Reproduction of Schneider´s Skink, *Novoeumeces schneideri aldrovandii* (Duméril & Bibron, 1839)

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INTRODUCTION

After the Blue-tongued skinks (*Tiliqua* spp.), Schneider´s skink is probably one of the better-known species of skink in terrarium circles. Many people, however, will know this species under a different name. In much of the older, but also in some of the more recent, literature this species is referred to as Algerian skink, *Eumeces schneideri algeriensis* or *Eumeces algeriensis.* In fact, these three names refer to the true Algerian skink, which is clearly a different species. Both species (Schneider´s skink and Algerian skink) can be distinguished based on some easily observed characteristics such as coloration and posture. Adult Schneider´s skinks can grow to approximately 40 cm, but usually remain slightly smaller.

Novoeumeces schneideri aldrovandii basking.

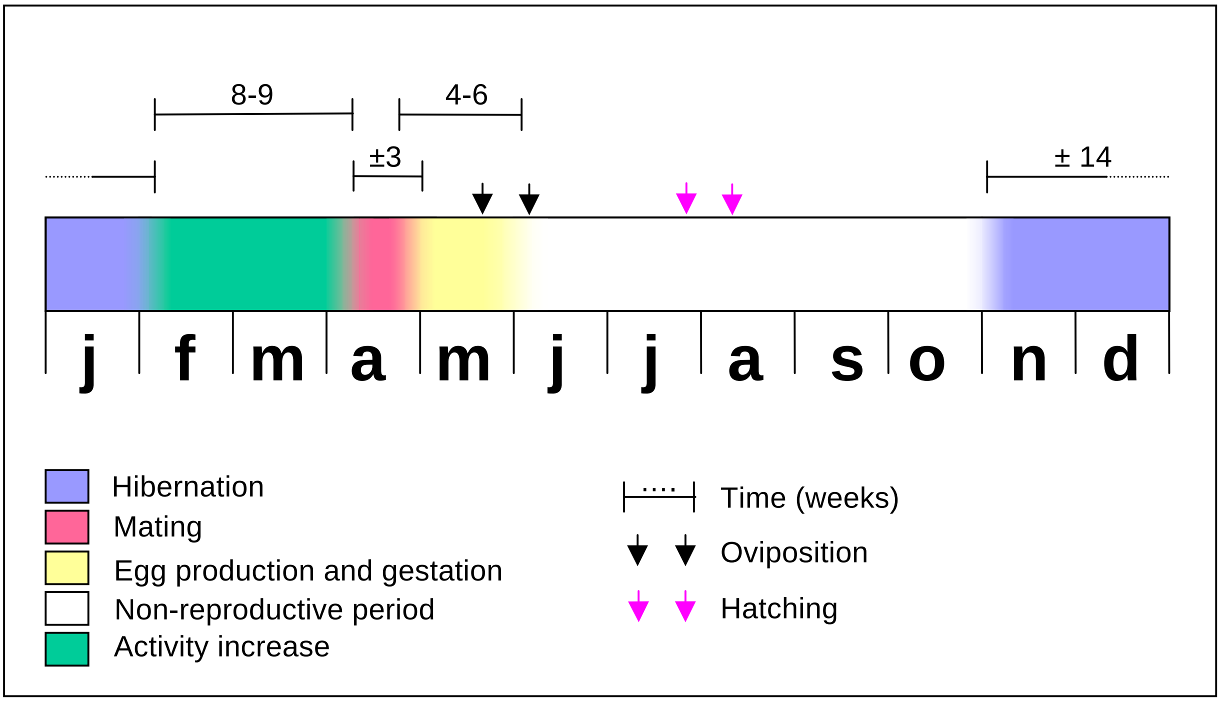
Photo: R. Struijk

The correct name for Schneider´s skink used to be *Eumeces schneideri*. Recently, however, Schneider´s skink and several other Old World species of *Eumeces* were placed in the genus *Novoeumeces* (GRIFFITH et al., 2000). Although six subspecies of Schneider´s skink have been described (e.g. HAUSCHILD & GAßNER, 1995), all individuals in the West European trade originate from Egypt, as far as I can tell, and probably all belong to the same subspecies. ATTUM (2001) also reports that the Egyptian trade in animals has greatly increased in the last few years and that a number of species (including Schneider´s skink) have been taken from the wild and exported abroad, primarily to the United States.
Based on their origin, it is suspected that the animals in the pet trade are of the subspecies

