



Chameleonology
Chameleonoculture
Chameleonopromotion



- Chameleon In Ancient Cultures
- A Breakthrough In Captive Management
- Quadruplets, Triplets And Twins
- Leaf Walking

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The Chameleon (Reptilia: Chamaeleonidae) in ancient cultures of the Mediterranean Region & Near East, amongst superstitions, myths, magic and science

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Abstract: The basis of analysis of ancient scripts, artifacts, biology, the position of chameleon in ancient cultures of the Circum-Mediterranean region and Near East is discussed. Surprisingly, the representation of such a strange and interesting animal as the chameleon, very little represented in writings and art; it is absent from myths in this region; only single artifacts are known. Based on the interdisciplinary analysis, it seems more likely that the animal acting in the biblical story of Adam and Eve and their first sin, is not a snake but rather a chameleon. It seems also that the belief about the etymology of the contemporary word “chameleon” is not an “earth lion” but rather an “invisible beast.”

Key words: Chameleon, antiquity, myth, legend, superstition, science, snake, serpent, coin, statue

INTRODUCTION

The interdisciplinary text is compiled from two perspectives: historical and cultural factography (marked with dark blue, written mainly by the first author) and the biological and linguistic comments (marked with maroon, written mainly by the second author).

The Ancient period comprises of all ancient cultures predating the middle Ages. The Classical Ancient period is centered around the Mediterranean Sea, where cultures under strong influence of Ancient Greece and Ancient Rome flourished. Beginning in the 8th century BC, from the beginning of the archaic Greek culture, reigning until 476 AD, at the fall of the Rome Empire. We concentrate here exactly on these times and in the Circum-Mediterranean and Near-Eastern cultures.

People have known chameleons since the dawn of history. They have met them in the Mediterranean, North Africa and the Middle East since the early civilizations. The unusual animal was not dangerous, but its bizarre appearance and difficult to understand characteristics (independently moving eyes, ability to color, shooting tongue) differed significantly from other creatures. Therefore, it is no wonder that from the very beginning the chameleon evoked inconsistent feelings in people.

Chameleons are lizards of the family Chamaeleonidae that are well known for many special morphological and physiological adaptations; such as laterally flattened body, pyramidal head, lungs with extensive pulmonary sacks,

prehensile tail, color change, independently movable protruding eyes, long extendable tongues, special pincer-like arrangement of the digits etc. This combination of features is really absolutely unique amongst all reptiles and even vertebrates (NECAS 1999; TOLLEY & HERREL 2014).

Chameleons were physically known by the ancient civilizations from Northern-African and Eastern Mediterranean coast by the Common Chameleon – *Chamaeleo chamaeleon* (LINNAEUS, 1758) and from the Nile delta and region along the river Nile by the African Chameleon – *Chamaeleo africanus* (LAURENTI, 1768). This is the present known range of these two species in the pertinent region. However, as the climate under which the ancient civilizations flourished was obviously different (colder, moister), then nowadays (DUGLAS & KENNET, 2006), it is not excluded that the mentioned two species have been distributed more widely and the more inland. Additionally, some chameleon species might have occurred in areas from which they are now absent and pushed by the aridisation and increase of the temperatures into their current refugees, such as potentially the Arabian Chameleon – *Chamaeleo arabicus* (MATSCHIE, 1893) along the coast of Arabian peninsula from Oman to the north, or the Indian Chameleon – *Chamaeleo zeylanicus* (LAURENTI, 1768) along the Persian coast from Pakistan westwards, both potentially reaching the ancient Mesopotamia.

THE NAME OF CHAMELEON

The origin of the present word “chameleon” is remarkable. It is traditionally explained that it comes from the ancient Greek χαμαιλέων (khamailéōn), which is a composite of the words khamai, which means “on earth”, and the Léon, which means “lion”. For the purpose binomic nomenclature, codified first by CARL VON LINNAEUS in 1758, the original Greek word was Latinized and transliterated into “*Chamaeleon*”, building the base for national derivatives and modifications in different languages around the world: like Chameleon (English), Caméléon (French), camaleón (Spanish), camaleão (Portuguese), chameleon (Czech) and хамелеон (Russian). The Greek word *khamailéōn* originates from an even older Akkadian 𒌦𒍪𒍪𒍪 *nēšu sa qaqqari*, literally a “lion on the ground” or more generically a “predator, beast crawling on the ground.” The same expression appears in the EPIC OF GILGAMESH (XI. Table) (MATOUŠ, 2018) (WEBSTER’S 1913; WIKTIONARY.ORG).

The reasons which the ancient peoples led to a comparison of a chameleon with a lion can only be speculated. Most likely, the chameleon's casque reminded them of a lion's mane and the general anatomy with side-wise flattened body is the only model in lizards to resemble a big cat. It is also interesting that the modern greek word χαμαι means “lost”, “invisible”, which would make a bit more sense, because to be “unseen” is one of the chameleon's outstanding skills while movement on the ground is actually quite rare in their life history, because all the anatomy is adapted to living in trees and bushes (NECAS 1999).

It seems, that the potential interpretation of the etymological roots of the word “chameleon” is in fact much wider and reaches from the traditional “ground lion” to “invisible beast.”

The BIBLE (LEVITICUS) uses as a name for one of the “unclean” creatures the term *tinshemeth* (תִּנְשֶׁמֶת). The term was originally translated as „ground crocodile“ or „mole“. In the later and revised editions of the BIBLE, the word chameleon appears, reflecting the meaning of the word *tinshemeth* in the root of the Hebrew expression נָחָשׁ (nah'ash), which refers to a creature, that loudly breathes or hisses. The translation „chameleon“ was used because of the infamous ability of the chameleon to blow up its body and hiss. The Aramean translates the word chameleon as זָקִיטָא (*zakita, zikita*) (INTERNATIONAL STANDARD BIBLE ENCYCLOPEDIA ONLINE; MELAMED 2005).

CHAMELEONS IN LITERATURE

The first written records of chameleons are from the Middle East. The chameleon is listed in the list of exotic animals on an Akkadian clay table with a map of Mesopotamia from the 6th century BC, found in today's Iraqi Sippar (ARCHEOLOGY 2016).

As a probably good example, the chameleon was used by the King of Assyria, ESARHADDON (681-669 BC),

writing in the Succession Treaty: “May your flesh and the flesh of your women, your brothers, your sons and your daughters be altogether like the flesh of a chameleon” (ORACC 1988).



Fig 1. Akkadian clay table with a map of Mesopotamia from the 6th century BC, Sippar, Iraq; Drawing VLADIMÍR HRUŠA

In contrast, the Bible classifies chameleons among unclean animals. The third book of MOSES (LEVITICUS) written in the 6th century BC says, “Furthermore, you will be unclean for vermin swarming on the ground: a mole, a mouse, various lizards, geckos, skinks and a chameleon” (BIBLE, LV 11:29 - 30).

All these creatures were unclean, and whoever touched their carcass was unclean until the evening. If the carcass of the chameleon (or any other creature) touched any object, it was also unclean and had to be either thoroughly washed or destroyed, whether it was a simple water tank or a furnace or fireplace - they were even to be demolished (BIBLE, LV. 11:29 - 38).

While Bible does not address usually the reptiles in too much detail, collectively labeling them as unclean and not paying too much attention to them, the text from LEVITICUS (BIBLE, LV 11:29 - 30) is surprisingly precise, defining here almost all recently known lizard families: “various lizards” seems to refer to the families of the fast moving and superficially similar lizards Agamidae, Lacertidae and Varanidae; “geckos” to the family Gekkonidae; “skinks” to

the family Scincidae and “chameleon” to the family Chamaeleonidae, leaving only the remaining family of the legless lizard Anguidae unmentioned, obviously for the reason of their almost unidentifiable resemblance to snakes.

misinterpreted the use of the expression *nēšu sa qaqqari* as a poetic turn for the reptile, thus for a snake (SJÖBERG 1985).



Fig 2. Adam and Eve in the Garden of Eden; Drawing ANASTASIIA SHIRIAEVA

Quite interesting is the story at the beginning of the Bible and Torah. It is generally believed that the creature that seduced Adam and Eve in the third chapter of Genesis to eat fruit from the tree of the knowledge in the Garden of Eden was a snake (BIBLE, GN 3). After all, this animal is named in all translations of the Bible and has become a symbol of cunning and deceit.

But was the biblical seducer really a snake?

SJÖBERG first criticizes the generally accepted translation of the aforementioned EPIC OF GILGAMESH. Here, too, the treacherous creature that deprives GILGAMESH of immortality is a snake. For a creature that alienates GILGAMESH'S immortality plant, the original text uses the term *nēšu sa qaqqari*, means “lion on earth”, the Greek *χαμαιλέων* – *khamailēōn*, the chameleon. According to SJÖBERG, the translators were confused when they

A similar confusion occurred also in the third chapter of Genesis, when the Hebrew expression *nah'ash*, generally denoting a reptile that hisses or whispers, was also misinterpreted and translated as a snake. And because the biblical story has its roots in Epic about GILGAMESH, SJÖBERG believes, that the chameleon is the logical conclusion.

