UKRAINIAN JOURNAL OF VETERINARY SCIENCES

2024. Volume 15, No. 2. P. 138-156

Received: 07.02.2024 Revised: 27.04.2024 Accepted: 29.05.2024

DOI: 10.31548/veterinary2.2024.138

UDC 598.112.21:611.9:591.4:611.07

Features of topography and macroscopic structure of the digestive organs of the Yemeni chameleon (*Chamaeleo calyptratus*)

Mykola Kushch*
Doctor of Veterinary Sciences, Professor
State Biotechnological University
61002, 44 Alchevskykh Str., Kharkiv, Ukraine
https://orcid.org/0000-0002-5280-9755

Serhii Skachko
Graduate Student
State Biotechnological University
61002, 44 Alchevskykh Str., Kharkiv, Ukraine
https://orcid.org/0009-0001-1229-5980

Iryna Fesenko
PhD in Veterinary Sciences, Senior Lecturer
State Biotechnological University
61002, 44 Alchevskykh Str., Kharkiv, Ukraine
https://orcid.org/0000-0002-6076-5545

Olga Miroshnikova
PhD in Veterinary Sciences, Associate Professor
State Biotechnological University
61002, 44 Alchevskykh Str., Kharkiv, Ukraine
https://orcid.org/0000-0002-8371-9023

Olena Byrka
PhD in Veterinary Sciences, Associate Professor
State Biotechnological University
61002, 44 Alchevskykh Str., Kharkiv, Ukraine
https://orcid.org/0000-0001-7316-2500

Abstract. The relevance of this study is conditioned by the lack of detailed information on the structure and topography of the digestive organs of the Yemeni chameleon (*Chamaeleo calyptratus*). The purpose of this study was to find out the specific features of changes in body

Suggested Citation:
Kushch, M., Skachko, S., Fesenko I., Miroshnikova O., & Byrka, O. (2024). Features of topography and macroscopic structure of the digestive organs of the Yemeni chameleon (*Chamaeleo calyptratus*). *Ukrainian Journal of Veterinary Sciences*, 15(2), 138-156. doi: 10.31548/veterinary2.2024.138.

**Corresponding author*

weight, topography, and structure of the digestive organs of the Yemeni chameleon, to determine their morphometric parameters in animals from 1 day to 1 year of age. The research material included the tongue, oesophagus, stomach, intestines, liver, and pancreas of chameleons of different sexes of 9 age groups. The data obtained were processed by one-factor analysis of variance (ANOVA). According to the topography, macroscopic structure and surface of the mucous membrane, there are three intestines in the small intestine: duodenum, jejunum, and ileum, and two intestines in the large intestine: the colon with a diverticulum and the rectum, which passes into the cloaca. A feature of the serous membrane of the chameleon intestine is that it is coloured black by melanin. From 1 day to 1 year of age, the body weight of chameleons increased 185.9 times, the snout-vent length (SVL) increased 6.7 times, the length of the digestive tract increased 3.8 times, and the ratio of the length of the digestive tract to SVL decreased from 3.2 to 1.8 times. The most intensive increase in body weight and SVL occurred during the second and third months of life. The relative length of the small intestine in chameleons of different age groups was 65.1-81.6%, with the longest part being the jejunum. The increase in the morphometric parameters of the stomach, intestines, liver, and pancreas was asynchronous. The most pronounced changes in their relative weight were determined in animals of 2-3 months of age. The obtained materials supplement and clarify the information on the topography and structure of the digestive organs of the Yemeni chameleon, and therefore they will be useful in X-ray and ultrasound examination during veterinary manipulations

Keywords: reptiles; stomach; intestine; liver; pancreas; topography

Introduction

According to E.E.V. Crouch *et al*. (2021), various species of small reptiles are commonly traded and kept in home terrariums. As pointed out by G.S. Tang *et al*. (2020), captivity is an important measure for the conservation of endangered species and is a hot topic in conservation biology. At the same time, unbalanced nutrition, caging, lighting, substrate, temperature, and humidity can lead to stress and the development of various diseases. H.J. Sollom & H.R. Baron (2023) found that nutritional disorders in captive reptiles are still quite common despite improved knowledge of their breeding and feeding practices. As L.V. La'Toya (2023) points out, due to the specific features of compensatory mechanisms, reptiles do not immediately manifest the disease and owners seek veterinary care only when the problem is advanced and close to terminal.

According to B.J. Pinto *et al*. (2019), the reptile family *Chameleonidae* comprises over 200 species, which originate mainly from Africa and slightly extend into South Asia and Europe. They are distinguished by their zygodactyl paws, long retractable throwing tongue, which has no analogues in other vertebrates, rotating eye turrets that move independently of each other, a clinging tail, and a striking appearance, primarily due to psychedelic skin colour changes. M. Kubiak *et al*. (2020) noted that despite the popularity of chameleons as pets, these species are difficult to keep in captivity. According to A. Melero *et al*. (2023), Yemeni (veiled) chameleons (*Chamaeleo calyptratus*) and panther chameleons (*Furcifer pardalis*) are the most popular chameleons in the world, and therefore the two most commonly encountered species in veterinary practice. Furthermore, as found by

B.J. Pinto *et al*. (2019), Yemeni chameleons have attracted the attention of researchers as an important biological model for studying the role of functional morphology and evolutionary biology in the adaptation to arboreal life. However, according to K.A. Mathes *et al*. (2019), A. Melero *et al*. (2020), there are currently no published studies of the normal anatomy of these lizards.

According to Ardente *et al.* (2023), involving a veterinarian early in the life of exotic companion animals can help ensure that they are properly fed from the start of their lives to support growth and create a solid foundation for a healthy transition to adulthood. There is limited or no research on the energy and nutrient requirements of exotic domestic animals of different ages, especially young animals. According to M.V. Skrypka *et al*. (2020), the morphological features of the gastrointestinal tract in reptiles have been investigated only partially and require further research. There is a need to expand the basic knowledge of the species, to conduct a thorough anatomical study of its digestive organs for further physiological, pathological, and phylogenetic research. K.A. Mathes *et al*. (2019), O.I. Tul (2021) pointed out that for the correct diagnosis and interpretation of diagnostic images of X-ray and ultrasound examination results, veterinary specialists need in-depth knowledge of the special anatomy of a particular animal species. Furthermore, according to E. Engelke *et al*. (2020), during clinical trials, the nomenclature of organs is a problem in the diagnosis of reptile diseases, which is not the only one, which can lead to misunderstandings about the affected parts of the digestive system. Therefore, it is an urgent task to develop a unified nomenclature of the internal organs of the Yemeni chameleon for practicing veterinarians, based on anatomical research methods.

The purpose of this study was to determine the specific features of topography, macroscopic structure of digestive organs and their age-related linear and mass parameters of the Yemeni chameleon (*Chamaeleo calyptratus*).

Materials and Methods

The study was conducted in 2022-2024 at the Department of Normal and Pathological Morphology of the State Biotechnological University (Kharkiv, Ukraine). Material for morphological studies was collected from Yemeni chameleons of 9 age groups: 1-, 7-, 14-day-old, 1-, 2-, 3-, 6-, 8-month-old, and 1-year-old chameleons (n = 5) of different sexes. All experimental studies were conducted following the European Convention for the Protection of Vertebrate Animals Used for Experimental and Scientific Purposes (1986). Animals for the research were obtained from private reptile nurseries and veterinary clinics. Some chameleons were euthanised for clinical reasons unrelated to digestive diseases. Some cadavers were obtained from a private reptile nursery located in the combat zone in the east of Ukraine, where the electricity supply was suddenly cut off, creating impossible conditions for keeping animals. Such animals died as a result of hypothermia or were slaughtered forcibly. The bodies of such animals or their organs were fixed in a 10% solution of neutral formalin.