Novoeumeces schneideri aldrovandii. This is not completely sure because the systematics of the various subspecies is not completely clear nor have their distributions been mapped in any detail.
Although this species has been readily available in the pet trade for quite some time, the captive breeding of this species has not been very successful save for a few exceptions. In the year 2000, the author managed to breed one juvenile. Since the majority of the papers dealing with captive propagation of *N. s. aldrovandii* deal with failed attempts (e.g. BOGAERTS, 1996; HOLFERT, 1995; WEGNER, 2001), it seems useful to compile the currently available information and present it in a clear fashion. In this review I will also incorporate my own experiences and data. Hopefully it will contribute to an increased success rate in future captive breeding attempts.

CAPTIVE BREEDING

In order to breed *N. s. aldrovandii* a hibernation period is recommended. It is possible that the animals retreat by themselves at some point since occasionally they are less active and consume less (or no) food. This period of inactivity lasts in my terrariums for approximately three months at temperatures of 10-16°C. It starts around early November and lasts until approximately the beginning of February. ROGNER (1994) indicates an inactivity period of more than four months (late October-early March), but he does not indicate to which subspecies this applies. The duration of the inactivity period may differ for the other subspecies. For example, HAUSCHILD & GAßNER (1995) recommend a period of two months for *N. s. princeps* and also report that two of their animals died three months into a hibernation period. Unfortunately, they do not mention any temperatures, but possibly individuals of the subspecies *N. s. aldrovandii* are better able to withstand a longer period of inactivity. It even proved to be possible to leave these animals at temperatures of 5-10°C for five months (Bogaerts, pers. comm.). Such a long hibernation period may lead to increased risks and a time frame of approximately three months is my preference. It is assumed that a period of hibernation or inactivity synchronises the reproductive cycle of both sexes and that it increases the number of fertilised eggs as compared to years when no hibernation takes place (Stockwell, pers. comm.).



Approximate annual cycle of *Novoeumeces schneideri aldrovandii* in the terrarium.

Diagram: R. Struijk

During the first weeks of April (approximately nine weeks after the end of the hibernation) the mating season starts. It lasts for about three weeks. The male will repeatedly mate with the female during this period. If multiple females are present it may still be possible that the male only mates with one single female. In order to stimulate fertilisation of the other females, it may be smart to (temporarily) remove the already fertilised female. The actual copulation lasts only 3-6 minutes, according to WEGNER (2001), approximately seven minutes in BOGAERTS' (1996) animals and 8-9.5 minutes in HONKARINTA's (1999) animals.

Copulation of *Novoeumeces schneideri aldrovandii*.

Photo: R. Struijk

The duration of the gestation in *N. s. aldrovandii*, when counting from the end of the mating season, is approximately 5-6 weeks. However, ROGNER (1994) reports a gestation of 5-6 weeks from the first mating. Determining the exact length of the gestation period, based on sight alone, is virtually impossible since it is often hard to determine when the first successful copulation took place. It is possible that a gravid female will not eat much during this period and will use up her fat reserves. Therefore it is important to supply the female before and after hibernating with high quality nutrition (generously supplemented with vitamins and calcium). Products like Carmix, Sporavit, but also boiled eggshells can be used for this purpose.
A few days before oviposition the female may stop eating. It is recommended to isolate the female at this time by removing all other animals from the terrarium. It is also wise to supply the female with at least one oviposition box, filled with slightly moist sand. One can

Novoeumeces schneideri aldrovandii almost invariably lays its eggs on top of the substrate and does not bury them. This female chose a burrow she excavated under a rock for oviposition.

Photo: R. Stockwell

never be sure whether the female will actually use this box. On one occasion, one of the author's animals laid three eggs in one such box, whereas a second female deposited four eggs under a flat rock. Stockwell (pers. comm.) reports that his animals usually oviposit in a cavity under a rock, which they excavate themselves. Another clutch, consisting of a single egg, was placed on top of the substrate (sand) (Tuomola, pers. comm.). The fact that the eggs are sometimes not buried but placed on top of the substrate is noteworthy and often reported (BOGAERTS, 1996; Struijk, pers. obs.; WEGNER, 2001). The number of eggs produced varies from one to five. Reports on clutches of 20 eggs (ROGNER, 1994) appear highly unlikely based on observations in captivity. Table I presents an overview of the clutch and egg related data known from various authors.