This idea is further supported by the Bible itself when God punishes a guilty creature, “You will crawl on your stomach and eat dust all the days of your life” (BIBLE, GN 3:14). Another controversial question arises here: Why would God punish a snake who had crawled on its belly long before...?

The character of snake in this Biblical story is questionable. Amongst all snakes known to occur in the potential area of the Garden of Eden, none is known to

climb trees, on contrary, exclusively all are either terrestrial or have an affinity to water. It does not mean that under special circumstances they cannot climb a tree, but it is very unlikely and observations like that are very scarce and absolutely not typical (DISI & AL 2001). Even if a snake would be encountered on a tree (like the members of the genera *Psammophis* or *Coluber*) it would rather seek a very quick escape than give any sounds. The opposite is true for the chameleon, which spends the vast majority of its life in trees; especially in trees with flowers and fruits, which attract flying insects, building the majority of its diet. The chameleon is also one of the few reptiles in the pertinent region, if not the *only* one, which could account for the only sound mentioned – which chameleons can produce – the hissing or puffing sound of a snake (NECAS, 1999). If a human would corner or even touch a chameleon on a tree, it would not flee, but it would very likely hiss (or whisper), as is described in the original text of the BIBLE and TORAH.

GENESIS (3:1) states, “Now the serpent was more crafty than any of the wild animals the Lord God had made.” The allocation of the animal to a snake is questionable, as it usually is even not explicitly said to be a snake but a “serpent.” The term “serpent” originates from the Latin word *serpens*, which is an adjective, present active participle of *serpō* (“crawl, creep”), cognating with Sanskrit सर्प (sarpá, “snake, serpent”) and Ancient Greek ἑρπετόν (herpetón, “serpent, creeping or crawling animal”).

The expression “serpent” is often used also as a noun and then translated as “snake,” but its original meaning is “a creeping animal” and can be and is interpreted in many other ways also (coluber, anguis, draco, vipera, jaculus, monster, sea monster), so not always and not explicitly a snake. The behavioral patterns, especially general locomotion of a chameleon fits much more (or at least same as) the “creeping animal” imagination, than a snake.

The Hebrew word נָחָשׁ (nah’ash) is used to identify the serpent that appears in Genesis 3:1. Its meaning is again translated as “snake, legless reptile or serpent”.

There is a debate about whether the serpent in Eden should be viewed figuratively or as a literal animal. According to one Midrashic interpretation in Rabbinic literature, the serpent represents sexual desire; another interpretation is that the snake is the “yetzer hara,” inclination to do evil, by violating the will of God. Modern Rabbinic ideas include interpreting the story as a psychological allegory where Adam represents reasoning faculties, Eve the emotional faculties, and the serpent the hedonistic sexual/physical faculties.

Moreover, the general label given to the biblical creature in question is “crafty,” sometimes the words “subtle” or “cunning” are used also. The serpent is portrayed as a deceptive creature or trickster, who promotes as good what God had forbidden and shows particular cunning in its deception. While the chameleon is notoriously known as a trickster that fools the world around it using its ability to “disappear” and become invisible (thanks to its special body

form, color change capabilities and behavioral patterns) (NECAS 1999), these characteristics seem to be attributed to the snake solely based on the Biblical tradition.

In religion, mythology, and literature, serpents and snakes often stand for fertility or a creative life force. They have also been associated with water and earth because many kinds of snakes live in the water or in holes in the ground. The ancient Chinese connected serpents with life-giving rain. Traditional beliefs in Australia, India, North America, and Africa have linked snakes with rainbows, which in turn are often related to rain and fertility. Thanks to the shedding old skin, snakes become symbols of rebirth, transformation, immortality, and healing. The ancient Greeks considered snakes sacred to Asclepius, the god of medicine. For both the Greeks and the Egyptians, the snake represented eternity. Ouroboros, the Greek symbol of eternity, consisted of a snake curled into a circle or hoop, biting its own tail. Living on and in the ground, serpents came to be considered in some religions and mythologies as guardians of the underworld, representing hidden wisdom or sacred mysteries. Snakes as symbols of death, evil, or treachery may be related to the fact that some of them are venomous and dangerous. Satan and other devils have frequently been portrayed as snakes. The Nagas of Hindu and Buddhist mythology symbolize both good and evil, hopes and fears (MYTHS AND LEGENDS). An ancient Slavonic tradition believed the snake is a protector of a household (P. NECAS, PERS. OBS.). From these other accounts it becomes obvious that the association of the snake as a trickster is present only on the base of the biblical story and nowhere else.

Taking into consideration all these perspectives, the chameleon appears to be a much more suitable candidate for the animal – seducing Eve to act against God’s commandment – than the snake.

The story continues then with verses, clearly referable to a snake or serpent (GENESIS 3:14,15):

The Lord God said to the serpent,
“Because you have done this,
Cursed are you more than all cattle,
And more than every beast of the field;
On your belly you will go,
And dust you will eat
All the days of your life;
And I will put enmity
Between you and the woman,
And between your seed and her seed;
He shall bruise you on the head,
And you shall bruise him on the heel.”

The question is, why should the snake be punished for an act made by another animal? Chameleons are notoriously known as animals that fool everyone; this is one of the unexplained details to which such a monumental story then pays no attention. The next interesting question to be raised is, why should a snake be cursed to do something already in its nature (namely to go “on your belly”)? It remains unclear whether the message was meant to be a collective sentence

and punishment for all snakes, or just for this very individual. Both concepts of collective guilt and benefit, as well as individual responsibility, are commonly used throughout all holy scripts. What God tells the serpent perhaps implies that before the event, this animal had legs. From an evolutionary point of view, snakes actually originate from ancestors with limbs, and the remnants of pelvis and limbs are identifiable on the skeleton of snakes both from fossil records as well on current ones (GARBEROGLIO & AL. 2019). Was it possible for the ancient cultures to know snakes had remnants of legs? Being considered unclean and therefore inedible, the anatomy of snakes was very likely not well known. Interestingly enough, there are little skinks living in the pertinent region, such as *Ophiomorus persicus* (STEINDACHNER 1867) and related species, widespread in Persia and Near East; or *Chalcides sepsoides* (AUDOUIN 1829) widespread in Palestine, which all look like small snakes with tiny limbs.

In the Jewish tradition, the chameleon is considered a creature, capable of living from breathing air only. The rationale of this myth comes probably from his ability to inflate the body and hiss, combined with the ability of long fasting (HIRSCH & HYVERNAT 1906).

The Chameleon is also present in the compilation of rabbinic discussions – in the BABYLONIAN TALMUD, TALMUD BAVLI. This Talmud was completed only around the year 500 AD in text and the final design was made in the beginning of 8th century AD, it means in the early medieval period, its oral version, however, originates deep in the Ancient Period (BRITISH LIBRARY 2020).

First note on the chameleon in the is mentioned in LEVITICUS: „Mishna: One who catches or wounds any one of the eight kinds of reptiles enumerated in the Scriptures (the weasel, the mouse, the tortoise, the hedgehog, the chameleon, the lizard, the snail and the mole) is culpable; one who wounds worms or any other kind of reptiles (not enumerated above) is free. One who catches them for a purpose is culpable; he who does so without the intention (to use them) is free. He who catches such animals or birds as are within his domain is free, he who wounds them is culpable.“ (THE BABYLONIAN TALMUD 8st century ADa).

The second note is a story, told by the Noah's son Shem. Chameleon was one of the animals, saved from the great flooding in Noah's Arch, there was however a problem with its food:

„We had great trouble in the ark to feed all the animals. The creature whose habit it is to eat in the daytime we had to feed in the day, and those whose habit it is to eat in the night, we have to feed in the night. A chameleon, my father did not know what its food is. It happened one day that he cut a pomegranate and a worm fell out of it, and the above consumed it, and from that time prepared its food from the worms found in rotten apples.“ (THE BABYLONIAN TALMUD 8st century ADb).

The story is in accordance with the commands concerning animals from the BIBLE. They should be treated

with respect and kindness; they should be observed, and their needs should be fulfilled. Until Noah observed the chameleon, he didn't know how to feed him properly. But then he learned, and the chameleon was no longer hungry.

For the ancient Greeks and Romans, the chameleon was a repulsive creature, but at the same time it had many wonderful, sometimes bizarre qualities.

The historian PLUTARCH used the chameleon and his lightning conversion capability to describe the negative qualities of the warlord ALCIBIADES – an all-capable defector of the bloody Peloponnese War – when he said the defector would be, “Assuming more violent changes than the chameleon. That animal, however, as it is said, is utterly unable to assume one color, namely, white; but ALCIBIADES could associate with good and bad alike and found naught that he could not imitate and practice” (PLUTARCH, 46-119/127 AD).

The Common Chameleons (*Chamaeleo chamaeleon*) use color change for many reasons, especially when thermoregulating while overheated, and can produce even white or whitish colors. Many other chameleon species can produce pure white areas on their skin such as *Bradypodion thamnobates* (RAW 1976), *Archaius tigris* (KUHLE, 1820), *Furcifer pardalis* (CUVIER, 1826) etc. (NECAS 1999).

