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SOME MORPHOLOGICAL AND MORPHOMETRICAL STUDIES ON THE LIVER AND BILIARY DUCT SYSTEM IN GOOSE, TURKEY, DOVE, SPARROW, JACKDAW, HOOPOE, OWL AND DARTER

(With 4 Tables and 13 Figures)

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بعض الدراسات الشكلية والقياسية على الكبد و الجهاز القنوي المراري في كل من الأوز والرومي واليمام والعصفور والغراب والهدهد والبومة والغاق

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تم في هذا البحث دراسة الخصائص الطبوغرافية والشكلية للكبد والجهاز القنوى المـــراري لكل من الأوز والرومي واليمام والعصفور والغراب والهدهد والبومة والغاق. ولقد إتضح من هذه الدراسة أن الكبد يختلف في الشكل والموقع ومن حيث إحتوائها على الحويصلة المرارية أم لا. ويتكون الكبد في كل الطيور تحت الدراسة من فص أيمن كبير وايسر صغير إلا فـــي حالة البومة حيث وجد أن الفصين الأيمن والأيسر متساويين تقريبا. كما أن الفـــص الأيمـــن ينقسم مرة أخرى إلى جزئين أنسى ووحشي في العصافير فقط، بينما ينقسم الفص الأيسر في الرومي والأوز واليمام والغراب والهدهد أما الغاق فإن الفصين غير منقسمين. ذلك وقد وجد أن الكبد يمثل نسبا متفاوتة من الوزن الكلى للجسم في الطيور تحت الدراسة فكـــانت هـــذه النسبة أعلى ما يمكن في الأوز (٥.٣٣ %) وكانت أقل ما يمكن في اليمام (٩٩, %). كمـــا إتضح من الدراسة أن الجهاز القنوى المرارى يتكون من قناتين كبديتين يمنى ويسرى واللتان تتحدان عند الحفيرة الكبدية لتكونا القناة الكبدية العامة والتى تنشأ منها القناة الكبدية المعويـــة العامة والتى تصب في الجزء الهابط من العفج في كل من الأوز والرومى والهدهد والغـــراب والبومة والغاق أما في حالة اليمام والعصافير ولغياب الحوصلة الصفراوية فإنه توجد فقـــط قناة كبدية معوية والتى تنشأمن القناة الكبدية العامة والتى تصب في العفج. هذا وقد تم مناقشة النتائج المستخلصة مع الأبحاث المتاحة في الطيور الأخرى.

SUMMARY

The liver is situated in the ventral part of the body cavity against the sternum. The relation between the caudal termination of the liver and the caudal end of the sternal crest depends upon the species. In the owl, the right lobe of the liver terminates at the same level of the sternal crest while the left one projects 0.9cm behind the caudal end of the sternal crest. In dove and sparrow, the liver terminates nearly at the caudal end of the sternal crest. In darter, goose, turkey, jackdaw and hoopoe, the liver projects 2.2, 1.2, 0.9,0.8 cm behind the caudal end of the sternal crest respectively. The length of the liver forms variable percentages of the total length of the body cavity in different species under study. It forms about 48% in sparrow, 45% in jackdaw, 43.9% in hoopoe, 43.3% in turkey, 41.1% in dove, 37.7% in goose, 31.1% in darter and 30.8% in owl. On the other hand, the liver represents 5.33% of the total body weight in goose, 4.6% in jackdaw, 1.6% in darter, 1.4% in sparrow and owl, 1.1% in hoopoe, .99% in dove and 0.67% in turkey. Morphologically, the liver is divided in all examined bird species by cranial and caudal interlobar fissures into a large right lobe and a small left lobe except in the owl where the two lobes are nearly equal. Only in sparrow, the caudal part of the right lobe is subdivided into lateral and medial parts while the left lobe is subdivided in turkey, dove, jackdaw and hoopoe into caudodorsal and caudoventral parts. The lobes of the liver are drained by the right and left hepatic ducts. These two ducts unite with each other at the hepatic porta forming the common hepatic duct except in dove and sparrow where a common hepatic duct arises from this duct and opens in the distal part of the descending duodenum. In jackdaw and owl, there is a right hepatoenteric duct in addition to the common duct. The gall bladder is drained by cysticoenteric duct that opens in the ascending duodenum.

Key words: *Liver – birds – morphology.*

INTRODUCTION

In general, the liver is often an important organ for nutrition studies and for experiments in disease problems. A little information is available about the topography and morphology of the liver and its biliary duct system in many birds. McLelland (1975), Nickel and Schummer (1977) as well as King and McLelland (1984) described briefly the liver in fowl, duck and pigeon. In addition, Ibrahim, Abdalla, Mansour and Taha (1992) detailed the morphology and topography of the liver and biliary system in fowl, duck, pigeon, quail, heron and kestrel. The aim of this study is to throw light on the topography and

morphology of the liver and its biliary duct system in number of birds with different modes of life and habits of feeding viz., goose, turkey, dove, sparrow, jackdaw, hoopoe, owl and darter. In addition some morphometrical aspects have been taken in consideration in this work.