Generally a single clutch is produced per year. Although very rare, two clutches per year are not impossible (Stockwell, pers. comm.). Directly or shortly after oviposition it is possible to tell whether the eggs are fertilised by checking for the presence or absence of a germinal disc. This feature can be seen by shining a light through the egg. According to some authors the females show parental care (BECH & KADEN, 1990). In all documented cases of captive propagation the eggs were incubated artificially in or on top of moist vermiculite or sand at temperatures between 27-30°C.

If everything goes well the eggs will hatch after approximately 47 to 57 days, depending on the incubation temperature (29-30°C and 27-30°C respectively). With Honkarinta's animals (pers. comm.) a single clutch hatched after 70 days. I think it is doubtful that these eggs were incubated under exactly the same conditions as previous clutches. The relative difference between the duration of this incubation and that of the other clutches is 23%, which seems a very large difference to me. The time between the hatching of the first egg of the clutch and the last one is four days at the most (HONKARINTA, 1999). At the moment of hatching, the juveniles have a total length of 12 to 14.5 cm and weigh approximately seven grams.

Table I: Collected data on egg clutches of *Novoeumeces schneideri aldrovandii* (BOGAERTS, 1995; HOLFERT, 1995; HONKARINTA, 1999; Van Lienden, pers. comm.; Struijk, pers. obs.; Tuomola, pers. comm.; WEGNER, 2001).

Author/Source	Oviposition date	Number of eggs	Average size (mm)
Bogaerts	30-05-1995	2	-
Holfert	??-05-1991	5	-
	28-05-1992	4	-
	22-05-1993	4	-
Honkarinta	06-06-1999	5	33.0 x 15.0
Van Lienden	01-07-1996 [I]	2	-
	22-07-1996 [II]	1	-
	17-06-1997 [I]	2	-
	25-07-1997 [II]	3	-
	10-07-1999 [I]	3	-
	15-07-1999 [II]	3	-
Struijk	04-06-2000	3	37.5 x 17.0 *
	12-05-2001	4	-
Tuomola	21-05-2002	1 **	30.0 x 15.0
	03-05-2003 [I]	3	41.3 x 19.3
	09-06-2003 [II]	4	-
Wegner	-	4	-

* Average size of two eggs, measured after collapsing
** First clutch of this specific female
[I] refers to female 1
[II] refers to female 2

These *Novoeumeces schneideri aldrovandii* eggs were (barely) interred and incubated on top of the substrate (sand).

Photo: R. Stockwell

Table II: Results of incubation of *N. schneideri aldrovandii* eggs at different breeders

Breeder (year)	Number of eggs	Percentage fertilised	Incubation temperature (°C)	Duration of incubation (days)	Remarks
Bogaerts (1995)	2	50 *	27-28	-	fertilised egg contained dead, almost fully developed embryo
Holfert (1991)	5	100	28	-	embryos died
Holfert (1992)	4	100	28 (16-34)	-	3 eggs did not develop, 1 egg contained a dead, almost fully developed embryo
Holfert (1993)	4	100	29.5	-	development started, but embryos died prematurely
Honkarinta (1999)	5	80	27-30	55-57	1 egg with dead, fully developed embryo, 3 eggs hatched
Lienden, van (1996)	2 I 1 II	- -	28-30 28-30	- -	both clutches probably not fertilised
Lienden, van (1997)	2 I	100	28-30	±48	one egg contained dead, fully developed embryo. Second egg hatched I
	3 II	0	28-30	-	eggs collapsed after a few days II
Lienden, van (1999)	3 I	100	28-30	±48	two eggs contained dead, fully developed embryos, third egg hatched I
	3 II	-	28-30	-	one egg eaten by parents, two eggs collapsed after several weeks II
Struijk (2000)	3	33,3	30	47	juvenile appeared healthy but died after ten days
Struijk (2001)	4	25	30	-	all eggs collapsed
Tuomola (2002)	1 I	0	-	-	-
Tuomola (2003)	3 I	100	28-30	47-50	all eggs hatched
	4 II	25	28-30	-	3 eggs developed fungus after one day, fourth egg still developing
Wegner (2001)	4	100	27	-	1 egg did not develop, 3 eggs contained dead embryos

