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SNAKE EGG INCUBATION

Snakes are either oviparous (egg laying) or viviparous (live bearing). Those species, which produce live young, are usually found in cooler climates or at higher altitudes. Unlike tortoises, turtles, alligators and crocodiles, whose gender is determined in large part by the incubation temperature, the gender of a snake is determined by its genes, as it is in the case of birds and mammals. Snakes, which lay eggs do not typically build or dig nests, in the manner of many other reptiles. The King Cobra is an exception. Among other species of Cobra, the King Coma may also guard her nest. Some oviparous species select a crevice in which to lay. Grass snakes choose to lay their eggs in decaying vegetation, which as it decomposes produces heat. The site is selected based on its temperature, humidity and substrate, and if specific environmental needs are not met, the eggs will not hatch. Of the species commonly kept as pets, only the python actively broods her eggs. She coils about the eggs, and rhythmic contractions of her muscles produce heat to warm the eggs. She may loosen the coils to decrease the temperature at which the eggs are kept when ambient temperature rises, or toward the end of incubation when a slight decrease in temperature may be beneficial to some species. Some pythons will leave the clutch for a short time, bask and then return to transmit the absorbed heat to the clutch.

Unlike the python, the Colubrid snake does not care for her young after she has laid them. Once the eggs have hatched, maternal care is negligible or non-existent for all snake species. Snakes in their natural environments select a nest site, which has an appropriate temperature and humidity range, as well as the correct substrate. In spite of the intricacies and unknowns of the natural process, attention to detail and sound research will allow healthy snakes to be hatched in captivity. Familiarize yourself with the natural habitat, breeding and nesting behaviors and needs of your species.

The egg producing species commonly kept in captivity are members of the pythonidae and the colubridae. All pythons lay eggs, as do most colubridae. The colubrid snakes include King snakes and Milk snakes *(Lampropeltis* species). Rat snakes and Corn snakes *(Elaphe* species). Rough Green snakes *(Opheodrys aestivus),* Western Hog Nosed snakes *(Heterodon nasicus)* and the Grass snake *(Natrix natrix)* are other examples of egg bearing colubrid snakes. Most of the colubrid species lay 15-20 eggs in a clutch. The Rough Green snake, however, lays just four, while the Corn snake *(Elophe guttata)* and Grass snake may lay up to 30. 15-30 is a typical clutch size for a python, with a few notable exceptions. The Royal or Ball python *(Python regius)* lays just four to eight eggs, while the Burmese python *(P. molurus)* might lay up to 50 eggs and the Reticulated python *(P. reticulatus)* might lay 60 and in rare instances. 100 eggs.

THE INCUBATOR

Incubators may be bane made or purchased commercially. The principles of a good reptile egg incubator apply equally.

- An incubator should be running for at least 48 hours before it holds eggs. This should allow you to be sure that temperature and humidity variations are within acceptable limits.
- The incubator must insulate the eggs against heat and humidity losses and significant ambient temperature fluctuations. A homemade incubator can consist of a plastic container, which holds the

eggs, placed inside an insulated box, such as a Styrofoam cooler. The incubator should be located in a room, which does not experience drastic temperature variations.

Reptile eggs should not be turned, and the incubator should be kept where it will not experience undue vibration or jarring. Be certain that the turning function can be disconnected in the case of a commercial chick incubator. If the incubator has a fan, it should be disconnected as it will lower the humidity within the incubator and likely dehydrate the eggs.

Some incubators have built in water baths. This allows f‹r even heat distribution and provides humidity. The same effect can be achieved in a homemade incubator by suspending an opaque plastic container, which holds the eggs, in a water bath in a Styrofoam box. In this case a submersible aquarium heater works well to heat the water. An alternative is to place a dish of water in the incubator, which will increase humidity through evaporation. A hygrometer to measure humidity is recommended.

Ventilation is crucial, particularly as the hatch date approaches and fetal oxygen demands rise. Sane holes ‹r vents should be present in the incubator to allow f‹r the escape of heat and carbon dioxide and f‹r the entry of oxygen. Opening the lid of the incubator briefly, every one to three days, depending on the number of eggs being incubated should allow adequate fresh air exchange, without cooling or drying the eggs excessively. Indeed, some minor fluctuations, within the incubation temperature range are likely beneficial, as they more closely mimic the natural situation. A window should be present to allow you to see the eggs without opening the incubator.