The animals were kept in a separate room with comfortable conditions for reptiles. Adult animals were kept individually in terrariums with ventilation holes. The bottom of the terrarium was covered with paper, which was changed every week, allowing the chameleons to move around. The terrariums were equipped with bamboo branches for the animals to climb. The air temperature in the cold zone of the terrarium was maintained at 21-27°C, and in the warm zone – at 32-38°C. Along with heating and lighting provided by daylight and fluorescent lamps, the animals received ultraviolet radiation via UV lamps. The relative humidity was 40-70%. Reptiles of 1 day to 1 year of age were fed with Jamaican field crickets (*Gryllus locorojo*) of different sizes, which were pretreated with calcium powder. The water was supplied continuously by drip and was fresh. The physiological condition of the animals was monitored during the keeping. Attention was paid to the behaviour, skin condition, including changes in its colour, mouth, eyes, muscle tone, limbs, cloaca, shape, and consistency of faeces.

The animals were necropsied through the abdominal wall with an incision in the median plane from the intermaxillary space to the cloacal slit to open the viscera. During the selection of internal organs, their topography, shape, size, and colour were determined. The absolute body weight of animals and organs was determined using the VLKT-500 balance and the Techniprot Waga Torsyjna-WT 250 torsion balance. The linear parameters of the organs were determined using a ruler, measuring tape, and callipers. The snout-vent length (SVL) of the animals' bodies was determined separately, as well as the length of the entire body from the top of the nose to the tip of the tail. The length of the digestive tract was determined as the length of the mouth, oesophagus, stomach, intestines, and cloaca. To describe the surface of the mucous membrane of the digestive tract, it was opened on the antimesenteric side. Subsequently, the preparations obtained in this way were photographed for documentation purposes.

The digital data were processed by one-factor analysis of variance (ANOVA). The data were analysed using the statistical analysis software Biostat LE 7.3 (AnalystSoft Inc., 2020). The difference between the values of indicators for each organ in different age groups of chameleons was determined according to the Tukey test, where the difference at $P < 0.05$ (including the Bonferroni correction) was considered significant. Numerical data in the tables are presented as x ± SD (x ± standard deviation). Changes in body weight and length, as well as digestive system parameters of chameleons were assessed in comparison with the previous age. Considering the different lengths of different chameleon intestines in different age periods, the mean age index (MAI) was determined for their evaluation. The SVP of each intestine was determined as the arithmetic mean of 9 age-specific relative lengths of each intestine.

Results and Discussion

In the diagram of the structure of the digestive tract of the Yemeni chameleon (*Chamaeleo calyptratus*), the oropharynx, oesophagus, stomach, small and large intestine, ending in the cloaca, were identified. Thus, the digestive apparatus is comparable to that of higher vertebrates and other lizards, which is consistent with the relevant data of N. Hamdi *et al*. (2014), E. Engelke *et al*. (2020).

Three parts of the Yemeni chameleon's tongue were identified: proximal, middle, and distal. The proximal and middle parts of the chameleon's tongue occupy almost the entire oral cavity. The proximal part of the tongue is cylindrical, its dorsal surface is represented by the tongue cushion. The anterior free end of the tongue is slightly bifurcated in the horizontal plane, which creates a lingual fossa with a more forward projecting lower part. The middle part of the tongue has an elongated tube-like folded structure. Generally, the data obtained are consistent with the information of Y.A. Fouda *et al*. (2015), S. Frei *et al*. (2020) regarding the structure of the Yemeni chameleon's tongue. According to S. Frei *et al*. (2020), in the tongue of three species of chameleons – *Chamaeleo chamaeleon*, *Chamaeleo africanus*, and *Chamaeleon vulgaris* – three parts are distinguished: proximal, middle, and distal, which have some species-specific structural features. According to P.C. Wainwright *et al*. (1991), the distal part is located among the soft tissues in the intermaxillary space.

The thoracic abdominal cavity of Yemeni chameleons is limited by the skeletal frame formed by the vertebral column and sternum, as well as the ribs connecting them. The spinal column consists of thoracic, lumbar, and sacral vertebrae. The ribs have two segments: bony vertebral-costal and cartilaginous sternocostal (Fig. 1).

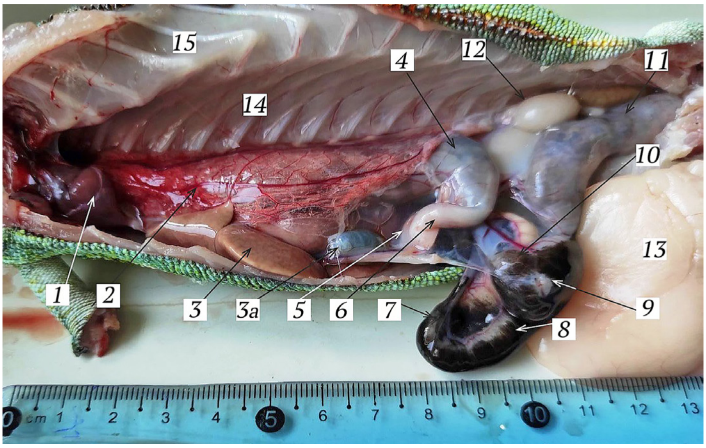

Figure 1. Organs of the thoracic-abdominal cavity and its wall of a 1-year-old Yemeni chameleon (*Chamaeleo calyptratus*)

Notes*: Left side. 1 – heart; 2 – lungs; 3 – liver; 3a – gallbladder; 4 – stomach; 5 – pancreas; 6 – duodenum; 7 – jejunum; 8 – ileum; 9 – colon; 10 – colonic diverticulum; 11 – rectum; 12 – testis; 13 – adipose body; 14 – vertebral-costal segments of ribs; 15 – sternocostal segments of ribs*

Sourse*: developed by the author of this study*

Some ribs present a third cartilaginous segment located between the vertebral-costal and sternocostal segments. The distal cartilaginous segments of several parasternal ribs merge along the midline of the abdomen and form the parasternum caudal to the sternum. Caudoventrally, it is generally delimited by a soft abdominal wall. The oesophagus enters cranially through the inlet (*apertura thoracis cranialis*), and the cloaca enters caudally through the outlet (*apertura pelvis caudalis*).

The oesophagus, a thin, short tube, is located along the axis of the body and shifts to the left before entering the stomach. There was no clear boundary between the oesophagus and the empty stomach. When the stomach was filled with food, it was clearly distinguished by a much larger diameter than the oesophagus (Fig. 2). When empty, the stomach is cylindrical. The body of the stomach is located mainly in the right part of the thoracic cavity, dorsal to the liver and caudal vena cava, and its pyloric section is located on the left side. The pyloric part of the stomach passes without a sharp border into the small intestine, which has a much smaller diameter and is located mainly in the caudal part of the thoracic cavity. Ventral to the stomach is the spleen, which is spherical and cherry-red in colour.

