

KRABBE-PAULDURO, U. & PAULDURO E. jr. (1988): Pflege und Nachzucht der Afrikanischen Dornschwanzagame *Uromastyx acanthinurus* BELL, 1825. Salamandra 24 (1): 27-40

Salamandra 24, Pages 27--40

Care and breeding of the North African Spiny-tailed Lizard *Uromastyx acanthinurus* BELL, 1825 (Sauria: Agamidae)

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With 5 illustrations

Bonn, 15. 4. 1988

Abstract

Keeping conditions and reproduction of *Uromastyx acanthinurus* are described. Mating took place in March; nine fertilized eggs were laid in May. After 122 days (incubation temperature 23.1-33.1 °C) the first of five young hatched 75 mm long, weight 6-7 g. The difficulties during the hatching process are discussed. Key words: Sauria; Agamidae; *Uromastyx acanthinurus*; keeping; reproduction in captivity; difficulties during embryonic development.

1. Introduction

Successful breeding of the North African Spiny-tailed Lizard is hardly documented in literature. To our knowledge, only two reports (GRIMM 1982, 1986) have become known about the successful reproduction of this popular lizard species. Since these two reports are basically very informative, but contain only a few data on the breeding of *Uromastyx acanthinurus*, we would like to expand the knowledge of reproductive biology with this article, but above all describe the problems of breeding. The four North African Spiny-tailed Lizards acquired in November 1980 are a male, two females and a smaller, very shy animal, whose sex we could not determine based on external characteristics (Table 1).

1. Keeping in the terrarium

The terrarium in which the four *Uromastyx acanthinurus* are cared for has the dimensions 150 x 80 x 40 cm (LBH). The equipment consists of a 10 cm high soil layer of medium grain river sand. Serving as hiding places and sleeping places a hollow stone and a stone structure (limestone) assembled by plaster with three sleeping caves. All living caves reach 10 cm deep into the ground. The substrate in the living caves is regularly slightly moistened. The lighting of the terrarium consists of four fluorescent lamps (2 Philips TL-D 36W/84, 1 True-Lite Power-twist 40 W, 1 Philips UV-A fluorescent lamp TL 40W /09), which are mounted directly above the terrarium. The heat source is a 60 W spotlight, which is installed about 15 cm above a stone intended as a sunbathing spot. The lighting duration varies from 13 h in summer to 8 h in winter, with the fluorescent lamps controlled by a timer. The spotlight is operated via a self-developed, daylight-dependent dimmer circuit. Temperatures range from 25 to 35 °C during the day; directly in the radiant center of the spotlight, up to 55 °C are reached on hot summer days. The North African Spiny-tailed Lizard then only visit this area for a short time to warm up. At night, the temperature drops to values of 18 to 20 °C. It is striking that the North African Spiny-tailed Lizards are probably less attached to the temperature and light intensity rather than air pressure. We assume this because the *U. acanthinurus* often remain in their

