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SOME ANATOMICAL AND MORPHOMETRICAL STUDIES ON THE INTESTINAL TRACT OF CHICKEN, DUCK, GOOSE, TURKEY, PIGEON, DOVE, QUAIL, SPARROW, HERON, JACKDAW, HOOPOE, KESTREL AND OWL

(With 4 Tables & 18 Figures)

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بعض الدراسات التشريحية والمورفومترية على السبيل المعوي في الفراخ والبط والأوز والرومى والحمام واليمام والسمان والعصفور وأبو قردان والغراب والهدهد والعوسق المصرى واليومة

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شبيها لما هو في الثدييات يمكن تمييز السبيل المعوي في الطيور إلى قسمين رئيسيين هما: الأمعاء الدقيقة والأمعاء الغليظة . تنقسم الأمعاء الدقيقة مورفولوجيا إلى العفج والصائم واللفائفى. بينما تختلف الأمعاء الغليظة في الطيور عنها في الثدييات وتتكون من زوج من المعي الأعورى والقولون والمستقيم الذي يفتح في المذرق .مقارنة بطول جسم الطائر يمثل السبيل المعوي حوالي (٣,٦-٠,٨) مرة الطول الكلى لجسم الطائر في الاوز والهدهد بالترتيب. ويشكل طول السبيل المعوي حوالي(١١,٥-٣,٢) مرة الطول الكلى لتجويف الجسم في البط والهدهد. بينما يمثل وزن السبيل المعوي حوالي(١,٠-٠,٠١) من الوزن الكلى لجسم الطائر في الاوز والهدهد . ويختلف طول ووزن الأمعاء الدقيقة بين أجناس الطيور تحت الدراسة حيث يبلغ المتوسط النسبي لطول الأمعاء الدقيقة لطول السبيل المعوي أقصاه في اليمام (٩٦,٥%) بينما يبلغ أقل نسبة له في الهدهد (٨٢%) . ويبلغ المتوسط النسبي لوزن الأمعاء الدقيقة لوزن السبيل المعوي أقصاه في اليمام (٩٥%) بينما تبلغ أقل نسبة له في اليومة (٣٨%).ويشكل معدل المتوسط النسبي لطول الأمعاء الغليظة للطول الكلى للسبيل المعوي أقصاه في الهدهد (٢٩,٥%) بينما تبلغ أقل نسبة له في اليمام (٣,٥%). ويبلغ المتوسط النسبي لوزن الأمعاء الغليظة لوزن السبيل المعوي أقصاه في اليومة (٦١,٦%) بينما تبلغ أقل نسبة له في اليمام (٥,٣%).ويختلف شكل وامتداد و طول العفج الكلى وكذلك جزئية بين أجناس الطيور تحت الدراسة حيث يبلغ المتوسط النسبي لطول العفج لطول الأمعاء الدقيقة أقصاه في اليومة (٢٩,٤%) بينما تبلغ أقل نسبة له في الرومى (١٠,٢%). والصائم هو أطول أجزاء الأمعاء الدقيقة في كل الطيور تحت الدراسة ويختلف شكله ووضعه حسب الطيور. ويبلغ الطول الكلى

للصائم لطول الأمعاء الدقيقة أقصاه في الرومي (٨٣,٤%) ويبلغ أدناه في اليمام (٦٧%). ويمثل اللفائفي الجزء الانتهائي القصير من الأمعاء الدقيقة ويقع بين الأعورين. و يساوى طوله نفس طول الأعورين في الفراخ والرومي والبط والأوز والسمان والبومة ويبلغ المتوسط النسبي لطول اللفائفي لطول الأمعاء الدقيقة أقصاه في البومة (١٧,٦%) بينما تبلغ أقل نسبة له في الفراخ (٢,٧%).. ويتكون الأعورين من زوج من المعي الأعوري في جميع الطيور ماعدا في الهدهد حيث لا يوجد له أعور بينما في أبو قردان والعوسق المصرى فيكون لكل منهما أعور واحد. والقولون يكون قصيرا جدا ومتسع في الغراب والعوسق المصرى وعلى هيئة أنبوب طويل في البط والأوز والرومي والسمان واليمام وأبو قردان. بينما في الهدهد فيكون على شكل كيس طويل متسع . حيث يبلغ المتوسط النسبي لطول القولون لطول الأمعاء الغليظة أقصاه في الاوز (٧٨,٣%) بينما تبلغ أقل نسبة له في الغراب(١٤,٣%).بينما يبلغ الوزن النسبي للقولون لوزن الأمعاء الغليظة أقصاه في الغراب(٨٨%) ويبلغ أدناه في السمان (٧,١%). و يبلغ المتوسط النسبي لطول المستقيم لطول الأمعاء الغليظة أقصاه في الغراب (٨٥,٧%) بينما تبلغ أقل نسبة له في الاوز (٢١,٧%).بينما يبلغ الوزن النسبي للمستقيم لوزن الأمعاء الغليظة أقصاه فى البومة (٦٤,٥%) ويبلغ أدناه في الغراب (٥,١%).

SUMMERY

Similar to that of mammals the intestinal tract of birds can be differentiated into two main divisions: small intestine and large intestine. The small intestine can also be subdivided morphologically into; duodenum, jejunum and ileum. However, there are many differences between the large intestine of birds and that of mammals. The large intestine of birds consisted of two caeca, short single colon, and short rectum open in the cloaca. In relation to the body; the absolute value of the intestinal length was about (3.6-0.8) time that of the total body length in goose and hoopoe respectively. However the absolute value of the intestinal length was about (11.5-3.2) time that of the total length of the body cavity in duck and hoopoe. The absolute value of the intestinal weight equal to (0.1-0.01) that of the total body weight in goose and hoopoe. The length and weight of the small intestine varied between the different species of birds. The mean relative value of the length of the small intestine to the total intestinal length ranged between (96.5%in dove- 82%in hoopoe). While the mean relative value of the weight of the small intestine to the total intestinal weight ranged between (95%in dove- 38.4%in owl). However that for the large intestine measured about (18.3% in hoopoe- 3.5% in dove). On the other hand, the mean relative value of the weight of the large intestine to the total intestinal weight constituted about (61.6%in owl- 5.3% in dove). The length of the duodenal loop and its parts as well as its shape and extension varied along the examined birds. Concerning the mean percentage of the

duodenal length to the total length of the small intestine it was observed that the highest one was noticed in owl (29.4%) while the lowest one was presented in turkey (10.2%). In all examined bird species the jejunum was the longest part of the small intestine. Its shape and arrangement was differed in different examined birds. Concerning the highest mean percentage of the jejunal length to the total length of the small intestine was observed in turkey (83.4%); while the lowest one was present in dove (67%). The ileum lied between the two caeca. Its length was nearly the same length of the caeca in chicken, turkey, goose, duck, and quail. In birds with very short caecum; pigeon, dove, sparrow, kestrel, heron and jackdaw or without caecum as hoopoe; the ileum could be demarcated by the supraduodenal loop of the jejunum. The mean percentage of the length of the ileum to the total length of the small intestine revealed that the highest percentage was in dove (17.6%) and the lowest one was in chicken (2.7%). In all examined bird species there were two caeca, except in hoopoe which had no caecum as well as that of heron and kestrel which had only one caecum .The two caeca appeared as short bud in pigeon, sparrow, dove and jackdaw. While in chicken, duck, goose, turkey, quail and owl they were long cylindrical expansions, with rounded apex in quail, duck and goose; ampullated sac with rounded end in owl. In heron and kestrel the caecum was in the form of finger like projection. The shape of the colon differed among the examined birds.It was very short dilated sac in jackdaw and kestrel; long tube with the same caliber along its length in duck, goose, turkey quail, dove, and heron. In hoopoe it was in the form of a sac like dilatation. The mean percentage of the length of the colon to the total length of the large intestine reached its highest value (78.3%) in goose and its lowest one (14.3%) in jackdaw. The mean percentage of the weight of the colon to the total weight of the large intestine reached its highest percentage in jackdaw (88%) and its lowest one in quail (7.1%).

