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FURTHER NOTES ON THE HUSBANDRY, BREEDING, AND BEHAVIOR OF *CHONDROPYTHON VIRIDIS*

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My involvement with *Chondropython viridis* began in early 1976. For the first two years the animals were maintained and observed in my home. In late 1977 I began to place my private specimens on loan to other collectors and institutions. From that time on all of my work has been done at the National Zoological Park (NZP) with zoo owned specimens. To date I have worked with 40 specimens and have experienced four fertile egg clutches from captive breedings as well as one from an imported gravid female. Both artificial and maternal egg incubation methods have been experimented with. This has resulted in a great deal of valuable data although relatively few hatchlings have been produced. In 1977, I published a paper on my early work covering husbandry techniques, breeding, artificial egg incubation, and juvenile care. This paper will review some of the material in the published paper but will concentrate on new insights into past results and new information from recent work. No literature citations are made in the body of the paper but a list of significant papers and successful breeders is included.

HOUSING AND HUSBANDRY

Initially my *Chondropython* were housed individually and paired up only for breeding. Caging consisted of upright 30 gallon aquariums. Cage furniture was restricted to bamboo rods which were attached to walls to serve as perches and plastic ferns which hung over certain areas for cover. Newspaper was used as substrate and water bowls were placed on cage floors.

A twelve hour, year round photo period was established with overhead Vita-lites on timers. Red lights were positioned around the snake room so that nocturnal observations could be made without disturbing the animals. Heat was provided to the cages by heat tapes under the slate bottoms and humidity was increased by daily mistings. Movable polyethylene shields were fitted over the screen tops of the cages. By opening and closing the shields, in conjunction with daily mistings, climatic fluctuations were obtained. The daily climatic cycle consisted of a cool, dry period from late night to early morning 23°C and 55% relative humidity), gradual increase in temperature throughout the day, and a peak in temperature and humidity by late afternoon/early evening (30°C and 100% relative humidity. Seasonal climatic variations were not recorded during the first year of the project, but it was noted that slightly cooler periods occurred between September and October resulting from the influence of cold outdoor weather on the building

In late 1977 I decided to try several larger communal cages housing from four to six specimens of both sexes. This caging arrangement was abandoned shortly thereafter as a result of several aggressive interactions.

At the NZP a new method of housing was established using 30 gallon aquariums. The aquariums were set on end with the cage tops serving as front doors. Special "door-tops" were constructed to minimize problems with specimens injuring their mouths when striking at intruders. These "door-tops" consisted of wood frames covered with perforated sheet metal. One side of the sheet metal was smooth and this was faced into the cage. Adjustable polyethylene sheets covered the "door-tops" to help regulate temperature and humidity. Bamboo rods were attached to cage wall at three levels. The photoperiod was governed by natural light from skylights and was that of the Washington, D.C. area. Twenty-five watt red bulbs with metal reflectors were placed on the tops of the cages. This provided some heat and a slight thermal gradient from the highest to lowest perches. For nine months of the year (December-August) the cages were subjected to daily climatic fluctuations similar to those of my home set-up. From September through November the daytime highs were about the same as at other times of the year, but the nighttime low temperatures were allowed to drop to 15.5°C.

The specimens were maintained on a diet of mice, rats, and chicks. The feeding schedule varied according to individual animals. Young animals and undernourished adults were fed every five to seven days. Well nourished adults were fed every two to three weeks.

HEALTH CARE

The majority of the *Chondropython* in this project were acquired as newly imported wild caught adults. Although most specimens fed readily on rodents and chicks, some were unable to attain suitable body weight. Fecal examinations revealed that most of the animals were heavily parastized. Parasites most commonly encountered include, roundworms, hookworms, pinworm, and tapeworm. Because of the high concentrations of parasites and body weight problem, I decided to worm all the specimens in the project. Appropriate wormers such as telmin, T.B.Z., piperazine, and yomesan were administered by tube to fasted snakes. Two weeks later follow up wormings were done by offering the snakes small feed animals with wormer implanted into their body cavities. Subsequent wormings were given at approximately six month intervals. Soon after the initial worming the thin specimens began to gain weight and no parasite related compliations occurred thereafter. Specimens acquired at the N.Z.P. have been subject to experimental worming procedures by zoo veterinarians with varying results. Parasite related problems and deaths have occurred with females at the N.Z.P. after stress associated with fasting, pregnancy, and egg laying.

