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The topography of the thoracic and abdominal organs of the Nile crocodile (*Crocodylus niloticus*)

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ABSTRACT

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The pleural cavity of the Nile crocodile is divided into two separate cavities by means of a complete mediastinum. The pleural cavity contains the lungs, while the heart is situated in its own cavity, the pericardial cavity. The pleural cavity is separated from the hepatic coelom, which contains the liver, by the post-pulmonary membrane. The hepatic coelom is separated from the peritoneal cavity by the post-hepatic membrane. The peritoneal cavity contains the abdominal organs.

INTRODUCTION

Brief studies of the macroscopic anatomy of the gastro-intestinal tract of *Alligator mississippiensis* (Guibe 1970; Reese 1910; Evans 1986) and *Alligator sclerops* (Guibe 1970; Grünwald 1931) are available, but similar studies of the Nile crocodile, *Crocodylus niloticus,* have been neglected in the literature. Duncker (1979), however, did report on the coelomic cavities of crocodilians. The present study was carried out to describe and document the topography of the thoracic and abdominal organs in the Nile crocodile.

MATERIALS AND METHODS

Eight two-year-old female Nile crocodiles, with nose to tail lengths varying between 1,1 and 1,4 m, were obtained from a breeding farm. These animals were shot, exsanguinated and routinely skinned. The thoracic and abdominal ribs were exposed and counted. The thoracic and abdominal cavities were opened by removing the dorsal thoracic and abdominal body walls in three specimens and, similarly, the ventral body wall in five specimens. At this stage the specimens were photographed and the topography of the thoracic and abdominal organs was illustrated.

Four specimens were eviscerated and the gastro-intestinal tracts were dissected to reveal the different parts. These specimens was then illustrated or photographed.

RESULTS

The Nile crocodile has 11 to 13 thoracic ribs and six to seven abdominal ribs. At the thoracic inlet the trachea is situated to the left of the oesophagus which lies in the midline within the dorsal mesentery. The trachea then turns abruptly to the right before dividing into a left and right primary bronchus (Fig. 1).

The pleural cavity is divided into separate left and right cavities by means of a complete mediastinum. The cavities are roughly triangular in shape, with the

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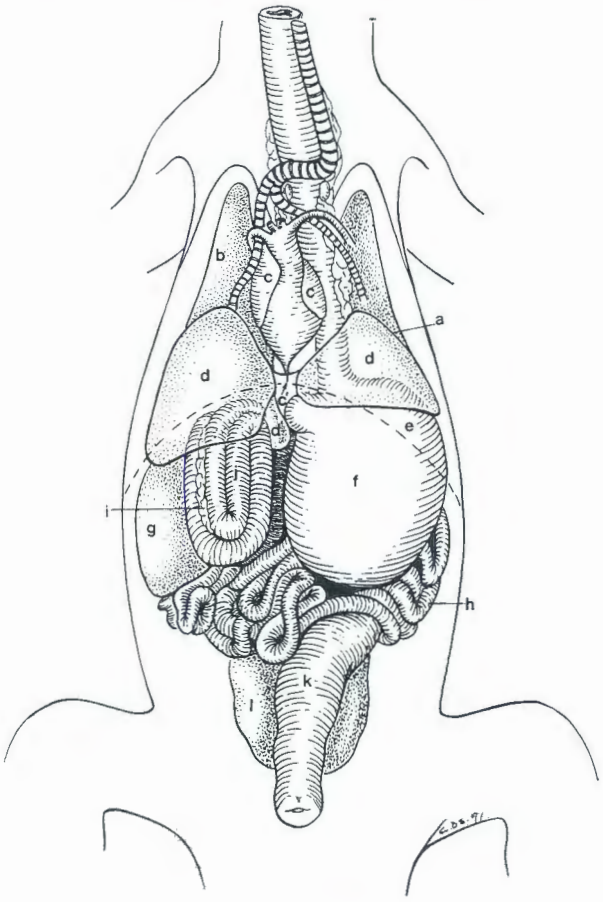