Key Words: *Anatomy, Morphomerrey-Intestinal tract-Birds*

INTRODUCTION

The intestine is the most important part of the digestive system for chemical digestion and absorption of the food. This vital role of the intestine depends mainly upon the different parameters; which contributed to the nature of the intake food. This important aspect of the intestinal anatomy received little attention. Gadow (1891a), Magnan

(1911a), Browne (1922), Calhoun (1954), Bradley (1960), Ziswiler and Frarner (1972), McCLelland (1975), Nickel, Schummer and Seiferle (1977) as well as King and McCLelland (1984). The main aim of the present study is to through light on the morphology and morphometry of the intestinal tract of different species of birds differ completely from each other in the nature of food intake including herbivores and grainvores birds with long intestinal tract and carnivores with short intestinal tract.

MATERIALS and METHODS

The present investigation was carried out on the intestinal tract of ten adult birds of both sexes including chicken *(Gallus domesticus)*, duck *(Anas domestica)*, goose *(Anser domestica)*, turkey *(Meleagris gallopavo)*, pigeon *(Columbia Livia)*, dove *(Zenadia auriculata)*, quail*(C. Coturnix)*, Sparrow (Prunella modularis), heron *(Ergeta barzzeta)*, jackdaw *(Corvus monedula)*, *Buff headed wood*-hoopoe *(Phoeniculus bollei)*, Kestrel (*Flaco timnunculus*) and owl *(Asio otus)*. The birds under investigation were weighted and the total body length was measured and slaughtered and dissected for anatomical study of the intestinal tract. Immersed in (10%) formalin after that the intestinal tract was removed and weighted and measured. Also measurements and weight of the different parts of the intestinal tract were also taken. The Nomenclature used according to Nomina Anatomica Avium (1979).

RESULTS

The avian intestinal tract can be differentiated into two main divisions, the small intestine and the large intestine. Similar to that of mammalian species the small intestine can be subdivided morphologically into duodenum, jejunum and ileum. In relation to the body; the mean absolute value of the intestinal length was equal to 3.6 times that of the total body length in goose, 3.4 in duck, 3.3 in quail, 2.8 in turkey, 2.6 in chicken and kestrel, 2.5 in pigeon, 2.1 in owl, 1.8 in dove, 1.3 in jackdaw and sparrow; 1.1 in heron and 0.8 time in hoopoe of the total body length Table (1). However the mean absolute value of the intestinal length was equal 11.5 times that of the body cavity length in duck, 10.6 in turkey, 8.9 in goose, 6.3 in pigeon, 6.2 in chicken, 5.1 in jackdaw and kestrel, 4.3 in owl and heron, 4.1 in dove, 3.3 in sparrow and 3.2 times in hoopoe Table (1). On the other hand, the relation

between the mean absolute value of the intestinal weight to the total body weight was equal to 0.1 time in goose, 0.09 in quail, 0.05 in chicken, duck and sparrow, 0.04 in pigeon and jackdaw, 0.03 in kestrel, 0.02 in turkey, dove, heron and owl; 0.01 time in hoopoe Table (1a).

In relation to the body length the longest intestinal tract was observed in herbivore birds (goose and duck), followed by grainivores birds (quail, turkey, chicken and pigeon) then the carnivores (owl, jackdaw, heron and hoopoe). On the other hand the results of the relation of the intestinal weight to the total body weight was in the same direction with that of the length as the highest value of intestinal weight was observed in herbivores and grainivores (goose, quail, chicken, duck, sparrow and pigeon) then that in carnivores (hoopoe, owl, heron, kestrel and jackdaw).

The highest relative length of the small intestine to the total intestinal length was observed in dove (96.5%) followed by turkey (95.3%) then jackdaw, goose and pigeon (94%); kestrel, duck and chicken (93%). While the lowest value was observed in hoopoe (82%) followed by sparrow (86%) then quail, heron and owl (90%) Table (2) and Fig (2). On the other hand, the highest relative weight of the small intestine to the total intestinal weight was observed in dove (95%) followed by pigeon (92%) then jackdaw (89%); chicken, goose and sparrow (85%); duck (84%); kestrel (83%); heron (82%); turkey (76%); quail (75%); hoopoe (72%) and owl (38%) Table (2a) and Fig (2a).

The characteristic avian large intestine was very short than that of mammals and was formed of two caeca, short single colon and short rectum, which open in the cloaca. Fig (5-17).

The highest relative length of the large intestine to the total intestinal length was observed in hoopoe (18.3%) followed by sparrow (14%) then quail (9.9%); owl (9.6%); heron (9.3%); duck (7%); chicken (96.8%); kestrel (6.6%); jackdaw (5.7%); goose (5.6%); pigeon (95.3%); turkey (4.7%) and dove (3.5%) Table (2) and Fig (2).

However the highest relative weight of the large intestine to the total intestinal weight was observed in owl (61.6%); hoopoe (28.4%); quail (25%); turkey (24%); heron (18.2%); kestrel (17.4%); duck (16.4%); goose and chicken (15.4%); sparrow (14.7%); jackdaw (11%); pigeon (8.1%) and dove (5.3%) Table (2a) and Fig (2a). In all examined bird species the duodenum formed a duodenal loop consisted of descending and ascending limbs. This loop starts from the dorsal blind sac of the gizzard in most examined bird species except in heron,

jackdaw, hoopoe, kestrel and owl where their stomach lacked this sac Fig (1,5-17).

The descending duodenum was slightly shorter than the ascending one in all examined birds except in kestrel where it was shorter and the ascending one described three festoons Fig (1,16). On the other hand, in sparrow and heron the two limbs were of the same length Fig (1,12,13). In contrary to that in turkey the descending duodenum was slightly longer than the aescending one Fig (1,8), (Table '3).

The duodenal loop curved to the left side only around the ventral contour of the gizzard in turkey, dove, sparrow and jackdaw Fig (8,9,10,12,14). While in pigeon, quail, hoopoe and kestrel the duodenal loop curved more dorsally reaching the distal third of the gizzard Fig (9,11,15, 16). On the other hand, it passed more dorsally till about the beginning of the distal half of the gizzard in chicken, duck, goose, heron and owl Fig (5,6,7,13,17). The descending duodenum curved sharply to form the ascending duodenum, which passed to the right side caudal to the cranial mesenteric artery where it continued as the jejunum.

The highest relative length of the duodenum to the total length of the small intestine was (29.4%) in owl; (27.2%) in hoopoe; (24%) in sparrow; (18.6%) in goose; (18.3%) in pigeon; (18.1%)in duck; and (10.2%) in turkey Fig (3) and Table (3). On the other hand, the highest relative weight of the duodenum to the total weight of the small intestine was in owl (51%); heron (43.1%); (42.6%) in hoopoe; (36.6%) in sparrow; (35.1%) in kestrel; (34.8%) in turkey; (32.5%) in jackdaw; (31.8%) in dove; (31.2%) in pigeon; (26.5%) in quail; (23.6%) in duck; (22.2%) in goose and (21%) in chicken Fig (3a) and Table (3a).

In all examined bird species the jejunum was the longest part of the small intestine. It occupied most of the right caudal part of the body cavity. It was related to the stomach, right lobe of the liver and spleen. The shape and arrangement of the jejunal loop differed in different examined birds in pigeon, dove, sparrow and hoopoe it was in the form of disc Fig (1,10a, 11a, 13a, 14a). The disc formed three centripetal spirals inside three centrifugal ones in pigeon and sparrow as well as four centripetal spirals inside three centrifugal ones in dove and hoopoe. The jejunum of the owl Fig (1, 17a) formed an intestinal disc consisted of 2-3 centripetal coils besides two elongated jejunal loops one before the disc and the other after it. In chicken; quail and kestrel Fig (1,5a, 11a, 16a) the jejunal loops were in the form of festoons of varying size and number. In duck Fig (1,6a) the jejunum described seven convoluted parallel loops of varying length while in goose Fig (1,7a) it forms seven

loops of variable length, which appear as rounded circles, and long loops encircle each other. In the turkey Fig (1,8a) the jejunum forms 6-7 circular loops while in jackdaw Fig (1,14a) the jejunum was formed a cone shaped disc consisted of five centripetal spirals inside four centrifugal ones (Table "3).