MATERIALS and METHODS

The present study was carried out on ten adults (males and females) of each of goose (Anser domestica), turkey (Meleagris gallopavo), sparrow (Prunella modularis), Buff-headed wood-hoopoe (Phoeniculus bollei), owl (Asio otus) and darter (Anhinger rufa). The examined birds were weighed, slaughtered and the body cavity was opened to investigate the topographic aspects of the liver. The liver was then removed, weighed and preserved in 10% formalin solution. A number of morphometrical measurements namely; total body length, total body weight and length of the body cavity (including its prehepatic, hepatic and posthepatic portions) were made. Additionally, some length and weight relationships were calculated in different species under study. The nomenclature used in this study were those of the Nomina Anatomica Avium (1979).

RESULTS

In all examined species except hoopoe and darter, the liver is located in the cranial and middle third of the body cavity. In hoopoe it lies at the cranial part of the middle third of the body cavity. It lies against the sternum, but the relation between its caudal termination and the caudal end of the sternal crest differs in the different studied species. In dove and sparrow, the liver terminates nearly at the caudal end of the sternal crest; while in darter, goose, turkey, jackdaw and hoopoe the liver projects 2.2 cm, 1.2 cm, 1.9 cm and 0.8 cm behind the caudal end of the sternal crest respectively. In the owl, the right lobe of the liver terminates at the caudal end of the sternal crest, however the left one projects 0.9 cm behind the caudal end of the sternal crest.

The weight of the liver (in relation to the total body weight) differs in different species. As recorded in Table (2) and Fig. (2), the weight of the liver represents its highest percentage of the body weight in goose (5.33%) followed by jackdaw (4.6%), darter (1.6), sparrow and owl (1.4%), hoopoe (1.1 %), dove (0.99%) and finally turkey (0.67%). However the relative length of the liver to the length of the body cavity

records 48% in sparrow, 45% in jackdaw, 43.9% in hoopoe, 43.3% in turkey, 41.1% in dove, 37.7% in goose, 31.1% in darter and 30.8% in owl (Table 4).

The colour of the liver varies from red brown (in owl, hoopoe and darter) through light brown (in dove and goose) to yellow (in jackdaw and turkey). In sparrow, the liver is a mosaic of dark brown and yellow colors.

The general form of the avian liver is nearly the same, however considerable variations may occur. The liver in all examined birds is divided by cranial and caudal interlobar fissure into right and left lobes which are joined together cranially in the middle by an interlobar part. The relative proportions of the right and left lobes vary greatly between species and even between individuals of the same species. An intermediate process projects from the visceral surface of each right and left lobes in goose, turkey, dove, jackdaw and hoopoe (Fig. 5-12).

In all examined birds, the right lobe is longer and heavier, in general, than the left one. Table (3) shows the length of the right lobe in different species. It is 9.8cm in goose, 7.8cm in turkey, 5.4cm in jackdaw, 3.7cm in dove and owl, 2.8 in darter and 2.5cm in sparrow and hoopoe. The left lobe, on the other hand, measures 6.2cm in goose, 5.6cm in turkey, 3.9cm in jackdaw, 3.2cm in owl, 2.2cm in dove and darter, but it measures 1.2cm in sparrow and hoopoe. In other words, the left lobe represents 90% the length of the right lobe in owl, 76% in darter, 70% in turkey and jackdaw, 60% in goose and dove and 50% in sparrow and hoopoe. Table (2) and Fig (1) show that the right lobe represents 80% of the weight of the liver in hoopoe, 78% in dove and jackdaw, 69% in sparrow, 68% in goose, 58% in turkey and 51% in owl and darter. However, the left lobe represents 49% of the liver weight in owl and darter, 32% in goose and turkey, 31% in sparrow, 22% in dove and jackdaw and 20% in hoopoe. One can also say that the weight of the right lobe is 3.9 times that of the left one in hoopoe, 3.6 times in dove and jackdaw, 3 times in darter, 2.1 times in goose, 1.4 times in turkey and they are nearly equal in owl.

In goose, turkey, dove, owl and darter, the two lobes of the liver envelope the apical left half of the heart cranially forming a deep cardiac impression (Fig. 5, 6, 7, 11, 12). In jackdaw, the lobes of the liver have only a very small cardiac impression as they touch only the apex of the heart (Fig. 9). While in hoopoe the two lobes just contact the apex of the heart (Fig 10).

The liver has two surfaces, ventrally directed parietal and dorsally directed visceral surfaces. The parietal surface is convex and smooth except in its cranioventral part where there is a deep cardiac impression in goose, turkey, dove and owl (Fig. 5, 6, 7, 11). It is molded to the contour of the body wall and is related to the sternum and ribs on both sides, in sparrow only on the left side. The visceral surface, contrarily, is concave and quite irregular since it is molded to the adjacent viscera which make permanent and well defined impressions on it (Fig 5-12). It is related to the terminal part of the esophagus, stomach, intestine, spleen and the gall bladder except in dove and sparrow.