On two occasions well acclimated specimens died after exhibiting no apparent symptoms of illness. Both animals had abnormal amounts of fat reserves throughout their body cavities. Death in both cases was attributed to excess fatty tissue around the heart. As a result of these experiences I cut back on the amount of food given and frequency of feeding in slow growing and adult specimens.

Pseudomonas infections have been another common problem with the *Chondropython* in this project. Recently imported specimens with mouth injuries and/or heavy parasite loads appeared to be particularly vulnerable to *Pseudomonas*. Symptoms varied depending on stress factors. Respiratory problems, enteritis, and mouth rot were attributed to *Pseudomonas* in a number of the snakes. Sulfa drugs, Chloramphenicol, and Gentamycin were used with some success in combating *Pseudomonas* in these animals.

Other less common problems affecting the *Chondropython* in this project have been tumors and bacterial granulomas. One male specimen succumbed to a malignant tumor of the hemipenis after enjoying an active sex life for several years. Two specimens were lost to bacterial granulomas in the trachea. No obvious symptoms of illness were observed in these animals until several days prior to death when it was noted that they were having difficulties in breathing.

In a survey of the reptile collection at the N.Z.P. it was discovered that the majority of our *Chondropython* were hosts for different strains of *Salmonella*. It was later determined that *Salmonella* is not common pathogen in the collection and no *Salmonella* related deaths occurred in our *Chondropython*.

BREEDING AND BEHAVIOR

Since beginning the *Chondropython* project in 1976, I have witnessed over 80 breeding encounters. In my home set-up, the majority of this activity occurred between the months of July and September. At the NZP, breeding activity has been observed in September thru November. It is my opinion that the main breeding periods (M.B.P.'s) for my *Chondropython* correspond directly to seasonal periods when daily temperature fluctuations are the greatest and when evening temperatures are cooler. Other boids in my care, including *Corallus canina*, *Corallus enydris*, *Sanzinia madagascariensis*, *Python sp*, and *Epicrates cenchria* show similar breeding periodicity. More controlled research is necessary, before it can be established how climatic fluctuations actually affect breeding cycles in *Chondropython*.

The majority of observed courtships and resulting copulations began soon after dark when the temperature and humidity were on the decline. Sexual contact lasted for as little as an hour in some instances but often continued until daylight. On occason a breeding pair would remain intercoiled on a perch for over twenty-four hours after breaking cloacal contact.

During a M.B.P., I have noticed female *Chondropython* scent marking cage branches. This activity involved a prowling female rubbing her opened cloaca on the surface of a branch and excreting small amounts of whitish liquid. Courtship pursuits by a male often followed this activity.

The male courtship pursuit appeared to be similar to that of other arboreal boids. An excited male would slowly and methodically follow a female over cage branches while rapidly flicking his tongue over surfaces and the female. If the female was sprawled on a branch, the male would crawl over her back in a parallel position while titillating her body with his anal spurs. Eventually the male aligned vent to vent with the female and titillated her vent until she became receptive and allowed penetration by one hemipenis. By this time the anterior sections of the snakes' bodies would typically hang vertically below the branch and copulation continued. On occasion the female would already have come to rest in a coiled position before the male overtook her. In this case the male intercoiled with the female on the branch and then continued courtship as described above. Only once have I witnessed a copulation while both male and female were on the cage floor.

On several occasions, while maintaining specimens communally, I witnessed aggressive interactions between two sexually excited males. One male would attempt to court another male only to be struck at by the offended party. The result was frequently a fall with the bitten party suffering lacerations from the bite. In another situation I witnessed a resting gravid female attack a non-gravid female which was on the prowl.

RECOGNITION OF GRAVID FEMALES

There are a number of characteristics which I have come to recognize as signs of pregnancy in *Chondropython*. These are: loss of appetite, changes in behavior, a deflated head appearance, and abdominal swelling.