sleeping burrows on so-called bad weather days, although both the lighting and the heating of the terrarium are in operation. In relation to the outdoor situation, this hypothesis seems to make sense insofar as the dwellings of the North African Spiny-tailed Lizards, long and deep tunnels (e.g. OBST et al. 1984), have a relatively uniform microclimate. Therefore, periods of good and bad weather are probably recognized by other influences. Every year, during the months of November and December, a hibernation period of about two months is carried out at room temperature (about 18 °C) and with the lights switched off. Problems never occurred. Before hibernation, the North African Spiny-tailed Lizards are not fed for four to six weeks to ensure complete emptying of the intestinal tract until the onset of the resting period. In preparation for the winter rest, first the heating is gradually reduced over a period of two weeks, then the lighting. At the end of the rest period, the fluorescent lamps and the spotlight are switched on over the same period, but in reverse order. It has been shown that individual North African Spiny-tailed Lizards remain in their shelters even in January, and even more rarely in February. Nevertheless, we have not extended the hibernation. For a balanced diet, a range of foods is offered that is as varied as possible. For example, the North African Spiny-tailed Lizards receive chicory, endive lettuce, lamb's lettuce, radicchio, radish leaves, romaine lettuce, lamb's lettuce and aromatic herbs such as borage (*Borago officinalis*), dill (*Anethum graveolens*), chervil (*Anthriscus cerefolium*), lovage (*Levisticum officinale*), parsley (*Petroselinum crispum*), rosemary (*Rosmarinus officinalis*), sage (*Salvia officinalis*), sorrel (*Rumex acetosa*) and lemon balm (*Melissa officinalis*). Apple pieces, daisies (*Bellis perennis*), coltsfoot (*Tussilago farfara*), dandelions (*Taraxacum officinale*) and chickweed are also popular (*Stellaria media*), with the yellow flowers of coltsfoot and dandelion being particularly popular. The *U. acanthinurus* animal food includes crickets (*Acheta domestica*), two-spotted crickets (*Gryllus bimaculatus*), larvae of the greater wax moth (*Galleria mellonella*) and Egyptian migratory locusts (*Locusta migratoria*). During her pregnancy, the female ate larvae of the flour beetle (*Tenebrio molitor*) for the first time. Occasionally, the male took nest-young mice. All food animals are dusted with a lime/mineral mixture (Osspulvit) before feeding. A mixture of different grains (brown and red lentils, hemp, corn, mung beans and peas) rounds off the food palette. Sepia shell broken into small pieces is regularly served. It should be noted that each animal has its own special favourite food in addition to the basic food offered. We would like to point out at this point that after the reactor accident in Chernobyl in the spring of 1986 we did not feed any plant-based outdoor food. During this time, the North African Spiny-tailed Lizards received sprouts of mung beans (*Phaseolus aureus*), alfalfa (*Medicago sativa*), lentils (*Lens esculenta*), wheat (*Triticum aestivum durum*) and sunflowers (*Helianthus annuus*), germinated in a commercially available germinator. The drinking water, which is regularly ingested in small quantities from a small water vessel with chewing mouth movements, contains an addition of calcium lactate (1/2 teaspoon/! water) and vitamin D3 (2 tablets of Vigantol 10,000 of 10,000 IU/1 water). The drinking water is renewed every third day.

3. Reproduction

3.1 Behavior during the reproductive season

After hibernation in November and December 1985, the *U. acanthinurus* began their full activity over the course of about four weeks. After all specimens regularly reappeared from their hiding places in the morning to warm up in the cone of light of the spotlight, feeding began.

In the months of February and March 1986, both the male and the two females showed for the first time an increased activity compared to previous years, which manifested itself in the fact that the

two females literally fought each other. This sometimes resulted in violent bites in the flanks and tails. At first, the disputes, accompanied by loud hissing, were kept within acceptable limits, as the agamas were always in the various hiding places and peace returned immediately when the visual contact was interrupted. The increased activity of the male manifested itself in intermittent, rhythmic movements up and down of the front body and in a sequence of movements described by GRIMM (1982) as a gyroscopic dance, primarily on the stone serving as a place in the sun. We were able to determine that these activities occurred preferably in the presence of the beige-colored female. In the afternoon of March 28, we were able to observe a mating between the male and the beige female for the first time. The male bit himself on the side of the neck of the female and pushed his tail under that of the female in such a way that both cloaca could be pressed together. The copulation lasted about 2 minutes. Shortly after the two North African Spiny-tailed Lizards had separated, the male withdrew the protruding hemipenis. Unfortunately, this was the only opportunity to observe copulation, as we were traveling for 10 days in the evening of the same day. It is possible that the animals had mated several times during this time, as the neck of the beige female was so badly bitten on both sides that parts of the skin were missing. Since the two females bit each other's tails bloody in the following time, we separated the pair from the other conspecifics. For this purpose, an opaque partition wall was installed in the middle of the terrarium. We treated the bloody wounds with Kanamytrex, whereupon the injured areas healed well. From the time of the separation, there was silence. The beige-colored female took in noticeably more food in the following time, which we now enriched with vitamins (Multimulsin) and minerals (Osspulvit). Now it showed a pronounced preference for animal food: Egyptian migratory locusts, crickets, Mediterranean crickets and larvae of the flour beetle. Since well-fed specimens of *U. acanthinurus* always appear a bit chubby, the assessment of pregnancy was difficult. Shortly before egg laying, eggs were palpable in the female's abdomen, but any bulges on the body were not visible. In contrast to other reptile or lizard species, the pregnant female ate until shortly before laying eggs.

