Keeping and breeding the Two-fingered skink *Chalcides mauritanicus* (DUMÉRIL & BIBRON, 1839), and the first proof of its viviparity

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INTRODUCTION

Chalcides mauritanicus is one of the smallest and least known species within the genus *Chalcides*. It is a fossorial skink, but genetically CARRANZA et al. (2008) put *C. mauritanicus* basal in the clade of grass-swimming *Chalcides* (including for example *Chalcides chalcides*, *Chalcides minutus* and *Chalcides guentheri*; rather than with the semi-fossorial *Chalcides mionecton*). It separated from the rest of this group 9.9 million years ago and evolved into a sand swimming species, much like *C. mionecton*. This species has received little attention through the years and even now relatively little is known about its distribution, ecology, life history, population densities etc. (see BOGAERTS, 2013).
C. mauritanicus has rarely, if ever, been kept in captivity, and after raising this species for almost ten years, it is concluded not to be a suitable form for captivity. Do not read this paper as a recommendation to keep this species. However, the knowledge collected from these captive specimens adds important new data on this species.

TAXONOMY

Chalcides mauritanicus was initially described as *Heteromeles mauritanicus*. *Heteromeles* was established as a new genus for this species by DUMÉRIL & BIBRON (1839) because of the absence of several fingers and toes. However, they already wrote that its morphology resembles that of 'Seps chalcide' (now *Chalcides chalcides*). The first specimen was delivered to them by lieutenant-colonel Levaillant and came from Algeria. No exact locality is given but according to PASTEUR & BONS (1960) it should be Oran as

Greyish adult specimen of *Chalcides mauritanicus*.

stated in BOULENGER (1891). The latter author included the skink in the genus *Chalcides*. Later PASTEUR & BONS (1960) revived *Heteromeles* as a subgenus. PASTEUR (1981) again placed it in *Chalcides*, a taxonomic choice followed by most authors to the present day, certainly after the work of CARRANZA et al. (2008).

Newly born juvenile of *Chalcides mauritanicus*.

DESCRIPTION

Chalcides mauritanicus is an elongated and small-sized skink with strongly reduced limbs. CAPUTO et al. (1995) gave measurements for ten adult specimen with mean snout-vent length ranging from 54.7-71.8 mm. MARTÍN et al (2015) measured snout-vent lengths of 64-74 mm for males and 70-83 mm for females. Tail lengths range from 54 mm for males to 64-74 mm for females. My heaviest animal (probably the female) weighed 3.6 g but lost its tail during the weighing. I weighed the tail separately and it weighed 1.2 g so the tail made up 33% of the total body weight. My animals are heavier than cited by MARTÍN et al. (2015) or CAPUTO et al. (1995). However, the lengths of my animals fall within the range of these publications. My largest animal measured 155 mm in total length (Table 1).

Skink	Date	Snout-vent (mm)	Tail length (mm)	Total length (mm)	Weight (g)	Remark
Adult 1	July 25, 2014	80	75	155	3.6	complete tail
Adult 2	July 25, 2014	79	72	151	3.1	complete tail
Adult 3	July 25, 2014	69	36	125	2.2	regenerated tail
Adult 4	July 25, 2014	75	54	129	2.9	regenerated tail
Adult 5	July 25, 2014	78	43	121	3.0	regenerated tail

Table 1: Measurements and weight of adult *Chalcides mauritanicus*.

BOULENGER (1891) stated: "Snout conical, slightly projecting; ear opening minute, hardly distinguishable; nostril entirely in advance of the suture between the rostral and the first labial; fourth upper labial entering the orbit; supranasals distinct. Body much elongated. 18 scales round the body. Limbs very short; the anterior didactyle, the posterior tridactyle; third toe nearly twice as long as second; the hind limb equals the length of the head, and the fore limb the distance between the end of the snout and the posterior border of the eye. Yellowish or greyish above, with a lateral band formed of closely-set large black dots". In CAPUTO et al. (1995) was concluded that *C. mauritanicus* has an even longer and narrower body than *C. mionecton*, which fits to its more fossorial life.