FIG. 1 A semi-schematic drawing of a ventral view of the opened plural and peritoneal cavities

a – Post pulmonary membrane
b – Lungs
c – Heart with its attachment to the post-pulmonary membrane c'
d – Liver
d – Gall bladder (within hepatic coelom)
e – Post hepatic membrane (partially removed)
f – Stomach
g – Fat body
h – Loops of jejunum and ileum
i – Pancreas
j – Duodenum (showing double loop)
k – Rectum
l – Kidneys

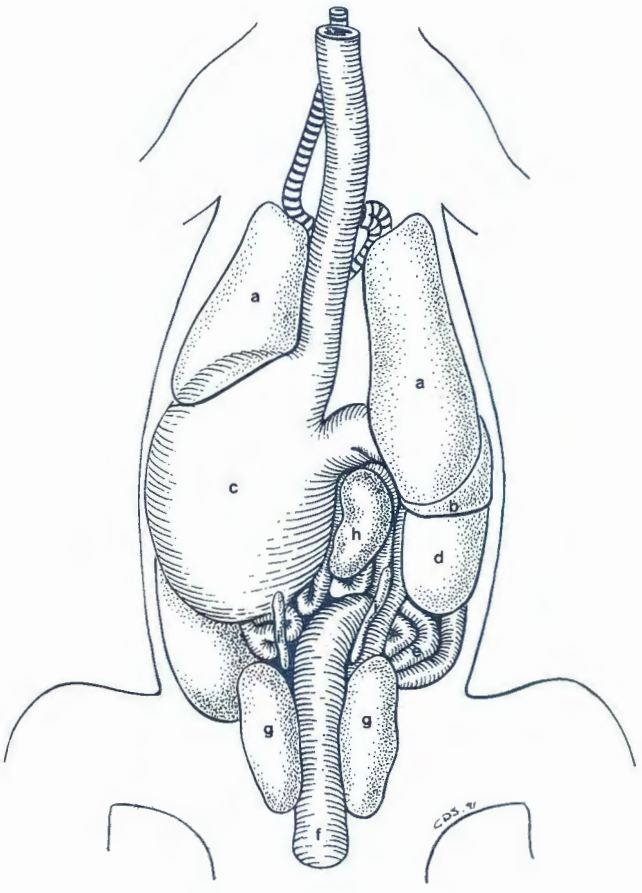

FIG. 2 A semi-schematic drawing of a dorsal view of the pleural and peritoneal cavities with post-pulmonary and post-hepatic membranes removed

a – Lungs
b – Right lobe of liver
c – Stomach
d – Fat body
e – Jejunum and ileum
f – Rectum
g – Kidneys
h – Spleen
i – Gonads

base situated caudally and the apex terminating in cupulae, both extending a short distance (± 15 mm) beyond the first thoracic rib. Caudally, the pleural cavity is bound by a post-pulmonary membrane (Fig. 1) and divided into left and right cavities by means of a complete mediastinum. The diaphragmatic surfaces of the two lungs are attached to the post-pulmonary membranes, while the caudal third of the medial borders are attached to the mediastinum. The four-chambered heart, with a cranio-caudal orientation, is situated between the fourth and eighth thoracic ribs. The apex of the heart is attached to the pericardial sac by means of a ligament. A ligamentous attachment in the midline exists between the pericardial sac and the post-pulmonary membrane. (Fig. 1). The post-pulmonary membrane extends to between the ninth thoracic and first abdominal ribs. The dorsal part of the post-pulmonary membrane is completely membranous, while the ventral third is muscular.