The relations between the lobes of the liver and the thoracic cage are variable. In darter, turkey, dove and jackdaw, the right and left lobes begins cranially nearly at the same level opposite to the second intercostal space (3rd rib). The right lobe terminates 2.2, 1.9cm, 0.9cm and 0.8cm caudal to the last rib respectively. The left one ends 1.5, 0.2cm, 0.3cm and 0.7cm caudal to the foregoing rib respectively. In goose, hoopoe and owl, the right lobe begins slightly cranial to the left one (caudal to the 3rd intercostal space with 0.2cm in goose and hoopoe and 0.7cm in owl) and terminates caudal to the last rib by 1.2cm, 0.8cm and 0.3cm respectively. The left lobe terminates 0.1cm in goose and 0.9cm in owl caudal to the last rib, while in hoopoe, it terminates at the level of the sixth intercostal space. In sparrow, the right lobe extends from the 2nd intercostal space to end 0.2cm caudal to the last rib, where the left one extends from the 1st intercostal space to the level of the 3rd rib.

The shape of the liver lobes are differs in different species of the examined birds (Fig. 5-12). In goose, the right lobe is tongue-shaped while the left one is like a heart on a playing card. In turkey, the right lobe is elongated oval, however the left one is pyramidal in shape. The dove has a large rounded right lobe and a small triangular left lobe. In sparrow, the right lobe is long and rectangular while the left one is short and triangular. The liver of hoopoe has an elongated tongue-shaped right lobe and triangular left lobe. The right lobe of jackdaw's liver is triangular while the left one is pyramidal in shape. Both right and left lobes of owl are triangular with their apices cranially directed and the basis caudally directed. In darter, the right lobe is pear-shaped while the left lobe is tongue-shaped.

The right lobe is only subdivided in sparrow by a caudal intralobar fissure that extends cranially for about 0.6cm dividing it into a

small medial part and a large lateral part (Fig. 8). The left lobe is also subdivided in turkey, dove, jackdaw and hoopoe by an intralobar fissure (Fig. 6, 7, 9, 10). In turkey, this fissure extends cranially for 1.1cm dividing the lobe into medial and lateral parts. It is visible on both parietal and visceral surfaces. In dove, Jackdaw and hoopoe, this fissure extends transversely for 0.4, 0.7, 0.8 cm respectively, dividing the left lobe into caudodorsal and caudoventral parts. The caudoventral part is the largest in hoopoe, while the caudodorsal part is the largest in dove and jackdaw (Fig. 7, 9, 10).

The gall bladder (Vesica fellae) which is absent in dove and sparrow (Fig. 7, 8) is situated in the Fossa vesicae felleae on the visceral surface of the liver of goose, turkey, jackdaw, hoopoe, owl and darter (Fig. 5, 6, 9-12). It is located at the middle of the visceral surface in turkey, jackdaw, hoopoe and darter (Fig. 5, 6, 9, 10, 12), while in owl it is located at its proximal fourth (Fig. 11). The shape and length of the gall bladder is variable, it is cylindrical in goose and jackdaw (3.5 and 1.7 cm), elongated cylindrical in turkey (3.8 cm), pear-shaped in hoopoe and darter (1.1 cm) and rounded in owl (3.2cm). The relative length of the gall bladder to the length of the right lobe (Fig. 4 an Table 4) records 86.5% in owl, 48.7% in turkey, 44% in hoopoe, 40% in darter, 36% in goose and 32% in jackdaw.

The apex of the gall bladder projects 0.6cm from the caudal border of the liver in turkey and hoopoe. It can be seen from the parietal surface of the right lobe only in turkey and hoopoe (Fig. 6, 10).

The biliary duct system (Fig. 13):

The bile canaliculi of birds in general drain into interlobular ducts which extend through the liver in close association with the branches of the portal vein and hepatic arteries. These canaliculi unite forming the lobar bile ducts which finally form the right and left hepatic ducts at the hepatic porta (Fig. 12). The latter two ducts drain the right and left lobes of the liver. The number of the lobar bile ducts varies in different examined species. In goose, turkey and hoopoe, their number ranges between 5 and 6 for the right lobe and 3-4 for the left lobe. In dove, sparrow, jackdaw and owl, they are 2-3 in number for the right and left lobes. In all examined birds, the right and left hepatic ducts unite on the visceral surface of the right lobe forming the common hepatic duct (Ductus hepaticus communis). From this duct , the common hepatoenteric duct (Ductus hepatoentericus communis) arises and passes distally in the mesoduodenum to open by a small papilla on the mucous

Table (1): Total body weight as well as the weight of the liver and its lobes in different birds under study.