The highest relative length of the jejunum to the total length of the small intestine was in turkey (83.4%) followed by chicken (83%); dove (79%) then pigeon (77%); duck (72%); goose, jackdaw and sparrow (71%); heron (69%); hoopoe and kestrel (68%); quail (67%) and owl (53%) Fig (3) and Table (3). On the other hand, the highest relative weight of the jejunum to the total weight of the small intestine was observed in chicken (75%) followed by goose (70%); then duck (65.6%); dove (64.2%); turkey (56.9%); quail (56.3%); jackdaw (53.9%); kestrel (52.1%); hoopoe (51%); sparrow (50%); heron (45.4%); pigeon (44.7%) and owl (36.4%) Fig (3a) and Table (3a).

The ileum is the terminal and shortest part of the small intestine. It lied between the two caeca. The length of the ileum was nearly the same length of the caeca in chicken, turkey, duck, goose, quail and owl Fig (1,18). While in birds with very short caecum as in pigeon, dove, sparrow, heron and kestrel Fig (1,18) the ileum could be demarcated from the jejunum by the supraduodenal loop, formed by the terminal part of the jejunum and the first part of the ileum.

The length of the ileum in owl was (17.6%) followed by dove (16.9%) then quail (12.5%); goose (10.3%); duck (9.6%); kestrel (9.4%); heron (8.2%); jackdaw (6.9%); turkey (6.4%), sparrow (5%); hoopoe (4.2%); pigeon (4.2%) and chicken (2.7%) Fig (3) and Table (3). On the other hand, The highest relative value of the weight of the ileum to the total weight of the small intestine was observed in pigeon (24%) followed by quail (17.4%); jackdaw (13.6%); sparrow (12.9%); kestrel (12.8%); owl (12.5%); heron (11.5%); duck (10.8%); goose (8.5%); turkey (8.3%); hoopoe (5.9%); dove (4%) and chicken (3.9%) Fig (3a) and Table (3a).

The characteristic avian large intestine consisted of two ceaca, short colon and short rectum, which opened in the cloaca Fig (1,5a-17a). In all birds under investigation there were two caeca except in heron and kestrel which had only one as well as hoopoe which had none Fig (1,18,5a-17a). The two caeca appeared as very short buds in pigeon, dove, sparrow and jackdaw. In heron and kestrel the caecum was in the form of a finger like projection of reduced size. In chicken, duck, goose, turkey, quail and owl the caeca were long cylindrical thin walled

intestinal expansion with rounded apex in duck, goose and quail and very long ampullated sac with rounded end in owl. However in chicken the apex of the right caecum was rounded while that of the longer left one was pointed. The mean absolute value of the caecal length reached about (18cm) in goose, (13cm) in chicken and turkey, (12cm) in quail and that for the left caecum of duck. However the right one was slightly longer (12.5cm); (7cm) in owl; (0.4) cm in sparrow, (0.35cm) in dove (0.3cm) and (0.25cm) for the right caecum of heron and kestrel respectively where the left one is absent and (0.2cm) in pigeon.

The relative value of the weight of the caecum to the total weight of the large intestine was about (39.6%) for the left caecum and (34.7%) for the right one in quail; (34.5%) for both caeca in chicken; (30%) in turkey; (29%) in dove; (19%) in duck; (12.5%) in sparrow; (11.3%) in owl; (10.6%) in goose; (5.1%) in pigeon; (3.4%) in jackdaw; (2.4%) in kestrel and (2.1%) in heron.

The colon was very short and more dilated in case of pigeon, sparrow, jackdaw and kestrel; formed a long tube with the same caliber along its length in chicken, duck, goose, turkey, quail, dove, heron and owl. In hoopoe the colon formed a large sac like dilatation Fig (1,5a-17a, 18).

The relative value of the length of the colon to the total length of the large intestine was about (78%) in goose, (76%) in duck, (70%) in heron, (69%) in chicken, (62%) in pigeon (61%) in sparrow; (57.6%) in quail and hoopoe; (41%) in owl; (33.3%) in kestrel, (31%) in dove, (27.2%) in turkey and its lowest value was (14.3%) in jackdaw Fig (4) and Table (4). On the other hand, the highest relative value of weight of the colon to the total weight of the large intestine was (88.1%) in jackdaw while the lowest one was (7.1%) in quail.

The mean percentage of the length of the rectum to the total length of the large intestine recorded its highest value in jackdaw (85.7%) and its lowest value in goose (21.7%) Fig (4) and Table (4). However the mean percentage of its highest weight was observed in owl (64.5%) and its lowest value in jackdaw (5.1%).

DISCUSSION

The result of the present study was in agreement with that of McClelland (1975), Nickel et al (1977), Strukie (1976), Magnan (1910a, 1911a), Sterenson (1933) and Herpol (1966) who mentioned that the relation between the length of the intestinal tract and that of the body

was influenced by the food habitate as it is very long in herbivores birds followed by grainivores however it is very short in carnivores birds. The results of the present study revealed that, the relation between the weight of the intestinal tract and that of the body passed also in the same direction with that mentioned for the length; however similar of this relation was not discussed before. The present observation revealed that, the relation of the intestinal length to the length of the body cavity ranged between (11.5 times in duck to 3.2 times in hoopoe); this is in agreement with that mentioned by Gadow (1891a) who mentioned that the length of the intestinal tract to the length of the body cavity measured between the first thoracic vertebra and the vent varies from 3 times body length in common swift to more than 20 times in ostrich with average 8.6 times. However, Magnan (1911a) and Herpol (1966) related the length of the intestine to the body weight as they mentioned that the intestinal length equal to $\sqrt[3]{B.\ W.}$ Herpol (1966) observed that an increase of 1%in cubic root was associated with 1.59% increase in length.

The result of the present investigation appeared that the small intestine in the birds under investigation was subdivided morphologically into; duodenum, jejunum and ileum. This was in agreement with that mentioned by Dyce and Sacks (1987) in chicken and turkey as well as Nickel et al (1977) in chicken, duck, goose and pigeon, McClelland (1975) in chicken, Pilz (1937) in birds and Grau (1943a,b)in chicken. On the other hand King and McClelland (1979) mentioned that the small intestine consists of duodenum, jejunum and ileum although none of these organs can be differentiated from each other either grossly or histologically as in man. Bradley (1960) and Strukie (1976) stated that only the first part can be distinguished (duodenum) and there is no demarcation between the jejunum and the ileum; Strukie (1976) mentioned that some other authors referred to that part beyond the duodenum as the upper and lower ileum. However McClelland (1975) mentioned that some authors referred it as jejuno-ileum. The result of the present study revealed that in all examined birds the intestinal tract are much longer than the body cavity consequently the intestine were arranged into different forms, this is in agreement with that described by King and McClelland (1979, 1984) Nickel et al (1977), McClelland (1975) and Gadow (1891a). The latter authors added that the intestine were arranged either in two forms (closed intestinal loop) in which the two limbs of the loops were closely held together by

The present observation recorded that in all examined bird species the duodenum forms a loop consisting of descending and ascending parts; this is in agreement with that mentioned by Bradley (1960), McClelland (1975), Strukic (1976), Nickel et al (1977) as well as King and McClelland (1979, 1984).

The result of the present study revealed that the length of the duodenal loop and its parts as well as the shape and extension varies along the examined birds. The two limbs were equal in sparrow and heron, long ascending limb in kestrel and turkey long descending limb in all other examined birds. Similar results were mentioned by King and McClelland (1979, 1984) who mentioned that in few species the duodenal loop was a compound structure consisting of more than one loop or series of secondary folds. Similar to that of the kestrel where the ascending duodenum was longer, formed festoon shape three short loops. Beddard (1911) mentioned that the duodenum does not form a loop in certain fruit eating pigeon.