The liver, which consists of right and left lobes, is situated in its own coelomic cavity, the hepatic coelom, which is bound cranially by the post-pulmonary membrane and caudally by the post-hepatic membrane (Fig. 1). These two membranes are intimately associated with the cranial and caudal surfaces of the liver, respectively. The right and left pleural cavities communicate with the hepatic coelom by means of two openings situated left and right dorsally in the membranous part of the post-pulmonary membrane. A sheet of striated muscle extends from the pubis and is inserted on the ventral and lateral attachment line of the post-hepatic membrane. The gall bladder is situated to the right of the midline within the hepatic coelom (Fig. 1). The bile duct opens in the proximal part of the duodenum.

The stomach is situated to the left of the abdominal cavity, between the tenth thoracic and the sixth abdominal ribs, with the greater curvature facing to the left (Fig. 1 and 2). A very acute angle is present between the cardia and pylorus (Fig. 2). An oval to round, dorso-ventrally flattened, encapsulated portion of adipose tissue, the so-called "fat body", occupies the right cranial part of the abdominal cavity (Fig. 1). The duodenum is arranged in the form of a double loop on the right, with the pancreas situated between the arms of the outer loop. (Fig. 1). The pancreas also extends to the cranial broad part of the spleen and along the proximal part of the jejunum. The latter part is attatched to the dorsal body wall. The ileum and jejunum, which are of equal length, fill the right and left side of the peritoneal cavity. The proximal part of the jejunum is firmly attached to the dorsal body wall. The mesentery then lengthens to allow free coiling of the remaining portions of the jejunum and ileum. The rectum (in the midline) extends into the cloaca (Fig. 1). The kidneys are situated caudo-dorsally, partly within the pelvic cavity (Fig. 2). The gonads lie cranio-medially to the kidneys (Fig. 2). The spleen is pear-shaped with the broad end pointing cranially and it is attached to the dorsal body wall between the second and third abdominal ribs (Fig. 2).

The dissection of the gastro-intestinal tract revealed the stomach of which the minor curvature displayed a very acute angle, resulting in the cardia and pylorus lying adjacent to each other. A pyloric antrum or dilatation is separated from the main part of the stomach by a distinct sphincter. (Fig. 3). The duodenum is arranged in a double U-shaped loop (Fig. 1 and 3), with the proximal part of the duodenum forming the inner loop and the distal part the outer loop. The jejunum is situated between the duodenum and ileum. The beginning of the latter is demarcated by the presence of the *A. mesenterica cranialis.* An ileo-rectal junction is present where the narrow ileum abruptly changes into the wide rectum. The rectum continues into the cloaca (Fig. 3).

DISCUSSION

The findings of the present study confirm Duncker's (1979) statement that the crocodilians possess a pleural cavity, hepatic coelom and peritoneal cavity. This is in contrast with the Chamaeleonidae, where only the ventral part of the post-pulmonary septum is present; and dorsally, the pleural and peritoneal cavities are continuous, forming a pleuro-peritoneal cavity (Duncker 1979).

In the vertebrate embryo, the *diverticulum hepaticum* grows into the *septum transversum* as the anlage of the liver (Starck 1955). The *septum transversum* forms the connective tissue component of the liver and, in higher vertebrates, the major part of the diaphragm. In the crocodile the *septum transversum* presumably not only forms the connective tissue of the liver, but also the post-pulmonary and post-hepatic membranes. In the Chamaeleonidae the dorsal part of the *septum transversum* either does not develop, or it regresses at a later stage of development. The sheet of striated muscle extending from the pubis to the post-hepatic membrane seen in the present study, corresponds to the *Musculus diaphragmaticus* described by Duncker (1979).

The appearance of the stomach in *Crocodylus niloticus* conforms to that in *Alligator mississippiensis* in that there is an acute angle between the cardia and the pylorus, and a pyloric antrum is present (Chiasson 1962; Guibe 1970; Evans 1986). In *Alligator sclerops* (Grünwald 1931) the stomach is rather elongated without a pyloric dilatation as is the case in snakes and lizards (Goin & Goin 1971).