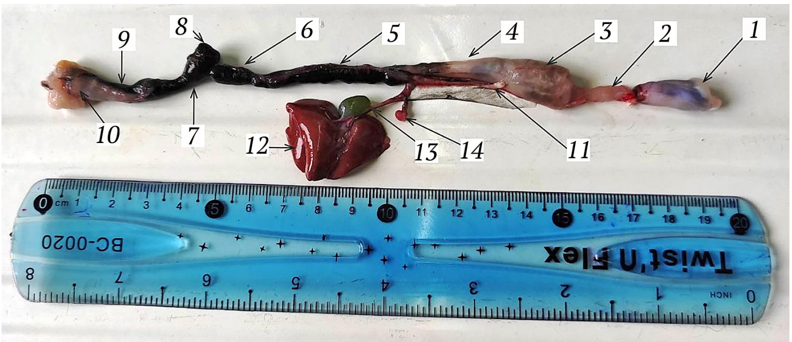

Figure 2. Digestive organs of an 8-month-old Yemeni chameleon (*Chamaeleo calyptratus*)
Notes: *1 – tongue; 2 – oesophagus; 3 – stomach; 4 – duodenum; 5 – jejunum; 6 – ileum; 7 – colon; 8 – colonic diverticulum; 9 – rectum; 10 – cloaca; 11 – pancreas; 12 – liver; 13 – gallbladder; 14 – spleen*
Sourse: *developed by the author of this study*

The liver of the Yemeni chameleon is located in the cranioventral part of the thoracic cavity, where it borders ventrally on its wall. It borders cranially on the apex of the heart, dorsally on the lungs, and caudally on the intestines and fatty bodies. The gallbladder is located between the lobes of the liver, has an ovoid shape, and when filled, it protrudes caudally beyond the lobes and borders the intestines and fatty bodies. The liver in the segmental plane is triangular, brownish-grey, and consists of two lobes: the right lobe, to which the gallbladder with green bile is attached, and the left lobe. The size of the right lobe of the liver has a pronounced individual variation: it is slightly or significantly larger than the left lobe, which is consistent with the data of A.A. Al-Doaiss *et al*. (2023) and A. Melero *et al*. (2023) and contradicts the data of O.I. Tul (2021), according to which the left lobe of the liver is the largest in the Yemeni chameleon. In some animals after 6 months of age, the gallbladder contents are represented by a transparent dense oval-shaped green body, which is consistent with findings of A. Gimmel *et al*. (2017) on the detection of cholelith in the gallbladder of reptiles. The right lobe of the liver has two caudal processes: one larger in the caudal corner of the dorsal margin, the other smaller in the middle of the dorsal margin; the left lobe has one process in the middle of the dorsal margin. A.A. Al-Doaiss *et al*. (2023) reported melanin deposits in the liver of a Yemeni chameleon. According to the findings of this study, no melanin pigmentation of the chameleon liver surface was detected.

According to S. Mans (2013), the gastrointestinal tract is the most diverse of all reptile body systems, which poses a particular challenge for veterinarians when trying to provide nutritional advice, interpret diagnostic tests, and develop treatment regimens. According to N.D. Youngblut *et al*. (2019), reptiles have a less differentiated gastrointestinal anatomy compared to mammals. Ö. Çakici & E. Akat (2013) in the snake-eyed lizard (*Ophisops elegans*), the intestine was divided only into small and large intestines, without division into separate intestines. In the Egyptian mastigure (*Uromastyx aegyptiaca*), M. Zaher *et al*. (2012) also did not divide the small intestine into separate intestines. R. Diaz-Figueroa & M.A. Mitchell (2006) distinguished the small and large intestine, as well as the colon, in the reptilian intestine. According to N. Srichairat *et al*. (2018), the intestine of the Asian water monitor (*Varanus salvator*) lacks the jejunum and caecum, and according to M.V. Skrypka *et al*. (2020), the sand lizard (*Lacerta agilis*) lacks the caecum. H.S. Lee & S. Ku (2004) identified the duodenum, small intestine, and colon in the intestine of the mountain grass lizard (*Takydromus wolteri*). There is limited information on the structure of the Yemeni chameleon's intestines. According to R. Nesas (2004), the intestinal tract of the Yemeni chameleon is short and poorly differentiated. According to N. Hamdi *et al*. (2014), the small intestine of the African chameleon (*Chamaeleo africanus*) is not divided into duodenum and ileum, and the large intestine can be divided into colon and rectum.

When dividing the small and large intestines of the Yemeni chameleon into separate intestines, this study was guided by the detailed description of the digestive organs of the central bearded dragon (*Pogona vitticeps*), which belongs to the family *Agamidae*, provided by E. Engelke *et al*. (2020). These data were obtained based on a study of the macroscopic structure of the intestine, the relief of the mucous membrane, and its blood supply. The small intestine is located in the caudoventral part of the thoracic cavity, cranially bordering the liver and lungs, caudodorsally – the kidneys. Three intestines were identified in the small intestine of the Yemeni chameleon: duodenum, jejunum, and ileum. The duodenum is separated from the jejunum by the confluence of the pancreatic duct and bile duct. On the surface of the duodenum, there was a pancreas, which had the shape of a narrow thin strip of pale pink colour (Fig. 3).

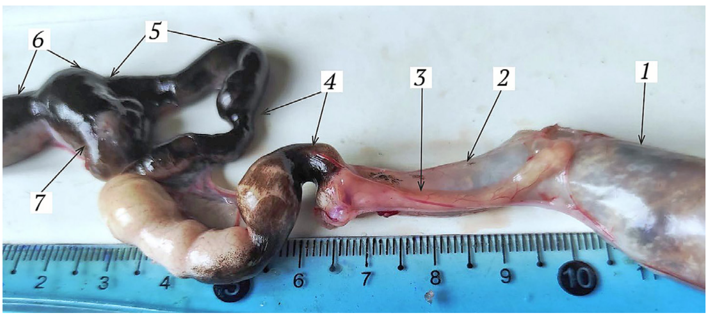

Figure 3. Digestive organs of a 1-year-old Yemeni chameleon (*Chamaeleo calyptratus*)
Notes: *1 – stomach; 2 – duodenum; 3 – pancreas; 4 – jejunum; 5 – ileum; 6 – colon; 7 – colonic diverticulum*
Sourse: *developed by the author of this study*

As a result of anatomical examinations, it was found that there was no division of the pancreas into lobes. At the same time, R. Nesas (2004) points to the presence of two lobes in the pancreas of the Yemeni chameleon, although not always separate. The caecum is the longest and forms a U-shaped loop that is held in place by a long mesentery. At the end of the distal part of the loop, the caecum passes into the short ileum, which flows into the colon. The boundary between the ileum and colon is a narrow opening formed by the ileocolic sphincter. In chameleons up to 2 months of age, the remnant of the yolk bladder was detected on the surface of the caecum in the form of a yellowish spherical formation with a diameter of 1.0-1.5 mm. As pointed out by T. Mazurkevych & S. Usenko (2023), in birds, a permanent structure is formed at the site of the remnant of the yolk duct, which connects the yolk bladder cavity with the small intestine cavity during embryonic ontogeny, – Meckel's diverticulum, which is an organ of immune defence.

Two intestines were identified in the large intestine of Yemeni chameleons: the colon and the rectum. The colon is located mainly in the middle of the whole between the right and left fatty body in the caudoventral part of the abdomen. Compared to the ileum, the colon has a much larger diameter. Its characteristic feature is the presence of a bulge – a diverticulum corresponding to the caecum. Relative to the colon, the axis of the diverticulum is directed somewhat caudally. Before passing into the rectum, the colon narrows and forms the colic isthmus. In contrast to the central bearded dragon's colon, which is spherical (ampulliform), as found by K.A. Mathes *et al*. (2019), the Yemeni chameleon's colon is cylindrical. The rectum has a large diameter, is located directly along the axis of the body and passes into the cloaca. Attention is drawn to the complete or partial black discolouration of the intestinal serosa, which was observed from the duodenum and extended to the rectum inclusive. There is no such information available on the structure of the intestines of both chameleons and other reptile species.

The surface structure of the mucous membrane of the digestive tract has substantial features in different parts of the tract (Fig. 4).

