
Ph.D. THESIS

The morphology of the digestive system in zoophagous-polyphagous birds

SUMMARY OF Ph.D. THESIS

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INTRODUCTION

Birds are the most diversified species of vertebrates, adapted to the habitat they are populating. It is considered that birds evolved from a common ancestor, the Archaeopteryx, reptiles that present feathers evidently similar to the feathers of birds from our era. Primordial birds do not present essential characteristics for flight compared to modern birds.

Nutritional strategies are crucial for comprehending the evolution of species because it stimulates interspecific competition, and birds represent a good model for highlighting the diet in the process of speciation and extinction.

The digestive system morphology evolved in time after the principle of integrity for satisfying nutritional necessities in order with the available feedstuff present in the medium. The digestive system of birds is a continuous tube, composed of the beak, oropharyngeal cavity, esophagus, ingluvius ventriculus, proventriculus, small intestine, cecum rect and cloaca. It does not present teeth, and the jaw muscles are less developed. Also, for the adaptation to flight, the body of birds has moved its center of gravity in the interior of the thoracoabdominal cavity for enhancing flight maneuverability.

THESIS STRUCTURE

The Ph.D. thesis entitled "The morphology of the digestive system in zoophagous-poliphagous birds" contains a number of 138 pages and presents a relevant iconography of 79 Figures. It is structured in two parts and was realized in conformity with the methodologies for writing Ph.D. theses of IOSUD UASMV Cluj-Napoca.

The first part of the thesis, current state of knowledge, contains 41 pages and is structured in three chapters.

Chapter I "General evolutive aspects of the Aves class" offers general information regarding the evolution of birds.

Chapter II, entitled "Diet and its impact on the morphological aspects of the digestive system in some species", offers general information about the way through which birds have adapted to the medium and the modifications induced by the diet upon the morphology of the digestive system"

Chapter III, "General aspects of the digestive system's anatomy in birds"

The second part of the thesis, the personal contribution, extends over 93 pages and is structured in six chapters. It contains the Working hypothesis, General objectives, Materials and methods, The anatomical study of the superior digestive system in species of zoophagous-polyphagous birds, The anatomical study of the inferior digestive system in species of zoophagous-polyphagous birds, the anatomical study of the adnexal organs of the digestive system in species of zoophagous-polyphagous birds, the comparative analysis of the statistical data for 26 species of zoophagous-polyphagous birds, the general conclusion and the originality and innovative contributions of the thesis.

THE MANUSCRIPT OBJECTIVES

1. *Examining the morphological features of the upper digestive system of various zoophagus-polyphagous birds to highlight the morphofunctional adaptations and variations among species.*
2. *Examining the morphological characteristics of the lower digestive system of certain zoophagus-polyphagous birds to highlight the morphofunctional adaptations and differences between the species.*
3. *Examining the morphological characteristics of the digestive's tract adnexal glands in different zoophagus-polyphagous birds to highlight the differences that exist between species.*
4. *To highlight differences in the dimensions of the digestive system, morphometric evaluation was done for the species taken in the study.*

MATERIALS AND METHODS

The study was realised starting with the dissection of 69 zoophagus-polyphagous birds, the birds being classified into 9 orders. The digestive system was examined macroscopically *in situ* and separated from the carcass for each species studied, the anterior digestive segments, the lower digestive segments and the liver were weighed and measured and a statistical basis was to be performed to help us determine the differences of the environments between the segments of the digestive tube for each order.

RESULTS AND DISCUSSIONS

Chapter VI, entitled "The anatomical study of the upper digestive system in zoophagus-polyphagous bird species", includes anatomical observations of the upper digestive segment to highlight the anatomical adaptations of the digestive system for species from different habitats, the concrete and as complete description of the segments of the superior digestive tract and comparing the data obtained with the data from the scientific literature, mapping the existing anatomical aspects at the level of the digestive tract for each species, as well as highlighting the differential aspects existing between species in an attempt to highlight clear correlations between the bird species, the type of food and the habitat of which species originates.