3.2 Egg-laying

From May 3, the pregnant female became very restless. Excitedly, it ran around the terrarium, constantly scratching, trying to dig up the ground in various places. Since it was looking for a suitable egg-laying site, two obviously preferred sites were moderately moistened. During the entire time, we left the male in the terrarium, as the female did not feel disturbed by the presence of the male. Under the hollow stone serving as a shelter, the egg-laying took place on the morning of May 6th, which we did not observe. At noon we found the female with a heavily sunken body and completely exhausted. Both the stone and the entrance to the shelter were covered with sand. The now no longer visible opening of the shelter was further worked by the female, first pressing the damp crumbly sand with her front body and then compacting it with rapid forward and backward movements of the head; It continued to exhibit this behavior for another 14 days even after removing the eggs from the laying trough.

Fig. 1. Egg clutch of *Uromastyx acanthinurus*.

That same evening, we put the eggs in an incubator that had been prepared in the meantime. The clutch consisted of nine unglued eggs, which were on average 3.6 cm long (Fig. 1). Some of the eggs had already sunk in slightly, as the substrate had become a little drier because of the high temperature prevailing in the terrarium. It should be mentioned here that up to this point we had no experience with the incubation of lizard eggs. We had already produced eggs of various snake species (*Elaphe guttata*, *Eirenis modestus*, *Opheodrys aestivus*), but as far as lizard offspring were concerned, we had so far only had experience with the breeding of viviparous species such as *Cordylus warreni depressus* (KRABBE-P AULDURO & P AULDURO 1986) and *C. jonesii* (KRABBE-PAULDURO & PAULDURO in previousness).

The fact that the eggs of the North African Spiny-tailed Lizards are much thinner-shelled than comparatively eggs of the snake species mentioned above was found when we took the eggs out of the laying hollow.

3.3 Incubator

The plastic tank in which the nine snow-white eggs were incubated (Fig. 2) had the dimensions of 23 x 13 x 15 cm (LBH). We used damp crumbly sand as a substrate. We placed the eggs in small recesses of the substrate, each with a distance of 1 to 2 cm due to the expected increase in size and volume. Via a 2.5 cm diameter acrylic glass tube attached to the floor in one corner of the incubator, the substrate could be indirectly moistened. The incubator was covered with a 4 mm thick, opaque acrylic glass pane and placed in an empty tank of our terrarium facility. The incubator was heated by fluorescent lamps from below and above. During the day, the temperature could be regulated by opening a display window.

Fig. 2. Incubator.

3.4 Incubation and difficulties with hatching

Since the eggs had already sunk in a bit, the first thing to do was to achieve humidity in the incubator. To speed up this process, we covered the eggs with damp flowing paper. The next day they had become plump. We could clearly see that they were fertilized by the 1 cm large, clearly visible germinal disc. Since condensation collected under the flowing paper after some time, we removed it on the 6th day of incubation. As a result of the high humidity, the acrylic glass lid of the incubator bulged, causing the humidity to drop to 80%. Two of the eggs again showed slight dents. We could see how sensitive the eggs were to a drop in humidity from the fact that they fell immediately when the humidity dropped to 80 to 85 %, even for a short time. To reduce the loss of moisture through the curved acrylic glass pane, we placed a sturdy plastic film between it and the edge of the pool. The necessary air exchange was ensured both by lifting the lid for daily checking of the eggs and by a small slit through which the connecting cable for the temperature sensor/digital thermometer led.

