h, a neonate began to emerge from egg #2. A perforated top was placed on the jar. The following morning the first hatchling had fully emerged. Four days later egg #3 slit at 0830 and the lizard emerged at 0945. The neonate from egg #1 was discovered at 0830 on 23 May. Total incubation time was 95-101 days. Each neonate had an egg tooth visible on the snout. the young lightened in color within the first and second day of hatching. Each

lizard was placed in a gallon jar with damp paper towels for a couple of days.

CARE OF HATCHLINGS

A screened rectangular enclosure was built measuring 140cm x 62cm x 170cm high. Substrate consisted of oak leaves in a shallow loose layer. This cage was placed outside in filtered sunlight during the summer. Branches and rock were used for security. A water bowl was always present.

DIET

The hatchlings were fed dusted crickets, mealworms, and an occasional Anolis or Uta. They were ravenous feeders. Raising the monitors outside seemed ideal, for they grew quickly and had no health problems.

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Varanus gilleni

Bred:	1/24-25/78
Eggs Laid:	2/12/78
Hatched:	5/17-23/78
Total Incubation Time:	96-101 days

Table - I Measurement of Eggs

	Weight	Length (mm)	Width (mm)
#1	3.8g	30.0mm	14.0mm
#2	4.1g	32.0mm	15.0mm
#3	4.0g	30.0mm	15.0mm
-			
x=	3.9g	30.6mm	14.6mm

Table - II Measurements and Weight of Young

	Weight	Length (mm) TL	SV Length (mm)
#1	3.0g	136mm	63mm
#2	3.3g	132mm	61mm
#3	3.2g	135mm	63mm
-			
x=	3.1g	134mm	62mm

Table - III Measurement of Young on 2/2/79

	Length (mm) TL	SV Length (mm)
#1	220mm	103mm
#2	284mm	124mm
#3	282mm	126mm
-		
x=	262mm	117mm

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THE CAPTIVE BREEDING AND REARING OF THE MEXICAN BEADED LIZARD, *Heloderma horridum*, at the DETROIT ZOO

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INTRODUCTION

Since 1978, the Detroit Zoo has had one pair of beaded lizards, *Heloderma horridum*. In the past they have been housed in an exhibit containing gravel, large rocks, and a large pool. In 1980 their first clutch was laid. This consisted of 7 eggs which were laid over a 4 day period in early September. The eggs were laid on top of the gravel, but were removed for incubation. They were buried in moist vermiculite with the tops showing. The room temperature was 25.5-28.3C degrees. After approximately 125 days they were opened; a partially solidified white mass was found inside.

In 1981 a clutch of 10 eggs was laid on 21 August. This time the eggs were only half buried in the vermiculite, but we still had the same unfortunate results.

Sometime after the second clutch was laid and before breeding started in 1982 the exhibit was changed. The incubation techniques were also changed. These two changes may have contributed to our success.

MATERIALS AND METHODS

Both adult lizards are kept on exhibit together all year. Their exhibit area is 117cm deep, 119.5cm wide, and 99cm sloping to 147cm high. A sand medium of 5-13cm deep is used. Props consist of a large rock and a piece of driftwood. The water is provided in a 12cm diameter and 5cm deep dish. The temperature range is 23.9-31.9C degrees. Other than the building's heating system, a heat lamp and a 200W incandescent bulb (Westinghouse Corp.), are used. Artificial light is provided by two high intensity 60W Vitalites (Duro-Test Corp.). They are turned on at 7:00 am each day and turned off at 4:00 pm in the winter and off at 5:00 pm in the summer. Natural light is used to light the public area of the building; this exposes the lizards to the natural light cycle.

The exact ages of these animals are unknown. One of the lizards is from a group of 4 that we had in 1974. Three of these died. In 1978 another beaded lizard was donated. This animal was not fully grown; we believe it is the male. We estimate it to be about 5-10 years old. The female was keyed out to be *Heloderma horridum horridum*. The male did not key out clearly; he may be an intergrade (*H.h. horridum* x *alvarezi*). This past winter the adults were measured and weighed. The female weighed 1063.5g and the male weighed 946.2g. The female measured 37.3cm nose to vent and 61.6cm nose to tip of tail. The male measured 33.1cm nose to vent and 61.0 nose to tip of tail. Sex was determined by observing copulation.

Their diet consists of 5 week old mice. The male is removed from the exhibit for feeding so we can keep track of how much each animal

eats. After copulation was observed, bone meal was added to the female's diet. This supplement was given until the eggs were laid.

RESULTS

Breeding was observed in late June through early July. As the female filled with eggs she started lying on her side. On 25 August a single egg was laid. This was removed. The following day 7 more eggs were laid. On 27 August one more egg was laid. This one was obviously infertile. The egg was yellow and hard.

INCUBATION AND HATCHING

The eggs were numbered as they were taken out of the exhibit. They were then placed, 2 at a time, in gallon jars. The jars contained vermiculite that was dampened, then had the excess water squeezed out. The eggs were laid on top of the vermiculite. All the jars had tops. The tops were removed once a week for 30-60 minutes for air exchange. The room temperature ranged from 26.6-29.1C degrees.

By 10 September, three of the eggs had gone bad. This left five eggs. On day 143, two weeks after the incubation found for H. suspectum (Wagner et al., 1976), one egg was randomly selected to be opened. The embryo inside was alive, but died within 24 hours.

On the afternoon of 28 January eggs #1 and #2 collapsed. Egg #2 was opened by hand at this time. When we saw the lizard was alive and well, it was left to come out on its own. Three days later, on 31 January, the lizard was completely out of its shell. Egg #1 was left to open on its own. When, after 2 days, it had not opened, we slit it by hand. This lizard was alive as well. It came out of its shell on 1 February, 2 days after opening.

On 31 January egg #5 started to collapse. The next morning the egg was found slit open. Two days later the lizard was completely out of its shell. More than a week later on 9 February egg #7 collapsed. Again a slit open egg was found the following morning. Only one day later, on 11 February the lizard was completely out of its shell.

Incubation periods ranged from 154-167 days. All four young had the typical black and yellow coloration. According to Bogert and del Campo (1956), this is the typical hatchling pattern for this species. There were five large yellow spots down the middle of their backs. The spot closest to the head was smaller than the rest. They each had seven yellow bands on their tails. Along their sides were three pairs of yellow bands. The rest of the body was mostly black with small yellow spots.

Lizards #2 and #7 (numbered the same as their eggs), were the only lizards whose yolk sac was not completely absorbed by the time they emerged from their shells. The amount of yolk sac protruding from #2 was about 10mm. A week after slitting open, a small portion of the sac fell off. The portion remaining was tied off close to the body, and the portion past the knot was cut

off. It wasn't until June that the wound was well healed. Lizard #7's sac was absorbed completely the day after emerging from its shell. No egg tooth was seen on any of the lizards.

REARING

After slitting open either by hand or on their own, the first three eggs were placed in individual plastic shoe boxes. Damp paper towelling was used as bedding. We believe this kept the shell soft and pliable and enabled the hatchlings to get out. As the young are venomous like the adults, rubber gloves were wrapped around the boxes to secure the lids. "HOT" signs were displayed on the lids. When the lizards fully emerged from their shells, dry towelling was used for bedding instead of the damp towelling. On 2 February water dishes were introduced. They were 4.5cm across and 2cm deep.

On 10 February the lizards were moved to small (less than 10 gal.) aquariums with screen tops. This was done primarily to allow the proper light through. It also gave easier access to the animals and allowed them more space to move around.

Light was provided by a 30W Vitalite (Duro-Test Corp.). Since a natural light cycle was not present in the room containing the aquariums, a timer was set up to simulate the natural light cycle of Detroit, Michigan. The temperature of the room averaged 26.6C degrees.

A hide box was provided, but was removed because the lizards preferred hiding under their paper towelling. Since drinking from the water dish was only observed once, we started misting the animals on 10 March. They were misted two to four times each week.

When egg #7 slit open it was put into an aquarium immeadiately and received the same treatment as described above.

On 24 March, lizard #5 was moved to an exhibit. This was done because of a news release on the hatchlings. We selected #5 because of its aggressiveness and its good eating habits. The exhibit is a glass fronted stainless steel cage, with dimensions of 57cm deep, 36.5cm wide, and 32cm high. The top is screen. The outside was padded with styrofoam to keep the cage warmer. Indoor-outdoor carpeting was used as bedding, which could easily be removed for cleaning. We put two rocks together in such a way as to enable the animal to crawl under the rocks. A hide box was also provided. Water was available in a 8cm diameter and 4cm deep dish. For light we used two high intensity 40W Vitalites (Duro-Test Corp.). The exhibit was exposed to natural light.

On 8 July all four animals were put in an exhibit together. The size is identical to the exhibit holding the two adults (see BREEDING). Sand is used as the medium, and rocks and pieces of driftwood were used as exhibit props. A hot rock is buried under the sand in a corner. One piece of driftwood was placed over this area so the lizards could hide while seeking heat. Two high intensity Vitalites (Duro-Test Corp.) are used for light. The exhibit is exposed to the natural light cycle. although a water dish is provided (same size as used for the adults, see

BREEDING), we still mist the lizards two to four times each week.

To monitor growth, two methods were used. First was weight. To keep disturbances to a minimum, the first three animals were not weighed until a few days had passed, on 7 February. Lizard #7 was weighed when two days old. We measured lengths as well.

Development of the bones was checked in two ways. First was by squeezing the jaws. Since this method is not very accurate we decided to used X-rays as well. These were taken on 3 March of all the lizards. Just in case the X-rays did any damage, only the smallest (#2) and the largest (#7) lizards were X-rayed a second time. When we measured the lengths of the lizards we did it by measuring their X-rays. We measured down the spine. As we only took multiple X-rays of lizards #2 and #7 these are the only animals we have lengths for over a period of time.

Another method used to follow development and change was photography. As the pattern changed on the lizards, photos were taken for identification purposes. Of course this also enables us to see just how the pattern changes.

Our first attempt at feeding the young lizards was on 8 February. Only three lizards were hatched at the time and they ranged from 7-11 days old. Lizard #7, the last to hatch, was offered its first meal when it was five days old. The first item offered to all the lizards was a pinky mouse (0-7 days old).

During the first few weeks different feeding items were offered to find the lizard's preferences. They were offered food three to four times a week. As mentioned before, pinky mice were used as well as crickets, Anolis lizards, and Herp diet, which is no longer available. Small furry mice (8-14 days old) and three week old mice were used as the lizards grew. Our crickets are fed a rich protein diet. The Anolis are fed these same crickets as well. Before offering Anolis to the beaded lizards the Anolis were put in the freezer for five minutes to slow them down. Herp diet is a prepared diet designed as a direct replacement for small mammals, birds, or fish that are usually fed to reptiles. For the young lizards we added calcium carbonate.

The first pinkys offered had no supplement on them. The second pinky offered was dipped in a mixture of linatone and geveral protein. The rest of the rodents offered were supplemented with a mixture of calcium carbonate and water, until 9 April. At this time Pervinal was also added. The mixture was either injected into the mouths of the mice, dusted on, or painted on their bodies.

To get the lizards to eat we often had to force the feed items into their mouths. Once in the mouth the lizards would continue to eat it on their own. This was done with rodents and the Anolis lizards only.

On 6 April a new technique was tried to get the lizards to feed on their own. Since Herp diet was preferred we would spread it on the rodents or Anolis as an enticement. This was done for the animals that would not eat on their own.

After four weeks we kept to a rough schedule for feeding. At least one rodent was offered each week. This usually took place on Tuesday or Wednesday. Then a second feed item, either crickets, Anolis, or Herp diet, was fed on Friday or Saturday. Because of appetites or availability of food the schedule could

not always be followed.

After they were put on exhibit with a sand substrate, the lizards were taken off exhibit and fed separately. this prevented sand from being ingested and let us keep track of how much each animal was eating.

RESULTS

All manners of housing employed worked fine for their purposes. the plastic shoe boxes held some moisture, which for the lizard trying to get out of its shell was important. Inappropriate light traveling through the plastic and the inconvienence of the rubber bands made the aquariums a better choice. When they were active they climbed on their water dishes.

When #5 was first put out on exhibit alone, it spent most of its time in the hide box. The rock set up for hiding under was also used for basking, once the young lizard got used to its surroundings.

When all four lizards were put together they were all very active, and climbed on the wood and rocks and dug holes. After a couple of weeks their activity dropped. They mostly rested on the hot rock or near one of the props.

Table I contains the information gathered from weighing the lizards. The growth curve was determined by this information. From this curve we see that the growth rate increased for all the lizards after 21 April. Lizard #2 definitely has grown slower than the others. The lengths of lizards #2 and #7 are shown in Table II. After hatching all the lizards were approximately 10cm snout to vent.

In the X-rays we saw that the bones looked normal. Also we were able to follow the development of the osteoderms. the osteoderms start developing at the head and the development moves towards the tail. Lizard #7 showed much more development than lizard #2.

The series of photos taken of the lizards showed us a few things about the pattern changes. The pattern always started to change on the tail. Scales in the yellow bands started getting darker with each shedding. Some of the scales in the large yellow spots on the back also started to change to black. With age some of the dark areas got lighter, but not as light as the original yellow spots. Lizard #5 started shedding for the first time on 5 March. This is when the first color changes started to appear. Lizards #1 and #7 followed shortly afterwards. It wasn't until June that #2 started to change. At this writing lizard #7's pattern looks more like the adult's than the other young lizards. Lizard #2 still retains a very juvenile pattern.

The first time each was offered a feed item only lizards #5 and #7 ate. Table III shows the first feeding for each animal.

From the choice of food items, the lizards least liked the crickets. We last offered them to the lizards on 3 March. They took the Herp diet with no problems. Because our desire to feed natural food when we can and because of the fact that Zu-Preem no

longer carries the product, we tried to limit Herp diet to a last choice for the week and for enticement. It worked well for enticing lizards #1 and #7 to eat on their own. By the time we were trying this technique lizard #5 was eating well on its own. Lizard #2 eats Herp diet on its own but has only eaten one cricket and one pinky without being force fed. It is, however, easier now to get the feed item into its mouth.

Anolis were taken well, especially with Herp diet on them, and pinkies and small mice proved to be taken well too. The animals do not seem bothered about being removed from their exhibit to eat.

The only problem we had was regurgitation. Lizard #5 ate a pinky on 22 March, and on 24 March regurgitated. This may be the reason for the small increase in weight during the period of 10 March to 29 March. The lizard only gained .9g during this time, a small amount compared to weight gains during other periods. Lizard #2 regurgitated after eating an Anolis lizard on 20 May. There didn't seem to be any ill effects from this.

DISCUSSION

As the beaded lizard had not been successfully bred in captivity before this year, we had little information to go on. In comparing it to the gila monster we saw some differences. The breeding seasons are different. At the Toledo Zoo (V. Roach, pers.comm.) a clutch of Heloderma suspectum eggs were laid in early June, 1982. Our beaded lizards had not yet bred at this time of year. We also see a difference in incubation periods among gila monsters. According to Wagner et al., (1976), the incubation period is 124-129 days. Incubation time for the clutch in Toledo was about 145-150 days. Our beaded lizards hatched after 154-167 days.

It's hard to pinpoint a single reason for our success. The exhibit change could have helped, as the lizards could no longer soak in water as they did when they had a large pool. They are able to dig and burrow in the sand. Fertility of the animals is a factor that wasn't measured, and if the male is between 5-10 years old perhaps he has finally matured enough to produce offspring.

We do feel that our incubation technique made a difference. the eggs were placed on top of the vermiculite, this left them drier than before.

On rearing the young we had only a few problems. Opening egg #2 the same day it collapsed was probably too soon. This could have contributed to the yolk sac problem. After slitting open, but before the animal was out of the egg, the egg was handled a lot for photographic purposes. This could have contributed to the animal having a slow start, and luckily there was no infection because of the yolk sac. Hopefully this will not affect the anmal at any future time.

The last 2 weeks of June and the first week of July 1983, the adults were observed breeding. There are a few things we would like to do different if she lays eggs. We want to measure

the humidity and temperature inside the jars during incubation. We also hope to weigh and measure the eggs.

We must remember that lizards are living organisms so we can never tell if the outcome this year will be the same as last. I hope it is because, even though it is time consuming and a lot of work, I for one, would like to help raise another clutch of young beaded lizards.

TABLE I

WEIGHTS OF BEADED LIZARDS

DATE	LIZARD #1		LIZARD #2		LIZARD #5		LIZARD #7	
	AGE DAYS	WEIGHT GM	AGE DAYS	WEIGHT GM	AGE DAYS	WEIGHT GM	AGE DAYS	WEIGHT GM
2-7	8	32.5	10	30.5	6	38.0		
2-12							2	37.3
2-25	26	39.3	28	31.4	24	42.8	15	42.4
3-10	39	44.0	41	33.6	37	48.7	28	49.7
3-29	58	55.8	60	35.1	56	49.6	47	60.3
4-21	81	62.4	83	41.7	79	59.4	70	66.9
6-8	129	95.3	131	51.8	127		118	96.4
7-23	174	129.9	176	81.1	172	99.1	163	122.7

TABLE II

LENGTHS OF BEADED LIZARDS

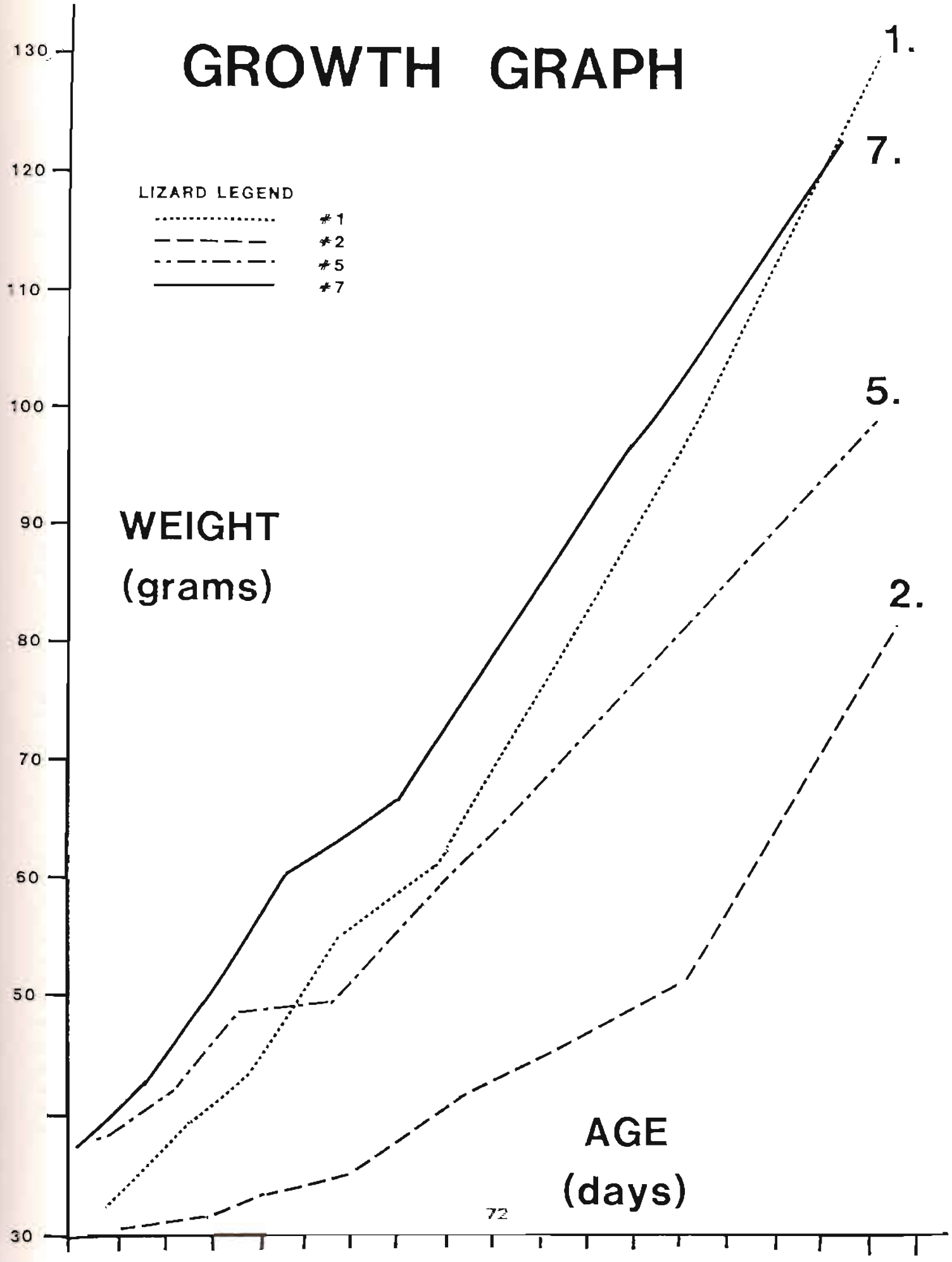
	LIZARD #2		LIZARD #7	
DATE	N TO V	N TO T	N TO V	N TO T
3-31	12.3cm	20.3cm	14.0cm	23.5cm
5-05	13.3cm		16.2cm	
6-30	15.5cm	25.5cm	18.0cm	30.5cm

N=nose, V=vent, T=tip of tail

TABLE III

FIRST FEEDING CHART

LIZARDS	date 1st offered	date 1st ate	food item
1	2-8	2-16	pinky (force fed)
2	2-8	2-11	cricket
5	2-8	2-8	pinky
7	2-15	2-15	pinky


GROWTH GRAPH
LIZARD LEGEND
#1
#2
#5
#7
130
120
110
100
90
80
70
60
50
30
WEIGHT
(grams)
AGE
(days)
1.
7.
5.
2.

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CAPTIVE HUSBANDRY OF THE TUBERCULATE GECKOS OF THE GENUS : *Coleonyx*

Keith Neitman

INTRODUCTION

Geckos of the genus *Coleonyx* are restricted to portions of the United States, Mexico, and Central America. The northernmost forms, the Banded Gecko (*Coleonyx variegatus*) and the texas Banded Gecko (*Coleonyx brevis*), are small, averaging 10-15 cm total length. They have skin that is covered by small granular scales. They particularly occupy arid and semiarid habitats (Klauber, 1945).

The southernmost forms, the Central American Banded Gecko (*Coleonyx mitratus*) and the Yucatan Banded Gecko (*Coleonyx elegans*), are larger, averaging 16-18 cm total length. In addition to granular scales, their skin is also composed of enlarged tubercules. The large tuberculate forms primarily inhabit tropical and subtropical habitats (Klauber, 1945), although at least one specimen has been collected in arid tropical scrub in the Chilpancingo region of Mexico (Davis and Dixon, 1961).