Often there is a darker stripe visible along the mid-dorsal, especially in adults. Lateral sides are darker and the ventral side is grey. The tail is a lighter, grey-white colour with dark stripes and barely discernible ocelli. There are no ocelli on the body. In juveniles the tail is bright red until they are 7-8 months old (DOUMERGUE, 1901). I can confirm that the tail is bright orange-red for the last two-thirds of the tail. This colouration fades within a year, starting at the dorsal side of the tail. Meanwhile the striped pattern slowly develops from the base of the tail. The tail retains a lighter colour in contrast to the darker body.

DISTRIBUTION

At first this skink was only known from the littoral / coastal area of northwestern Algeria (DOUMERGUE, 1901). WERNER (1929) was said to have obtained a specimen from a locality called Le Kreider (now El Kheiter), Algeria, which has never been reconfirmed as it is far south from the coast. It was not known from Morocco until recently. Even in 1981 Pasteur only knew it from the coastal districts of Oran and Algiers provinces of Algeria, although PASTEUR & BONS (1960) claim its presence as highly probable in the north-east in their overview of the reptiles of Morocco.

The first authors to confirm its presence in Morocco are MELLADO et al. (1987) for 2 km east of Ras El Ma (southeast of Melilla). In MATEO et al. (1995) four localities are mentioned: one for Algeria, about 25 km from the Moroccan border (between Algiers and Ghazouat: DOUMERGUE, 1901), and three for Morocco: Ras el Ma, Melilla and Beni Enzar. The skink was already considered extinct for Melilla (MATEO et al., 2009). It is known to exist in the following protected areas: mouth of the Moulouya river and Sebkha Bou Areg (MATEO et al., 2009). BONS & GENIEZ (1996) suspected it also lived in sandy areas west of Melilla, but so far it has not been found there. It is mainly a coastal, lowland species that is known up to at least 140 m above sea level (MATEO et al., 2009).
Recently the skink has been found on the Chafarinas islands (MARTÍN et al., 2015). A distribution map can be found on the red list website (see MATEO et al., 2009).

ACTIVITY

The activity period of the species starts at the earliest in March when MARTÍN et al. (2015) did their survey. My observations were done in April 2009 and April 2013. Searches in December 2012 in the same habitats yielded no skinks, which indicates that they probably hibernate during that period (other *Chalcides* species were also not found active in December). The activity probably stops somewhere in September, perhaps depending on the weather.
DOUMERGUE (1901) described this species as extremely difficult to catch, often leaving you with only the fragile tail in your hands. This ease of tail loss is also true in captivity. When cleaning out the tank my skinks nervously move their tails when caught and it falls off very easily. MARTÍN et al. (2015) described that 85.2 % of all adults in their study had a regenerated tail.

HABITAT

DOUMERGUE (1901) described finding this skink under stones in the sandy (dune) areas along the coast of Oran. MELLADO et al. (1987) described the habitat two km east of Ras el Ma in the coastal zone behind the dunes where exotic trees are planted like *Eucalyptus*, along with *Acacia* and *Retema*.
MARTÍN et al. (2015) mentioned that the skinks on the Chafarinas are restricted to small sandy microhabitats of Congreso Island, far from the seashore. These microhabitats were characterised by a high percentage of sandy soil without vegetation and medium sized rocks (20-60 cm), also showing a cover of leaf litter and grass. Subarboreal vegetation was also sparser at the sites occupied by skinks, with a significantly lower cover of *Salsola* bushes than its average availability. Soils occupied by skinks had a higher proportion of sand, and a lower proportion of gravel, silt and clay. MATEO et al. (1995) reported finding them by turning over dead wood, cardboard boxes, and stones very near to the sea. I found *C. mauritanicus* only in dry sandy soils, which are a part of (the former) dunes west of the centre of Saïdia at three localities, and at one locality near Ras el Ma. They were found only by turning over rubbish like old clothes, cardboard, plastic etc. The soils were not disturbed by human digging activities. Skinks were never seen active out of their hiding place, confirming what was found by MARTÍN et al. (2015) who in their survey never found *C. mauritanicus* above the soil surface. The first locality was an isolated area within a building area west of Saïdia (roughly N35°05'28" W2°15'11"). It is a last remaining part of a dune area that has not yet been built up with houses, but it surely is now surrounded by newly built houses. The locality is situated about 350 meters south of the coastline. Skinks were found in the small sand dunes that were already well covered with vegetation. Five animals were seen on April 12, 2009. They were warming up under pieces of garbage (cardboard, clothes and so on) and not under plastic or stones. Other herps found there were: *Discoglossus pictus*, *Chalcides parallelus, Tarentola mauritanica, Trogonophis wiegmanni, Acanthodactylus boskianus* and *Testudo graeca.*
A second location about 900 meters west of the first was explored on April 13, 2013 (N35°05'44" W2°15'39"). This was in the dunes about 100 m from the seashore and apparently, looking at the waste, parts of it were sometimes flooded by the sea. It was along a path used for people to reach the beach. Here there was more rubbish to turn over; we saw four individuals. Other species found were *Chalcides parallelus* and *Macroprotodon abubakeri.*

