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Uromastyx Acanthinura: An Updated Bibliographic Review

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Abstract – This work focuses on *Uromastyx acanthinura*: an herbivorous species of the Agamidae family that lives specifically in North Africa, particularly in Algeria. In this review, we locate the classification and describe some of the characteristics of this species such as morphology, behaviour, habitat, reproduction, diseases, and threats. This work constitutes the first part of a study carried out on this animal.

Keywords: *Uromastyx acanthinura*, Saharan Lizard, African spiny-tailed lizard.

1. Introduction

The *Uromastyx acanthinura* (U.a), often known as the spiny-tailed agamid, is a Saharan herbivorous Agamidae (Grenot, 1976). A very colourful lizard that is widespread throughout the semi-desert and desert regions of North Africa as a whole and continues through Asia to northwest India. It lives mostly in rocky habitats areas that can support its burrows (Bartlett, 2003; Gray, 2001; Highfield and Slimani, 2010).

These lizards feed on plants (Grenot, 1976) and their burrows serve as thermal refuges for many other species (Wilms *et al.*, 2010). They have the particularity of being a sedentary diurnal, ectothermic species (Grenot, 1976) and usually lives in groups of several individuals occupying very extensive territories (Zug, 1993).

The constraints of the desert environment have led these lizards to develop a great resistance to heat and fasting: their morphology, their behavior and physiological adaptations allow them to evolve in a prohibitive habitat for most animal species. They develop a great capacity of food storing during unfavourable periods by regulating their feeding behaviour depending on the availability of food. In the spring, they feed and accumulate fat for unfavourable periods (summer and winter) while in winter, their activity is slowed down (Grenot & Loirat, 1973). This species usually absorbs water from the plants it consumes and adopts a water economy strategy by building up reserves that it stores in the dorsal part of the abdomen, in the kidneys (Moali, 2009).

The rate of activity of U.a is related to the climatic conditions of the environment and the physiological stage of the individual meanwhile the external light/dark conditions also affect its body temperature and activity (Grenot and Loirat, 1973).

The U.a might represent an interesting model for endocrinological and neurobiological approaches during fasting (Barka-Dahane *et al.*, 2010; Chaabane, 2011), recent studies suggest that Uromastyx can also be an antidiabetic treatment in diabetes (Brito-Casillas *et al.*, 2016; Waqas *et al.*, 2021), yet it is not clearly well studied, and little is known about this Saharan lizard.

The aim of this review is to provide a better description of the species *Uromastyx acanthinura*, including recently acquired knowledge in the area of ecology, physiology and pathology. The present paper is part of a global work that aims to understand the central adaptive mechanisms in this lizard living in an extreme environment.

2. Classification

Lizards are vertebrates belonging to the class of Reptiles, from the Latin "crawling" reptilis. They are the suborder Saurians, from the Greek sauros "lizard", into the order of the Squamates, from the Latin squamata "scales" (Savey, 2009).

Lizards of the species *Uromastyx acanthinura*, 1825, called Bell's Dabb Lizard, Black Spiny-tailed Lizard, Dabb's Mastigure in English, Dob in Arabic and Fouette-queue Epineux in French, belong to the Agamidae family, one of three families belonging to the infraorder Iguania.

Branching	**Vertebrates**
Super class	Tetrapods
Class	Reptilia
Subclass	Diapsids
Order	Squamata
Suborder	Sauriens (Lacertiliens)
Family	Agamidae
Genus	Uromastyx (Bell, 1825)
Species	Acanthinurus (Bell, 1825)

Table 1. Classification of the species *Uromastyx acanthinura*.

CITES data trade records of *Uromastyx.spp* reported over 200 000 specimens traded internationally, with an increasing trend after 1994 (Knapp, 2004).

The morphological revisions of the genus Uromastyx (e.g., Mateo *et al.*, 1999; Wilms, 2001; Wilms & Böhme, 2000a, 2000b; Wilms & Schmitz, 2007; Wilms *et al.,* 2009) and molecular phylogenetic studies (e.g., Amer & Kumazawa, 2005a, 2009; Harris *et al.*, 2007; Amer *et al.*, 2012), have led to the identification of six different species groups of Uromastyx: Hardwicki, Asmussi, Ornatus, Princeps, Aegyptius, Acanthinurus (Wilms & Böhme 2000b; Wilms, 2001). However, the astonishing variety of morphology in the pattern of the different groups of Uromastyx makes any division controversial subspecific based essentially on pigmentation criteria (Grenot, 1974).

The *Uromastyx acanthinura* lizard belongs to the acanthinurus (Bell, 1825) group along with two other species *U.dispar* (Heyden, 1827) and *U.geyri* (Mueller, 1922).

Several subspecies of *Uromastyx acanthinura* have been described but are difficult to differentiate thus subspecies designations are ignored by some authorities or considered as separate species (Bartlett, 2003; Gray, 2001; Highfield and Slimani, 2010; Zari, 1991).

