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REPRODUCTION OF CHONDROPYTHON VIRIDIS

(REPTILIA, SERPENTES, BOIDAE)

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It has been shown for the Indian python (Python molurus molurus) and its subspecies (P. m. bivittatus) that the female not only coils around her eggs and exhibits brooding behavior, but that she also incubates them by raising the temperature within the coil to about 33-34°C (91-93°F) (Hutchison et al, 1966, Vinegar et al, 1970, Van Mierop et al, 1976a,b, 1978). Furthermore, the animal is able to keep this high temperature quite constant at ambient temperatures between 26 and 31°C (79 and 88°F). During the incubation period of about 56 days the female exhibits jerky body contractions the frequency and force of which vary with the ambient temperature. These contractions are believed to represent the mechanism by which the animal generates heat.

Because similar contractions of the body have been observed in brooding females of Python curtus (Noble, 1935) and Chondropython viridis (Kratzer, 1962), Vinegar et al postulated that these two species may also have physiological thermoregulatory ability. Thusfar however no actual measurements have been made to substantiate this and in the case of C. viridis we are aware of only three instances (Kratzer, 1962, Switak, 1975, Olexa, 1979) in which the female was allowed to tend to the clutch of eggs.

Recently we had the opportunity to demonstrate that the reproductive behavior of C. viridis is remarkably similar to that of P. molurus and that this species does have thermoregulatory ability.

MATERIALS AND METHODS

The female (NZP 302315) has been in captivity since about 1975 and was obtained by the National Zoological Park in August, 1978. The male was hatched in captivity in March 1977 (Walsh, 1977) and was transferred to Gainesville, Florida in April 1979, followed by the female in February 1981. Each of the two wooden cages in which the animals were housed had a glass door and removable panels in adjacent sides allowed access from one cage to the other without the need for handling either of the two animals. Perches were located at several levels. The wooden nesting box measured 14 x 17 x 18 cm and had a 6 cm round entrance opening in one side. The opposite wall consisted of plexiglass. The top of the box had a square opening 10 x 10 cm which allowed access to the female during incubation. The nesting box was suspended from the inside top of the glass cage door with its plexiglass side towards the glass (Fig 1). Foam plastic weather stripping along the four sides of the plexiglass wall rested against the glass of the cage door so that the nesting box in effect had a double transparent wall. When observations were not made this part of the door was covered by a sheet of black paper.

Two type 401 thermistor probes were led into the nesting box through its floor with their tips approximately 2 cm apart and protruding from the peat moss-sphagnum moss substratum. A third type 401 probe was used to measure the temperature inside the coil among the eggs(T_C). All probes were connected to a YSI model 44TD Thermistemp telethermometer. The substratum was [illegible]m thick and was damp when put in but had completely dried within a few weeks. Humidity within the cage was measured with an Abbeon hygrometer and the ambient temperature (T_A) with a Stortz MMT-15 maximum-minimum self-registering thermometer. This thermometer and the thermistor probes were checked against an ERTCO type 1003 precision mercury thermometer.

Contractions of the body were counted visually over 2-minute periods at least twice a day, at the coolest and at the warmest times of the day.

Temperatures were measured inside and outside the cavity of a hollow, but living tree with max-min, self-registering thermometers. The diameter of the cavity was 20 cm, the entrance measured 30 x 7 cm.

OBSERVATIONS

The male was allowed access to the female on November 21, 1981 and the animals were found in copula at 0800 hr the next morning. T_A at this time was 17°C (63°F) . Mating continued until about 1600 hrs. by which time T_A had increased to 29°C (84°F). Thirty-nine copulations were observed over the next three months, the last one occurred on February 9, 1982. Male and female were separated by replacing the partitions for periods of two to five days on five occasions for purposes of feeding and shedding. During this period the female took three rats, the last one on January 24 after much hesitation. The male took a rat on November 29, killed and partly swallowed one on December 20 and January 24, but regurgitated both. On February 14 the animals were separated permanently. The male shed on March 5 and resumed feeding on March 8.