Locality 1: habitat west of Saïdia.

The third locality was about 500 m inland from the seashore, also in an isolated former dune area. It was searched on April 16, 2009 (N35°05'37" W2°15'11"). It was difficult to find *Chalcides mauritanicus* because there was much less trash to turn over; only two specimens were seen. Other species observed were *Agama impalearis*, *Psammodromus algirus*, *Chalcides parallelus, Tarentola mauritanica, Acanthodactylus boskianus, Testudo graeca* and *Macroprotodon* sp.

The fourth locality where *C. mauritanicus* was found is west of the Moulouya river in the dunes of Ras el Ma. This is a nature reserve with well vegetated dunes with *Retema* bushes and *Acacia* trees. It is very difficult to find skinks here as there is little trash or wood or stones to turn over. Only one individual was found on April 8, 2013 under a piece of wood (N35°07'56" W2°23'50"). Besides that, *Chamaeleo chamaeleon*, *Psammodromus algirus*, *Chalcides parallelus, Tarentola mauritanica, Acanthodactylus boskianus, Testudo graeca,* and *Macroprotodon* sp. were also found.

As *Macroprotodon* was seen in almost all localities, it is most likely that this snake is a main predator of *C. mauritanicus*.

Diet samples were obtained by collecting faeces of live skinks.

TERRARIUM

Because very little is known about the breeding ecology or behaviour of *C. mauritanicus,* I considered it opportune and scientifically re-

Locality 2: habitat in dunes west of Saïdia.

levant to take three animals from the first locality in 2009 to study their behaviour in captivity. However, they never bred and one died during hibernation in 2011. I presume this occurred because they were all of the same sex. In April 2013 it was very difficult to find animals at locality 1, which had been further destroyed. I succeeded in collecting three new animals to add to the group of two that remained in my care. As this habitat is being destroyed, these captive skinks are serving a scientific purpose. Any animals that die will be deposited in a natural history museum.

The animals were kept together as a group in a small terrarium (50x40x20 cm, lxwxh) since April 2009. Fine sand of 4-5 cm in height was used as substrate. Some flat stones and pieces of bark served as hiding places. A small water bowl was always present. Water was refreshed every week. The soil was cleaned every few weeks with a sieve to remove dead food items and faeces. Once a year half of the soil was completely refreshed. A heating mat under the terrarium and two 12W halogen light bulbs were producing heat, light and some UV. Throughout the year the lighting and temperatures vary slightly. In winter the temperatures drop permanently to around 10°C for about two months when all heating and lights are switched off. The rest of the year temperatures within the terrarium vary from 15°C to 35°C (under the spots when the heating mat is on).

It is very hard to tell the sexes apart. MARTÍN et al. (2015) determined the gender of adult skinks by examining the cloaca and carefully everting the hemipenis of males. I never tried this as I was too afraid that the manipulation would make the skinks lose their tails. I could not determine the sexes very easily, but suspected that I started out with three males, and more recently probably added two more males and one female.

The skinks were mainly fed with larvae of *Alphitobius laevigatus* (Tenebrionidae beetles) and juvenile crickets (*Gryllus assimilis*). All food items were dusted with Calcium and D_3 (ReptiCalcium by ZooMed with D_3 22,907 IE/g), and gut loaded with a mixture of carrot and dry dog food. MARTÍN et al. (2015) found Formicidae (ants) and Coleoptera (beetles) the most abundant food items during spring (84.1% of all invertebrates eaten).