Uromastyx groups (scientific name)	Common name
[Hardwicki Group]	
U. hardwicki *(Gray, 1827)*	Indian Spiny-tail
[Asmussi Group]	
U. asmussi (Strauch, 1863)	Iranian Spiny-tail
U. loricatus (Blanford, 1874)	Iraqi Spiny-tail
[Ornatus Group]	
U. benti (Anderson, 1894)	Poreless Spiny-tail
U. macfadyeni *(Parker, 1932)*	Somali Spiny-tail
U. ocellatus (Lichtenstein, 1823)	Smooth-eared Spiny-tail
U. ornatus (Heyden, 1827)	Ornate Spiny-tail
U. phi/byi (Parker, 1938)	Yemeni Spiny-tail
[Princeps Group]	
U. princeps (O'Shaughnessy, 1880)	Armored Spiny-tail
U. thomasi (Parker, 1930)	Omani Spiny-tail
[Aegyptius Group]	
U. aegyptius (Forskal, 1775)	Egyptian Spiny-tail
[Acanthinurus Group]	
U. acanthinurus *(Bell, 1825)*	African Spiny-tail
U. dispar (Heyden, 1827)	Sudanese Spiny-tail
U. geyri (Mueller, 1922)	Saharan Spiny-tail

Table 2. Classification of the genus Uromastyx.

3. Characteristics of the Acanthinurus group

The U.a is a large lizard (300-770 g). The legs are large and strong, especially the hind legs, with heavy claws. There are heavy, spiny scales on the thighs. The analysis of its growth made it possible to establish five age classes (or demographic stages) from a height criterion, the mouth-vent length (L b-cq) (Grenot, 1976). The U.a generally are adult at sizes over 12 inches, often exceeding 16 inches in total length, with the heavy, spiny tail comprising a bit less than half of the total length, making them larger than typical Ornatus Group species. Females are somewhat smaller, at least in most populations, and tend to have narrower heads than males. The head is short and blunt as usual for the genus, the nostrils are large, the scales are irregular, and the enlarged scales in front of the ear opening are strongly denticulated. The scales of the back are small, but still countable without much difficulty, and the sides have obvious wrinkles or folds of skin. The high eyebrows and large nostrils are typical for several spiny-tails, the snout is relatively narrow and almost pointed. The tail is heavy, often with nearly parallel sides, and quite spiny, but the spines are relatively short compared to some other species of the genus. This North African group of very similar species differs from the Ornatus Group in having the tail whorls distinct under the tail all the way to the tip (Boulenger, 1885; Gray 2000).

As for the colouration, the U.a are often very colourful lizards marked with dark reticulations on bright yellow or green and with black heads and legs. The colour variation depends on the age, mood, locality, and individual. A familiar colour of this lizard consists of a pale often yellow of greenish body and black legs and tail, the U.a is as dark as the Egyptian spiny-tail Uromastyx aegyptius but notice more the pointed head, less depressed body, and lack of strong wrinkles on the sides and back. The tail is brownish, often marked with reddish or black spots. Commonly there are a few dark stripes down from the eye over the jaws. The belly is typically whitish or pale yellow, with or without irregular narrow brown bands or meshwork (Boulenger, 1885; Zoffer, 1996).

When warmed up to full activity or exposed to UV light, the colours become considerably brighter, and the back may turn bright yellow or green (Zoffer, 1996).

U.a is not notably sexual dimorphic (Grenot, 1974), but females may show a tendency to have cleaner, whiter bellies than males, but it also is not uncommon for the undersurfaces of the body to be almost black. Many males when ready to breed show reddish heads. Hatchlings (about 3 inches long) are pale reddish brown above and white on the sides and belly, with few darker markings (Zoffer, 1996).

4. Living characteristics

In the table below, we gathered typical values of some characteristics of the living environment of U.a (Savey, 2009).

Temperature (hot point)	**Temperature (cold point)**	**Humidity**	**Lighting**	**Special features of the terrarium layout**
Day 40°C **Night 22°C**	Day 28°C Night 20°C	About 40%	UVB ray and lighting from 10 a.m. to 12 p.m.	Substrate: fine sand Size: 100 cm long for 45 deep and 45 high

Table 3. Living characteristics of *Uromastyx acanthinura*.

U.a is a sedentary diurnal species, heliothermic and ectothermic (mainly dependent on external heat sources). Its locomotor activity is reduced. It spends long periods of the day in the sun and only leaves its small territory when it has accumulated enough energy. It then becomes active in search of food and to meet sexual partners (Grenot, 1976).

5. Distribution and habitat

The Uromastyx genus inhabits desert areas and ranges across North Africa, including the Sahel and the Horn of Africa, eastwards to Iran through the Arabian Peninsula and northwards to central Syria and Iraq (Wilms, 2005; Sindaco & Jeremčenko, 2008; Wilms & Schmitz, 2007; Uetz et al., 2017). It is mainly found in deserts and semi-desert habitats of compacted ground (they do not occur on sand dunes), covered with rocks, scattered stones, gravel and sparse vegetation (Grenot 1976; Wilms, 2005). However, the species of U.a lives in desert or semi-desert habitats in northwest Africa, Algeria, Tunisia, Morocco and northern Western Sahara, in the northwest of Libya (Atlas of Libya). It has been studied in detail by Grenot (1976) and by Lemire et al. (1982) in the region of Beni-Abbes in Algeria located 1240 km southwest of Algiers, 240 km south of Bechar at 30˚7 North latitude and 2˚ West longitude. Beni-Abbes occurs at the confluence of the four major Saharan biotopes: djebel (mountains), reg (rocky plains), erg (mobile dunes) and oued (water courses).

Typical population densities are of the order of 0.1-0.2 individuals per hectare but may reach three to six per hectare in very favourable habitats, such as the Monts d'Ougarta (Grenot and Vernet 1973). The density of its population would increase from a relative humidity of less than 60% (Grenot, 1976). Typical populations range from 10 to as many as 100 animals per km2, each with a home range of one to five hectares (Highfield and Slimani, 1998).