During the mating period T_A varied between 17 and 24°C (63 and 75°F) in the morning and 26 to 29°C (79 to 84°F) in late afternoon. Relative humidity (R_H) varied between 60 and 85%. During the last week of April the female became restless at night exploring every part of her cage. On April 27 the nesting box was placed in the cage and the next morning the female was found inside it. Over the next four days the animal coiled on top of the box during the day and entered it at night.

On May 2 at 0740 hr the female lay coiled inside the box with the head tucked inside the coil. T_A at this time was 23°C (73°F). At 0945 hr a few eggs had been laid and oviposition had been completed by about 1430 hr. The head had reappeared and the coil was almost closed. Contractions of the body were observed at a rate of 11-15 per minute. The body coil was very high, almost cylindrical (Fig 2). The bottom and top turns of the coil were much smaller than those in the middle and the coil therefore was shaped somewhat like a very short capsule. The eggs must have barely rested on the substratum, if at all. Because of this, the tips of the two substratum thermistor probes were not located among the eggs, as intended, but had been bent over and laid flat between the body of the female and the substratum. The tip of the third probe was placed among the eggs by inducing the female to open the top of the coil momentarily by gentle prodding. It was repositioned as necessary so that during the first eight days of incubation temperature measurements from the interior of the coil could be made at any time. Thereafter it was replaced only every 3-5 days since there proved to be a constant relationship between the temperature as measured by the coil probe (T_C) and the substratum probes (T_S). T_C was always 1.5°C (3°F) higher than T_S, therefore it was not necessary to disturb the female as often as we had anticipated. The diameter of the coil was about 12 cm, thus the floor space of the nesting box was almost completely occupied.

The coil was kept tightly closed throughout the incubation period, regardless of T_A. No shedding took place, nor were excreta produced and water in a plastic container affixed to the nesting box just outside the entrance opening was ignored.

Contractions of the body continued throughout the incubation period. At low ambient temperatures contractions were frequent and forceful, occurring in groups initiated by a strong contraction followed in rapid succession by three or more of decreasing intensity and then a pause. Only the first contractions of each group were counted. At a T_A over 27°C (81°F) the frequency of the contractions decreased to 3 or less per minute and became barely detectable. Contractions were particularly frequent during the first two weeks, then decreased and became quite infrequent during the last week. For example, at ambient temperatures of 26 and 27°C (79 and 81°F) the mean contraction rate during the first two weeks was 16/min., during the next four weeks it was eight/min and during the last 10 days only four/min.

Temperature measurements were recorded 8-15 times a day, generally between 0700 hr and 2330 hr but at times also during the night. During the first two weeks T_A was allowed to fluctuate between 21 and 23°C in the morning and 27-29°C in late afternoon. Thereafter the temperatures of the room and the cage were kept moderately well controlled at various levels for at least several hours by the use of an air conditioning unit. At T_A of 25-28°C (77-82°F) the T_C was about 31.5°C (89°F). At lower T_A the T_C could no longer be held at that level but even at a T_A of 21-22°C (70-72°F) a temperature differential of 7°C (13°F) was observed. At a T_A of 29°C (84°F) T_C increased to over 32°C (90°F) and we did not think it advisable to increase the ambient temperature further.

On June 23, 53 days after oviposition, a hatchling was seen to protrude from between two coils of the female for about 1/4 of its body length. Because it seemed to be in some difficulty the female was removed. Two eggs had completely collapsed and were stained dark brown, the other 14 were in excellent condition and barely soiled. By June 26, all young had hatched, all were bright yellow with brownish red markings. Mean body weight of the 14 hatchlings 4-6 days after birth was 13.5 g (range 9.4-15.6 g). The first shed took place between July 6 and 8, about 13 days after hatching. Caudal luring was observed on several occasions. By July 19 twelve hatchlings had accepted live or thawed out frozen infant mice with mild to considerable coaxing, one had spontaneously taken a live pink and another a *Hyla squirella*. The female took a live rat on June 25 and 29, and July 3 and 14. The animal shed on July 13.