Therefore, the studied species are included in the Pelecaniformes order, represented by the little heron, the night heron, the great egret, the red heron, the gray heron, showed similar anatomical characteristics, the beak was long and pointed, the upper jaw was equal in length to the maxilla inferior. On examination of the

oropharyngeal cavity, the hard palate and oropharyngeal isthmus were missing, the choana were short, the tongue is sharp and long, the oropharyngeal mucosa was not presenting openings of the secretory gland ducts. The esophagus was long and distensible, it presents longitudinal folds on its entire surface, more evident in all specimens in the terminal portion. The longitudinal folds also continue on the surface of the glandular stomach, which is reduced in size. The glandular stomach communicates directly with the muscular stomach, the two segments do not present a clear demarcation. The wall of the ventricular stomach is thicker, has no longitudinal folds, and the pyloric orifice is located in the caudal portion of the muscular stomach.

The studied species of the Piciformes family, represented in the study by the green woodpecker, the great spotted woodpecker and the small spotted woodpecker, show common characteristics of the upper digestive tract, namely the long tongue, which slides under the laryngeal protuberance, the short esophagus, with the ingluvius in its lower third. The passage between the esophagus and the glandular stomach, respectively between the glandular stomach and the triturator, is marked by a well-defined isthmus zone.

The examined species of the Suliformes order, represented by the great cormorant, presented a long beak with a curved tip, the upper jaw longer than the lower jaw. The nostrils are not visible and resemble the appearance of a line, located near the base of the upper jaw. The esophagus was long and distensible and presented longitudinal folds on its entire surface. The esophagus was continuous with the glandular stomach without a clear delimitating line, but there is a clear demarcation line between the glandular stomach and the muscular stomach. The pyloric orifice opened into the last portion of the muscular stomach.

The birds of the Accipitriformes order represented in the study by the birds of the Pandionidae family by the kingfisher, respectively by the birds of the Accipitridae family, the Eurasian sparrowhawk, the Eurasian goshawk, the common buzzard and the rough-legged buzzard. There are common features among the studied species of this order, the short and strongly curved beak, the upper jaw more developed compared to the lower jaw, the tip of the beak pointed, short esophagus with longitudinal folds on its entire surface, the poorly developed stomach, compartmentalized and elongated with a pear-like appearance. The studied birds of the osprey species presented a short esophagus, with the ingluvius in the lower part, and the passage between the esophagus, glandular stomach and muscular stomach was poorly highlighted. The studied birds of the Accipitridae family, the pigeon owl and the bird owl, have a non-protruding, firm tongue, which presents at the base cornified papillae arranged in the shape of the V letter. The oropharyngeal cavity could be distended with the help of longitudinal folds. The esophagus was short, the ingluvius was identified in the upper third. The transition between the esophagus and the glandular stomach was marked by a zone of constriction. The ventricle has an elongated appearance. The passage between the two gastric compartments was difficult to notice, because the musculature of the glandular stomach merges with that of the muscular stomach. The Eurasian goshawk presents morphological

aspects similar to the Eurasian sparrowhawk. The esophagus is short and distensible, there is ingluvium in the upper esophageal portion. Esophageal folds were evident on its entire surface, becoming more pronounced near the glandular stomach. These folds disappeared in the structure of the proventriculus. The transition between the glandular stomach and the muscular stomach is abrupt, without an intermediate zone or isthmus. The muscular stomach had thin walls with randomly arranged folds. The pylorus opens near the junction between the gastric compartments. The common buzzard presented, like the rough-legged buzzard, cornified papillae in the oropharyngeal cavity at the level of the palatal ridges, at the lingual level and at the level of the glottal process. The esophagus was short, it has two portions, a narrower upper portion, and more voluminous lower portion that is, more dilated near the proventriculus. The weakly developed proventriculus communicates with the muscular stomach through a weakly highlighted isthmus. The musculature of the triturator stomach consists of a thin layer, and the cavity narrows to the pyloric region.

The birds of the Falconiformes family, represented in the study by the Eurasian hobby, the common kestrel and the red-footed falcon show common characteristics, namely the short and strongly curved beak, the presence of the tomial tooth at the level of the upper jaw, cornified papillae on the edge of the hard palate, at the base of the tongue and caudal to the laryngeal mound. On macroscopic examination of the oropharyngeal cavity, multiples openings of the salivary gland ducts were observed caudal to the choana and on the sides of the glottis. The esophagus was short with longitudinal folds on the entire surface, and in the cranial portion, the ingluvium was represented by the widening of the esophageal portion, with a fusiform appearance. The compartmentalised stomach is poorly developed, it has the appearance of an elongated pear. At the border between the esophagus and the glandular stomach, a zone of isthmus can be observed, as well as between the proventriculus and the muscular stomach. The ventricle was poorly developed, had the shape of a biconvex lens, with a thick wall.