6. Homeostasis and behaviour

Food and diet

According to Dubuis and his colleagues in 1971, U.a has a typically herbivorous diet, but with a very marked polyphagia (Grenot, 1976). It does not feed on a regular basis but by following the cycle of the seasons and according to precipitation and food availability (Grenot, 1976). In times of abundance, it feeds on waterlogged plants (80 to 85%). During these periods, the animal builds up reserves that it stores in the dorsal part of the abdomen, in the kidneys (Moali, 2009).

In spring, vegetation is abundant, and temperatures are mild, so U.a emerges frequently from its burrow to feed, warm up in the sun and to reproduce (Grenot, 1976). In the hot season the vegetation becomes scarce, it feeds on plants in the water content is very low (<30%) and the Na+ K+ concentrations are very high (Nagy, 1973) like certain perennials, leaves, grains…etc and even herbivorous droppings and can even adopt, temporarily, a mixed diet (Dubuis, 1971).

During winter, the very low temperatures and scarcity of vegetation force this lizard to adapt a slower state of life, it remains at the bottom of its burrow: its aptitude for fasting is great, which is why its metabolism remains very low at temperatures below 35 ° C (Grenot, 1976). The interval is necessary between the end of wintering and mating to allow the accumulation of fat reserves and development of ovarian follicles before fertilization (Dubuis, 1971).

Water economy and osmoregulatory capacities

The U.a is known to "harvest" rain (Seshadri 1957), this lizard usually absorbs water from the plants he consumes (Zoffer, 1996) and has a highly specialized system to collect water from the atmosphere and moist sand. The surface of its body contains fine channels and by capillary action, water is captured and constantly brought to their mouths (Mattison, 1989). Although this species still experiences severe hypernatraemia during the summer and autumn months in Algeria (Bradshaw, 1997).

Water and mineral metabolism in Reptilia have been reviewed by Dantzler and Holmes (1974) who pointed out that lizards are the only terrestrial reptiles which have been shown to possess extrarenal excretory organs: their salt glands secrete a fluid rich in potassium (Cloudsley-Thompson, 1992). Indeed, herbivorous lizards consume a lot of potassium in their diet and their nasal salt gland help them excrete the excess salts. They also excrete potassium urate salts in higher concentration in their urine (Dunson 1976).

Plasma potassium concentrations, in contrast to sodium, are well regulated in field populations of U.a and this appears to reflect the activity of the nasal salt gland of this species. A well-developed salt gland was described by Grenot (1968) and has since been studied extensively, both anatomically and physiologically, by Lemire et al. (1970, 1972, 1980) and by Lemire (1983) and Lemire and Vernet (1982).

Lemire et al. (1980) and Lemire and Vernet (1982, 1983) results suggest that the (Na+ + K+) ratio variation allows the lizards to adapt to natural variations - seasonal or geographic - in their plant food.

Studies on the hormonal control of this nasal gland were reported by Bradshaw et al. (1984a), who measured circulating levels of aldosterone and corticosterone in salt-injected animals and assessed the effects of exogenous injections of aldosterone and dexamethasone (Bradshaw, 1997).

Reptiles are unable to produce urine that is hyperosmotic to their plasma (Cooper, 2017; Ford & Bradshaw, 2006; Bradshaw & Bradshaw, 2002). In U.a, we note a significant variation of urinary bladder volume, this suggests a capacity for long-term water storage and may also serve more complex osmoregulatory functions (Bell et al., 2010; Talmatamar et al., 2020).

A histological and microscopic examination of the kidney in the U.a demonstrates the existence of structural particularities of the nephron segments. In addition, important morphometric changes in the renal corpuscle and uriniferous tubules between seasonal changes appear to be closely related to body water economy (Talmatamar et al., 2020).

Nycthemeral rhythm and temperature of activity in nature

U.a is a sedentary and diurnal animal. At the beginning of spring and autumn its peak activity begins around 9-10 a.m. It heats up for long periods of time on the threshold of its burrow by exposing a maximum surface of his body to solar radiation then starts looking for his food. After taking food, it remains on its territory reduced to a few square meters, standing on more often at the threshold of its burrow, at a constant temperature, around 30 ° C (Grenot, 1973).

In summer, the outings start just before sunrise. The already active animal does not need solar radiation direct to heat. In the middle of the morning, the animal finds a refuge where it protects itself from high temperatures, then comes out at the end of the afternoon. Excess heat can therefore influence the rate of activity of U.a (Grenot, 1973).

In winter, the activity is very slow. The outings are less regular (Grenot, 1973). The cloacal temperatures are much higher subject to climatic fluctuations as they are directly linked to the duration of sunshine and the mass of the animal. In nature, thermal conditions can be insufficient to allow animals to reach their thermal preferendum (De Witt, 1967a).

The rate of activity of U.a is closely related to the climatic conditions of the seasons and the physiological stage of the individual, for example small individuals warm up passively faster than the big ones, which allows them to have a certain activity outside their burrow. Demonstrated by the difference between the cloacal temperatures of lizards living on the same conditions at the same time (Grenot, 1973).

It is in spring and summer that internal temperatures are the highest. In April they vary between 33 and 39 ° C and in June they are most often between 35 and 42 ° C, they can reach the maximum voluntarily tolerated, close to 45 ° C (Grenot, 1973).