The double loop of the duodenum in the Nile crocodile is in contrast with *A. mississippiensis* (Chiasson 1962; Guibe 1970; Evans 1986) and *A. sclerops* which exhibit only a single loop (Grünwald 1931).

The small intestine forms coils in all crocodilians (Chiasson 1962; Guibe 1970; Evans 1986), as is the case in snakes and lizards (Goin & Goin 1971; Stidworthy 1971). However, snakes and lizards have a colic caecum, which is absent in crocodiles (Goin & Goin 1971) and this is confirmed in the present study. In all reptiles an abrupt transition from small to large intestine is a prominent feature (Goin & Goin 1971; Hyman 1942), which is also the case in the Nile crocodile.

The "fat body" was described by Rathke in 1862 (Vorstman 1939). However, little reference has been made to this structure in the literature, presumably due to the fact that most autopsies were done on old emaciated zoo specimens in which it had disappeared (Vorstman 1939). In crocodiles the fat body is associated with the dorsal mesenterium, whereas in snakes the paired fat bodies are associated with the gonads (Vorstman 1939).

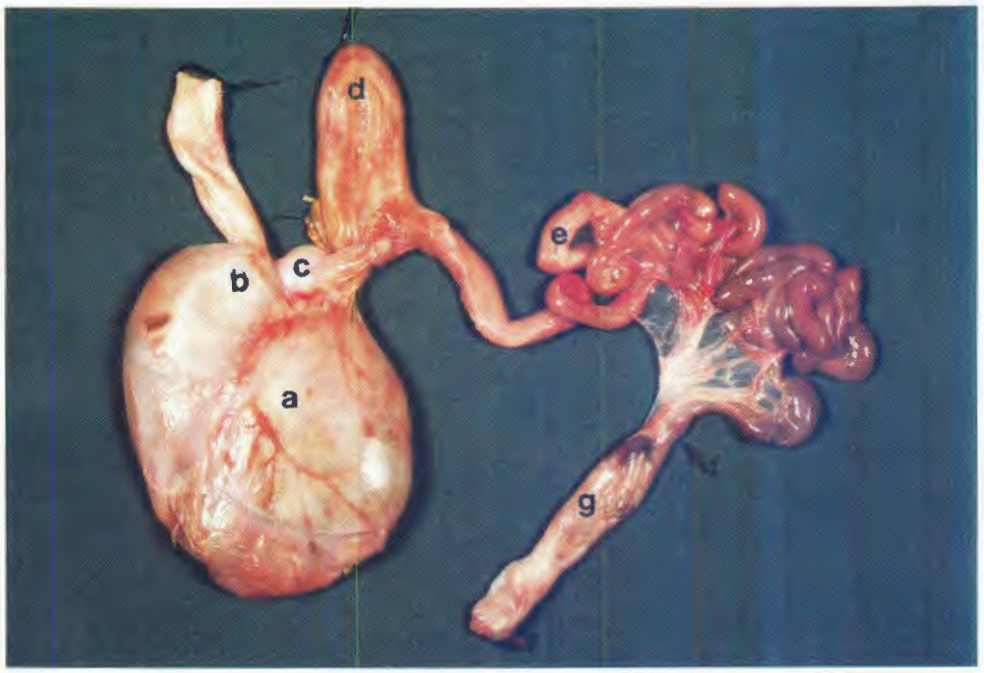

FIG. 3 A photograph of the stomach and intestines removed

a – Stomach
b – Cardia
c – Piloric dilatation
d – Duodenum (showing double loop)
e – Jejunum and ileum
f – Ileo-rectal junction (note the abrupt transition from ileum to rectum)
g – Rectum

As the specimens examined were immature females, no definite conclusion in respect of the topography of active gonads could be made.

CONCLUSIONS

This study provides information hitherto unknown as to the topography and organs of the Nile crocodile. Some similarities to other crocodilians are present, but some unique features also occur.

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