The studied individuals from the Gaviiformes order, represented by the black-throated loon and red-throated loon, presented a straight beak with a sharp tip, the upper jaw with the same length as the lower jaw. Cornified papillae were noticed on the sides of the choana, caudal to the choana and lateral to the infundibular fissure. The tongue presented an elongated appearance with a sharp tip. Longitudinal folds were observed on the ventral side of the oropharyngeal cavity. The esophagus is distensible, it has folds along its entire length. The folds disappear at the border with the glandular stomach, there is no isthmus area between the esophagus and the proventriculus. The proventriculus and ventricle are fused and have a fusiform appearance. Caudal to the proventriculus, the triturator stomach is identified, separated by an evident isthmus area.

The red-necked grebe belonging to the order Podicipediformes, have a long beak, the upper jaw is the same length as the lower jaw. The tongue is long and sharp, the esophagus distensible. In the lower part of the esophagus, a gradual distension of the esophagus is observed, followed by a gradual return to the previous volume. The passage between the esophagus and the glandular stomach is made through an area of isthmus.

The stomach has a fusiform appearance, on the surface of the glandular stomach numerous openings of the channels of the gastric glands can be observed. At the transition between the gastric compartments, an isthmus could be observed. The ventricle is well developed with thin walls, and the pyloric orifice opens on the left side of the muscular stomach, near the isthmus between the gastric compartments.

The studied birds from the Strigiformes order, represented in the study by the birds from the Strigidae family, the Tawny owl, the Ural owl, the Little owl and the Long eared owl, respectively by the birds from the Tytonidae family, the Barn owl. All the specimens studied show common anatomical features, respectively a short and curved beak with a ventrally oriented tip. The cornified papillae are abundant on the sides of the choana, lateral to the infundibular fissure, on the lingual surface, on the edges of the glottis. The openings of the ducts of the salivary glands are observed on the sides of the infundibular fissure, on the faces and on the floor of the oropharyngeal cavity. The esophagus is short, has longitudinal folds, does not have an ingluvium. The proventriculus is reduced in size, a folding of the surface structural planes can be observed. The transition between the glandular stomach and the muscular stomach is abrupt, without an intermediate zone. The ventricle is a small organ, with fine, thin muscular walls. Also, folds covered by the gastric cuticle can be observed on the surface of the muscular stomach. The pyloric orifice opens on the left side of the muscular stomach.

Chapter VII, entitled "Anatomical study of the lower digestive system in zoophagous-polyphagous bird species", had the aim of deepening knowledge regarding the anatomical data of how the studied birds adapted to the habitat, completing the existing data in the scientific literature and highlighting the way through which the lower digestive tract has adapted and compressed to favor the maneuverability of the organism in the air and to absorb the nutrients necessary for the functioning of the organism. Therefore, the objective of this chapter was to present the existing anatomical differences between the sexes, especially at the cecal level and to perform measurements on the lower digestive system.

The species of the Pelecaniformes order have a short small intestine, a poorly developed cecum, simple, singular, located at the level of the ileo-cecal junction, oriented cranially. The short colon opens to the outside through the cloacal orifice.

The studied species from the Piciformes order presented a short small intestine, it was not possible to delimit the duodenum from the jejunum and the jejunum from the ileum. The cecum was not identified in any examined individual. The border between the small intestine and the large intestine was not be distinguishable.

Among the studied species of the Accipitriformes order, the birds of the Pandionidae family presented a long small intestine, a double, short cecum, located at the junction between the ileum and the large intestine, the colon is short and opened in the outside through the cloacal orifice. The species of the Accipitridae family presented a short small intestine folded into several loops with the help of the mesentery. The cecum is poorly developed, of a vestigial type, the large intestine is short, it extends from the level of the ileo-cecal junction to the level of the cloacal orifice.

The studied species from the Suliformes order had a long small intestine, a double, short and conical cecum, a reduced colon, which opens to the outside through the cloacal orifice.

All studied species of the order Falconiformes presented a short small intestine, without a clear demarcation between duodenum, jejunum and ileum. The next segment, the cecum was poorly developed of a vestigial type. The large intestine is short, the rectum extends from the level of the ileo-cecal junction to the cloacal orifice.