The study of four Uromastyx captured during a winter afternoon, in the same day and place showed that: two juveniles exhibited a temperature high for the season 36.6 and 35 ° C, while two adults only had a temperature of 16.8 and 17 ° C. This suggests that Uromastyx living in an identical location and considered at the same time, may present very high cloacal temperature differences (Grenot, 1973).

According to external conditions (light or darkness), U.a may choose a given temperature range within the gradient. When it comes out during the day, the animal maintains a temperature activity as close as possible to the optimum, while at night this lizard is inactive, and its body temperature usually falls to that of the environment. The U.a seems to deliberately seek out a cold environment to spend the night even with the possibility of finding a warmer area (Grenot, 1973).

7. Coupling and social behaviour

Agamids have an oviparous mode of reproduction. Sexual dimorphism is marked depending on the species or genera (Matz et Vanderhaege, 1990; Aulio et al., 2003).

When the adults U.a come fully out of brumation in February or March. The male marks a territory by secreting a white substance from their femoral and anal glands upon reaching sexual maturity (Highfield and Slimani, 2010). In the wild, female U.a are sexually mature at around 4 years of age (Grenot, 1976). If a female is ready to mate, she allows the male to hold her in position to mate (Walls, 1996).

U.a generally mate in April and eggs are usually laid one month after fertilization occurs. The typical mating season lasts from March to July. The female Tail Whip lays 12 to 14 eggs in summer in a diverticulum of her own burrow or in a special hole, about sixty centimetres deep, which is capped. The eggs are elliptical in shape and have leathery shells. Post-oviposition parental investment in North African spiny-tailed lizards consists of the attendance and guarding of the nest by the female. Males have no parental investment beyond fertilizing the eggs. The female guards the eggs at least for the 8 to 12 weeks it takes for the eggs to hatch. The eggs take about 8 to 12 weeks to hatch, and the newly hatched lizards measure 3.5 x 2 cm and weigh on average 5g weigh between 4 and 6 g. The young will typically remain in their mother's burrow for another few weeks to a few months. However, U.a is a solitary and territorial species, young lizards are very likely to be completely independent upon leaving the burrow and must establish their own territories. It is also likely that the mother retains her own burrow ("Uromastyx acanthinura", 2006; Bartlett, 2003; Gray, 2001; Highfield and Slimani, 2010; Moali, 2009).

The young U.a don't start growing slowly until the following spring and only gradually switch from an insectivorous to a vegetarian diet (Moali, 2009).

8. Reproductive neuroendocrinology and Oogenesis the Ovarian Cycle

The hypothalamic–pituitary–gonadal (HPG) axis in reptiles is similar to that described in other vertebrates (Licht et al., 1987; Licht, 1995). The pituitary gonadotropes of U.a, have been characterized as having only follicle-stimulating hormone (FSH)-like secretory capacity, at least as far as immunoreactivity to human LH and FSH antibodies may demonstrate (Hammouche et al., 2007).

Although two neurohormones and gonadotropins GTHs, homologous to FSH and LH, are part of the generalized reptilian HPG axis, early studies had difficulty demonstrating separate reproductive functions or even that there were two GTH in some lizards (Licht et al., 1976; 1979).

A study using immunocytochemical methods of specific antisera against human FSH (hFSH) and LH (hLH), Hammouche et al., (2007) has identified only FSH like containing cells in the pars distalis from the pituitary gland of adult female U.a. However, two populations of gonadotropic cells expressing FSH-like or both hormones (FSH and LH) were revealed suggesting that as in other vertebrates, gonadotropic cells can be classified as bihormonal because they contain both glycoprotein hormones, FSH and LH.

In the U.a, granulosa cells of atretic follicles stained positive for testosterone, 17β-estradiol, and progesterone. β-endorphin is present in the atretic follicles, particularly in the apoptotic granulosa cells and oocyte cytoplasm of the previtellogenic follicles in sexually quiescent lizards when steroidogenesis is interrupted, whereas it is absent in the vitellogenic and previtellogenic follicles, this opioid peptide also acts in the modulation of ovarian steroidogenesis of this species (Hammouche et al., 2009). Also, localization of GnRH I and GnRH I receptor in the granulosa cells of the atretic follicle in ovary of C. versicolour suggests that GnRH I may be regulating follicular selection by promoting atresia (Singh et al., 2008).

At the end of the previtellogenic stage, during transition to vitellogenic follicles, the granulosa layer changes considerably. It diminishes in width as the pyriform cells become reduced in size. The follicular epithelium gradually undergoes changes as result of apoptosis of the intermediate and pyriform cells (Motta et al., 1995, 1996).

During initial apoptosis the mitochondria of the pyriform cells are translocated unaltered to the oocyte (Tammaro et al., 2007). The pyriform cells lose their apical processes, changing their shape to round cells that resemble the intermediate cells. Shortly after, the form and size of the cells that constitute the follicular epithelium becomes homogeneous.

The follicular epithelium turns monolayered and only small cells persist as a unique component of the epithelium until ovulation (Filosa, 1973). In late previtellogenic follicles the cellular theca interna is separated from a fibrous theca externa by a net of small blood vessels and capillaries.

Homogeneous, lightly stained vacuoles occupy the peripheral ooplasm and may open into the ZP. On the oocyte surface, microvilli are numerous. Many coated pits are situated along the base of the oocyte microvilli, and coated vesicles, ribosome granules and other granular clusters are present in the peripheral ooplasm (Laughran et al., 1981; Vieira et al., 2010). The ooplasm contains fibrillar granules mainly located at the periphery and the center exhibits a finely granular cytoplasm. A distinct nucleus is localized near the centre of the oocyte.