After some time, a relatively stable state of humidity had set in. The temperature, on the other hand, was less uniform (see Table 2), which was mainly due to the switching off of all lighting in the evening. On June 26 (52nd incubation day) we took an egg out of the incubator for control. The sand under the egg had compacted a lot, and it was very damp. After an examination of the remaining eggs, it was found that they had taken on a glassy reddish color on their underside. Together with Dipl. Biol. R. WICKER, we then X-rayed all the eggs. Blood vessels and a poorly developed embryo were clearly visible. Mr. WICKER diagnosed a perfect condition of the nine fertilized eggs with the advice to keep the substrate in the incubator a little less moist in the future. On August 10 (97th incubation day), an egg was damaged during the daily check. The egg shell tore open about 5 mm, whereupon colorless egg fluid immediately leaked out of the egg, which was under high pressure, and it collapsed strongly. We immediately placed a piece of damp paper tissue on the opening and pressed it lightly. After 3 hours this egg had become plump again; we could therefore hope for further development. After eight days, we removed the piece of paper because mold had settled on it. The egg lying next to it also had two pinhead-sized mold spots, presumably because of the egg fluid that had leaked there. After we had roughly removed the mold from the eggs with a brush, we coated the infested areas twice a day with a Nipagin solution (a few crystals to 1 ml of water). From the third day after this treatment, no more mold appeared. After 119 days of incubation (1.9.), small drops of water appeared on one of the North African Spiny-tailed Lizard eggs; according to literature reference to the imminent hatching (ZIMMERMANN 1983). After another three days, the upper side of another egg was slashed about 1 cm lengthwise, and the head of a young animal protruded from the opening. The day before, there were no signs (water droplets) of imminent hatching on this egg. On the advice of

Mr. WICKER, we opened the egg, on which water droplets had previously formed. Inside, we found a fully developed cub, but it had already died. Dr. E. ZIMMERMANN informed us on request that the appearance of small drops of water on the surface of the egg was completely normal and announced hatching (see ZIMMERMANN 1983). If the young have not opened the eggs on their own after a day, we should open them immediately. Since the first cub whose egg had shown drops of liquid had died in the egg, we decided to open the eggs as soon as there was the slightest indication of water droplets. On September 5 (123rd incubation day) in the afternoon at 3:30 p.m., water droplets appeared on two more eggs. We opened the eggs, first with a longitudinal cut on their top (from the middle). The lizards laid on their backs with their heads on one of the two egg poles. Directly above the body was the tail. We freed one of the two young animals halfway out of the egg through cross-sections on the egg shell, whereupon the still quite large yolk sac became visible. The other juvenile still remained in the protective egg fluid (Fig. 3) and moved from time to time. It seemed important to us to expose the head of the young animals to such an extent that they were able to breathe. In the following days we managed to free three more young animals from the eggs in the described way (including the two eggs that had mold infestation and one of which had been damaged!). In the case of the other two eggs, water droplets formed during the night, and although we checked the eggs every 2 hours, one of the young animals had already died in the egg, the other was still alive for about 2 hours after opening the egg. During this time, it kept its eyes open and breathed at large intervals. The first cub, the only one that had opened the egg on its own, literally grew more and more out of the egg. In the process, the remaining umbilical cord came into contact with the sand in the incubator. An infection at this site was probably responsible for the fact that the cub died three days later. The remaining five *U. acanthinurus* were then bedded on paper towels soaked in chamomile solution. The humidity was now around 80%, so that the yolk sac could not dry out. While the young animals remained in the egg, the yolk sac was used up within about three days. After that, the young were about three times as big as the egg originally. The remaining umbilical cord of about 1 cm in length was pulled into the body except for a remnant of 1 mm (which later dried up and fell off). Here, despite the paper towels, some grains of sand had reached the umbilical cord of three young animals. We removed the adhering sand with chamomile-soaked cotton swabs.