*The (infertile) second egg was eaten
I refers to female 1
II refers to female 2

PROBLEMS WITH THE JUVENILES

In my collection and in Van Lienden's, one and two juveniles hatched, respectively. None of these three juveniles stayed alive for more than two weeks. Van Lienden reported the hatching of one juvenile with a relatively large yolk sac (1997), which died four days later. His second hatchling was active and looked fine; it died seven days after hatching without ever having eaten (Van Lienden, pers. comm.). The juvenile that hatched in my collection in 2000 did accept food after four days (little slugs and cut-up moth larvae). However, it died after ten days. HONKARINTA'S (1999) hatchlings also started accepting food from the fourth day on (both live and dead), but he never experienced any problems rearing the juveniles. A similar situation was seen with Stockwell (pers. comm.) and Tuomola, neither of who experienced any problems rearing their young. Tuomola's juveniles accepted mealworms, crickets, canned dog food and apple (Tuomola, pers. comm.). The latter breeder housed the young individually in plastic boxes with a thin layer of sand, bark and some dry leaves. The lizards were fed every other day and sprayed with water every night. The temperature was around 30°C.

AGGRESSION

Aggression is generally something one would sooner expect between individual males than between females. In *N. s. aldrovandii,* aggression between females is also very possible. In my collection two newly introduced females were not accepted by one of the two already present females. Both new females lost part of their tail in the ongoing aggressive behaviour and one actually had a foot bitten off. The female that had been the companion of this aggressive lady was invariably left in peace. It should be noted that females do tolerate each other when they are all placed in the terrarium at the same time. Stockwell (pers. comm.) also observed this intolerance of one female towards another. Keeping two males together is not recommended but does not necessarily lead to significant aggression (Bruins, pers. comm.).

DISCUSSION

Incubation methods

Three important aspects of the incubation of reptile eggs are temperature, gas exchange and humidity. The temperature range for the incubation of *N. s. aldrovandii* eggs appears to be between 27-30°C. At this temperature several eggs have hatched, although occasionally fertilised eggs did not hatch. Considering that several fully developed dead embryos were found in the eggs, something must have gone awry near the end of the incubation. One possibility is that the hatchling may not have been able to leave the egg because some factor, such as drought, has somehow changed the structure of the eggshell. Such a structural change may also negatively affect gas exchange. The egg absorbs gas (oxygen) from its environment and exudes other gasses (like carbon dioxide). When the size of the embryo increases, its gas exchange rate increases as well and all kinds of physiological changes take place. If this increase in gas exchange rate is not possible, the embryo may die. This could also be a reason why the young died in an advanced developmental stage. In any case, further research is desired.
Another interesting point is the fact that the eggs are almost invariably deposited on top of the substrate and are not covered. This is probably no coincidence as it causes a strongly reduced area of contact with the substrate as opposed to eggs that are interred. The result is that the gas exchange can be very high. In addition, this strategy has its effects on the fluid balance. In regulating the fluid balance, two major factors play a role: relative humidity and water potential. The relative humidity (%) is the percentage of the maximum amount of water vapour that the air can absorb at a certain temperature. The term water potential refers to the degree of saturation of a substrate (kPa (kiloPascal)). In a completely

saturated substrate, the water potential is 0 kPa. When compared with a much drier substrate (e.g. -100 kPa) there exists a considerable difference in water potential. However, the relative atmospheric humidity that occurs at both of these two water potentials barely differs (IN DEN BOSCH, 1996). When eggs are interred, the water potential is therefore the better measure for the moisture level of the surroundings in which the eggs are incubated. However, when the eggs are incubated on top of the substrate, the relative humidity is more important. Stockwell (pers. comm.) currently incubates his eggs on top of moist sand and has been successful. On the other hand, HONKARINTA (1999) and Tuomola (pers. comm.) have incubated their eggs successfully about halfway interred into moist vermiculite. None of these breeders have taken any measurements of the water potential or relative humidity. Research into the preferred incubation conditions for Schneider´s skink is therefore still needed.