The four gravid, captive-bred females in my project all went off feed soon after the M.B.P. These females and a fifth wild caught gravid specimen fasted for an average of 70 days prior to egg laying. Soon after going off feed, the other common symptoms of pregnancy became apparent. All five specimens underwent drastic changes in disposition. In four of these instance the normally aggressive nature of these animals became quite subdued while the fifth female became more hostile in the gravid state. All five gravid females became noticeably less active and at times would remain coiled on a branch under cover for days on end. Another interesting, yet presently unexplained, physical trait is a change in the appearance of the female's head, which persists until the eggs are laid. I call this condition the "deflated head appearance," in which the sides of their normally bulbous heads take on a sunken look. This condition may be related to a change in the circulation to accomodate increased blood supplies in the oviducts during egg development. This appearance may also be attributed to a form of thermal regulation in which absorbed heat in the head is channeled via blood to the oviducts to aid egg development.

At times I have found it difficult to determine gravid *Chondropython* solely by abdominal swellings associated with egg masses. In three instances I had females which produced small clutches of 11 to 13 eggs. The abdominal swellings in these snakes could easily have been mistaken for fat reserves of healthy non-gravid *Chondropython*. However, on two other occassions I was able to distinguish egg masses early in pregnancy. In these two cases the females contained large clutches of over 20 eggs.

CARE AND BEHAVIOR OF GRAVID FEMALES

Between 1976 and 1978 fourteen female *Chondropython* were bred repeatedly. Of these only four specimens became gravid. In retrospect I realize that these four snakes were treated differently from the others after the M.B.P.. They had the opportunity of thermal choice. Twenty to 40 watt red bulbs were mounted directly on top of their cages so that nocturnal observations could be made. These lights were focused on the heavily camouflaged sections and left on 24 hours a day, producing hot spots. Daily temperature data at those hot spots was not recorded but periodic checks showed them to be approximately 28° to 29°C. The egg producing females remained under the hot spots throughout their pregnancies until a restless stage just prior to egg laying. At the time I thought these females chose to remain under the red lights solely because of the seclusion offered at these sites. Now I'm inclined to believe that the hot spots were at least as much of an attraction. If so, this indicates that female *Chondropython* may require a constant warm environment after the M.B.P. in order to develop and produce fertile eggs. This is another area where controlled studies are necessary before definite conclusions can be drawn. In preliminary studies with other boids at the N.Z.P. I have found that gravid females do have specific thermal preferences which are different from those in a non-gravid state.

EGG LAYING AND INCUBATION

Three of my captive bred *Chondropython* laid eggs in mid-January. The time between the last observed breedings and oviposition ranged from 103 to 113 days. Clutches of 25, 13, and 11 eggs were produced. The fourth captive bred gravid female died in the latter stages of pregnancy due to an injury sustained in an aggressive interaction with a non-gravid female. This specimen contained 24 fertile eggs. The wild caught gravid female laid a clutch of 13 eggs in early November after three months in isolation.

My only hatching success to date resulted from the 1977 clutch of 25 eggs. The eggs were taken from the female, weighed, measured, and set up in incubators. The mean size and weight of the eggs was 37.9 x 27.5mm and 13.9g. By candling the eggs it was determined that two were infertile and one was dead when laid (blood ring apparent).

Two ten gallon tanks with perforated plastic covers served as incubators. Heat was provided by heat tapes under the tanks and they were maintained at two temperatures. Tank A averaged 28.3°C and tank B 30.6°C. The relative humidity in both tanks was approximately 100%. Near the end of incubation the eggs in both tanks began to develop gray-transparent areas. By airing out the tanks briefly each day the eggs would return to their normal creamy color. After 51 days of incubation the eggs began to hatch. A total of ten eggs pipped in tank A. Nine yellow babies with red and white markings successfully emerged from the eggs. The mean weight of the offspring was 9.3g. None of the eggs in tank B hatched because the temperature was apparently too great to support embryonic development.