The present study was in agreement with that described by McClelland (1975), Nickel et al (1977), King and McCLeland (1979,1984) and Dyce and Sacks (1987) that the jejunum is the longest part of the small intestine and its arrangement showed more variation than any other part of the intestinal tract. King and McClelland (1979, 1984) added that this variation in arrangement does not appear to be related to the diet. However the present study supposed that this arrangement was related to the size of the jejunum and that of the body cavity. The result of the present study indicates that the jejunum of chicken was arranged in festoon shape. This is similar to that described by King and McClelland (1979) who mentioned that the jejunum and ileum are expanded into number of undifferentiated corrugations (open loop). However King and McClelland (1984) described the jejunal coils as a short garland. On the other hand Nickel et al (1977) described the jejunal loops of varying size and form ¾ circle. However, King and McClelland (1979) stated that the jejunal loops of galiform species expanded into a number of undifferentiated corrugation (forms open loop). Beddard (1911) described three types of loops, axial loop, and supraduodenal loop and ansa supracecalis. The present study was in agreement with that of Dyce and Sacks (1987), Nickel et al (1977); that the jejunum of duck was arranged in the form of parallel loops. The numbers of these loops are 7. However Nickel et al (1977) stated that these loops reach 6-8 in number and all are of equal length. The present study described that the jejunum of goose formed 7 loops of variable

length encircling each other which differed completely with that described by Nickel et al (1977); Dyce and Sacks (1987) who described that the jejunum of goose as a parallel loops similar to that of duck. The result of the present study mentioned that the jejunum of the pigeon was arranged in the shape of disc; formed of three centripetal spirals inside three centrifugal ones. However Dyce and Sacks (1987), Nickel et al (1977) stated that the jejunum of pigeon formed cone shape with outer 3-4 centripetal and inner 2-3 centrifugal coils. The result of the present study recorded 83cm for the jejunum of the fowl, 151cm for turkey, 120cm for duck, 138cm for goose and 55cm for pigeon. Bradley (1960) recorded 120cm for chicken, Nickel et al (1977) recorded 105cm, McClelland (1975) recorded 85-120cm. On the other hand, Nickel et al (1977) recorded 60cm for pigeon and 165cm for goose, 105cm for duck. The present study contributed these variations in length to species differences.

The present study was in agreement with that described by Dyce and Sacks (1987), King and McClelland (1984), Nickel et al (1977); McClelland (1975) that the ileum is that part of the small intestine between the two caeca (in birds with long caeca) and containious with the large intestine. However in other birds with short caeca or without caecum. the ileum was demarcated with the supraduodenal flexure. McClelland (1975) recorded 13-18cm for the chicken ileum, however that of the present study was 3cm only.

The present study concluded that the longest duodenum was observed in owl (29.4%) while the shortest one in turkey (10.2%). The heaviest duodenum was observed in owl (51%) and the lowest one in chicken (21%). The longest jejunum was observed in turkey (83.4%) while the shortest one in owl (53%). The heaviest jejunum was observed in chicken (79%) while the lightest one was observed in owl (36.4%). The longest ileum was observed in owl (17.6%) while the shortest one was observed in chicken (2.7%). while the heaviest ileum was observed in quail (24%) while the lightest one was observed in chicken (3.9%).

The result of the present investigation mentioned that there were great differences between the large intestine of birds and that of mammals this is in agreement with that mentioned by all authors mentioned afore. However, Similar to that was described by Bradley (1960) in fowl. The present study found that the large intestine of the birds consisted of two caeca, short single colon and short rectum which open in the cloaca.However, Nickel et al (1977), Dyce and Sacks (1987) mentioned that the large intestine of birds consists of the paired caeca

and the colon. On the other hand King and McClelland (1979, 1984) stated that the large intestine consisted of paired caeca and short straight intestine, which is probably homologous to the mammalian rectum. However, Campana (1873) considered that a colon was absent. Sturkie (1976) mentioned that, the large intestine extends from the caeca to the cloaca and there is no sharp line of demarcation between the rectum and colon as in mammals. McClelland (1975) stated that, the large intestine of chicken consisted of paired caeca and short straight intestine continuous with the ileum and cloaca without giving any terminology. He also mentioned that; although the true homology of this part of the intestine seems still to be uncertain, the term rectum will be used. McClelland (1975) also stated that Mcleod (1939) suggested the terminology Colo-rectum, Romanoff (1960) described it as a colon and rectum as he mentioned that; in birds the portion of the intestine homologous to the mammalian colon is included within the rectum.

The results of the present study reveals that all examined birds had two caeca except in heron and kestrel, which had only one, and hoopoe had no caecum. King and McClelland (1979, 1984) mentioned that in most birds right and left caeci arise from the rectum close to the junction with the ileum; a single caecum is usually described in the Ardeidae, Columbiform and Piciform species and caeca are widely reported to be absent in Psittaciforms, Apodiforms, Kingfisher, the Hoopoe and some Columbidae. Dyce and Sacks (1987) stated that, chicken and turkey had a relatively long caeca, passerine bird and pigeon had very short caeci and psittacines have non. Browne (1922) concluded that in some species (grain eaters) the caeca are large prominent and paired, where as in some species they may be single, rudimentary or absent. However, the results of the present study and that described by King and McClelland (1979) found that the correlation between the length of the caeca and the food habits appears to be very limited. As the caeca tend to be large in herbivores and omnivores (goose and duck) and reduced in grainivores and piscivores (sparrow, pigeon, dove, chicken, turkey and quail) they show wide variation in length in carnivores and insectivores (owl, kestrel and jackdaw).

The present study was in agreement with that mentioned by Dyce and Sacks (1987), King and McClelland (1984), Nickel et al (1977), McClelland (1975), Bradley (1960) that the caecum of chicken is elongated thin wall blind cylindrical tube measured about 13-18cm in length; However Nickel et al (1977) recorded 12-25cm in length, McClelland (1975) recorded 14- 23.5cm. The present study mentioned

that the apex of the left caecum in chicken was pointed while the right one was rounded, McClelland (1975) mentioned that the apex of both coeci are pointed. The present study was in accordance with that described by Dyce and Sacks (1987) in turkey and that of Nickel et al (1977) in duck and goose that the coeci were long tube with rounded apex. The result of the present observation recorded 18cm in length for goose. (12-12.5) Cm in duck, 13cm in turkey. Nickel et al (1977) gave 10-20cm in duck, 22-34cm in goose and 2-7mm in pigeon. On the other hand the present study revealed that in pigeon the caeca reached about 2mm only. However King and McCLellamd (1984) mentioned that the caecum of pigeon was rudimentary. The present study mentioned that the caecum of owl is long cylindrical thin walled expansion as it formed an ampullated sac; this is in agreement with that of King and McCLellamd (1984) who mentioned that the apex of the owl's caecum is enormously expanded. Similar to present results Naik and Dominic (1963, 1969) classified the caeca into 4 main types according to the shape and structure: The first was intestinal type where the caecum resemble the rest of the intestinal tract. (Galliform, gruiform, anseriform, cuculiform species) as that of the present study in chicken, turkey, goose, and duck. The second was glandular type in which the caecum is very long and contains numerous actively secreting units (strigiform species) as that of the owl in the present study; the third was lymphoid type where the caecum was reduced in size (ciconiform, Pelecaniform, falconiform and some columbiform species) similar to that of kestrel and heron in the present study. The last type was Vestigial type where the caecum was extremely small and has a very reduced lumen (columbiforms and passeriforms) as that of pigeon, dove, sparrow and jackdaw in the present study.

The present study was in agreement with that of Bradley (1960) in chicken, Campana (1873), Sturkie (1976), Nickel et al (1977) in fowl, duck and goose and King and McClelland (1979,1984) who stated that there is a single colon in all examined birds. McClelland (1975) suggested that there is no colon in birds. Mcleod (1939) and Romanoff (1960) considered that all the portion of the intestine from the ileum to the cloaca homologous to the mammalian colon is included within the rectum. Mcleod (1939) used the terminology colo-rectum. Dyce and Sacks (1987) in chicken and turkey; considered all this part was colon and open directly in the cloaca. The result of the present study revealed that the colon of hoopoe is more dilated sac. However that of pigeon, sparrow, jackdaw and kestrel represented a very short dilatation

measured about 2.5cm, 1.4cm, 0.5cm and 1cm in length respectively. On the other hand, Nickel et al (1977) recorded 3.4cm for the length of the pigeon's colon. In this respect the present investigation recorded 5.5cm for the length of the colon in chicken, while Dyce and Sacks (1987) recorded 10 cm and Nickel et al (1977) recorded 8-11cm for the length of the colon in the same bird. In duck and goose the length of the colon measured about9.5cm and9cm respectively. In this concern, Nickel et al (1977) recorded 7-12cm for the duck and 16-22cm for the goose.

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LEGENDS FOR FIGURES

Fig (1): Diagram illustrate the form and arrangement of the intestinal tract in the examined bird species: 1-Chicken 2-Duck 3-Goose 4-Turkey 5-Pigeon 6-Dove 7-Quail 8-Sparrow 9-Heron 10-Jackdaw 11-Hoopoe 12- Kestrel 13-Owl.