BEHAVIOUR

MARTÍN et al. (2015) never observed a skink above the soil surface. After 10 years of keeping them, I must conclude that one rarely sees them above the sand. These skinks

Adult *Chalcides mauritanicus.*

Skink	Date	Snout-vent (mm)	Tail length (mm)	Total length (mm)	Weight (g)
Juvenile 1	August 10, 2013	37	32	69	0,2
Juvenile 2	August 10, 2013	39	37	76	0,3
Juvenile 3	August 10, 2013	40	39	79	0,4
Juvenile 1	November 1, 2013	44	40	84	0,5
Juvenile 2	November 1, 2013	44	41	85	0,5
Juvenile 3	November 1, 2013	44	42	86	0,5
Juvenile 1	November 21, 2014	66	61	127	not measured
Juvenile 2	November 21, 2014	65	62	127	not measured
Juvenile 3	November 21, 2014	66	41	107 (regenerated tail)	not measured

Table 2: Measurements and weights of juvenile *Chalcides mauritanicus* of the first clutch.

remain well-hidden under the sand and mostly ambush their prey from under the sand. They only come above ground to search for food when small crickets are offered and sometimes stick their heads out of the sand when they notice movement. Even warming up occurs in the sand or under the flat stones provided. It seems the skinks are not very aggressive towards each other; a character trait which appears similar to *Chalcides mionecton* (HARBIG, 2002). Several other *Chalcides* species that I have kept in the past e.g., *Chalcides bedriagai* (see BOGAERTS, 1995) or *Chalcides lanzai* (see BOGAERTS, 2006) became very tame in captivity and would beg for food, but *C. mauritanicus*, even the captive bred specimens, never became 'tame'.

BREEDING ECOLOGY

I have never observed breeding behaviour, nor have I seen animals chasing or biting each other in spring, which can be observed in other *Chalcides* species. I was therefore completely surprised to find juveniles in the terrarium on the 10th of August 2013. In total three juveniles were found in the tank. They, in sharp contrast to their parents, actively explored the terrarium. Their measurements and weights are given in table 2. They were measured and weighed again after three months and then after a year. It was, however, impossible to follow them individually. The data show that they grow rapidly and reach adult size the next year. I expected them to start breeding the second spring after being born. Their tails had not changed colour after three months, but the next year only a slight hint of orange remained. On the 19th of July 2014, again in the morning, two new juveniles were found actively exploring the tank (see table 3).

Both times the juveniles were kept separated from the adults immediately after finding them. They were raised in a miniature version of the adult terrarium and fed with very tiny crickets and grew rapidly (Table 2). Sadly,

Skink	Date	Snout-vent (mm)	Tail length (mm)	Total length (mm)	Weight (g)
Juvenile	July 19, 2014	42	36	78	not measured
Juvenile	July 19, 2014	41	34	75	not measured

Table 3: Measurements and weights of juvenile *Chalcides mauritanicus* of the second clutch.

Adult group May 2014.

there has not yet been an F2 generation. In nature juveniles are found at the end of July or the beginning of August, and measure SV+T 36+24 mm (DOUMERGUE, 1901). This matches with my observations in the terrarium. MARTÍN et al. (2015) suspected that the animals have small litter sizes. My case confirms their suspicion, with three and two juveniles.

It was unclear if this species is viviparous or not (MARTÍN et al., 2015; MARTÍNEZ et al., 2019). Therefore, upon discovery of the juveniles in the terrarium I cleaned it out completely to check for more juveniles and to see if there were any eggshells to be found. No remnants whatsoever were noticed and from this I conclude that this observation is the first confirmation that this species is viviparous.

CONSERVATION

This species is considered Endangered by the IUCN because its 'Extent of Occurrence' is less than 5,000 km^2, its distribution is severely fragmented, and there is continuing decline in the extent and quality of its (coastal) habitat. It is not known to exist in severely degraded habitats (MATEO et al., 2009). I can confirm that it does not seem to survive in degraded habitats as I found it difficult to find the species again after four years in the same even further degraded habitat (locality 1). Further surveys are needed to better determine the range of this species, especially in Algeria. MATEO et al. (2009) suspect the collection of driftwood for use as firewood by local people has contributed to the disappearance of the skink. I think the replacement by rubbish and trash adds up pretty well to the loss of driftwood.

The main threat to their habitat is its destruction for coastal developments (tourism and holiday villages) west of Saïdia in the direction of the Moulouya river. On Google Earth one can see photos of the area in 2004. At that time Saïdia was still a small town, and our localities 1, 2 and 3 still look pretty intact. During our visits in 2009, 2012 and 2013 we have seen the ongoing developments. On Google Earth now it is seen that most of the habitats are gone. And as these sandy habitats vanish, so will this little-known skink.