In 1956 a new species of *Coleonyx* was described from west Texas. This new gecko, the Big Bend or reticulated Gecko (*Coleonyx reticulatus*) is a large, tuberculate form that occupies arid and semiarid regions. Despite the type of habitat the Big Bend Gecko occupies, it is considered closely allied to the southern tropical forms (Davis and Dixon, 1958).

Groups of the three tuberculate species of *Coleonyx* were maintained and successfully reproduced either in the author's private collection, or at the Houston Zoological Gardens. Two of the species, *Coleonyx mitratus* and *Coleonyx elegans*, were bred more consistently than *Coleonyx reticulatus*. The captive husbandry techniques used for the more successful species are discussed below.

MATERIALS AND METHODS

Housing: Specimens were maintained in three types of cages. Clear plastic shoe boxes (15 x 30 x 9 cm), clear, plastic sweater boxes (25 x 37.5 x 15 cm), and 5 gallon aquariums (20 x 35 x 25 cm) were utilized.

All cages were ventilated and the bottoms were either covered with brown paper or a substrate of *ca.* 5 cm deep bark mulch. Cages with paper substrate were supplied with plastic containers filled with damp bark mulch for retreats. The containers were made by taking empty refrigerator storage containers (400 ml) with lids and cutting a hole *ca.* 4 cm in diameter in the side, midway between the bottom and the top. The containers were half filled with damp bark mulch. Besides being used as retreats, the containers also served as egg deposition sites and offered the geckos a humidity gradient. While the remainder of the cage was kept dry, the plastic containers offered a more moist environment.

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In those cages containing bark mulch as a substrate, curved pieces of bark were added for hiding places. The substrate was usually dry. The old bark mulch was replaced with fresh mulch if it became contaminated by fecal matter or dead food animals.

Water was available ad libitum from a dish containing small stones. The stones, too large to be accidently consumed by the lizards, prevented the food items and the younger geckos from becoming trapped in the water bowl and drowning.

The lighting conditions varied, with some cages receiving light provided by Vitalite (Durotest corp.) flourescent tubes at varying distances and other cages receiving reflective natural light only. The light cycle coincided with the natural day length. Both species were nocturnal and spent the daylight hours hidden with no basking behavior observed.

Temperature in summer ranged from ca. 2530 C degrees during the day, with a night temperature range of ca. 2528 C degrees. During the winter the temperature averaged ca. 28 C degrees.

Food: The diet of the geckos consisted of appropriate size crickets (Gryllus) offered 23 times a week. The crickets were dusted with a vitamin and calcium mixture prior to each feeding. This mixture consisted of ca. 3 parts Super Preen multivitamin powder (RHB Laboratories, Inc.)and 1 part powdered calcium carbonate (Mallinckrodt, Inc.).

In addition to the crickets, the geckos were also offered mealworm (Tenebrio) larvae and pupae. The mealworms were offered only while in a postecdysis condition, during which they were soft and possibly less of a digestive problem. The majority of the geckos preferred mealworms over crickets.

Corngrubs (Sarcophaga)and waxworms (Galleria) were also offered for variety. However, corngrubs were often passed undigested, so they were eliminated from the diet.

Young: The newly hatched young were generally kept on a paper substrate for the first several months. This helped facilitate capture of food items by reducing the number of retreats available to the insect offered as food. This resulted in quick, efficient prey capture during the geckos early growing stages, and increased the chances for the vitamin dusted prey items to be consumed while still coated with the vitamin mixture.

Care was taken to assure all young accepted food and did not lose weight. If weight loss did occur or a young gecko did not exhibit a proper rate of growth, competition from cagemates was usually considered to be the primary factor. This problem was usually resolved by isolating the gecko showing weight loss and feeding it separately.

Adults: Adult male C. elegans as well as C. mitratus were usually aggressive to one another, especially during the breeding season. Therefore, our breeding groups consisted of one male and one or several females each. Sex was determined by the presence of post cloacal swelling in males. These were absent in females.

Males, at times, have also shown aggression to females, sometimes resulting in the death of the female (T. Lilley, Pers. Comm.). Although aggression between sexes has occurred in our groups of animals, none of the injuries were severe, and a brief separation alleviated the problem.

Courtship and copulation were rarely observed due to the nocturnal nature of the animals. Observed copulatory behavior was simi-

lar to what I have observed in the Leopard Gecko (Eublepharis macularius). the male approached the female from the side and seized her by the skin of the neck with his mouth. The male then straddled her body while bringing his tail under the female's tail to position the cloacal openings together.

Observed copulation lasted ca. 23 minutes. Tears or scars on the skin of the female gecko's neck region often resulted from attempted or successful breedings. These marks served as good indicators of reproductive activity, even if no such behavior was observed.

RESULTS

As a result of the captive husbandry techniques described, reproduction was successful in both species of geckos, (Neitman, in prep.) and mortality was minimal. From an original breeding group of 1.2 C. mitratus. 12 young were produced during one breeding session.

Mortality in C. mitratus occurred under the following circumstances:

1. One hatchling from a pair of eggs laid by a young female was weak at hatching and had a large yolk sac still attached. It died within 24 hours of hatching.
2. A young female died eggbound with her first clutch of eggs. In Coleonyx, as in many other genera of geckos, the eggs of a gravid female are visible through the ventral surface for several days prior to egg deposition. However, in this case the eggs remained visible for weeks but were never deposited. The female lost her appetite, showed rapid weight loss and became sluggish prior to death.
3. One of two hatchlings apparently died of dessication when it was deprived of water for 24 hours before hatching.
4. The main breeder male of unknown age showed a loss of appetite and eventually died. This may have been related to old age.

From an original breeding group of 2.1 C. elegans at the Houston Zoological Gardens, the collection increased to 14 animals through reproduction. Of these 14, only one animal died. this was a female that had been the first captive hatched C. elegans at the zoo and had a small spinal deformity at the base of the tail. She was bred by one of the adult males when she was about 1 1/2 years old. Eggs developed and were readily visible through the ventral surface but were never passed. This female apparently died eggbound. The observed deformity at the base of her tail suggested the possibility of other deformities in the pelvic region which may have contributed to a problem in passing the eggs.

DISCUSSION

Although the tuberculate forms of the genus Coleonyx are of medium size for gekkonids and are attractive in coloration and pattern, they are seldom found in zoological collections (Slavens, 1982). This is probably due to their nocturnal nature, which does not lend itself well to exhibition, and the fact that they are rarely offered for sale by animal dealers. However, in a private breeder's

collection they can become an interesting addition and should prosper with a reasonable amount of care.

Perhaps through captive reproduction these geckos will find their way into many more collections. They may even lend themselves to exhibit animals if offered properly designed displays that take into consideration their nocturnal habits and secretive nature.

PRODUCTS MENTIONED

Super Preen powder, RHB Laboratories, Inc., Santa Anna, CA. 92705
Vitalite, DuroTest Company, N.J. 07047
Calcium Carbonate Precipitated, Mallinckrodt, Inc., Paris, KE. 40361

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COMMUNICATION AND AGNOSTIC BEHAVIOR OF ANOLIS CHLOROCYANUS IN CAPTIVITY

Vincent L. Bels

INTRODUCTION

Behavioral activity of many species of Iquanidae (Anolis aeneus, Stamps, 1977; Anolis sp., Jenssen, 1977; Tropidurus sp., Carpenter, 1970; Anolis sp. , Moermond, 1970) have already been studied in the field and in captivity. Displays exhibited by these species have been reported (Anolis opalinus, Jenssen 1979; Anolis limifrons, Hover & Jenssen 1976; Sceloporous sp., Purdue and Caprenter 1972; Tropidurus sp., Carpernter 1970) and analyzed to establish criteria for behavioral evolution in the Iguandae. We had the opportunity to receive from Hispanola 19 adult males of Anolis chlorocyanus. Only one paper (Garcia and Gorman, 1968) has reported a part of the species-specific display of A. chlorocyanus. Here, we will report display, display modifiers and behavioral interaction occuring in the male-male encounters of A. chlorocyanus. We will emphasize the agnostic interactions between the males in two conditions of captivity. Finally, we have tested the effects of the removal of the olfactory stimuli on communication in male-male interactions of A. chlorocyanus.

MATERIALS AND METHODS

Our experiences were conducted over 10 months on 19 adult male lizards, Anolis chlorocyanus, obtained from the Island of Hispanola. Animals were kept in whole glass or glass fronted terrariums measuring 10 x 60 x 60 cm and 60 x 60 x 60 cm. Terrariums were lined with various species of plants (Bromeliaceae, Phylodendron sp., ...) and limbs in order to simulate arboreal habitat. They were lighted by fluorescent tubes (Grolux and Vita-lite) and additional black-lite tubes (Sylvania) to provide additional ultra-violet light. All the specimens were maintained under photoperiods calculated according to the formula of Jones (1978) : H = 2/15 acros (-tan L tanD)1(L being the latitude (= 18 degrees N) and D being the apparent declination on the sun for this latitude). Photoperiod was kept constant at the maximum value during the whole period of observation. Each terrarium was soaked twice a day to maintain high relative humidity (= 90%) and drinking water was provided to the lizards. The temperature was kept constant at 32C degrees during the day and at 24C degrees during the night.

Two experimental conditions were constructed:

1) two males housed together in the same terrarium (situation 1)
2) one male introduced in a glass fronted terrarium (60 x 60 x 60 cm) in which another was housed for two or three months (situation 2).

Observation, filming and video taping of the lizards was always conducted under the same conditions. The display of the animals in both conditions were video taped with a Sony video camera (HVC -

3000P) with a Sony 1.4-70mm zoom lens. The camera was channelled into a JVC 7600 video tape recorder allowing frame by frame playback capacity (25 frames/1 second). The amplitude of the movements was measured from the displays occuring in the level perpendicular to the camera objective. In addition, displaying lizards were photographed with a Cannon A1 with 1.4 - 50 mm zoom lens.

RESULTS

Typical records of the displays performed by the 19 adult males of Anolis chlorocyanus are shown in figure I. The display patterns are shown only partially. Patterns correspond to displays of five different males exhibited in the encounters under the two laboratory conditions (see above). The major types and the units (black block) of the display of Anolis chlorocyanus will be reported in a future paper. However it appears in this study that many types of units are a part of each display and a statistical analysis of display units and their variations will be computed.

In the male-male encounters of Anolis chlorocyanus, the following types of display have been observed: head bobs only, head bobs with extended throat and head bobs with extended dewlap.

1) Head bobs only: this display (figure 2) included closer head bobs (type A) or an elevation of the head (type B) (more or less) during the observation period. In 93% of the type A display, three head bobs followed the first small one. This display was exhibited under both of laboratory conditions. A comparison of the total time of the display in both conditions shows that the display lasted longer in the first situation ($t = 750$; $P<0.05$). The duration of the type B display was long ($\leq$ 1.5 seconds) and this display occured in both conditions. But in both conditions, the non-displaying male exhibited a submissive posture. Inter-individual variation between the mean duration of the type A is presented in figure 3A. a Mann-Witney non parametric test performed on the mean duration is not significant. Individual variability was also observed under the first set of experimental conditions (figure 4A1) or in the second experimental conditions (figure 4A2).

2) Head bobs with extended throat: the display of a male with extended throat (figure 6B) is illustrated in figure 1 (A,B,C,D). A,B, and C correspond the display with the head always recovering its initial position elevation. In 32% of the examples the head of the displaying male reached a certain level and either remained at this level or lowers to another level during all the display (figure 1D). Inter-individual variation between the mean duration of this behavior is presented in figure 3B. A Mann-Witney non-parametric test performed on the mean duration is not significant, but the individual variability could serve as an individual cue. Individual variations were also observed without (figure 4B) or with (figure 4C) display modifiers.

3) Head bobs with extended dewlap: figure 1E presents an example of a male displaying with an extended dewlap. the dewlap was extended prior to the head bobs or just at the beginning of the display. Inter individual variation between the mean duration of this display is presented in figure 3C and 3D. A Mann-Witney non-parametric test

performed on the mean duration is not significant. Individual variation was also observed without (figure 4D) or with (figure 4E) display modifiers.

OTHER BEHAVIORAL COMPONENTS

1) Tongue protuded: during the display or during the displacement of a lizard, the animal pushed his tongue forward between the lips, touching the substrate and withdrew it immediately after the contact. This behavior was observed in other species of Anolis (A. carolinensis, A. sagnei) and may be explained only as an olfactory contact of the lizard to the substrate. This behavior was exhibited in 47% on observed displaying males.

2) Biting: after a sequence of the display repertoire with or without display modifiers, one male bit the head of the other in 9% of observed displays (figure 11).

3) Biting with display: this behavior was observed in two situations. It was preceded by opening of the mouth. The displaying male tried not to bite the head of the challenged male. One male withdrew after 1-4,5 minutes and in 91% of the sample both males displayed again. One male ran away in 9% of the sample.

4) Submissive posture: This posture is illustrated by the individual II in the figure 6A. The lizard was on the limb and turned from green (light) to brown (dark). He did not try any movements and in time, he left his perch.

DISPLAY MODIFIERS

Displays of Anolis chlorocyanus varied according to the morphological variation of the displaying male. Display modifiers are either static or dynamic (Jenssen & Hover, 1976; Jenssen, 1979). In Anolis chlorocyanus, only four static modifiers have been observed: erected nuchal crest, lateral body compression, opened mouth, and erected dorsal crest.

1) Nuchal crest: the erectible nuchal crest was restricted to the neck region. The nuchal crest was erected for varying periods of time cand with a varied amplitude. Two examples report the modalities of the nuchal crest erection (figure 7, E1 and E2). In E1, the displaying and non-displaying male had the same erected nuchal crest (± 2mm), The displaying male exhibited an extended dewlap during his display. in E2, the displaying male had a large erected nuchal crest (>3mm). This figure shows the independance between the behavior exhibited during dislacements (1), display with extended throat (6) or with extended dewlap (2). The exhibition of an erected nuchal crest just before the first contact corroborates the hypothesis by Jenssen (1979) of an action of the adrenergic system.

2) Lateral body compression: many species of Iguanidae exhibit lateral body compression. This static modifier occured during the

display repertoire of the male and was associated with other static modifiers (erected nuchal crest, open mouth, ...). A lizard solely displaying with head bobs has never been observed with a lateral body compression. The body amplitutde height of a male was largely increased when he was laterally compressed (figure 8).

3) Open mouth: in many case of displaying lizards, the mouth was partially or completely opened (figure 9B). At variance with Anolis opalinus (Jenssen, 1979), the mouth was widely gaped in 76% of the sample.

The tongue was not protruded but was visible to the challenged male. The opening of the mouth by a male was followed (96% of recorded displays) by the opening of the mouth of the other male (figure 9A). this male either displayed or did not, before or after opening the mouth.

4) Body nuchal crest: this static modifier was exhibited in only one case: the biting of one male by the other one (figure 11).

AGNOSTIC INTERACTIONS

It is not possible to report all the modalities of the male-male interactions in laboratory conditions 1 and 2.

Figure 7A shows behavioral interactions between two conspecific males, Anolis chlorocyanus, housed together in the same terrarium (laboratory condition 1). Each line either represents a behavioral component of the display repertoire or the displacement of one male. The relative timing of each behavior is represented by its own rectangle (white rectangle : display types; black rectangle: head bobs exhibited during this display type). The relative timing of each displacement of the lizards is represented by its own arrow. Either the extension of the dewlap or of the throat of one animal was followed by head bobs or head bobs were exhibited during the display. The same animal performed any component of its display repertoire in any order. We tested the dependance between the display of both animals. Table I shows the relations hid between the display of the two animals during a 5 hour observation period. We have not used a chisquare analysis to establish the dependance of the behaviors of both animals because the conditiond for application of this test were not fulfilled (Lemon and Chatfield, 1971). We think that the observed frequencies in table 1A show an evident dependance between behaviors exhibited by each male. The posture of each male was variable but lateral compression of the body was often (82% of observed display) correlated with a modification of the posture of the male who became perpendicular to the challenged male. This position was rapidly exhibited ($\bar{x}$ = 2.5 seconds) just before displaying.

In the experimental condition 2, one male (intruder male) was introduced into the terrarium of another male (resident male) housed for two months. Figure 10C presents the interactions between the resident and the intruder males. The legend of this figure is the same as figure 7. As soon as the intruder was introduced in the resident's terrarium, he exhibited a submissive posture (see above) and the resident male achieved many displacements in the terrarium (Figure 10). The observation of the resident male during the two

mouths period had revealed that he was (79% of the day time) in a peculiar position during the most part of the day. This position was variable for each male. It is suggested that this position corresponded to the center of the territory and therefore called the "preferential position." But in contrast to Anolis sagrei, it was not possible to observe the boundaries of a territory of a resident male Anolis chlorocyanus.

Two types of displacements appeared: displacement towards the intruder and displacement in any other direction. these displacements are presented in figure 10A. The resident male moved around the limbs of the terrarium in a complicated pattern . His displacements were interrupted by periods of rest. Never has a resident male attacked an intruder directly and no direct displacements from his preferential position to the intruder were observed. No correlations between both types of displacements were proved. During 62.4% of displacements the resident male protruded his tongue in the substrate (limbs, leaves of plants, ...).

DISCUSSION

It is established that four channels (auditive, visual, olfactive and tactile) are used in the communication in male-male interactions. Visual communication through the display repertoire and the modification of colour (not studied here) seem to be very important in the communication between the two males. For most species of Anolis, head bob displays seem to be the major type of communication in the male-male interactions. In both laboratory conditions, the display repertoire was certainly the more important communicative signal between the cospecific males. Therefore, the modifiers (morphological modifications) and the different postures (perpendicular or towards the challenged male) appeared to be important in the modulation of the exhibited signal. The static modifiers helped communication of the display (figure 7) but also had a communicative function, i.e. the lateral body compression whithout any display directly induced a submissive posture in 19% of challenged males.

We have tested the effect of the removal olfactive communication on the display in male-male interactions by use of a simple apparatus. A plexiglas box completely covered with a plexiglass panel was introduced in the terrarium in accordance with the two experimental conditions (see below). Two long plastic tubes, one of which was connected to an air pump, allowed a flow of respirable air in the box. this box was lined with two small limbs. In this case, only visual and possibly auditory signals were discernible by each male. One male was introduced in the box and two or three hours later the box was introduced to the observation terrarium. We have not observed any modifications of behavior or each male in both cases (Table 2). The displacements described above of a resident male (experimental condition I) presented the same modalities. However, we have observed no biting essay nor mouth opening by any male. These behaviors required proximal agonistic interactions (± 10m/m). Maybe they were not exhibited because the plexiglas well was already 3 m/m thick.

This experience shows that the display repertoire and associated behaviors (static modifiers) were not challenged by the removal of the

olfactory channel of communication in the male-male encounters.

ACKNOWLEDGEMENTS

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Fig. 1. Typical recording of displays of male of Anolis chlorocyanus in male-male encounters.

Legend : A : head-bobs with extended throat
B : " " " "
C : " " " "
D : " " " "
E : head-bobs with extended dewlap

Fig. 2. Illustration of both types of display "head-bobs only" of male Anolis chlorocyanus in the male-male encounters.

Legend : A : type 1
B : type 2.

Fig. 3. A. Interindividual variations of the total time of display "head-bobs only" of nine male of Anolis chlorocyanus in male-male encounters in captivity condition 1 (males 1 and 2) and in captivity condition 2 (males 3, 4, 5, 6, 7, 8 and 9).

B. Interindividual variation of the display with extended throat without display modifiers.

C. Interindividual variation of the display with extended dewlap without display modifiers.

D. Interindividual variation of the display with extended dewlap and with opened mouth.

Fig. 4. Intraindividual variation of the display types of Anolis chlorocyanus.

Legend : A : head-bobs only
(A_1 : captivity condition 1 ; A_2 : captivity condition 2)
B : head-bobs with extended throat without opened mouth
C : head-bobs with extended throat with opened mouth
D : head-bobs with extended dewlap without opened mouth
E : head-bobs with extended dewlap with opened mouth.
1 : male 1 ; 2 : male 2 ; 3 : male 3.

Fig. 5. Mean duration of the head-bobs with extended throat. Vertical line indicate mean duration, outer ends of white bars indicate standard error of the mean and outer ends of black blars are 95 % confidence limits of the mean. Numbers over bars provide sample size.

Fig. 6. Two characteristic postures of male of Anolis chlorocyanus.
A : submissive posture (the arrows indicate the posture of the lizard along the limb).
B : displaying posture with extended throat.

Fig. 7. Exemple of male-male interaction of Anolis chlorocyanus in laboratory condition 1 (see more explanations in the text).
Legend : A : Each rectangle represents the duration of each behavior and each arrow represents the displacement performed by each male (black block : head-bobs in the differend display type performed by each male).
1 : displacement of the male 2
2 : display with extended dewlap of the male 2
3 : displacement of the male 1
4 : display with extended throat of the male 1
5 : display with extended dewlap of the male 1
6 : display with extended throat of the male 2
7 : biting of the male 2 on the male 1
8 : erected nuchal crest of the male 2
B : I_1 : male 1, I_2 : male 2
Each arrow plesents morphological variation in displaying or no-displaying male.
E_1 and E_2 are explained in the text.

Fig. 8 : Amplitude shift of male Anolis chlorocyanus exhibiting lateral body compression.

Fig. 9. A : exemple of male-male interaction when two males of Anolis chlorocyanus display with opened mouth.
Legend : Each line represents a behavioral type of one male and each rectangle represents the duration of each behavior (black block : head-bobs in the different display types of each male).
A_1 : displaying of male 1
B_1 : opening of the mouth of the male 1
C_1 : opening of the mouth of the male 2
A_2 : displaying of the male 2
B_2 : opening of the mouth of the male 2
C_2 : opening of the mouth of the male 1

Fig. 10. A : Series of displacement of the resident male of Anolis chlorocyanus in the captivity condition 2 (black block : movement of the resident male to his preferentiel position ; see explanations in the text).

B : Types of movements of the resident male (1) of Anolis chlorocyanus in the terrarium when the intruder (2) was introduced in the terrarium.

Legend : ⟶ : movement on the limbs

⇢ : spring from a limb to another.

C : Exemple of male-male interaction when a intruder male of Anolis chlorocyanus was introduced in the terrarium (see explanations in the text).

Legend : ➧ introduction of the intruder male

A : display (one of the for types from the display repertoire) of the resident male

B : submissive posture of the intruder male

C : displacement of the resident male

: disolacement of the resident male to the intruder

: displacement of the resident male in a other direction

D : displacement of the intruder male

Fig. 11. Biting between two males in the end the male-male of Anolis chlorocyanus interaction in captivity condition 2.

Table 1 : Transition matrix (observed frequencies (A) and expected frequencies (B)) of selected behavioral components for male-male interactions of Anolis chlorocyanus in laboratory condition 1. In the transition matrix, the number of paired bouts (i.e. row and column total) equals 225 (see more explanations in the text).