Bird	Total body weight	Liver weight	Weight of the right lobe	Weight of the left lobe
Goose	1500 ± 50.3	79.9.0 ± 21.1	54.11 ± 3.60	25.8 ± 2.12
Turkey	2588 ± 90.5	17.4 ± 1.8	10.07 ± 1. 80	7.33 ± 0.50
Dove	175 ± 16.7	1.74 ± 0.12	1.36 ± 0.08	0.38 ± 0.01
Sparrow	22.5 ± 5.0	0.32 ± 0.05	0.22 ± 0.02	0.1 ± 0.01
Jackdaw	275 ± 18.2	12.7 ± 1.7	9.95 ± 0. 80	2.74 ± 0.1
Hoopoe	85 ± 6.2	0.93 ± 0.1	0.74 ± 0.04	0.19 ± 0.03
Owl	950 ± 25.0	13.6 ± 1.1	6.92 ± 0. 50	6.63 ± 0.70
Darter	110 ± 9.5	1.78 ± 0.1	1.30 ± 0.1	0.48 ± 0.02

Table (2): Wight percentage of the liver to the body as well as the weight percentages of the liver lobes to the liver weight.

Bird	Liver weight % of the body weight	Right lobe % of the liver weight	Left lobe % of the liver weight
Goose	5.33 ± 0.50	67.7 ± 5.31	32.3 ± 3.57
Turkey	0.67 ± 0.02	57.7 ± 5.15	32.3 ± 2.52
Dove	0.99 ± 0.03	78.2 ± 6.16	21.8 ± 1.67
Sparrow	1.4 ± 0.03	68.8 ± 4.99	31.3 ± 2.57
Jackdaw	4.6 ± 0.60	78.4 ± 6.22	21.6 ± 1.66
Hoopoe	1.1 ± 0.08	79.6 ± 5.16	20.04 ± 1.28
Owl	1.4 ± 0.07	50.9 ± 3.71	48.8 ± 3.58
Darter	1.6 ± 0.09	73.1 ± 6.8	26.9 ± 1.9

Table (3): The absolute values of the length (in cm) of the bird, body cavity as well as its three portions (prehepatic, hepatic and posthepatic) and liver and its lobes.

Bird	Total body length	Total length of body cavity	Prehepatic part	Hepatic part	Posthepatic part	Length of the right lobe	Length of the left lobe	Length of the gall bladder
Goose	57.0 ± 4.5	26.0 ± 2.1	4.5 ± 0.40	9.8 ± 0.80	11.7 ± 1.5	9.8 ± 0.70	6.2 ± 0.52	3.5 ± 0.18
Turkey	67.5 ± 5.7	18.0 ± 1.4	3.1 ± 0.20	7.8 ± 0.60	7.1 ± 0.80	7.8 ± 0.63	5.6 ± 0.35	3.8 ± 0.15
Dove	20.5 ± 1.6	9.0 ± 0.7	2.0 ± 0.06	3.7 ± 0.20	3.3 ± 0.11	3.7 ± 0.12	2.2 ± 0.12	-
Sparrow	13.0 ± 1.2	5.0 ± 0.4	0.8 ± 0.05	2.4 ± 0.23	1.8 ± 0.07	2.4 ± 0.11	1.2 ± 0.09	-
Jackdaw	47.5 ± 3.9	12.0 ± 1.0	2.5 ± 0.08	5.4 ± 0.50	4.1 ± 0.34	5.4 ± 0.45	3.9 ± 0.21	1.7 ± 0.15
Hoopoe	17.5 ± 1.3	5.7 ± 0.6	1.9 ± 0.09	2.5 ± 0.24	1.3 ± 0.09	2.5 ± 0.12	1.2 ± 0.08	1.1 ± 0.18
Owl	26.5 ± 1.8	13.0±0.9	2.6 ± 0.21	4.0 ± 0.22	6.4 ± 0.53	3.7 ± 0.25	3.2 ± 0.14	3.2 ± 0.15
Darter	35.0 ± 2.9	9.0±0.9	4.4 ± 0.24	2.8 ± 0.20	1.8 ± 0.13	2.8 ± 0.23	2.1 ± 0.19	1.1 ± 0.09

Table (4): The relative values of the lengths (in cm) of the three portions of the body cavity (prehepatic, hepatic and posthepatic), liver and its lobes.

Bird	Relative length of prehepatic part to the length of body cavity	Relative length of hepatic part to the length of body cavity	Relative length of posthepatic part to the length of body cavity	Relative length of the gall bladder to liver length
Goose	17.3 ± 1.59	37.7 ± 2.08	45.0 ± 3.12	35.7 ± 1.01
Turkey	17.9 ± 1.42	43.3 ± 3.08	39.4 ± 2.01	48.7 ± 3.08
Dove	22.2 ± 1.83	41.1 ± 2.11	36.7 ± 3.01	-
Sparrow	16.0 ± 1.29	48.0 ± 3.07	36.0 ± 2.66	-
Jackdaw	20.8 ± 1.28	45.0 ± 2.05	34.2 ± 3.76	31.5 ± 2.01
Hoopoe	33.3 ± 2.59	43.9 ± 2.04	22.8 ± 2.76	44.0 ± 3.08
Owl	20.0 ± 1.35	30.8 ± 2.12	49.2 ± 3.04	86.0 ± 5.01
Darter	48.9 ± 3.9	31.1 ± 2.8	20.0 ± 1.9	40.0 ± 3.9

membrane of the distal part of the of the descending duodenum. In owl, jackdaw and darter (Fig. 13 C), another right hepatoenteric duct arises from the right hepatic duct to open in the beginning of the descending duodenum.