Temperature should be controlled by a thermostat, and at least two thermometers (not just the one which is sold with the incubator) should be clearly visible. Digital thermometers with remote sensing probes work well. A maximum-minimum thermometer is highly recommended. The temperature must be checked at the level of the eggs and heat should be spread uniformly throughout the incubator. The eggs must not sit on “hot spots” or next to a ventilation port. Commercial incubators are usually equipped with heating coils and thermostats. In the case of a homemade incubator, the heat source can be a heating coil or a submersible aquarium heater. It is not recommended that the incubator simply be placed on a heating pad, as this is a potential fire hazard and does not allow particularly fine temperature control.

The substrate in which the eggs rest can be potting soil, sphagnum moss, sand or vermiculite. It is best to use a substrate which you know has been used successfully, as it is possible to see detrimental effects on the egg should something in the chemical make up of the shell react with the substrate. The eggs should be nestled no more than half way in to the substrate. Changes in orientation during incubation should be avoided. That is, the side of the egg, which was uppermost when the egg was placed in the incubator, should remain so for the duration of incubation.

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Humidity affects the ease with which oxygen enters the egg through the shell and the rate at which carbon dioxide leaves it. For the incubation of snake eggs, the substrate should be moistened. Recommendations vary, but as a guide, a weight ratio of two-parts substrate to one-part water should work. The substrate must be damp, not dripping when squeezed. The moisture level must be checked regularly during incubation and water added as necessary. Sane authors suggest misting the eggs with tepid water or covering the eggs with sphagnum moss to increase humidity or to slow evaporation. Either technique may help if humidity is too low, but moistening the substrate interferes less with the egg itself: and so is preferable. A hygrometer to measure humidity is recommended. These can be purchased at many hardware stores. 90% humidity is recommended.

Humidity and temperature specifics are determined by the species being incubated. In the wild, natural fluctuations occur. In captivity, incubator temperature should be in the range of 28-32° C (82-88° F). Recommendations vary, but pythons appear to prefer the warmer end of the range, 30-32° C (85-88° F). There is evidence that at least some pythons drop by two degrees Celsius, the temperature at which they incubate their eggs, for the last two weeks. This has not proven necessary in artificial incubation, but it is worthwhile remembering that as the fetus grows, his oxygen requirements increase, but at higher temperatures gas exchange across the shell does not happen as easily. This is important if a large number of eggs are to be incubated, as they will have a greater demand for oxygen toward the end of incubation, and attention must be paid to ventilation. Given that the safety margin narrows when the eggs spend more time at the upper end of the range, a more moderate temperature and slightly slower growth rate are preferable. Colubrid snake eggs should hatch successfully if incubated from 28-30° C, with the occasional dip to 26° C or brief rise to 32° C. This is a diverse group of snakes, however, and knowledge of the natural history is important. Many of these snakes are from relatively cooler environments and 26-28° C (80-82° F) is more appropriate for some, such as the King snake. Temperatures above and below the range will increase the incidence of abnormalities and fetal deaths. Extended periods above 32° C are fatal.

THE EGG

Snake egg incubation times vary and are influenced by several factors. A few weeks after the hibernation or cooling period necessary for the successful reproduction of many oviparous species, a shed will occur, which in females is known as the “pre-ovulatory” shed. At this time the male is often paired with the female, and she should ovulate in the weeks after this shed. Copulation or mating occurs before ovulation, and in most species this happens several times over several weeks. Fertilization is the union of egg and sperm, not the act of mating. This means that the precise date of fertilization is not certain. In addition, snakes are able to store sperm, so fertilization may occur sometime after mating, and in the absence of male. Just as the time from mating to ovulation varies, so does the time from ovulation until oviposition, or laying.

Gravidity or pregnancy, that is the presence of eggs in the oviduct (the structure equivalent to a mammal's uterus) can be difficult to determine. The snake can be expected to swell in the mid to hind section of her body, but in the case of overweight animals, the swelling can be obscured by fat deposits. The snake may bask more. Her appetite may decrease. Her body position may change; she may lie on her side or may coil more loosely than normal. Close to the time she will lay, she may be more restless. Gravid snakes typically shed about two weeks before they lay. This is an important

date to note. The swellings of eggs may be visible in lean animals, because they may be palpated (felt by an experienced keeper or a reptile veterinarian), they may also be visible on a radiograph (X-ray). Take care when handling heavily gravid snakes, the follicles prior to ovulation as well as the eggs in the oviduct are fragile structures, and have been known to rupture. Once she begins, the snake should finish laying within 24 hours.