Table 2 : Frequencies of occurence of head-bobbing displays by males, Anolis chlorocyanus in two situations :

1) male-male interactions with all the channels of communication (laboratory condition or situation 1 and 2) ;
2) male-male interactions without olfactive and tactile channels of communication (laboratory condition or situation 1 and 2).

Table 1.

A OBSERVED FREQUENCIES

MALE 1 \ 2	C_1	C_2	C_3	C_4	C_5	C_6	
R_1	31	14	12	15	0	0	72
R_2	0	0	0	2	2	0	4
R_3	0	0	14	0	0	7	21
R_4	0	24	57	25	0	0	106
R_5	0	3	3	3	7	0	16
R_6	0	0	0	0	0	6	6
	31	41	86	45	9	13	225

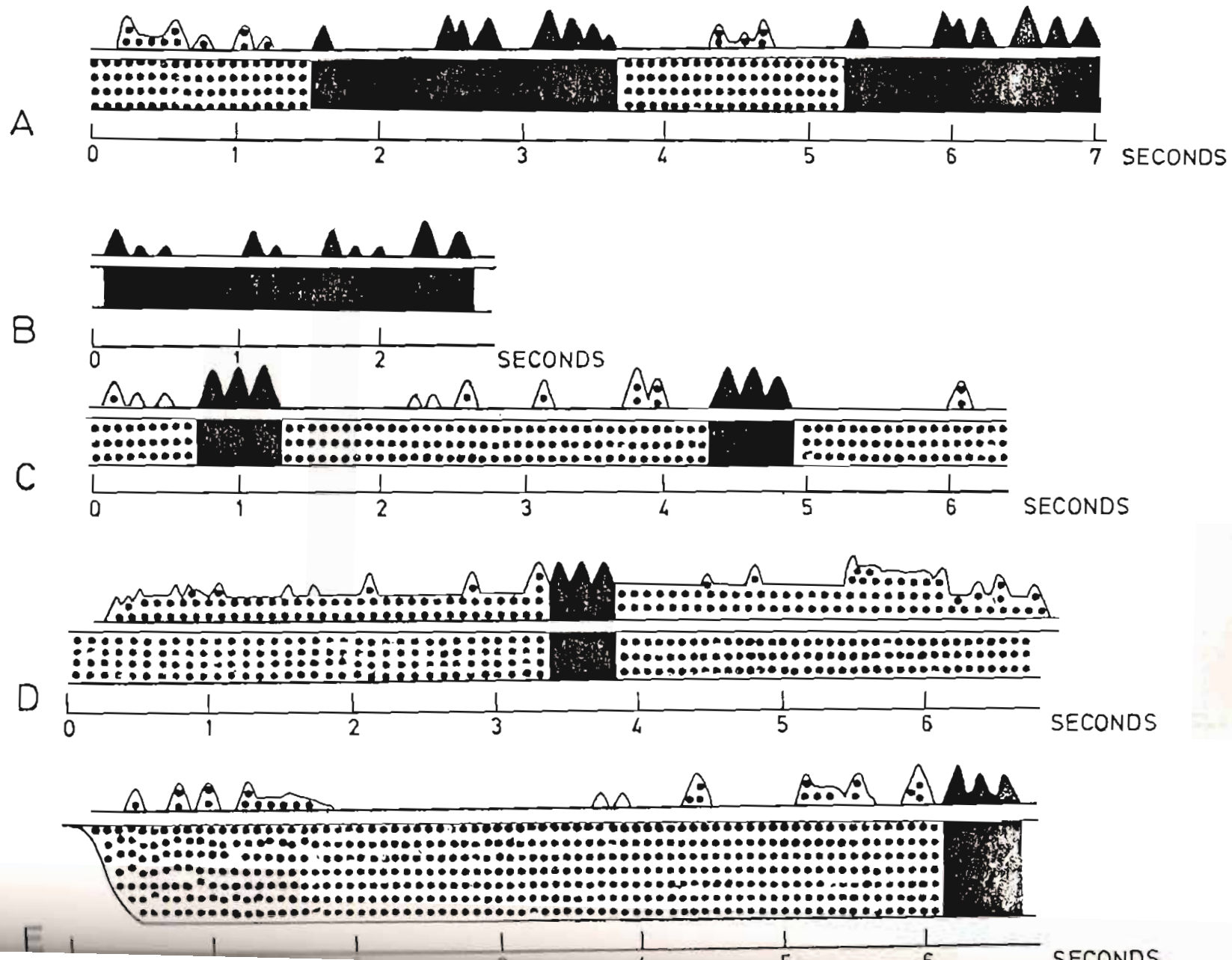
B EXPECTED FREQUENCIES

MALE 1 \ 2	C_1	C_2	C_3	C_4	C_5	C_6
R_1	9,92	13,12	27,52	14,40	2,88	4,16
R_2	0,55	0,73	1,53	0,80	0,16	0,23
R_3	2,89	3,83	8,03	4,20	0,84	1,21
R_4	14,60	19,32	40,52	21,20	4,24	6,12
R_5	2,20	2,92	6,12	3,20	0,64	0,92
R_6	0,83	1,09	2,29	1,20	0,24	0,35

$C_1 = R_1$ = head-bobs with extended dewlap
$C_2 = R_2$ = head-bobs with extended throat
$C_3 = R_3$ = extended dewlap
$C_4 = R_4$ = extended throat
$C_5 = R_5$ = opened mouth
$C_6 = R_6$ = head-bobs only

Table 2.

Display	Interaction with all the channels of communication		Interaction without olfactive and tactile channels of communication	
	Situation 1	Situation 2	Situation 1	Situation 2
Head-bobs only	8 (46,6 %)	9 (5,9 %)	26 (46,4 %)	5 (4,6 %)
Head-bobs with throat extended	22 (36,6 %)	76 (50,3 %)	23 (41,07 %)	72 (66,6 %)
Head-bobs with dewlap extended	7 (11,6 %)	29 (19,2 %)	5 (8,9 %)	27 (25 %)
Head-bobs with throat extended and mouth opened	3 (5 %)	29 (19,2 %)	2 (3,5 %)	4 (3,7 %)
Head-bobs with dewlap extended and mouth opened	-	8 (5,2 %)	-	-
	$n_{total} = 60$	$n_{total} = 151$	$n_{total} = 56$	$n_{total} = 108$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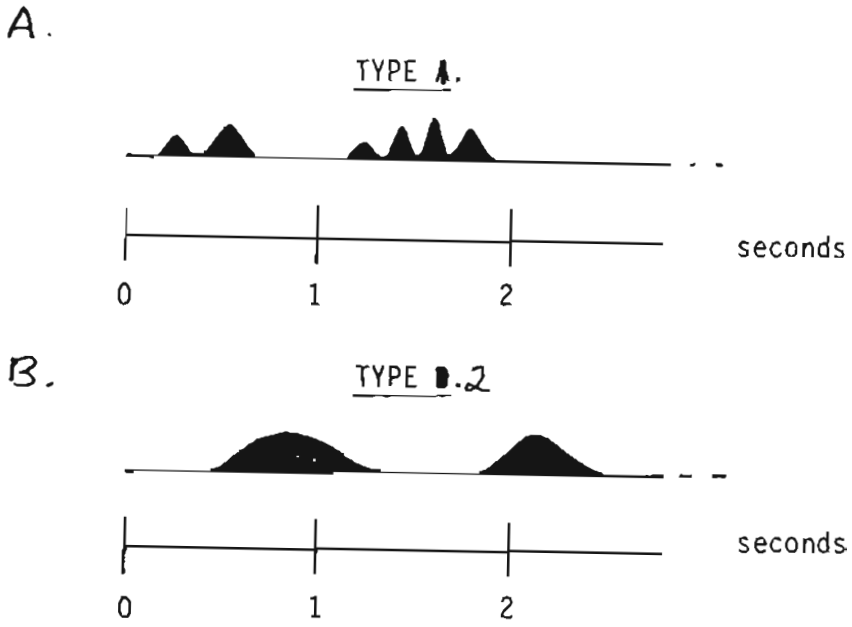
SECONDS

Figure 2.



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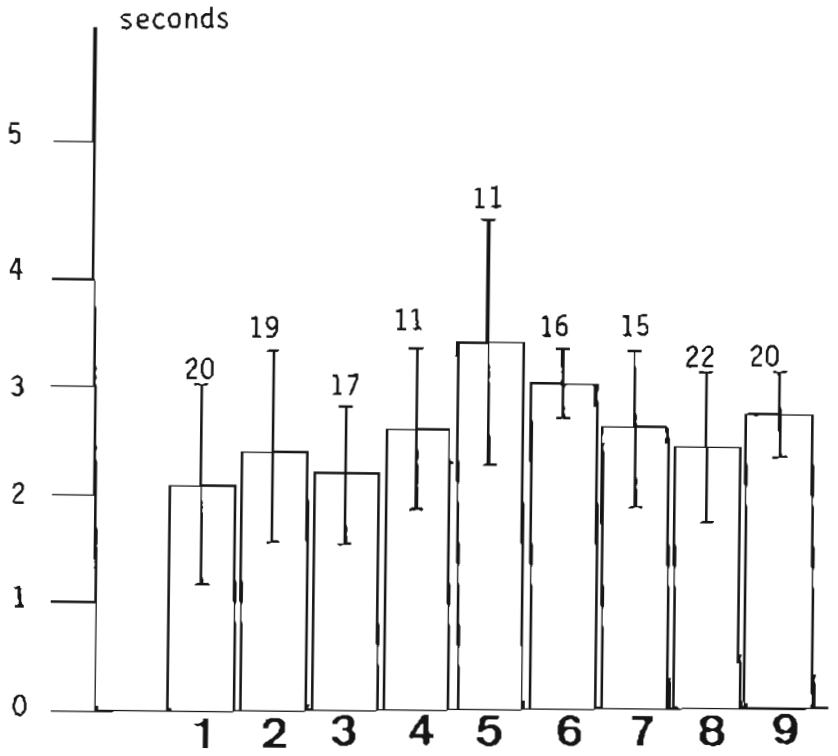

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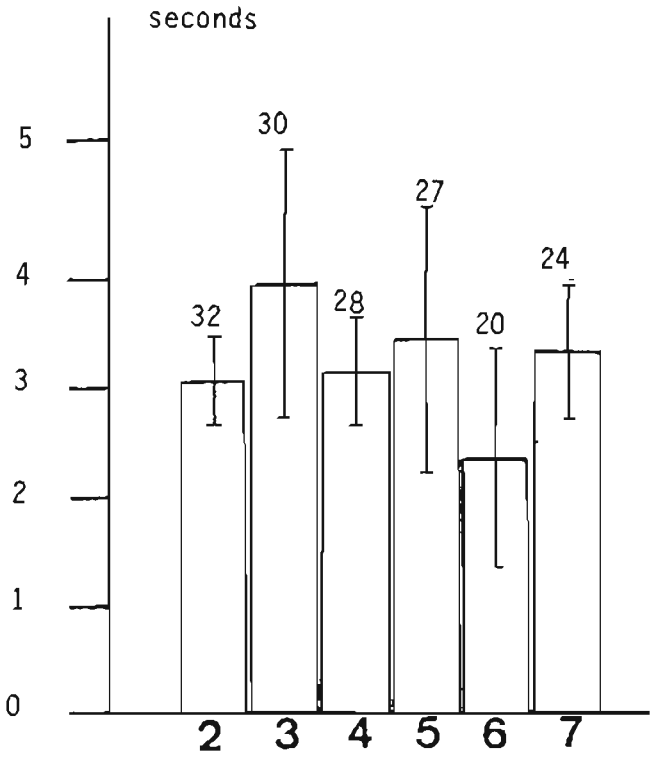

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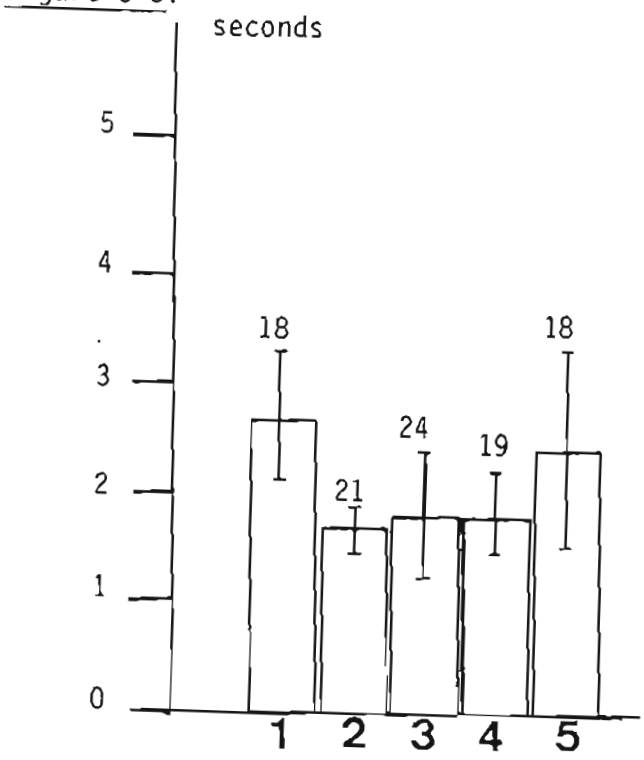

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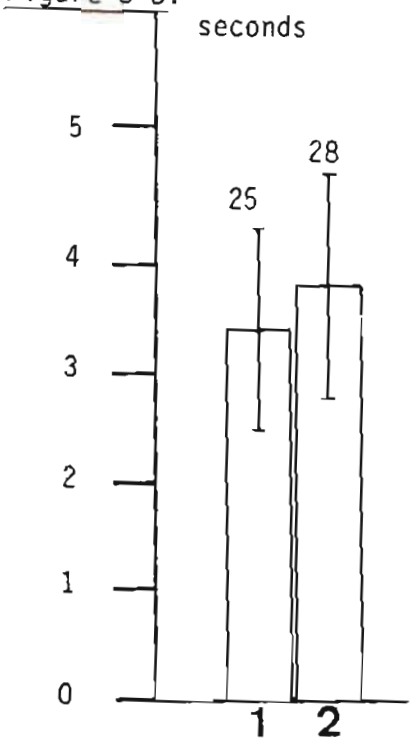

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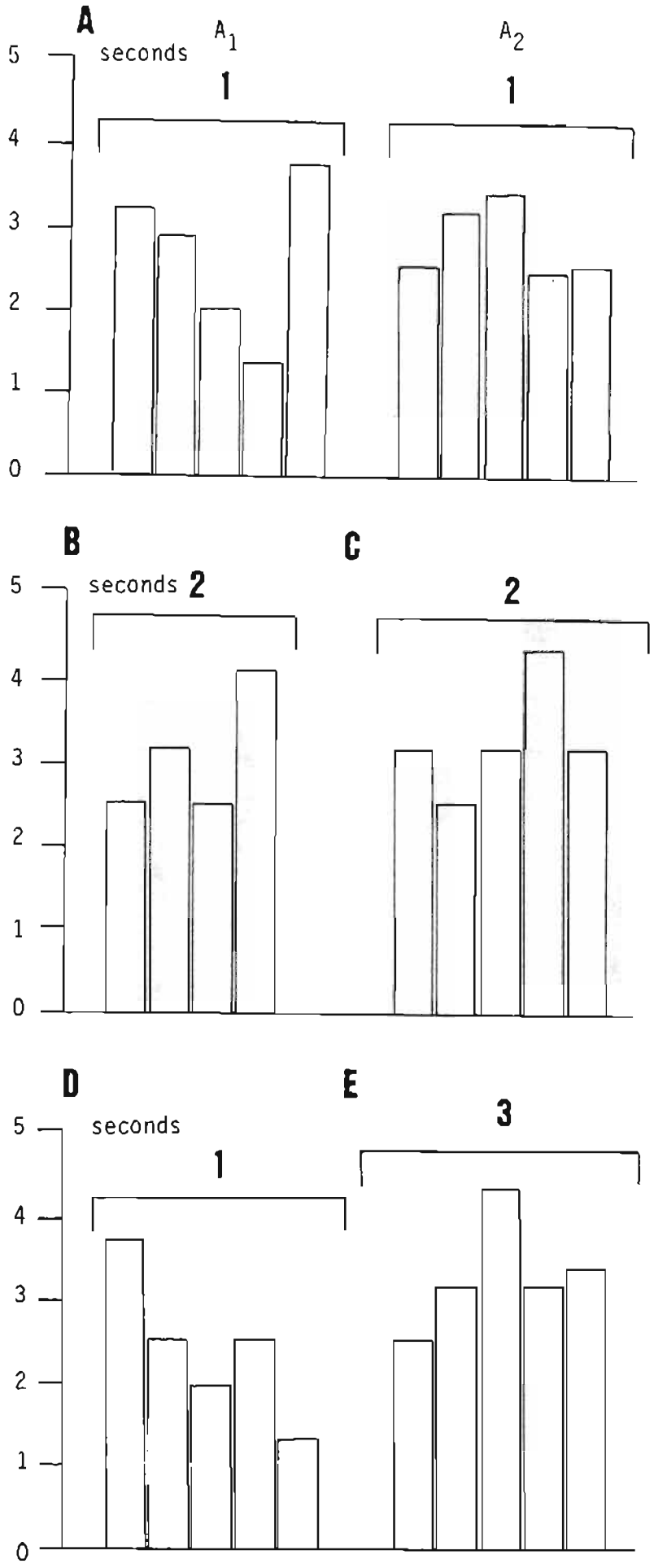
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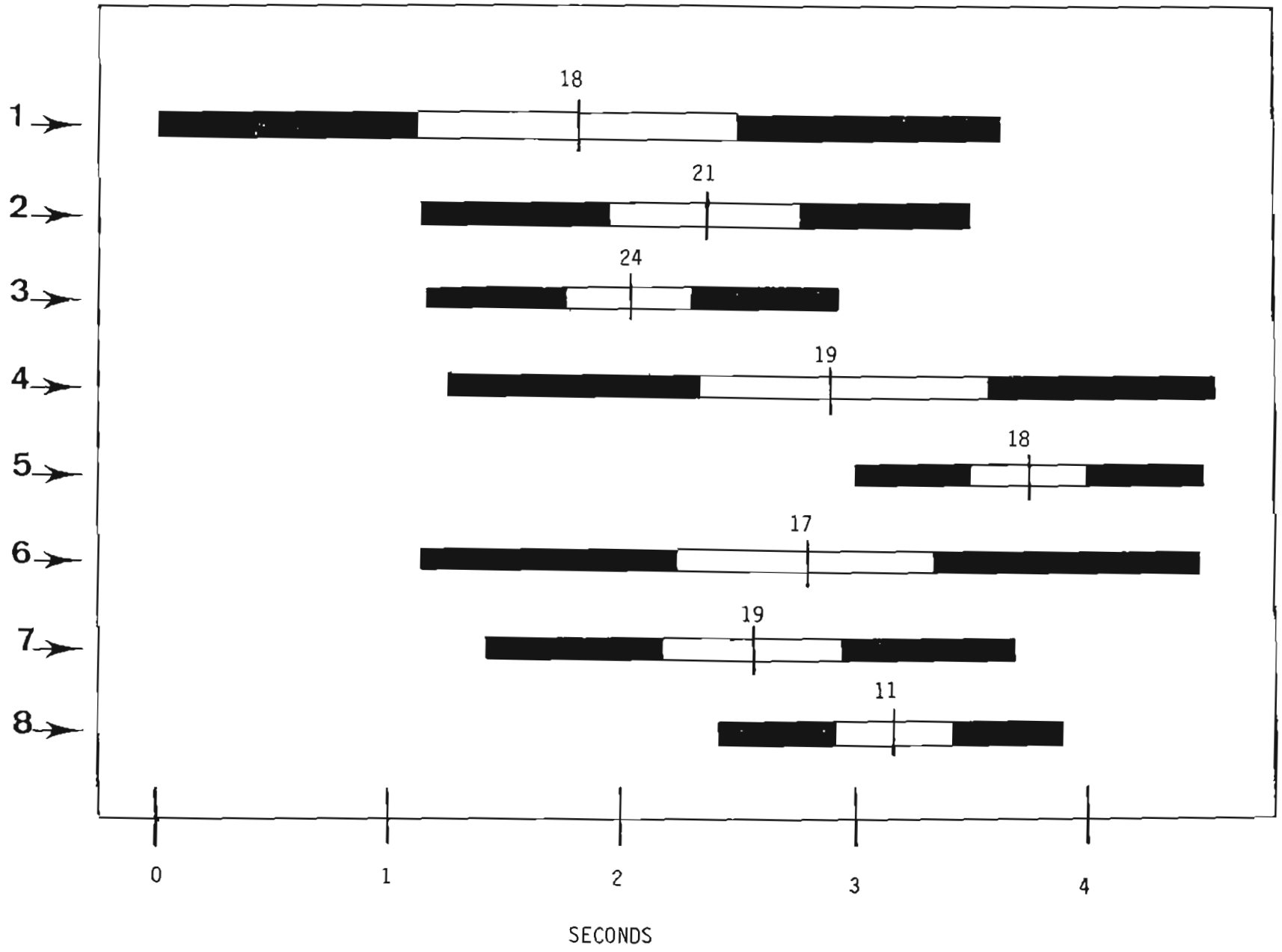
Figure 5.