Ample information about the chameleon can be found in the work “Naturalis historia,” by Roman natural scientist GAIUS PLINIUS SECUNDUS, also known as PLINIUS MAIOR (23-79 AD). While ARISTOTLE'S scientific description of the chameleon (see later) was taken over in Book 28, in Book 29 (PLINIUS), he often presents funny "facts". He refers to the writings of the Greek philosopher DEMOCRITUS OF ABDERA (460 - 370 BC), “Of the Power and Nature of Chameleons” (KITCHELL 2014), who, though, "... in fact, has no amusement, revealing as it does, and exposing the lies and frivolities of the Greeks.”

According to PLINIUS, the Greeks believed that if a hawk would fly over a chameleon, it would fall dead to the ground. Moreover, the chameleon has the power to attract and leave it as prey to other animals.

Chameleons consider smaller birds as potential prey and big birds as predators. They can shoot smaller birds right out of the air with their tongues, to swallow and kill for a quick meal (NECAS & MISKUFF 2019). On the other hand, chameleons are in fact so afraid at the sight of a big bird, they will often express a shock reaction by falling “dead” after such encounter (NECAS 1999). It is possible to see a bird falling dead because of a chameleon's trickery – as the chameleon can indeed cause this – but not in the case of larger birds like hawks. If a bird of prey, using its fabulous eyesight, spots a chameleon on a tree, it will try to hunt for it. The males of many chameleon species expose themselves throughout the canopy to watch over their territories, risking being visible to birds high overhead. The bird can therefore descend down trying to hunt for the chameleon, in which the lizard (with excellent eyesight) would very likely notice the incoming attack and perch itself on the opposite side of

branch (known as “shadowing”). The bird would then land and search for the prey – being so focused on the hunt, it might not notice other dangers in the form of some big cat or other predator, for example. It can be noted by the observer, the bird being attracted by the chameleon and eaten by some other animal, as the text says.

Also, very bizarre are other statements that PLINIUS, he says, do not believe too much, yet he cites them in detail. Here we extract some to comment:

- Chameleon head burned on oak wood or tiles in the house can summon a storm.
- The right eye, taken from a live animal applied with goat's milk, removes diseases of (crystalline) tissue plague in the eyes.
- If a live chameleon is present in the house, it will facilitate childbirth, but it must not be retrieved from the outside.
- Rubbing the feet with ash from the left foot of a chameleon mixed with pig milk will cause gout.

While the association of the healing powers of the parts of a chameleon's body is a bit obscure and difficult to interpret. Rather than having potential to work through a placebo effect, there is a strange association with a gout. Chameleons are quite often known to develop this metabolic disorder in captivity, but it has been observed also on wild specimens (NECAS 1999, PERS. OBS.). Also, when on ground, chameleons often move in a very strange way, like a shaking leaf in the wind – laying the foot on the ground several times before stepping on it – which might actually resemble the staggered gait of a human walking during a gout attack, as it is very painful and might force the person to step several times with the same leg. Whether there is an association, or it is just coincidence, is hard to judge.

The following is an enumeration of many magical obscure practices, the culmination of which is that if the left foot of a chameleon is burned in a furnace with a plant called chamæleon-plant, the ash is poured into a clay ball and placed in a wooden container. A person holding it in hand will become invisible (PLINIUS; GASPAREV 2004).

This practice refers definitely to the ability of chameleon to blend with the environment and become “invisible” and tries to lend this superpower from the chameleon in a magical way doubling the effect through using the animal itself and a plant of the same name. The chameleon plant in fact exists, it is a Bugle or Common Bugleweed - *Ajuga reptans* L., an herbaceous perennial plant species native to the northern Mediterranean region to eastern Europe to Iran. It belongs to the Mint family Lamiaceae, has beautiful blue flowers and is known to be toxic, potentially fatal – it contains narcotic hallucinogenic alkaloids and iridoids, though is also used for medicinal purposes as a tea as analgesic, cardio, healing, astringent and laxative (ANONYMOUS 2020B).

Unfortunately, the original work of DEMOCRITUS has not been well preserved to this day. Its existence, however, is indirectly confirmed by another Roman naturalist AULUS

GELLIUS, when PLINIUS was criticized for citing DEMOCRITUS (HOWLEY 2014). The entire text of PLINIUS reads like this:

“To these animals we shall annex some others that are equally foreign, and very similar in their properties. To begin then with the chameleon, which Democritus has considered worthy to be made the subject of an especial work, and each part of which has been consecrated to some particular purpose. This book, in fact, has afforded me no small amusement, revealing as it does, and exposing the lies and frivolities of the Greeks. In size, the chameleon resembles the crocodile last mentioned, and only differs from it in having the back-bone arched at a more acute angle, and a larger tail. There is no animal, it is thought, more timid than this, a fact to which it owes its repeated changes of color. It has a peculiar ascendancy over the hawk tribe; for, according to report, it has the power of attracting those birds, when flying above it, and then leaving them a voluntary prey for other animals. Democritus asserts that if the head and neck of a chamæleon are burnt in a fire made with logs of oak, it will be productive of a storm attended with rain and thunder; a result equally produced by burning the liver upon the tiles of a house. As to the rest of the magical virtues which he ascribes to this animal, we shall forbear to mention them, although we look upon them as unfounded; except, indeed, in some few instances where their very ridiculousness sufficiently refutes his assertions. The right eye, he says, taken from the living animal and applied with goats' milk, removes diseases of the crystalline humours of the eyes; and the tongue, attached to the body as an amulet, is an effectual preservative against the perils of child-birth. He asserts also that the animal itself will facilitate parturition, if in the house at the moment; but if, on the other hand, it is brought from elsewhere, the consequences, he says, will be most dangerous. The tongue, he tells us, if taken from the animal alive, will ensure a favorable result to suits at law; and the heart, attached to the body with black wool of the first shearing, is a good preservative against the attacks of quartan fever. He states also that the right fore-paw, attached to the left arm in the skin of the hyena, is a most effectual preservative against robberies and alarms at night; that the pap on the right side is a preventive of fright and panics; that the left foot is sometimes burnt in a furnace with the plant which also has the name of “chamæleon,” and is then made up, with some unguent, into lozenges; and that these lozenges, kept in a wooden vessel, have the effect, if we choose to believe him, of making their owner invisible to others; that the possession, also, of the right shoulder of this animal will ensure victory over all adversaries or enemies, provided always the party throws the sinews of the shoulder upon the ground and treads them under foot. As to the left shoulder of the chamæleon, I should be quite ashamed to say to what monstrous purposes Democritus devotes it; how that dreams may be produced by the agency thereof, and transferred to any

person we may think proper; how that these dreams may be dispelled by the employment of the right foot; and how that lethargy, which has been produced by the right foot of this animal, may be removed by the agency of the left side. So, too, headache, he tells us, may be cured by sprinkling wine upon the head, in which either flank of a chameleon has been macerated. If the feet are rubbed with the ashes of the left thigh or foot, mixed with sow's milk, gout, he says, will be the result. It is pretty generally believed, however, that cataract and diseases of the crystalline humours of the eyes may be cured by anointing those organs with the gall for three consecutive days; that serpents may be put to flight by dropping some of it into the fire; that weasels may be attracted by water into which it has been thrown; and that, applied to the body, it acts as a depilatory. The liver, they say, applied with the lungs of a bramble-frog, is productive of a similar effect: in addition to which, we are told that the liver counteracts the effects of philtres; that persons are cured of melancholy by drinking from the warm skin of a chamæleon the juice of the plant known by that name; and that if the intestines of the animal and their contents – we should bear in mind that in reality the animal lives without food – are mixed with apes' urine, and the doors of an enemy are besmeared with the mixture, he will, through its agency, become the object of universal hatred. We are told, too, that by the agency of the tail, the course of rivers and torrents may be stopped, and serpents struck with torpor; that the tail, prepared with cedar and myrrh, and tied to a double branch of the date-palm, will divide waters that are smitten therewith, and so disclose everything that lies at the bottom and I only wish that Democritus himself had been touched up with this branch of palm, seeing that, as he tells us, it has the property of putting an end to immoderate garrulity. It is quite evident that this philosopher, a man who has shown himself so sagacious in other respects, and so useful to his fellow-men, has been led away, in this instance, by too earnest a desire to promote the welfare of mankind.”

Another Roman who mentions the breathtaking abilities of a chameleon is ALEXANDER OF MYNDUS (1st century AD). He claims that the snake cannot eat the chameleon because the chameleon has too thick of skin. Even more interesting, if a snake wants to eat a chameleon, the chameleon will grab a stick, which in turn defies the mouth of the snake, thus rescuing itself (KITCHELL 2014).

This writing is referring to some very interesting biological aspects. Indeed, the skin of the chameleon is surprisingly resistant environmental influences; it is not overly thick but is highly resistant to perforation and is not permeable to water in either direction (TOLLEY & HERREL 2014; P. NECAS, PERS. OBS.). To see a chameleon injured by a snake is a real rarity; with the exception of the big venomous snakes of sub-Saharan Africa like mambas of the genus *Dendroaspis* or boomslangs – *Dyspholidus typus* (SMITH, 1828), which possess very sharp needle-like fangs.