The two most recent clutches were set up for maternal incubation in hopes of gaining insight into the brooding habits of this species. After laying eggs the females and their clutches were transferred to special brooding cages. The enclosures consisted of two 20 gallon tanks which were fitted with perforated tops. Damp sphagnum moss was used as substrate. A domed section of corkbark was placed over the first brooding female and a piece of damp cloth over the other. This cover was added to help shield the females and eggs from the overhead heat sources. Heat was supplied by 25 to 40 watt red bulbs which were placed on the cage tops. The relative humidity in the tanks was maintained between 85 to 95% by spraying the moss around the brooding females. Data on a variety of parameters were recorded twice daily. These included female behavior and brooding position, temperature of the females, clutch, and several points within the tanks.

The two laying females coiled around their eggs when re-introduced to them in the brooding cages, but in each case the eggs were abandoned after two weeks. Parasite related health problems and inadequate brooding conditions were attributed to the desertions. The two abandoned egg clutches were put into incubators but failed to hatch. The experiments were not a total loss, however, as the accumulated data provided a stimulus for speculation as to the needs and behavior of brooding *Chondropython*. Hopefully the information and speculations will lead to more successful hatchings in the future.

I reason that there might be a least four means by which brooding *Chondropython* are able to control or regulate clutch temperature and humidity. These methods may be used alone or in conjunction. They include: selection of the brooding site, basking, muscular contractions or twitches, and the position of the female on the eggs.

My observations and those of others indicate that gravid *Chondropython* exhibit unusual behavior and activity prior to oviposition. During these periods specimens have been seen exploring their cages and occasionally coming to rest on the ground in a tight disk-like coil. It would appear that this behavior is associated with the selection of an egg-laying and brooding site.

Some brooding pythons, like *Python regius*, have been observed leaving their eggs for short periods to bask. When their bodies have absorbed sufficient heat they return to their eggs and coil around them. The absorbed body heat is transferred to the egg mass and maintained by the enveloping coils. I observed this basking behavior on a number of occasions during the *Chondropython* brooding experiments. At times when the heat source was focused on an area of the cage away from the female and eggs, the female would leave her clutch to bask. The female would later return to the clutch. When the heat source was focused on the brooding site the female stayed on the eggs.

Brooding *Python molurus* are able to raise and precisely control their body and clutch temperatures by means of muscular contractions or twitches. A number of people have reported seeing female *Chondropython* twitching while brooding eggs. Others have witnessed *Chondropython* brooding eggs from the time of egg laying to hatching and have observed no twitching. Both of the *Chondropython* in my brooding experiments were observed twitching. It appears that *Chondropython* may employ muscular contractions merely to maintain absorbed heat. My females ceased twitching when the ambient temperature at the brooding sites dropped below 26.2°C or went above 29.6°C. It was my impresssion that the females were more comfortable when the clutch temperatures were between 28°C and 29°C.

The type of coiling also appears to have some effect on the temperature and humidity of the clutch. I identified three different coiling positions: a spherical coil, a stacked coil, and a flat coil. The sperical coil totally enveloped the egg mass. The widest coil of the sphere was in the middle and the eggs were actually lifted off the substrate. The stacked coil resembled a cone. The coils were tightly stacked three or more layers high and the widest coil was at the bottom. In this case the eggs were totally covered but were in contact with the substrate. The flat coil covered the eggs like a plate. The widest coil was again at the bottom but the coils were much looser and only two or three layers high. In this position the egg mass was less compacted and individual eggs could be seen between coils.

A brooding female's use of different coiling postures may be related to the climate and physical makeup of the brooding site. If so, it is possible that the different coiling positions are used in conjunction with basking and twitching as another means to regulate the temperature and humidity of the egg mass. For instance, if a well insulated brooding site were available, such as a tree hollow, a female might be able to maintain a suitable clutch atmosphere while expending little effort. A snake in this situation might bask infrequently and maintain a preferred temperature and humidity by a combination of twitching bouts and a flat or stacked coil structure. On the other hand, if a less protected brooding site was used, the female might have to bask more frequently, use spherical coiling, and employ regular rapid twitches to achieve the proper temperature and humidity for incubation.