Fig (2): A histogram showing the relation between the relative value of the length of the small and large intestine to the total length of the intestinal tract in examined birds.

Fig (2a): A histogram showing the relation between the relative value of the weight of the small and large intestine to the total weight of the intestinal tract in examined birds.

Fig (3): A histogram showing the relation between the relative value of the length of the duodenum, jejunum and ileum to the total length of the small intestine in examined birds.

Fig (3a): A histogram showing the relation between the relative value of the weight of the duodenum, jejunum and ileum to the total length of the small intestine in examined birds.

Fig (4): A histogram showing the relation between the relative value of the length of the colon and rectum to the total length of the large intestine in examined birds.

Fig (4a): A histogram showing the relation between the relative value of the weight of the colon and rectum to the total weight of the large intestine in examined birds.

Fig (5-17): A photograph showing the topography of the intestinal tract within the body cavity in the examined birds.

Fig (5a-17a): A photograph showing the different parts of the intestinal tract in examined birds.1-Duodenal loop [a- Ascending part b- Descending part] 2- Jejunum 3- Ileum 4-Caeca 5-Colon 6-Rectum 7-Cloaca S-Stomach L- Liver H- Heart.

Fig (18): Diagram illustrates the form of the caeca in different examined birds.

Table (1):Showing the mean absolute value of the total length of the body, body, Cavity, intestine, as well as intestine /total body and intestine /Body cavity ratio .

Bird	Total body length(TBL) (cm)	Body cavity length(BCL) (cm)	Intestinal length(cm)	Intestinal /TBLratio	Intestinal /TBLratio
Chicken	45	19	117.5	2.61:1	6.18:1
Duck	52	15.5	178.5	3.43:1	11.52:1
Goose	57	26	205.5	3.57:1	7.90:1
Turkey	67.5	18	190.0	2.8:1	10.55:1
Pigeon	29.5	12	75.0	2.54:1	6.25:1
Dove	20.5	9	36.9	1.8:1	4.1:1
Quail	21.5	8	71.0	3.3:1	8.88:1
Sparrow	13	5	16.4	1.26:1	3.28:1
Heron	50.5	12.5	54.0	1.06:1	4.32:1
Jackdaw	47.5	12	61.5	1.29:1	5.13:1
Hoopoe	22.5	5.7	18.0	0.8:1	3.16:1
Kestrel	17.5	9	45.5	2.6:1	5.06:1
Owl	26.5	13	56.4	2.13:1	4.34:1

Table (1a): Showing the mean absolute value of the total weight of the body, intestine as well as intestine / total body ratio .

Bird	Body weight (gm)	Intestine weight (gm)	Intestinal / body
Chicken	1200	54.8	0.045:1
Duck	1375	70	0.05:1
Goose	1500	153	0.10:1
Turkey	2588	43.16	0.017:1
Pigeon	335	14.53	0.043:1
Dove	175	3.19	0.018:1
Quail	187.5	17.7	0.094:1
Sparrow	22.5	1.09	0.048:1
Heron	275	5.33	0.019:1
Jackdaw	275	10.7	0.039:1
Hoopoe	85	.0.95	0.011:1
Kestrel	89.5	2.3	0.026:1
Owl	950	22.9	0.024:1

Table (2) Showing the relation between the relative value of the length of small and large intestine to the total intestinal length in examined birds.

	Large intestine		Small intestine	
Bird	%	SD	%	SD
Chicken	6.8	± 0.16	93.2	± 0.14
Duck	7.0	± 0.07	93.0	± 0.11
Goose	5.6	± 0.09	94.4	± 0.16
Turkey	4.7	± 0.14	95.3	± 0.33
Pigeon	5.3	± 0.22	94.7	± 0.21
Dove	3.5	± 0.19	96.5	± 0.16
Quail	9.9	± 0.16	90.1	± 0.09
Sparrow	14.0	± 0.19	86.0	± 0.30
Heron	9.3	± 0 .23	90.7	± 0.26
Jackdaw	5.7	± 0.28	94.3	± 0.31
Hoopoe	18.3	± 0.09	81.7	± 0.16
Kestrel	6.6	± 0.06	93.4	± 0.29
Owl	9.6	± 0.15	90.4	± 0.13

Table (2 a) : Showing the relation between the relative value of the weight of the small and large intestine to the total intestinal weight in examined birds .

	Large intestine		Small intestine	
Bird	%	SD	%	SD
Chicken	15.3	± 0.14	84.7	± 0.40
Duck	16.4	± 0.11	83.6	± 0.23
Goose	15.4	± 0.21	84.6	± 0.28
Turkey	24.0	± 0.31	76.02	± 0.15
Pigeon	8.12	± 0.19	91.9	± 0.36
Dove	5.3	± 0.16	94.6	± 0.21
Quail	25.4	± 0.18	74.7	± 0.29
Sparrow	14.7	± 0.11	85.3	± 0.13
Heron	18.2	± 0.05	91.8	± 0.21
Jackdaw	11.03	± 0.16	88.9	± 0.26
Hoopoe	28.4	± 0.21	71.6	± 0.29
Kestrel	17.4	± 0.15	82.6	± 0.18
Owl	61.6	± 0.21	38.4	± 0.07

Table (3): Showing the relation between the relative value of the length of the duodenum, Jejunum and ileum to the total length of small intestine in examined birds

	Duodenum		Jejunum		Ileum	
Bird	%	SD	%	SD	%	SD
Chicken	21.5	± 0.13	75.8	± 0.03	2.7	± 0.32
Duck	18.1	± 0.09	72.3	± 0.13	9.6	± 0.11
Goose	18.6	± 0.19	71.1	± 0.22	10.3	± 0.21
Turkey	10.2	± 0.12	83.4	± 0.35	6.4	± 0.07
Pigeon	18.3	± 0.11	77.5	± 0.18	4.2	± 0.06
Dove	19.7	± 0.01	78.7	± 0.31	16.9	± 0.15
Quail	20.3	± 0.09	67.2	± 0.02	12.5	± 0.33
Sparrow	24.1	± 0.23	70.9	± 0.03	5.0	± 0.21
Heron	22.5	± 0.15	69.4	± 0.12	8.2	± 0.15
Jackdaw	22.4	± 0.03	70.7	± 0.14	6.9	± 0.07
Hoopoe	27.2	± 0.07	68.0	± 0.31	4.8	± 0.31
Kestrel	22.4	± 0.06	68.2	± 0.20	9.4	± 0.16
Owl	29.4	± 0.12	53.0	± 0.16	17.6	± 0.11

Table (3 a): Showing the relation between the relative value of weight of the duodenum, jejunum and ileum to the total weight of small intestine in examined birds .

	Duodenum		Jejunum		Ileum	
Bird	%	SD	%	SD	%	SD
Chicken	21.1	± 0.07	75	± 0.11	3.9	± 0.05
Duck	23.6	± 0.11	65.6	± 0.19	10.8	± 0.09
Goose	22.2	± 0.21	69.5	± 0.27	8.5	± 0.12
Turkey	34.8	± 0.16	56.9	± 0.06	8.3	± 0.24
Pigeon	31.2	± 0.21	44.7	± 0.09	24.0	± 0.08
Dove	31.8	± 0.09	64.2	± 0.15	4.0	± 0.14
Quail	26.5	± 0.04	56.3	± 0.31	17.4	± 0.06
Sparrow	36.6	± 0.15	50.5	± 0.18	12.9	± 0.07
Heron	43.1	± 0.23	45.5	± 0.09	11.5	± 0.18
Jackdaw	32.5	± 0.18	53.9	± 0.11	13.7	± 0.21
Hoopoe	42.6	± 0.21	51.5	± 0.14	5.9	± 0.14
Kestrel	35.1	± 0.11	52.1	± 0.11	12.8	± 0.11
Owl	51.1	± 0.19	36.4	± 0.13	12.5	± 0.08

Table ('3): Showing the relation between the relative value of the length of the duodenal parts to the total length of the duodenum in examined birds.