4. Rearing of the young animals

It was not until 9 September that the five young *U. acanthinurus* (see Table 3 for data) became active. Previously, they had lain in a prone position in the darkened brood container with their eyes closed (Fig. 4) and occasionally turned their heads from side to side. Too much light, for example during regular check-ups, caused accelerated and violent breathing. Since the belly button was still quite open, we first placed the five young animals in a plastic tank (36 x 18 x 23 cm LBH) with a paper backing. In the beginning, the young North African Spiny-tailed Lizards visibly had difficulties coordinating the movement of their extremities. They often stepped on the front legs with their hind legs, bending in the process. The head was pointed downwards when running, the tail, which was only spiked at the beginning, far upwards: an extremely untypical way of posture and locomotion for *U. acanthinurus*.

On Sept. 14th the juveniles had an average length of 7,5 cm. During the first time specimens 4 and 5 did not take much food; therefore, they showed some weight loss. In the afternoon of September 14, we housed the five cubs in a terrarium equipped with sand as a substrate (75 x 45 x 40 cm LBH). Flat, hollow stone slabs served as shelters. The lighting corresponded to that in the terrarium of the parent animals. Due to the smaller size of the breeding terrarium, we only installed a 40 W mini spotlight as a heat source. Two of the young animals immediately moved into a living cave. The young North African Spiny-tailed Lizards became increasingly active, but only really lively at temperatures above 32 °C. The first food, which consisted of crickets and caterpillars of the greater wax moth, was taken up

on 13.9. It was hardly possible to feed smaller free-roaming crickets, as even the slightest touch, for example, with one of the antennae, caused panic in the North African Spiny-tailed Lizards. We therefore fed killed crickets from the tweezers. In terms of vegetable food, the young animals were the first to receive freshly germinated alfalfa, from which sprouts were later eaten. The young only began to eat properly when we offered the abdomen of larvae of the Egyptian migratory locust. Only gradually did the young animals learn to catch prey on their own. From the very beginning, we fed all food animals, including parts of them, with a lime/mineral preparation (Osspulvit). The drinking water, which was regularly consumed, was also enriched as for the parents.

After the five juvenile *U. acanthinurus* spent three weeks together in their breeding terrarium, their sense of territory developed. Their initially fearful behavior quickly changed. Hissing and biting wildly, they chased each other. Three of the young animals were clearly suppressed. If one of the oppressed animals only showed up at the other end of the terrarium (at least 75 cm away), the attacker opened his mouth, hissed and pounced on his conspecific, hissing and with a bloated body and bit it in the tail or flanks. Therefore, we first separated the young *U. acanthinurus* into two groups of three and two juveniles. After a few days, the animals had become so accustomed to their new environment that the aggressive behaviors began again. In order to prevent an undesirable development due to stress, we have been keeping all five young animals individually since then. With a diet of crickets, larvae of the Egyptian migratory locust, caterpillars of the greater wax moth and freshly germinated seedlings of alfalfa, mung beans, sunflowers, lentils and wheat, they develop into magnificent young animals.