9. Diseases and threats

Like every living being the U.a is also sensible to environment and diseases, some of the diseases that can touch this species are:

Bacterial Dermatoses

Among the species most susceptible to this type of dermatosis are the Uromastyx genus. Many factors can promote the development of bacterial infections: abrasion of the keratinized layer of the animal's skin trauma or environmental conditions: humidity, temperature, quality of the food that are not suitable for the reptile (Harkewicz, 2002). When stored in an environment that is too humid. The skin thickens and takes on a yellowish colour. A specific condition has been described in this species which is the cause of cellulitis associated with a gram-positive filamentous bacterium (Kopolos *et al.*, 2000).

This condition is characterized by chronic hyperkeratosis predominantly in the lips, but the lesions may extend to the neck or tail. The diagnosis is made by histopathology by identifying gram-positive filamentous and pleomorphic bacteria in the tissues. Treatment consists of giving an appropriate antibiotic and changing environmental conditions (Savey, 2009).

Coelomite due to the release of egg yolk directly into the coelom

Uromastyx are prone to problems affecting the reproductive tract and more specifically to this type of coelomitis which occurs during the preovulatory phase. The reason for the rupture of the ovarian follicle and its detachment remains unknown. Diagnosis is difficult, as the general condition of these lizards tends to deteriorate suddenly for no reason. X-rays and abdominal ultrasound, however, can be very helpful. High white blood cell count with pictures of toxic cells and elevated blood calcium can also help in the diagnosis. It is then possible to perform a laparoscopy, but in all cases a celiotomy is necessary to clean the coelomic cavity and attempt to repair the affected ovary (Stahl, 2003a).

Secondary hyperparathyroidism of nutritional origin

Secondary hyperparathyroidism of nutritional origin appears during unbalanced diets or inadequate breeding practices. U.a is a victim of this disease (Wright, 2008).

The presence of parasites has been recorded in this species. Therefore, parasitism and predation are likely two factors affecting life span (Gray, 2001). U.a acts as host to several types of internal parasites including roundworms, pinworms, tapeworms, and protozoan. The nematode species Foleyella candezei has been found in the liver or under the skin of the Algerian U.a. External parasites include various mites and ticks. Since U.a is an herbivore, it may assist in spreading the seeds of the plants it eats (Bartlett, 2003).

Other diseases might be added to the previous list in particular: Pneumonia (Savey, 2009), Hypoervitaminose (Stahl, 2003a), Acute Respiratory Distress Syndrome (Maddalena et al., 2017), Ocular Neural Heterotopia (Clancy et al., 2019). Meanwhile additional threats to this species includes agricultural grazing on plants that U.a commonly eats which creates competition for resources.

More important factors that threaten its survival tend to come from humans through the pet trade and trapping for food and medicine. In addition, road mortality, the alteration of the natural habitat and the disruption caused by road traffic increase stress hormone levels in U.a lizards (Kechnebboua et al., 2019).

10. Conservation status and species recognition

The international commercial trade in spiny-tailed lizards is regulated by the International Trade in Endangered Species Act 2008 by Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) also known as the Washington Convention, which is a multilateral treaty to protect endangered plants and animals. The U.a and all the other Uromastyx species are listed. Although successful trade regulation is difficult to maintain as many can be sold illegally.

This species has not been evaluated by the International Union for Conservation of Nature (IUCN) whose mission is to "influence, encourage and assist societies throughout the world to conserve nature and to ensure that any use of natural resources is equitable and ecologically sustainable (Knapp, 2004; Highfield and Slimani, 2010).

The U.a feeds on plants and its burrows serve as thermal refuges for many other species (Wilms et al., 2010). Therefor unregulated and unsustainable hunting of spiny-tailed lizards may adversely affect the ecosystem.

11. Conclusion

The Uromastyx acanthinura remains one of the important Saharan species in the north region of Africa, especially in Algeria. Due to its physiological and biological particularities, it can be used in many therapeutical approaches, yet little is known about this lizard, more research is required. In addition, there are far more concerning husbandry and captive breeding of Uromastyx acanthinura than concerning their ecology and behaviour in the wild.

12. References

Amer SA, Kumazawa, Y (2005a) Mitochondrial DNA sequences of the Afro-Arabian spiny-tailed lizards (genus Uromastyx; family Agamidae): Phylogenetic analyses and evolution of gene arrangements. *Biological Journal of the Linnaean Society*. 85: 247–260.

Amer SA, Kumazawa, Y (2009) Molecular affinity of Somali and Egyptian mastigures among the Afro-Arabian Uromastyx. Egyptian. *Journal of Experimental Biology*. 5: 1–7.

Amer SA, Ahmed MM, Wilms TM, Shobrak M, Kumazawa, Y (2012) Mitochondrial DNA variability within Uromastyx ornata philbyi (Agamidae: Squamata) from Southwestern Saudi Arabia. *Comparative and Functional Genomics*. 851379.

Aulio R, Daoues K, Gerard P, Hussard N, Schilliger L (2003) Atlas de la terrariophilie, Volume 3 : les lézards. Animalia éditions, 192 pp.

Barka-Dahane Z, Bendjelloul M, Estabel J, Exbrayat JM (2010) The distribution of vasotocin and mesotocin immunoreactivity in the hypothalamic magnocellular neurosecretory nuclei of the Saharan herbivorous lizard, Uromastyx acanthinura Bell, 1825 (sauria-Agamidae). *Histology Histopathology*. 25: 159-175.