However, they do not inhabit the region of our interest. Moreover, the chameleon, if approached by a snake while sitting in a bush, often plays the “shadowing game,” meaning it turns always to the opposite side of the stick so that the snake cannot attack it. Even if it tries, access to the chameleon is blocked by the branch and the snake might just end up with a piece of wood in its mouth (NECAS IN PREP, PERS.OBS.).

ARTEMIDORUS DALDIANUS (2nd century BC), a Greek diviner and author of many writings on divination and magic, warns in the second book of the five-volume *Oneirocritica* that “To a dream of a chameleon was inauspicious” (KITCHELL 2014).

The boundary between superstitions, magic and legends was very thin in the ancient world. It didn't matter at what time the scholar lived, but how he approached the world and solving problems.

A shining example in this respect is the Greek philosopher ARISTOTLE (384 - 322 BC), the most prominent pupil of PLATO and the teacher of ALEXANDER THE GREAT. In his work *Historia Animalium*, or “The History of Animals,” he devoted a whole chapter to chameleons (ARISTOTLE; The Internet Classics Archive).

ARISTOTLE'S description of the chameleon, though we may find it a little odd today, adheres to the facts available to him at the time. Although ARISTOTLE lived four centuries earlier than PLINIUS, we do not find references to any magical rituals in his work, only a factual description of the chameleon's anatomy. From ARISTOTLE'S writing, it is obvious that the chameleon was not only observed but also dissected:

“The chameleon resembles the lizard in the general configuration of its body, but the ribs stretch downwards and meet together under the belly as the case with fish, and the spine sticks up with the fish. Its face resembles that of the baboon. Its tail is precisely long, terminates in a sharp point, and is for the most part coiled up, like a strap of leather. It stands higher off the ground than the lizard, but the flexure of the legs is the same in both creatures. Each of its feet is divided into two parts, which bear the same relation to one another that the thumb and the rest of the hand bear to one another in man. Each of these parts is for a short distance divided after a fashion into toes; on the front feet the inside part is divided into three and the outside into two, on the hind feet the inside part into two and the outside into three; it has claws also on these parts resembling those of birds of prey. Its body is rough all over, like that of the crocodile. Its eyes are situated in a hollow recess, and are very large and round, and are enveloped in a skin resembling that covers the entire body; and in the middle and slight aperture is left for vision, through which the animal sees, for it never covers up this aperture with the cutaneous envelope. It keeps twisting its eyes round and shifting its line of vision in every direction, and thus contrives to get a sight of any object that it wants to see. The change in color takes place when it is inflated with

air; it is then black, not unlike the crocodile, or green like the lizard but black-spotted like the pard. This change of color takes place over the whole body of alike, for the eyes and the tail come alike under its influence. In its movements it is very sluggish, like the tortoise. It assumes a greenish hue in dying and retains this hue after death. It resembles the lizard in the position of the oesophagus and the windpipe. It has no flesh anywhere except a few scraps of flesh on the head and on the jaws and near the root of the tail. It has blood only round the heart, the eyes, the region above the heart, and all the veins extending from these parts; And in all these there is little blood after all. The brain is situated above the eyes but connected with them. When the outer skin is drawn aside from the eye, something is found surrounding the eye, which gleams through a thin ring of copper. Membranes extend well over the entire frame, numerous and strong, and surpassing in respect of the number and relative strength of those found in any other animal. After being cut open along its entire length it continues to breathe for a significant time; a very slight motion goes on in the region of the heart, and while the contraction is especially manifested in the neighborhood of the ribs, and similar motion is more or less discernible over the whole body. It has no spleen visible. It hibernates, like the lizard.”

The description of chameleon’s anatomy by ARISTOTLE is so precise, that outside the expressions relevant to his epoch, there is hardly anything to comment on besides the preciseness and detailed overview of other animals’ anatomy, attributing to this work the label “comparative anatomy.”

To the honor of PLINIUS MAIOR, however, it should be added that Aristotle’s literal description of the chameleon has been included in Book 8 of Chapter 51 of his work. Only then, in Book 28, he dealt in detail with the aforementioned magical rituals (PLINIUS).

The Roman poet PUBLIUS OVIDIUS NASO (43 BC - 17 AD) writes about the chameleon in his collection of poems „Metamorphosis“ the following: „And the chameleon, little creature whose food is wind and air, takes on a color of anything its rests on.“ (OVIDIUS 1st century BC – 1st century AD). He makes the interpretation of the already mentioned belief, the chameleon lives just from breathing the air. He also mentioned the wrong assumption that the chameleon adapts the color of the underlying objects, which it walks over.

Chameleons do NOT use their ability of active color change to “blend” with their environment, it is a common myth. The public believes, chameleon use their ability to change color for blending with the environment and they do in color and pattern. They are often given as a textbook example of this phenomenon and kids are taught this at school. The truth is that this is a misconception. Instead for making them invisible with color change, they use this ability on contrary to become even more visible than normally.

Chameleons primarily use their ability to actively change colors for the following mechanisms:

1. Intraspecific communication

Colors and patterns are the language of chameleons, due to the fact the vision is their primary sense, they can express excitement, rivalry, surrender, gravidity, submission, receptivity, etc.

2. Interspecific recognition

Females tell based on colors and patterns the belonging to the same/different species of the approaching male.

3. Thermoregulation

Light colors reflect the sun IR beams and cool down the bodies, dark colors foster heat intake.

4. Other mechanisms

The color pattern is also influenced by the: health state, nutritional state, hunting, rest, sleep, etc.

Chameleons adapt very rarely by their color and pattern to the environment, there are only a few documented cases when this happens (eg. in the genus *Rhampholeon*), but they are rather an exception and not a rule. The fact that that chameleons often look similar to their environment, is not the result of an active color change, but a long-term evolutionary adaptation to the environment in which they live and in which it is beneficial for them to be “invisible” (NECAS 1999).

Very interesting is the observation of Roman philosopher LUCIUS ANNAEUS SENECA (4 BC - 65 AD); he was the first to ponder the way in which chameleons change colors. By a purely logical reasoning, he connected the coloring to the refraction of light.

“Seneca offers some thoughts on the mechanism by which animals like the chameleon change color and offer an opinion that may be related to the refraction of the light” (KITCHELL 2014; SENECA, L.A.).

This brilliant philosophic (not biological) conclusion precedes the science by two millennia! It was for long believed, that the color change in chameleons happens based on differently colored pigment granules by their dispersion or aggregation in specialized cells called chromatophores (NECAS 1999). This is true just only for melanin in melanocytes, but the rest of the color change happens in two superposed layers of iridophores, that contain nanocrystals of guanine, which can, based on tuning of a lattice of these nanocrystals, reflect light of different wavelengths – thus creating colors. This mechanism has been discovered only recently, in 2015 by THEYSSIER & AL.

CLAUDIUS AELIANUS (175-235 AD), a Roman writer and philosopher, discusses in his work “De Natura Animalium” a chameleon changing color before the eyes of an observer, “...And appears different, like an actor who puts on another mask or another garment” (CLAUDIUS AELIANUS). He postulates the nature that created such a creature is called a witch. He then quotes ALEXANDER OF MYNDUS (1st century AD), mentioning his description of a chameleon defending himself with a stick against a snake and adds: “Chameleon annoys snakes and makes them go

hungry in this way." Moreover, the chameleon has so tight skin that it "Cares not at all for the fangs of the snake" (CLAUDIUS AELIANUS).

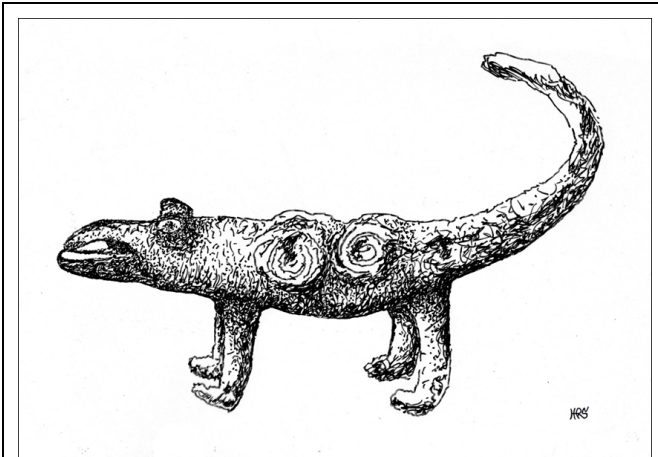


Fig 3. Bronze statue of a chameleon from the Roman Empire, Museo Nacional Arqueológico de Tarragona; Drawing VLADIMÍR HRUŠA

One of ARISTOTLE'S disciples wore the name CHAMAELEON (350-275 BC). However, despite his name, he did not care about nature. He wrote works on ancient Greek poems and, among other things, had a dispute with another Greek philosopher HERACLEIDES PONTICUS (390-310 BC), accusing him of stealing his work about HOMER. CHAMAELEON'S works have not been preserved, known only from the references of other ancient authors and a few fragments (MARTANO, MATELLI & MIRHADY 2012).