The gall bladder, when prsesent (Fig. 13 A & C), is attached to the common hepatic duct by a hepatocystic duct. A cystoenteric duct originates from the gall bladder and open in the distal part of the descending duodenum proximal to the hepatoenteric duct. In birds without gall bladder (dove and sparrow), a hepatoenteric duct arises from the common hepatic duct and opens directly in the ascending duodenum (Fig 13 B).

DISCUSSION

The present results ascertained that the liver generally fills most of the ventral parts of the cranial and middle regions of the body cavity, this comes in agreement with McLelland and King (1970) as well as King and McLelland (1984). In the same concern, Nickel et al. (1977) reported that, the largest part of the liver is situated in that part of he body which is enclosed by the ribs. Moreover, the present results also supports the findings of Ibrahim et al. (1992), in fowl, duck, pigeon, quail, heron and kestrel, that the relation between the caudal termination of the liver and the caudal end of the sternal crest varies according to the species. In the present findings, the liver terminates nearly at the caudal end of the sternal crest in dove and sparrow, while it projects about 1cm behind the caudal end of the sternal crest in goose, turkey, jackdaw and hoopoe, while in darter it projects 2.2cm. This finding coincidentally matches with the absence of the gall bladder in dove and sparrow.

The present study also shows that the longitudinal distance occupied by the liver in the body cavity varies in different studied birds. The hepatic part of the body cavity represents its highest percentage of the total length of the body cavity in sparrow (about 48%), then decreases to reach its lowest value in owl (about 30%). Higher percentage have been recorded by Ibrahim et al. (1992) in duck (about 62%), but the same authors reported values, nearly of the same range as our results, in quail, heron, pigeon, fowl and kestrel.

Concerning the weight percentage of the liver to the total body weight, the present work shows that the liver represents its highest

percentage in goose and jackdaw (about 5%), but the percentage in other studied birds ranges between 1.4% in sparrow and owl to 0.67% in turkey. The values for all studied birds except goose are relatively low when compared with that mentioned in fowl, duck and pigeon (1.5-4.1%) by Nickel et al. (1977) as well as in fowl, duck, pigeon, quail, heron and kestrel (1.3-2.7%) as mentioned by Ibrahim et al. (1992). Most of the birds with higher liver weight percentage in the present study are either omnivorous or carnivorous in their feeding habits i.e. fed rations rich in protein and fat contents. In the same respect, Sturkie (1976) reported that the carnivorous birds had much higher hepatic enzyme level than did the chicken.

Whilst the general form of liver in birds seems to be constant within a species, considerable variations may occur. In all examined birds, the liver is divided by cranial and caudal longitudinal fissures into right and left lobes which are joined together cranially at the midline by an interlobar part. This result agrees with the previous findings, in both domestic and wild birds (Beddard, 1898; Grau, 1943; Lucas and Derington, 1956; Flechsig, 1964; McLelland, 1975; Nickel et al., 1977; King and McLelland, 1984 and Ibrahim et al., 1992). The relative length of each of the two lobes of the liver varies greatly among the studied birds. Similar to that mentioned by Beddard (1898), Lucas and Derington (1956), the left lobe represents about 2/3 the length of the right one in goose, turkey and jackdaw, ½ in sparrow, hoopoe and darter while in owl the two lobes are nearly of the same length. On the other hand, the weight of the left lobe represents ½ that of the right one in goose and sparrow, 2/3 in turkey, 1/5 in dove, ¼ in jackdaw, owl and darter. According to Ibrahim et al. (1992), the left lobe represents about 2/3 the length of the right one in fowl quail and heron, 1/5 in pigeon and kestrel and 1/6 in duck. On the other hand, the same authors reported that the weight of the left lobe represents 6/7 that of the right lobe in quail, 2/3 in fowl and kestrel, ½ in heron, ¼ in pigeon and 1/8 in duck.

An intermediate process is observed on the visceral surface of the liver ventral to the porta only in goose, turkey, dove, hoopoe and jackdaw. In the same respect King and Mclelland (1984) in turkey, duck and goose. Simic and Jankovic (1959-1960) have also described a papillary process, in domestic birds except goose, arising from the visceral surface of the craniodorsal part of the right lobe.

In the present study, sparrow and dove lack gall bladder. As mentioned by Nickel et al. (1977), and Ibrahim et al. (1992), the pigeon also lacks gall bladder. The biliary duct system in the current work resembles the previous finding in fowl (King and Mclelland, 1984) as well as in fowl, duck, pigeon, quail, heron and kestrel (Ibrahim et al., 1992). According to Simic and Jankovic (1959-1960), two hepatoenteric ducts in addition to the cystenteric duct were described in goose.