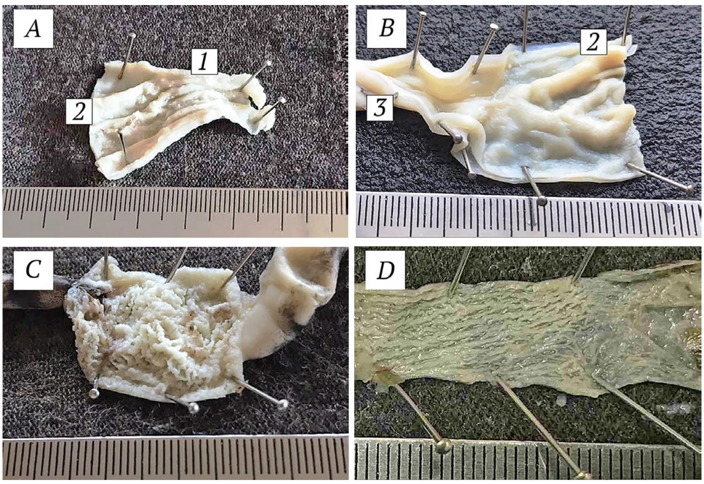

Figure 4. The surface structure of the mucous membrane of the oesophagus, stomach and small intestine of the Yemeni chameleon (*Chamaeleo calyptratus*)

Notes: *A – oesophagus – stomach; B – stomach – duodenum; C – caecum; D – ileum. 1 – oesophagus; 2 – stomach; 3 – duodenum*

Sourse: *developed by the author of this study*

In the oesophagus, the mucous membrane forms several longitudinal, almost parallel folds that continue to the entrance to the stomach. The gastric mucosa contains several thick folds that have different directions, which is consistent with the reports of T.S. Parsons & J.E. Cameron 1977) regarding their non-parallel direction and the presence of both wavy and straight parts of the folds. In the duodenal mucosa, there were clearly visible thin longitudinal folds, which in the duodenum were much more numerous, thin, wavy, and had a somewhat chaotic arrangement, which is consistent with the data of T.S. Parsons & J.E. Cameron (1977). In the ileum, the number and height of the folds are smaller. The ileum and colon are separated by the ileocecal foramen, which is based on a thick circular fold that forms the ileocolic valve. The mucous membrane of the colon and rectum contains several longitudinal folds and is separated from each other by a circular fold.

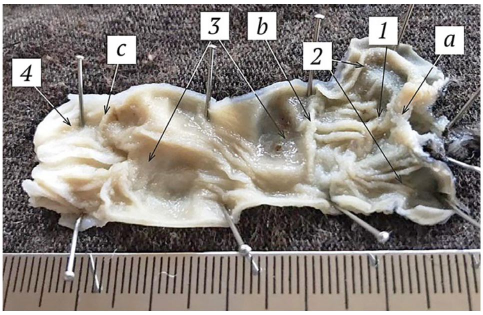

Figure 5. Surface structure of the mucous membrane of the large intestine of the Yemeni chameleon (*Chamaeleo calyptratus*)
Notes*:* 1 – colon; 2 – colonic diverticulum; 3 – rectum; 4 – caecum; a – ileocolic valve; b – circular fold between colon and rectum; c – circular fold between rectum and caecum
Sourse*: developed by the author of this study*

The area of the colon in front of the rectum has several distinct longitudinal folds, its diameter decreases slightly, which corresponds to the colic isthmus. The mucous membrane of the colic diverticulum is smooth. The mucous membrane of the cloaca forms several distinct longitudinal folds. Generally, the features of the relief of the mucous membrane of the oesophagus, stomach, and individual intestines of the Yemeni chameleon are comparable to those of the central bearded dragon, which is consistent with the data of E. Engelke *et al*. (2020). Compared to 1-day-old animals, the body weight of 1-year-old Yemeni chameleons increased 185.9 times (Table 1), which corresponds to the data of A. Herrel *et al*. (2014) on the increase in body weight of this species within a year after hatching by up to two orders of magnitude. During the first month of postnatal ontogeny, the body weight of chameleons increased by 92.9%, in the second month – by 240.7%, and in the third month – by 452.3%. In the period from 3 months to 6 months of age, the increase was 197.6%, from 6 to 8 months of age – 13.6%, from 8 months to 1 year of age – 392.4%. Thus, during the observation period, the most intensive increase in chameleon body weight occurred during the second and third months of life.

Table 1. Body weight and length of Yemeni chameleons of 1 day – 1 year of age (M ± Std, n = 5)

Age	Body weight, g	Body length, cm	SVL, cm	Digestive tract length, cm	Ratio of digestive tract length to SVL
1 day	1.4 ± 0.1^{a}	7.0 ± 0.5^{a}	3.1 ± 0.3^{a}	10.0 ± 1.5^{ab}	3.2 ± 0.4^{c}
7 days	1.8 ± 0.1^{ab}	7.4 ± 0.1^{ab}	3.3 ± 0.3^{ab}	7.5 ± 0.8^{a}	2.3 ± 0.3^{ab}
14 days	2.1 ± 0.1^{ab}	9.3 ± 0.1^{ab}	4.0 ± 0.2^{ab}	8.6 ± 0.7^{ab}	2.1 ± 0.1^{ab}
1 month	2.7 ± 0.3^{ab}	9.9 ± 0.2^{ab}	4.4 ± 0.4^{ab}	10.2 ± 1.9^{ab}	2.4 ± 0.1^{b}
2 months	6.5 ± 0.4^{ab}	13.6 ± 0.3^{b}	6.6 ± 0.5^{b}	12.8 ± 0.7^{ab}	1.9 ± 0.2^{ab}
3 months	29.4 ± 3.3^{ab}	16.0 ± 0.6^{bc}	8.1 ± 1.2^{bc}	16.3 ± 1.7^{b}	2.0 ± 0.1^{ab}
6 months	58.1 ± 6.3^{b}	26.2 ± 0.9^{c}	12.3 ± 1.8^{c}	23.7 ± 2.4^{bc}	1.9 ± 0.2^{ab}
8 months	66.0 ± 3.0^{bc}	27.3 ± 0.4^{cd}	12.9 ± 0.7^{cd}	22.6 ± 2.9^{bc}	1.8 ± 0.2^{ab}
1 year	260.2 ± 28.3^{c}	44.3 ± 1.0^{d}	20.8 ± 1.9^{d}	38.0 ± 6.3^{c}	1.8 ± 0.2^{a}

Notes: **different letters indicate values that differ substantially within a column based on Tukey's test ($P < 0.05$) with Bonferroni correction*
Source*: developed by the author of this study*

The SVL of 1-year-old chameleons was 6.7 times higher than that of 1-day-olds. In the first month of keeping these animals, it increased by 41.9%, in the second – by 50.0%, in the third – by 62.1%, from 6 to 8 months of age – by 4.9%, and from 8 months to 1 year of age – by 61.2%. Thus, like body weight, SVL growth was most intense during the third month of life. It is during the period of the most intensive growth that chameleons are particularly sensitive to adverse environmental factors, which must be considered when breeding them. During the observation period, the general pattern of changes in the length of the digestive tract of Yemeni chameleons was its increase. The length of the digestive tract in 1-year-old animals was 3.8 times longer than in 1-day-old chameleons. At the same time, in the period from 1- to 7-day of age and from 6- to 8-months of age, a decrease was observed, which was also described by P.A. Iji *et al*. (2001), which focused on the uneven growth rate of the digestive organs. The ratio of the length of the alimentary canal to the SVL was highest up to and including 1 month of age. Subsequently, this indicator decreased and reached the lowest values in animals of 8 months and 1 year of age.