Bird	Descending duodenum		Ascending duodenum	
	%	SD	%	SD
Chicken	46.8	±1.02	53.2	±1.02
Duck	46.7	± 0.9	53.3	±1.01
Goose	48.1	±1.0	52.8	±1.07
Turkey	51.4	±1.01	48.6	±0.99
Pigeon	46.2	±0.84	53.9	±0.85
Dove	42.9	±0.97	57.1	±0.94
Quail	46.2	±0.99	53.9	±0.68
Sparrow	50.0	±1.29	50.0	±1.06
Heron	50.0	±1.04	50.0	±1.04
Jackdaw	46.2	±1.06	53.9	±1.00
Hoopoe	42.5	±0.89	57.5	±0.99
Kestrel	36.8	±1.01	63.2	±0.91
Owl	53.3	±0.98	46.7	±0.98

Table ('3): Showing the relation between the relative value of the length of the jejunal parts to the total length of the jejunum in examined birds.

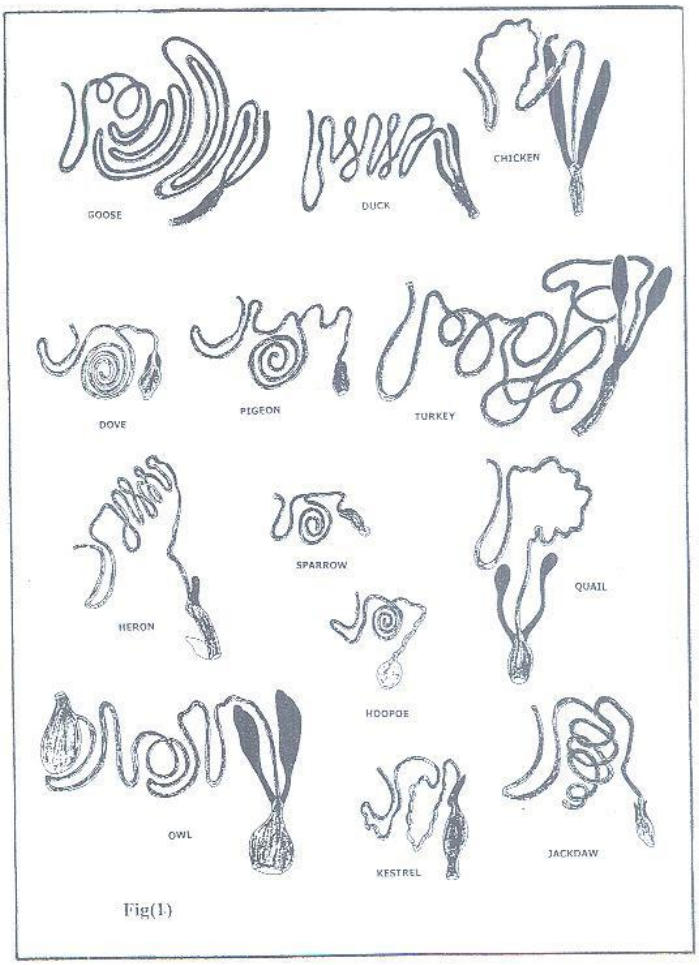
Bird	Centripetal		Centrofuga		Loop1		Loop2	
	%	SD	%	S	%	SD	%	SD
Chicken	----------		----------		----------		----------	
Duck	----------		----------		----------		----------	
Goose	----------		----------		----------		----------	
Turkey	----------		----------		----------		----------	
Pigeon	40	±1.02	21.8	±0.98	----------		----------	
Dove	42.9	±0.99	57.1	±1.05	----------		----------	
Quail	----------		----------		----------		----------	
Sparrow	35	±0.87	65	±1.0	----------		----------	
Heron	----------		----------		----------		----------	
Jackdaw	53.7	±0.91	21.9	±1.14	----------		----------	
Hoopoe	----------		----------		----------		----------	
Kestrel	----------		----------		----------		----------	
Owl	16.7	±1.04	24.1	±0.68	27.8	±1.04	31.5	±1.02

Table (4) : Showing the relation between the relative value of the length of The colon and rectum to the total length of the large intestine in examined birds.

Bird	Colon		Rectum	
	%	SD	%	SD
Chicken	68.7	± 0.18	31.3	± 0.07
Duck	76.0	± 0.26	24.0	± 0.06
Goose	78.3	± 0.03	21.7	± 0.02
Turkey	72.2	± 0.11	27.8	± 0.14
Pigeon	62.5	± 0.09	37.5	± 0.13
Dove	30.8	± 0.31	69.2	± 0.25
Quail	57.1	± 0.22	42.9	± 0.11
Sparrow	60.9	± 0.16	39.1	± 0.31
Heron	70.0	± 0.21	30.0	± 0.26
Jackdaw	14.3	± 0.18	85.7	± 0.15
Hoopoe	57.6	± 0.14	42.4	± 0.22
Kestrel	33.3	± 0.32	66.7	± 0.16
Owl	40.7	± 0.09	59.3	± 0.03

Table (4a) : Showing the relation between the relative value of the weight of the colon and rectum to the total weight of the large intestine in examined birds.

Bird	Colon		Rectum	
	%	SD	%	SD
Chicken	16.1	± 0.07	14.9	± 0.05
Duck	45.2	± 0.11	16.5	± 0.09
Goose	38.3	± 0.09	19.1	± 0.16
Turkey	21.4	± 0.17	18.5	± 0.14
Pigeon	62.7	± 0.19	27.1	± 0.07
Dove	29.4	± 0.21	11.8	± 0.08
Quail	7.1	± 0.08	18.4	± 0.13
Sparrow	25.0	± 0.30	50.0	± 0.16
Heron	85.6	± 0.21	12.4	± 0.22
Jackdaw	88.1	± 0.18	5.1	± 0.11
Hoopoe	70.4	± 0.07	29.6	± 0.09
Kestrel	83.0	± 0.23	14.6	± 0.13
Owl	12.8	± 0.18	64.5	± 0.06


GOOSE
DUCK
CHICKEN
DOVE
PIGEON
TURKEY
SPARROW
HERON
QUAIL
HOOPOE
OWL
KESTREL
JACKDAW

Fig(1)

Fig (2) : Histogram showing the relation between the relative value of the length of small and large intestine to the total length of the intestinal tract in examined birds

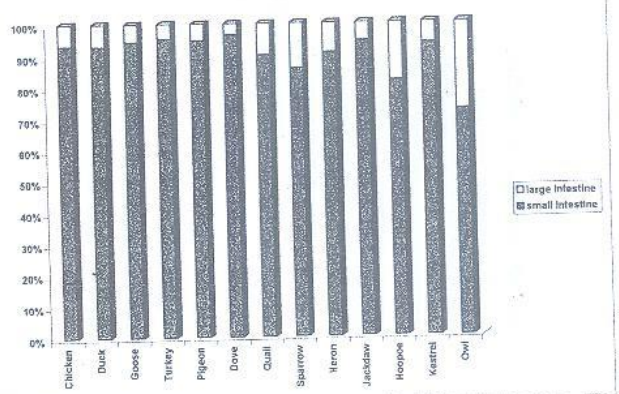


Fig (2a) :Histogram showing the relation between the relative value of the weight of small and large intestine to the total weight of the intestinal tract in examined birds

Fig (3): Histogram showing the relation between the relative value of the length of duodenum ,jejunum and ileum to the total length of the small intestine in examined birds

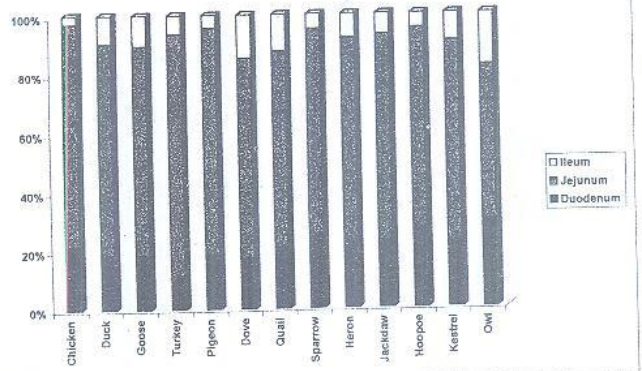


Fig (3a) :Histogram showing the relation between the relative value of the weight of duodenum, jejunum and ileum to the total weight of the small intestine in examined birds