The developing snake embryo (early developmental stage) receives nutrition from the large yolk, to which it is attached by the umbilical cord. As the fetus (later developmental stage) develops, the yolk shrinks and sinks, so that the young snake will hatch on top of the egg. The shell contains calcium deposits, but in a lower concentration than that of a bird or tortoise egg — hence the more pliable, leathery feel of the snake egg. The shell, under the appropriate conditions of temperature, humidity and gas (oxygen and carbon dioxide) concentrations; permit the exchange of moisture and gas, while protecting the embryo. The three membranes inside the egg, which sustain the growing animal, are: the amnion, which surrounds the embryo and controls the immediate fluid environment; the chorion, which receives nitrogenous wastes; and the allantois, which eventually fuses with the chorion to form a gas exchange organ when the fetus is sufficiently developed. Formation of the air cell is m‹re variable than in the case of bird eggs. Generally, development is faster when temperatures are at the higher end of the range. Incubation at high temperatures is not necessarily desirable, however, as the safety margin will be narrowed, increasing the chances of abnormalities and making lethal temperatures more likely. The eggs should hatch in 45 to 70 days.

Typically colubrid snakes lay 8 to14 days after the pre-lay shed, and pythons lay 18 to 26 days after the shed. Offer the nest at the time of the pre-lay shed, to allow the snake time to become accustomed to something new in her environment. The health of the female and the environmental and husbandry conditions play a determinative role. Unlike the female bird, if conditions do not suit her, the female reptile will not lay her eggs. It is not unusual to see egg binding or other complications in otherwise healthy animals, which simply have not been provided an adequate site to lay. See related articles for information on housing and breeding snakes. For most snakes, an opaque container with an entrance hole on the top, half-filled with one of the moistened substrates discussed above will suffice. The ovipositorium (nest) should be placed within the temperature gradient of the cage, such that a thermometer at the level of the eggs reads 28-30 C (82-86° F).

To discourage the snake from laying in her water dish, replace a large dish with one in which she cannot fit to coil. Once she begins to lay, all eggs should be produced within 24 hours. If the eggs stick together, do not try to separate them. Remove the eggs to the incubator, trying not to rotate them. Reptile eggs lade the rope like structures called chalazae, which anchor the yolk of a bird egg. Turning the egg may cause the embryo to be crushed by the yolk. The membranes within the egg and surrounding the embryo and the blood vessels may also be more susceptible to the shearing forces, which result from egg turning once incubation has begun.

Most breeders will make a light pencil mark on top of the egg to assist in its orientation. This is also a way to identify each egg, for purposes of record keeping. The egg should be half-buried in the moistened substrate. If multiple clutches are being incubated, identify the plastic container holding the eggs. Place a thermometer at the level of the eggs.

If more than one species is to be incubated, they should be in individual incubators if possible. This will minimize the risk of disease transmission and allow for refinement of incubator parameters.

The eggs may take on a mottled or “chalky” appearance, but there should be no darkening or collapse of the shell, or fuzzy mould growth. Viable eggs are firm, slightly pliable, dry and white. The presence of mould indicates fetal death. A collapsing shell indicates dehydration. If this is seen, assess the moisture content of the substrate, adding m‹re water, as required. Consider also, whether or not the ventilation might be excessive, leading to dehydration.

After two to three weeks (earlier with experience) candling can be used to assess whether ‹r not the egg is fertile and alive. Candling involves holding the egg, with its orientation unchanged, over a bright light source, in a darkened room. It is helpful to focus light on the egg by holding the light source under a sheet of cardboard, for example, with a hole cut in it, which is slightly smaller than the egg. A dark area, representing the fetus and an organized web of blood vessels can sometimes be seen. Experience is required to become proficient at candling. Eggs develop, or in the case of infertile eggs, decompose in different ways, so it will not necessarily be obvious which are viable and which are not. In addition, reptile egg development rates are notoriously unpredictable, and handling the egg may well jeopardize its health. Unless performed by an experienced breeder, candling should not be undertaken more than once every three to four weeks. Candling is a fascinating learning process, but can be very uncertain and the risks must be weighed against the potential for harm, unless you are certain that the egg is non-viable (ie. it is hard, dry, and the yolk rattles), it will go back into the incubator, just in case.
If you are sure of egg death or non-viability, remove the egg in question, as it may become a source of bacterial contamination, infecting other eggs.