It is also interesting to note that brooding pythons of many species, including *Chondropython*, tend to bury their heads in the tops of their coils periodically. This suggests that females may use their heat sensitive facial ptis to monitor the temperature of their egg masses.

HATCHING AND HUSBANDRY OF YOUNG

The nine *Chondropython* from the 1977 hatch were housed in three ten gallon tanks. The cage furniture and environmental cycles used for these snakes were similar to those used for the adults. Prior to first sheds the offspring were fairly inactive and showed no interest in food. Food offered included pinkies, *Anolis*, and *Hyla*. Ten to fifteen days after hatching the babies shed and began to prowl in the evening hours. Caudal luring was first noted at this time. Four specimens ate pinkies after much coaxing on the night of their first sheds. The other babies were assist fed pinks until they began to feed on their own.

Weights were taken on two of the offspring on a regular basis. One animal weighed 101 g at six months, 272 g at a year, 455 g at a year and a half, and 520 g at two years. The growth rate of the second specimen was comparable to that of the first. During the two year period each snake consumed approximately 1500 g of food and shed 19 times.

At six months of age the color transformation from juvenile to adult pigment began. When first noticed, the bright red dorsal markings were fading to a grayish cast. It's interesting to note that the red pigment was the first to develop in the growing fetus. Within several days of the red fading, the electric yellow pigment began to turn green along the mid dorsal region. Over a two week period the red markings turned blue and green along the mid dorsal areas darkened and spread ventrally to the edge of the belly scutes.

The color transformation process appears to vary among individuals. One wild caught juvenile in my collection took a year and a half to complete the change and it occurred in a different manner then with my captive hatched specimens. When acquired, the body color of this animal was light orange and it had red, black, yellow, and white dorsal patterns. When the color change began the specimen weighed 79 g and and was approximately 45 cm long. At first a few scattered green flecks appeared on the head and sides of the body. The green pigment spread from the core of these flecks and the orange base pigment turned to a dull yellow. The red, black, yellow, and white dorsal juvenile pattern completely faded out. At the end of a year and a half the specimen had taken on a mottled green and yellow pattern with a 60 green to 40 yellow ratio. Although this adult coloration is unusual for *Chondropython*, I have seen half a dozen other specimens of a similar appearance.

SUMMARY AND CONCLUSION

In recent years dozens of zoos and private collectors have gotten eggs from captive bred *Chondropython*. Most of these breeders have purposefully employed climatic cycling in order to stimulate breeding with their animals. Unfortunately, hatching *Chondropython* eggs still appears to be a hit or miss operation as only a handful of these people have had success. Successful breeders other than myself include: Henry Kratzer, 1962; Prague Zoo, 1974 and 1977; Steinhart Aquarium, 1974 (from a wild caught female); Sedgwick County Zoo, 1976; Terry Odegard, 1977; and the Philadelphia Zoo, 1979.

Only three of the above allowed maternal brooding as a means of incubation (Kratzer, Prague Zoo, and Steinhart Aquarium). Successful incubation temperatures have ranged from 27°C (Prague Zoo) to 30.5°C (Terry Odegard) with most hatches being at temperatures from 28-29°C. Incubation periods have varied from 47 days (Henry Kratzer) to 60 days (Terry Odegard). The hatch ratio per clutch has generally been very low and only twice has a 100% hatch been reported (Steinhart Aquarium, Philadelphia Zoo).

As noted earlier, four hatchings of *Chondropython* occurred in 1979 alone. Hopefully more success will be reported in the near future as more is learned about the behavior and needs of this species. In particular, more information is needed on how to successfully and consistently hatch the eggs. One means of doing this is to set up and monitor females with their eggs in controlled brooding situations. This has been done by Dr. Van Mierop successfully with other *Python sp.* In so doing it is possible to determine the precise temperature and humidity required by the eggs at different stages of incubation. It would also give us more information on the brooding females behavior in relation to how they maintain a preferred clutch atmosphere.

At the N.Z.P. we did not cycle our *Chondropython* for breeding in 1979 due to complications with building renovation. However, we hope to be in a position to resume our work with this species some time in 1980 or 1981. All things considered, there is still much more to be known about *Chondropython viridis*.

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