CHAMELEONS IN ART

We would like to introduce a wide range of images of a chameleon from antiquity, but in this respect, we came across a "blind spot". Although ancient legends and serious writings of naturalists and philosophers mention the chameleon, it seems as if it did not exist for the artist. Likewise, the chameleon does not appear in any ancient myth. The only artifacts that we managed to find in the resources available to us are two small objects.

The National Archaeological Museum of Tarragona (Spain) houses a bronze statue of a chameleon from the Roman Empire. With dimensions of 5 x 8.2 x 1.5 cm, however, it is quite a small work (MUSEO NACIONAL ARQUEOLOGICO DE TARRAGONA 2020).

In North African Cyrenaica (present-day Libya) silver coins were minted in the years 431-321 BC (BIBLIOTHEQUE NATIONALE DE FRANCE 2020), the reverse side of which, together with the magical and medicinal plant *Silphium* (used in ancient times as contraceptive and for abortion), depicted a chameleon as a creature that enhanced its power. But even here, it is barely recognizable. His presence reveals a large eye protruding from a confusing background (BIBLIOTHEQUE NATIONALE DE FRANCE 2020).

The mysterious plant *Silphium* is mentioned by PLINIUS MAIOR (Book XIX, Chapter 15). It was endemic in the Cyrenaica region, and in ancient times it was a highly sought-after plant for its strong therapeutic and aphrodisiac effects. It is still not clear what kind of plant it was, nor are there exact reasons for its disappearance. PLINIUS states that in his time (second half of the 1st century AD) it no longer grew in Cyrenaica. The last stem of *Silphium* found was presented to the Emperor NERO (37-68 AD),

"The juice of this plant is called "laser", and it is greatly vogue for medicinal as well as other purposes, being sold at the same rate as silver. For these many years past, however, it has not been found in Cyrenaica..."

Within the memory of the present generation, a single stalk is all that has ever been found there, and that was sent as a curiosity to the Emperor Nero."

The importance of *Silphium* is illustrated by the fact that its image was minted on coins; the obverse side of the coin held the head of Zeus Ammon; the reverse side depicts the so-called triple *Silphium*, together with animals that enhance its strength: an owl, a gazelle, a lion, an eagle holding a snake in its beak, a crab, a dolphin... the chameleon - sometimes neglected - was included in Cyrenaica into the society of animals, which were much more important in the ancient world and its mythology (BIBLIOTHEQUE NATIONALE DE FRANCE 2020).

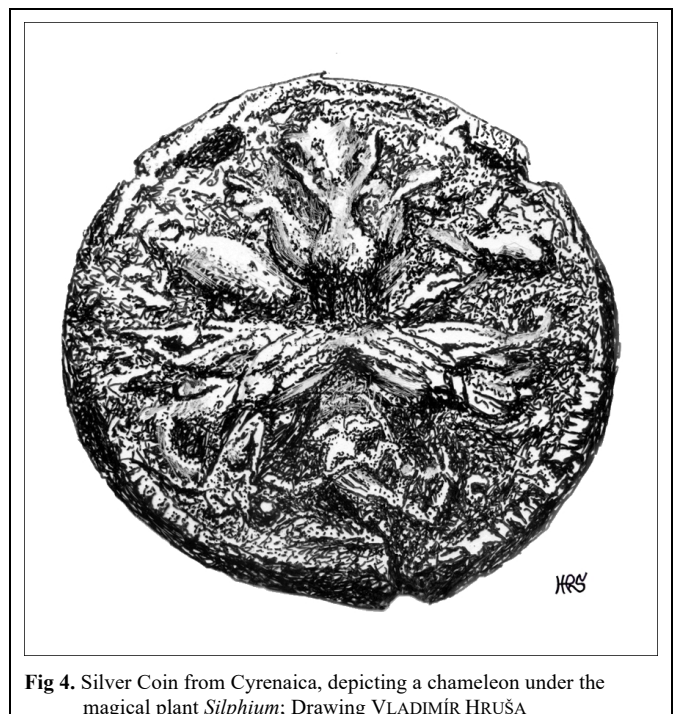


Fig 4. Silver Coin from Cyrenaica, depicting a chameleon under the magical plant *Silphium*; Drawing VLADIMÍR HRUŠA

CHAMELEONS IN MYTHOLOGY

Interestingly, although the “bestiary” of ancient myths is extremely varied, there is no place for the chameleon. It is hard to say why the Greeks did not include it in their mythology. Perhaps, with his qualities, he was so far beyond other creatures that he was simply incomprehensible to practically based Greeks.

Greek ceramics or frescoes depict animals with which the Greeks were either in everyday contact or performed in their mythology. But the chameleon, able to blend in perfectly with the surroundings, seemed to have disappeared in front of ancient artists. Maybe, the chameleon wished to remain unseen and therefore, simply we cannot see him...

The chameleon is truly the “invisible beast” and not the “earth lion”

...What do you say?

ACKNOWLEDGEMENTS

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The Naturalistic Chameleonoculture – a breakthrough in captive management of chameleons Part 1: The NC Foundation and Guiding Principles

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ABSTRACT

On the brief review of chameleon captive husbandry status, a new term, NC – Naturalistic Chameleonoculture, within the frames of Chameleonoculture in general and Herpetoculture is introduced and defined. Under the umbrella of the meaning “As close to nature as possible”, the main guiding principles are declared dealing with the following topics: Space and structure, Behavior, Vital conditions, Lethal conditions, Food, Hydration, Thermoregulation, Reproduction, Conservation, Legal, Limiting stress, Boundary management, Science, Exchange, Education. The metaphorical chameleon rights declaration is presented.

Key words: NC, naturalistic, chameleonoculture, chameleons, husbandry, captive management

PROLOGUE

We live in a world that values science and facts. But, let us not be so strict, as there are things between the earth and heavens. Every heroic story of people that change the world starts the same: A “normal man” lives a “normal life” until something crucial happens, then, the journey begins...

The first time I saw a chameleon was like a fairy tale... It was in a mystical country, which since ancient times housed ancient civilizations. It was on the territory where King Solomon went to visit his love, the Queen of Sheba, the land of frankincense and spices, the Arabia Felix of Herodotos, and the land where Cafe do Mocca was labeled from, passing through the most important port (Mocca, W of Taizz, abandoned nowadays) for the coffee trade in the past centuries... And, it was within the reach of the royal city of Taizz...

Yes, it was in Yemen!

The first chameleon I saw alive in my life was the Yemen Chameleon, *Chamaeleo calyptratus*. And it was a majestic male... Hard to explain what I felt. I do not even remember whether I was breathing that moment. The male was sitting about 2 meters above the ground at the terminal part of an *Accacia* tree branch and was totally calm and just watched me. I remember every millisecond of that encounter.

It was quite symbolic indeed, as if it would be a moment, when a prophecy was spoken out: “This, my dear, this lush green garden in the middle of the high mountains, in the middle of the deserts, in the land of our biblical ancestors and just across Africa yet not in Africa, is the place, where a strange, deaf and dumb messenger, dressed in one of the most colorful dresses in the universe is telling you: this will be your destiny and your life, look at me and listen to me! You will cross deserts, crawl through jungles and climb high mountains to talk to those who do not hear and can not talk. Your mission is to understand though and bring their tidings about the meaning of life to people to understand...”

You can hardly imagine a more mystical moment for a teenager that time... I knew it is an important moment in my life but only now I can understand what was the depth of the meaning it had and has for me... It changed my whole life.

INTRODUCTION

For about three decades chameleons have been gaining in popularity as pets and two species have been established in large numbers in captive populations including *Chamaeleo calyptratus* and *Furcifer pardalis*. Recently, *Furcifer lateralis*, *Furcifer oustaleti*, *Trioceros jacksonii* and *Calumma parsonii* have also been successfully bred in captivity in increasing numbers and other species have been

reported to be propagated in captivity in several generations, such as:

Archaius tigris;
Bradypodion damaranum, pumilum, setaroi, thamnobates;
Brookesia stumpffi, thieli, therezieni;
Calumma nasutum, globifer;
Chamaeleo chamaeleon, arabicus, senegalensis;
Furcifer balteatus, campani, labordi, minor, petteri;
Kinyongia boehmei, matschiei, tavetana, uthmoelleri;
Rhampholeon acuminatus, spectrum;
Rieppeleon brevicaudatus, kerstenii;
Trioceros johnstoni, merumontanus, montium, pfefferi, quadricornis;

and others (P. NECAS 1999, PERS. OBS.; M. BAILEY, M. BARTSCH, S. DECKERS, G. FRITSCH, J. HOLLERAN, J. JANPIERRE, M. JUNGSMANN, N. LUTZMANN, O. MARTINOTTI, M. PAYNE, J. SCHMIDT, W. SCHMIDT, K. STANDFORD, J. VAN OVERBEKE, PERS. COMM.)