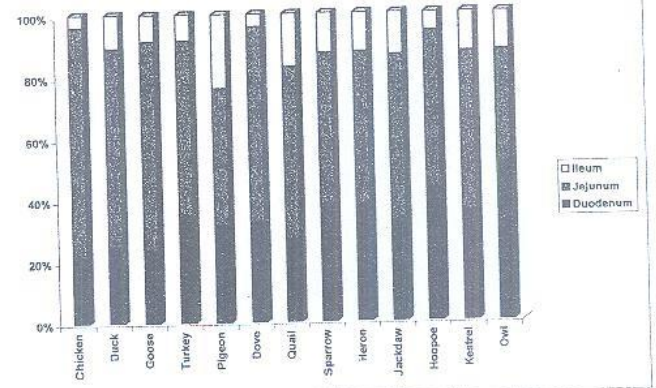


Fig (4) : Histogram showing the relation between the relative value of the length of colon and rectum to the total length of the large intestine in examined birds

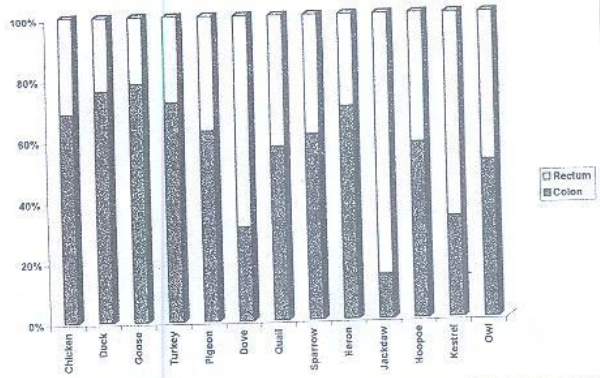
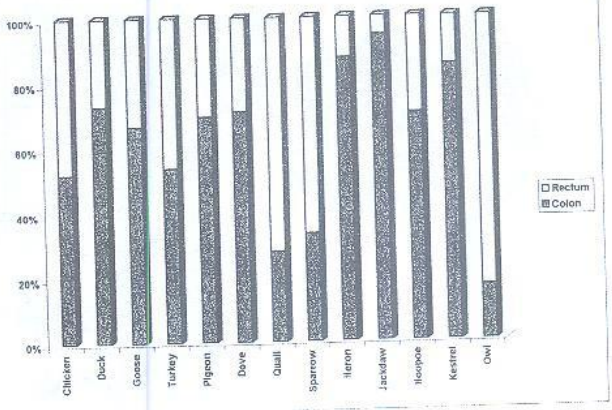
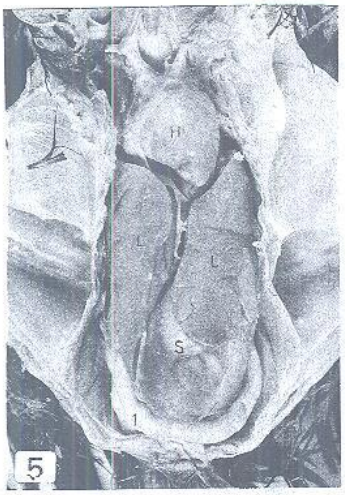


Fig (4a) : Histogram showing the relation between the relative value of the weight of colon and rectum to the total weight of the large intestine in examined birds





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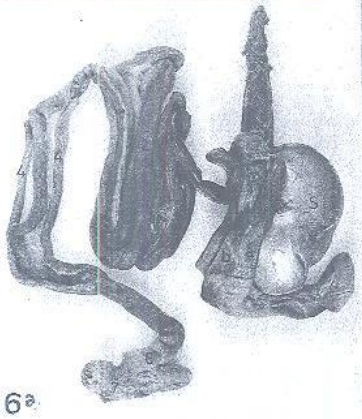

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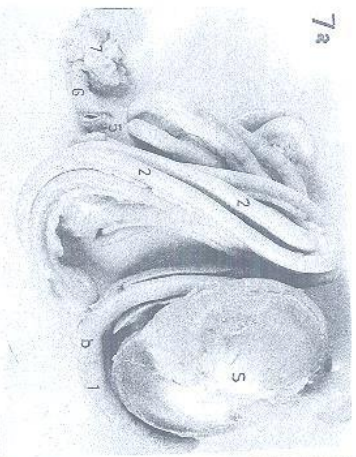

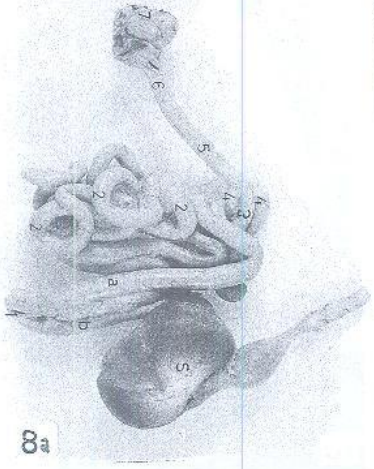

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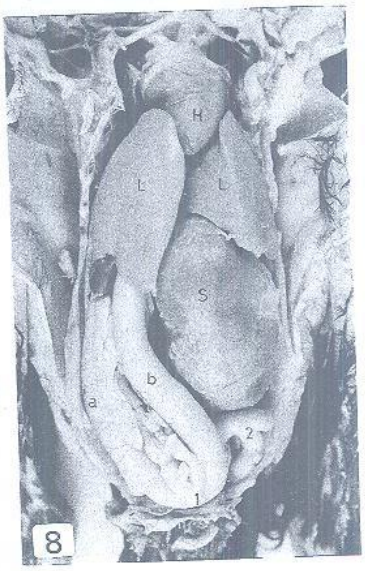

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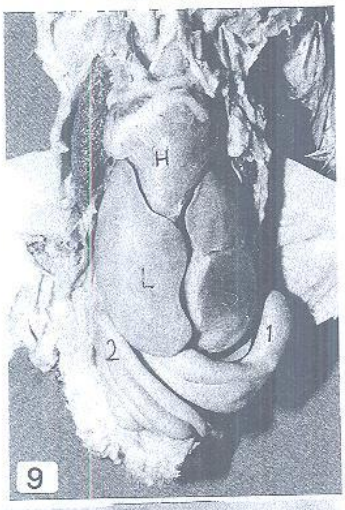

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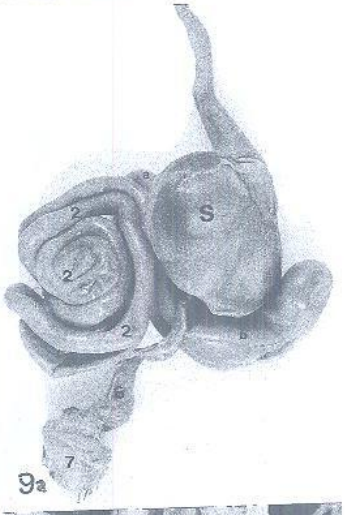

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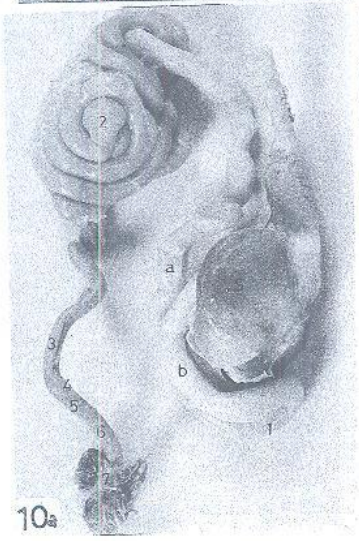

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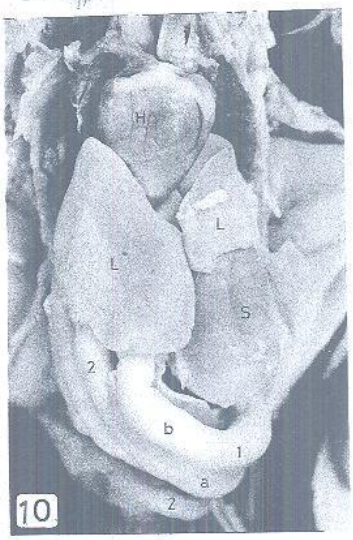