In parallel with the increase in the weight and length of the Yemeni chameleons' bodies, the absolute weight of their stomachs and intestines also increased. Thus, the absolute weight of the stomach and intestine in 1-year-old animals was 170.5 and 226.3 times higher, respectively, compared to 1-day-old chameleons (Table 2). In the first month, these figures increased by 204.0% and 268.8%, respectively, in the second month – by 99.3% and 317.0%, in the third month – by 321.1% and 92.7%, and in the period from 3 to 6 months of age – by 95.8% and 130.0%. Compared to 6 months of age, the absolute weight of the stomach of 8-month-old chameleons was 10.8% higher, and the intestines were 23.4% lower. From the age of 8 months to 1 year, the weight of the stomach increased by 207.8%, and the weight of the intestines – by 334.1%. The relative weight of the stomach and intestines increased until 2 months of age and was lower in older animals.

Table 2. Stomach and intestine weight of Yemeni chameleons of 1 day – 1 year of age (M ± Std, n = 5)

Age	Stomach weight		Intestines weight	
	absolute, mg	relative, %	absolute, mg	relative, %
1 day	27.8 ± 4.3[a]	2.0	60.8 ± 4.8[a]	4.3
7 days	46.8 ± 6.2[ab]	2.7	86.8 ± 11.6[ab]	5.0
14 days	70.4 ± 8.4[ab]	3.4	114.2 ± 14.2[ab]	5.5
1 month	84.6 ± 12.6[ab]	3.1	224.2 ± 63.0[ab]	8.1
2 months	168.6 ± 15.5[ab]	2.6	510.0 ± 69.0[ab]	7.8
3 months	710.0 ± 157.2[b]	2.4	1,802.0 ± 570.5[b]	6.0
6 months	1,390.0 ± 305.4[c]	2.4	4,188.0 ± 925.4[bc]	7.1
8 months	1,540.0 ± 152.1[cd]	2.7	3,174.0 ± 181.2[bc]	4.9
1 year	4,740.0 ± 609.9[d]	1.9	13758.0 ± 3786.4[c]	5.2

Notes: *different letters indicate values that differ substantially within a column based on Tukey's test (P < 0.05) with Bonferroni correction*
Source*: developed by the author of this study*

Against the background of a significant increase in the absolute weight of the stomach and intestines with age, their linear indicators changed to a lesser extent. Thus, compared to their 1-day-old age, the length and width of the stomach were 5.1 and 11.0 times longer in 1-year-old animals, respectively (Table 3), and the length of the intestine was 3.2 times greater (Table 4).

Table 3. Linear stomach parameters of Yemeni chameleons of 1 day – 1 year of age (M ± Std, n = 5)

Age	Length, mm	Width, mm
1 day	11.4 ± 0.8^{a}	1.4 ± 0.1^{a}
7 days	14.0 ± 1.0^{ab}	1.8 ± 0.1^{ab}
14 days	15.2 ± 1.6^{ab}	2.2 ± 0.2^{ab}
1 month	18.2 ± 1.1^{ab}	2.6 ± 0.1^{ab}
2 months	20.4 ± 2.1^{b}	5.6 ± 0.4^{b}
3 months	24.4 ± 1.9^{bc}	9.8 ± 0.6^{c}
6 months	23.8 ± 2.3^{bc}	10.6 ± 0.8^{cd}
8 months	25.4 ± 5.0^{bc}	9.4 ± 1.5^{cd}
1 year	57.6 ± 8.4^{c}	15.4 ± 1.8^{d}

Notes: *different letters indicate values that differ substantially within a column based on Tukey's test (P < 0.05) with Bonferroni correction*
Source*: developed by the author of this study*

Table 4. Length of intestinal sections
of the Yemeni chameleon 1-day-old to 1-year-old (M ± Std, n = 5)

Age	Total length, mm	Thin section length, mm	Thick section length, mm	Relative length of the thin section, %	Ratio of intestines length to SVL
1 day	75.0 ± 13.9^{ab}	61.2 ± 12.4^{ab}	13.8 ± 1.5^{a}	81.6	2.4 ± 0.4^{b}
7 days	43.5 ± 8.5^{a}	28.6 ± 6.59^{a}	14.9 ± 2.0^{ab}	65.7	1.3 ± 0.2^{ab}
14 days	50.4 ± 3.9^{ab}	32.8 ± 3.8^{ab}	17.6 ± 2.6^{ab}	65.1	1.3 ± 0.1^{ab}
1 month	61.2 ± 4.2^{ab}	44.0 ± 4.0^{ab}	17.2 ± 1.1^{ab}	71.9	1.4 ± 0.1^{ab}
2 months	81.6 ± 10.8^{bc}	59.8 ± 9.1^{b}	21.8 ± 4.6^{ab}	73.3	1.2 ± 0.1^{ab}
3 months	96.8 ± 15.6^{b}	70.4 ± 13.8^{bc}	26.4 ± 2.2^{b}	72.7	1.2 ± 0.1^{ab}
6 months	156.0 ± 19.6^{cd}	121.6 ± 16.0^{cd}	34.4 ± 4.3^{c}	77.9	1.3 ± 0.1^{ab}
8 months	144.4 ± 13.8^{c}	102.6 ± 18.5^{c}	41.8 ± 8.3^{d}	71.1	1.1 ± 0.1^{a}
1 year	242.4 ± 35.4^{d}	181.0 ± 30.0^{d}	61.4 ± 6.1^{e}	74.7	1.2 ± 0.2^{ab}

Notes: *different letters indicate values that differ substantially within a column based on Tukey's test (P < 0.05) with Bonferroni correction*
Source*: developed by the author of this study*

According to the data obtained, in the Yemeni chameleon, the largest relative length of the small intestine was observed in animals of 1 day of age, and the smallest – in animals of 7-14 days of age. In chameleons of 1 month to 1 year of age, it was 71.1-77.9%. The high values of both absolute and relative length of the jejunum and the entire small intestine in 1-day-old animals are probably related to the significance of this intestine in digestion and absorption of nutrients from the gallbladder during the embryonic period of ontogeny. As K.D. Kohl *et al*. (2016) point out, the length of the intestine and its individual intestines is a rather labile structure that responds quickly to the body's nutrient needs and dietary composition. According to K.D. Kohl *et al*. (2016), omnivorous Ruibal's tree iguanas (*Liolaemus ruibali*) fed plant-based food had a 17% longer small intestine than lizards fed mixed food, although no differences in small intestine weight and volume were observed. In most animals, juveniles are not simply miniature versions of adults. In fact, as identified by S.J. Gould (1977), they differ in many aspects, including morphology, physiology, locomotion, and nutritional preferences. According to K. Troyer (1984), young and adult reptiles have different needs for nutrients and specific features of the structure of their digestive organs.

Growing iguanas digest food 1.3-2.0 times faster than adults, and can reduce the time it takes to pass it.

According to the results of determining the relative length of individual intestines of chameleons of different ages and the mean age index (MAI) of this parameter, it was found that the largest length was the caecum, which was almost half of the total length of the intestine, then in descending order of this index the intestines were located as follows: colon, duodenum, and ileum (Tables 5, 6).