Fig 1. *Furcifer pardalis* (Ambilobe, Madagascar), is a well established species in captivity; Foto PETR NEČAS

While the advanced keepers succeed to keep even the species from the extreme montane or desert conditions in captivity, the layman seem to be merely successful in keeping the two most widespread species for several years only in captivity: *Chamaeleo calypttratus* (only the populations assigned to the nominotypical subspecies, originating from the vicinity of Ibb and Taizz in Yemen) and *Furcifer pardalis* (mainly populations from three localities: Nosy Be, Ambanja and Ambilobe). Long term captive management still represents a challenge even in these two species (though we see them in thousands to appear on the pet market), mainly due to the negative effects of inbreeding in the first species (NECAS & DVORAK 2020) and cross-breeding in the second one (NECAS 2020). Their longevity is also a challenge, as *C. calypttratus* lives in captivity for 3-5 years on average though it can live up to 14 years and the same captive life expectancy or even less applies to *F. pardalis*, being able to reach up to 10 years.

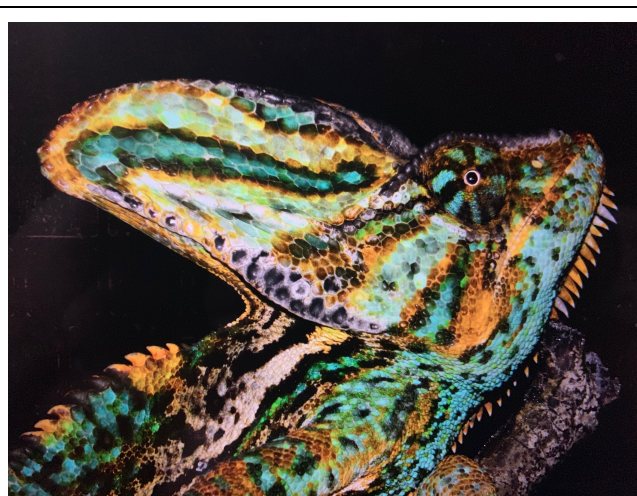


Fig 2. *Chamaeleo calypttratus* (Yarim, Yemen), is a well established species in captivity; Foto PETR NEČAS

While longevity might not be the only factor for assessment of quality of life, it is a good indicator if the life duration and longevity records are in big contradiction (which is the case here). The main reasons are of course wrong captivity management, including overfeeding, malnutrition, overheating and wrong water management. Chameleons, as masters of disguise, keep the symptoms of no-wellbeing not evident for layman eye and once they demonstrate state of heavy illness it is usually too late to turn it back and fatalities are the logical final.

CHAMELEONOCULTURE AS A PART OF HERPETOCULTURE

The origin of the word "herpetoculture" is credited to TOM HUFF, who defined himself as "herpetoculturist" – working to keeping reptiles and amphibians alive and healthy. He separated it from what was his understanding that "herpetologist" of his time were doing – collecting specimens for preservation in museum collections. The word itself is a melt of "herpeto-" of Greek origin where "herpien", which means "to creep", referring specifically to Amphibians and Reptiles, being also the focus of Herpetolog., and the English word "culture" more fostering its meaning "cultivate" than the "culture" as such. (WIKIPEDIA 2020, REPASHY 2017) It was then codified by the AFH: The American Federation of Herpetoculturists as:

1. The interdisciplinary ethnozoological field concerned with the captive husbandry and propagation of amphibians and reptiles.
2. The subculture involved in the captive husbandry and propagation of amphibians and reptiles.

The term herpetoculture was popularized by the Vivarium, and used especially by PHILIPPE DE VOOSJOLI and ALLAN REPASHY gaining the final meaning separating "Herpetoculture" from "Keeping pets" as a multidisciplinary

nary approach of keeping amphibians and reptiles in captivity for the main purpose of their propagation based on correct captive management and conditions. It is further used e.g. by BION in the even more developed term “Responsible herpetoculture” (BION 2019),

CHAMELEONOCULTURE is in that respect an approach of keeping Chameleons in captivity for the purpose of their long-term reproduction and thriving.

THE NC: THE NATURALISTIC CHAMELEONOCULTURE

In the wide field of chameleon husbandry done in many ways, it is necessary to define the NC as the highest possible ambition on Chameleonoculture, clearly keeping distance from technological and simplified approaches using fake artifacts, methods and instruments and wrong, not natural materials and methods. In that sense,

NC is an approach of:

- **simulating the vital natural conditions in the undisturbed nature where chameleons live and thrive and**
- **elimination the fatal factors at maximal possible level at same time.**

As new scientific facts appear, and new technologies arise, this is to be understood as a dynamic process, that will further develop, not as a status quo, as our ability to simulate natural vital conditions is clearly driven by knowledge on one side and technical possibilities on the other. The key for success in this approach is the deep knowledge and understanding, not technologization and blank advice.

There are two overruling axioms of NC:

1. **“As close to nature as possible”,**
2. **“In doubt, go safe”.**

All guiding principles of the NC are under the umbrella of these axioms and are as follows:

Respect and rights

NC declares and endorses that any interaction of any human with any other human and animal being it to be respectful. The chameleons are a living entity that deserves respect within the modern understanding of animal rights: “Animal rights is the idea in which some, or all, non-human animals are entitled to the possession of their own existence and that their most basic interests – such as the need to avoid suffering – should be afforded the same consideration as similar interests of human beings.” This principle is traditionally more respected in some cultures, less or at all in some others. In the most developed countries it found even reflection in the legislation. Extremistic interpretations and practices such as those conducted by some international organizations are not meant here, same as I disapprove all animal cruelty practices common till now i.a. in some countries of E and SE Asia and Africa.

Welfare

NC adheres to the principles of animal welfare. Animal welfare refers to the state of the animal; the treatment that an animal receives is covered by other terms such as animal care, animal husbandry, and humane treatment. Protecting an animal's welfare means providing for its physical and mental needs.



Fig 3. *Trioceros deremensis* (E Usambara Mts, Tanzania), is nowadays bred in several generations in captivity; Foto PETR NEČAS

Space and structure

The chameleons must be kept in naturally structured spacious enclosures, which allow them to exhibit all their natural behaviors comfortably and fully, even though in a meaningfully limited way. Bioactivity is not an explicit but possible integral part of the captive space floor arrangement, applicable only if it does not conflict with other simulated features and the space is enough for doing so.

Behavior

The chameleons have the right to exhibit all their natural behaviors comfortably and fully, even though in a meaningfully limited space and way.

Vital conditions

NC endorses providing all vital conditions from the wild, leading to thriving and long life of the chameleon, such as temperature and humidity gradients, seasonality, space, biotope, interaction with living plants, exposition to electromagnetic waves, including visible and invisible light spectrum etc., all based on the science, knowledge of their natural biotopes and life history.

Lethal conditions

NC eliminates all the lethal extremes of the above-mentioned conditions, that would lead to stress, suffering or death of the chameleons. It also meaningfully eliminates any kind (e.g. physical, visual) of the negative influence of the predators, parasites, diseases, disorders and traumas.

Food

NC endorses providing as natural food as possible concerning its composition, nutritional value, size periodicity and amount, including plant matter (leaves, flowers) and incidentally but regularly swallowed particles (like pollen, dust, soil and natural gut-load of the feeders) and including the possibility to hunt. It strictly absconds from offering unnatural food, which is in the wild naturally rejected and/or poisonous and/or harmful (e.g. some beetles, large locusts etc.) and balances the difference between the natural food and captive available selection of food with meaningful safe supplementation of minerals, vitamins and other vital substances.



Fig 4. *Brookesia stumpffi* (Nosy Komba, Madagascar), has been bred in captivity but still, it is not established well; Foto PETR NEČAS

Hydration

NC endorses the naturalistic hydration that meaningfully simulates the natural circadian as well as seasonal and annual cycles and events including night fog, clouds, dew, mist and rain. NC absconds from all forms of stressful and forceful hydration (like showering, bathing, forceful drinking), dangerous hydration technologies (e.g. pressurized water entering eyes) as well as from cutting the availability of water causing unnatural level of dehydration and meaningless stress.



Fig 5. *Furcifer petteri* (Montagne de Ambre, Madagascar), is a very Rare species to be bred in captivity; Foto PETR NEČAS

Thermoregulation

NC endorses the close-to natural conditions and behavior setup for meaningful thermoregulation within the natural vital range of temperatures and does not forcefully overheat or dangerously undercool the chameleons.

Reproduction

The chameleons have the right to (and the mission of NA is to ensure they will) reproduce in frames defined by the genetic diversity, purity and quality (e.g. absconding from deliberate inbreeding and cross-breeding and reproduction of genetically stunted, ill or suspect individuals), respecting the natural state of things at population level.

Conservation

The chameleons have the right to receive protection of themselves as living being in captivity as well as in the wild, including their natural biotopes, in frames of national and international legislation (e.g. CITES) and beyond, in the sense of highest ethical principles and moral. In case, they need to be removed from a territory, to which they have been introduced, this process must respect the highest ethical standards and any useless killing of animals must be avoided and replaced by any other meaningful methods such as translocation or depositing in captivity.

Legal

NC respects all regulations and laws and acts in compliance with if meaningful; if not proper or under changed conditions, it may initiate legislation changes.