Bartlett R (2003) *Spiny-tailed Agamids: Uromastyx and Xenagama*. Hauppauge, New York: Barron's Educational Series, Inc.

Bell CJ, Hollenshead MG, Mead JI, Swift SL (2010) Presence of a urinary bladder in Egernia depressa (Squamata: Scincidae) in Western Australia. *Records of the Western Australian Museum*. 25(4): 459-462.

Brito-Casillas Y, López-Ríos L, Wiebe JC, Muñozmediavilla C, Nóvoa-Mogollón FJ, Ojeda A, Wägner AM (2016) Uromastyx acanthinura as a natural treatment in a mouse model of type 2 diabetes. *Endocrinology Nutrition*. 63(1):13-18.

Bradshaw, S. D. (1997). Thermal homeostasis. In *Homeostasis in Desert Reptiles*, Springer, Berlin, Heidelberg: 123-165

Bradshaw SD, Lemire M, Vernet R, Grenot CJ (1984a) Aldosterone and the control of secretion by the nasal gland of the North African desert lizard, Uromastix acanthinurus. *General and Comparative Endocrinology*. 54: 314-323.

Bradshaw SD, Bradshaw FJ (2002) Arginine vasotocin: site and mode of action in the reptilian kidney. *General and comparative endocrinology*. 126(1): 7-13.

Boulenger George-Albert (1885) Catalogue of the lizards in the British museum (Natural history). Order of the trustees. London.

Cooper W, AL-Johany A (2002) Chemosensory responses to foods by an herbivorous acrodont lizard, Uromastyx aegyptius. *Journal of Ethology*. 20: 95-100.

Cooper CE (2017) Endocrinology of osmoregulation and thermoregulation of Australian desert tetrapods: a historical perspective. *General and Comparative Endocrinology*. 244: 186-200.

Chaabane I (2011) Etude structurale et ultrastructurale des noyaux supraoptiques de l'hypothalamus en période d'activité physiologique (printemps) et en période de latence hivernale chez le lézard saharien Uromastyx acanthinura (Bell, 1825). Mémoire de magister. FSB/USTHB, Alger. Numéro d'ordre : 05 / 2011-M / S.B

Cloudsley-Thompson JL (1992) Ecophysiology of Desert Arthropods and Reptiles. Adaptations of Desert Organisms. *The Quarterly Review of Biology*. 67(4): 547-548.

Clancy CS, Mainenti M, Van Wettere AJ (2019) Ocular Neural Heterotopia in a Moroccan Uromastyx (Uromastyx acanthinurus nigriventris). *Journal of Comparative Pathology*. 172:107-109.

Dantzler WH, Holmes WN (1974) Water and mineral metabolism in Reptilia. *Chemical Zoology*. 9: 277-336.

DE Witt CB (1967A) Behavioral thermoregulation in the desert iguana. *Sciences (NY)*. 158: 809~810

Dubuis A, Faurel L, Grenot C, Vernet (1971) Sur le régime alimentaire du Lézard saharien Uromastyx acanthinurus Bell. *Comptes Rendus de l'Académie des Sciences*. Paris. 273: 500-503.

Dunson WA (1976) Salt glands in reptiles. In Gans C & Dawson WR (eds.) *Biology of the reptilia*. Vol. 5, Physiology A. London: Academic Press. pp. 413–441.

Ford SS, Bradshaw SD (2006) Kidney function and the role of arginine vasotocin in three agamid lizards from habitats of differing aridity in Western Australia. *General and Comparative Endocrinology*. 147(1): 62-69.

Filosa S (1973) Biological and cytological aspects of the ovarian cycle in Lacerta sicula sicula Raf. *Monitore Zoologico Italiano*. 7: 151–165.

Gray R (2001) The Natural History, Husbandry and Captive Propagation of the Moroccan Spiny-tailed Lizard, *Uromastyx acanthinurus*. *The Vivarium*. Volume 10 Number 1.

Grenot C, Loirat F (1973) L'activité et le comportement thermorégulateur du lézard saharien Uromastyx acanthinura (Bell, 1825). La Terre et la Vie. *Rev. Ecol. Appl*. 27 : 435–455

Grenot C (1976) Ecophysiologie du lézard saharien Uromastix acanthinurus Bell, 1825 (Agamidae herbivore). *Centre de Recherches sur les Zones Arides (C.N.R.S.) Paris*. 7: 44-136.

Grenot C, Vernet R (1973) Les Lezards Heliophiles du Sahara: Facteurs Ecologiques et Conditions d'Elevage. *Bull. Soc. Nat*. Afrique du Nord. 64 : 53-78.

Grenot CJ (1968) Sur l'excretion nasale de sels chez le lezard saharien Uromastic acanthinurus. *Comptes Rendus de l'Académie des Sciences (Paris)*. 226:1871-1874.

IUCN Red List (2015) The IUCN Red List of Threatened Species. Version 2015-3. www.iucnredlist.org. Viewed on 12 October 2015.

Savey C (2009) Les Affections Des Lézards Liées Aux Conditions De Captivité. *Thèse de doctorat vétérinaire*. Créteil. Faculté de Médecine.

Sindaco R, Jeremčenko VK (2008) The reptiles of the Western Palearctic. 1. Annotated checklist and distributional atlas of the turtles, crocodiles, amphisbaenians and lizards of Europe, North Africa, Middle East and Central Asia. Edizioni

Belvedere Latina. *Monografie della Societas Herpetologica Italica*.