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LEGENDS

Fig. 5-12: Photomicrographs showing the parietal (a) and visceral (á) surfaces of the liver in goose (5), turkey (6), dove (7), Sparrow (8), jackdaw (9), hoopoe (10), owl (11) and darter (12).

Abbreviations:

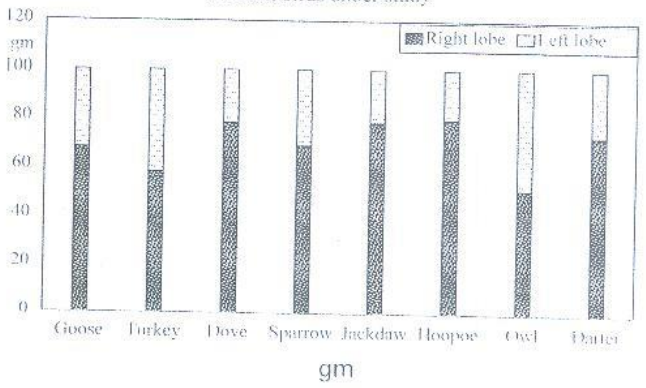
1-Cranial interlobar fissure.
2-Caudal interlobar fissure.
3-Interlobular fissure.
4-Right hepatic lobe.
5-Left hepatic lobe.
6-Caudodorsal part.
7-Caudoventral part.
8-Cardiac impression.
9-Intermediate process.
10-Gall bladder.

Fig. 13: Diagram showing the biliary duct system in the different examined birds. A: goose, turkey and hoopoe. B: dove and sparrow. C: Jackdaw, owl and darter.

Abbreviations:

1-Lobar bile duct.
2-Left hepatic duct.
3-Right hepatic duct.
4-Common hepatic duct.
5-Common hepatoenteric duct.
6-Right hepatoenteric duct.
7-Hepatocystic duct.
8-Cystoenteric duct.
9-Gall bladder.

Fig (1): Weight percentage of the right and left lobes to the total liver weight in different birds under study



Fig(2): The relative weight of the liver to the total body weight in different studied birds.

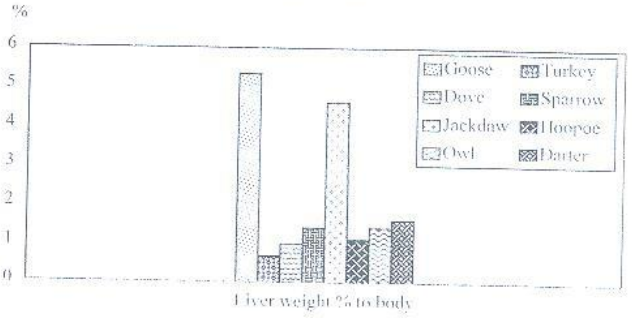


Fig (3): Position relation of the liver in the body cavity in the studied birds.

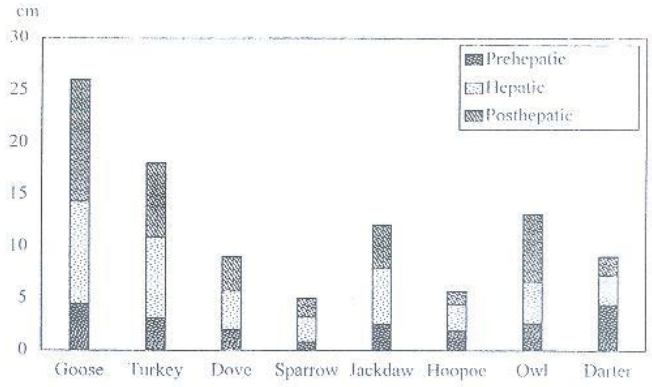
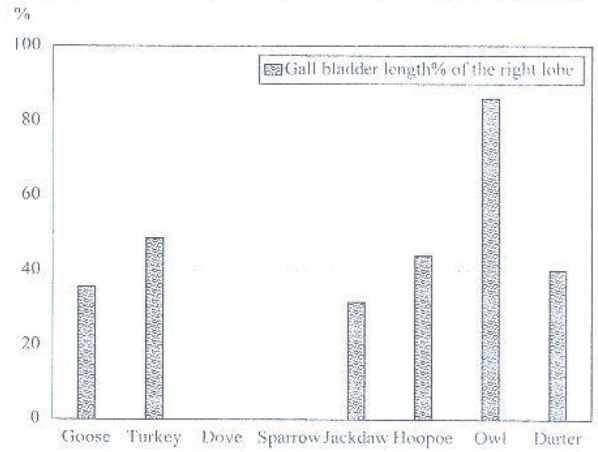
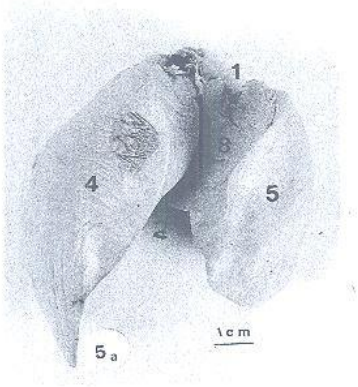
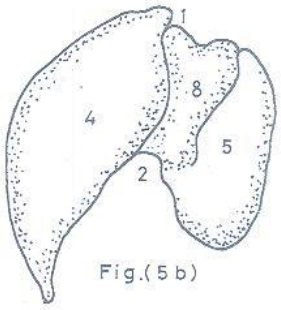


Fig (4): The relative length of the gall bladder to the length of the right lobe.