Limiting stress

NC endorses all procedures and handling and treatment being stress-free, or at adequate temporary effective stress level in order to solve a concrete issue.

Boundary management

NC endorses all activities being undertaken by a competent person, who respects legal regulations and boundary management, especially in executing veterinary medicine activities or in use of drugs and medications.

Science

NC commits to science and valid, evidence-based experience, as the only bases for correct strategic decisions relating to chameleons.

Exchange

NC initiates, supports and endorses exchange of all parties in order to respect and execute the mentioned ground principles. It supports publishing of valuable facts in the form of peer-reviewed communications saved safe and accessible way.

Education

NC commits to fulfill a meaningful role in presenting information and education of people in frames of NC and related areas in captivity and in the countries of origin of the chameleons.

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Fig 5. *Kinyongia matschiei* (E Usambara Mts., Tanzania), has been bred in captivity very rarely; Foto PETR NEČAS

EPILOGUE

CHAMELEON RIGHTS DECLARATION

Chameleons do not hear, except of sensing very low tones and infrasound, and can not speak. We deliberately and metaphorically use here an anthropomorphization to demonstrate, what chameleons, in our understanding and belief, would require from humans if it comes to their rights, they would request to be respected.

"I am not property.

I am a living being.

It is not my free choice to be here, but if you respect my rights and give me what I deserve, I am ready to enrich your life.

I have the right to roam freely in an organic environment, and express all natural behaviors, such as climbing, resting, hunting, thermoregulating, reproducing etc.

I have the right to clean air, proper ventilation and humidity; and natural or simulated full-spectrum solar radiation including IR, visible light and UV, as in the wild.

I have the right to a low-stress environment that supports the natural reaction to stimuli, including temperature gradients and hiding places.

I have the right to be fully safe from predators, even in sight, and from all environmental factors and handlings that limit my well-being.

I have the right to grow to a natural size, weight, and structure, consistent with health and longevity.

I have the right to receive knowledgeable management of reproductive behaviors, and a commitment to genetic diversity.

I have the right to nutritional homeostasis and stimulation to hunt, as can be found in nature; and through supplementation, feeder, and hydration management.

I have the right to live a healthy life, free from diseases and parasites, to receive prompt treatment in the case of any health issues, ensuring the best possible quality of life.

I have the right to live as nature intended, and to die without suffering.

I am chameleon."

(MISKUFF & NECAS 2018, advocating chameleons)

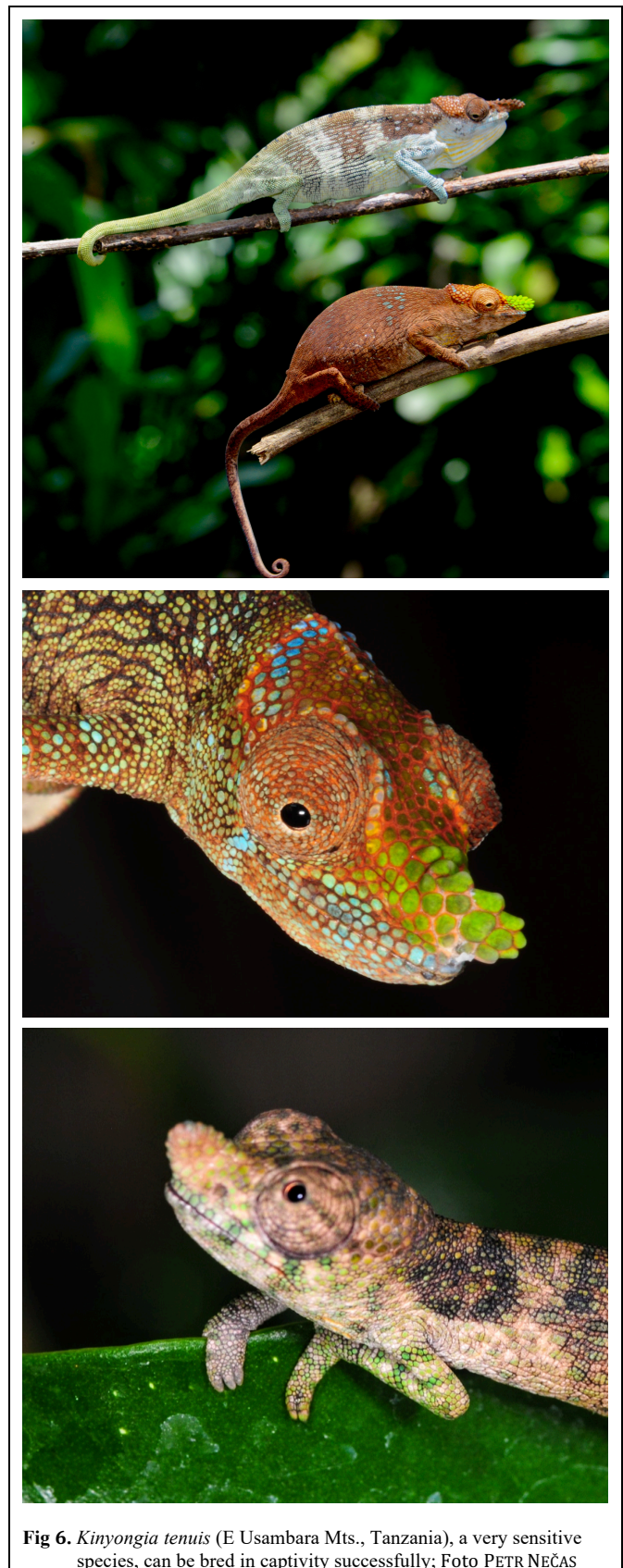


Fig 6. *Kinyongia tenuis* (E Usambara Mts., Tanzania), a very sensitive species, can be bred in captivity successfully; Foto PETR NEČAS

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Quadruplets, Triplets and Twins in Chameleons (Sauria: Chamaeleonidae)

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ABSTRACT

A historical overview of documented occurrence of chameleon twins, triplets and quadruplets and their life history is presented, with reports on the first documented twins in *Calumma parsonii parsonii* (CUVIER, 1852) and *Trioceros laterispinis* (LOVERIDGE, 1932); second documented triplets in *Chamaeleo calypttratus* DUMÉRIL & DUMÉRIL, 1851 and *Furcifer pardalis* (CUVIER, 1829) and first documented quadruplets in *Chamaeleo calypttratus*.

Key words: *Calumma parsonii*, *Chamaeleo calypttratus*, *Furcifer pardalis*, *Trioceros jacksonii*, *Trioceros laterispinis*, *Trioceros quadricornis*, twins, triplets, quadruplets, captivity

INTRODUCTION

For about three decades chameleons have been gaining in popularity as pets and two species have been established in large numbers in captive populations including *Chamaeleo calypttratus* and *Furcifer pardalis*. Recently *Furcifer lateralis*, *Furcifer oustaleti*, *Trioceros jacksonii* and *Calumma parsonii* have also been successfully bred in captivity in increasing numbers.

As data on the reproductive biology of chameleons in the wild are still rather scarce and there is no single observed case of twins or triplets from the wild, we rely in the study of this phenomenon, on observations from captivity, which are, unfortunately, not often published. From the hundreds of thousands of chameleons produced in captivity annually in recent years (PETR NEČAS'S estimate based on analysis of internet data), the occurrence of twins or triplets is very rare, with documented observations being reported only several times in history. The occurrence of twins and triplets is likely appearing more frequently than reported, as the birth process is very rarely observed in captivity in viviparous species as well as the little more frequently but still rarely observed hatching process of oviparous species. Also, very rarely, numbers of empty eggshells are compared with the numbers of hatchlings, which often count dozens of individuals remaining the probability of noticing the twins much lower than in the case of some other reptiles,

producing significantly lower numbers of eggs.

It is currently unknown to what an extent conditions captivity influence the frequency of occurrence of twins and triplets. There is also virtually no base from which to assess the reasons of their appearance both in the wild and in captivity. Therefore, it can be assumed their occurrence is based solely on coincidence. There is, however, evidence collected by SERGII PROKOPIEV, that inbreeding increases the frequency of the appearance of twins significantly.

HISTORICAL OVERVIEW

There are known cases of only 6 species in total (including this report), of both viviparous species (2 – marked with VP) as well as oviparous species (4 – marked with OP) having been reported to produce twins:

Calumma parsonii (OP),
Chamaeleo calypttratus (OP),
Furcifer pardalis (OP),
Trioceros laterispinis (VP),
Trioceros jacksonii (VP),
Trioceros quadricornis (OP).

There are known cases of only 2 species in total (including this report), of oviparous species having produced

triplets (4 cases in history known only, including this report):

Chamaeleo calyptratus,

Furcifer pardalis.

Quadruplets have been reported in Chamaeleonidae only today in the following species:

Chamaeleo calyptratus.

KENT MANCHEN (1994) reported on a case of two pairs of twins within one clutch of *Furcifer pardalis*.

KENT MANCHEN (1994) simultaneously reported on a case of dead siblings birth of *Trioceros jacksonii* from Hawaii mentioned by THOMAS VILLEGAS.