CONCLUSION

Chalcides mauritanicus is a viviparous species that has small litters of two or three young. The species is extremely fossorial and does not become 'tame' in captivity and are therefore not recommended as pet, since hand-feeding is sometimes necessary to help animals in a poorer condition. Even studying their behaviour is hard in captivity. It seems

Already in 2009 destruction of the *C. mauritanicus* habitat had started at Saïdia (locality 1).

Locality 4: pristine habitat, dunes of Ras el Ma.

the skinks are not very aggressive towards each other, a trait which appears similar to *Chalcides mionecton*.

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SUMMARY

Chalcides mauritanicus is one of the smallest and least-known species within the genus *Chalcides*. It is a fossorial skink that has rarely, if ever, been kept in captivity. The skink is only found in the coastal areas in northeastern Morocco, the northwest of Algeria and on the Chafarinas Islands. I found this species in four localities of littoral dunes in Morocco. From 2009 to the present day, I have kept this species in vivaria and have successfully bred it twice. The animals were kept together as a group in a small terrarium (50x40x20 cm), with a floor of fine sand. Temperatures in the terrarium vary from 15°C to 35°C (under the spots when the heating mat is on). A short winter resting period at 10°C is provided for two months.
The skinks were mainly fed with larvae of *Alphitobius laevigatus* and juvenile crickets *Gryllus assimilis*. All food items were dusted with a Calcium preparation and gut loaded with a mixture of carrots and dry dog food. The captive bred specimens never became tame and are only seen when they hunt for prey, and even that seems to occur mostly underground. The first birth was three juveniles on August 10, 2013 and a second batch of two juveniles was found on July 19, 2014. The juveniles were kept separately from the adults immediately upon being spotted. Mine is the first confirmation that *C. mauritanicus* is viviparous. Although the species is considered Endangered by IUCN because its Extent of Occurrence is less than 5,000 km^2, and its distribution is severely fragmented, there is a continuing decline in the extent and quality of its (coastal) habitat without any conservation measures being taken.

SAMENVATTING

Chalcides mauritanicus is een van de kleinste en minst onderzochte soorten van het genus *Chalcides*. Het is een gravende skink die zelden tot nooit in een terrarium gehouden is. De soort komt alleen voor in de kustgebieden van noordoost Marokko, in het noordwesten van Algerije en op de Chafarinas eilanden. Ik vond de vorm op vier plaatsen in de kustduinen van Marokko.
Vanaf 2009 tot en met heden verzorg ik de soort in terraria. Tot nu toe valt tweemaal voortplantingssucces te noteren. De volwassen dieren zijn als een groep ondergebracht in een klein terrarium (50x40x20 cm), met een bodembedekking van fijn zand. De temperatuur in de bak varieert van 15°C tot 35°C (dit laatste onder de spotjes met het warmtematje aan). ´s Winters krijgen ze een rustperiode van twee maanden bij 10°C. Het voer bestaat voornamelijk uit larven van het kevertje *Alphitobius laevigatus* en jonge krekeltjes van *Gryllus assimilis*. Alle voedseldieren krijgen worteltjes en droge hondenbrokken te eten, en worden voor het voederen bestoven met een kalkpreparaat. De skinken werden nooit tam in die zin dat ze komen bedelen voor voer en ze eten niet vanaf het pincet. Zelden ziet men ze prooien jagen want zelfs dat lijkt voornamelijk ondergronds te gebeuren. De eerste jongen, drie stuks, zag ik op 10 augustus 2013. Op 19 juli 2014 vond ik weer twee jongen. Deze diertjes werden gelijk in een apart terrarium geplaatst. Dit artikel vormt de eerste melding dat de soort levendbarend is.
Hoewel *C. mauritanicus* door de IUCN ondergebracht is in de categorie Endangered (bedreigd) vanwege het kleine en verbrokkelde verspreidingsgebied (<5,000 km^2), is er helaas een duidelijke en voortdurende vermindering van de beschikbare oppervlakte en een kwalitatieve habitatverslechtering te melden, terwijl er absoluut geen beschermingsmaatregelen voor het kustgebied worden ondernomen.

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