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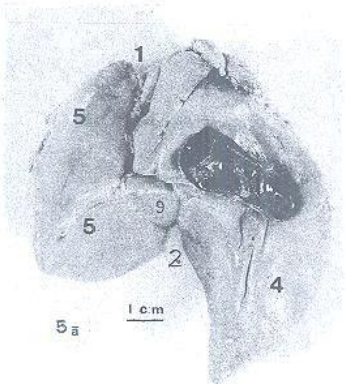

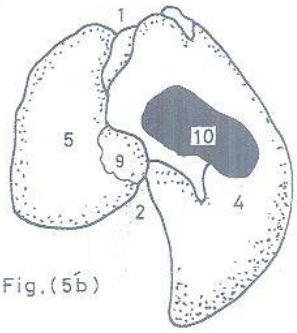

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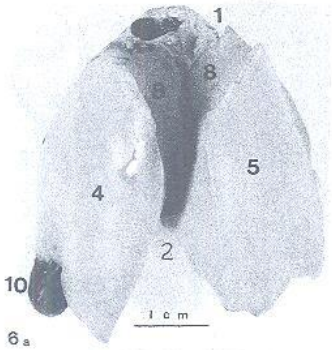

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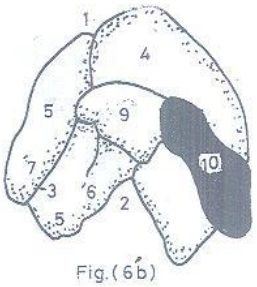

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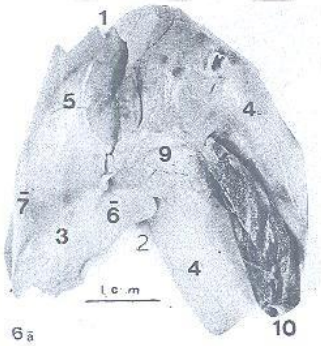

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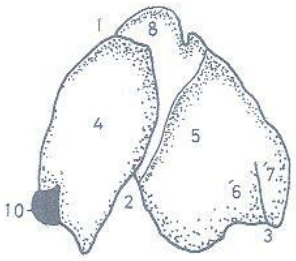

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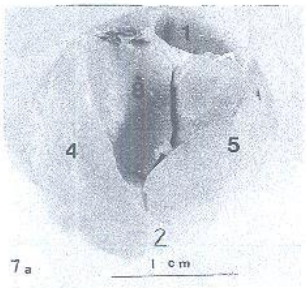

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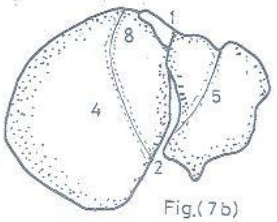

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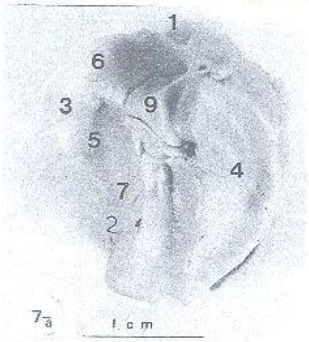

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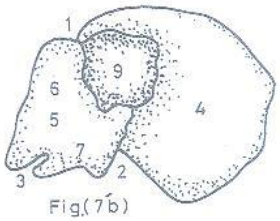

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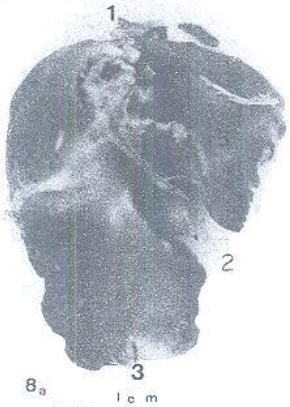

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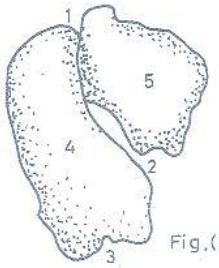

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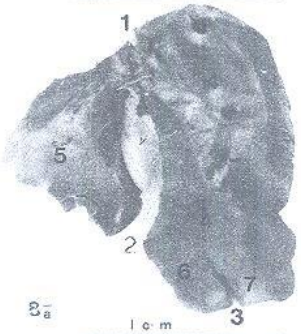

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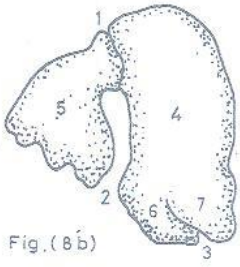

