INCUBATION OF GRASS SNAKE *(NATRIX NATRIX HELVETICA)* EGGS

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Despite the often repeated account that Grass Snakes mate in April and May, lay their eggs in June or July in compost and dung heaps with hatching taking place 6-10 weeks later, a cursory look at the literature suggests that there remains a great deal to be discovered about the reproductive biology of the Grass Snake. Of particular interest to me is where do they "normally" lay their eggs and under what conditions will they successfully develop? Certainly there is extensive evidence that Grass Snakes do use artificial compost and dung heaps for egglaying, where microbial fermentation may produce an enormous amount of heat with temperatures rising to as much as 40-70° C. Stebbings (pers. Comm.) has observed that a population of Grass Snakes in Dorset migrated over considerable distances to lay their eggs in piles of saw-dust where he recorded temperatures of over 40° C. But where do they lay their eggs when man has not provided a convenient incubation chamber and what extremes of temperature can be tolerated? Perhaps they use natural compost heaps consisting of decaying vegetation at the bottom of a sunny bank, or even occasionally lay their eggs in open patches of sand to be warmed by the sun? Or are the eggs able to develop successfully at relatively cool temperatures, i.e. at ambient shade temperatures; certainly I known of areas with Grass Snake populations where there are no obvious artificial egglaying sites. If eggs are able to hatch successfully under the great thermal range likely to exist under the different situations outlined above, then this species will have developed a great flexibility not seen in many other snakes.

My own, rather limited observations on this subject were made this year when I divided a clutch of eggs and artificially incubated them at three different temperatures. A gravid female snake, approximately 1 m in length was found basking on an old pig-slurry heap on an Essex farm in June. I was informed that several snakes appear at the site at about the same time each year to lay their eggs, despite the fact that the piggery closed some 15 years earlier, which I assume results in the dung-heap no longer being "active". The snake was maintained in captivity for 13 days when it laid a total of 28 good eggs, after which it was fed twice on Common Frogs and released to the wild. The eggs were divided into three groups and placed on vermiculite in small plastic containers, relative humidity approximately 90%. The main group of 17 eggs was maintained at 27-28°C and a smaller group of 4 eggs at 34-35°C in laboratory incubators (Gallenkamp), while a further group of 7 were placed in an unheated room with naturally fluctuating temperature; maximum and minimum temperatures were recorded on a weekly basis. Incubation period and hatching success rate are illustrated in the Table.

Of course we have to be careful about drawing conclusions from only one clutch of eggs. However, the results clearly show that a constant temperature of 27-28°C (which is the temperature at which I usually incubate temperate colubrid eggs) produced a very good hatch rate of 94%, with only one egg failing to hatch. In the group of 4 eggs maintained at 34-35°C, three failed to hatch and when examined were found to have "corkscrew" tails, a deformity associated with high incubation temperatures in other species; this result indicates that 34-35°C is on the limit of their tolerance. The hatch rate in the final group (fluctuating temperature, range 17-30°C) was equally poor (29%); in this situation the eggs were protected from the extremes of temperatures which might be experienced outside if not laid in a heat-generating (i.e. compost heap) site, but more akin to ambient temperatures. There was a noticeable growth of mould on all the eggs in this group during the latter part of the incubation period, but based on experience with other species I do not think this would have affected their viability. This low hatch rate, therefore, is somewhat surprising, although the very small sample size must be considered. Finally, there was an obvious size difference in babies between each of the three groups, with those from the 34-35°C group being quite small, those from the 27-28°C group "medium" size, and those from the fluctuating temperature group the largest.

No. eggs	Incubation temperature	Incubation period	No. hatched (%)	Comments
17	27-28°C	42 days	16 (94)	All hatched babies perfect. One apparently normal baby dead in shell
4	34-35°C	31 days	1 (25)	Hatched baby perfect. Remaining 3 babies dead in shell with "cork-screw" tails.
7	17-30°C Weekly Max. Min 26 24 25 21 30 22 25 21 27 19 24 20 24 17 24 17	62-63 days	2 (29)	Hatched babies perfect. One egg died after 17 days and removed. Remaining eggs contained apparently normal babies dead in shell. All eggs covered in a light mould.