Table 5. Length of the small intestine of Yemeni chameleons of 1 day – 1 year of age (M ± Std, n = 5)

Age	Duodenum		Jejunum		Ileum	
	abs., in mm	rel., %	abs., in mm	rel., %	abs., in mm	rel., %
1 day	4.6 ± 1.4^{a}	6.1	53.2 ± 10.6^{bc}	70.9	3.4 ± 0.5^{a}	4.5
7 days	7.4 ± 1.7^{ab}	17.0	16.4 ± 4.3^{a}	37.7	4.8 ± 1.2^{ab}	11.0
14 days	6.6 ± 1.5^{ab}	13.1	22.0 ± 3.7^{ab}	43.7	4.2 ± 0.5^{ab}	8.3
1 month	5.6 ± 1.3^{ab}	9.1	32.0 ± 5.1^{ab}	52.3	6.4 ± 1.3^{ab}	10.5
2 months	10.6 ± 3.1^{ab}	13.0	40.2 ± 5.1^{b}	49.3	9.0 ± 1.5^{ab}	11.0
3 months	13.4 ± 4.4^{b}	13.8	45.4 ± 6.1^{bc}	46.9	11.6 ± 4.1^{b}	12.0
6 months	17.6 ± 4.8^{bc}	11.3	90.8 ± 8.9^{d}	58.1	13.2 ± 3.1^{bc}	8.6
8 months	18.8 ± 2.6^{bc}	13.0	71.4 ± 15.7^{c}	49.4	12.4 ± 2.3^{bc}	8.6
1 year	32.6 ± 9.3^{c}	13.4	121.4 ± 15.8^{e}	50.1	27.0 ± 7.1^{c}	11.1
MAI		12.2 ± 1.0		50.9 ± 3.1		9.5 ± 0.8

Notes: *different letters indicate values that differ substantially within a column based on Tukey's test (P < 0.05) with Bonferroni correction*
Source*: developed by the author of this study*

Table 6. Length of the large intestine
and cloaca of Yemeni chameleons of 1 day – 1 year of age (M ± Std, n = 5)

Age	Colon		Rectum		Cloaca
	abs., in mm	rel., %	abs., in mm	rel., %	abs., in mm
1 day	7.2±1.3^{a}	9.6	6.6±0.8^{ab}	8.8	3.0±0.5^{a}
7 days	8.9±1.2^{ab}	20.5	6.0±0.8^{a}	13.8	3.0±0.5^{a}
14 days	11.2±1.8^{ab}	22.2	6.4±0.8^{ab}	12.7	3.2±0.5^{ab}
1 month	9.6±0.9^{ab}	15.7	7.6±0.7^{ab}	12.4	3.6±0.5^{ab}
2 months	12.8±2.7^{ab}	15.7	9.0±1.9^{ab}	11.0	3.8±0.8^{ab}
3 months	14.0±1.8^{b}	14.5	12.4±2.1^{b}	12.8	4.4±0.6^{ab}
6 months	16.8±2.7^{bc}	10.8	17.6±2.1^{bc}	11.3	5.2±0.5^{b}
8 months	22.2±5.3^{c}	15.4	19.6±3.5^{c}	13.6	5.4±0.6^{bc}
1 year	33.8±3.8^{d}	13.9	27.6±3.7^{d}	11.4	12.2±2.0^{c}
MAI	–	15.4±1.4	–	12.0±0.5	–

Notes: *different letters indicate values that differ substantially within a column based on Tukey's test (P < 0.05) with Bonferroni correction*
Source*: developed by the author of this study*

The data obtained suggest an uneven and asynchronous growth of the length of both individual intestines and the corresponding parts of the intestine in Yemeni chameleons, which is a manifestation of a known biological pattern regarding the growth of this organ in other animal species, as also indicated by D. Yovchev *et al*. (2013), P.M. Gavrylin &

M.O. Nikitina (2017). For instance, during the second and third months of keeping animals, the length of the duodenum increased by 89.3% and 9.4%, respectively, the length of the jejunum – by 25.6% and 12.9%, the ileum – by 66.6% and 28.9%, the colon – by 33.3% and 9.4%, and the rectum – by 15.4% and 37.8%. Over these age periods, the length of the small intestine increased by 35.9% and 17.7%, respectively, and the length of the large intestine – by 26.7% and 21.1%.

In the first month of postnatal ontogeny in Yemeni chameleons, the absolute weight of the liver and pancreas increased by 150.0% and 209.1%, respectively, in the second month – by 192.0% and 170.6%, in the third – by 616.5% and 271.7%, in the period from 3 months to 6 months of age – by 83.7% and 51.5%, from 6 to 8 months of age – by 11.3% and 4.2%, from 8 months to 1 year of age – by 313.3% and 192.6% (Table 7).

Table 7. Morphometric parameters of the liver and pancreas of the Yemeni chameleon of 1 day – 1 year of age, M ± m, n = 5

Age	Liver		Pancreas		
	absolute weight, g	relative weight, %	absolute weight, mg	relative weight, %	length, mm
1 day	27.0 ± 1.5[a]	1.9	1.1 ± 0.3[a]	0.07	5.4 ± 1.9[a]
7 days	38.0 ± 6.5[ab]	2.1	1.7 ± 0.5[ab]	0.09	8.4 ± 1.7[ab]
14 days	48.0 ± 3.3[ab]	2.3	1.8 ± 0.5[ab]	0.09	8.0 ± 1.3[ab]
1 month	67.4 ± 16.7[ab]	2.5	3.4 ± 1.0[ab]	0.12	6.8 ± 1.5[ab]
2 months	196.8 ± 34.1[ab]	3.0	9.2 ± 2.8[ab]	0.14	12.0 ± 3.6[ab]
3 months	1,410.0 ± 409.2[ab]	4.7	34.2 ± 11.5[ab]	0.12	9.6 ± 3.5[ab]
6 months	2,590.0 ± 462.3[ab]	4.5	51.8 ± 7.3[ab]	0.09	19.4 ± 5.1[b]
8 months	2,882.0 ± 190.3[b]	4.4	54.0 ± 6.1[ab]	0.07	20.4 ± 2.6[bc]
1 year	11,910.0 ± 2,699.0[c]	4.6	158.0 ± 69.5[b]	0.06	35.2 ± 8.1[c]

Notes: *different letters indicate values that differ substantially within a column based on Tukey's test ($P < 0.05$) with Bonferroni correction*
Source*: developed by the author of this study*

The relative liver weight increased until the age of 3 months and then stayed within 4.4-4.7%. The relative weight of the pancreas increased until 2 months of age, and gradually decreased in older animals. Thus, during the observation period, the most intensive increase in both liver and pancreas weight in chameleons occurred during the third month of life, reaching a maximum value at 3 and 2 months of age, respectively.

Thus, based on the results of morphological studies, the specific features of the topography and macroscopic structure of the digestive organs of the Yemeni chameleon, as well as age-related changes in their mass and linear parameters, were determined. The obtained findings can be useful in species morphology, for clarifying the development of digestive organs in the postnatal period of ontogeny, during diagnostic studies, for determining morphological changes in pathology, which will contribute to the development of new approaches in animal treatment.

Conclusions

Keeping reptiles as exotic pets is not an easy task for owners due to the diversity of species and lack of knowledge about their biological characteristics. Errors in feeding and housing lead to diseases of reptiles, among which one of the most common is pathologies of the digestive system. Among reptiles, Yemeni chameleons (*Chamaeleo calyptratus*) are considered especially popular for keeping at home. The lack of information on the topography and structure of the digestive organs of these animals is a limitation for performing veterinary diagnostic procedures, especially radiographic and ultrasound. The study found that the location of the digestive organs and their macroscopic structure in the Yemeni chameleon corresponded to the general patterns of structure in lizards. The chameleon tongue has three parts: proximal, middle, and distal. The stomach has a cylindrical shape, which passes into the duodenum without a sharp border. The liver consists of two lobes: the larger right lobe, to which the gallbladder is attached, and which has two branches, and the smaller left lobe, which has one branch. The pancreas is a strip on the surface of the duodenum, not divided into lobes. According to the specific features of topography, macroscopic structure and mucosal surface structure, three intestines are distinguished in the small intestine: duodenum, jejunum, and ileum, and two intestines are distinguished in the large intestine: the colon with diverticulum and the rectum, which passes into the cloaca. The relief of the mucous membrane of the digestive tract has features in different parts of it. In the oesophagus, the mucous membrane forms several thick longitudinal folds, and in the stomach – several thick folds with different directions. In the small intestine, the mucous membrane forms thin, numerous folds, which are wavy and more numerous in the large intestine. The mucous membrane in the colon and rectum, as well as the cloaca, has predominantly longitudinal folds, and is smooth in the diverticulum of the colon. In the period from 1 day to 1 year of age of Yemeni chameleons, morphometric parameters of the liver, pancreas, stomach, and intestines increased against the background of body weight growth, which occurred asynchronously and unevenly and most intensively at 2-3 months of age. The linear parameters of the digestive system increased to a much lesser extent compared to the weight. The period of the most intensive growth corresponded to higher relative weight of the digestive organs. In the future, it is planned to investigate the microscopic structure of the digestive organs of the Yemeni chameleon.