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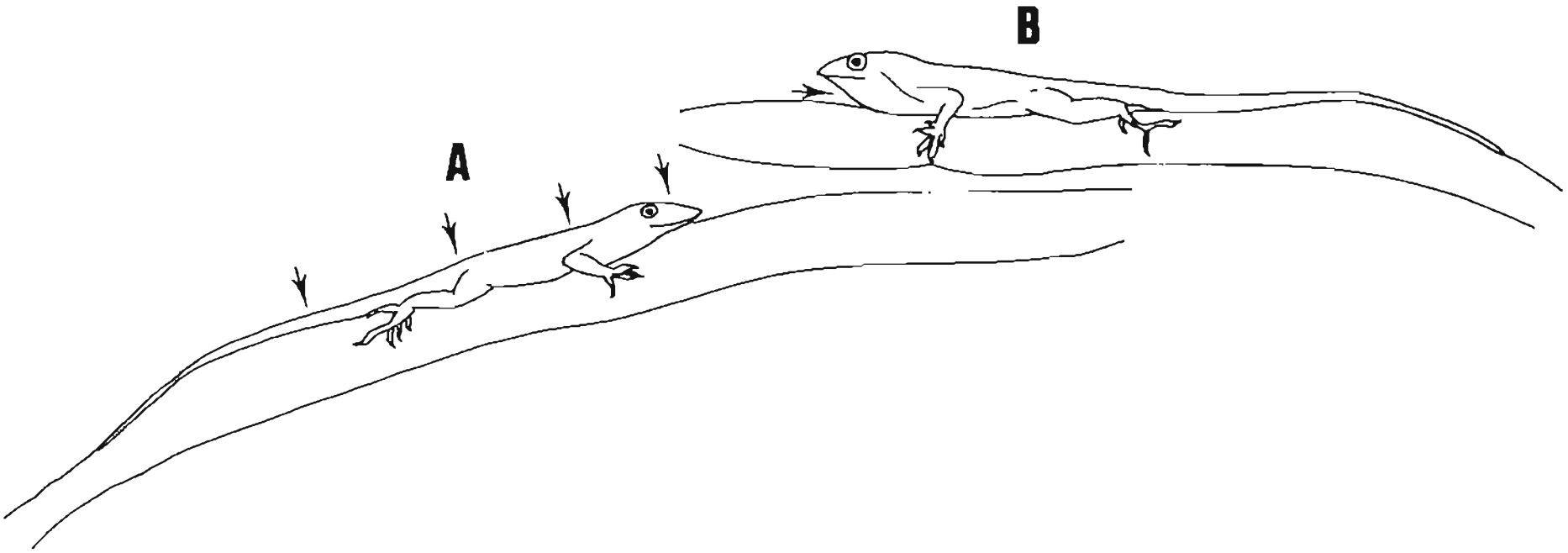

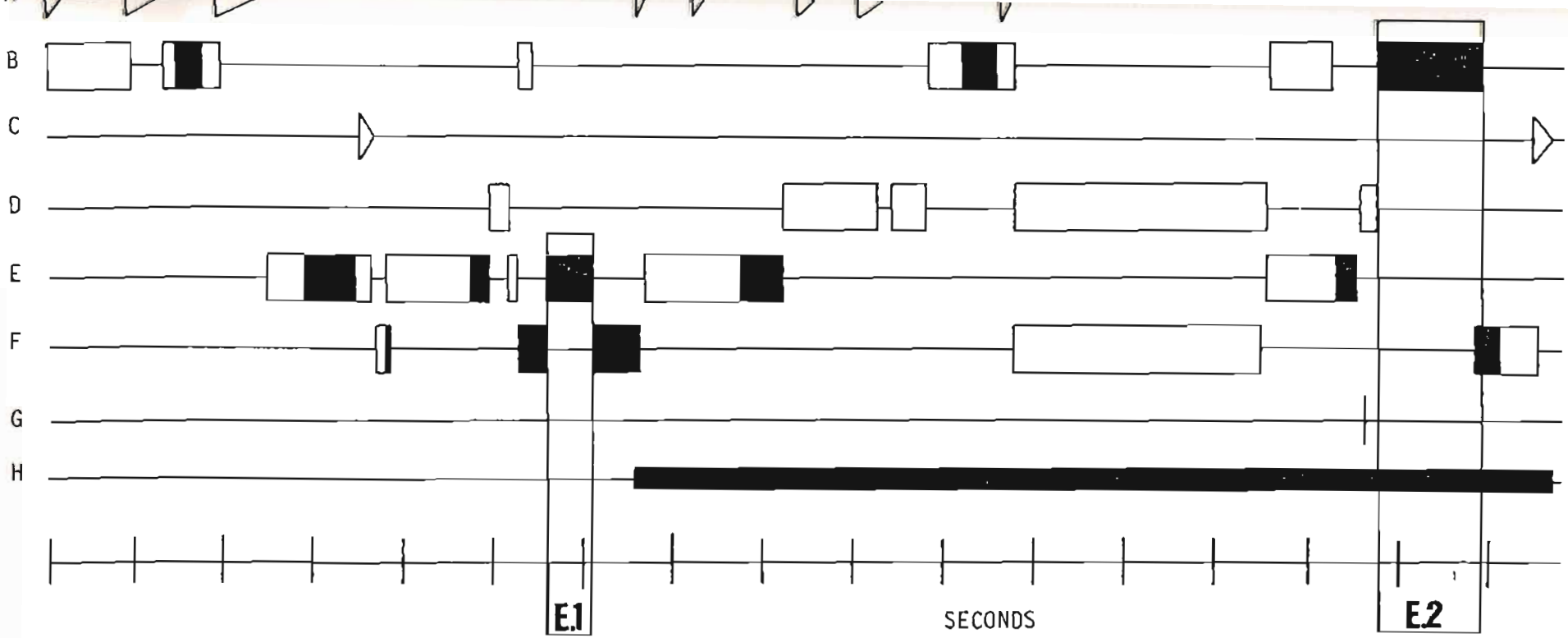
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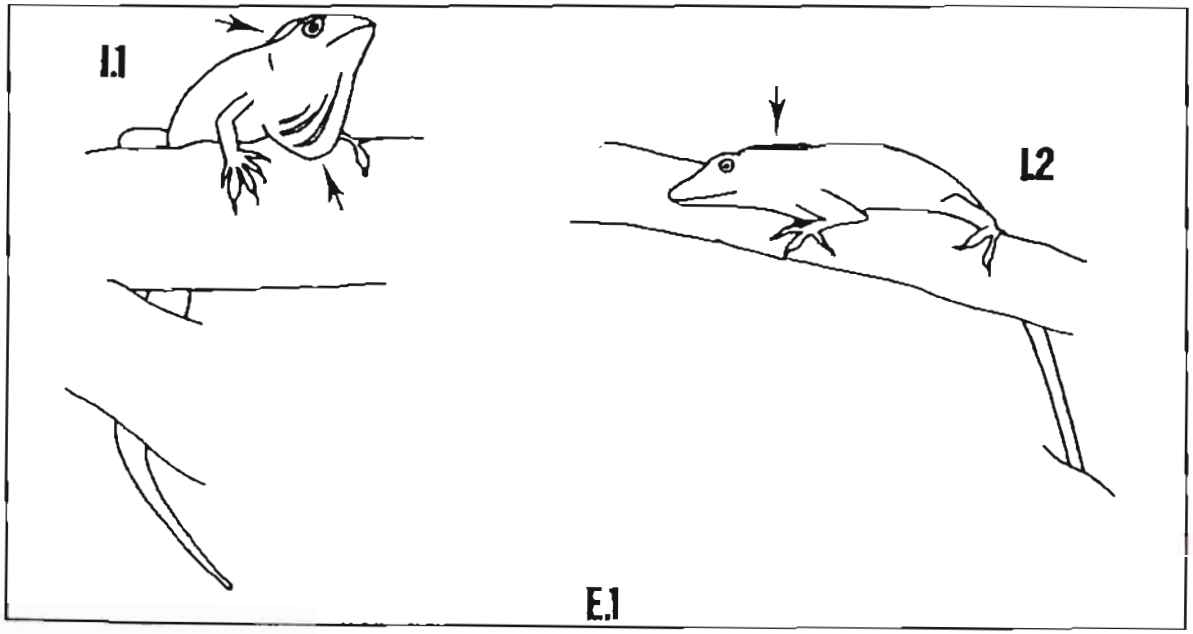
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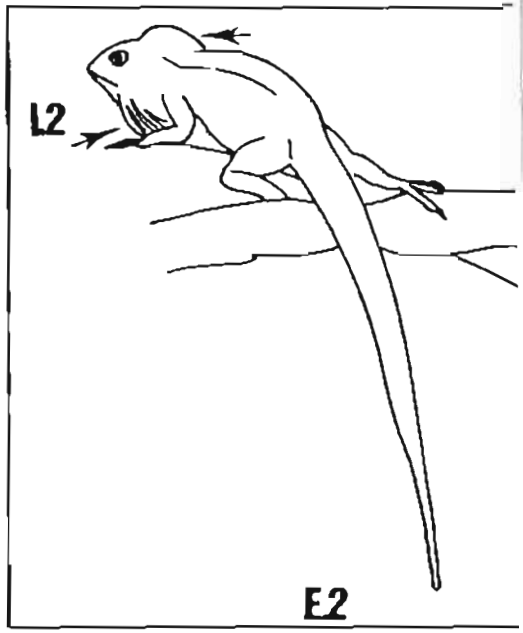
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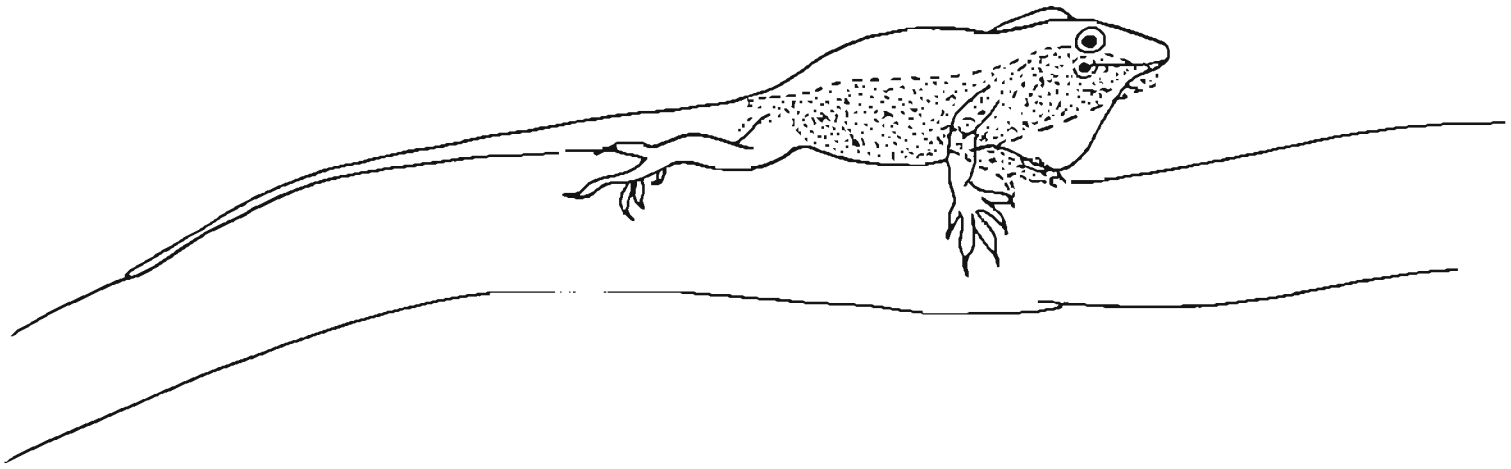

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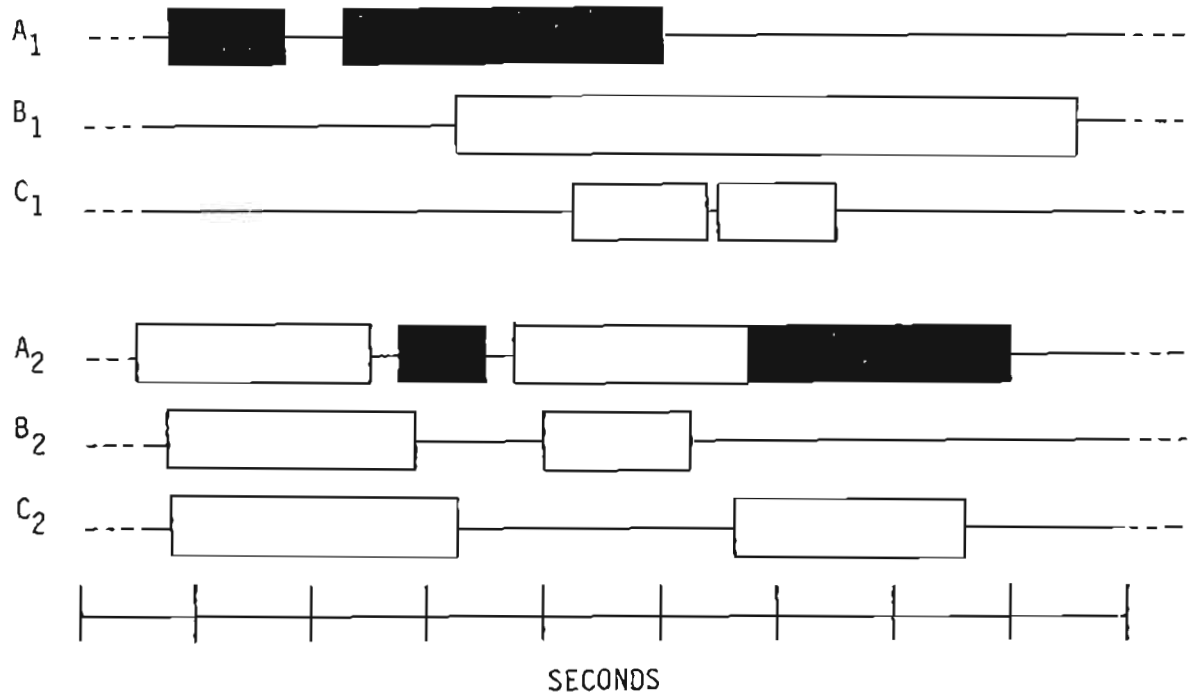

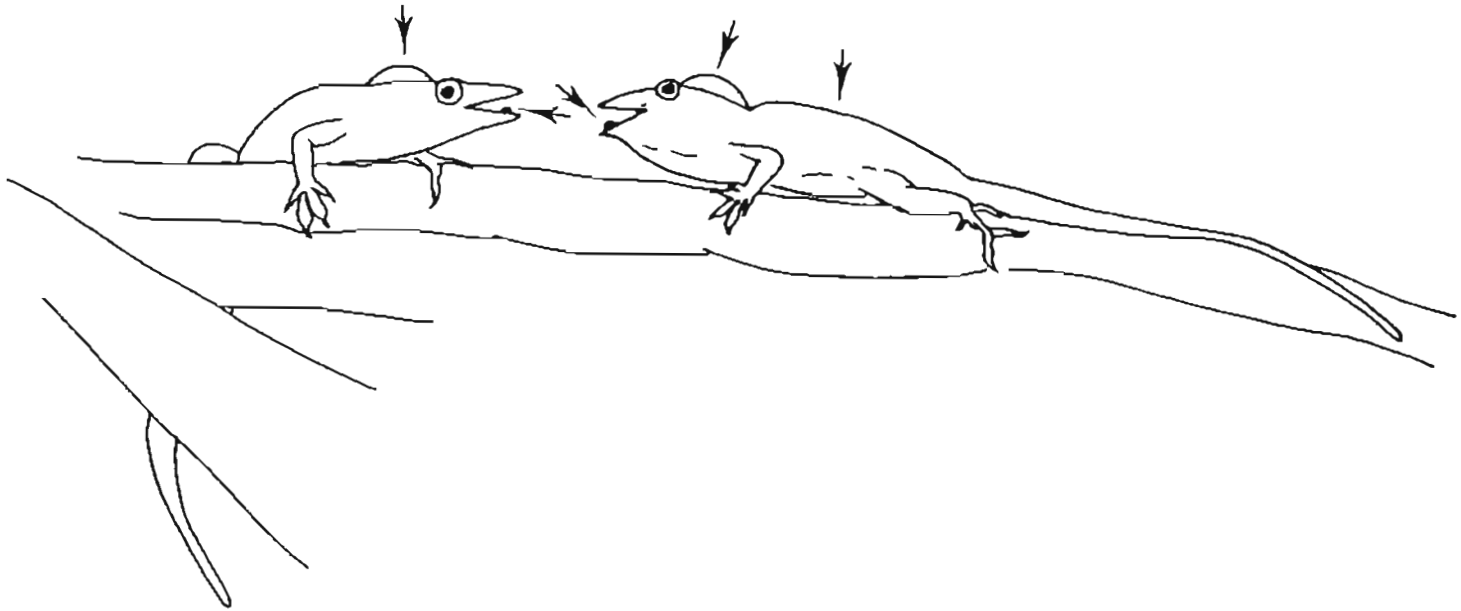

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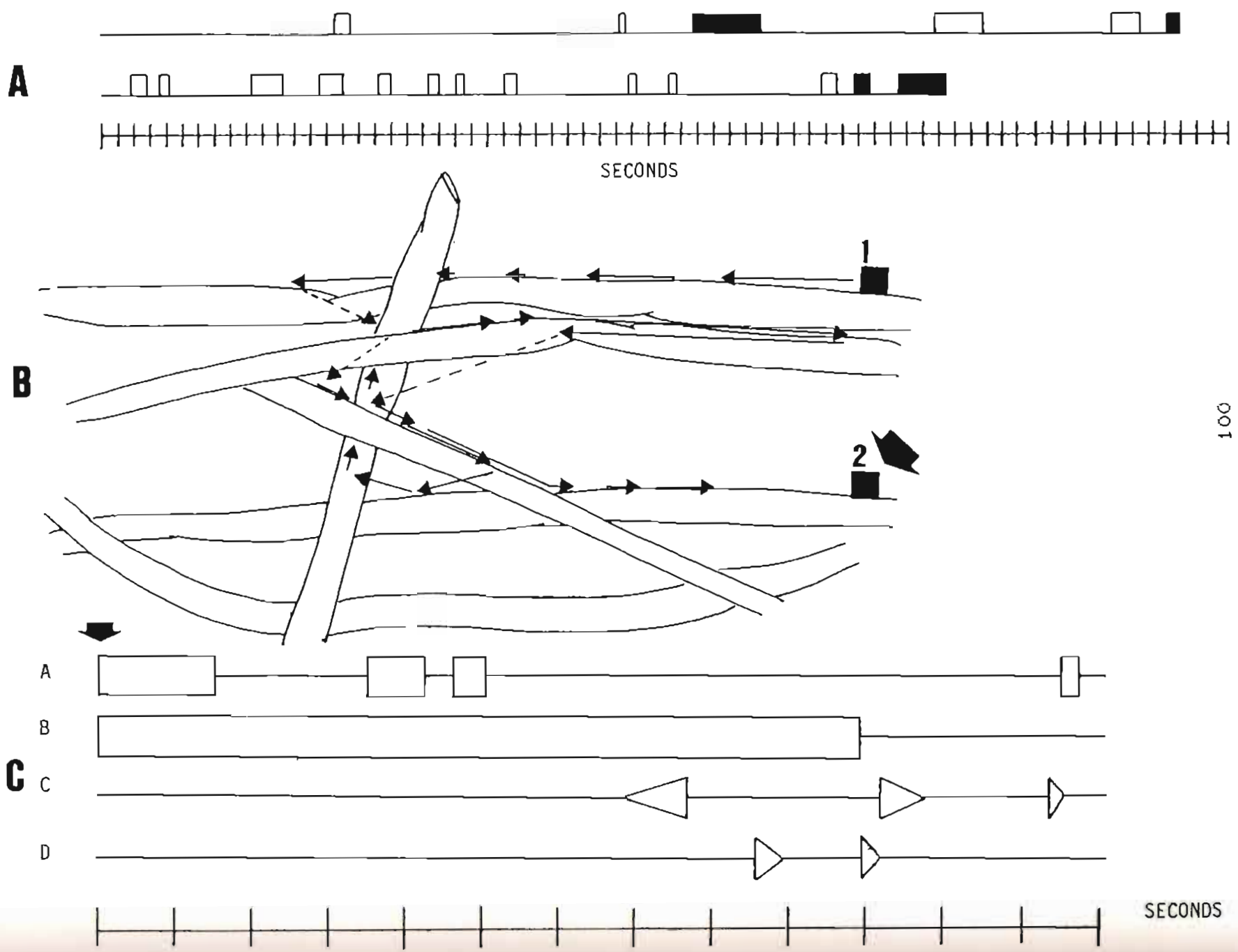

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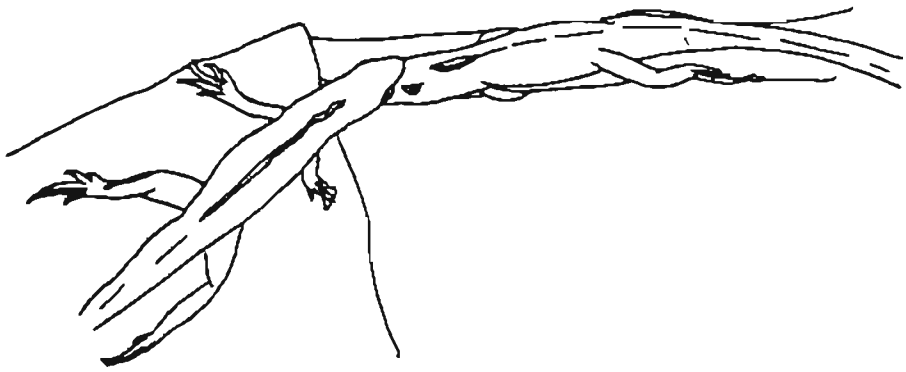

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NOTES ON CAPTIVE REPRODUCTION

in the

WEST AFRICAN GABOON VIPER

(Bitis gabonica rhinoceros schlegal)

at the

RIO GRANDE ZOOLOGICAL PARK

Dora M. Jacobs and A. Dale Belcher

INTRODUCTION

Gaboon Vipers (Bitis gabonica ssp.) have long been regarded as difficult to maintain in captivity. While respectable longevities of 10+ years for B. G. gabonica and 13+ years for B. g. rhinoceros (Bowler 1977) have been achieved, premature mortality has been common. In addition, neither taxa has been frequently bred in U.S. zoos (1974: San Diego Zoo; 1977: Los Angeles Zoo, Tulsa Zoo; 1978: Tulsa Zoo, Houston Zoo; 1979: New York Zoological Park, San Diego Zoo (International Zoo Yearbook 1959-1981); 1981: Knoxville Zoo (Howard Lawler pers. comm.), Rio Grande Zoo; 1982: Rio Grande Zoo).

In this paper, we detail two captive reproductions at the Rio Grande Zoo and offer tentative conclusions based on our observations regarding the seeming delicacy of the species in captivity.

MATERIALS AND METHODS

The breeding pair of Bitis gabonica rhinoceros at the Rio Grande Zoo were acquired simultaneously on April 16, 1979 from an animal dealer. Captured in the wild, purportedly maintained in captivity for "a couple of years," the female was mature when received, the male apparently quite young.

During the routine fecal exams, both specimens were found to be harboring heavy infestations of endoparasites, specifically capillaria, ascarids, strongyles and cestodes.

At first we attempted to treat them with Mebendozol (22mg/kg) injected IP into feed rats, but the snakes almost invariably refused the rats, apparently detecting the medication. Ultimately, we administered Thiabendazole (60mg/kg) and then Fenbendazole (50 mg/kg) by stomach gavage. The snakes were restrained in a double lucite tube with a slitted lucite plate taped over the end. The snakes were easily persuaded to crawl into a tube of sufficient diameter for them to turn their heads back on themselves. Then a tube approximately the greatest diameter of the snake would be slipped over the tail, and both animals backed readily into it. The gavage tube, supported by a stiff wire stylus, was then introduced through the slit in the end plate and into the snake's mouth and pharynx. The stylus was held in place while the tube was passed down the esophagus into or near the

stomach. The vermifuge was then administered by syringe. Since the lucite allowed for maximum visibilty at close range, it was quite simple to medicate the animal, withdraw the gavage tube, and tilt the outer tube upward for several minutes to prevent regurgitation before releasing the snake by simply slipping out the smaller of the lucite tubes and letting the snake crawl forward into its cage. By this method, we were able to rid our Gaboon Vipers of all internal parasites before attempting to breed them. Both have remained negative since December, 1980.