The intensity of the orange colour is considerably less in the juveniles than in the adult: here a mother and her young.

Photo: R. Struijk

Parental care

It is not clear whether Schneider´s skinks show parental care or not, although this has been suggested occasionally. As far as *N. s. aldrovandii* is concerned, no publications have referred to parental care in this subspecies. BOGAERTS (1996) mentions that the female remained with her eggs during the first night, but stayed away the next one. HOLFERT (1995) also indicates that his female did not display any parental care. I could not determine whether this behaviour was present in my animals. I did notice that after lifting a rock under which eggs were deposited, the female almost instantly covered them with sand. Whether or not this behaviour classifies as parental care, however, I cannot say. HOLFERT (1995) reports at the end of his article that the possible cause of his failed incubation attempts was due to a lack of parental care in the female. Female Schneider's skinks appear to not only guard the eggs but also regulate their water balance by burying them deeper and create the proper humidity by urinating on the eggs (BECH & KADEN, 1990). In addition, HOLFERT (1995) reports that some people are of the opinion that the female’s urine contains certain substances that are important for the development of the eggs. I am not aware of any research that sheds a light on this issue. Stockwell (pers. comm.) observed one incident that may completely oppose the parental care theory. He determined that both the mother as well as other adults in the group might eat the eggs. Whether these eggs were fertilised or not fertilised, and therefore consumed by the lizards (it might make sense to eat the unfertilised eggs), is not known.

Both male and female *Novoeumeces schneideri aldrovandii* are capable of eating the eggs of their own species; here, a female devours one of her own eggs.

Photo: R. Stockwell

Health of the parents

Possibly the health of the parents was not optimal and therefore caused the eggs to not develop completely. Possible reasons could be an incomplete diet, deficiency in certain vitamins, minerals and/or trace elements or a lack or shortage of UV-light (and concomitantly vitamin D_3), resulting in no or insufficient calcium absorption. The latter factor may play a critical role since it is often assumed that calcium deficiency plays a substantial role in premature death of the embryo during late stages of development (in den Bosch, pers. comm.). It is very possible that the answer to the failed incubation attempts of several breeders can be found in this particular deficiency. Also, since the only three successful breeders of *N. s. aldrovandii* I know, use two different incubation methods. But all three breeders do use UV-light in their vivariums; this may explain their success. For example, in *Uromastyx maliensis* (which occurs in a comparable habitat but has an entirely different life history and diet) this can also be an extremely important factor in a successful captive breeding attempt (HOFSTRA, 2001).
Apart from the use of UV-light, a more accurate dosage of calcium and vitamin supplements, a change of dietary supplements and/or a more or less natural diet may help increase the quality of the eggs. However, the author does not know what would constitute the natural diet of *N. s. aldrovandii*. It is interesting to note that in the author’s and in Van Lienden’s collections, eggs hatched but the young died within two weeks. Possibly these juveniles were too weak and unhealthy because of a nutritional deficiency in the parents or perhaps because they themselves did not receive any UV-light.

SUMMARY

Breeding Schneider´s skink is possible but has so far not been very successful. Obtaining eggs (1-5) seems very possible with simulated seasons, but the main problem seems to lie with the incubation of the eggs. Several times the eggs appeared to be fertile and commenced development, but the embryos died in a fairly late developmental stage. What causes this die-off is still unclear. However, on more than one occasion a calcium

deficiency has been suggested as a probable cause for the premature death of the embryos. It is expected that this can play a crucial role in the reproduction of Schneider´s skinks. In order to attain sufficient calcium absorption, increased UV-light (or vitamin D_3-supplements) may be a solution. The breeders who manage to rear their offspring problem free use UV-lights. This theory is substantiated even more by the fact that each breeder uses a different method of incubation. Other authors who report failed breeding attempts did not mention supplying their animals with additional UV-light. A suitable temperature range appears to be between 28-30°C. Which moisture level is most appropriate (both relative humidity and water potential) is still unclear. It also remains unclear which requirements the eggs have in terms of the intensity of the gas exchange. However, it is striking that the eggs are almost invariably deposited on top of the substrate. All these individual factors could also have a combined effect. Therefore it seems desirable that additional research takes place, carefully documenting as many aspects of development and reproduction as possible.

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