MIKE MONGE (KEN KALISCH IN WWW) reported on triplets of *Chamaeleo calyptratus* in one egg.

NECAS (1999) mentioned rare cases of twin birth and observed (PETR NECAS, PERS. OBS.) twins of *Trioceros jacksonii xantholophus* and in *Chamaeleo calyptratus*.

KATRIN PAWLIK (IN LITT.) from Berlin, Germany, had in 2010 two pairs of twins within 20 eggs of the wild caught *Furcifer pardalis* from Toamasina (= Diego Suarez). The twin hatchlings were significantly smaller than their siblings and their growth rate was slower. They were raised individually with special care till adulthood.



Fig 1. Twins of *Chamaeleo calyptratus* (Yemen); foto SERGI PROKOPIEV

“FLCHAMS” from Florida, USA, reported in Facebook on 24th September 2015 about a case of Siamese twins of *Chamaeleo calyptratus* joined in the pelvic region.

BARBARA SUSAN BOWEN (IN LITT.) from the USA reported about a case of twins of *Furcifer pardalis* (Ambanja local form), originating from a clutch produced by captive bred, hatched in 2016. Both twins hatched alive, one being significantly smaller. The smaller one died at age of 2 weeks, the larger one at 4 weeks age.

LISA GIBBS (IN LITT.) from the USA reported in March 2017

on conjoined twins of *Furcifer pardalis* that died fully developed prior hatch. They originated from a captive bred pair from Nosy Faly local population.



Fig 2. Ventrally conjoined Siamese twins of *Trioceros quadricornis* (Cameroon); foto TYLENE DUNCAN

TYLENE DUNCAN (IN LITT.) reported on two cases of twins of *Trioceros quadricornis*, one pair was conjoined ventrally (siamese).

“CHAMELEON HOUSE” reported in Facebook on 29th March 2018 about a case of twins of *Furcifer pardalis*.

CHERYL GARCIA (IN LITT.) from PEMBERVILLE, USA, reported about a case of twins of *Trioceros jacksonii xantholophus* being born in one egg-sac on 11th October 2018. They were a part of a big clutch of 32 siblings, deposited by a wild caught female imported gravid from Kenya. The female was rather weak, so were the newborn ones; they had to be assisted penetrating and leaving the egg-sac and died within few days after birth, actually same as all their siblings.

“WORLD OF REPTILES” reported in Facebook on 19th October 2018 about a case of twins of *Chamaeleo calyptratus* (Translucent form).

BARBARA SUSAN BOWEN (IN LITT.) from the USA reported about a case of twins of *Furcifer pardalis* (Ambanja local form), originating from a 20 eggs clutch produced by captive bred parents (dam Tiamat, sire Mythos), hatched

on 24th December 2018. Both twins hatched alive, were same size and started moving around within 5 minutes after hatching. One of the twins died within few days, but the second was still alive at age of three months, showing slower growth rate than other siblings from same clutch.

ECKHARDT (2018) reported on a triplet from a single egg in *Furcifer pardalis*.

revealed. Unfortunately, though showing some signs of life initially, they did not survive. Later, one more egg from same clutch revealed further un-hatched twins. The eggs originated from a wild caught gravid female. It laid 60 eggs, out of which 48 made it full term. Neither the size of the clutch, nor the twins were the result of the captive conditions obviously. This is the first known documented case of reported (double) twins in this species.



Fig 3. Twins of *Calumma p. parsonii* (Madagascar); foto CRAIG DURBIN

OBSERVATIONS

Double case of twins in *Calumma parsonii parsonii*

On the 30th January 2019, CRAIG DURBIN found an evidently hatching egg of the same size within a series of eggs of *Calumma parsonii parsonii*, the s.c. “Yellow lip form”. After cutting it open, two fully developed babies, twins, of a little smaller size than other siblings, were

Triplets and twins in *Chamaeleo calypttratus*

SERGII PROKOPIEV provided evidence (except the unconfirmed pers. observation of M. MONGE – see above) of the first reported triplets of *Chamaeleo calypttratus*, as well as the first reported case of twins in the partially albinotic breeding line (called “translucents” in the USA and “piebalds” in Europe) of the same species, hatched in 2016. The triplets were not able to hatch and died in the egg.

Many cases of twins (around 40) originate in his own extensive breeding program within the last 20 years, which has produced many tens of thousands of offspring of *Chamaeleo calypttratus*. On average, one case of twins is appearing every 1250 hatchlings. The appearance of twins in partly albinotic hatchlings is about three times more frequent than in normally colored hatchlings. In one clutch of 45 eggs, as a rarity 5, even 7 pairs of twins were present! The twins have often difficulties with hatching and die (70%) within the hatching process or several days after, showing general weakness, sleepiness and inability to eat. As a rule, if they survive, survive both. About 10% of the twins can make it to adulthood without special care, further 20% with special care. They are however weaker, showing much slower growth rate as their siblings from same clutch.



Fig 4. Triplets of *Chamaeleo calypttratus* (Yemen);
foto SERGII PROKOPIEV



Fig 5. Quadruplets of *Chamaeleo calypttratus* (Yemen);
foto SERGII PROKOPIEV



Fig 6. Triplets of *Furcifer pardalis* (Ambilobe, Madagascar);
foto CHRISTOPH ROTH



Fig 7. Twins of piebald *Chamaeleo calypttratus* (Yemen);
foto SERGII PROKOPIEV

Triplets of *Furcifer pardalis*

CHRISTOPH ROTH provided evidence of a triplet of *Furcifer pardalis* (from Ambilobe population) as a result of his breeding program. On 18th July 2018, 27 eggs were laid, incubated at 25°C in moist Vermiculite. They started to hatch the first week of March 2019. The conjoined triplet was found in a collapsed egg after cutting it open. It did not show signs of life.



Fig 7. Twins of *Furcifer pardalis* (Toamasina, Madagascar);
foto KATRIN PAWLIK

Twins of *Trioceros laterispinis*

JÜRGEN VAN OVERBEKE from Belgium reported on twins in *Trioceros laterispinis* of extremely small size, which were raised with intensified care till adulthood.

Quadruplets in *Chamaeleo calyptratus*

SERGII PROKOPIEV found quadruplets in one egg in January 2020, laid by a female, which was partially albinotic and was of unusual small and dwarfed habitus, very likely due to problematic genetics of the lines heavily affected by inbreeding.

CONCLUSIONS

As a rule, the following observations are made:

- The eggs with twins are often different than others in shape and size (bigger), sometimes indistinct from others,
- The twins are of smaller size than the non-twin siblings,
- The twins are often malformed,
- The twins are weak,
- The twins have difficulties in hatching and often have to be assisted,
- The twins often keep their fetal position,

- The twins sleep almost all the time,
- The twins have difficulties starting to eat,
- The twins show a lower survival rate and die usually within hours or days after birth,
- Siamese conjoined twins appear rarely,
- Rarely, the twins grow to adulthood and even reproduce,
- Neither triplets nor quadruplets have been reported alive, no data on their biology are therefore available.



Fig 8. Twins of *Trioceros jacksonii xantholophus* (Kenya);
Foto CHERYL GARCIA



Fig 9. One of the twins of *Furcifer pardalis* (Ambanja, Madagascar),
at age of 3 weeks; Foto BARBARA SUSAN BOWEN

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Fig 10. Twins of *Calumma p. parsonii* with shared yolk sac (Madagascar); Foto CRAIG DURBIN

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The Language of Chameleons: how the animals, which cannot talk and do not hear, communicate

Leaf Walking

PETR NEČAS,
with illustrations of ANASTASIIA SHIRIAEVA and photos of PETR NEČAS

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Note: this text is an example from the book dealing exactly with this topic, this is just a sample

LEAF WALKING

FOUL THE PREDATORS BY IMITATING A LEAF IN THE WIND.

Chameleons adapted a very strange way of moving, known also from some insects such as stick-insects and preying mantis. When they walk either on a leafless branch or on the ground, they feel they aren't secure and they feel exposed. It is because under normal circumstances, they sit

in the bush and in the leaves and are hard to detect because they are inconspicuous. On a place where they are well visible, they use a perfect trick: they do not hide, on contrary, they make themselves even more visible while moving very strange dancing-like and shaking there and back to imitate a leaf in the wind. This way they on one side draw attention to their body but also foul the potential predator by giving the impression that it is not something to eat, just a leaf moving in the wind.



Leaf walking *Furcifer pardalis* (N Madagascar); Foto PETR NEČAS

A chameleon, walking across the pedestrian zone on the ground, is meeting a cat...

Cat: "Is there anything to eat?"

Chameleon: "Nothing, nothing, there is no thing, no, no, no thing, nothing..."

Cat: "Hey, there is something I can see on the ground! It is moving: that must be alive!"

Chameleon: "No-no, it is a leaf, it is a leaf, a dead leaf, moving in the wind, as the wind blows, the leaf is moving... It is nothing to eat, really nothing."



Leaf walking 1; Drawing ANASTASIIA SHIRIAEVA



Leaf walking 2; Drawing ANASTASIIA SHIRIAEVA