The breeding procedure has been to place the pair together on exhibit for a few months once we estimated that the male should have reached sexual maturity and then separate them when the female began to increase significantly in weight. In 1981, the pair were kept together in our exhibit model from January 26 through April 9. During this period, the female's weight increased from 6900g to 8370g. During the following breeding season, the animals were kept together on exhibit between September 11, 1981 and April 29, 1982. The female weighed 5130g in September and 6960g in April. Copulation was suspected on January 25, 1982 and again on February 10, 1982, in both instances overnight when nobody was observing. The animals were found the following mornings in nearly full body contact and this unusual proximity was the only observed clue to nocturnal copulations.

During the reproductive cycle, the female was kept in a fiberglass module measuring 118cm long X 92cm wide X 86cm high. Ambient temperature in the surrounding room was 25-30 degreesC and lighting was provided by two 40 watt Vitalites during the full photoperiod plus two 40 watt daylight 64 tubes for four (4) hours at midday. These are placed over the module itself, separated by a screen from the snakes. The diurnal lighting cycle varied seasonally from 9.5 hours of daylight on June 15 to 16 hours on December 15, in an effort to simulate southern hemispheric photoperiod. Keeper access is from the top and rear, with hinged panels latched by a locking window mechanism to which only herpetarium personnel and upper management have keys for safety reasons.

In 1981, the module was decorated fairly simply with two cottonwood log sections mounted on boards running under large rocks, gravel varying from approximately 1 to 2cm in diameter plus several large plastic and fabric tropical plants and ferns. A 1.5 liter clear glass water bowl 20cm in diameter and 7 cm deep was provided at all times. For the 1982 season, the landscaping was changed to provide two levels of substrate and more open space for the birth process, since it was believed that some of the neonates may have been crushed by the female during the first birth, which commenced during the night. A two level effect was achieved with the use of a low, broad cottonwood stump acting as a curb. Only one upright log was retained, as were the artificial plants. Leaf litter donated by the Rainforest was strewn over the gravel for ease in cleaning as well as visual effect. As expected, handling of the neonates during the course of the birth was simplified by this layout.

Off exhibit, the Gaboon Vipers are housed in fiberglass holding cages, 107cm long X 63cm wide X 50cm high with clear lucite sliding fronts secured by wing nuts and bolts slipped through holes drilled through both the fiberglass and the lucite. Newspaper substrate and a glass water bowl identical to the one in the exhibit module allow for ease in cleaning. Newspaper curtains are necessary for both animals

most of the time when off exhibit, since they tend to thrash around and occasionally strike at the front. The female was especially nervous when an x-ray showed a number of fractured ribs, probably incurred during one of her occasionally ungraceful jumps off the handling hooks into the holding bucket.

Handling has been accomplished with the female since her arrival and with the male as soon as he reached sufficient size, with two thick hooks 163cm and 133cm in length, the metal hooks padded with plastic tubing to provide a larger, softer contact surface for the snakes. Both have readily become accustomed to handling and submit readily to being lifted most of the time. The female will acutally travel forward if prodded near the tail and can be persuaded to crawl over the module door into and from the holding bucket, in this case, laid on its side. This method was used exclusively while her ribs healed. Both animals are least traumatically returned to the exhibit module by laying the bucket on the shelf formed by propping the rear door on a trash can and then porodding them out with a hook.

Shedding has occurred once a year in the case of the male, during our summer. The female has shed more frequently, usually every eight or nine months except after her first parturition, when she shed immediately afterward and then again only four months later. Quality of shedding improved dramatically after the worming process.

Both animals have fed with reasonable regularity since their arrival. The male would eat only hamsters when he first arrived, but since August 28, 1980, he has been maintained primarily on rats, with occasional pigeons and turkey chicks taken when rats were not available. He refused sporadically until cleared of parasites.

The female has accepted rats from her arrival and has been occasionally fed pigeons, turkey chicks and squab when rats were scarce. She refused a hamster. She has eaten well, except when gravid (during periods, she refused entirely). Food animals are offered with a universal tong, 100cm in length.

All neonates were, at first, kept in clear plastic shoe boxes 30cm X 16cm X 8.5cm with holes drilled in the lids for ventilation. These lids were held in place by two or three elastic bands around the boxes. Paper toweling was used as a substrate and water bowls were provided. Boxes were stacked three or four deep on wall shelves. Juveniles were transferred to larger boxes of the same design, but 35cm X 24cm X 16cm , when they reached such a size as to make handling in the shoe boxes very hazardous.

The two neonates kept in 1981 were exhibited for about year in a thirty gallon glass aquarium, 91cm X 45cm X 31cm , lighted by a Vitalite 20 watt tube. On reserve, they and the 1982 offspring were kept in wooden boxes, 40cm X 31cm X 25cm , with sliding lucite fronts. The 1982 juveniles, upon outgrowing this box, were transferred to fiberglass holding cages, 53cm X 30cm X 23cm , with sliding glass fronts.

RESULTS

In 1981 , the female began refusing food on May 4, but had increased her weight to 8580g by August 4. On the morning of September 4, 53 neonates were found with the female. She shed September 5 and

weighed 5130g on September 8. In 1982, she began refusing food on April 8, increased in weight to 6900g by July 31 and gave birth to 22 live and 10 stillborn neonates on August 24. She weighed 4680g immediately after giving birth and shed on October 21.

Of the 53 1981 neonates, 23.24 were recovered alive and six were either stillborn or crushed before discovery. Three were euthanized within the first month following birth, due to deformities. The babies varied in weight after 25.5g to 32.5g with an estimated average weight of 27.3g. Not all neonatal weight records were saved, unfortunately. The two kept were weighed quarterly as per our standard procedure for all herptiles at Rio Grande Zoo. The one ultimately shipped out (a male) weighed 30.5g at birth, nearly doubled his weight in the first month, weighing 58.7g on October 2. His weight increased to 95g on Jaunary 15, 1982, more than doubled to 216g on April 19, 1982 increased to 360g on July 8, 1982 and added approximately 300g in each of the three succeeding quarters (630g on November 4, 1982, 930g on January 30, 1983 and 1200g on April 25, 1983). The other neonate (a female), which we have kept, weighed 29.2g at birth and increased to 47g by October 2, 1981. She more than doubled her weight to 110g on January 16, 1982. By April 25, 1983 she weighed 1290g. As of July 13, 1983, she had dramatically doubled her weight to 2430g. Three others from the same parturition, which we kept past their seventh month, showed approximately the same growth rates.

The second breeding yeilded fewer neonates than the first, 12.10 live and 10 stillborn, but they were larger in size, ranging from 31.6g to 46g and averaging 39.4g.

A juvenile from the second breeding (a female) was born at 37.7g, weighed 89.5g at three months on November 1, 1982, 150g on January 31, 1983, 420g on April 3, 1983 and 690g on July 13, 1983. This individual, considering that it was one month younger at the times of the quarterly weighings than those of the first breeding, retained its initial size advantage throughout its early growth.

The animals we kept through one year of age achieved roughly 18 to 20 times their starting weight at that point.

RESULTS

All neonates shed either during the birth process or shortly thereafter. They established a pattern of shedding every three or four months thereafter.

Most of the neonates ate fuzzy mice readily within a few days and maintained good appetites. One which refused to eat was euthanized at one month of age. The female juvenile kept from the second breeding went through periods of having to be coaxed to eat. Size of feed mice was increased according to the snakes' growth and acceptance. Food was offered by means of a 29cm long forceps, followed by 54cm long crucible tongs as the snakes grew. Mice larger than the fuzzies were killed before feeding.

A graded series of hooks from 38cm in length to 76cm was used as juveniles grew. We are now beginning to use two hooks to lift the two year old, as she tends to stiffen herself and slide off one hook.

Of the first breeding, 21 of the offspring were sold, 2 were traded, 20 were placed on breeding loan and one has been kept with the intention of attempting a second generation breeding with a female, approximately the same age as ours, acquired from Knoxville Zoo. Of

the second breeding, 18 were sold and 4 were placed on breeding loan.

DISCUSSON

Based on experience with over 70 animals, the authors believe that Bitis gabonica rhinoceros is not a difficult animal to maintain in captivity. We have been able to follow the progress of the majority of neonates produced at the Rio Grande Zoo and, of the 69 neonates produced, we are aware of only three mortalities.

It is our contention that Gaboon vipers may be somewhat difficult to acclimate to captivity. It appears that the process of collection and transport from the wild to captivity in North America can be very stressful. In addition, animals may not receive food or water for rather long periods of time. Often the animals are compromised by very heavy parasite burdens (Louis Porras pers. comm.) and we believe that this compromise, combined with stress, often results in mortality.

We believe that most, if not all, endoparasites can be eliminated and that husbandry can be geared for 'minimum stress. These factors should minimize premature mortality. If compatible pairs are secured, reproduction will likely become commonplace in the future.

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Carolina Culture Dish (water bowls) - Carolina Biological Supply Company, Burlington, North Carolina 27215.
Herp Hut Snake Cage - Herp Hut Sales, 3118 faith Lane, Tyler, Texas 75701.
Reptile Hooks - Furhman Diversified, 1212 West Flamingo Drive, Seabrook, Texas 77586.
Universal Tongs - Manco, Inc., P.O. Box 51, Eldon, Missouri 65026.
Vitalite, Daylite 65 - Duo-Test Corporation, 2321 Kennedy Blvd., North Bergen, New Jersey 07047.

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HUSBANDRY AND BREEDING OF THE BRAZILIAN RAINBOW BOA

Epicrates cenchira AT THE NATIONAL ZOOLOGICAL PARK

Trooper Walsh and Bob Davis

INTRODUCTION

Six litters of Brazilian rainbow boas (*Epicrates cenchria*) were born between December 1979 and February 1981. The first three litters (1979-80) were produced under carefully controlled conditions while the 1981 breedings occurred during a period of fluctuations in environmental conditions that were beyond our control. For this reason the majority of this paper is concerned with the first three broods with comments on the 1981 births.

MATERIALS AND METHODS

Breeding Group

The original breeding group consisted of one male and three females. The females were captive born in 1975 and are unrelated. The male was received in 1968 as a wildcaught adult. At the time of the first successful breedings, the females ranged in weight from 1751-2345 g and the male weighed 1900 g.

Husbandry

The adults were housed and bred in two different types of enclosures, an exhibit cage and a breeding-brooding cage (BBC). The details of these cages are summarized in Table 1. The exhibit cage was sprayed with water daily to increase humidity. During the day temperature and humidity peaked at approximately 28 C degrees and 85% relative humidity while at night they dropped to 22C and 70% humidity.

In the BBC, a cork bark pile and heat lamps resulted in a thermal gradient and a 24 hour heat cycle. The cool end of the BBC ranged from 18-23C degrees. Temperatures at the warm end on top of the cork bark were approximately 34C during the day and 29C at night. The bottom of the cork bark at the warm end was approximately 24C. A relative humidity of about 85% was maintained during the day by hosing the walls and furniture and by filling the tank with water to the top of the gravel. In the evening the cage was drained and the relative humidity dropped to less than 70%

RESULTS

Breeding

In July 1976 the three young females were placed in the exhibit cage and the male was put in the BBC. The animals remained this way for two years. In the spring, summer, and fall of 1978 breeding encounters were run in the BBC. Although copulations were observed with one female, no offspring resulted. In December 1978, the male was placed in the exhibit with the females and they were left together for five months. No breeding behavior was seen during this period. Specimen manipulations and breeding encounters were again attempted in the spring of 1979. The male was seen copulating with the females repeatedly in May while housed in the BBC.

The male and two of the females refused food on 1 June 1979. The third female went off feed on 11 July. The male resumed normal feeding in early August. On 22 August, two of the females accepted small rats after much teasing; this was the only meal taken by these animals from the time of observed breedings through parturition (Table 2).

Care of Young

The majority of the neonates fed on newborn mice within two days after birth. First sheds occurred from 7 to 19 days after birth. Housing for the offspring consisted of 10 gallon aquaria. Ten babies were maintained in each aquaria. The details of these rearing enclosures are in Table 1.

1981 Breeding

Three litters of *E. cenchria* were born between February and September of 1981. The first two of these litters were characterized by large numbers of stillborn and infertile egg masses (Table 3). The last litter in September produced 28 live neonates with no stillborn or infertile egg masses. During this period the animals were not situated in their normal breeding enclosures due to building renovation. The holding cages were subjected to uncontrolled fluctuations in temperature. As a result, breeding ocurred at an unscheduled time and the females were exposed to undesirable temperature extremes. It is our feeling that these fluctuations in temperature caused the high ratio of stillborns and infertile egg masses. Since that time the animals have been returned to their breeding enclosures and cycled at temperatures similar to those used for the first three breedings. Breeding has resulted and we are currently waiting for new young.

DISCUSSION

It appears that breeding in *E. cenchria* and other tropical boids is influenced by seasonal and daily climatic variations. Our specimens bred during a three month period of the year when the daily temperature fluctuations were the greatest. Brunner (1978) came to similar conclusions about the influence of seasonal rhythms on breeding while working with the southern subspecies *E. c. crassus*. Over a two year period, Brunner noticed a significant correlation between breeding activity in *E. c. crassus* and a sharp 4.5 degree C drop in daily

minimum temperatures. Work at NZP with a number of genera of boids (Chondropython, Corallus, Python, and Sanzinia) shows correlations between breeding and cooler a seasonal cycle (Walsh, 1977: Walsh, 1979; Van Mierop, Marcellini, and Walsh 1982). Python molurus are known to breed under almost any conditions, however, even this species follows a pattern with breeding during cooler months (Ross, 1978).

Symptoms of pregnancy in our E. cenchria included going off feed, basking, and mid-abdominal swelling. Other breeders report similar symptoms. Andreotti (1977) and Brunner (1978) both state that gravid female E. c. crassus go off feed months before giving birth and that they utilize hot spots. When deprived of hot spots Andreotti noted that gravid specimens became restless. In this study gravid animals preferred temperatures ranging from 29-34C for most of the gestation period. Brunner (1978) reports a prefered temperature range of 35C for gravid animals. Male and non-gravid females in all three studies avoided hot spots and chose temperatures of between 21-26.5C.

Gestation periods for the NZP E. cenchria averaged 197 days from the first observed breedings. Andreotti (1977) and Brunner (1978) report maximum gestation periods of 168 to 186 days respectively.

The number and size of neonates per brood of E. cenchria is moderate for this genus. Literature reports of brood size range from 12 to 28 (Groves, 1980; Lincoln, pers. comm.; Murphy, Barker and Tryon, 1978). Reported size for newborns is fairly consistent, with individuals ranging in weight from 26-32.5 g, with lengths from 390-490 mm (Groves, 1980; Lincoln, pers, comm.; Murphy, Barker and Tryon, 1978). These are consistent with the measurements of the NZP young.

A number of breeders report post-partum interest of females towards young in E. cenchria and other boids. In the present study, female 3 showed some interest in the neonates that were still encased in their fetal membranes and was alert to any movement in the cage. Tongue flicking and prodding by the female continued until all the young were free of their sacs. Groves (1980) reports a female E. cenchria eating stillborn young after her nudging failed to produce a response. Observations by other breeders are cited by Groves (1980) which involve varying degrees of post-parturient behavior. Five species of Epicrates and Eunectes gigas are included in these observations. Several of the situations involved females ingesting apparently live, normal young. Miller (1980) reports a female Corallus enydris enydris ingesting an entire litter of infertile egg masses. These reports indicate that breeders of boids should guard against the possibility of females eating young. The provision of neonate hide areas may be one way to avoid this situation.

The young of E. cenchria are relatively simple to care for compared to the offspring of most other species in this genus. Huff (1977) states that neonates from many island forms of Epicrates refuse food until two to four weeks after birth. Many Epicrates sp. are very specific about food items at first and will accept only small lizards and frogs (Huff, 1977). Our E. cenchria have all accepted young mice as their first meals. Most individuals fed before their first sheds. The E. cenchria young under the care of Andreotti (1977), Brunner (1978) and Lincoln (1975) also started off feeding on small rodents with little trouble.

At NZP we have committed ourselves to working with E. cenchria on a long term basis. In addition to being good exhibit animals, they

show promise of being excellent research subjects due to their generally hearty nature, good breeding potential, and the ease of rearing of young. We hope to build up a breeding group of these snakes involving at least 6 adult males and 18 adult females. At present we are looking to acquire young wild-caught specimens and unrelated captive stock in order to form new bloodlines.

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TABLE 1. Caging details for exhibit, breeding-brooding (BBC) and neonate holding.

ENCLOSURE TYPE	MATERIALS AND DIMENSIONS	LIGHT/HEAT PHOTOPERIOD	SUBSTRATE	FURNITURE
Exhibit	Molded fiber glass with front and screen top. 100X90X104mm	Four 15' flourescent Vitalights. 12 hour	Pea gravel with leaf mulch surface 4cm deep.	Tree Stump plastic foliage, water crock.
BBC	Cement tank with wire top. Polyethelene sheet covering 2/3 top. 150X56X70mm.	250 W incandescent red heat lamp/ 24 hours. 150 W incandescent Durolight 12/hrs	Large stream gravel 3cm deep.	Cork bark piled at one end, plastic foliage water crock.
Neonate Holding	Aquaria with wire mesh top and movable polyethelene covers. 52x27x31 mm.	Heat tapes under one end. Flourescent room lighting.	Newspaper	Cork bark pile, water crock.

Table 2. Timing of events during breeding and gestation

EVENTS	FEMALE 1	FEMALE 2	FEMALE 3
Off feed until parturition	192 days	199	184
1st feeding until 1st basking	81	82	83
1st basking until parturition	107	112	130
1st breeding until prepar-turition shed	162	169	179
Preparturition shed until birth	26	25	34
1st breeding until parturition	188	194	213
Parturition until 1st meal	same day	1	3
Parturition until post parturition shed	19	22	18

Table 3. Total lengths and weights for six broods of *Epicrates cenchria* as newborns and yearlings.

Litter Number Parturition Date	No of Young	Length (mm) X (range)	Weight (g) X (range)	No. of Yearlings	Weight
1 12/16/79	13 live 1 stillborn 1 infertile egg	420.2 (390-445)	27.9 (26.5-29.6)	4	522 (366-589)
2 12/22/79 497	23 live	428	27.5	4	(424-597)
3 1/10/80	17 live	442 (420-455)	30.7 (28-32.5)	4	431 (375-554)
4 2/7/81	1 live 5 stillborn 8 infertile eggs	430.8 (425-440)	23.3 (20-26)		
5 8/1/81	4 live 7 stillborn 11 infertile eggs	463.8 (450-480)	29.1 (28-31.5)		
6 9/26/81	28 live	461.5 (430-599)	27.9 (25.4-30.8)		

A PRELIMINARY REPORT ON THE CAPTIVE MANAGEMENT AND REPRODUCTION OF THE ROUND ISLAND BOA (*Casarea dussumieri*)

Quentin Bloxam

INTRODUCTION

Round Island is a small volcanic island situated 22km north north-east of Mauritius and is approximately 150 hectares in area. Rabbits and goats were introduced in the nineteenth century which resulted in extensive damage to the vegetation. This in turn has made more nesting areas available to burrowing shearwaters and predictably there is now extensive erosion across the whole island. The goats appear to have been eliminated but the rabbits still remain.

There are eight reptile species on the island including the Round Island boa, *Casarea dissumieri*, which this paper will deal with.

Between 1977 and 1982 eleven living specimens were received from the Mauritian government on loan.

ACCOMMODATION

Each specimen is accommodated individually in a glass vivarium. The size of the vivarium varies according to the size of the boa. The males tend to have smaller accommodations than the females, which are much larger. The dimensions of a typical vivarium for males are 40 x 60 x 80 cm high and for the female 80 x 60 x 55 cm high.

All vivaria have a gauze strip along the rear quarter of the top of the tank to allow ventilation. The substrate is dry peat and the boas are provided with pieces of cork bark as retreat areas. Branches also decorate the areas, allowing the boas to climb if they show an inclination to do so.

The room containing the boas is heated to a daily summer temperature of 30 degrees C and dropped at night to 26 degrees C. Winter temperatures are approximately 4 degrees C lower. The room is lit by one 5' Vita-lite flourescent tube which is controlled by a time clock, and hand controlled individual strip lights lie on top of each vivarium. This enables us to provide a dawn and dusk period. Photoperiod ranges from 11 1/4 hours in December to 13 1/4 hours in June.

DIET

In the wild state *Casarea* feeds on other reptile species, the Round Island skink (*Leiolopisma telfairii*) and Round Island gecko (*Phelsuma guentheri*) forming the major part of their diet. Because of the impossibility of providing the boas with a regular supply of geckos or skinks it was decided to persuade them to feed on mice. This proved to be a fascinating and frustrating task. Great individuality was shown by the snakes, some proving to be particularly difficult and some particularly easy. In the case of three specimens, mice were taken avidly almost immediately. The other boas had to be "fooled" into taking such an alien diet. This was done in a variety of ways; some eventually accepted mice that had strips of gecko laid across their backs. Other inexplicably accepted mice with pieces of

chicken flesh laid in a similar fashion. One specimen started feeding on strips of heart and was then weaned on to mice by laying the heart on the mouse's back. Three specimens are now fed dead mice held in forceps, the others accept live food. Once each individual fed for the first time, then that particular format was adhered to. Casarea are of a nervous and "finicky" disposition and quickly go off their feed if changes are made.

BREEDING

First attempts to breed the Casarea were made on 18 Jan 80 at 14:00 hours. Five specimens, which included the only two males, were placed in a large vivarium decorated in similar fashion as their own vivaria. By 15:25 hours one male was seen tightly constricted around the cloacal area of the female. They separated, however, after 15 minutes. On two other occasions that day similar behavior was recorded. No further breeding activity was observed, and on 26 Jan 80 all specimens were separated again. In February they were placed together again and a further mating attempt was made. No further activity was recorded and the specimens were finally separated on February 11th.

On 20 May 80 a dessicated egg was found on the floor of the vivarium at 0800 hours, on 24 May 80 a second egg was laid, and on 31 May 80 a third egg was discovered. All were partially collapsed and were not incubated, fertility could not be ascertained.