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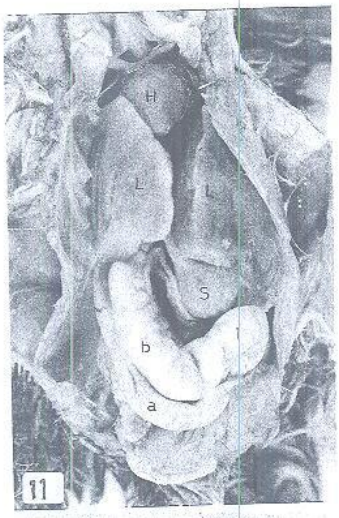

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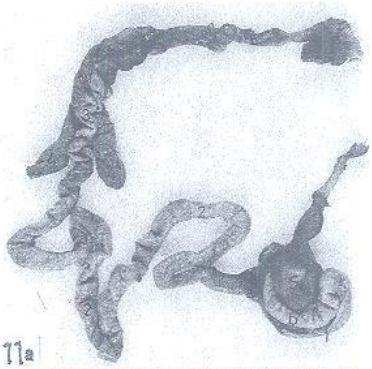

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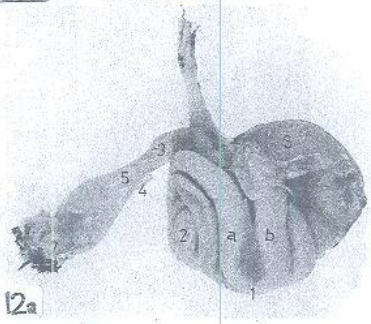

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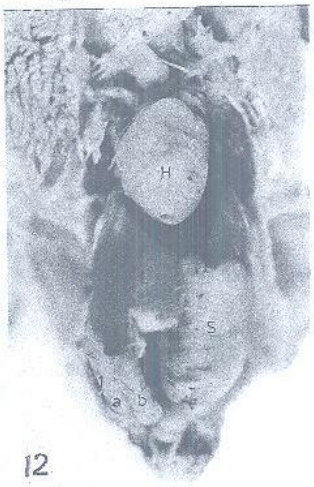

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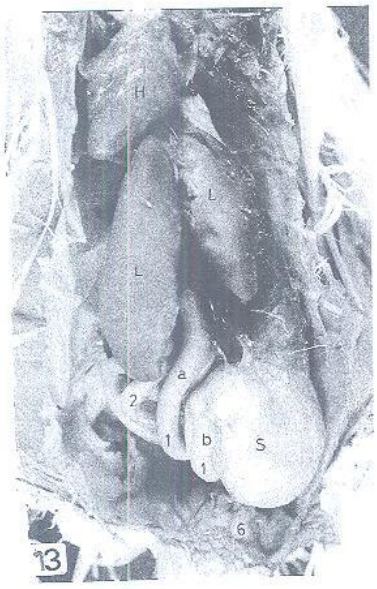

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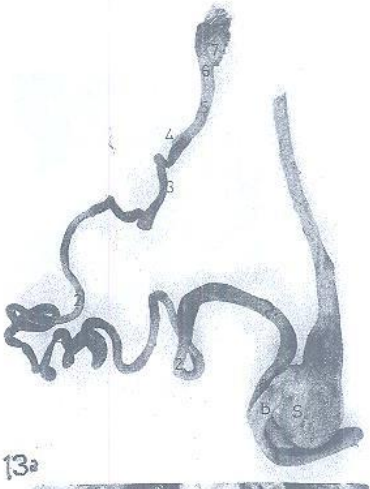

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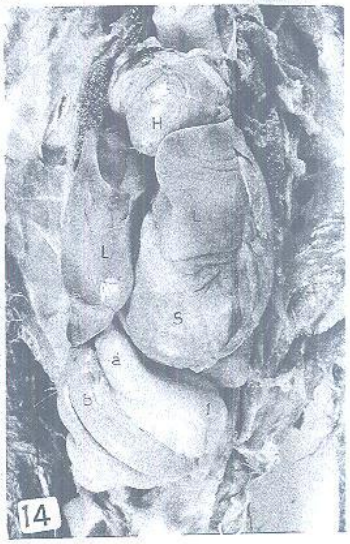

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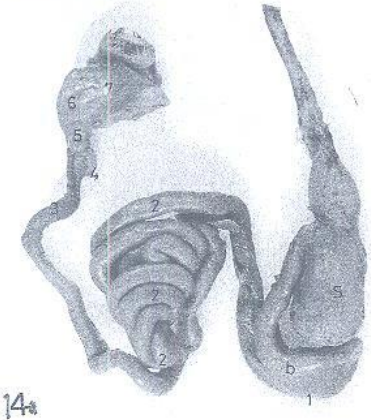

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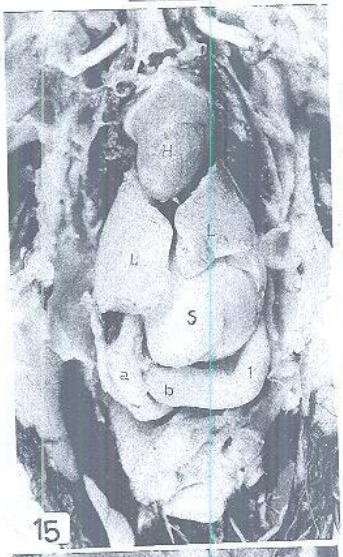

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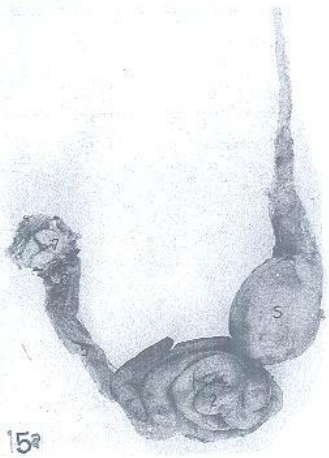

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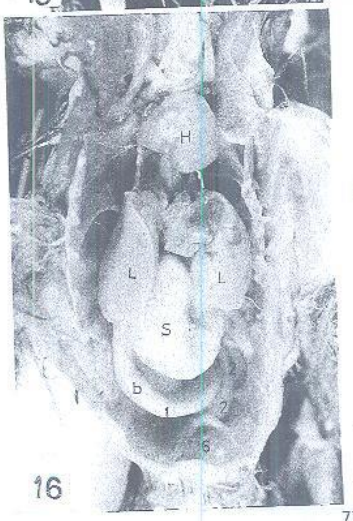

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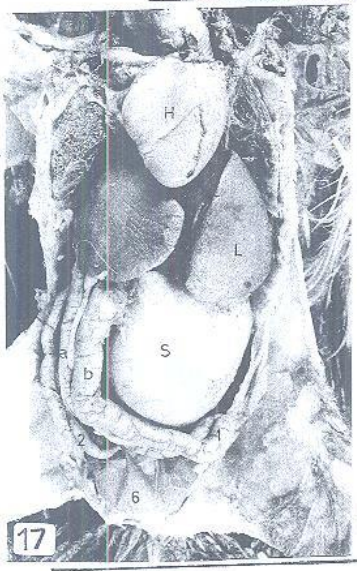
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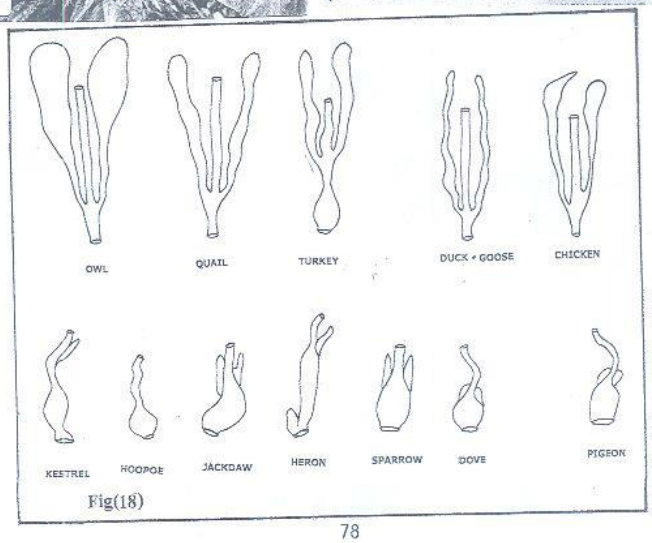
OWL
QUAIL
TURKEY
DUCK + GOOSE
CHICKEN
KESTREL
HOOPOE
JACKDAW
HERON
SPARROW
DOVE
PIGEON

Fig(18)