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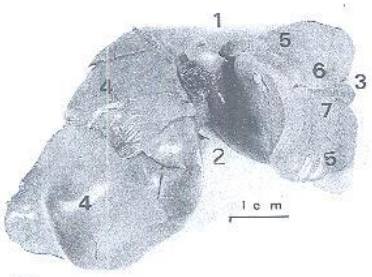

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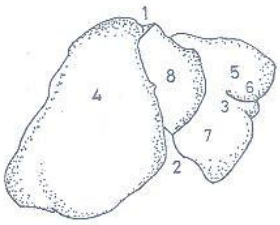

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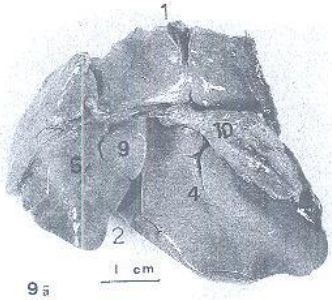

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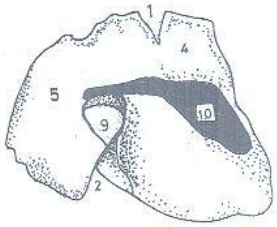

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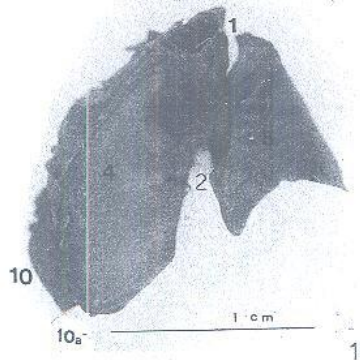

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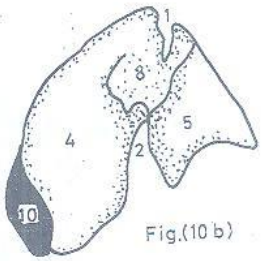

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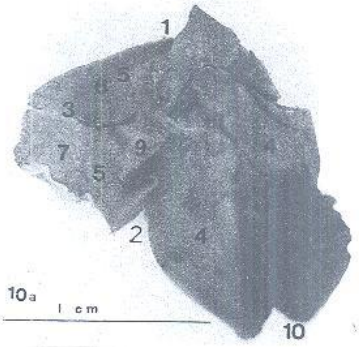

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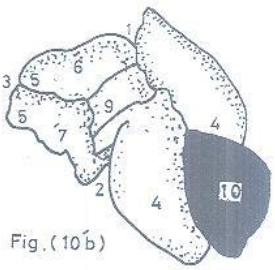

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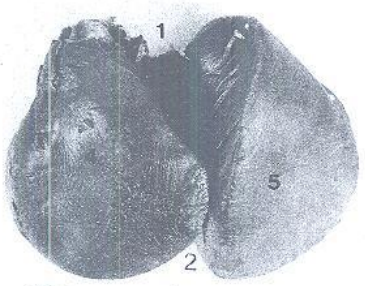

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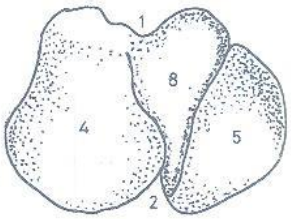

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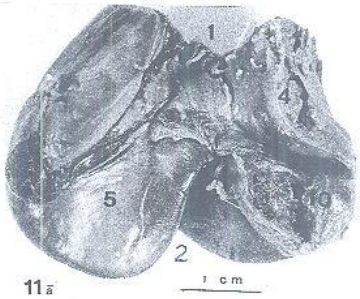

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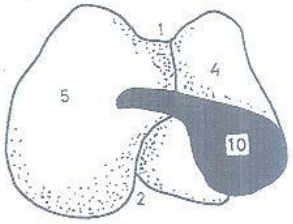

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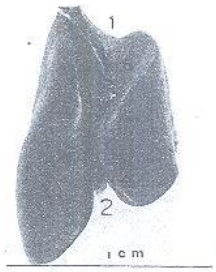

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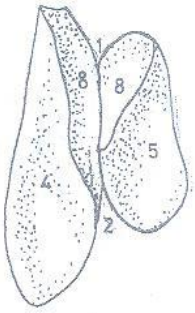
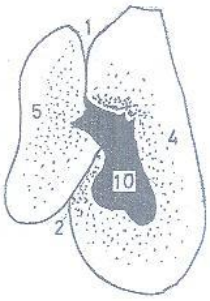


Fig.(12 b)

12 a'



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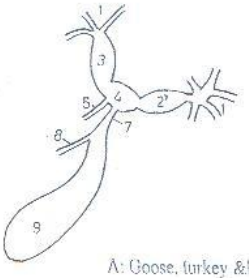
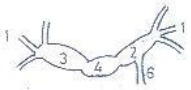
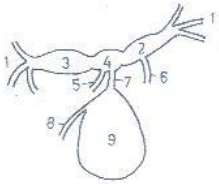


A: Goose, turkey &hoopoe



B: Dove & sparrow



C: Jackdaw, owl & darter

Fig .(13)