At the end of the same year, on December 3rd, specimens were again placed together and separated on the 23rd of February, 1981. During this period if breeding activity ceased then specimens were separated for a few days before being reunited again. Attempted matings were recorded but great difficulty occurred in ascertaining how long matings lasted as observations had to be made through a room window. Entering the room was avoided in case the disturbance caused a cessation of breeding activity. It did seem, however, that only one female was receptive as on a number of occasions other females were observed to dislodge the males on the vivarium furniture. There were no eggs laid by any of the females from the sexual activity recorded at that time.

In December 1981 specimens were again placed together and mating was again observed. Once more a preference seemed to be shown for one female and extended mating was observed for the first time. Once more other females were observed to dislodge attentive males and in the case of the largest female, which presumably was the fully mature specimen, no interest was shown whatsoever!

On April 23, 1982 the apparently receptive female was checked and 5 eggs were discovered beneath her. Three appeared collapsed, and the other 2 appeared viable. All the eggs were removed and placed in a plastic lunch box on moist vermiculite. The box was placed in a human baby incubator (incubation temperature was 29 degrees C and humidity was 90%). On May 1st it was felt that three of the eggs had started to develop as all had filled out and increased in size.

At 0800 on May 17th - 25 days after their discovery - one egg hatched and a second had chipped. By the next day the second infant had vacated the shell. Infant No. 1 weighed 3.1 g and the total length was 152mm. A decision was made to open the third egg and it revealed a fully formed but dead infant. The last two eggs revealed

some development confirming that all were fertile. Accurate incubation time was impossible to establish as the laying date is unknown. The live infants were bright orange in color with some black markings on the underside of the tail and cloacal area. Each infant was placed in an individual plastic box using paper towelling as a substrate and a plastic tube as a hiding place water was provided in a shallow plastic container.

INFANT HUSBANDRY

It was assumed that the natural prey of baby Casarea would be hatchling geckos and accordingly hatchling house geckos (Gehyra mutilata) were offered. However, both infants ignored the prey and it was postulated that the geckos were too big. It soon became apparent that stimulating the infants to feed was going to be a major problem. Subsequently every imaginable prey item was offered including cockroaches, crickets, earthworms, slugs, centipedes, millipedes, pieces of heart, pieces of chick, Phelsuma tails, Anolis tails, live hatchling Anolis, woodlice and small pieces of fish.

Finally, small pieces of gecko tail and chick were offered on the end of a dental pick and one specimen did respond and started feeding. The same specimen even ate tiny strips of heart. However, neither baby ever really fed satisfactorily and both subsequently died on September 14 and 25 respectively.

DISCUSSION

The program has proved to be a source of elation and of great disappointment. Some questions have been answered. Casarea will reproduce having been weaned on to an unnatural diet. A factor that concerned us was whether their physical well being would suffer from such a change. It is now established that they are oviparous, a hitherto unknown fact, and the general maintainence techniques used here have proved to be successful, all specimens appear to be in excellent health and eat very well.

On the other hand it is difficult to understand why the males pay most attention to the one female. Extra males may be necesary for fewer numbers of females to stimulate wider interests. Finally it is extremely disappointing to have lost the babies particularly as feeding responses were stimulated. It can only be assumed that either the prey item was just unsatisfactory or possibly the stress of interfering with them caused further deterioration.

We do conclude, however, that steps forward have been made and there is a sufficient basis for regarding the future with a degree of confidence.

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Jersey Wildlife Preservation Trust, Channel Islands, Great Britain

DETERMINATION OF LITTER SIZE AND EMBRYO VIABILITY IN THE CUBAN BOA, *Epicrates angulfer*, BY THE USE OF IMAGING ULTRASONOGRAPHY

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INTRODUCTION

Attempts to determine the reproductive states of female snakes have usually been limited to abdominal palpation or visual examination of external body configuration. While these methods are useful for certain species, one cannot be certain whether a female is carrying viable offspring or infertile ova, and in some cases, pregnancy may be completely undetected (Huff, 1977). In our work with the Cuban boa, *Epicrates angulfer*, we found palpation yielded little information due to the large size, heavy trunk musculature, and great strength of these snakes. Recent advances in the use of "real-time" ultrasonic scanning in zoo animals (Sweeney, 1975; O'Grady et al., 1978), and the technical sophistication and higher resolution of the newer ultrasound units convinced us that ultrasound was a safe, reliable, non-invasive technique that could be used repeatedly to assess the reproductive state of our female boids. By using imaging ultrasonography, we were able to visualize not only developing embryos *in utero*, but also developing ovarian follicles as small as 8 mm in diameter.

MATERIALS AND METHODS

Ultrasound scanners generate high-frequency sound waves by electrical stimlation of a piezoelectrical crystal. This crystal transducer can be used to direct these sound waves through a gel or a fluid medium into the body of an animal by direct contact of a probe housing these crystals. The degree to which this high frequency sound is transmitted through tissue layers depends upon the frequency and amplitude of the sound waves generated by the crystal and is controlled by the electronic circuitry of the machine, and the acoustic impedance of the tissue contacted. Tissues with higher acoustic impedance reflect sound waves more completely than tissues of lesser density; the frequency and intensiy of these returning echos are amplified and reconverted into an electrical signal which is displayed on a cathode ray tube. A more complete discussion of ultrasound theory can be found in Sanders et al. (1977).

We used a Diasonics Cardio-Vue 100 ultra-sound generator with a Diasonics 7.5 Mhz pediatric probe. Fluid interfaces between probe and snake were maintained with the use of Aquasonic 100 transmission gel or a water bath constructed by filling a latex surgical glove with water, sealing it, and placing it between the probe and the snake. Ultrasound "real-time" images were recorded on TDK high-output, high-resolution video cassettes by a JVC BR-6400U videocassette recorder incorporated into the console of the scanning unit. The plane view was determined by the position of the head of the probe in relation to the snake's body. If an image of longitudinal section was visible on the screen, a probe-head rotation of 90 degrees would produce an image of a transverse section.

RESULTS

A large (2m total length) female E. angulifer, #038, was observed copulating with a male of the same species several times during August and November of 1982. Despite the fact that these copulations took place later in the year than normal (see Tolson, 1982), the female later appeared to be gravid. On 8 March 83 we performed an ultrasound scan on this snake to confirm the pregnancy and to determine if she was carrying viable offspring. Examination of this female revealed six images that were interpreted as young snakes and a seventh that was interpreted as an infertile egg mass. Movement of the young in utero was clearly visible and confirmed that the female had a viable pregnancy. This snake gave birth to seven young on 21 April 83, two of which died shortly after birth. Fig. 1a shows a real-time longitudinal section of one of the young seven weeks prior to parturition. Fig. 1b shows the same embryo in transverse section.

The high resolution of these images of embryos convinced us that we could monitor follicular development within the ovary and detect ovulation after it occurred. We therefore initiated a program of ultrasound scanning of the ovaries of our six adult female E. angulifer on 18 May 83. By starting at the anterior end of the animal and slowly moving the probe along the longitudinal axis of the snake, we were able to visualize follicles developing within the ovaries. Repeated observations over a number of weeks allowed us to monitor their enlargement or regression. For example, follicles as small as 8 mm were observed in females 036 and 040 on 8 June 83. Female 038, which gave birth in April, 1983, had no follicles large enough to be detected by this method, while female 037 had at least 20 immature follicles of 10 mm or greater diameter. Two snakes, 034 and 036, had developing follicles in the ovaries, but had expelled infertile ova in late 1982. Female 040, which has had no contact with a male since her capture as a juvenile in 1977, appears at present to have at least three follicles maturing in the ovaries.

All females were scanned at intervals of two weeks and the development or regression of their ovarian cycles noted. Fig. 3a shows a real-time image of a group of small follicles in female 036 and Fig. 2b shows an image of a medium sized follicle in female 037. These data are part of a study on the effects of courtship and the role of the male in follicular growth and ovulation and will be presented elsewhere.

DISCUSSION

This work demonstrates that ultrasonography with a high-resolution system can be used to obtain high-quality images of both developing embryos *in utero* and developing follicles in the ovaries. In addition, these techniques will allow the monitoring of pregnancies and follicular cycles in other squamates with a minimum of risk to the mother and developing offspring. We expect these techniques to be less useful in working with chelonians since they have a bony carapace shielding the internal organs. Smaller animals may also be difficult to examine unless a unit with sufficient resolution is available.

A technician trained in diagnostic ultrasound applications and image interpretation is highly desirable for this type of work, and it is helpful to be familiar with the anatomy of the animals under investigation. Even with a clear image on the screen, interpretation can be difficult. For example, a mass we suspected of being an infertile ovum in female #037 turned out to be a normal-appearing baby snake.

Despite the high cost of equipment and the difficulties associated with certain interpretations, ultrasound scanning provides a fast, non-injurious method of evaluating reproductive states in squamates. It is a repeatable technique free of the cumulative risks associated with sequential x-ray examinations. We suspect that this technique will enjoy greater application in the years to come both as a diagnostic tool for obstetrical and abdominal problems in zoo animal medicine as well as in research dealing with the female reproductive cycles of selected species.

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Toledo Zoological Society, 2700 Broadway, Toledo, OH 43609 (Tolson and Richard), Department of Biology, University of Toledo, Toledo, Richard (Black), and Department of Radiology, Wayne State University Medical School, Detroit, MI (Slovis).

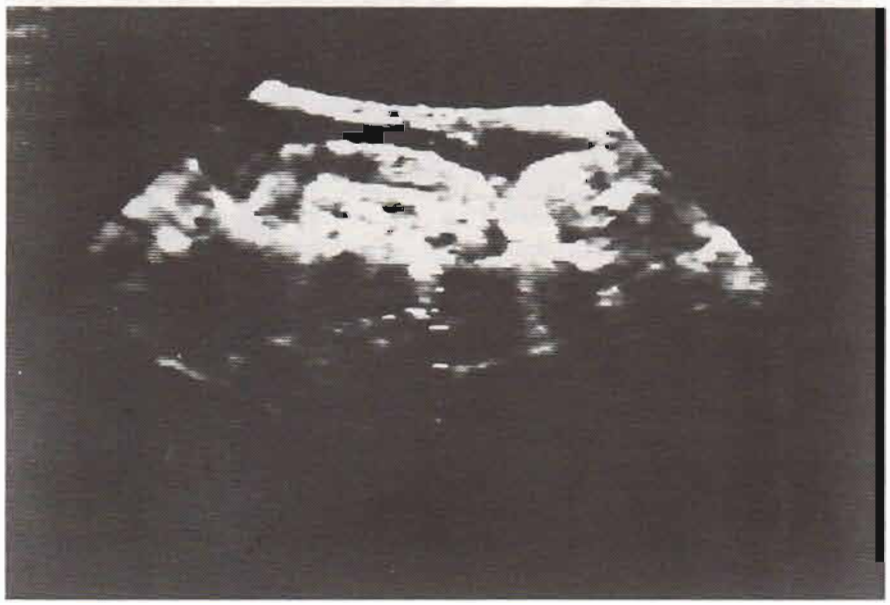

Figure 1a. A nearly full term embryo in longitudinal section. Part of a second embryo can be seen at right. The white radiating bands at the ribs of the adult female 038, the mother.

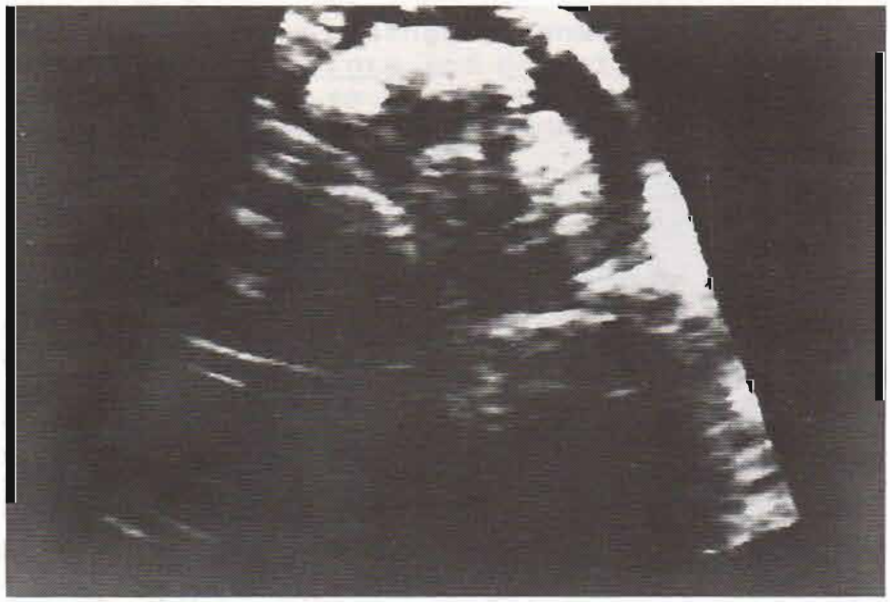

Figure 1b. The same embryo in transverse section. The large shadow in the left side of the photograph appears to be a section of a second embryo.

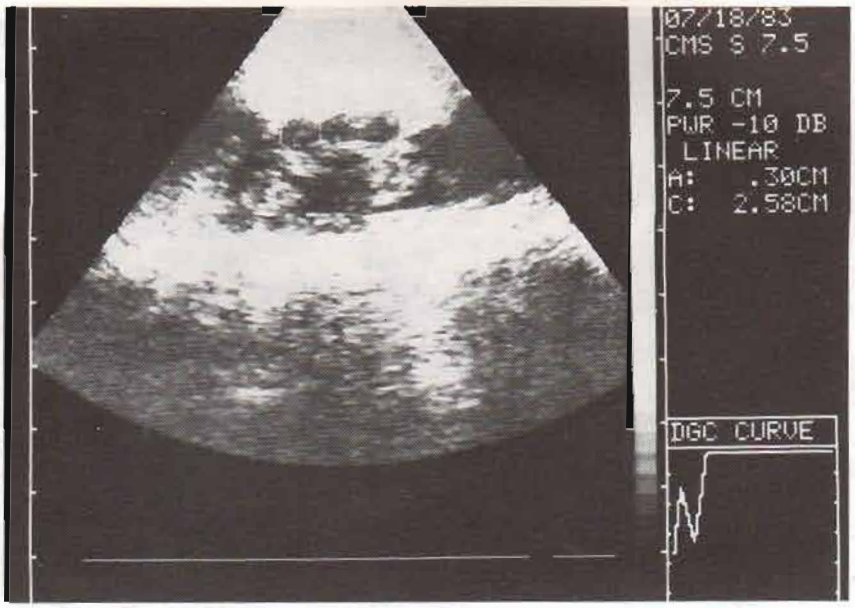

Figure 2a. A group of three small pre-ovulatory follicles in female 036. A: refers to the area of the follicle on the left (.30cm) and C: the circumference of the follicle (2.58cm) as calculated by the ultrasound unit.

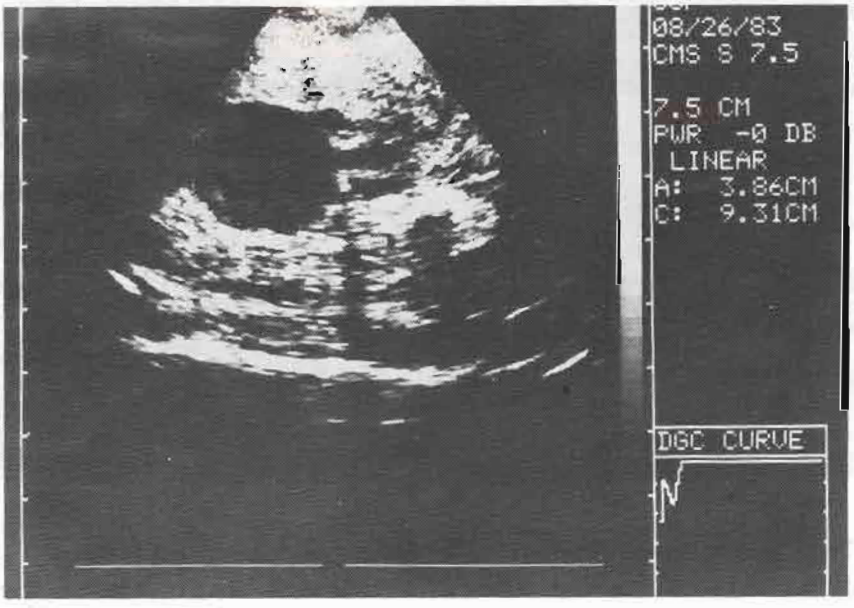

Figure 2b. A medium sized follicle in female 037. A=3.86cm; C=9.31cm.

REPRODUCTION IN CAPTIVITY OF MALAGASY TREE BOAS, *Sanzinia madagascariensis* (SERPENTES : BOIDAE)

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The Malagasy or Madagascar tree boa, *Sanzinia madagascariensis*, is a small boid (seldom exceeding a total length of two meters) endemic to the Malagasy Republic. It is distributed throughout the island with the exception of the sparse xerophyllous zones of the extreme southwestern area (Branch, 1983). *S. madagascariensis* exhibits strong arboreal tendencies but is equally adaptable to a terrestrial existence (Foekema, 1971). Branch (1983) has suggested that *Sanzinia* fills the arboreal niche left open in Madagascar that is filled in continental Africa by competing colubrid, elapid and viperid snakes. The tree boa's terrestrial behavior has been documented by Foekema (1971) who reported that in the Perinet region *Sanzinia* were more commonly encountered than the ground dwelling boas of the genus *Acrantophis*. Specimens, particularly gravid females, were discovered in the morning coiled up on the ground usually in damp surroundings. The general external morphology has been described by Guibe (1949) who enhanced this earlier work with a detailed examination of all Madagasy snakes (Guibe, 1958). The Madagasy herpetofauna exhibits a large number of endemic species (Blanc, 1972) and Mechisin (1979) offered an excellent review of the postulated origins of this unique fauna. *S. madagasgariensis* is believed to have strong systematic affinities with *Acrantophis* (Underwood, 1976) and both Malagasy boid genera are considered to have evolved from a single transoceanic colonizing ancestor (Mertens, 1972). Both *Sanzinia* and *Acrantophis* are grouped with the neotropical *Boa* and *Xenoboa* in the tribe Boini with whom they share primitive features though this group may represent an unnatural assemblage (McDowell, 1979).

S. madagascariensis is a threatened species and is accorded Appendix I status by C.I.T.E.S., principally as a result of destruction of habitat. Although threatened, there is no evidence that wild populations are endangered or over-exploited (Branch, 1983). The species is recognized as rare by the IUCN (Honegger, 1968) and the size of existing wild populations will remain unknown until ecological field studies are undertaken. *Sanzinia* is poorly represented in United States collections with approximately 50 specimens in a relativevely even sexual ratio of 25 males and 26 females (Slavens, 1982). Internationally the species is distributed in 14 collections representing a total of 38 specimens (Olney, 1981). The number of specimens in private collections is unknown.

Published information on reproduction in *S. madagascariensis* is represented in the literature with reports on the results of wild breedings (Branch and Erasmus, 1976; Foekema, 1971; Frogscha and Lehmann, 1970) and captive breedings (Branch and Erasmus, 1976; Foekema, 1975; Groves and Mellendick, 1973). Branch (1983), in his review of the breeding potential of African and Malagasy boids presented information that indicated although *Sanzinia* had bred on many occasions at over a dozen institutions the overall captive populations in the world's zoos had shown no growth othe than temporary peaks.

high infant mortality and the sensitivity the species shows to respiratory and gastric infections (Branch, 1983). This report will discuss reproductive attempts in the author's collection, and will describe the breeding behavior, gestation, parturtion and neonates of S. madagascariensis.

MATERIALS AND METHODS

One female (F - 1; ca. 1.1m total length; 1242.4 g) was received as a captive born juvenile on 13 January 1978 and a captive born juvenile male (M - 1; ca. 1.1m total length; 1128 g) was received on 18 October 1978. An additional pair of captive born juveniles (F - 2;ca. 1 m total length; 1151.2 g) and (M - 2; ca. 1.2 m total length; 1568 g) that were siblings with female-1 were received on 4 June 1980. One of the adult females that produced this litter in captivity in March of 1977 was obtained on 25 August 1981 (F -3; ca. 1.3 m total length; 1437.2 g) as were a pair of her offspring (M - 3; ca. 1.3 m total length; 1318 g) and 9 F -4; ca. 1.1 m total length; no weight taken). On 7 November 1982 an additional female (F -5; ca. 1 m total length; no weight taken) was received on breeding loan. Breeding groups were represented by 2.2.0 in 1980; 3.4.0 in 1981-1982 and 3.5.0 in 1982-1983. Adult specimens were weighed and measured on 25 July 1983. Taxonomic allocations follow Stimson (1969).

Adult specimens were maintained in three glass-fronted cages (120 x 41.2 x x80 cm; 120 x 37.5 x 43.7 cm; 90 x 42.5 x 45 cm; respectively) which contained a paper substrate in addition to hide boxes and tree limbs. Juveniles were maintained in plastic containers (38.5 x 27 x 16 cm) with paper substrate, hide box and tree limb. Light was provided naturally from two south and east facing windows and from overhead incandescent lights. Temperatures ranged seasonally from 18C degrees during winter to 31C degrees during summer and relative humidity ranged 60 to 75 percent. Water was available ad libitum, and feeding occurred every 7-21 days on 3-6 laboratory mice or small rats per specimen. Photoperiod reflected seasonal variation natural in Houston, Texas from 1979 to date. From September through December, specimens were occasionally sprayed with water which served to stimulate courtship behavior. Weights of adults and neonates were taken to the nearest 0.1 g on a triple-beam balance. Lengths were taken to the nearest 10.0 mm utilizing a metric ruler for adult specimens and to the nearest 1.0 mm using the squeeze-box technique (Quinn and Jones, 1974) for neonates. Gravid females were provided a thermal gradient by positioning a heat plate to create a basking site which reached 30.0C degrees $\pm$ 2.0C degrees in temperature. Gravid females frequently used these basking sites.