5. Discussion

Considering that nine fertilized eggs had been laid in the offspring of the North African Spiny-tailed Lizards described here and that all eggs contained fully developed embryos, it is a great pity that only five young animals could be helped to hatch. Nine fully developed young (without any deformities) certainly indicate an adequate supply of vitamins and minerals to the mother, which LANGERWERF (1979) also considers to be one of the most important prerequisites for the successful breeding of oviparous lizards. It became clear to us that the young animals were not able to hatch from the eggs themselves when we later came across the work of BRAUNWALDER (1979). In this report on the ovation problem in the green iguana (*Iguana i. iguana*), exactly the same problem that occurred during the last phase of incubation in *U. acanthinurus* is discussed. Thus, BRAUNWALDER (1. c.) puts the thesis up for discussion: "Both too high and high constant air and substrate moisture lead to the death of the eggs in general and especially in the very last production phase, namely by suffocation death of the embryo." The following remarks by BRAUNWALDER, which as far as we know are discussed in this form for the first time, largely confirm the difficulties that had arisen during the last maturation phase of the *U. acanthinurus* eggs. References to the difficulties in hatching *U. acanthinurus* can be found in GRIMM (1982). Also, here the eggs "sweated" shortly before hatching, and none of the young animals had opened the eggshell themselves. We therefore believe that we can assume that our African North African Spiny-tailed Lizards were not able to free themselves from the egg shell on their own at the end of incubation due to too high air (93 %) and substrate moisture. Certainly, in this case, too, the film of water forming on the surface of the egg (initially small drops of water) was responsible for the fact that some of the embryos suffocated in the egg. The question therefore arises as to the extent to which liquid droplets on the surface of the egg actually announce the imminent hatching (ZIMMERMANN 1983). The fact that too much moisture must have had an effect on the embryos was evident from the watery swollen skin of the young animals that have died in the egg. In the relevant literature, for example, there are mainly indications that the breeding of reptiles or lizard eggs must take place under high humidity (sometimes up to 100 %!). However, the fact that towards the end of the incubation period a reduction of both the air and the substrate

moisture is necessary for the hatching of various lizard species is nowhere to be read in the relevant literature. It is possible that other people have had similar experiences with difficulties in producing lizard eggs, without ever having learned the reason for the death of the embryos shortly before hatching. Regarding the breeding of *Heloderma suspectum*, we know that breeding successes failed because fully developed embryos also died in the egg during the last incubation phase.

6. Outlook

Since our adult *U. acanthinurus* male died of a generalized bacterial infection (FRANK, briefl. Mitt.), therefore no repetition of an offspring can take place for the time being. We hope that the smaller, very shy specimen is a male, so that sooner or later our thorn-tailed dragons may reproduce again.

7. Acknowledgements

We would like to thank Mrs. U. JANIK and Mrs. M. REICHEL for taking care of the *U.-acanthinurus*-eggs during our three-week vacation. We would also like to thank Dr. E. ZIMMERMANN, Stuttgart, for her advice regarding the incubation of eggs. We would especially like to thank Dipl. Biol. R. WICKER (head of the Exotarium of the Zoological Garden Frankfurt am Main) for always supporting us with words and deeds in the production of the eggs. We would like to thank Mr. E. PFILIPS (Senckenberg Museum, Frankfurt am Main) for creating the black-and-white enlargements.

Summary

In addition to the keeping (terrarium, lighting, heating and food) of four adult specimens of the North African Spiny-tailed Lizards *Uromastix acanthinurus*, the incubation of a clutch of nine fertilized eggs and the hatching of the young animals as well as the difficulties encountered are described. The 3.6 cm long eggs were incubated at temperatures ranging from 23.1 to 33.1 °C and a relative humidity of 93.6% on average. After an incubation period of 122 days, the first of five 7.5 cm long and 6 to 7 g pups hatched. During the first weeks of life, the young animals were very clumsy both in eating and in coordinating the movement of their extremities. Three weeks after hatching, the young North African Spiny-tailed Lizards developed an increasing aggressiveness towards their conspecifics. In order to prevent stress-related developmental damage, the young animals were then kept individually. It is debated whether the appearance of liquid droplets on the egg surface during the last incubation phase actually announces the hatching of young animals or whether this is an indication that fully developed young animals are not able to leave the egg on their own due to too high air and substrate moisture shortly before hatching.

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