Mean high temperatures inside and outside the cavity of the hollow tree in May 1982 were 28°C (83°F) and 31°C (88°F), in August they were identical. Corresponding mean low temperatures however were 19°C (66°F) and 17°C (62°F) in May, and 24°C (75°F) and 22°C (71°F) in August. Mean daily temperature fluctuations inside and outside the cavity in May therefore were 9°C (17°F) and 14°C (26°F), in August they were 4°C (7°F) and 9°C (17°F).

DISCUSSION

Our observations confirm that the female *Chondropython viridis* does indeed have physiologic thermoregulatory ability. Its reproductive behavior and the means by which heat is presumably generated are very similar indeed to that of *P. molurus*. Because of its small size, *Chondropython* obviously cannot be expected to maintain a reasonably constant and high incubation temperature without providing for some means of insulation, e.g. by burrowing or by selection of some other sheltered nesting site. Our measurement clearly demonstrate the tempering effect on temperature of a hollow tree.

Even at the lower strata of a tropical rain forest ambient temperatures fluctuate significantly (4-6°C, 8-10°F) during the day (Ripley, 1964). Moreover, Chondropython is known to occur from sea level up to altitudes of 1800 m (6,000 ft) and not only in rain forest, but also in mountain forests, scrub land and coffee plantations (McDowell, 1975). Considering its strongly arboreal habits it seems likely that the eggs in the wild are laid and incubated above ground level, e.g. in a hollow tree or similar sheltered place. The behavior of our female during the 4-5 days prior to oviposition supports this notion: a nesting box on the floor of the cage was ignored, the one (described above) suspended high up in the cage was immediately entered. Scattering eggs indiscriminately over the cage floor or dropping them from a perch as has been observed on a number of occasions by others (e.g., Rundquist, 1980, Walsh, 1978) we believe to be abnormal behavior, probably related to absence of a suitable nesting site. Artificial incubation in general has had mediocre results at best. Recently this has been ascribed, at least in part, to too high incubation temperatures and a temperature of about 28°C (82°F) has been recommended. This value may have been arrived at because of the reports by Kratzer (1962) and Switak (1975) of successful hatchings at ambient temperatures of 28°C (82°F) and 29°C (84°F). In both those instances, however, the female was allowed to incubate the eggs and, as our study shows, the ambient temperature does not reflect actual incubation temperature, which is considerably higher. This would explain why the incubation period as reported by Kratzer and Switak was less than 50 days, while eggs incubated artificially at about 28°C have required incubation periods of well over 60 days. The incubation period of

53 days in our study, 5-6 days longer than that reported by Kratzer (47 days) and Switak (48 days is undoubtedly related to the rather low T_C (28.5-31.5°C, 83-89°F) during the first two weeks of incubation.

Mean body weight of hatchlings has been reported to be 9.3 g (range 8.5-10 g, Walsh, 1977), and 9.5 g (range 7.2-10.5 g, Grow, 1977). Olexa (1979) gave a weight range of 9-10.8 g and a single specimen hatched at the Oklahoma City Zoo weighed 10 g (Rundquist, 1980). The larger size of our hatchlings (only one weighed less than 10 g) may be due at least in part to genetic factors: We have observed that some females of P. molurus and P. regius consistently produce larger eggs and young than others, without there being a correlation between weight of the eggs and hatchlings and size of the parent. In addition, artificial incubation in our experience tends to result in smaller young. Of three P. molurus clutches in which part of the clutch was randomly removed as the eggs were laid and incubated artificially at the same temperature as measured within the coil and at 100% humidity, all young hatched at the same time, but the artificially incubated eggs produced young which were on the average 3.5-11% lighter. Perhaps this is due to differences between the microclimates inside the coil and in the incubator.

In conclusion we would recommend that, as with other pythonid snakes, the female Chondropython be allowed to incubate the clutch and to this purpose be provided with a reasonably well insulated nesting box suspended well above the cage floor. An ambient temperature of 26 - 28°C (79-82°F) and a humidity of 70 - 90% we believe to be ideal. No source of radiant heat, natural or artificial, should be allowed near the nesting box. Moderate fluctuations of T_A, e.g. between 23 and 28°C (73 and 82°F), are well tolerated.

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