RESULTS AND DISCUSSION

Courtship behavior was observed in December 1980 although no copulations were noted. On 6 May 1981 female- 1 was apparently gravid and was provided with a heat plate for basking and moistened sphagnum for retreat. The female was passive and when disturbed would hiss loudly and attempt to hide her head beneath body coils. This female passed six infertile egg masses on 8 June 1981. During this time an additional two males and two females were obtained on breeding loan. Courtship behavior was recorded from October - December 1981 with copulation observed on 25 November and 1 December. Combat as descibed by Carpenter et al., (1978) was observed on at least 12 occasions between September and December. Combats occurred principally between a small male (M - 1) and a larger male (M - 3), the smaller male being the aggressor. Male - 2 usually avoided combat bouts and retired to the far end of the cages when combat was initiated. After combat bouts, males were separated and introduced to females for breeding. All males frequently utilized their pelvic spurs during both combat and courtship as detailed by Carpenter et al (1978). Copulation usually occurred within 30 minutes after introduction and all three males had access to all four females at various times. On 30 December 1981 a group of 2.2.0 were transfered to the Houston Zoological Gardens (HZG) on breeding loan. In early January 1982 two females with pronounced abdominal swelling were presumed to be potentially gravid. Female - 1 in the author's collection was immeadiately provided with a heat plate wile female - 2 at HZG was provided with an infrared bulb that produced temperatures of 32C degrees directly on branches beneath the bulb and 26C degrees on the cage floor ca. one meter from the bulb. Female - 2 spent much time basking beneath this infrared bulb. By 20 April 1982 female - 2 had displayed reduced abdominal swelling and the breeding loan was cancelled. Upon introduction to the breeding group in the author's collection on 21 April 1982 several combat bouts were initiated by several males from 22:30 h to 01:50 h on 22 April 1982. Head shaking as desribed by Carpenter et al (1978) was observed in male - 1 at the approach of newly introduced females. This was the first time agonistic and courtship behavior was observed in months other than October through December. By late May 1982 female - 1 was increasing in girth and spending much time during the day coiled over the heat plate while retiring at night to the water bowl or tree limb. The gravid female became noticably darker in coloration as described for this species by Hudson (1983). The female last accepted food on 9 June 1982 and by 23 June the female was very dark colored and laterally positioning herself over the heat plate. On 5 July 1982 the female's weight was 1629.4 grams. Parturition occurred on 23 July 1982 with two infertile masses, one still-born and seven living young produced between 01:00 - 07:00 hours. The female was opaque and preparing for ecdysis. Reproductive data on living neonates of this brood are given in Table 1. Post-partum weight of this female was 1068.3 g on 23 July 1982. the difference between the pre-partum and post-partum weights was 561.1 g indicating a relative clutch mass of approximately 29 percent. the infertile masses measured 73 x 26 mm and weighed 21.8 grams. the still-born neonate was a male measuring 393 mm and weighig 33 grams. As noted by Branch (1983), the juveniles could readily be induced to accept small mice and had all fed at least once by 11 August 1982. Groves and Mellen-

dich (1973) recorded a juvenile as feeding on salamanders in captivity. The neonates shed within seven hours of parturition and all shed again 34 to 40 days after this initial ecdysis. the neonates displayed the characteristic red coloration common to the young of this species. this red coloration changed to green at five to six months of age although one juvenile retained the red coloring into April of 1983. This ontogenetic color change has been documented for other arboreal boids such as the Indo-Australian Chondropython viridis and Corallus caninus of South America.

When first disturbed, the young assumed defensive postures and struck repeatably but became docile when handled. Sexing the young was easily accomplished by observations of spur size with males having enlarged spurs and those of females much reduced. Juveniles were generally active at night and prefeerred to hide during the daytime.

On 25 August 1982 combat was observed between three males. when separated and introduced to the four females, courtship and attempted coitus was noted. All males bred with three of the females on several occasions from September to December. Female - 1 having just produced a brood did not engage in sexual behavior and was unreceptive to males. On 7 November 1982 a young female (- 5) was received as a breeding loan. When placed with the breeding group the female was immediately courted by two males. Within one hour copulation had ensued with male - 2 and while this pair bred both were actively courted by the remaning males. Female - 2 at this time became active and crawled near the males while lifting her tail and popping her cloaca as described by Carpenter et al., (1978). this female was ignored by the non-copulating males who preferred to vigorously court the breeding pair. Female - 5 bred with all three males on several occasions into early February 1983. At this time two of the females (3 and 4) exhibited abdominal swelling and were subsequently separated from the group. On 24 April 1983 female - 5 also exhibited abdominal swelling and was placed in the parturition cage with the other gravid females. All three gravid females exhibited behavior similar to that of the first gravid individual, including the gradually darkening coloration. The second parturition occurred on 12 June 1983 with 13 infertile masses, one still-born, and one living neonate produced. The still-born neonate was a female weighing 17.6 grams. The third parturition occurred on 25 July 1983 with five infertile masses and six living young born between 01:30 - 09:00 hours. three of the progeny from this third brood suffered anomalities such as spinal deformities and incompletely sealed umbilici. Progsch and Lehmann (1970) reported similar anomalies among a brood of 12 with five deformed young. Reproductive data on the living neonates of broods two and three are presented in Table 1.

The courtship period for these captive S madagascariensis appears well-defined in North America as September through December as supported by these and other data (Groves and Mellendick, 1973; T. Walsh , pers. comm.). Male combat behavior was identical to that described for this species by Carpenter et el., (1978) and more closely duplicates that of Python molurus (Barker, 1979) than the directly related Acrantophis dumerili as postulated by Murphy et al., (1981). Progscha and Lehmann (1970) observed copulation in wild caught females in May and June and Branch and Erasmus (1976) offered supporting data on a wild caught female which was collected in June with 14 fertilized ova measuring 40 x 35 mm in size. Foekema (1971) believed that wild S.

madagascariensis had a sharply defined breeding season with broods being produced in February and March. Data supplemented by Branch and Erasmus (1976) indicated that this breeding season may be ill-defined with reports on broods produced as early as December and as late as May. The data of Progscha and Lehmann (1970) suggested a gestation period of 145 - 161 days while Branch and Erasmus (1976) suggested minimum gestation periods of of between 167 to 235 days. Foekema (1973) suggested that the gestation period of S. madagascariensis is similar to that of the Boa constrictor while branch and Erasmus (1976) postulated the gestation period for Sanzinia to be approximately six to seven months or two months shorter than the gestation period of the closely related ground boa, A. dumerili. The data presented herein supports this postulated gestation period of six to seven months although gestation periods are difficult to determine in captive snakes as a result of sperm retention and artificial conditions.

The darkening coloration of gravid females has been postulated by Hudson (1983) to be a possible physiological adaptation to absorb radiant heat. This color change was observed in gravid females of this report. Utilizing the color standards of Ridgway (1912) and female - 1 as a model, this color change was further demonstrated. In January 1982 the females normal ground color was Pyrite Yellow (plate 9:23) but by May 1982 the gravid female had darkened to Citrine (plate 9:21). The female's color had darkened to Medal Bronze (plate 9:19) on the parturition date. After the first post-parturient ecdysis, the ground color returned to Pyrite Yellow. Branch (1983), in his review of reproduction in both wild caught and captive specimens of Sanzinia indicates that the number of neonates produced at parturition range from one to 16 with the statistical mean of 10.3. In an earlier contribution, Branch and Erasmus (1976) noted that neonates range in size from 43 to 48 cm and weight from 33 to 39 grams. Progscha and Lehmann (1970) reported from a smaller brood but this brood may have been subject to possible temperature induced anomalities as may well be the case for the third brood in Table 1. It should be noted, however, that all three females were exposed to identical temperatures and no explanation of this phenomena can be offered at this time. As Branch (1983) demonstrated, the overall captive population level of S. madagascariensis has shown no marked increase over the years primarily as a result of high neonatal mortality (Branch and Erasmus, 1976; Groves and Mellendick, 1973). Although Sanzinia can be sexually mature at 18 months (Foekema, 1975) this boa can be a difficult species to breed and maintain in captivity. Factors that may be important in successful reproduction of captive specimens include utilization of male combat behavior to induce frequent copulation, and seasonal temperature adjustment of specimens which serves to induce reproductive cycling. One additional factor that may be extremely important is the provision of a constant heat source as soon as females are determined to be gravid. These data reflect captive specimens that may have adapted to an artificially induced reproductive cycling peiod that does not necessarily represent conditions in nature. The reproductive biology of wild S. madagascariensis populations remains a mystery and as Branch (1983) pointed out in his review, ecological studies of the Malagasy herpetofauna are long overdue.

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Table I. Parturition dates, number of young, neonate measurements and weights of *Sanzinia madagascariensis*

Female	Date	Number of Young	Total length (mm) X range	Weight (g) X range
1	23 July 1982	3.4.0	459 (442-482)	44.1 (41.5-46.3)
3	12 June 1983	0.1.0	418 (_____)	32.7 (_____)
4	25 July 1983	0.6.0	386 (340-435)	30.4 (22.5-39.0)
4	25 July 1983	0.6.0	386 (340-435)	30.4 (22.5-39.0)

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REPRODUCTION OF THE D'ALBERT'S PYTHON, *Liasis albertisi* AT THE OKLAHOMA CITY ZOO

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INTRODUCTION

In 1982, the Oklahoma City Zoo's D'albert's python produced 12 offspring. This hatching was the culmination of many years effort by several people. I will discuss the methods used, the results, and the problems encountered in this lengthy effort.

MATERIALS AND METHODS

The Oklahoma City Zoo acquired a male D'Albert's python in 1975. This animal is unusual because it is not the normal iridescent blue-black color, but is a bright gold color. The zoo then purchasd a blue-black female in 1977. Both animals appeared to be sub-adults and at that time we could find no established data for size at sexual maturity or reproductive methods in captivity. Both were put on a heavy feeding schedule and various methods were attempted to induce reproduction, but we met with no success.

By 1982, the female had grown to 187 cm. in length and weighed 1,965 g. and the male to 152 cm. with a weight of 1,534 g. Some reproductive data (Ross, 1978) was now available and as suggested, we began with separation in late May 1982 by keeping the male on exhibit while removing the female. High humidity was maintained during this period by heavy daily sprayings during the AM husbandry routine, attaining an average humidity of 90%. The summer photoperiod is May 15 through September 15 and is gradually changed from the rest of the year's 12/12 hours dark cycle to 14 hours daylight/10 hours dark. Temperature manipulations in the exhibit were not possible so none were attempted. Daytime temperatures would reach the low 40's C. and nighttime temperatures were in the mid to upper 20's C.

By June 10, the female shed and we attempted to induce breeding by placing her and her shed in the freshly misted exhibit with the male, even though he was beginning to appear opaque. Nothing occurred, and the female was removed the following day to await the male's shed. Ten days later, the male shed overnight and the female was introduced the following afternoon at 2:30. Courtship and TSCA (tail search and copulatory attempt) were observed at 3:50 PM but copulation could not be confirmed. On June 20, however, copulation was confirmed at 3:10 PM. Two weeks later the female began refusing food and a damp sphagnum moss nest area 30 cm square and 13 cm deep was made for her in the exhibit. On August 10, 7 weeks after copulation, she was found in her moss nest wrapped around a clutch of eggs. The eggs were removed from the female's coils (which was no small feat) for artificial incubation. There were 13 eggs, 12 in one egg mass that appeared viable and one that was separate that did not appear good. The egg mass was placed in a deep plastic shoe box filled with a 1 to 1 ratio by weight of water/vermiculite to a depth that covered all but a portion of the top eggs and was covered with it's ventilated lid. The remaining egg was similarly arranged in a gallon jar. They were then

degrees C. with a plus/minus fluctuation of 2 degrees C.

RESULTS AND DISCUSSION

Previous efforts suggested that incubation would take 8 weeks and we also found this to be true. On October 8, exactly 8 weeks after the eggs were laid, 2 eggs slit and 2 heads emerged. In 3 days, the 12 eggs hatched and as suspected, the 13th was infertile.

At birth, the hatchlings were aggressive animals with the characteristic blue-black heads and white lips, but dull grey-brown bodies. Their average lenth was 30 cm. with an average weight of 28 g. The sex ratio was 10.2. Two of the young were born missing their supraocular scales exposing bones of the skull. Unfortunately, one of these defective animals was one of only two females.

Initially, two different types of containment were tried to maintain a humid environment. Some were placed in gallon jars with gravel 6-7 cm. deep as substrate with water standing in the lower half of the gravel. Others were placed in 2 or 5 gallon aquaria with paper substrate and a small plastic container filled with damp peat moss with a small hole in the top providing access. All were provided with water bowls, hiding places and perchs were misted daily. The animals in the aquaria refused to use the peat filled containers and so all were eventually placed in gallon jars.

Initial efforts to get the hatchlings to eat were unsuccessful. Live and dead pinkies were tried, live and dead lizards (Uta stansburiana), warmed dead prey, prey scented with chicks, prey scented with parrot nests, and pinkies with their heads split open. No amounts of cajoling were successful and force feeding was implemented to prevent starvation.

In March, 1983, four of the juveniles, including both with the congenital defects, died within one week. It was suspected that they succumbed to dehydration and the remaining animals were all placed in 2 gallon aquaria with dampened sheet moss used as substrate. The peat-filled containers were again tried and this time were utilized by the juveniles. The remaining animals ate several split-head pinkies within one week of their transfer to new quarters and have been eating well since and growing rapidly. They are presently changing their coloration to the iridescent blue-black of the adults.

No certainties can be drawn from a single success, but it seems important to place the hatchlings in a humid environment that they find acceptable. It appears that they will not eat until this criterion is met. In this instance, no winter cooling was necessary and it appeared that the shedding of the male, not the female, triggered copulation.

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ON THE REPRODUCTIVE BIOLOGY OF THE RUSSIAN RAT SNAKE

Elaphae s. schrencki (Squamata: Colubridae)

Sergei V. Kudryavtsev and Vladimir E. Frolov

INTRODUCTION

Due to its brightest colouring and comparatively large size for a representative of its genus, the Russian rat snake is of great interest not only to zoos but to a large variety of hobbyists as well.

The Russian rat snake is found in the USSR in the Primorsky and Khabarovski Regions up to Kosomolsk-on-Amur and Maly Khingan in the west. In northern and north-eastern China and in Korea the other subspecies is to be found - Elaphae schrencki anomala (Boulongue, 1916), differing from the nominal form in the brown coloration with regular narrow cross stripes on the body and tail and the presence of undivided subcaudal scales.

Information on keeping and breeding in captivity of the Russian rat snake untill now remained scarce (Koch, H. 1970). At the Moscow Zoo the Russian rat snake was kept repeatedly. We did not only manage to provide the conditions necessary for its successful and prolonged husbandry in captivity, but secured successful breeding as well. In our opinion, the following information, considering the difficulty of obtaining it in the wild, is of considerable interest not only to zoo professionals, but to herpetologists in general, and can shed light on some aspects of reproductive biology of the species.

Considering all the aforesaid, we found it useful to share our experience derived from keeping the Russian rat snake in captivity.

MATERIALS AND METHODS

The first data we received on breeding Elaphae schrencki was in 1977. A pair of adult snakes was kept in a terrarium measuring 1 x 0, 6 x 0, 7m, without soil, heated and lit by heated bulbs. The temperature in the warmer part reached up to 33 degrees C, and in the cooler part 24 degrees C. The light period ranged between 9 and 11 hours, with no reference to the seasons. Humidity was about 70%. Food consisted of laboratory mice, chickens, and occasional small hen's eggs, and was given once a week. Periodic ultraviolet irradiation was performed with a 200 WT quartz lamp at a distance of 1m, with an exposure time of 5 minutes.

RESULTS

On January 25, 1978 mating was observed. In the night of 26/27 February the female laid 13 eggs. Two eggs were underdeveloped and were removed from the clutch immediately. The weight of the whole clutch was 270g. Normal eggs measured in length from 50 to 56 mm, and in width, from 29 to 31 mm. Most eggs were glued together. The eggs were incubated in an incubator at t degrees = 29 $\pm$ - 1 degree C and a relative humidity of 53%. Five days after the incubation started, mould appeared in the place where the two underdeveloped eggs had been removed. Mould was removed with the help of dry cotton wool, but it

did not help to stop the process and the progressing of the lesion resulted in the loss of five eggs. On March 24, 1978 the eggs began to decrease in volume, and on March 1 one of the eggs showed an incision. From April 1, 1978, until April 3, four rat snakes came out of the eggs. Two eggs remaining in the incubator were opened on April 5. One contained a fully formed rat snake, 260 mm long. The other one contained an embryo which had died at an early stage of embryogenesis. The new-born snakes measured 310 mm, 310 mm, 280 mm, and 290 mm, and weighed 15.790 g, 13.550 g, 10.580 g, and 12.160 g, accordingly.

The young snakes became opaque on April 10, and the first shedding occurred on April 17, all the young shed in one day. We expected the snakes to begin feeding just after the first shedding, but it was not so. Because of this we had to force feed the young snakes with dismembered new-born mice. We connect the difficulties in rearing the young with an unfavorable incubation regime.

On January 12, 1979 five more Russian rat snakes were added to the collection. They were kept in a terrarium with sphagnum peat moss as a substratum. In other respects the conditions were noted as before. In June 1979 mating of three males with two females was observed. On July 12,17, and 19 the females laid 13, 11, and 12 eggs, accordingly. The eggs measured from 47 to 50 mm in length, and from 26 to 31 mm in width, and weighed from 20.05 to 24.95 g. This time the eggs were incubated in a plastic box at t= 30 degrees C and humidity about 70%. In all the cases incubation was successful, and resulted in 100% hatching.

In December, 1979 two rat snakes were received by our zoo. The total length of the female, which was caught in the wild, measured 1,620 mm, with a weight of 600 g. The male was 1,580 mm long and weighed 888 g. It must be noted that before arriving at the zoo the male had lived for eight years in the private collection of one of the staff. Husbandry conditions were as in the first case. In March, 1981 both snakes were injected with "Tetravit", 1 ml of which contains 50,000 i.u. of vitamin A, 25,000 i.u. of vitamin D3, 20 mg of vitamin E and 5 mg of vitamin F. The dose was 1 ml/1 kg of body weight. The frequency of ultraviolet radiation was increased simultaneously. With the measures taken an increase of the male's sexual activity was observed. In this case no mating was observed. By April 3 the female's weight reached 948 g. In the night of April 28/29 the female laid 11 eggs. The eggs measured from 50 to 66 mm in length and from 28 to 31 mm in width, and weighed from 25.65 to 32.74 g. The whole clutch weighed 322.27 g. After being removed from under the female we preserved the original spatial orientation of the eggs. The eggs were incubated under the same temperature and humidity conditions. As noted previously, 100% hatching occurred on August 16, 1981. The first shedding took place on August 23, the second one on September 9, and the third one on October 8. During their first year in captivity young rat snakes usually shed 14 to 16 times. Changing of the juvenile pattern occurs in the sixth month in the most quickly developing specimens.

In an example of successful keeping of the Russian rat snake in a private collection, a breeding of a pair of snakes twice a year with artificial hibernation should be noted. In that case matings took place on August 7, 1979 and on January 24, 1980, egg laying on September 8, 1979 (11 eggs) and on February 25, 1980 (12 eggs), hatching of

the young on October 17, 1979 and on April 1, 1980. During the incubation of the first clutch a temperature drop to 17 degrees C was observed due to technical faults. It had no visible influence either on the longevity of the incubation period, or on the health of the new-born snakes.

Comparing the data with that received on Elaphe schrencki in the wild (Korotkov, 1978) the following should be noted. The Russian rat snakes are born in the wild with a total body length of 210 to 230 mm and a weight of 12.2 +- 1.0 g. By the end of the first year their weight reaches 15.4 +- 2.3 g, and by two years 42.3 +- 7.7 g. In all the breeding cases at the Moscow Zoo the whole body length of the new-born snakes ranged from 295 to 383 mm with the weight of the young snakes exceeds 100 g when reared in a terrarium without artificial hibernation. Weight and size increases of two young Russian rat snakes (chosen randomly) during their first year in captivity is represented in Table I.

TABLE I

Weight and Size Increase of Elaphe schrencki During Their First Year in Captivity.

AGE	1 day	1 mon	2 mon	3 mon	4 mon	5 mon	7 mon	1yr.
MALE								
TOTL BODY LENGTH mm	380	445	490	532	589	610	714	810
WEIGHT g		23			53	61	82	118
FEMALE								
TOTL BODY LENGTH mm	383	450	503	551	604	621	730	811
WEIGHT g		23			52	60	85	114

DISCUSSION

The basic conclusions we find it possible to draw after analyzing the received information are as follows:

1. The conditions of keeping the Russian rat snakes described in the article /t degrees = 26-31 degrees C and humidity about 70%) can be considered suitable for prolonged keeping and breeding of the species in captivity;

2. The Russian rat snakes can breed in captivity in any season of the year;

3. By observing the conditions described above and using artificial hibernation, breeding of one pair of snakes can be achieved twice a year;

4. Artificial hibernation is not compulsory for keeping the species and for duration of stimulation breeding;

5. The pregnancy duration of the Russian rat snake is about 1 month;

6. The incubation period with t degrees = 29 - 1 degree C and high humidity ranges from 34 to 44 days;

7. Artificial removal from the glued clutch of underdeveloped eggs or those affected by bacterial or fungal processes is as pointless as in any other species of egg-laying snakes;

8. During the first year of their life in captivity young Russian rat snakes shed 14 to 16 times;

9. Changing of the juvenile pattern of the Russian rat snakes in captivity without artificial hibernation occurs after six months of age;

10. Observing the described conditions and the incubation regime, the Russian rat snakes born in captivity outstrip considerably those of the same age in the wild in size and birth weight as well as growth rate.

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THE THIRD GENERATION OF THE BAMBOO PIT VIPER, *Trimeresurus gramineus*, (Squamata, Crotalidae), AT THE MOSCOW ZOO AND AN ATTEMPT AT SEX DETERMINATION IN EARLY ONTOGENESIS

Sergei V. Kudryavtsev and Vladimir E. Frolov

INTRODUCTION

In the autumn of 1977 the private collection of one of the hobbyists in Paris received a group of bamboo pit vipers *Trimeresurus gramineus*. One of the females proved to be pregnant and on February 21, 1978 gave birth to several young. Two of the juveniles of that brood arrived at the Moscow Zoo in January, 1980. On arrival the snakes had a s-v length of 620mm and 680mm with body weights of 36.2g and 87.1g respectively. The first snake was of more slender build. The ratio of its body length to tail length was 24%. The second snake was much bigger and with a longer body had a shorter tail, its body length/tail/length ratio being 17%. Based on these signs, and taking into consideration visual manifestation of sexual dimorphism in snakes (Clark 1977, Honegger, 1978, Klauber, 1943), the first snake was presumed to be male, and the second, a female. On May 15, 1981 the sex of the snakes was re-determined by the sex-probing method (Lazlo, 1975, Nickerson, 1970). In the first snake the probe penetrated freely up to the depth of seventeen subcaudal scales, and in the second one, till the depth of three only, which corroborated the previously drawn conclusion.