Singh P, Krishna A, Sridaran R, Tsutsui K (2008) Changes in GnRH I, bradykinin and their receptors and GnIH in the ovary of Calotes versicolor during reproductive cycle. *General and Comparative Endocrinology*. 159: 158–169.

Stahl SJ (2003A) Pet Lizard Conditions and Syndromes. *Avian and Exotic Pet Medicine*. 12(3): 162-182.

Tammaro S, Simoniello P, Filosa S, Motta CM (2007) Block of mitochondrial apoptotic pathways in lizard ovarian follicle cells as an adaptation to their nurse function. *Cell and Tissue Research*. 327: 625–635.

Talmatamar A, Chaabane I, Salem S, Touati H, Remana S, Chevalier C, Moudilou EN, Exbrayat JM, Barka-Dahane Z (2020) Kidney functional morphology variations between spring and winter in the Saharan male lizard Uromastyx acanthinura (Sauria, Agamidae), with special reference to body water economy. *Tissue Cell*. 67: 101448.

Uetz, P, Freed P, Hzrošek, J (2017). *The reptile database*.

Hammouche, S, Gernigon T, Exbrayat, JM (2007) Immunocytochemical localization and ultrastructural study of gonadotroph cells in the female desert lizard Uromastyx acanthinura. *Tissue Cell*. 39: 13–25.

Hammouche S, Gernigon, T Exbrayat, JM (2009) Correlation between ovarian steroidogenesis and β-endorphin in the lizard Uromastyx acanthinura: Immunohistochemical approach. *Folia Histochemica et Cytobiologica*. 47: S95–S100.

Harkewicz KA (2002) Dermatologic problems of reptiles. *Semin Avian Exot Pet Med*. 11: 151-161.

Harris DJ, Vaconcelos R, Brito JC (2007) Genetic variation within African spiny-tailed lizards (Agamidae: Uromastyx) estimated using mitochondrial DNA sequences. *Amphibia-Reptilia*. 28: 1–6.

Highfield, AC., & slimani, T. (1998). The Spiny-Tailed Lizard at home–Uromastyx acanthinurus in southern Morocco. *Reptiles Magazine*.

Kechnebbou M, Martín J, Chammem M, Arregui L, Nouira S (2019) Roads and urban areas as physiological stressors of spiny-tailed lizards, Uromastyx acanthinura. *Journal of Arid Environments*. 170:103997.

Klaphake E (2010) A Fresh Look at Metabolic Bone Diseases in Reptiles and Amphibians. *Veterinary Clinics of North America - Exotic Animal Practice*. 13(3): 375-392.

Knapp A (2004) An Assessment of the International Trade in Spiny-tailed Lizards Uromastyx with a focus on the Role of the European Union. TRAFFIC Europe. European Commission, Brussels, Belgium.

Kopolos P, Garner M, Besser T, Nordhausen R, Monaco R (2000) Cheilitis in lizards of the genus Uromastyx associated with filamentous gram-positive bacterium. *Proceedings of the 7th Annual Association of Reptilian and Amphibian Veterinarians Conference, Reno*. 73-75.

Laughran LJ, Larsen JH, Schroeder PC (1981) Ultrastructure of developing ovarian follicles and ovulation in the lizard Anolis carolinensis (Reptilia). *Zoomorphology*. 98: 191–208.

Lemire M, Grenot C, Vernet R (1982) Water and electrolyte balance of free-living Saharan lizards, Uromastix acanthinurus (Agamidae). *Journal of comparative physiology*. 146(1): 81-93.

Lemire M (1983) Contribution à l'etude des structures nasales des Sauriens. Structure et fonction de la glande "a sels" des lezards deserticoles. *These de Doctorat d'Etat*. Universite de Pierre et Marie Curie, Paris VI.

Lemire M, Vernet R (1983) Acclimation of nasal salt secretion in the lizard Uromastix acanthinurus (Agamidae). Effects of repetitive salt loads. *Journal of Arid Environments*. 6:145-153.

Lemire M, Deloince R, Grenot CJ (1970) Etudes des cavites nasales du Lezard Fouette-Queue, Uromastix acanthinurus Bell. *Comptes Rendus de l'Académie des Sciences (Paris)*. 270: 817-820.

Lemire M, Deloince R, Grenot CJ (1972) Etude histoenzymologique de la glande "a sels" du lezard saharien Uromastix acanthinurus Bell. *Comptes Rendus de l'Académie des Sciences (Paris)*. 274: 3414-3416.

Lemire M, Grenot CJ, Vernet R (1979) La balance hydrique d'Uromastix acanthinurus Bell (Sauria, Agamidae) au Sahara dans des conditions semi-naturelles. *Comptes Rendus de l'Académie des Sciences (Paris)*. 288: 359-362.

Lemire M, Grenot CJ, Vernet R (1980) Electrolyte excretion by the nasal gland of an herbivorous Saharan lizard, Uromastix acanthinurus (Agamidae). Effects of single NaCl and KCl loads. *Journal of Arid Environments*. 3: 325-330.

Lemire M, Grenot CJ, Vernet R (1982) Water and electrolyte balance of free-living Saharan lizards, Uromastix acanthinurus. *Journal of Comparative Physiology*. 146: 81-93.

Licht P (1975) Temperature dependence of the actions of mammalian and reptilian gonadotropins in a lizard. *Comparative Biochemistry & Physiology*. 50A: 221–222.