Acknowledgements

None.

Conflict of Interest

None.

References

[1] Al-Doaiss, A.A., Alshehri, M.A., Shati, A.A., Alfaifi, M.Y., Al-Kahtani, M.A., Ahmed, A.E., Eid, R.A., Alshuraym, L.A., Al-Mekhlafi, F.A., Al-Zharani, M., & Mubarak, M. (2023). Histomorphological, histochemical and ultrastructural studies on the healthy liver of Yemen veiled chameleon (*Chamaeleo calyptratus*) in southern Saudi Arabia. *International Journal of Morphology*, 41(5), 1513-1526.

[2] Ardente, A., Toddes, B., & Schultz, R.L. (2023). Nutritional considerations for juvenile exotic companion animals. *Veterinary Clinics of North America: Exotic Animal Practice*, 27(2), 449-463. doi: 10.1016/j.cvex.2023.11.016.

[3] Çakici, Ö., & Akat, E. (2013). Some histomorphological and histochemical characteristics of the digestive tract of the snake-eyed lizard, *Ophisops elegans* Menetries, 1832 (*Squamata: Lacertidae*). *North-Western Journal of Zoology*, 9(2), 257-263.

[4] Crouch, E.E.V., McAloose, D., McEntire, M.S., Morrisey, J.K., & Miller, A.D. (2021). Pathology of the Bearded Dragon (*Pogona vitticeps*): A retrospective analysis of 36 cases. *Journal of Comparative Pathology*, 186, 51-61. doi: 10.1016/j.jcpa.2021.05.004.

[5] Diaz-Figueroa, R., & Mitchell, M.A. (2006). Gastrointestinal anatomy and physiology. In *Reptile medicine and surgery* (pp. 145-162). Philadelphia: W.B. Saunders. doi: 10.1016/B0-72-169327-X/50016-X.

[6] Engelke, E., Pfarrer, C., Radelof, K., Fehr, M., & Mathes, K.A. (2020). Gross anatomy, histology and blood vessel topography of the alimentary canal of the Inland Bearded Dragon (*Pogona vitticeps*). *PLoS ONE*, 15(6), article number e0234736. doi: 10.1371/journal.pone.0234736.

[7] European Convention for the Protection of Vertebrate Animals Used for Experimental and Scientific Purposes. (1986). Retrieved from http://zakon4.rada.gov.ua/laws/show/994_137.

[8] Fouda, Y.A., Sabry, D.A., & Abou-Zaid, D.F. (2015). Functional anatomical, histological and ultrastructural studies of three chameleon species: *Chamaeleo chamaeleon, Chamaeleo africanus,* and *Chamaeleon vulgaris*. *International Journal of Morphology*, 33(3), 1045-1053. doi:10.4067/S0717-95022015000300038.

[9] Frei, S., Sanchez-Migallon Guzman, D., Kass, P.H., Giuffrida, M.A., & Mayhew, P.D. (2020). Evaluation of a ventral and a left lateral approach to coelioscopy in bearded dragons (*Pogona vitticeps*). *American Journal of Veterinary Research*, 81(3), 267-275. doi: 10.2460/ajvr.81.3.267.

[10] Gavrylin, P.M., & Nikitina, M.O. (2017). Morphometric parameters of the intestine and aggregated lymphatic nodules of meat rabbits. *Regulatory Mechanisms in Biosystems*, 8(4), 649-655. doi: 10.15421/0217100.

[11] Gimmel, A., Kempf, H., Öfner, S., Müller, D., & Liesegang, A. (2017). Cholelithiasis in adult bearded dragons: Retrospective study of nine adult bearded dragons (*Pogona vitticeps*) with cholelithiasis between 2013 and 2015 in Southern Germany. *Journal of Animal Physiology and Animal Nutrition*, 101(1), 122-126. doi: 10.1111/jpn.12616.

[12] Gould, S.J. (1977). *Ontogeny and phylogeny*. Cambridge: The Belknap Press of Harvard University Press.

[13] Hamdi, H., El-Ghareeb, A.-W., Zaher, M., Essa, A., & Lahsik, S. (2014). Anatomical, histological and histochemical adaptations of the reptilian alimentary canal to their food habits: II-Chamaeleon africanus. *World Applied Sciences Journal*, 30(10), 1306-1316. doi: 10.5829/idosi.wasj.2014.30.10.82395.

[14] Herrel, A., Redding, C.L., Meyers, J.J., & Nishikawa, K.C. (2014). The scaling of tongue projection in the veiled chameleon, *Chamaeleo Calyptratus*. *Zoology*, 117(4), 227-236. doi: 10.1016/j.zool.2014.01.001.

[15] Iji, P.A., Saki, A., & Tivey, D.R. (2001). Body and intestinal growth of broiler chickens on a commercial starter diet. 1. Intestinal weight and mucosal development. *British Poultry Science*, 42(4), 505-513. doi: 10.1080/00071660120073151.

[16] Kohl, K.D., Brun, A., Magallanes, M., Brinkerhoff, J., Laspiur, A., Acosta, J.C., Bordenstein, S.R., & Caviedes-Vidal, E. (2016). Physiological and microbial adjustments to diet quality permit facultative herbivory in an omnivorous lizard. *Journal of Experimental Biology*, 219(12), 1903-1912. doi: 10.1242/jeb.138370.

[17] Kubiak, M., Denk, D., & Stidworthy, M.F. (2020). Retrospective review of neoplasms of captive lizards in the United Kingdom. *Veterinary Record*, 186(1), article number 28. doi: 10.1136/vr.105308.

[18] La'Toya, L.V. (2023). Updates for reptile pediatric medicine. *Veterinary Clinics of North America: Exotic Animal Practice*, 27(2), 379-409. doi: 10.1016/j.cvex.2023.11.013.

[19] Lee, H.S., & Ku, S.K. (2004). An immunohistochemical study of endocrine cells in the alimentary tract of the grass lizard, *Takydromus wolteri* Fischer (*Laceridae*). *Acta Histochemica*, 106(2), 171-178. doi: 10.1016/j.acthis.2003.10.008.

[20] Mans, C. (2013). Clinical update on diagnosis and management of disorders of the digestive system of reptiles. *Journal of Exotic Pet Medicine*, 22(2), 141-162. doi: 10.1053/j.jepm.2013.05.006.

[21] Mathes, K.A., Radelof, K., Engelke, E., Rohn, K., Pfarrer, C., & Fehr, M. (2019). Specific anatomy and radiographic illustration of the digestive tract and transit time of two orally administered contrast media in Inland bearded dragons (*Pogona vitticeps*). *PLoS ONE*, 14(8), article number e0221050. doi: 10.1371/journal.pone.0221050.

[22] Mazurkevych, T., & Usenko, S. (2023). Morphogenesis of immune formations of ducks' intestine. *Scientific Messenger of LNU of Veterinary Medicine and Biotechnologies. Series: Veterinary Sciences*, 25(112), 90-97. doi: 10.32718/nvlvet11215.