Immediately after arrival the snakes were placed into a terrarium constructed in the form of a three-edged prism with the base sides 1 x 0, 9x0, 9m and 0.7m high. Sphagnum peat moss soaked in boiling water was used as substratum about 50mm thick. The drinking bowl was made of natural porous stone with a cavity in the middle. When filled with water up to the brim it kept the water no longer than 24 hours. The drinking bowl was installed in a metal saucer buried in the soil. Thus the water oozing from the drinking bowl moistened the soil and assisted in maintaining a more stable humidity level. The terrarium was moistened twice a day, in the morning and in the evening, with the help of a sprayer. For creating areas of higher humidity, horse tails, pieces of bark, and leaves of the broad-leaved species of trees were laid on the soil after it had been moistened. These helped to maintain an area with a higher humidity level for a longer period, creating the effect of a humidity chamber. A 15 watt daylight lamp was used for lighting. For heating a heated bulb was used, situated at a distance of 10cm from the nearest branch, where the snakes could bask. The temperature in that area reached 32 degrees C, with the general temperature in the terrarium 22-24 degrees C. At night the heating was switched off and the temperature fell to 20 degrees C. The described temperature regime coincides with that used by other authors for keeping this species in captivity (Trutnau, 1981). The light period ranged from 12 to 14 hours a day, without reference to the season of the year or to the animal's activity.

The bamboo pit vipers were fed on grass and frogs (*Rana temp-*

oraria) and laboratory mice. The snakes usually hunted on the branches and having caught the mouse never released it, which is characteristic of other tree snakes (Orlov, 1983, Nalleau, 1975). During all the time of keeping the bamboo pit vipers in captivity, the use of caudal luring was not observed, in spite of the brightly colored tail (Orlov, 1981, Henderson, 1970).

During a 24 hour period, the activity of the snakes change. They are mostly nocturnal animals. In the morning, after the heating and lighting have been switched on, the snakes were mostly found in the branches, after which they quickly went down or hid themselves in tree hollows and the above described humidity chambers, where they spent the most part of the day. Closer to 10 p.m. they crawled out into the branches and basked for one or two hours. Immediately after the lighting had been switched off, the snakes began to move actively. During all the time they were kept in captivity the irradiation and the vitamin supplementation regime was stable. The snakes were irradiated once a week with an 80 watt lamp at a distance of 0.5m and the exposure time of 10 minutes. The vitamin supplement used was "Tetravit" which was given in the quantity of 3 to 4 drops on the mouse already grasped by the snake. Supplementation was performed every third or fourth feeding.

Sexual behavior was observed for the first time on April 21, 1980. The period of high sexual activity lasted from that time until July 27, 1980. During all that time the female fasted. The mating observed on July 17 at 8:3 a.m. lasted for thirty minutes after it had been noted. On July 27 the female resumed feeding and began eating considerably more than before. Higher feeding activity was retained until November 16, when the female fasted again. The male fed regularly during the whole period of sexual activity.

RESULTS

On January 2, 1981 at 11 a.m. the female gave birth to 12 young. The partruition took place in the absence of the staff, so it was impossible to determine its duration. Several clots of blood and the remains of arachnoidal membrane which covered the young snakes at birth were discovered in the terrarium. All the young were very active and aggressive, and were able to injure each other. One of the new-born snakes had an inborn deformity manifest in the absence of the left eye. It also had the lightest weight. The day activity of the young snakes coincided fully with that of the adult bamboo pit vipers.

The first shedding of the young began on January 7, 1981, i.e. on the fifth day after birth. On this day only one young shed, on January 8 and 9 three snakes shed in each day. The remaining three snakes shed on January 12. The second shedding occured in two weeks after the first one, and the third one six weeks after the second one. By the end of the first year the young pit vipers shed once every two to four months, which corresponds to the shedding frequency of adult snakes.

The young snakes were offered food immediatly after the first shedding, but they began feeding on small grass frogs on the fourteenth day after birth only. The young snakes fed regularly, namely during the first five months once in five days, and later their feeding frequency decreased to once a week. The young were irradiated under the same regime as the adult snakes.

Of the 12 young bamboo pit vipers of that brood, three snakes died: one of them had an inborn deformity, one died in the process of force feeding and one more (No. 5) died in the tenth month. The clinical signs made us think of the manifestation of inborn pathology which might be connected with inbreeding, which is known for some representatives of the family Crotalinae, (Fenderson, 1981). Six bamboo pit vipers were transferred to other zoos. Six young snakes were observed, the weight and size increase of which is shown in Table I.

By analysing Table I we managed to follow the growth rate and growth peculiarities of male and female bamboo pit vipers. It is characteristic of males that at the age of nine months their weight increase stops and tail length becomes stable. The tail length increases most actively during the sixth and seventh months. Based on these data, a supposition about the age of maturity can be made. For males it is 9 to 10 months, and perhaps even earlier. The most active weight increase in males occurs during the sixth to eighth month. The females by the age of nine months must also be mature. Though their weight and body length increase continues even after a year old, body length and tail length increase are relatively porportional, which does not lead to considerable change of their relationship.

On September 8, 1981 all the young bamboo pit vipers were placed together. Immediately after putting them together, we managed to observe typical sexual behavior. Increased feeding activity and the weight increase rate of one of the ten month old females made us hope that she was pregnant. In Chart I this female is marked with an arrow. By January 2, 1982 her weight reached 141g, with stable measurements. This corroborated the conclusion we made about the age of maturity of the bamboo pit vipers, reared in captivity, basing on study their growth and weight increase rates.

The female that first gave birth resumed feeding on the twelfth day after the parturition and restored her weight quickly. Late in June to early in July 1981, the adult pair of bamboo pit vipers showed an increase in sexual activity again. On July 17, 1981 Mating was observed, which lasted for more than an hour. During that time the animals were often found in the morning in a position resembling mating, so that perhaps there were more matings than the one registered. Late in July the female fasted again, and on August 18 she gave birth to 12 more young. That time the parturition took place in the presence of the staff. It began at 10:00 a.m. and ended at 10:45 a.m. The birth of each snake occurs very quickly and takes about 10 seconds. The interval between births is about 4 minutes. The bamboo pit vipers were born in a curved position, covered with a thin arachnoidal membrane penetrated with blood vessels. As soon as the new born snake gets to the soil, the parturition taking place on the ground, it breaks the membrane immediately and hides itself in the nearest hiding place.

Immediately after birth the young bamboo pit vipers are very aggressive. On being taken out of the hiding place they assume a defensive position, curl into a ring, curve the neck into a spiral, and are constantly prepared to bite. In a state of excitement they can bite each other or warm objects, like a heated bulb.

Of the 12 newborn, one was stillborn and one had an inborn deformity consisting in deformation of the jugular part of the spine and was destroyed immediately after birth. One more pit viper died in the third month. We did not succeed in establishing the cause of death.

The young snakes were much smaller than the first litter (see Table II), which might be connected with the short interval between the first and the second birth. However, by the fifth month the male's weight equaled that of the males of the first brood, and the females even outstripped their 'sisters' (see Table III).

The first shedding of the young of the second brood began on August 23, 1981, on the fifth day after birth, just as in the previous case. The second shedding occurred on September 18, and the third one on November 8, 1981. The young bamboo pit vipers began to feed on small grass frogs on the seventh day after birth. At the age of ten months, some of the snakes began to eat mice, which they preferred to frogs from that time on.

The adult female resumed feeding on the 14th day after the second birth. A month after the parturition she had restored her weight completely.

On February 25, 1982 the female of the first brood, which is marked by an arrow on the chart, gave birth to three young and laid several adipose eggs, which supported our conclusion about the age of maturity of bamboo pit vipers reared in captivity.

One of the newborn snakes had an inborn deformity/deformation of the jugular part of the spine. All the young born in February 1982 died before reaching one month of age. Their size and weight at birth measured much less than that of those born in January and August 1981 (see Table II). We are inclined to refer the small amount of the newborn, the spinal deformity and quick death to manifestation of inbreeding.

On October 15, one more of the female of the first brood gave birth to two young and laid 14 adipose eggs. Those young bamboo pit vipers differed in having somewhat smaller measurements and weight from the vipers of the first two broods (see Table II), but looked quite normal.

Table II

While transferring the snakes to other collections, we encountered for the first time the problem of determining the sex correlation in a group of bamboo pit vipers that young. The signs of sexual dimorphism, well known for adult bamboo pit vipers, such as lighter weight of the males, more slender build, longer tail in relation to the body length, are difficult to determine immediately after birth. There are no correlation differencies registered for young male and female bamboo pit vipers, which is known for some other representatives of the family Crotalinae (Burger and Smith, 1950). One of the more certain methods of sex determination in snakes, the method of sex probing, is not to be used at an early age, especially immeadiately after birth, as it can cause injury in young snakes. The most convincing sign chosen among the signs of sexual dimorphism above mentioned, seemed to be the percent correlation of body length to tail length, which we code named "the tail index". It is especially important that this sign can be expressed mathematically. Unfortunately, having received the first brood and not considering the necessity of dividing it, we began measuring the body and tail length separately from the fourth month after birth only. Taking into consideration the experience of the first observations, on recieving the second and the following broods, we measured the body and the tail length separately

from the first days. Moreover, each specimen was kept separately and the terrariums were numbered, (see Table II). This provided complete reliability of the retrospective analysis.

Table III

Only once was the rule of separate keeping broken. Due to lack of space, two bamboo pit vipers were placed together. They were easy to distinguish by a great difference in size. That cause served as an additional example of inadmissability of keeping the snakes together; in spite of the abundance of food, the smaller viper was eaten by its bigger "neighbor" in the fourth month. That was the second case of cannibalism among bamboo pit vipers in our experience.

Analysing the percental relationship of the body length to tail length in Bamboo Pit Vipers immediately after birth, we received figures which could easily be formed into two distinct groups(see Tables IV and V). This made us think of the possibility of using the "tail index" for determining the sex correlation in a group of new-born bamboo pit vipers. A distinct division into groups was preserved at measuring conducted a month after birth. In the second, third, and fourth months no or partial separate measurements were taken. However, the numbering and the principle of separate keeping of young snakes were preserved. This provided absolute reliability of the data received by the following measurements. Complete measurements were taken again in the fifth month of life of the young snakes. On analysing the received figures, distinct signs of sexual dimorphism according to the chosen index were revealed, which at that age were confirmed already by a considerable weight difference of males and females. A retrospective analysis conducted after the young bamboo pit vipers had reached maturity and the sex discrimination was confirmed by the sex probing method, supporting completely the conclusion of the possibility of using the tail index for determining the sex subdivision in a group of young snakes, even new-born specimens.

Of course we can not fully guarantee the result of sex-determination, but the method of "tail index" can be considered the only one which makes it possible to evaluate the sex correlation in a group of young bamboo pit vipers at an early age at least approximately.

In our opinion, the chosen index can be used for sex determination not only in bamboo pit vipers, but in most other pit vipers of this Genus.

Summing up the results of the research, the following conclusions can be drawn:

- pregnancy of bamboo pit vipers in captivity, as well as in the wild (Fitch, 1976), can occur in any month of the year.

- bamboo pit vipers kept in captivity can breed twice a year without harm to the breeding pair.

- with short intervals between births juveniles can be born smaller than usual, but by the age of about five months, the smaller snakes, provided conditions are favorable, can reach the size of those of the same age born normal body weights.

- bamboo pit vipers kept in captivity reach sexual maturity by nine months of age.

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BASIC MAINTENANCE OF CAPTIVE OPHIDIA

A VIDEO PRESENTATION

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This is a narrative from a 35 minute video presentation introducing some basics of successful ophidian husbandry. A few techniques and concepts that have been proven useful to us will be explored. Video tape media was utilized because of its obvious advantage in demonstrating techniques that do not easily lend themselves to a verbalization.

The equipment needed for such a production is minimal and can be found to be cost effective when compared to other methods of recording visual information. As an herpetological tool, incontravertible information of individual specimens and documentation of ophidian behavior becomes possible. This media is still experimental for us, so there were some rough edits and glitches.

Sturdy, reliable equipment is absolutely essential to providing a safe, sanitary, stress free environment. The use of inadequate, inappropriate or unreliable equipment is dangerous to both the keeper and the kept and should be avoided. As most pieces of equipment will come in contact with specimens or their feces and consequently require rather frequent disinfection, durable corrison resistant implements are the most desirable. All implements should be thoroughly cleaned and disinfected after each use. Many disinfectants are commercially available and most are effective when package instructions are followed. Use caution when using corrosives such as bleach or HTH. It is probably wise to avoid disinfectants containing phenol due to its toxicity to reptiles. We disinfect our implements by complete immersion for 15 minutes in a 1/400 solution of Roccal-D.

Perhaps the most important consideration is utilizing the appropriate implements or combination of tools for the task at hand. In order to adequately support the body of a large female *Trimeresurus wagleri* the utilization of two sticks is required to efficiently remove her from a feeding stand. In addition to a small handling stick, it is advantagous to wear protective eye gear when handling such as a neonate *Naja naja sputatrix*. When handling a specimen with a single stick, one should attempt to lift the snake at its approximate center of balance. If the specimen feels insecure or uncomfortable it will be much more difficult to contain and control. In such cases, it may be necessary to employ alternate methods. A yearling, *Agkistrodon halys caraganus* is reluctant to stay on a stick, thus the use of forceps, to which,when gently used, the snake exhibits no exception. Such is not always the case. From time to time, the herper is called upon to rise above the level of mediocrity and strive for the clearness of mind that opens the doors of inspiration. An example of such inspired genius is tendered herewith. A scoop constructed with 3 X 5 cards, hinged with lengths of masking tape is not only utilitarian, but disposable. A neonate *Calloselasma rhodostoma* will neither stay on a hook nor tolerate physical restraints. Hence, the invention of this scoop; which subsequently led to the invention of the spatula.

Of all the various methods designed to restrain snakes, the most useful has to be the Murphy method or tubing. Although some practice may be required to become proficient, once mastered, the method has many advantages. This Aspidelaps lubricus for example, may be thoroughly examined without hazard to the handler or snake. Remember also, always grasp the snake and tube with the same hand. This should discourage twisting and prevents the snake from backing out of the tube.

An example of a well packed small snake, the bag turned inside out so that this two week old Lampropeltis triangulum angulata won't become tangled in the thread, is well constructed and free of runs and holes. The shredded paper towel is slightly moistened to minimize the possibility of dehydration. The bag will be washed and disinfected. The hands are disinfected with a mild solution of Roccal. As a general rule, implements should be used whenever possible, rather than the hands. Safety consideration aside, implements are easier to disinfect than hands. The incoming specimen is checked for obvious probable problems, weighed, sexed, assigned a data card and succession is complete. Maintaining accurate weight data can prove most useful. An unexplained weight loss discovered will well alert the keeper to a metabolic or parasitic problem in time to ensure a favorable prognosis. Probably the most opportune time to weigh a snake is some time after shedding but before its next meal. As many ophidians refuse feed during ecdysus, custom dictates herpers withhold food from their opaque charges. Most snakes have an empty stomach after shedding. It is also worth noting that most snakes defecate at this time. Further reducing spurious weight and insuring more consistent data. Weighing complete , the annulata is placed in a plastic shoebox. The first of many during the next 6-8 months. A sheet of paper towelling serves well as a substrate. A retreat or hidebox will be provided only if the specimen appears agitated or refuses to feed. The lid fits snugly on the box and is secured with 2 rubber bands just in case one breaks. For housing terrestrial neonates, it seems hard to beat a plastic shoebox or jar. Arboreal neonates are best housed in gallon jars. All are easily disinfected and inexpensive. Don't bother to drill holes in the lids, it is not necessary. As neonates are serviced frequently, there is little danger of asphyxiation.

Housing requirements in general are defined from the needs of the subject. The special requirements of a female Bitis are comfortably met. The substrate lends itself to easy replacement while being an excellent absorbate. Bark mulch used in this display not only has eye appeal, but is relatively inexpensive. The bark when fouled by feces is easily and safely removed with a long handled scoop. An enclosure of this size requires about three cubic feet of substrate. If this possibility exists for an unknowing individual to tamper with the enclosure, it certainly makes sense to put a lock on the door. The need for temporary containers or emergency housing is easily met by utilizing a variety of containers. The most important criteria is that they be snake proof. Basically, temporary housing should meet essentially the same requirements as permanent housing and they should be secure and fill the special requirements of the occupant. A large trash can on wheels can confortably accomodate a fairly large snake. The lid is easily secured with duct tape. This can has been a temporary abode of a large male Naja naja kaouthia. As is the case with the utensils and other equipment,the best candidates for temporary

housing are those containers that are easily disinfected. It is necessary to insure that all containers utilized to house specimens are thoroughly rinsed after disenfection and be allowed to air dry before reuse.

The primary ophidian food item, the mouse, is humanely sacrificed by separating and crushing the cervical vertebrae. Allowed to cool for a minute or two to minimize bleeding, the mouse is ready for dismembering. The legs and tail are removed to be used to persuade reluctant small snakes to feed. In addition to convenience, mouse parts fed to neonates essentially encourage more rapid rate of growth. Additionally, neonates reared on mouse parts never demonstrate the reluctance to accept furred mice, as so many snakes reared on pinks seem to do. When attempting to persuade a reluctant feeder, it may be necessary to scent food items with the odor of familiar prey. Scenting the food item may be accomplished by blending one part of prey to 2-3 parts water. The excess may then be frozen for future use. Equally effective is the scenting of the food item with a cloacal discharge of a prey item. Occasionally requiring some manipulation, most common prey items generously make copious donations with a moderate amount of persuasion. If scenting a food item fails to illicit a feeding response, the scent offered is likely inappropriate to the snake or the snake is stressed. This adult male Tropidophis greenwayi, a diminutive boa from the Caicos Island is offered a mouse leg scented with an old excretia. Apparently lizard feeders, Greenwyi usually voluntarily accept unscented mouse parts after only 2-3 feedings on scented parts. When the prey item is grasped, it is gently tugged to insure that the snake has made a commitment, then the prey item is gently released and the snake is allowed to complete the process of deglutination. In order to simplify the total feeding process in ophidians, it is convenient to separate the process into three parts: recognition of food item as prey, immobilization of food item and, the ingestion of food item. It is obvious that if any part of the sequence is interrupted or not completed, the specimen will not eat. It can be generally stated that ophidian prey recognition is based on one to 3 cues or a combination of cues. The cues are visible, olfactory and thermal. Most arboreal colubrids respond to visual cues,examples include Leptophis, Oxybelis, Ahaetulla, and Chrysopelea. Olfactory cues seem to be important to most forms, but more frequently in conjunction with another cue. Thermal cues are clearly demonstrated by the crotalids and boids. In order to illicit a feeding response it is necessary to stimulate the appropriate cue. If visual, move the food item. If olfactoy, scent it. If thermal, heat it. Frequently one can take advantage of the snakes defensive responses to induce feeding. A Trimeresurus wagleri is placed on a feeding stand preparatory to a slap feeding. Slap-feeding involves provoking the snake to strike at the food item. Then at the appropriate moment releasing the food item in such a manner as to not further alarm the subject. When employing this technique, patience is essential. Slapfeeding rarely succeeds at the first attempt. Frequently, a dozen or more attempts may be necessary to induce the proper results. If gentle abuse fails to illicit the strike, a vigorous spraying with water or tingling and bumping the tail of the subject with the food item may do the trick. It is not surprising to note that the slapfeeding is generally more successful when a freshly killed food item is offered. Considerable care should be taken to insure that the subject is not intimidated by the proce-

dure. Tedious to work with at first, many snakes that initially require slap feeding become so accustomed to the procedure that they will willingly accept anything offered by forceps or tongs. Assist feeding is performed when scenting the food item fails, and when the snake is intimidated by the roughness of slapfeeding.

Simply stated, assist feeding is persuading the specimen to complete the process of glutition after being persuaded to grasp the food after gentle manipulation. You will observe that this two year old Lioheterodon madagascariensis grasps and releases the mouse several times before committing to it. Once the snake has accepted the food item, it is usually necessary to remain still until glutition is complete. It is frequently the active nervous forms that usually respond best to slapfeeding. The risk of regurgitation is considerable if the specimen is disturbed prior to completion of its' meal. Assist feeding is usually most effective when the subject is restrained by hand and consequently of limited application to venemous taxa.

A variation of slapfeeding that may occasionally be employed when the subject is venomous is restraining the subject with a stick. Extreme care must be taken to avoid injury. It is interesting to note that once the feeding response is triggered, the subject continues to voluntarily accept any food offered. Common sense dictates how much food to freight-train in this situation, but better too little than too much. Force feeding is just that. It is traumatic and should be resorted to only as a last resort. The subject should be firmly restrained and a lubricated food item gently insinuated into the subject's mouth. The subject is then gently released and allowed to complete the process of eating undisturbed. Finally, on the subject of feeding, there are four don'ts. Don't offer more than one food item at one time. Don't offer live rodents unless prepared to observe feeding. Don't offer food when snake is in shed cycle and don't offer food to an obviously dehydrated snake. Rehydrate it first. Obviously water requirements will vary from one taxa to another. But those varying needs must be met. We find plastic petri dishes are ideal for watering most neonates. They are easily disinfected and inexpensive. For larger snakes, we use the plastic bowls. Arboreal neonates are provided with a six or eight ounce plastic cup filled 3/4 full. We offer water to neonate Lampropeltis every other day. Most xeric taxa, Cerastes cerastes, for example, are offered water once every two weeks. Most ophidia will do well if offered fresh water every fourth day. We feel that refilling or topping off water bowls is not only unsanitary, but often fails to induce the snake to drink. A typical watering schedule would be as follows: January 1,water: January 2, water removed: January 4, water: January 5 water removed, etc. etc.. With the exception of xeric forms of Cerastes, Echis and some Crotalus, snakes are provided with fresh water in a clear container during ecdycus. Arboreal forms such as Trimeresurus trigenocephalus do well with water provided continuously. In fact, frequent misting of the arboreal ophidian is desirable, as many prefer to drink the droplets that fall on their body. Remember a dehydrated snake will probably refuse to eat. If it does eat, it is likely to regurgitate. When in doubt, water more frequently.

Sex determination is really relatively simple in most ophidia. Some taxa, Trimmeresurus and Bothrops for example, are obviously sexually dimorphic. Manual eversion of the hemipenes will aide in sexing neonates. The procedure requires that the neonate be firmly

restrained and in the case of venemous subjects, cubed. With the thumb, a gentle even rolling pressure is applied to the ventral aspect of the tail towards the cloaca. The everted hemipenes indicate a male. The rocking action may take some practice, but when proficiency is obtained, the technique is relatively reliable. Probing is probably the most reliable means of sex determination. As in with other instruments it pays to use only good quality probes. Makeshift probes such as toothpicks and paperclips are accidents waiting to happen. Prior to attempting to insert the probe it is to be coated with a water soluble lubricant. Probing is usually smoother when the probe is inseted with a twirling motion. If the probe may be inserted well into the tail the subject is a male, if not and the procedure is properly executed, the subject is a female.

One can never take too many precautions. The possibility of injury or death as a result of dangerous handling of ophidia can not be over emphasized. Cost should never be a factor where safety is concerned. Obviously, proper equipment and its use is essential to dafe animal manipulation.

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