Licht P, Wood J, Owens DW, Wood F (1979) Serum gonadotropins and steroids associated with breeding activities in the green sea turtle Chelonia mydas. I. Captive animals. *General and Comparative Endocrinology*. 39: 274–289.

Licht P, Papkoff H, Farmer SW, Muller CH, Tsui HW, Crews D (1976) Evolution of gonadotropin structure and function. *Recent Progress in Hormone Research*. 33: 169–248.

Matz G, Vanderhaege M (1990) *Guide du terrarium*. Editions Delachaux et Niestlé, Paris, 350.

Mateo J, Geniez, P, López-Jurado L, Bons J (1998) Chronological analysis and morphological variations ofsaurians of the genus Uromastyx (Reptilia, Agamidae) inwestern Sahara. Description of two new taxa. *Revista Española de Herpetología*. 12: 97-109.

Maddalena I, Giacomo R, Gian EM, Marco C (2017) Acute Respiratory Distress Syndrome in an Uromastyx (U.anigriventris, 1820), *Journal of Exotic Pet Medicine*. 26(3): 192-195.

Mattison C (1989) *Lizards of the World*. New York, Facts on File, 192.

Moali A (2009) Bulletin d'information des Ressources Naturelles.

Motta CM, Castriota Scandenberg M, Filosa S, Andreuccetti P (1995) Role of pyriform cells during the growth of oocytes in the lizard Podarcis sicula. *Journal of Experimental Zoology*. 273: 247–256.

Motta CM, filosa s. Andreuccetti P (1996) Regression of the epithelium in the late previtellogenic follicles of Podarcis sicula: a case of apoptosis. *Journal of Experimental Zoology*. 276: 233–241.

Nagy K (1973) Behavior, Diet and Reproduction in a Desert Lizard, Sauromalus obesus. *Copeia*. 1: 93-102.

Seshadri C (1957) Water conservation in Uromastix hardwickii (Gray) with a note on the presence of Miillerian ducts in the male. *Journal of the Zoological Society of India*. 9: 103-113.

Vieira S, De Pérez GR, Ramírez-Pinilla MP (2010) Ultrastructure of the ovarian follicles in the placentotrophic andean lizard of the genus Mabuya (Squamata: Scincidae). *Journal of Morphology*. 271: 738–749.

Walls Jerry G (1996) Uromastyx & Butterfly Agamids. *TFH Publication*s. USA.

Shams, W.A., Onoja, S.O., Rehman, G., Islam, S.U., Khan, K., Ibrar, M., Sia, S.B., Ayaz, S.G., Ali, S., Israr, M. and Safi, D., 2021. Antidiabetic effects of ethanol extract of Uromastyx hardwickii Smith (Agamidae) skin on streptozotocin-induced diabetes mellitus in mice. Tropical Journal of Pharmaceutical Research, 20(3), pp.627-632.

Wright K (2008) Two Common Disorders of Captive Bearded Dragons (Pogona vitticeps): Nutritional Secondary Hyperparathyroidism and Constipation. *Journal of Exotic Pet Medicine*. 17(4): 267–272.

Wilms TM, Wagner P, Shobrak M, Lutzmann N, Böhme W (2010) Aspects of the ecology of the Arabian spinytailed lizard (Uromastyx aegyptia microlepis Blanford, 1875) at Mahazat as-Sayd protected area, Saudi Arabia. Salamandra. 46(3): 131-140.

Wilms T (2001) *Dornschwanzagamen. Lebensweise – Pflege – Zucht.* Second revised edition. 144 pp. Offenbach; Herpeton-Verla*g*.

Wilms T, Böhme W (2000a) A new Uromastyx species from south-eastern Arabia, with comments on the taxonomy of Uromastyx aegyptia (Forskål, 1775) (Squamata: Sauria: Agamidae). *Herpetozoa*. 13 (3/4): 133-148.

Wilms T, Böhme W (2000b) Revision der Uromastyx acanthinura-Artengruppe, mit Beschreibung einer neuen Art aus der Zentralsahara (Reptilia: Sauria: Agamidae). *Zoologische Abhandlungen aus dem Staatlichen Museum für Tierkunde Dresden*. 51(8): 73-104.

Wilms T (2005) Uromastyx – Natural History, Captive Care, Breeding. Offenbach. Germany: Herpeton.

Wilms TM, Schmitz A (2007) A new polytypic species of the genus Uromastyx Merrem 1820 (Reptilia: Squamata: Agamidae: Leiolepidinae) from southwestern Arabia. *Zootaxa*. 1394: 1-23.

Wilms T, Böhme W, Wagner P, Lutzmann N, Andreas S (2009) On the Phylogeny and Taxonomy of the Genus Uromastyx Merrem, 1820 (Reptilia: Squamata: Agamidae: Uromastycinae) – Resurrection of the Genus Saara Gray, 1845. *Bonner zoologische Beiträge*. 56: 55-99.

Zari T (1991) The influence of body mass and temperature on the standard metabolic rate of the herbivorous desert lizard, Uromastyx Microlepsis. *Journal of Thermal Biology*. 16/3: 129-133.

Zoffer DJ (1996) *Agamid Lizards (Herpetology series)*, TFH Publications, Incorporated, New Jersey, United States.

Zug, G.R. (1993). Herpetology: An Introductory Biology of Amphibians and Reptiles. Academic Press Inc, San Diego, California.