[23] Melero, A., Novellas, R., Mallol, C., Ríos, J., Silvestre, A.M., & Martorell, J. (2020). Ultrasonographic appearance of the coelomic cavity organs in healthy veiled chameleons (*Chamaeleo calyptratus*) and panther chameleons (*Furcifer pardalis*). *Veterinary Radiology & Ultrasound*, 61(1), 58-66. doi: 10.1111/vru.12820.

[24] Melero, A., Verdés, J., Espada, Y., Novellas, R., Encinoso, M., & Martorell, J. (2023). Computed tomography of the coelomic cavity in healthy veiled chameleons (*Chamaeleo calyptratus*) and panther chameleons (*Furcifer pardalis*). *Open Veterinary Journal*, 13(9), 1071-1081. doi: 10.5455/ovj.2023.v13.i9.2.

[25] Necas, P. (2004). *Chameleons. Nature's hidden jewels*. Frankfurt am Main: Edition Chimaira & Serpent's Tale, Frankfurt am Main.

[26] Parsons, T.S., & Cameron, J.E. (1977). Internal relief of the digestive tract. In *Biology of the Reptilia* (pp. 159-223). New York: Academic Press.

[27] Pinto, B.J., Card, D.C., Castoe, T.A., Diaz, R.E. Jr, Nielsen, S.V., Trainor, P.A., & Gamble, T. (2019). The transcriptome of the veiled chameleon (*Chamaeleo calyptratus*): A resource for studying the evolution and development of vertebrates. *Developmental Dynamics*, 248(8), 702-708. doi: 10.1002/dvdy.20.

[28] Skrypka, M.V., Panikar, I.I., Kyrychko, B.P., & Tul, O.I. (2020). The Morphological features of the digestive tube in sand lizards, *Lacerta agilis (Sauria, Lacertidae*). *Zoodiversity*, 54(5), 375-382. doi: 10.15407/zoo2020.05.375.

[29] Sollom, H.J., & Baron, H.R. (2023). Clinical presentation and disease prevalence of captive central bearded dragons (*Pogona vitticeps*) at veterinary clinics in Australia. *Australian Veterinary Journal*, 101(5), 200-207. doi: 10.1111/avj.13234.

[30] Srichairat, N., Taksintum, W., & Chumnanpuen, P. (2018). Gross morphological structure of digestive system in water monitor lizard *Varanus salvator* (*Squamata: Varanidae*). *Walailak Journal of Science and Technology*, 15(3), 245-253. doi: 10.48048/wjst.2018.3356.

[31] Tang, G.S., Liang, X.X., Yang, M.Y., Wang, T.T., Chen, J.P., Du, W.G., Li, H., & Sun, B.J. (2020). Captivity influences gut microbiota in crocodile lizards (*Shinisaurus crocodilurus*). *Frontiers in Microbiology*, 11, article number 550. doi: 10.3389/fmicb.2020.00550.

[32] Troyer, K. (1984). Diet selection and digestion in *Iguana iguana*: The importance of age and nutrient requirements. *Oecologia*, 61(2), 201-207. doi: 10.1007/BF00396761.

[33] Tul, O.I. (2021). Morphological structure of the liver and gall bladder of the Yemeni chameleon (Chamaeleo calyptratus). In *The international scientific and practical internet conference "Actual issues of forensic veterinary medicine, morphology and pathomorphology"* (pp. 31-32). Odesa: Odesa National Agrarian University.

[34] Wainwright, P.C., Kraklau, D.M., & Bennett, A.F. (1991). Kinematics of tongue projection in Chamaeleo oustaleti. *Journal of Experimental Biology*, 159, 109-133.

[35] Youngblut, N.D., Reischer, G.H., Walters, W., Schuster, N., Walzer, C., Stalder, G., Ley, R.E., & Farnleitne, A.H. (2019). Host diet and evolutionary history explain different aspects of gut microbiome diversity among vertebrate clades. *Nature Communications*, 10, 1-15. doi: 10.1101/484006.

[36] Yovchev, D., Dimitrov, D., & Penchev, G. (2013). Age weight and morphometrical parameters of the bronze turkey's (Meleagris meleagris gallopavo) intestines. *Bulgarian Journal of Agricultural Science*, 19(3), 611-614.

[37] Zaher, M., El-Ghareeb, A.-W., Hamdi, H., Essa, A., & Lahsik, S. (2012). Anatomical, histological and histochemical adaptations of the reptilian alimentary canal to their food habits: I. Uromastyx aegyptiaca. *Life Science Journal*, 9(3), 84-104.

Особливості топографії і макроскопічної будови органів травлення єменського хамелеону (*Chamaeleo calyptratus*)

Микола Кущ

Доктор ветеринарних наук, професор
Державний біотехнологічний університет
61002, вул. Алчевських, 44, м. Харків, Україна
https://orcid.org/0000-0002-5280-9755

Сергій Скачко

Аспірант
Державний біотехнологічний університет
61002, вул. Алчевських, 44, м. Харків, Україна
https://orcid.org/0009-0001-1229-5980

Ірина Фесенко

Кандидат ветеринарних наук, старший викладач
Державний біотехнологічний університет
61002, вул. Алчевських, 44, м. Харків, Україна
https://orcid.org/0000-0002-6076-5545

Ольга Мірошнікова

Кандидат ветеринарних наук, доцент
Державний біотехнологічний університет
61002, вул. Алчевських, 44, м. Харків, Україна
https://orcid.org/0000-0002-8371-9023

Олена Бирка

Кандидат ветеринарних наук, доцент
Державний біотехнологічний університет
61002, вул. Алчевських, 44, м. Харків, Україна
https://orcid.org/0000-0001-7316-2500

Анотація. Актуальність дослідження зумовлена відсутністю детальної інформації стосовно будови і топографії органів травлення єменського хамелеону (*Chamaeleo calyptratus*). Мета роботи полягала у з’ясуванні особливостей змін маси тіла, топографії і будови органів травлення єменського хамелеону, визначенні їх морфометричних показників у тварин від 1-добового до 1-річного віку. Матеріалом досліджень слугували язик, стравохід, шлунок, кишечник, печінка і підшлункова залоза хамелеонів різної статі 9 вікових груп. Отримані дані обробляли методом однофакторного дисперсійного аналізу (ANOVA). За особливостями топографії, макроскопічної будови і поверхні слизової оболонки в тонкому відділі кишечнику виділено три кишки: дванадцятипалу, порожню і клубову, а в товстому – дві кишки: ободову з дивертикулом і пряму, що переходить у клоаку. Особливістю серозної оболонки кишечнику хамелеонів є забарвлення меланіном в чорний колір. З 1-добового до 1-річного віку маса тіла хамелеонів збільшувалась в 185,9 раза, довжина тіла від верхівки носа до анального отвору (SVL) – в 6,7 раза, довжина травного каналу – у 3,8 раза, відношення довжини травного каналу до SVL зменшувалось з 3,2 до 1,8 раза. Найінтенсивніше зростання маси тіла і SVL відбувалось впродовж другого і третього місяців життя тварин. Відносна довжина тонкого відділу кишечнику в хамелеонів різних вікових груп становила 65,1-81,6 %, у складі якого найдовшою була порожня кишка. Збільшення морфометричних показників шлунка, кишечнику, печінки і підшлункової залози відбувалось асинхронно. Найвиразніші зміни показників їх відносної маси визначали в тварин 2-3-місячного віку. Отримані матеріали доповнюють і уточнюють інформацію стосовно топографії і особливостей будови органів травлення єменського хамелеону, тому будуть корисними в рентгенографічному і ультразвуковому дослідженні під час проведення ветеринарних маніпуляцій

Ключові слова: рептилії; шлунок; кишечник; печінка; підшлункова залоза; топографія