In the case of the studied species from the Gaviiformes order, the macroscopic anatomical aspects of the small intestine were difficult to observe due to the state of degradation of the corpses. The cecum was a paired organ, developed and elongated. The large intestine was short, originating at the ileo-cecal junction, ending with the cloacal orifice.

For the species of the order Ciconiiformes, the intestine presented as a compact mass, the small intestine long, extending from the level of the pyloric region of the triturating stomach to the level of the ileo-ceco-colic junction. The intestinal mass was folded into several loops, without a clear demarcation between the segments of the small intestine. The cecum was reduced, vestigial. The short colon opens to the outside through the anal orifice.

The species of the order Podicipediformes presented a short small intestine, the cecum consisting of two long loops, located at the level of the ileo-cecal junction. The large intestine was short and opens to the outside through the cloacal orifice.

Chapter VIII, entitled "Anatomical study of the digestive's tract adnexal glands in zoophagous-polyphagous birds", highlights the anatomical peculiarities of the appendage glands for the birds studied, in an attempt to understand how the digestive tract, including the appendages, have adapted to help the organism meet nutrient requirements. Therefore, the objective of this chapter is to present the common aspects existing in all the studied species of the accessory organs, and the measurement of the liver to highlight the degree of development of this organ correlated to the weight of the bird. Unfortunately, due to the cadaveric lysis, it was not possible to highlight other appendage organs of the digestive tract apart from the liver, respectively the pancreas in the case of some specimens.

The species of the Pelecaniformes order, represented in the study by the little heron, the night heron, the great egret, the red heron and the gray heron, all had a liver consisting of two elongated lobes, of different sizes (the right liver lobe is more developed compared to the left one), which join cranially on the midline and surround the apex of the heart. The gall bladder was present in most studied species of this order. As a whole, the gallbladder of birds of the order Pelecaniformes was well developed and exceeds in length the right lobe of the liver.

The birds of the Piciformes order, represented in the study by the green woodpecker, the great spotted woodpecker and the lesser spotted woodpecker, had a liver consisting of two lobes, the right hepatic lobe being more developed compared to the left hepatic lobe. The pancreas was not identified in any species examined.

The birds of the Suliformes order, represented in the study by the great cormorant, had an elongated liver, consisting of two lobes unequal in length, the gall bladder is reduced in size and not exceeded the visceral edge of the liver lobe. The pancreas was not identified during the dissections.

The birds of the order Accipitriformes, represented in the study by the kingfisher, Eurasian sparrowhawk, Eurasian goshawk, the common buzzard, and the rough-legged buzzard, presented a liver generally consisting of two lobes of different sizes, where the right lobe is more developed compared to the left. The exception to this ratio has been observed in species of the family Pandionidae, genus Pandion, which exhibit elongated, nearly symmetrical lobes. Also, the specimens examined from the bird species show a more developed left liver lobe compared to the right liver lobe. The gallbladder was identified in all species, it was more elongated in species of the genus Pandion, exceeding in length the visceral margin of the right hepatic lobe, while in species of the genus Accipiter and Buteo the gallbladder does not exceed the visceral margin of the right hepatic lobe. The pancreas was identified only in the rough-legged buzzard species at the level of the first duodenal curve.

The species studied from the Falconiformes order, represented by the common kestrel, the eurasian hobby and the red footed falcon, presented a liver consisting of two lobes of different sizes, where the right lobe was more developed compared to the left lobe. The gall bladder was well developed in all studied species, located on the visceral face of the right liver lobe. The pancreas was not highlighted during dissections in any of the studied species.

The birds of the Gaviiformes order, represented in the study by black-throated loon and red-throated loon, have a liver consisting of two lobes, but due to the state of putrefaction, no other morphological aspects could be highlighted. Also, the gall bladder and pancreas could not be identified due to the state of putrefaction.

The species of the order Podicipediformes, represented in the study by red-necked grebe, presented a liver consisting of two unequally developed lobes, but I was not able to highlight the gall bladder on the visceral liver face.

The birds of the Ciconiiformes order, represented in the study by the white stork, have a liver consisting of two lobes, the right lobe is more developed compared to the left lobe, which join cranially on the midline, located in the cranial portion of the coelomic cavity. The gallbladder is poorly developed and is located on the visceral side of the right lobe, covered by adipose tissue. The pancreas was identified in the first part of the duodenum, near the pyloric orifice, having an elongated appearance.