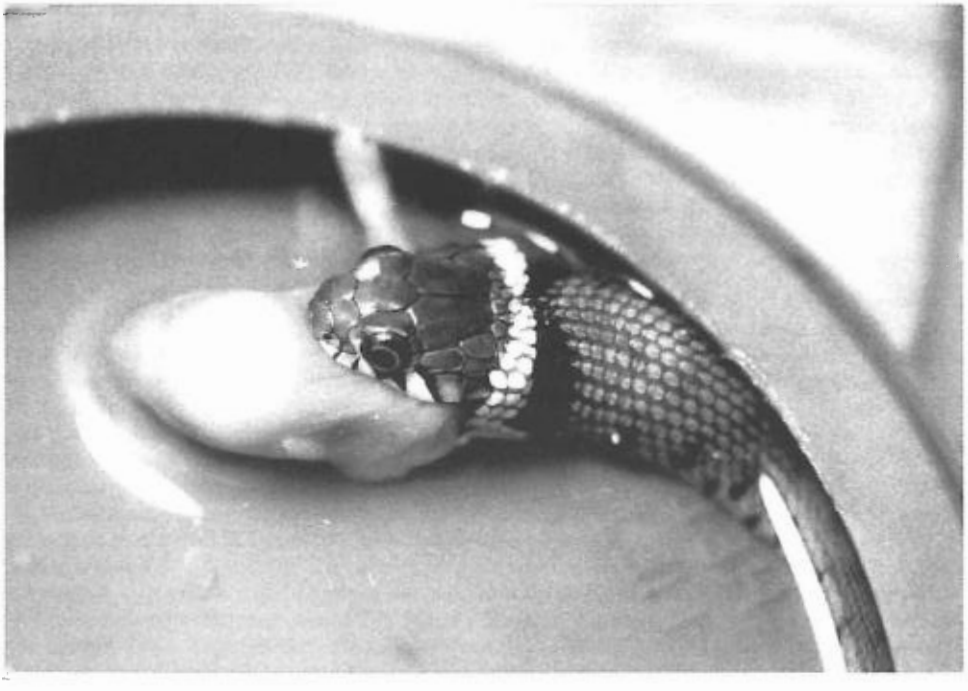

Plate 1. Baby Grass Snake feeding on a pre-killed newborn mouse

All the baby snakes fed voraciously on Common Frog tadpoles placed in approximately 0.5 cm of water in a shallow dish. Thankfully, my somewhat overcrowded garden pond produced a good supply of tadpoles until late September when all but 2 of the babies were released into the wild – a site chosen for its abundance of toadlets, solitude and plenty of cover for hibernation. The remaining two babies are being reared overwinter in a 30 x 15 cm plastic box with a thermal gradient of approximately 24-32°C in the daytime and a nightime temperature between 17 and 22°C. Both are growing rapidly; with the final disappearance of tadpoles in my pond, the two snakes have readily adapted to feeding on pieces of frozen/thawed Plaice, Trout and smoked Salmon which are simply placed in the water dish, with calcium and vitamin supplements ("Reptilin"; Sera) added to each feed. More recently they have been offered live baby mice which were refused. However, dead baby mice placed in the water dish which had been 'scented' with fish were readily taken (Plate 1). While it is well known that although the main diet of adult Grass Snakes consists of amphibians, they may also feed on fish, small birds and mammals. Indeed, I know of a snake which when picked up, promptly regurgitated a bird's wing – presumably the remains of some other predator's kill. However, little is known about the diet of baby Grass Snakes apart from the fact that they will readily accept amphibians. In captivity, I suspect they can be persuaded to eat all kinds of things they would not normally take, particularly if the new food item is 'scented' with acceptable food and the snakes are habituated to a feeding routine. In the excitement at a recent feeding session when Plaice was offered, one of the babies attempted to eat the other and had swallowed more than half if it from the rear end when discovered. However, it is not clear to what extent they prey on other animals such as fish, baby mammals or invertebrates in the wild. According to Malcolm Smith, "the young are often said to eat worms, slugs and insects", but I do not know of any direct observations of this.

It may be assumed that the use of compost/dung heaps as egg incubators is generally an advantage to this species in that its range can be extended further north into cooler climes than would otherwise be possible. But this habit may well have its disadvantages. For example, over the past three years we have had warmer and drier summers than usual. This relatively small increase or fluctuation in high summer temperatures is likely to cause more dramatic effects within the compost heap, with possible deleterious effects for developing eggs. My results indicate that a constant temperature of 34-35°C may cause deformities and death. While compost heap temperatures are likely to be fluctuating rather than constant, it is known that temperatures within compost heaps may far exceed 35°C. Certainly the lower temperatures did not produce a good result with my eggs. Perhaps in cool summers many of the eggs laid outside of suitable heat-generating sites fail to hatch? Malcolm Smith refers to the work of Rollinat in France who reported eggs found in a hole in the earth on the 14th of November which contained living young on the point of hatching, and that "following a cold summer it is not rare to find batches of eggs in the Autumn, in which the young are dead, having been killed by the cold". He also quotes from a letter of Gilbert White, "snakes lay chains of eggs in my melon-beds...which do not hatch out until the following Spring, as I have often experienced". The possibility that partially developed embryos may be able to hibernate within the egg is of considerable interest and deserves further investigation.

In conclusion, it seems there has been very little systematic research on the Grass Snake in the U.K. either in the field or laboratory, apart from the excellent but unpublished work of Stebbings carried out in Dorset some 20 years ago. Many of the points I have raised in this article have no doubt been studied elsewhere, perhaps in mainland Europe? Nevertheless, I hope other members will be stimulated to contribute articles or letters on Grass Snakes to the *Bulletin*.