Sometimes snake eggs will stick together after they have been laid. Do not separate these eggs but monitor them especially closely at hatching, as the young snake may pip into the attached egg.
If a viable egg is attached to a non-viable egg, do not separate them. Check the eggs daily, several times daily when close to hatching. Most of the eggs in a given clutch will batch within 24-48 hours of one another.

The snake pips with his egg tooth (caruncle), which is located at the level of his nostrils and will be lost after hatching. Usually the snake will pip at the top of the egg, and be may stay in the egg for 48-72 hours after pipping, in order to absorb the remainder of his yolk sac.

There are no clear rules as to when to assist but a snake, which has not pipped within 48 hours of his clutch mates, should likely have his shell slit for him. This carries some risk and must be done with care. A snake that is too weak to pip will die without assistance, but slitting the shell may damage the hatchling or the membranes and yolk, which sustain him. One cannot be certain that the snake is simply not yet ready to emerge; as a guide, the last egg should pip within 48 hours of the first. Leave the snakes in the incubator until they have vacated their shells entirely. Newly hatched King snakes should be separated as soon as possible, as they can show cannibalistic behavior.

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RECORDS

The serious reptile breeder keeps extensive records, but even the casual hobbyist will learn a great deal and have more success and a greater understanding of his reptiles if he keeps records. The short-term value of records is not always clear, but in time will lead to a greater number of healthier pet snakes. See related articles for information on record keeping. The following are points specific to the breeding of oviparous snakes, which should be noted:

- Dates of emergence from dormancy, pre-ovulatory shed, introduction of male and female.
- Observed mating behavior or actual population.
- Date of pre-lay shed and introduction of nest.
- Date eggs are laid; number and quality of eggs (eg. thin, rough or unshelled eggs); any difficulty in laying.
- Mark the eggs and the container, such that you are able to identify which pair produced which eggs.
- Incubation parameters including temperature and humidity ranges and unusual events such as power cuts or earthquakes.
- Any infertile eggs, as well as any, which die during development. Note the date of death in shell, as accurately as you can. This information can form patterns, which may help you to refine your incubation techniques.

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DEATH-IN-SHELL

Causes:

- **Genetics or inbreeding**
- **Maternal health:** although females who are not receiving adequate nutrition may lay eggs, there will likely be a reduced fertility rate, more deaths in shell and decreased survivability after hatching. The developing fetus receives calcium from the eggshell and from the yolk, so a healthy calcium balance in the mother snake is important. Incorrect housing of the female and health concerns such as obesity are significant contributing factors to low hatch rates. Snakes who have had difficulty laying in the past are in general, more likely to have future difficulty.

- **Parental factors:** Older parents increase the likelihood of poor quality eggs and sperm. Snakes of the same species may have wild origins, which are sufficiently different that the combination of their genetics and incubation requirements leads to decreased hatchability. As far as possible, try to pair snakes of like geographical origin.

- **Premature assisted pipping:** Snakes removed from the shell too early often do not survive. If not absorbed, the yolk sac is an ideal medium for bacterial growth, which can quickly infect and kill the young snake.

- **Incubation problems:** Excessive fluctuations in temperature, prolonged hot or cool periods, excessive drying or wetting of the eggs and excessive vibration are the more common reasons a fertile egg will fail to hatch.

DIAGNOSTIC TESTING:

Records can often point to trends or unusual happenings, which may explain the death of the egg or of the hatchling. Although less is known about the reptilian egg, as compared to the avian egg, a reptile veterinarian may be able to rule in or out several possibilities by performing an egg post mortem. This must be done quickly, as the egg will undergo rapid autolysis, that is, it will decompose quickly once the embryo has died. A gross post mortem can be performed, together with histology, which examines tissues microscopically. Tissue from the egg can be cultured to identify possible bacterial disease.
Your reptile veterinarian can also provide an objective eye, which may be able to see a pattern in your records to explain losses.

PREVENTION:

Start with healthy, well-kept parents. Be as sure as possible that they are of similar geographic origin. Learn the species natural history and nesting conditions. Talk to experienced breeders and keepers. Record all data related to parental activity, eggs and incubation parameters.
Realize that assisted pipping may save the animal, but may also kill it. There are no hard and fast rules. Make use of your reptile veterinarian and of successful breeders of your reptile's species.