Chapter IX, entitled “the Statistical Analysis of 26 species of zoophagus-polyphagous birds”, which included morphometric measurements of 69 species of birds, distributed in 9 orders, the data of which have been centralized and statistically interpreted.

Therefore, the research concentrates on the description of the studied population and implicitly of each sample, by calculating statistical parameters to gain a better understanding of the data collected for each analyzed feature and using statistical tests,

the Anova test, accompanied by the Bonferoni correction, for the analysis of the differences between the 9 orders, at the level of each feature.

Several conclusions were drawn following the statistical analysis of the digestive system in zoophagy-polyphage birds in the study.

Birds of the order Piciformes show significant differences compared to birds of the order Pelecaniformes, Suliformes, Ciconiiformes and Podicipediformes for the average of the upper digestive tract. The birds of the order Suliformes show significant differences compared to the birds of the group Piciformes, Accipitriformes, Falconiformes, Gaviiformes and Strigiformes for the average of the upper digestive tract. The average lower digestive tract shows significant differences compared to species of the order Pelecaniformes, Piciformes, Falconiformes, Podicipediformes and Strigiformes.

The mean upper digestive tract of birds of the order of Accipitriformes is significantly different from the species studied of the order Pelecaniformes, Suliformes and Ciconiiformes. The mean of the lower digestive tract in the same group shows significant differences with birds of the order Piciformes, Falconiformes and Strigiformes. The average length of the liver shows significant differences with birds of the order Piciformes and Strigiformes, and the average width of the liver shows significant differences with birds of the order Piciformes and Ciconiiformes.

Statistically, the average length of the upper digestive tract of birds of the Falconiformes order is significantly different from that of birds of the order Pelecaniformes, Suliformes, Ciconiformes and Podicipediformes. The average of the lower digestive tract shows significant differences compared to birds of the order Pelecaniformes, Suliformes, Accipitriformes, Gaviiformes and Ciconiiformes.

Statistically, the studied birds of the order Gaviiformes show significant differences in the mean of the upper digestive tract with the birds of the order Suliformes and Ciconiiformes. The lower digestive tract average shows significant differences with birds of the order Piciformes, Falconiformes and Strigiformes. The average length of the liver is not statistically significant, while the average width of the liver shows significant differences with birds of the order Ciconiiformes.

Birds of the order Ciconiiformes show significant differences for the upper digestive tract with birds of the order Piciformes, Accipitriformes, Falconiformes, Gaviiformes and Strigiformes. The lower digestive tract average shows significant differences with birds of the order Piciformes, Falconiformes and Strigiformes.

Statistically, the Podicipediformes order shows statistically significant differences for the upper digestive tract with birds of the order Piciformes, Falconiformes and Strigiformes. The average length of the lower digestive tract shows significant differences with the birds of the order Suliformes.

The order Strigiformes shows significant differences for the average of the upper digestive tract with birds of the order Pelecaniformes, Suliformes, Ciconiiformes and Podicipediformes. The mean of the lower digestive tract shows significant differences with birds of the order Pelecaniformes, Suliformes, Accipitriformes, Gaviiformes and Ciconiiformes. The average length of the liver shows significant differences with birds of

the order Pelecaniformes and Accipitriformes, and the average width of the liver shows significant differences with birds of the order Piciformes and Ciconiiformes.

Chapter X, entitled "General conclusions", summarises the aspects captured in the morphoanatomical investigations. Therefore, each studied order has its own characteristics.

The species examined in the order Pelecaniformes show a sharp and long tongue, as well as a right, distensible esophagus, the longitudinal folds at the esophageal level are also found on the surface of the glandular stomach. The stomach is poorly developed. The cecum small, singular, the liver has two elongated lobes, the right lobe more developed than the left lobe.

Species of the order Piciformes have a long and straight beak, long esophagus relative to the length of the neck, a clear isthmus area separates the stomach compartments. The boundary between the small intestine and the large intestine cannot be observed, the cecum was not identified. The liver consists of two elongated lobes, the right liver lobe more developed compared to the left liver lobe, the gallbladder is reduced in size.

Species of the order Piciformes have a long and straight beak, long esophagus relative to the length of the neck, a clear isthmus area separates the stomach compartments. The boundary between the small intestine and the large intestine cannot be observed, the cecum was not identified. The liver consists of two elongated lobes, the right liver lobe more developed compared to the left liver lobe, the gallbladder is reduced in size.

The species studied in the order Accipitriformes have common characteristics, although they are arranged in two distinct families. The beak is short, with curved tip, short tongue, short esophagus. The positioning of the ingluvium is influenced by the species and family in which the birds are placed. So, the osprey crop is located in the terminal esophageal region, the northern goshawk and the Eurasian sparrowhawk present the crop in the cervical portion of the esophagus, while the common buzzard and rough-legged buzzard present a gradual dilation of the esophagus near the glandular stomach. All species have a poorly developed stomach, short small intestine, folded into small loops, a vestigial cecum. The liver has peculiarities according to the species, the osprey presents elongated hepatic lobes, the gall bladder exceeds in length the visceral face of the right lobe. The northern goshawk, the common buzzard and the rough-legged buzzard have the right lobe bigger than the left hepatic lobe, while in the Eurasian sparrowhawk, the left lobe is more developed than the right liver lobe. The gallbladder does not exceed the visceral face of the right liver lobe in any studied species.

The species studied from the order of Falconiformes have strong, curved beak, the crop is located in the cranial portion of the esophagus. The stomach is not well-developed, and the upper digestive segments are separated from each other by isthmus zones. The small and large intestine is short, the poorly developed, the cecum is vestigial. The liver has the right lobe more developed compared to the left lobe.

The birds of the order Gaviiformes have a straight beak, a long and distensible esophagus, without crop, a poorly developed stomach, the upper digestive tract segments

are not clearly defined, short small intestine, the cecum is developed with an elongated appearance. The liver was not examined in the specimens from this order.

Species in the order Ciconiiformes have a straight beak, long, short and immobile tongue, long and distensible esophagus, no crop. The stomach is divided and has an isthm area between the glandular stomach and the gizzard. The small intestine is long, disposed in loops, the cecum is vestigial. The liver has a more developed right lobe compared to the left lobe. The poorly developed gallbladder, located on the right visceral liver face.

The studied specimens of the order Podicipediformes have a long beak, a sharp, long tongue. The esophagus is distensible, the crop was not found near the glandular stomach. The isthm area lies between the esophagus and the glandular stomach, and between the glandular stomach and the gizzard. The small intestine is short, the cecum consisting of two elongated parts of equal size. The liver consists of two unevenly developed lobes.

All birds examined in the order Strigiformes have similar anatomical characteristics. Short, pointed, ventrally oriented beak, distensible esophagus without crop, the stomach is poorly developed. Longitudinal folds from the esophageal level are present on the surface of the glandular stomach. The small intestine is long, the cecum is well developed. The right liver lobe is more developed than the left liver lobe, the gallbladder is poorly developed.

Chapter XI, "Originality and innovative contributions of the thesis", points out the most important aspects identified in the study.

The morphology of the superior digestive system in the studied species of the order Pelecaniformes presents peculiarities specific to birds that eat fish.

The morphology of the superior digestive system in the studied species of the order Pelecaniformes presents peculiarities specific to birds that eat fish.

The upper digestive tract of birds in the Piciformes order exhibits distinctive adaptations due to their feeding behavior and diet, which is predominantly insectivorous.

The digestive tract of the red-footed falcon is similar to that of the Falconiformes.

The upper digestive tract morphology of the studied birds from the Gaviiformes, Ciconiiformes, and Podicipediformes orders has not been described in the literature.

The characteristics of the lower digestive tract of the little bittern, great egret, and grey heron are similar to those of birds in the Pelecaniformes order.

The osprey, the common buzzard, and the rough-legged buzzard share common digestive tract characteristics with birds of the order Accipitriformes.

The morphology of the digestive system of the red-necked grebe has not been mentioned in the literature.

The barn owl and the long-eared owl have digestive features similar to Strigiformes.

The morphological appearance of the liver in the studied species of the order Pelecaniformes, Piciformes, Suliformes, Accipitriformes, Gaviiformes, Podicipediformes, Ciconiiformes, Strigiformes has not been mentioned in the literature.

Statistical analysis of the gastrointestinal tract and the data comparison to see significant differences in order that were not reported in the literature for the species studied.